

# TRAFFIC IMPACT STUDY

## Proposed Orange South Orange Village, Ohio

October 9, 2015

Prepared for:  
Pine Orange, LLC  
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PROPOSED ORANGE SOUTH

ORANGE VILLAGE, OHIO

**OCTOBER 9, 2015**

Prepared For:

PINE ORANGE, LLC  
1138 WEST 9<sup>TH</sup> STREET, 2<sup>ND</sup> FLOOR  
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## **EXECUTIVE SUMMARY**

This Traffic Impact Study (TIS) has been prepared at the request of Pine Orange LLC for the proposed Orange South multi-use development. The project site is bordered by Harvard Road to the north and Interstate 271 to the west in Orange Village, Cuyahoga County, Ohio. **Figure 1, Page 2** shows the proposed location of the development.

The proposed development is expected to consist of restaurants, a hotel, and office space. The full build out analysis of the development will include 20,000 square feet of restaurants, 450,000 square feet of office space, and a 170 room hotel. The development of 320 residential units on the Weintraub site will also be included in the analysis.

The site plan details three phases of development for the site. The first phase will include the 20,000 square feet of restaurants and the 170 room hotel. The second phase will include 250,000 square feet of office space. The third phase or future phase as labeled on the site plan will include the Weintraub residential component and an additional 200,000 square feet of office space.

Development access is proposed via a new roadway that would line up directly across from Orange Place. The proposed roadway would become the south approach of a four-way signalized intersection at Harvard Road and Orange Place. **Figure 2, Page 3** shows the proposed preliminary land use plan for the Orange South development.

The year 2016 will be analyzed as the opening year and include phase 1 generated traffic. The year 2018 will analyzed with the phase 2 portion of the site generated traffic. The year 2036 will be analyzed as the design year for the twenty year analysis and will include the full build out of the site.

The Pinecrest multi-use development is proposed to be built on the north side of Harvard Road. The Pinecrest development has been analyzed in a series of Traffic Impact Studies. The most recent version of the Pinecrest TIS was dated June 24, 2015. This TIS for the proposed Orange South development includes the traffic forecast data and recommendations from the June 24, 2015 Pinecrest TIS.

The study analyzed the following existing intersections located within the study area:

1. Harvard Road & I-271 Southbound Entrance/Exit Ramp
2. Harvard Road & I-271 Northbound Exit Ramp
3. Harvard Road & Orange Place
4. Harvard Road & Brainard Road

The weekday AM peak hour of traffic was determined to be 8:00 AM to 9:00 AM and the weekday PM peak hour of traffic was found to be 5:00 PM to 6:00 PM. These periods will be analyzed since they reflect the period of the highest volume of traffic flow for both the roadway and the development. Current AM and PM peak hour traffic volumes were shown in **Figure 5**.

The proposed development will generate additional traffic which may impact the area roadways. This traffic impact study presents an assessment of the impact of the traffic generated by the proposed development on the existing road network adjacent to the site. The results of the analysis have been used to determine what improvements will be required to handle the traffic which will be associated with this use.

The proposed Orange South development is expected to generate the following average hourly traffic during the AM and PM peak periods in 2016:

ITE TRIP GENERATION RESULTS ORANGE SOUTH MULTI-USE DEVELOPMENT PHASE 1	TRIPS END			
	Peak Hour Between 7-9 AM (Enter/Exit)		Peak Hour Between 4-6 PM (Enter/Exit)	
	167	129	159	117
TOTAL NEW TRIPS	296		276	

The proposed Orange South development is expected to generate the following average hourly traffic during the AM and PM peak under the full build Year 2018 conditions:

ITE TRIP GENERATION RESULTS ORANGE SOUTH MULTI-USE DEVELOPMENT PHASE 1 & 2	TRIPS ENDS			
	Peak Hour Between 7-9 AM (Enter/Exit)		Peak Hour Between 4-6 PM (Enter/Exit)	
	449	109	216	410
TOTAL NEW TRIPS	558		626	

The proposed Orange South development is expected to generate the following average hourly traffic during the AM and PM peak under the full build Year 2036 conditions:

ITE TRIP GENERATION RESULTS ORANGE SOUTH MULTI-USE DEVELOPMENT PHASE 1 & 2 & Future	TRIPS ENDS			
	Peak Hour Between 7-9 AM (Enter/Exit)		Peak Hour Between 4-6 PM (Enter/Exit)	
	651	214	326	612
TOTAL NEW TRIPS	865		938	

### ***Recommended Improvements to Serve Existing Conditions***

No improvements were found to be necessary to accommodate the existing 2015 traffic at the study area intersections.

***Recommend Improvements to Serve Future Conditions without the Development***

No improvements were found to be necessary to accommodate the expected 2016, 2018, and 2036 No Build traffic at the study area intersections.

***Recommended Improvements to Mitigate the Traffic Associated with the Development***

The following lane use and traffic control are recommended at the intersection of Harvard Road and the I-271 Southbound Ramps to accommodate the 2036 site generated (Build) traffic:

- Construct a second southbound left turn lane.

No additional improvements were found to be necessary to accommodate the expected 2016, 2018, 2036 Build traffic at the remaining study area intersections.

***Development Access Recommendations***

The following lane use and traffic control are recommended at the intersection of Harvard Road and Orange Place/Proposed Roadway to accommodate the 2016 and 2018 site generated (Build) traffic:

- Install a westbound left turn lane.
- Construct the proposed northbound approach to consist of a left turn lane and a shared through/right turn lane.
- Upgrade the traffic signal installation to include the proposed northbound approach.

The following lane use and traffic control are recommended at the intersection of Harvard Road and Orange Place/Proposed Roadway to accommodate the 2036 site generated (Build) traffic:

- Install a westbound left turn lane.
- Construct the proposed northbound approach to consist of two left turn lanes and a shared through/right turn lane.
- Upgrade the traffic signal installation to include the proposed northbound approach.

The following improvements are also recommended to improve the operation of the traffic signal control installations at the intersections of Orange Place with Harvard Road and the proposed Pinecrest Site Driveway under all development phases.

- Update the intersection traffic signal timings to ensure the timing and coordination of the two intersections is optimized for the additional traffic generated from the proposed Orange South and Pinecrest developments.

***Conclusions***

The 2036 improvements are based on twenty year predicted traffic volumes determined from historical traffic data and anticipated development generated traffic for the full build out of the Orange South development. It should also be noted that before any improvements can be implemented at the I-271 Southbound Ramps it would also be necessary to prepare an Interchange Modification Study to be reviewed and approved by the Ohio Department of Transportation.



It is our opinion that based on these factors the need for improvements to the I-271 Southbound Ramps and Orange Place should be re-analyzed at a time after the development has reached the Phase 2 level of build out and prior to the full build out of the remaining office space and the residential development.

A secondary access point to the development that would allow vehicles to enter and exit the site without using Harvard Road would likely lessen the likelihood of the recommended improvements at Orange Place and the I-271 Southbound Ramps.

We conclude that the surrounding roadway network can accommodate the future development traffic with the recommended improvements at the study area intersections based upon the results from the analyses in this study.

# **1. INTRODUCTION**

## **1.1 Purpose of Report**

This Traffic Impact Study (TIS) has been prepared at the request of Pine Orange LLC for the proposed Orange South multi-use development. The project site is bordered by Harvard Road to the north and Interstate 271 to the west in Orange Village, Cuyahoga County, Ohio. **Figure 1, Page 2** shows the proposed location of the development.

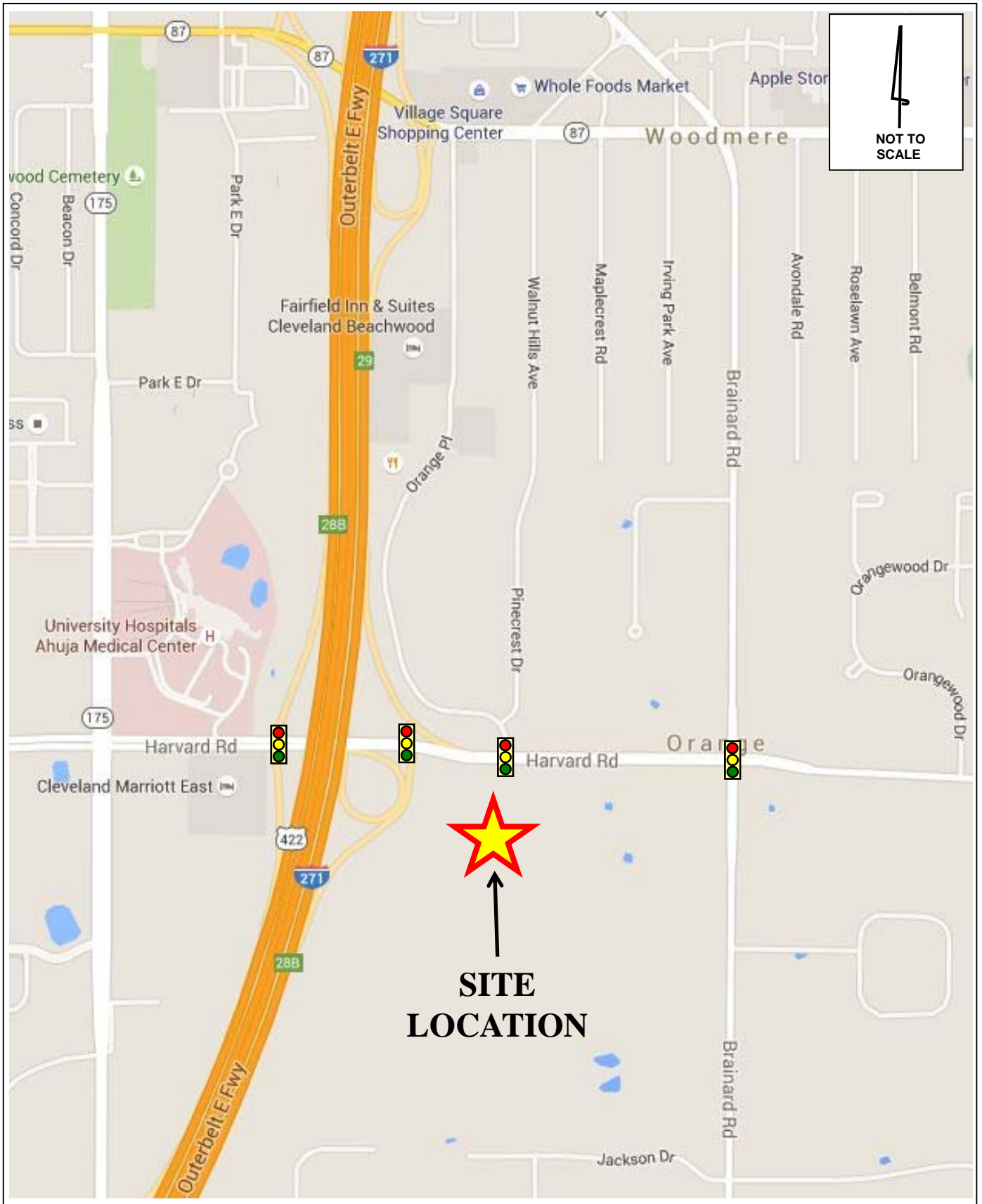
The proposed development is expected to consist of restaurants, a hotel, and office space. The full build out analysis of the development will include 20,000 square feet of restaurants, 450,000 square feet of office space, and a 170 room hotel. The development of 320 residential units on the Weintraub site will also be included in the analysis.

The site plan details three phases of development for the site. The first phase will include the 20,000 square feet of restaurants and the 170 room hotel. The second phase will include 250,000 square feet of office space. The third phase or future phase as labeled on the site plan will include the Weintraub residential component and an additional 200,000 square feet of office space.

Development access is proposed via a new roadway that would line up directly across from Orange Place. The proposed roadway would become the south approach of a four-way signalized intersection at Harvard Road and Orange Place. **Figure 2, Page 3** shows the proposed preliminary land use plan for the Orange South development.

The year 2016 will be analyzed as the opening year and include phase 1 generated traffic. The year 2018 will analyzed with the phase 2 portion of the site generated traffic. The year 2036 will be analyzed as the design year for the twenty year analysis and will include the full build out of the site.

The Pinecrest multi-use development is proposed to be built on the north side of Harvard Road. The Pinecrest development has been analyzed in a series of Traffic Impact Studies. The most recent version of the Pinecrest TIS was dated June 24, 2015. The TIS for the proposed Orange South development will include the traffic forecast data and recommendations from the June 24, 2015 Pinecrest TIS.





## 1.2 *Study Objectives*

This study is structured for the following purposes;

- to adequately assess the traffic impacts associated with the proposed development and to identify the level of off-site access and traffic,
- to provide a comprehensive study which evaluates and documents the traffic impacts and off-site improvements, where warranted,
- and to provide a technically sound basis to identify mitigation requirements to off-site traffic impacts.

This study documents the methodologies, findings and conclusions of the analysis, including the basis for all assumptions, traffic parameters utilized and conclusions reached.

The traffic impacts will be determined by comparing the existing intersection levels-of-service before the construction of the proposed development to the anticipated intersection levels-of-service after the opening of the development. Levels-of-service for the study area intersections and access driveways will be calculated using the computerized version of the Transportation Research Board's **Highway Capacity Manual, HCM2010 (HCS2010, Release 6.70)**.

## **2. AREA CONDITIONS**

### **2.1 Transportation Network Study Area**

The Ohio Department of Transportation functionally classifies roadways to help define a roadway's characteristics as well as identify roadways that are eligible for federal funds. Functional classification is the grouping of roads, streets, and highways in a hierarchy based on the type of highway service they provide. Generally, streets and highways perform two types of service. They provide either traffic mobility or land access and can be ranked in terms of the proportion of service they provide. The functional classification of the roadways in the study area can be seen on ODOT's website at:

<http://www.dot.state.oh.us/Divisions/Planning/SPPM/SystemsPlanning/Pages/RoadwayFunctionalClass.aspx>

**Harvard Road** is primarily a four-lane roadway with an east to west orientation in the study area. It is classified as urban minor arterial roadway according to the Ohio Department of Transportation. The speed limit along Harvard Road is 35 miles per hour in the study area. The land use along Harvard Road is commercial to the west of Orange Place and residential to the east. Harvard Road has an average daily traffic (ADT) of approximately 15,600 vehicles per day at Orange Place based on the 2015 traffic data collected for this study.

**Brainard Road** is a two-lane roadway with a north-south orientation in the study area. It is classified as urban minor arterial roadway according to the Ohio Department of Transportation. The speed limit along Brainard Road is 35 miles per hour in the study area. The land use along Brainard Road is mainly residential. Brainard Road has an average daily traffic (ADT) of approximately 6,600 vehicles per day at Harvard Road based on the 2015 traffic data collected for this study.

**Orange Place** is a two-lane roadway with a north-south orientation in the study area. Orange Place runs between Chagrin Boulevard to the north and Harvard Road to the south. It is classified as urban local roadway. The speed limit along Orange Place is 25 miles per hour in the study area. The land use along Orange Place is mainly commercial. Orange Place has an average daily traffic (ADT) of approximately 6,250 vehicles per day at Harvard Road based on the 2015 traffic data collected for this study.

**Interstate 271** is an urban interstate that runs between Interstate 90 to the north and Interstate 71 to the southwest. I-271 has a mainline average daily traffic (ADT) volume of approximately 155,010 vehicles per day at Harvard Road based on 2013 traffic provided by the Ohio Department of Transportation. The interstate has a full interchange at Harvard Road. The northbound exit ramp from I-271 to Harvard Road has an average daily traffic(ADT) volume of approximately 13,000 vehicles per day based on the 2015 traffic collected for this study. The southbound exit ramp from I-271 to Harvard Road has an average daily traffic(ADT) volume of approximately 7,100 vehicles per day based on the 2015 traffic collected for this study. The southbound entrance ramp from Harvard Road to I-271 has an average daily traffic(ADT) volume of approximately 9,600 vehicles per day based on the 2015 traffic collected for this study.

The following intersections in the study area are controlled by traffic signals:

1. Harvard Road & I-271 Southbound Entrance/Exit Ramp
2. Harvard Road & I-271 Northbound Exit Ramp
3. Harvard Road & Orange Place
4. Harvard Road & Brainard Road

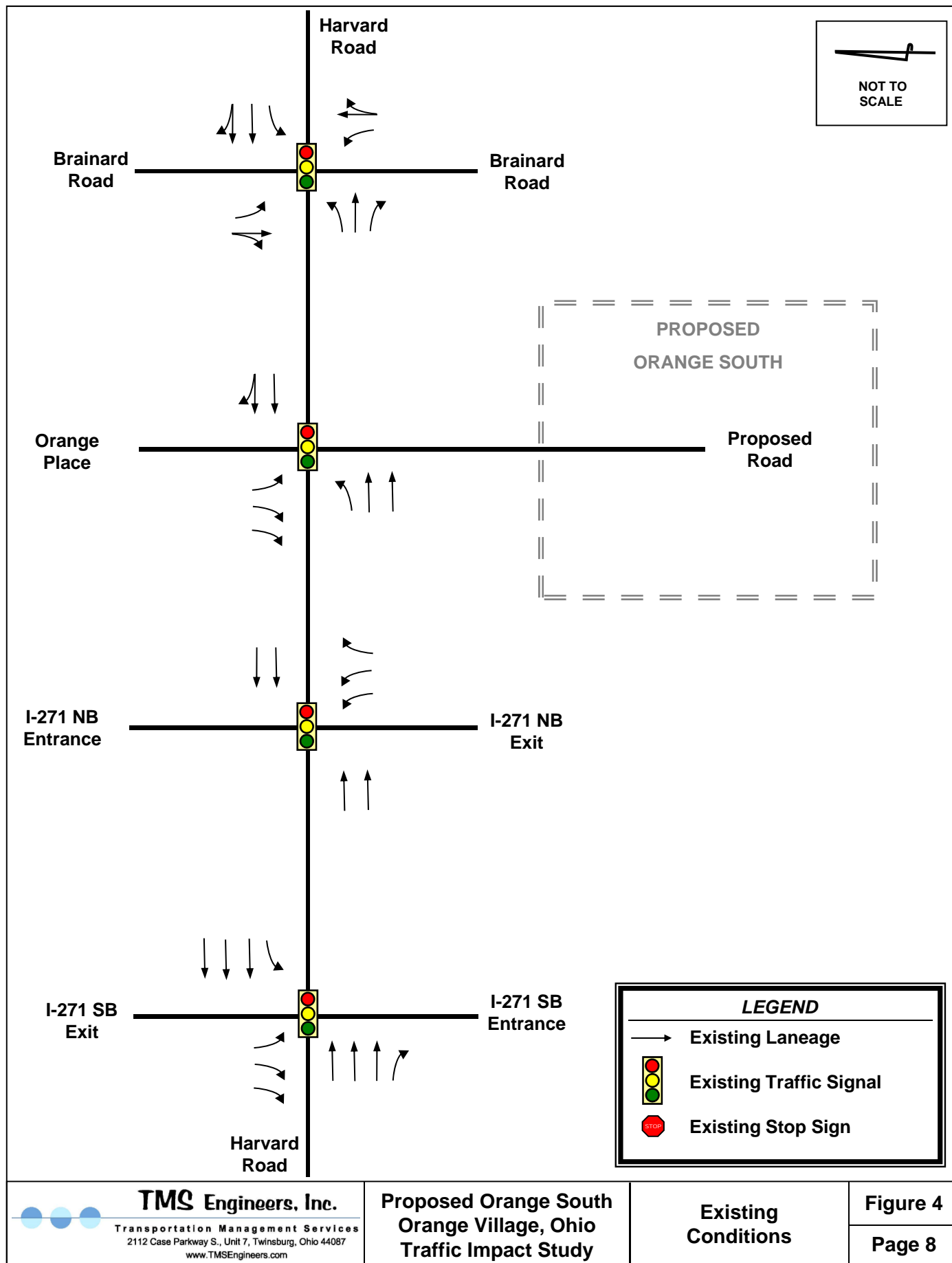
There are exclusive left turn lanes along Harvard Road at the study area intersections.

**Figure 3, Page 7** shows an aerial view of the existing conditions in the study area. **Figure 4, Page 8** shows the lane use and traffic control conditions based upon the existing conditions in the study area.









## **2.2 Traffic**

Weekday nine hour turning movement counts were performed at the following ten intersections within the study area:

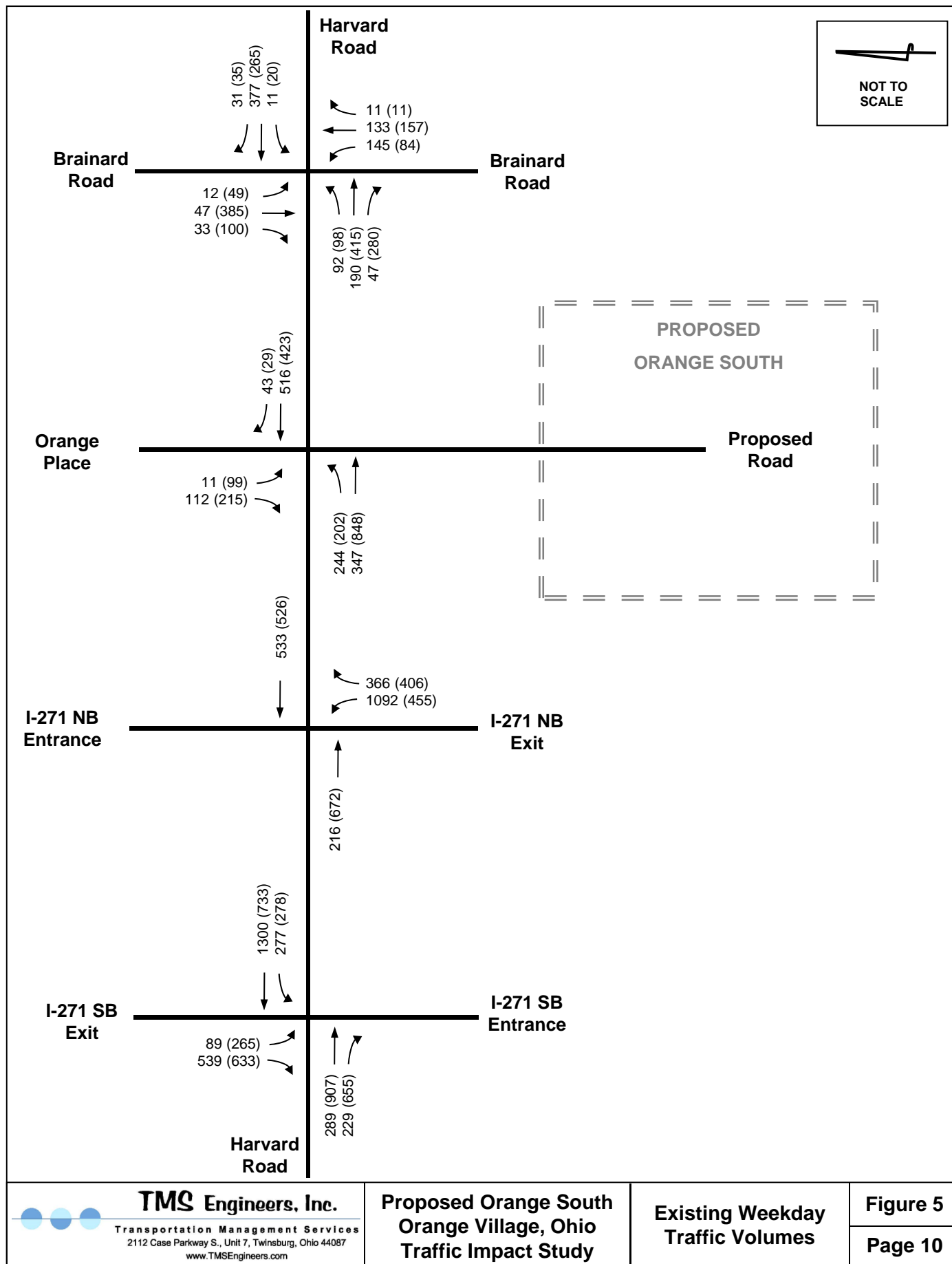
1. Harvard Road & I-271 Southbound Entrance/Exit Ramp
2. Harvard Road & I-271 Northbound Exit Ramp
3. Harvard Road & Orange Place
4. Harvard Road & Brainard Road

The traffic counts were performed on Tuesday, August 8, 2015. The weekday traffic counts were conducted in fifteen (15) minute intervals between the hours of 7 AM - 10 AM, 11 AM - 2 PM, and 3 PM - 6 PM, then hourly totals were calculated. Copies of the intersection turn movement counts are included in **Appendix A**.

Average daily traffic was calculated for each of the area roadways using expansion factors to account for daily and seasonal variations according to the recommendations and latest data from the Ohio Department of Transportation.

From the data, the weekday AM peak hour of traffic was determined to be 8:00 AM to 9:00 AM and the weekday PM peak hour of traffic was found to be 5:00 PM to 6:00 PM. These periods will be analyzed since they reflect the period of the highest volume of traffic flow for both the roadway and the proposed development. It will provide a worst case scenario for future traffic. It should be noted that the same peak hours were analyzed in the Pinecrest TIS.

The 2015 existing AM and PM peak hour traffic volumes can be seen in **Figure 5, Page 10**.



### 3. PROJECTED TRAFFIC CONDITIONS

#### 3.1 Site Traffic

##### Trip Generation

Calculating future total driveway trips requires an estimate of the traffic generated by the proposed development. The most widely accepted method of determining the amount of traffic that a proposed development will generate is to compare the proposed site with existing facilities of the same use. The Institute of Transportation Engineers (ITE) has prepared a manual titled “**Trip Generation Manual**”, which is a compilation of hundreds of similar traffic generation studies to aide in making such a comparison. The most recent update of this manual is the 9<sup>TH</sup> edition and was utilized for this study.

The Orange South development is a mixed used commercial development with restaurants, a hotel, and office space. The development of the Weintraub site with residential units will also be analyzed. Trip generation calculations for the development were performed utilizing data contained in the **Trip Generation Manual** and the methods outlined in the (ITE) **Trip Generation Handbook**. Copies of the trip generation worksheets can be found in **Appendix B**.

The Orange South development is anticipated to consist of the following land uses:

	<u>Land Use</u>	<u>Phase</u>	<u>Size</u>
1.	Restaurant	Phase 1	20,000 Square Feet
2.	Hotel	Phase 1	170 Rooms
3.	Office	Phase 2	250,000 Square Feet
4.	Office	Future Phase	200,000 Square Feet
5.	Residential	Future Phase	320 Units

### *Passer-by and Internal Trips*

It should be noted that retail land uses generate a different mixture of traffic than land uses such as residential homes and office facilities, which add all of the “new” traffic to the adjacent roadway system. Retail and service land uses also attract motorists from the existing passing flow of traffic. A portion of the estimated total generated trips are actually vehicles that are currently using the adjacent roadway system (i.e. motorists who are already on the road and stop by the drugstore on the way home from work). These vehicles are referred to as “Passer-by” trips.

The ITE **Trip Generation Handbook, Second Edition** provides pass-by rates for various land uses. The following table details the pass-by rates for the applicable portions of the Orange South development:

LAND USE	ITE CODE	PM PEAK HOUR		
		LOWEST	HIGHEST	AVERAGE
High-Turnover (Sit-Down) Restaurant	932	23%	63%	43%

While some passer-by traffic is expected to occur during the AM peak hour, no percentages have been documented by the **Trip Generation Handbook**. To provide a conservative estimate of future traffic, all peak hour trips will be considered new trips for the purpose of this analysis.

### *Internal Capture*

The proposed Orange South development can be classified as a multi-use development where trips can be made between two on site land uses without using the off-site road system. Because of the nature of these developments, the trip making characteristics are interrelated, and some trips are made among on-site uses. This capture of trips internal to the site has the net effect of reducing vehicle trip generation between the overall development site and the external street system (compared to the total number of trips generated by comparable land uses developed individually on stand-alone sites).

In order to calculate the internally captured trips the methodology used was developed as part of a research project sponsored by the National Cooperative Highway Research Program (NCHRP) entitled **Enhancing Internal Trip Capture Estimation of Mixed-Use Developments**, published as **NCHRP Report 684**. The methodology developed in the NCHRP project enriches the methodology presented in the ITE **Trip Generation Handbook, 2<sup>ND</sup> Edition**.

**NCHRP Report 684** provides a computer spreadsheet tool to assist in preparing the calculations of the internally captured trips. Copies of the internal trip capture calculations using the **NCHRP Report 684** spreadsheet for the opening year and the design year can be seen in **Appendix B**.

The following tables detail the trip generation calculations for each phase of the proposed Orange South development.

## 2016 OPENING YEAR TRIP GENERATION

### Orange South Development - Phase 1

ITE TRIP GENERATION			BUILDING SIZE	TRIP ENDS			
ITE Code	Description			Peak Hour Between 7-9 AM (Enter/Exit)		Peak Hour Between 4-6 PM (Enter/Exit)	
932	High-Turnover (Sit-Down) Restaurant		20,000 Square Feet	119	97	118	78
Internal Trip Reduction		App. B		2	3	6	5
Driveway Volumes Less Internal Trip Reduction				117	94	112	73
310	Hotel		170 Rooms	53	37	52	50
Internal Trip Reduction		App.B		3	2	5	6
Driveway Volumes Less Internal Trip Reduction				50	35	47	44
TOTAL NEW TRIPS				167	129	159	117
				296		276	

## 2018 DESIGN YEAR TRIP GENERATION

### Orange South Development - Phase 2

ITE TRIP GENERATION			BUILDING SIZE	TRIP ENDS			
ITE Code	Description			Peak Hour Between 7-9 AM (Enter/Exit)		Peak Hour Between 4-6 PM (Enter/Exit)	
710	Office		250,000 Square Feet	350	48	61	297
Internal Trip Reduction		App.B		41	27	2	2
Driveway Volumes Less Internal Trip Reduction				309	21	59	295
932	High-Turnover (Sit-Down) Restaurant		20,000 Square Feet	119	97	118	78
Internal Trip Reduction		App. B		30	32	8	7
Driveway Volumes Less Internal Trip Reduction				89	65	110	71
310	Hotel		170 Rooms	53	37	52	50
Internal Trip Reduction		App.B		2	14	5	6
Driveway Volumes Less Internal Trip Reduction				51	23	47	44
TOTAL NEW TRIPS				449	109	216	410
				558		626	

## 2036 DESIGN YEAR TRIP GENERATION

Orange South Development - Future Development

ITE TRIP GENERATION			BUILDING SIZE	TRIP ENDS			
ITE Code	Description			Peak Hour Between 7-9 AM (Enter/Exit)		Peak Hour Between 4-6 PM (Enter/Exit)	
710	Office		450,000 Square Feet	561	76	99	482
Internal Trip Reduction		App.B		49	27	4	6
Driveway Volumes Less Internal Trip Reduction				512	49	95	476
932	High-Turnover (Sit-Down) Restaurant		20,000 Square Feet	119	97	118	78
Internal Trip Reduction		App. B		52	33	19	21
Driveway Volumes Less Internal Trip Reduction				67	64	99	57
310	Hotel		170 Rooms	53	37	52	50
Internal Trip Reduction		App.B		2	20	7	6
Driveway Volumes Less Internal Trip Reduction				51	17	45	44
230	Residential Condominium/Townhouse		320 Units	22	108	105	50
Internal Trip Reduction		App.B		1	24	18	15
Driveway Volumes Less Internal Trip Reduction				21	84	87	35
TOTAL NEW TRIPS				651	214	326	612
				865		938	



## Distribution of Generated Traffic

The directional distribution for the new generated traffic is a function of several variables including size and type of the proposed development, the prevailing operating conditions on the existing roadways, population distribution within the defined area of influence and current land uses. The distribution pattern that was assumed is shown in the table that follows and is based upon engineering judgment of the preceding variables.

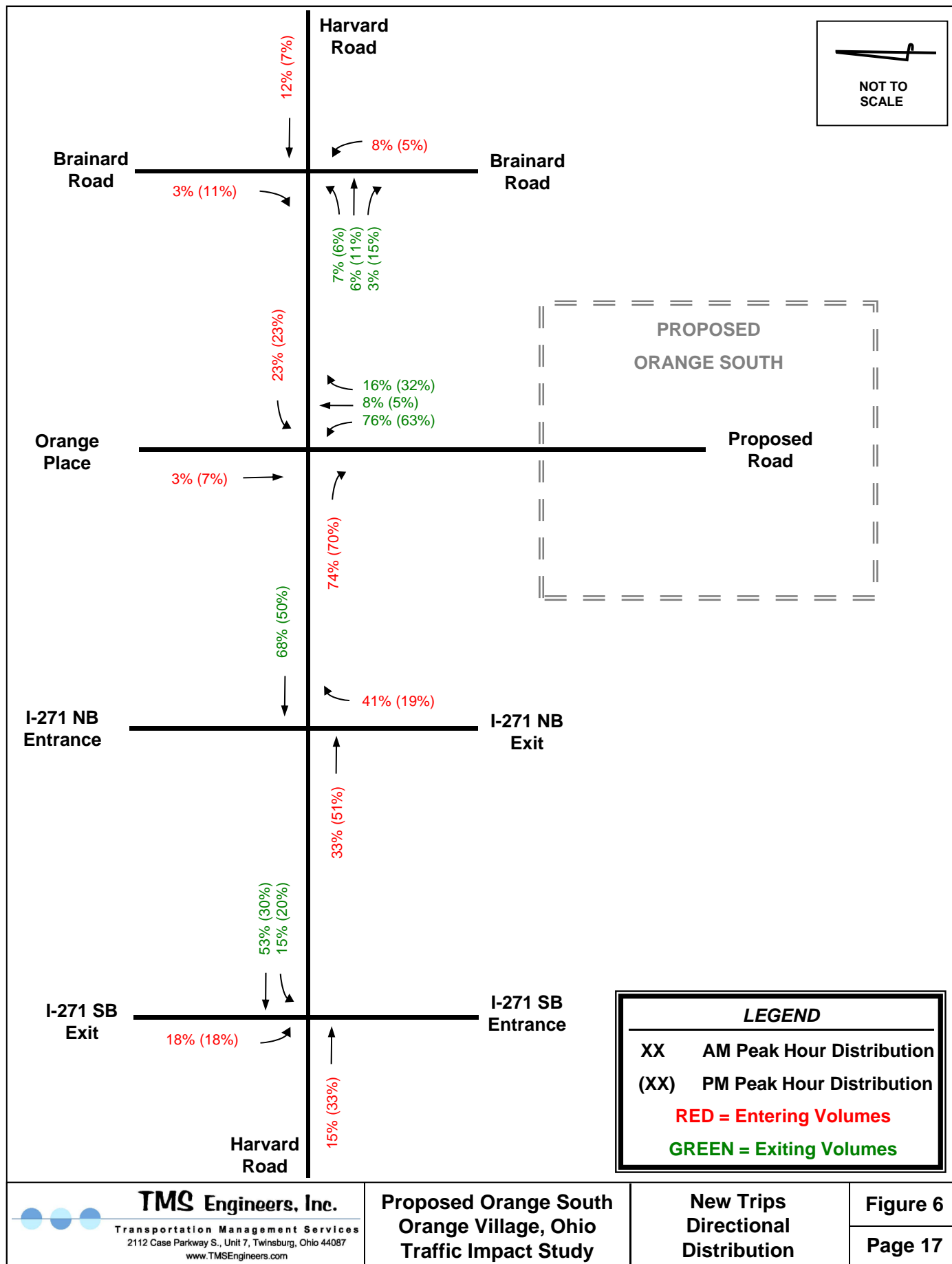
### ORIGIN AND DESTINATION

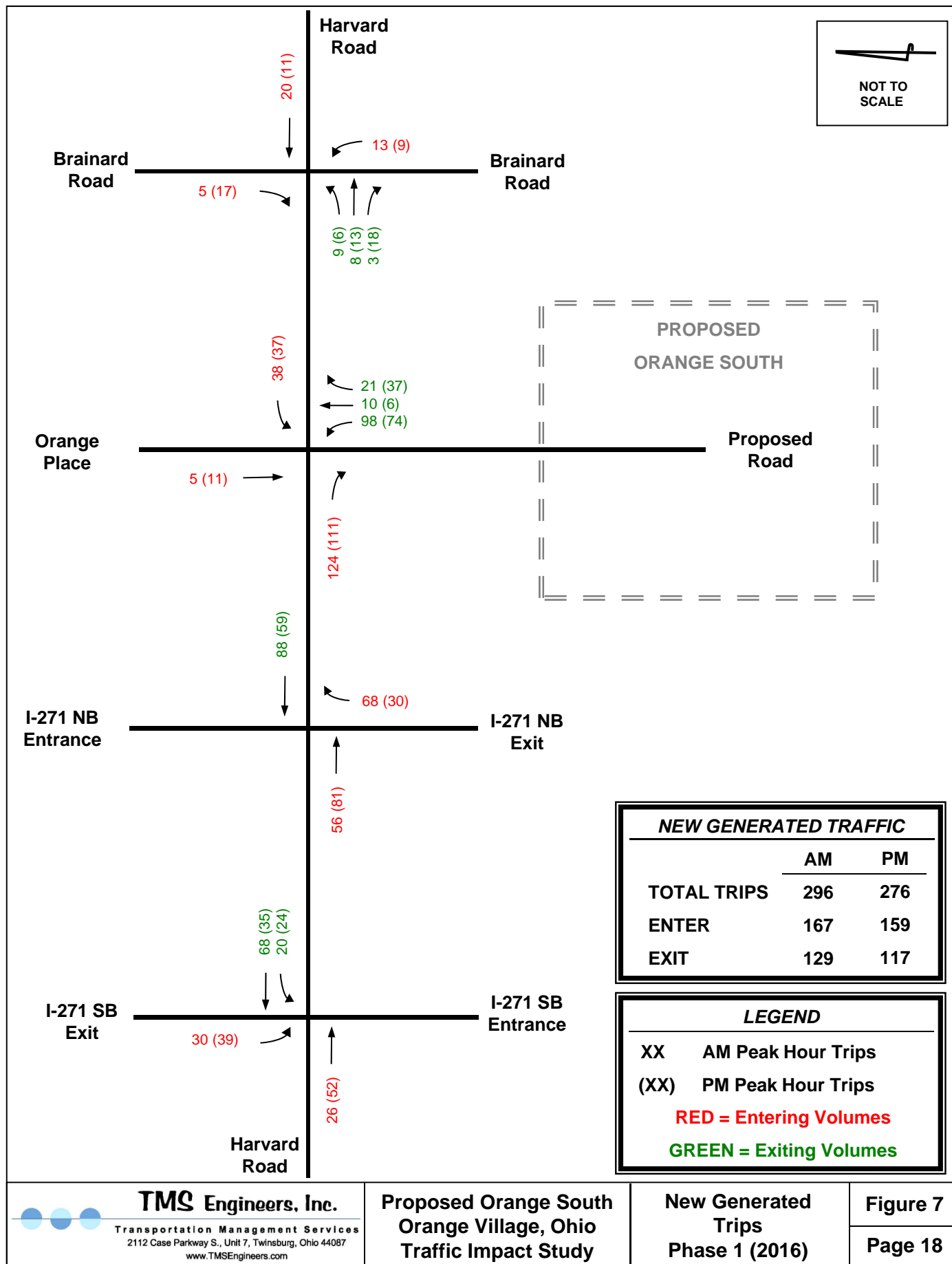
ORIGIN/DESTINATION	AM		PM	
	TO	FROM	TO	FROM
East (Harvard Road)	6%	12%	11%	7%
West (Harvard Road)	53%	15%	30%	33%
I-271 Northbound	8%	41%	13%	19%
I-271 Southbound	15%	18%	20%	18%
North (Orange Place)	8%	3%	5%	7%
North (Brainard Road)	7%	3%	6%	11%
South (Brainard Road)	3%	8%	15%	5%
Total	100%	100%	100%	100%

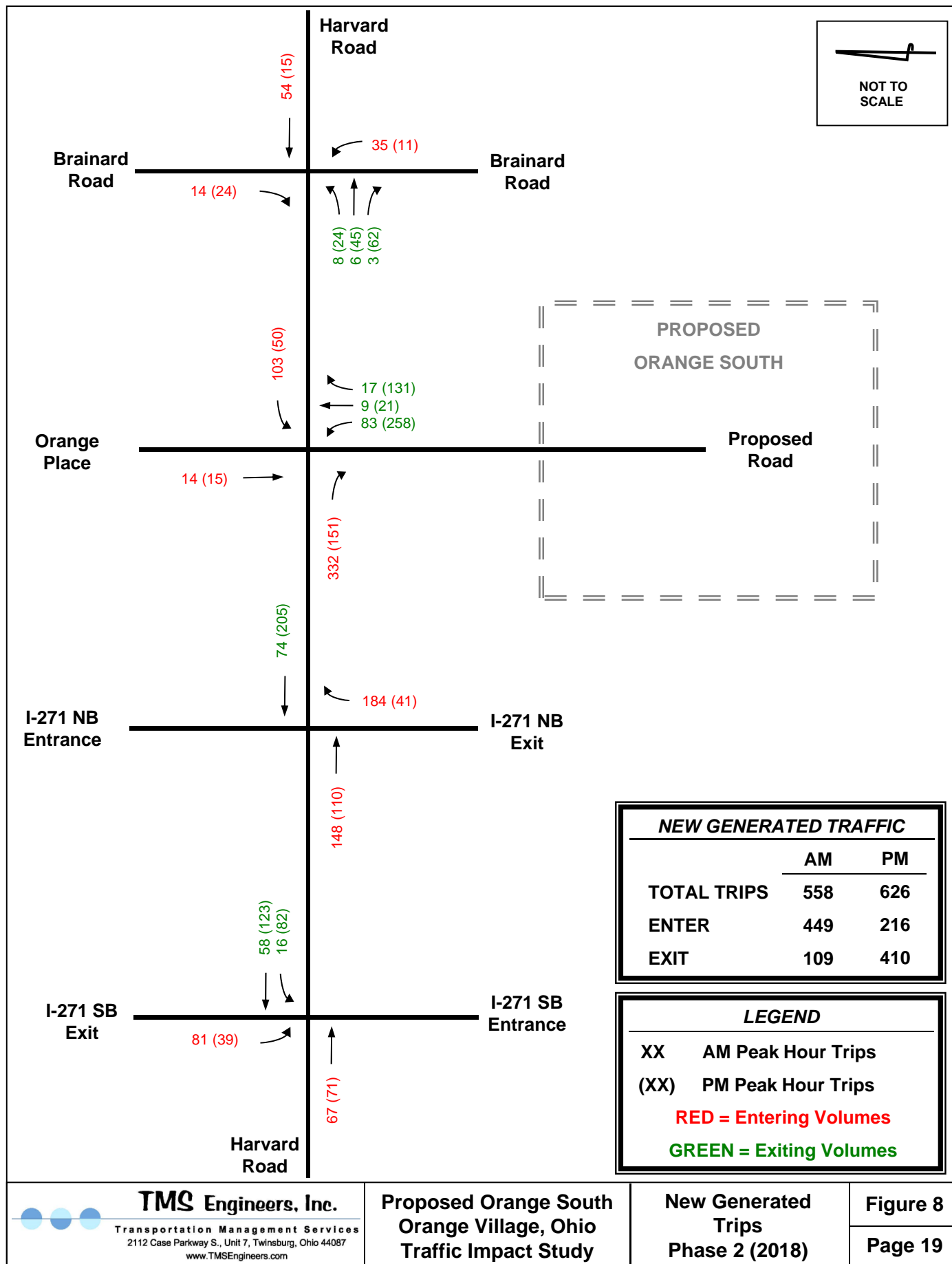
The directional distribution for the new AM and PM peak hour generated traffic volumes are shown graphically in **Figure 6, Page 17** for the proposed development.

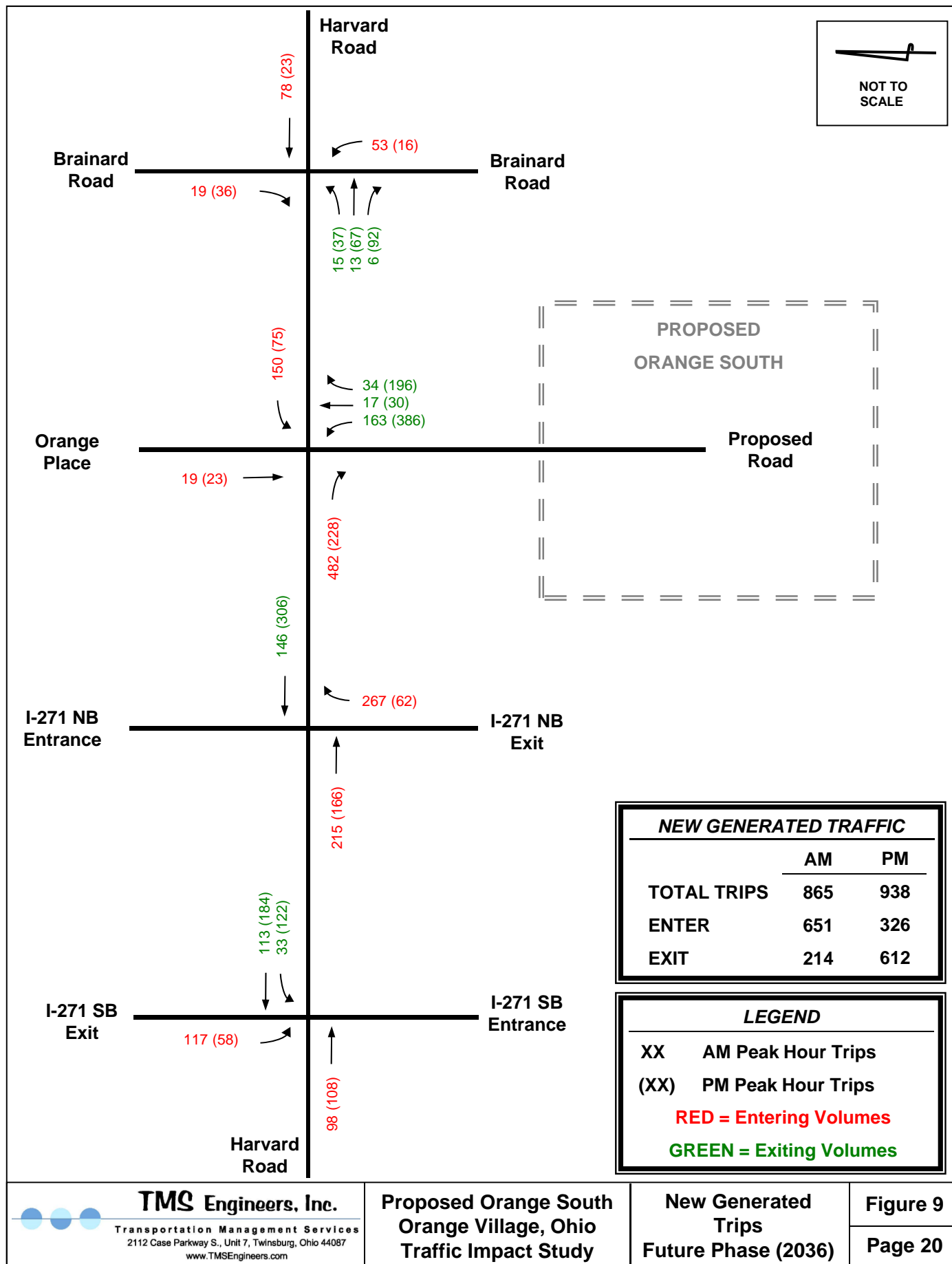
## Assignment of Generated Traffic

Based upon this distribution pattern, the new AM and PM peak hour generated traffic were assigned to the study intersections. The assignments of the estimated new generated traffic for the proposed development are shown graphically **Figure 7, Page 18** for Phase 1, **Figure 8, Page 19** for Phase 2, and **Figure 9, Page 20** for the future development.









### **3.2 Non-Site Traffic**

Design of new roadways or improvements to existing roadways should not usually be based on current traffic volumes alone, but should consider future traffic volumes expected to make use of the facilities. Roadways should be designed to accommodate the traffic volume that is likely to occur within the design life of the facility. In a practical sense, this design volume should be a value that can be estimated with reasonable accuracy. It is believed that the maximum design period is in the range of 15 to 24 years. Therefore, a period of twenty years is widely used as a basis for design. Traffic cannot usually be forecasted accurately beyond this period on a specific facility because of probable changes in the general regional economy, population, and land development along the roadway.

Roadways like I-271, Harvard Road, and Brainard Road carry a significant amount of through traffic due to their functional characteristics. This through traffic component generally increases as regional growth occurs. Therefore it is anticipated that existing traffic on this street will increase in future years and it will be necessary to estimate a historical growth rate in order to establish the future 2016 and 2036 traffic on the study area roadways due to non-site related conditions.

The ODOT traffic count website was consulted to determine past historical trends along state routes in vicinity of the study area. According to the web site, traffic count data was provided in 1980, 1984, 1988, 1992, 2000, 2003, 2007, and 2010. The data can be seen at the following web address:

<http://www.dot.state.oh.us/Divisions/Planning/TechServ/traffic/Pages/Traffic-Count-Reports-and-Maps.aspx>

Based on analysis of the historical data, the characteristics of the roadway due to their functional classifications, and to provide a conservative analysis of the study area a growth rate of 0.25% per year will be used to determine the anticipated study area volumes under the 2016 and 2036 No-Build conditions for I-271, Harvard Road, and Brainard Road. The remaining roadways are classified as local roadways and will not have a growth rate applied. These growth rates were determined based upon the historical trends in the ODOT traffic count data and the traffic count data that was collected for this report. A copy of the growth rate analysis can be seen in **Appendix C**.

### **3.3 Future Traffic**

#### *No-Build Condition*

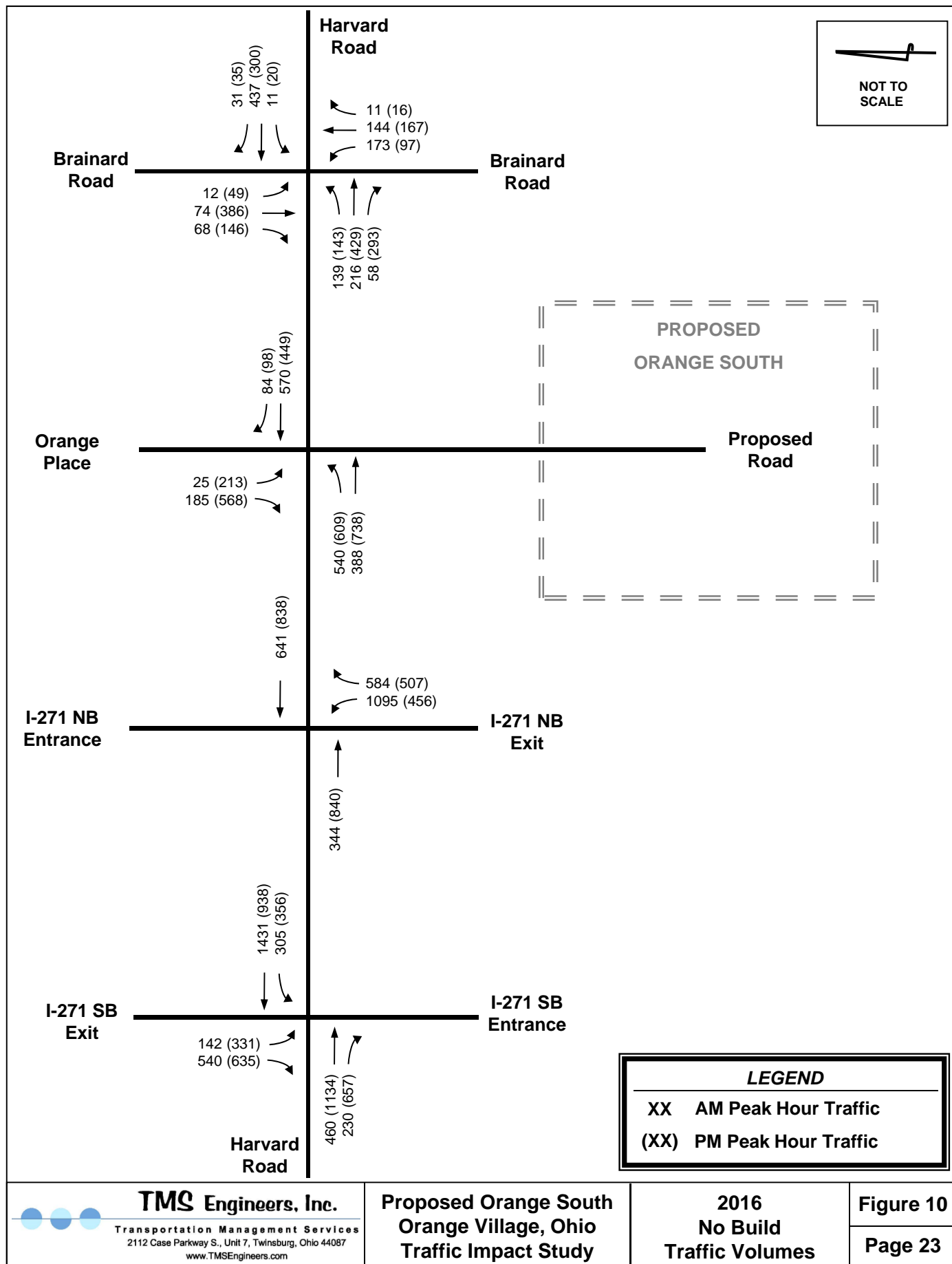
In order to estimate the future traffic considering non-project traffic conditions, the above mentioned historical growth rates were applied to the traffic data collected for this report. It should also be noted that the expected generated traffic volumes for the Pinecrest development are included in the No-Build conditions.

The estimated 2016, 2018, and 2036 No-Build traffic volumes for the study area are shown graphically in **Figures 10 - 12, Pages 23 - 25**. This traffic is the expected traffic if the proposed development **is not** constructed, the “**No-Build**” condition.

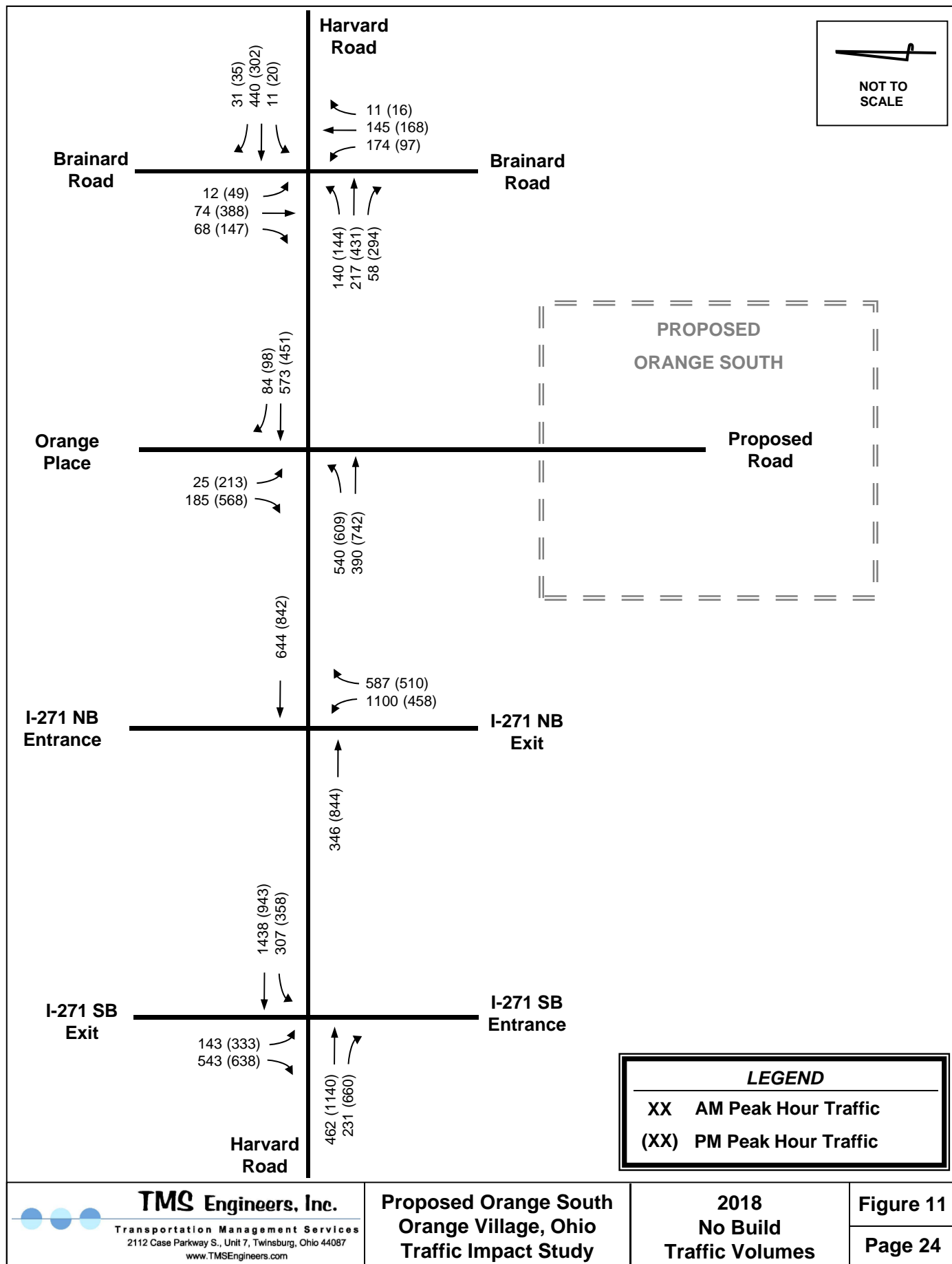
#### *Build Condition*

In order to estimate the future traffic considering project traffic conditions, the sum of the 2016 and 2036 No-Build volumes, shown in the previous figures, were added to the new generated traffic to equal the future Build peak hour volumes.

The estimated 2016, 2018, and 2036 Build traffic volumes for the study area are shown graphically in **Figures 13 - 15, Pages 26 - 28** for each phase of the proposed development. These traffic volumes are the expected volumes if the proposed development **is** constructed, or the “**Build**” condition.







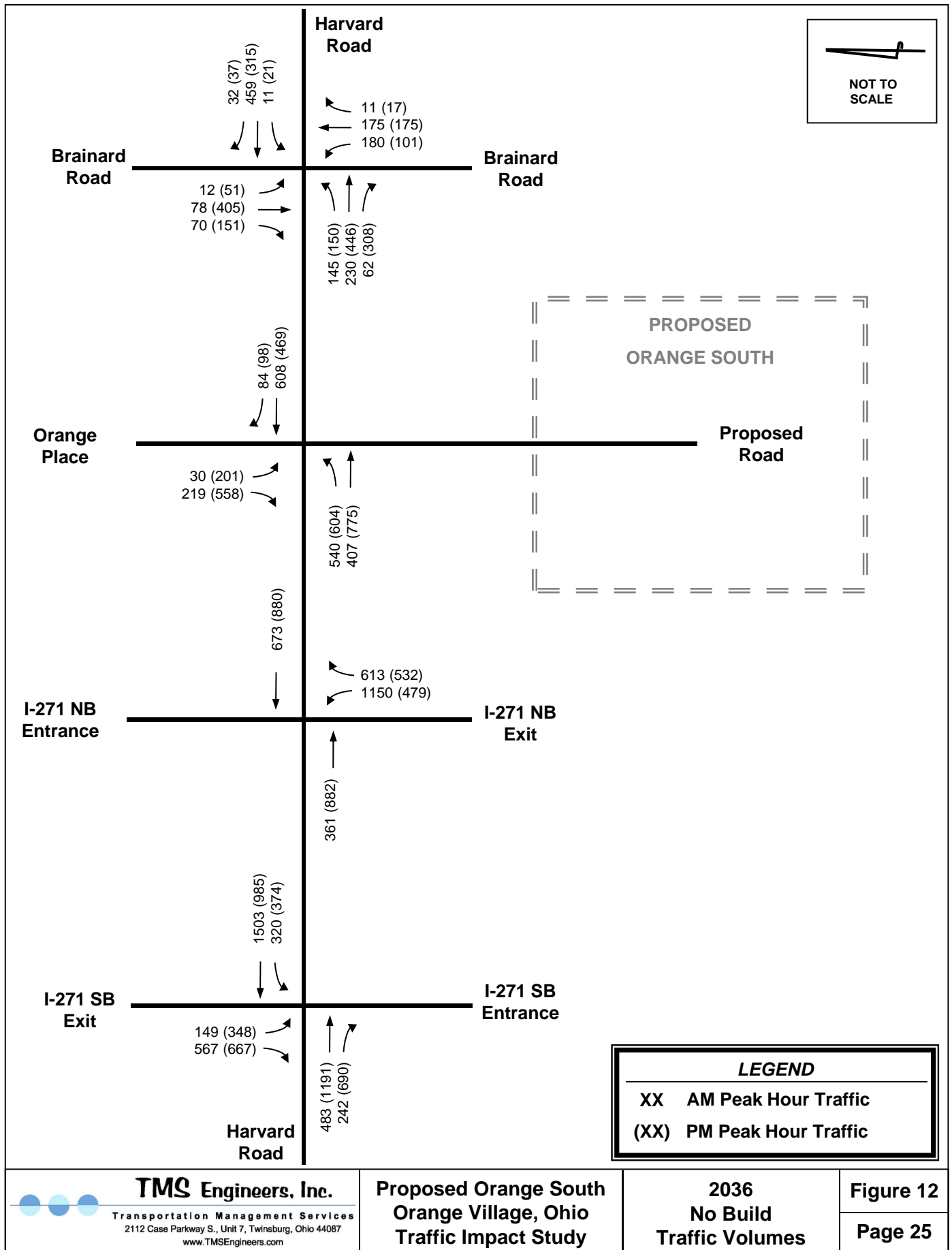
**TMS Engineers, Inc.**

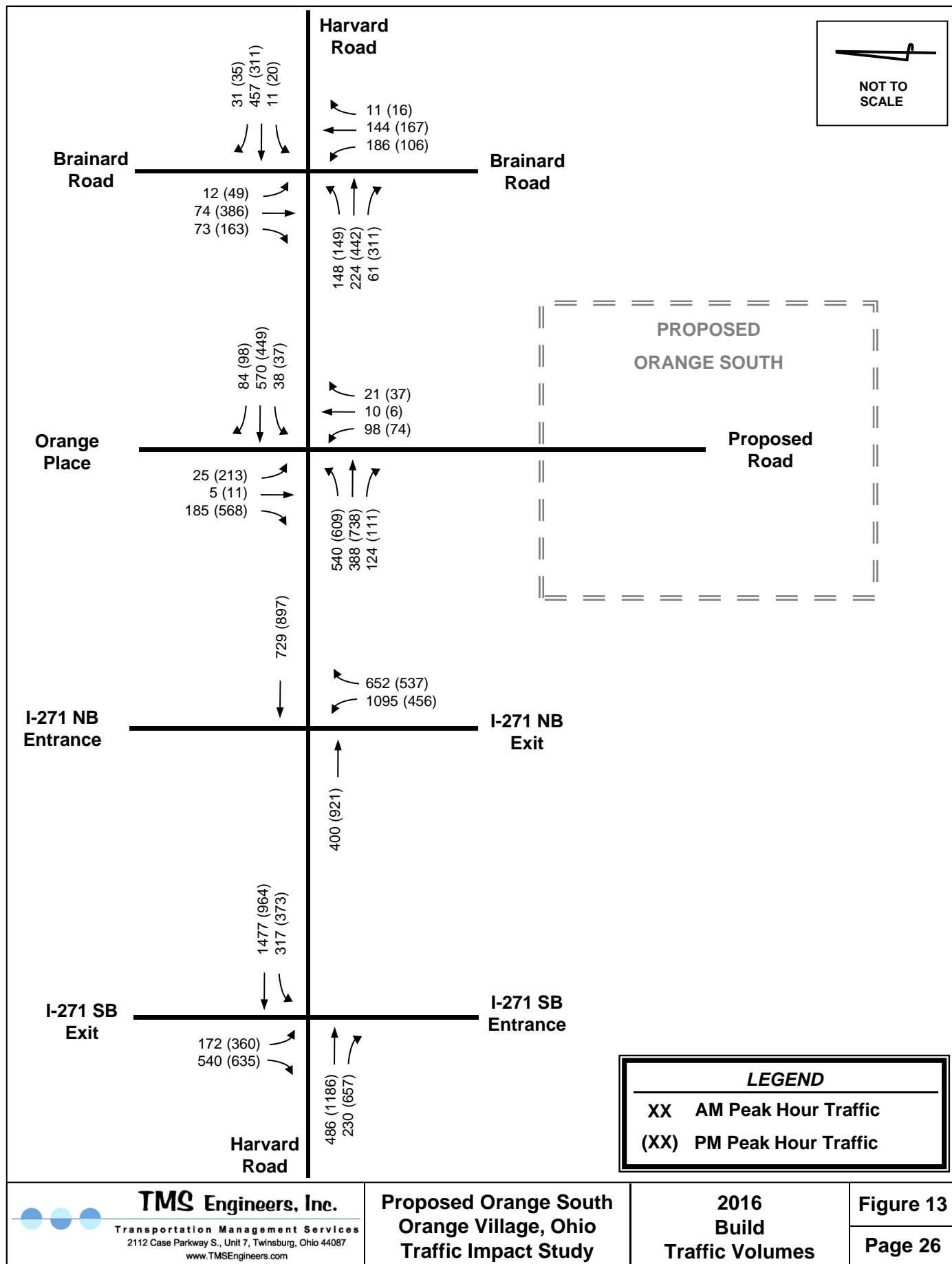
Transportation Management Services  
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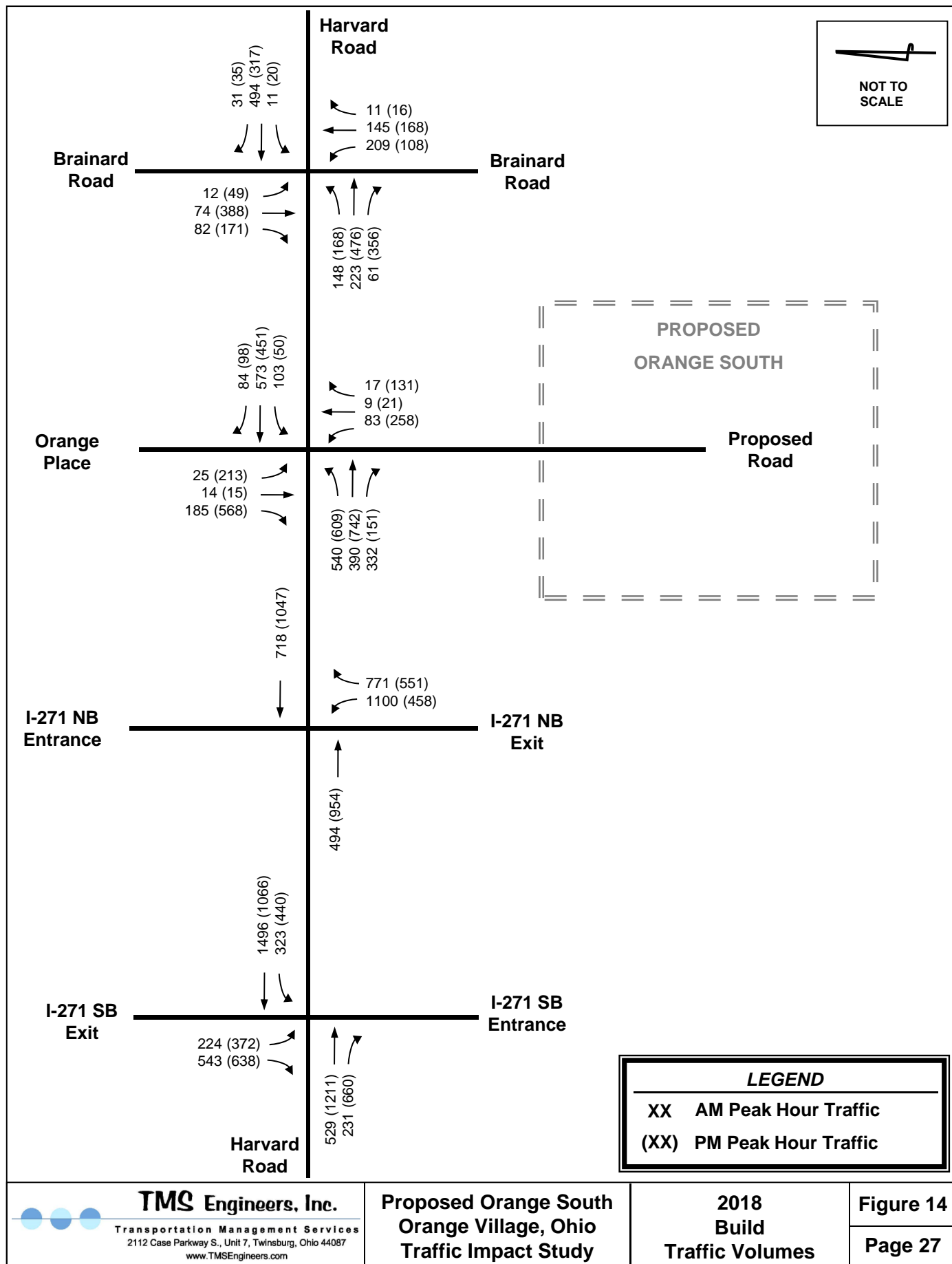
**Proposed Orange South  
Orange Village, Ohio  
Traffic Impact Study**

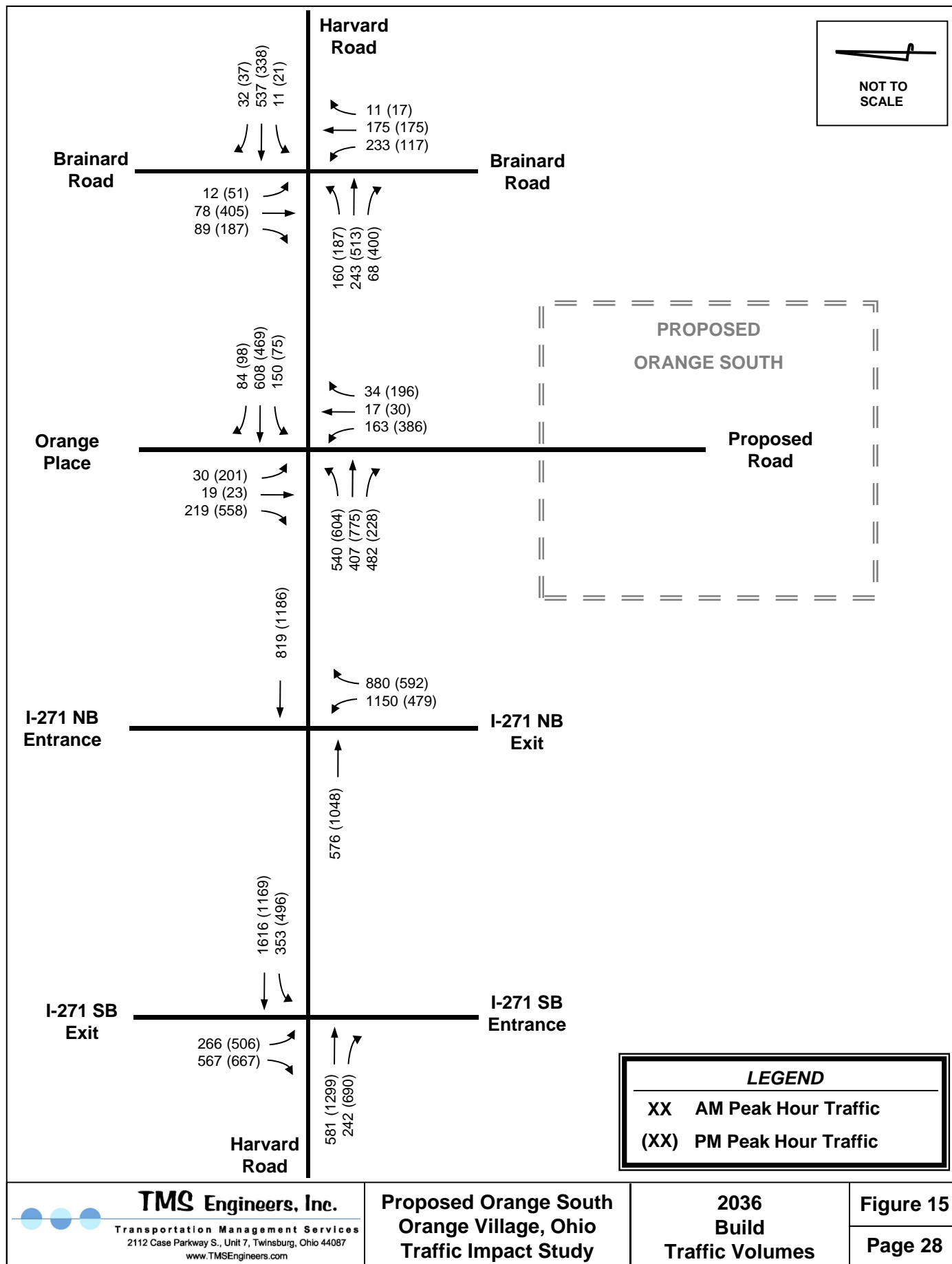
**2018  
No Build  
Traffic Volumes**

**Figure 11  
Page 24**









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**Proposed Orange South  
Orange Village, Ohio  
Traffic Impact Study**

**2036  
Build  
Traffic Volumes**

**Figure 15  
Page 28**

## 4. TRAFFIC ANALYSIS

### 4.1 Capacity and LOS at Study Intersections

Intersection capacity analyses were performed at the study intersections using the procedures outlined in the computerized version of the Transportation Research Board's **Highway Capacity Manual, HCM2010 (HCS2010, Release 6.70)**. The capacity analyses were performed in order to estimate the maximum amount of traffic that can be accommodated by a roadway facility while maintaining recommended operational qualities. 2015 Existing, 2016 No-Build, 2016 Build, 2018 No Build, 2018 Build, 2036 No-Build, and 2036 Build peak hour traffic volumes were analyzed to determine the level-of-service (LOS) at the study area intersections.

The capacity analysis procedures provide a calculated "average vehicle delay", which is based on traffic volumes, number of lanes, type of traffic control, channelization, grade, and percentage of large vehicles in the traffic stream at each intersection. The average delay calculated at an intersection is then assigned a "grade" or level of service (LOS) ranging from LOS A, the best, to LOS F, the worst based upon driver expectation. The intersection LOS "grades" as defined by the Transportation Research Board are as follows:

**INTERSECTION LOS**

LOS	UNSIGNALIZED AVERAGE DELAY PER VEHICLE (sec)	SIGNALIZED AVERAGE DELAY PER VEHICLE (sec)
A	≤ 10.0	≤ 10.0
B	10.1 to 15.0	10.1 to 20.0
C	15.1 to 25.0	20.1 to 35.0
D	25.1 to 35.0	35.1 to 55.0
E	35.1 to 50.0	55.1 to 80.0
F	> 50	> 80

The capacity analysis procedures and the resulting level of service grades and delays are a recognized traffic engineering standard for measuring the efficiency of intersection operations by such organizations as the Institute of Transportation Engineers, American Association of State Highway and Transportation Officials, and the Ohio Department of Transportation.

## Existing Conditions - 2015 Capacity Analysis

Analyses were performed for the current 2015 conditions under the Existing scenario. These analyses will be used to identify existing capacity and/or operational deficiencies. All analysis will assume that the signal timing would be optimized to balance critical lane delays at the signalized intersections. The traffic volumes used in this analysis can be seen in **Figure 5**. Copies of the capacity worksheets are included in **Appendix D**. The results of the 2015 Existing analysis are shown in the following table.

**2015 LEVELS OF SERVICE**  
(Existing Conditions - Signalized Intersections)

LOCATION	MOVEMENT	2015 AM PEAK LOS (DELAY)	2015 PM PEAK LOS (DELAY)
Harvard Road & I-271 Southbound Ramps	Intersection	B (18.1)	C (25.6)
	Eastbound	C (20.4)	C (27.3)
	Westbound	B (15.8)	B (11.0)
	Southbound	C (22.0)	D (39.2)
Harvard Road & I-271 Northbound Exit Ramp	Intersection	B (18.9)	B (18.2)
	Eastbound	B (17.2)	B (19.4)
	Westbound	B (19.7)	B (18.0)
	Northbound	B (18.9)	B (17.4)
Harvard Road & Orange Place	Intersection	B (16.1)	B (16.1)
	Eastbound	B (12.5)	B (14.1)
	Westbound	B (19.9)	B (19.9)
	Southbound	B (16.4)	B (17.1)
Harvard Road & Brainard Road	Intersection	B (19.8)	C (25.6)
	Eastbound	B (14.9)	C (24.6)
	Westbound	C (24.0)	C (29.7)
	Northbound	B (17.7)	B (14.1)
	Southbound	C (24.0)	C (29.9)

(XX.X) = Average vehicle delay in seconds per vehicle

Conditions at all of the signalized intersections are currently operating at an acceptable level-of-service during the AM and PM peak hours.

## No Build Conditions - 2016 Capacity Analysis

Analyses were performed for the projected 2016 opening day conditions under the No Build scenario. These analyses will be used to compare to the conditions expected under the Build scenario. All analysis will assume that the signal timing would be optimized to balance critical lane delays at the signalized intersections. The traffic volumes used in this analysis can be seen in **Figure 10**. Copies of the capacity worksheets are included in **Appendix E**. The results of the 2016 No Build analysis are shown in the following table.

**2016 LEVELS OF SERVICE**  
(No-Build Conditions - Signalized Intersections)

LOCATION	MOVEMENT	2016 AM PEAK LOS (DELAY)	2016 PM PEAK LOS (DELAY)
Harvard Road & I-271 Southbound Ramps	Intersection	B (19.0)	C (33.9)
	Eastbound	C (20.6)	C (33.9)
	Westbound	B (17.2)	C (33.9)
	Southbound	C (21.9)	C (34.0)
Harvard Road & I-271 Northbound Exit Ramp	Intersection	C (20.3)	C (21.2)
	Eastbound	B (19.9)	C (22.7)
	Westbound	C (22.9)	C (22.5)
	Northbound	B (19.3)	B (18.8)
Harvard Road & Orange Place	Intersection	C (21.0)	C (20.3)
	Eastbound	B (18.3)	B (17.8)
	Westbound	C (26.9)	C (30.4)
	Southbound	B (14.7)	B (17.4)
Harvard Road & Brainard Road	Intersection	C (20.5)	C (27.4)
	Eastbound	B (15.6)	C (27.1)
	Westbound	C (25.1)	C (32.5)
	Northbound	B (18.1)	B (13.7)
	Southbound	C (24.9)	C (31.4)

(XX.X) = Average vehicle delay in seconds per vehicle

Conditions at all of the signalized intersections are expected to continue to operate with acceptable levels-of-service during the AM and PM peak hours under the expected 2016 No-Build conditions.



## No Build Conditions - 2018 Capacity Analysis

Analyses were performed for the projected 2018 conditions under the No-Build scenario. These analyses will be used to compare to the conditions expected under the Build scenario. All analysis will assume that the signal timing would be optimized to balance critical lane delays at the signalized intersections. The traffic volumes used in this analysis can be seen in **Figure 11**. Copies of the capacity worksheets are included in **Appendix F**. The results of the 2018 No-Build analysis are shown in the following table.

**2018 LEVELS OF SERVICE**  
(No-Build Conditions - Signalized Intersections)

LOCATION	MOVEMENT	2018 AM PEAK LOS (DELAY)	2018 PM PEAK LOS (DELAY)
Harvard Road & I-271 Southbound Ramps	Intersection	B (19.1)	C (34.3)
	Eastbound	C (20.6)	C (34.0)
	Westbound	B (17.3)	C (34.6)
	Southbound	C (22.0)	C (34.5)
Harvard Road & I-271 Northbound Exit Ramp	Intersection	C (20.3)	C (21.3)
	Eastbound	B (19.9)	C (22.7)
	Westbound	C (23.0)	C (22.6)
	Northbound	B (19.4)	B (18.9)
Harvard Road & Orange Place	Intersection	C (21.1)	C (20.3)
	Eastbound	B (18.4)	B (17.9)
	Westbound	C (27.0)	C (30.4)
	Southbound	B (14.7)	B (17.4)
Harvard Road & Brainard Road	Intersection	C (20.6)	C (27.6)
	Eastbound	B (15.6)	C (27.2)
	Westbound	C (25.1)	C (32.5)
	Northbound	B (18.1)	B (13.7)
	Southbound	C (24.9)	C (31.7)

(XX.X) = Average vehicle delay in seconds per vehicle

Conditions at all of the signalized intersections are expected to continue to operate with acceptable levels-of-service during the AM and PM peak hours under the expected 2018 No-Build conditions.

## No Build Conditions - 2036 Capacity Analysis

Analyses were performed for the projected 2036 design year conditions under the No Build scenario. These analyses will be used to compare to the conditions expected under the Build scenario. The traffic volumes used in this analysis can be seen in **Figure 12**. Copies of the capacity worksheets are included in **Appendix G**. The results of the 2036 No-Build analysis are shown in the following table.

**2036 LEVELS OF SERVICE**  
(No-Build Conditions - Signalized Intersections)

LOCATION	MOVEMENT	2036 AM PEAK LOS (DELAY)	2036 PM PEAK LOS (DELAY)
Harvard Road & I-271 Southbound Ramps	Intersection	B (19.5)	D (39.1)
	Eastbound	C (20.6)	D (37.9)
	Westbound	B (17.9)	D (39.9)
	Southbound	C (22.5)	D (40.0)
Harvard Road & I-271 Northbound Exit Ramp	Intersection	C (20.9)	C (22.1)
	Eastbound	C (20.6)	C (23.7)
	Westbound	C (24.0)	C (23.5)
	Northbound	B (19.8)	B (19.3)
Harvard Road & Orange Place	Intersection	C (21.3)	C (20.1)
	Eastbound	B (18.3)	B (17.5)
	Westbound	C (27.6)	C (29.6)
	Southbound	B (15.0)	B (17.7)
Harvard Road & Brainard Road	Intersection	C (20.6)	C (28.7)
	Eastbound	B (15.7)	C (28.2)
	Westbound	C (25.2)	C (33.2)
	Northbound	B (18.3)	B (13.9)
	Southbound	C (25.2)	C (33.9)

(XX.X) = Average vehicle delay in seconds per vehicle

Conditions at all of the signalized intersections are expected to continue to operate with acceptable levels-of-service during the AM and PM peak hours under the 2036 No-Build conditions.

## Build Condition - 2016 Capacity Analysis

Analyses were performed for the projected 2016 opening day conditions under the Build scenario. This analysis will be used to determine the future levels-of-service at the study intersections under the anticipated build conditions. The traffic volumes used in this analysis can be seen in **Figure 13**. The results of the 2016 Build analyses are shown in the following table. Copies of the capacity worksheets are included in **Appendix H**.

**2016 LEVELS OF SERVICE**  
(Build Conditions - Signalized Intersections)

LOCATION	MOVEMENT	2016 AM PEAK LOS (DELAY)	2016 PM PEAK LOS (DELAY)
Harvard Road & I-271 Southbound Ramps	Intersection	B (19.2)	D (36.1)
	Eastbound	C (20.2)	C (34.0)
	Westbound	B (17.6)	D (37.5)
	Southbound	C (22.4)	D (37.8)
Harvard Road & I-271 Northbound Exit Ramp	Intersection	C (21.5)	C (22.5)
	Eastbound	C (21.7)	C (24.3)
	Westbound	C (25.9)	C (23.7)
	Northbound	B (19.7)	B (19.7)
Harvard Road & Orange Place	Intersection	C (24.1)	C (29.5)
	Eastbound	C (21.9)	C (26.3)
	Westbound	C (27.3)	D (45.2)
	Northbound	C (28.3)	C (25.3)
	Southbound	C (22.2)	C (24.3)
Harvard Road & Brainard Road	Intersection	C (20.7)	C (28.5)
	Eastbound	B (15.6)	C (27.8)
	Westbound	C (25.2)	C (32.8)
	Northbound	B (18.4)	B (14.1)
	Southbound	C (25.2)	C (33.9)

(XX.X) = Average vehicle delay in seconds per vehicle

Conditions at all of the signalized intersections are expected to continue to operate with acceptable levels-of-service during the AM and PM peak hours under the 2016 build conditions.

## Build Condition - 2018 Capacity Analysis

Analyses were performed for the projected 2018 conditions under the Build scenario. This analysis will be used to determine the future levels-of-service at the study intersections under the anticipated build conditions. The traffic volumes used in this analysis can be seen in **Figure 14**. The results of the 2018 Build analyses are shown in the following table. Copies of the capacity worksheets are included in **Appendix I**.

**2018 LEVELS OF SERVICE**  
(Build Conditions - Signalized Intersections)

LOCATION	MOVEMENT	2018 AM PEAK LOS (DELAY)	2018 PM PEAK LOS (DELAY)
Harvard Road & I-271 Southbound Ramps	Intersection	B (19.5)	D (41.7)
	Eastbound	C (21.1)	C (30.0)
	Westbound	B (17.6)	D (50.5)
	Southbound	C (22.5)	D (50.4)
Harvard Road & I-271 Northbound Exit Ramp	Intersection	C (23.7)	C (23.9)
	Eastbound	C (26.7)	C (24.4)
	Westbound	C (31.0)	C (26.2)
	Northbound	C (20.2)	C (20.9)
Harvard Road & Orange Place	Intersection	C (23.2)	D (38.7)
	Eastbound	C (20.3)	D (35.8)
	Westbound	C (27.6)	D (50.8)
	Northbound	C (28.1)	D (48.3)
	Southbound	C (22.9)	C (30.3)
Harvard Road & Brainard Road	Intersection	C (21.2)	C (29.9)
	Eastbound	B (15.6)	C (29.8)
	Westbound	C (25.6)	C (33.0)
	Northbound	B (19.3)	B (14.3)
	Southbound	C (25.5)	D (35.6)

(XX.X) = Average vehicle delay in seconds per vehicle

Conditions at all of the signalized intersections are expected to continue to operate with acceptable levels-of-service during the AM and PM peak hours under the 2018 build conditions.

## Build Condition - 2036 Capacity Analysis

Analyses were performed for the projected 2036 design year conditions under the Build scenario. This analysis will be used to determine the future levels-of-service at the study intersections under the anticipated build conditions. The traffic volumes used in this analysis can be seen in **Figure 15**. The results of the 2036 Build analyses are shown in the following table. Copies of the capacity worksheets are included in **Appendix J**.

**2036 LEVELS OF SERVICE**  
(Build Conditions - Signalized Intersections)

LOCATION	MOVEMENT	2036 AM PEAK LOS (DELAY)	2036 PM PEAK LOS (DELAY)
Harvard Road & I-271 Southbound Ramps	Intersection	C (20.3)	E (63.6)
	Eastbound	C (22.3)	E (63.4)
	Westbound	B (17.8)	E (63.7)
	Southbound	C (23.9)	E (63.7)
Harvard Road & I-271 Northbound Exit Ramp	Intersection	C (30.7)	C (27.2)
	Eastbound	C (31.8)	C (26.5)
	Westbound	D (43.9)	C (30.8)
	Northbound	C (25.0)	C (23.8)
Harvard Road & Orange Place	Intersection	C (25.6)	E (57.2)
	Eastbound	B (19.9)	E (56.1)
	Westbound	D (36.3)	F (82.7)
	Northbound	C (28.2)	E (65.3)
	Southbound	C (20.8)	C (32.5)
Harvard Road & Brainard Road	Intersection	C (21.7)	C (33.3)
	Eastbound	B (15.7)	C (34.3)
	Westbound	C (26.0)	C (34.6)
	Northbound	C (20.8)	B (14.6)
	Southbound	C (26.0)	D (39.9)

(XX.X) = Average vehicle delay in seconds per vehicle

Conditions at all of the signalized intersections are expected to continue to operate with acceptable levels-of-service during the AM and PM peak hours under the 2036 build conditions except at the intersections of Harvard Road at the I-271 Southbound Ramps and Orange Place.

In order to determine what mitigation would be necessary to improve the levels-of-service at the intersections of Harvard Road at the I-271 Southbound Ramps and Orange Place, certain improvements were tested with further capacity analyses. It was determined that the intersection of Harvard Road and the I-271 Southbound Ramps will require a second southbound left turn lane on the exit ramp approach. The intersection of Harvard Road and Orange Place was determined to require dual northbound left turn lanes on the proposed approach for the Orange South development.

The following table shows the capacity analysis results of the intersections with the recommended improvements. Copies of the capacity worksheets for the improved intersection are included in **Appendix K**.

**2036 LEVELS OF SERVICE**  
(Build Conditions - Improvements)

LOCATION	MOVEMENT	2036 AM PEAK LOS (DELAY)	2036 PM PEAK LOS (DELAY)
Harvard Road & I-271 Southbound Ramps	Intersection	C (20.1)	D (51.8)
	Eastbound	C (22.3)	D (51.5)
	Westbound	B (17.8)	D (51.9)
	Southbound	C (23.3)	D (52.1)
Harvard Road & Orange Place	Intersection	C (26.4)	D (39.7)
	Eastbound	B (19.9)	C (33.4)
	Westbound	D (36.3)	D (44.4)
	Northbound	D (37.4)	D (45.5)
	Southbound	C (20.8)	D (43.9)

(XX.X) = Average vehicle delay in seconds per vehicle

These improvements are based on twenty year predicted traffic volumes determined from historical traffic data and anticipated development generated traffic for the full build out of the Orange South development. It should also be noted that before any improvements can be implemented at the I-271 Southbound Ramps it would also be necessary to prepare an Interchange Modification Study to be reviewed and approved by the Ohio Department of Transportation.

It is our opinion that based on these factors the need for improvements to the I-271 Southbound Ramps and Orange Place should be re-analyzed at a time after the development has reached the Phase 2 level of build out and prior to the full build out of the remaining office space and the residential development.

## 4.2 Comparative Analysis - Build vs. No Build

A comparison was performed to show the incremental effects on the capacity of the study area intersections due to the construction of the proposed development. The following tables show a side by side comparison of the Build versus No-Build conditions for the 2016 and 2036 AM and PM peak hours.

### 2016 NO-BUILD VS BUILD SCENARIO

AM Peak Hour Comparison Table

LOCATION	MOVEMENT	NO BUILD LOS (DELAY)	BUILD LOS (DELAY)	DIFFERENCE (+ / -)
Harvard Road & I-271 Southbound Ramps	Intersection	B (19.0)	B (19.2)	+0.2
	Eastbound	C (20.6)	C (20.2)	-0.4
	Westbound	B (17.2)	B (17.6)	+0.4
	Southbound	C (21.9)	C (22.4)	+0.5
Harvard Road & I-271 Northbound Exit	Intersection	C (20.3)	C (21.5)	+1.2
	Eastbound	B (19.9)	C (21.7)	+1.8
	Westbound	C (22.9)	C (25.9)	+3.0
	Northbound	B (19.3)	B (19.7)	+0.4
Harvard Road & Orange Place	Intersection	C (21.0)	C (24.1)	+3.1
	Eastbound	B (18.3)	C (21.9)	+3.6
	Westbound	C (26.9)	C (27.3)	+0.4
	Northbound	-----	C (28.3)	-----
	Southbound	B (14.7)	C (22.2)	+7.5
Harvard Road & Brainard Road	Intersection	C (20.5)	C (20.7)	+0.2
	Eastbound	B (15.6)	B (15.6)	0.0
	Westbound	C (25.1)	C (25.2)	+0.1
	Northbound	B (18.1)	B (18.4)	+0.3
	Southbound	C (24.9)	C (25.2)	+0.3

(XX.X) = Average vehicle delay in seconds per vehicle

## 2016 NO-BUILD VS BUILD SCENARIO

### PM Peak Hour Comparison Table

LOCATION	MOVEMENT	NO BUILD LOS (DELAY)	BUILD LOS (DELAY)	DIFFERENCE (+ / -)
Harvard Road & I-271 Southbound Ramps	Intersection	C (33.9)	D (36.1)	+2.2
	Eastbound	C (33.9)	C (34.0)	+0.1
	Westbound	C (33.9)	D (37.5)	+3.6
	Southbound	C (34.0)	D (37.8)	+3.8
Harvard Road & I-271 Northbound Exit	Intersection	C (21.2)	C (22.5)	+1.3
	Eastbound	C (22.7)	C (24.3)	+1.6
	Westbound	C (22.5)	C (23.7)	+1.2
	Northbound	B (18.8)	B (19.7)	+0.9
Harvard Road & Orange Place	Intersection	C (20.3)	C (29.5)	+9.2
	Eastbound	B (17.8)	C (26.3)	+8.5
	Westbound	C (30.4)	D (45.2)	+14.8
	Northbound	-----	C (25.3)	-----
	Southbound	B (17.4)	C (24.3)	+6.9
Harvard Road & Brainard Road	Intersection	C (27.4)	C (28.5)	+1.1
	Eastbound	C (27.1)	C (27.8)	+0.7
	Westbound	C (32.5)	C (32.8)	+0.3
	Northbound	B (13.7)	B (14.1)	+0.4
	Southbound	C (31.4)	C (33.9)	+2.5

(XX.X) = Average vehicle delay in seconds per vehicle



## 2018 NO-BUILD VS BUILD SCENARIO

AM Peak Hour Comparison Table

LOCATION	MOVEMENT	NO BUILD LOS (DELAY)	BUILD LOS (DELAY)	DIFFERENCE (+ / -)
Harvard Road & I-271 Southbound Ramps	Intersection	B (19.1)	B (19.5)	+0.4
	Eastbound	C (20.6)	C (21.1)	+0.5
	Westbound	B (17.3)	B (17.6)	+0.3
	Southbound	C (22.0)	C (22.5)	+0.5
Harvard Road & I-271 Northbound Exit	Intersection	C (20.3)	C (23.7)	+0.4
	Eastbound	B (19.9)	C (26.7)	+6.8
	Westbound	C (23.0)	C (31.0)	+7.0
	Northbound	B (19.4)	C (20.2)	+0.8
Harvard Road & Orange Place	Intersection	C (21.1)	C (23.2)	+2.1
	Eastbound	B (18.4)	C (20.3)	+1.9
	Westbound	C (27.0)	C (27.6)	+0.6
	Northbound	-----	C (28.1)	-----
	Southbound	B (14.7)	C (22.9)	+8.2
Harvard Road & Brainard Road	Intersection	C (20.6)	C (21.2)	+0.6
	Eastbound	B (15.6)	B (15.6)	0.0
	Westbound	C (25.1)	C (25.6)	+0.5
	Northbound	B (18.1)	B (19.3)	+1.2
	Southbound	C (24.9)	C (25.5)	+0.6

(XX.X) = Average vehicle delay in seconds per vehicle

## 2018 NO-BUILD VS BUILD SCENARIO

PM Peak Hour Comparison Table

LOCATION	MOVEMENT	NO BUILD LOS (DELAY)	BUILD LOS (DELAY)	DIFFERENCE (+ / -)
Harvard Road & I-271 Southbound Ramps	Intersection	C (34.3)	D (41.7)	+7.4
	Eastbound	C (34.0)	C (30.0)	-4.0
	Westbound	C (34.6)	D (50.5)	+15.9
	Southbound	C (34.5)	D (50.4)	+15.9
Harvard Road & I-271 Northbound Exit	Intersection	C (21.3)	C (23.9)	+2.6
	Eastbound	C (22.7)	C (24.4)	+1.7
	Westbound	C (22.6)	C (26.2)	+3.6
	Northbound	B (18.9)	C (20.9)	+2.0
Harvard Road & Orange Place	Intersection	C (20.3)	D (38.7)	+18.4
	Eastbound	B (17.9)	D (35.8)	+17.9
	Westbound	C (30.4)	D (50.8)	+20.4
	Northbound	-----	D (48.3)	-----
	Southbound	B (17.4)	C (30.3)	+12.9
Harvard Road & Brainard Road	Intersection	C (27.6)	C (29.9)	+2.3
	Eastbound	C (27.2)	C (29.8)	+2.6
	Westbound	C (32.5)	C (33.0)	+0.5
	Northbound	B (13.7)	B (14.3)	+0.6
	Southbound	C (31.7)	D (35.6)	+3.9

(XX.X) = Average vehicle delay in seconds per vehicle

## 2036 NO-BUILD VS BUILD SCENARIO

AM Peak Hour Comparison Table

LOCATION	MOVEMENT	NO BUILD LOS (DELAY)	BUILD LOS (DELAY)	DIFFERENCE (+ / -)
Harvard Road & I-271 Southbound Ramps	Intersection	B (19.5)	C (20.3)	+0.8
	Eastbound	C (20.6)	C (22.3)	+1.7
	Westbound	B (17.9)	B (17.8)	-0.1
	Southbound	C (22.5)	C (23.9)	+1.4
Harvard Road & I-271 Northbound Exit	Intersection	C (20.9)	C (30.7)	+9.8
	Eastbound	C (20.6)	C (31.8)	+11.2
	Westbound	C (24.0)	D (43.9)	+19.9
	Northbound	B (19.8)	C (25.0)	+5.2
Harvard Road & Orange Place	Intersection	C (21.3)	C (25.6)	+4.3
	Eastbound	B (18.3)	B (19.9)	+1.6
	Westbound	C (27.6)	D (36.3)	+8.7
	Northbound	-----	C (28.2)	-----
	Southbound	B (15.0)	C (20.8)	+5.8
Harvard Road & Brainard Road	Intersection	C (20.6)	C (21.7)	+1.1
	Eastbound	B (15.7)	B (15.7)	0.0
	Westbound	C (25.2)	C (26.0)	+0.8
	Northbound	B (18.3)	C (20.8)	+2.5
	Southbound	C (25.2)	C (26.0)	+0.8

(XX.X) = Average vehicle delay in seconds per vehicle

## 2036 NO-BUILD VS BUILD SCENARIO

PM Peak Hour Comparison Table

LOCATION	MOVEMENT	NO BUILD LOS (DELAY)	BUILD LOS (DELAY)	DIFFERENCE (+ / -)
Harvard Road & I-271 Southbound Ramps	Intersection	D (39.1)	E (63.6)	+24.5
	Eastbound	D (37.9)	E (63.4)	+25.5
	Westbound	D (39.9)	E (63.7)	+23.8
	Southbound	D (40.0)	E (63.7)	+23.7
Harvard Road & I-271 Northbound Exit	Intersection	C (22.1)	C (27.2)	+5.1
	Eastbound	C (23.7)	C (26.5)	+2.8
	Westbound	C (23.5)	C (30.8)	+7.3
	Northbound	B (19.3)	C (23.8)	+4.5
Harvard Road & Orange Place	Intersection	C (20.1)	E (57.2)	+37.1
	Eastbound	B (17.5)	E (56.1)	+38.6
	Westbound	C (29.6)	F (82.7)	+53.1
	Northbound	-----	E (65.3)	-----
	Southbound	B (17.7)	C (32.5)	+14.8
Harvard Road & Brainard Road	Intersection	C (28.7)	C (33.3)	+4.6
	Eastbound	C (28.2)	C (34.3)	+6.1
	Westbound	C (33.2)	C (34.6)	+1.4
	Northbound	B (13.9)	B (14.6)	+0.7
	Southbound	C (33.9)	D (39.9)	+6.0

(XX.X) = Average vehicle delay in seconds per vehicle

It should be noted that the 2036 PM comparison analysis shown above does not include the recommended improvements to mitigate the poor levels-of-service at the intersections of Harvard Road at the I-271 Southbound Ramps and Orange Place.

### 4.3 Turn Lane Analysis

An analysis was performed to determine the necessary turn lane storage length for the proposed turn lanes at the intersection of Harvard Road and Orange Place/Proposed Roadway. The analysis was performed in accordance with the procedure recommended by the Ohio Department of Transportation in their **Location and Design Manual, Volume 1, Section 401**. The ODOT criteria and procedures are furnished in **Appendix L**. It should be noted that the recommended maximum left turn lane length is 600 feet, however if the calculated turn lane length is lower than these values the maximum length will not be applicable. The following tables shows the result of the analysis based upon the highest anticipated left turn volume at the intersection.

#### 2018 TURN LANE LENGTH ANALYSIS

Harvard Road & Orange Place/Proposed Roadway (Signalized)

Movement Direction	DHV	No. of Lanes	Cycles / Hour	Average Veh/ Cycle/ Lane	Design Speed (mph)	Fig. 401-10 Storage Length (ft)	Fig. 401-9 Condition <sup>1</sup>			Backup Length (ft)	Turn Lane Length* (ft)
							A*	B*	C*		
WB LT	103	1	40	2.6	40	150		125	261		325*
WB T & RT	657	2	40	8.2	40	325				325	
NB LT	258	1	40	6.5	30	275	325				325*
NB T & RT	152	1	40	3.8	30	175				175	

\* - Includes 50' Diverging Taper

The westbound left turn lane is recommended to be 325 feet long in order to accommodate the through traffic back up in the adjacent westbound through lanes. The westbound left turn lane only requires 261 feet to accommodate the deceleration and storage of the left turn vehicles. The additional turn lane length is necessary so that queued westbound through traffic at the intersection will not block entry to the left turn lane.

There is approximately 260 feet of striped pavement on the westbound approach that can be used for the proposed turn lane. In order to accommodate a 325 feet westbound left turn lane approximately 65 feet of the existing landscaped median would need to be removed.

## 2036 TURN LANE LENGTH ANALYSIS

### Harvard Road & Orange Place/Proposed Roadway (Signalized)

Movement Direction	DHV	No. of Lanes	Cycles / Hour	Average Veh/ Cycle/ Lane	Design Speed (mph)	Fig. 401-10 Storage Length (ft)	Fig. 401-9 Condition <sup>1</sup>			Backup Length (ft)	Turn Lane Length* (ft)
							A*	B*	C*		
WB LT	150	1	40	3.8	40	175		125	286		<b>325*</b>
WB T & RT	672	2	40	8.4	40	325				325	
NB LT	386	2	40	4.8	30	200	250				<b>250*</b>
NB T & RT	226	1	40	5.7	30	250				250	

\* - Includes 50' Diverging Taper

### Harvard Road & I-271 Southbound Ramps (Signalized)

Movement Direction	DHV	No. of Lanes	Cycles / Hour	Average Veh/ Cycle/ Lane	Design Speed (mph)	Fig. 401-10 Storage Length (ft)	Fig. 401-9 Condition <sup>1</sup>			Backup Length (ft)	Turn Lane Length* (ft)
							A*	B*	C*		
SB LT	506	2	40	6.3	40	250		125	361		<b>361*</b>
SB RT	667	2	40	8.3	40	325				325	

\* - Includes 50' Diverging Taper

The westbound left turn lane at Orange Place is recommended to be 325 feet long in order to accommodate the through traffic back up in the adjacent westbound through lanes. The westbound left turn lane only requires 286 feet to accommodate the deceleration and storage of the left turn vehicles. The additional turn lane length is necessary so that queued westbound through traffic at the intersection will not block entry to the left turn lane.

There is approximately 260 feet of striped pavement on the westbound approach that can be used for the proposed turn lane. In order to accommodate a 325 feet westbound left turn lane approximately 65 feet of the existing landscaped median would need to be removed.

#### **4.4 Improvements to Accommodate Study Area Traffic**

No improvements were found to be necessary to accommodate the existing 2015 traffic at the study area intersections.

No improvements were found to be necessary to accommodate the expected 2016, 2018, and 2036 No Build traffic at the study area intersections.

The following lane use and traffic control are recommended at the intersection of Harvard Road and Orange Place/Proposed Roadway to accommodate the 2016 and 2018 site generated (Build) traffic:

- Install a westbound left turn lane.
- Construct the proposed northbound approach to consist of a left turn lane and a shared through/right turn lane.
- Upgrade the traffic signal installation to include the proposed northbound approach.

No additional improvements were found to be necessary to accommodate the expected 2016 and 2018 Build traffic at the remaining study area intersections.

The following lane use and traffic control are recommended at the intersection of Harvard Road and Orange Place/Proposed Roadway to accommodate the 2036 site generated (Build) traffic:

- Install a westbound left turn lane.
- Construct the proposed northbound approach to consist of two left turn lanes and a shared through/right turn lane.
- Upgrade the traffic signal installation to include the proposed northbound approach.

The following lane use and traffic control are recommended at the intersection of Harvard Road and the I-271 Southbound Ramps to accommodate the 2036 site generated (Build) traffic:

- Construct a second southbound left turn lane.

The 2036 improvements are based on twenty year predicted traffic volumes determined from historical traffic data and anticipated development generated traffic for the full build out of the Orange South development. It should also be noted that before any improvements can be implemented at the I-271 Southbound Ramps it would also be necessary to prepare an Interchange Modification Study to be reviewed and approved by the Ohio Department of Transportation.

It is our opinion that based on these factors the need for improvements to the I-271 Southbound Ramps and Orange Place should be re-analyzed at a time after the development has reached the Phase 2 level of build out and prior to the full build out of the remaining office space and the residential development.

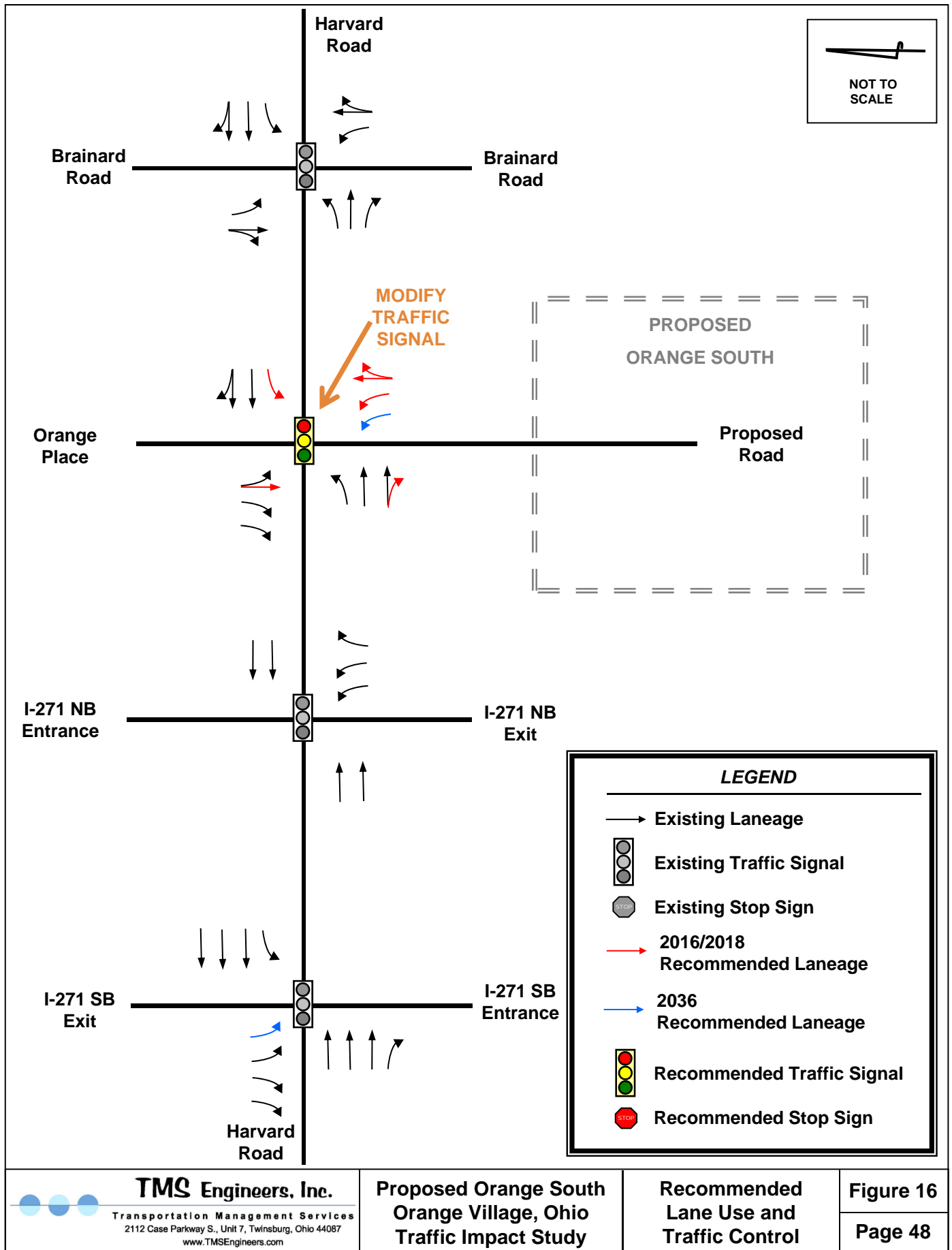
It should also be noted that a secondary access point to the development that would allow vehicles to enter and exit the site without using Harvard Road would likely lessen the likelihood of the recommended improvements at Orange Place and the I-271 Southbound Ramps.

The following improvements are also recommended to improve the operation of the traffic signal control installations at the intersections of Orange Place with Harvard Road and the proposed Pinecrest Site Driveway under all development phases.

- Update the intersection traffic signal timings to ensure the timing and coordination of the two intersections is optimized for the additional traffic generated from the proposed Orange South and Pinecrest developments.

The recommended lane use and traffic control for the study area to accommodate the proposed Orange South development can be seen in **Figure 16, Page 48**.





## 5. CONCLUSIONS

Based on the results of the analyses, we offer the following conclusions and recommendations:

- 5.1 This Traffic Impact Study (TIS) has been prepared at the request of Pine Orange LLC for the proposed Orange South multi-use development. The project site is bordered by Harvard Road to the north and Interstate 271 to the west in Orange Village, Cuyahoga County, Ohio. **Figure 1, Page 2** shows the proposed location of the development.
- 5.2 The weekday AM peak hour of traffic was determined to be 8:00 AM to 9:00 AM and the weekday PM peak hour of traffic was found to be 5:00 PM to 6:00 PM. These periods will be analyzed since they reflect the period of the highest volume of traffic flow for both the roadway and the development. Current AM and PM peak hour traffic volumes were shown in **Figure 5**.
- 5.3 The proposed development is expected to consist of restaurants, a hotel, and office space. The full build out analysis of the development will include 20,000 square feet of restaurants, 450,000 square feet of office space, and a 170 room hotel. The development of 320 residential units on the Weintraub site will also be included in the analysis.
- 5.4 The site plan details three phases of development for the site. The first phase will include the 20,000 square feet of restaurants and the 170 room hotel. The second phase will include 250,000 square feet of office space. The third phase or future phase as labeled on the site plan will include the Weintraub residential component and an additional 200,000 square feet of office space.
- 5.5 Development access is proposed via a new roadway that would line up directly across from Orange Place. The proposed roadway would become the south approach of a four-way signalized intersection at Harvard Road and Orange Place. **Figure 2, Page 3** shows the proposed preliminary land use plan for the Orange South development.
- 5.6 The year 2016 will be analyzed as the opening year and include phase 1 generated traffic. The year 2018 will be analyzed with the phase 2 portion of the site generated traffic. The year 2036 will be analyzed as the design year for the twenty year analysis and will include the full build out of the site.

- 5.7 The proposed Orange South development is expected to generate the following average hourly traffic during the AM and PM peak periods in 2016:

ITE TRIP GENERATION RESULTS ORANGE SOUTH MULTI-USE DEVELOPMENT PHASE 1	TRIPS END			
	Peak Hour Between 7-9 AM (Enter/Exit)		Peak Hour Between 4-6 PM (Enter/Exit)	
	167	129	159	117
TOTAL NEW TRIPS	296		276	

- 5.8 The proposed Orange South development is expected to generate the following average hourly traffic during the AM and PM peak under the full build Year 2018 conditions:

ITE TRIP GENERATION RESULTS ORANGE SOUTH MULTI-USE DEVELOPMENT PHASE 1 & 2	TRIPS ENDS			
	Peak Hour Between 7-9 AM (Enter/Exit)		Peak Hour Between 4-6 PM (Enter/Exit)	
	449	109	216	410
TOTAL NEW TRIPS	558		626	

- 5.9 The proposed Orange South development is expected to generate the following average hourly traffic during the AM and PM peak under the full build Year 2036 conditions:

ITE TRIP GENERATION RESULTS ORANGE SOUTH MULTI-USE DEVELOPMENT PHASE 1 & 2 & Future	TRIPS ENDS			
	Peak Hour Between 7-9 AM (Enter/Exit)		Peak Hour Between 4-6 PM (Enter/Exit)	
	651	214	326	612
TOTAL NEW TRIPS	865		938	

- 5.10 The Pinecrest multi-use development is proposed to be built on the north side of Harvard Road. The Pinecrest development has been analyzed in a series of Traffic Impact Studies. The most recent version of the Pinecrest TIS was dated June 24, 2015. This TIS for the proposed Orange South development includes the traffic forecast data and recommendations from the June 24, 2015 Pinecrest TIS.

5.11 The study analyzed the following existing intersections located within the study area:

1. Harvard Road & I-271 Southbound Entrance/Exit Ramp
2. Harvard Road & I-271 Northbound Exit Ramp
3. Harvard Road & Orange Place
4. Harvard Road & Brainard Road

5.12 No improvements were found to be necessary to accommodate the existing 2015 traffic at the study area intersections.

5.13 No improvements were found to be necessary to accommodate the expected 2016, 2018, and 2036 No Build traffic at the study area intersections.

5.14 The following lane use and traffic control are recommended at the intersection of Harvard Road and Orange Place/Proposed Roadway to accommodate the 2016 and 2018 site generated (Build) traffic:

- Install a westbound left turn lane.
- Construct the proposed northbound approach to consist of a left turn lane and a shared through/right turn lane.
- Upgrade the traffic signal installation to include the proposed northbound approach.

5.15 No additional improvements were found to be necessary to accommodate the expected 2016 and 2018 Build traffic at the remaining study area intersections.

5.16 The following lane use and traffic control are recommended at the intersection of Harvard Road and Orange Place/Proposed Roadway to accommodate the 2036 site generated (Build) traffic:

- Install a westbound left turn lane.
- Construct the proposed northbound approach to consist of two left turn lanes and a shared through/right turn lane.
- Upgrade the traffic signal installation to include the proposed northbound approach.

5.17 The following lane use and traffic control are recommended intersection of Harvard Road and the I-271 Southbound Ramps to accommodate the 2036 site generated (Build) traffic:

- Construct a second southbound left turn lane.

- 5.18 The 2036 improvements are based on twenty year predicted traffic volumes determined from historical traffic data and anticipated development generated traffic for the full build out of the Orange South development. It should also be noted that before any improvements can be implemented at the I-271 Southbound Ramps it would also be necessary to prepare an Interchange Modification Study to be reviewed and approved by the Ohio Department of Transportation. It is our opinion that based on these factors the need for improvements to the I-271 Southbound Ramps and Orange Place should be re-analyzed at a time after the development has reached the Phase 2 level of build out and prior to the full build out of the remaining office space and the residential development.
- 5.19 A secondary access point to the development that would allow vehicles to enter and exit the site without using Harvard Road would likely lessen the likelihood of the recommended improvements at Orange Place and the I-271 Southbound Ramps.
- 5.20 The following improvements are also recommended to improve the operation of the traffic signal control installations at the intersections of Orange Place with Harvard Road and the proposed Pinecrest Site Driveway under all development phases.
- Update the intersection traffic signal timings to ensure the timing and coordination of the two intersections is optimized for the additional traffic generated from the proposed Orange South and Pinecrest developments.

## **APPENDIX A**

### **Traffic Counts**

# VEHICULAR TRAFFIC COUNT SUMMARY

Municipality: Highland Hills				At Intersection of Harvard Road				and I-271 SB Ramps																
Date: 8/18/2015		Day: Tue.		Comments:				Project: 15-106																
Weather: Clear		Recorder(s): DHC&SLC		Data entry by: JJO				Date entered: Aug. 19, 2015		Harvard Rd & I-271 SB Ramps 081815														
TIME BEGINS	I-271 SB Exit Ramp FROM NORTH						Harvard Rd. FROM EAST						Harvard Rd. FROM WEST						TOTAL EAST WEST	TOTAL ALL DIREC.	PEAK HOUR FACTOR			
	Left	Thru	Right	Total	Trk	Bus	Left	Thru	Right	Total	Trk	Bus	Left	Thru	Right	Total	Trk	Bus			North	South	East	West
06:00																								
07:00	66	1	571	638	9	3		283	1238	0	1521	11	3	0	240	244	484	9	4	2005	2643	0.790	0.801	0.766
08:00	89	0	539	628	9	1		277	1300	0	1577	26	2	0	289	229	518	22	2	2095	2723	0.777	0.884	0.945
09:00	81	0	320	401	11	0		277	857	0	1134	18	1	0	253	233	486	14	3	1620	2021	0.802	0.886	0.880
10:00																								
11:00	85	0	219	304	9	3		260	592	0	852	20	3	0	399	315	714	16	5	1566	1870	0.864	0.947	0.850
12:00	90	1	230	321	9	2		236	719	0	955	17	5	0	556	356	912	15	4	1867	2188	0.922	0.908	0.832
1:00	82	2	289	373	10	3		311	695	0	1006	18	2	0	471	405	876	20	6	1882	2255	0.897	0.931	0.978
2:00																								
3:00	102	3	293	398	7	1		347	631	0	978	16	5	0	646	538	1184	12	1	2162	2560	0.732	0.951	0.911
4:00	200	1	378	579	14	0		278	585	0	863	7	1	3	900	645	1548	12	1	2411	2990	0.649	0.967	0.980
5:00	265	12	633	910	7	1		278	733	0	1011	5	5	0	907	655	1562	12	2	2573	3483	0.815	0.961	0.881
6:00																								
7:00																								
8:00																								
9:00																								
TOTALS	1080	20	3472	4552	85	14		2547	7350	0	9897	138	27	3	4661	3620	8284	132	28	18181	22733			
ADT	1650	31	5403	7084	2.2%			3964	11438	0	15401	1.7%	5	7253	5633	12891	1.9%			28293	35377			

HOURLY FACTOR: 1.69 MONTHLY FACTOR: 0.92 COMBINED FACTOR: 1.56

**TMS ENGINEERS, INC.**

2112 Case Parkway South # 7

Twinsburg, Ohio 44087

(330) 686-6402 FAX: (330) 686-6417

Figure #:

Page #:

# VEHICULAR TRAFFIC COUNT SUMMARY

Municipality: Highland Hills				At Intersection of Harvard Road and I-271 NB Ramps																															
Date: 8/18/2015		Day: Tue.		Comments:		Project: 15-106																													
Weather: Clear		Recorder(s): GFA		Data entry by: JJO		Date entered: Aug. 19, 2015		Harvard Rd & I-271 NB Ramps 081815																											
TIME BEGINS	FROM NORTH						I-271 NB Exit Ramp FROM SOUTH						TOTAL NORTH SOUTH			Harvard Rd. FROM EAST						Harvard Rd. FROM WEST						TOTAL EAST WEST		TOTAL ALL DIREC.		PEAK HOUR FACTOR			
	Left	Thru	Right	Total	Trk	Bus	Left	Thru	Right	Total	Trk	Bus	Left	Thru	Right	Total	Trk	Bus	Left	Thru	Right	Total	Trk	Bus	West	East	South	North							
06:00																																			
07:00													1017	0	335	1352	15	2									0.871	0.752	0.692						
08:00													1092	0	366	1458	25	2									0.914	0.813	0.740						
09:00													664	1	322	987	26	3									0.863	0.876	0.879						
10:00																																			
11:00													425	0	263	688	18	1									0.925	0.843	0.908						
12:00													458	0	300	758	16	3									0.850	0.936	0.967						
1:00													456	0	307	763	17	1									0.930	0.881	0.842						
2:00																																			
3:00													445	0	301	746	14	1									0.910	0.873	0.870						
4:00													391	0	339	730	5	1									0.908	0.921	0.769						
5:00													455	1	406	862	5	3									0.929	0.877	0.973						
6:00																																			
7:00																																			
8:00																																			
9:00																																			
TOTALS													5403	2	2939	8344	141	17										7545	15889						
ADT													8408	3	4574	12985	1.9%											11741	24726						

HOURLY FACTOR: 1.69 MONTHLY FACTOR: 0.92 COMBINED FACTOR: 1.56

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Figure #:

Page #:



# VEHICULAR TRAFFIC COUNT SUMMARY

Municipality: <u>Highland Hills</u>		At Intersection of <u>Harvard Road</u> and <u>Orance Place / Pinecrest Drive</u>	
Date: <u>8/18/2015</u>	Day: <u>Tue.</u>	Comments: _____	Project: <u>15-106</u>
Weather: <u>Clear</u>	Recorder(s): <u>PLR</u>	Date entry by: <u>JJO</u>	Date entered: <u>Aug. 19, 2015</u>
		Harvard Rd & Orance Pl 081815	


  

TIME BEGINS	Orange Pl. FROM NORTH					FROM SOUTH					Harvard Rd. FROM EAST					Harvard Rd. FROM WEST					TOTAL EAST WEST	TOTAL ALL DIREC.	PEAK HOUR FACTOR			
	Left	Thru	Right	Total	Trk	Bus	Left	Thru	Right	Total	Trk	Bus	Left	Thru	Right	Total	Trk	Bus	North	South			East	West		
06:00																										
07:00	9	0	58	67	1	1							0	490	23	513	0	0	147	319	0	466	7	2		
08:00	11	0	112	123	3	0							0	516	43	559	4	1	244	347	0	591	12	0		
09:00	21	0	130	151	1	1							0	419	30	449	4	0	195	315	0	510	13	3		
10:00																										
11:00	24	0	190	214	6	0							1	314	35	350	6	2	199	379	0	578	11	2		
12:00	45	0	103	238	5	4							0	381	48	429	3	3	239	438	0	677	12	4		
1:00	30	0	216	246	1	2							0	374	38	412	2	0	238	417	0	655	6	2		
2:00																										
3:00	39	0	189	228	3	1							0	417	25	442	8	2	187	475	1	663	6	1		
4:00	82	0	217	299	6	0							0	334	21	355	2	0	190	666	0	856	8	0		
5:00	99	0	215	314	0	1							0	423	29	452	4	3	202	848	0	1050	4	2		
6:00																										
7:00																										
8:00																										
9:00																										
TOTALS	360	0	1520	1880	26	10							1880	1	3668	292	3961	33	11	1841	4204	1	6046	79	16	
ADT	560	0	2365	2926	1.9%								2926	2	5708	454	6184	1.1%		2865	6542	2	9409	1.6%		

HOURLY FACTOR:	1.69	MONTHLY FACTOR:	0.92	COMBINED FACTOR:	1.56
----------------	------	-----------------	------	------------------	------



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 Twinsburg, Ohio 44087  
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Figure #:  
 Page #:

# VEHICULAR TRAFFIC COUNT SUMMARY

Municipality: <u>Highland Hills</u>		At Intersection of <u>Harvard Road</u> and <u>Brainard Road</u>	
Date: <u>8/18/2015</u>	Day: <u>Tue.</u>	Comments: _____	
Weather: <u>Clear</u>	Recorder(s): <u>DJS&amp;OPS</u>	Date entry by: <u>JJO</u>	Date entered: <u>Aug. 19, 2015</u>
Project: <u>15-106</u>		Harvard Rd & Brainard Rd 081815	


  

TIME BEGINS	Brainard Rd. FROM NORTH				Brainard Rd. FROM SOUTH				TOTAL NORTH SOUTH				Harvard Rd. FROM EAST				Harvard Rd. FROM WEST				TOTAL EAST WEST	TOTAL ALL DIREC	PEAK HOUR FACTOR								
	Left	Thru	Right	Total	Trk	Bus	Left	Thru	Right	Total	Trk	Bus	Left	Thru	Right	Total	Trk	Bus	North	South			East	West							
06:00																															
07:00	3	54	24	81	2	0	125	91	12	228	0	0	309	5	367	23	395	0	0	68	192	50	310	4	1	705	1014	0.844	0.559	0.731	0.923
08:00	12	47	33	92	1	0	145	133	11	289	5	0	381	11	377	31	419	1	1	92	190	47	329	5	0	748	1129	0.958	0.803	0.845	0.924
09:00	9	73	42	124	2	0	125	103	16	244	4	0	368	13	287	29	329	3	0	109	139	59	307	4	2	636	1004	0.816	0.685	0.875	0.925
10:00																															
11:00	18	88	51	157	1	0	70	98	13	181	5	1	338	8	214	32	254	6	3	101	192	85	378	6	2	632	970	0.835	0.923	0.920	0.875
12:00	27	118	78	223	1	0	79	116	16	211	1	2	434	13	252	31	296	2	4	141	237	65	443	6	4	739	1173	0.785	0.851	0.851	0.923
1:00	28	124	77	229	1	0	88	113	15	216	0	0	445	13	235	15	263	2	1	104	233	60	397	2	0	660	1105	0.939	0.915	0.889	0.878
2:00																															
3:00	23	148	108	279	2	0	76	132	16	224	4	2	503	27	240	25	292	4	1	102	214	108	424	3	0	716	1219	0.821	0.903	0.924	0.891
4:00	48	337	67	452	5	0	50	161	20	231	2	0	683	16	219	30	265	2	0	90	361	220	671	5	0	936	1619	0.890	0.635	0.883	0.795
5:00	49	385	100	534	1	0	84	157	11	252	3	0	786	20	265	35	320	0	2	98	415	280	793	1	0	1113	1899	0.820	0.913	0.808	0.885
6:00																															
7:00																															
8:00																															
9:00																															
TOTALS	217	1374	580	2171	16	0	842	1104	130	2076	24	5	4247	126	2456	251	2833	20	12	905	2173	974	4052	36	9	6885	11132				
ADT	338	2138	903	3378		0.7%	1310	1718	202	3231		1.4%	6609	196	3822	391	4409		1.1%	1408	3382	1516	6306		1.1%	10714	17323				

HOURLY FACTOR: <u>1.69</u>	MONTHLY FACTOR: <u>0.92</u>	COMBINED FACTOR: <u>1.56</u>
----------------------------	-----------------------------	------------------------------



**TMS ENGINEERS, INC.**  
 2112 Case Parkway South # 7  
 Twinsburg, Ohio 44087  
 (330) 686-6402 FAX: (330) 686-6417

Figure #:  
 Page #:

## **APPENDIX B**

### **Trip Generation Worksheets**

# HIGH-TURNOVER (SIT-DOWN) RESTAURANT

ITE CODE = 932

Orange South- Phase 1

Date:

9/3/2015

Trip Generation based on:

Size of Analysis Area:

20.00

1000 Sq Ft

1,000 Square Feet Gross Floor Area

	Average Rate	Standard Deviation	Adjustment factor	Driveway Volume
Average Weekday 2-way Volume	127.15	41.77	1.00	2543
7-9 AM Peak Hour Enter	5.95	0.00	1.00	119
7-9 AM Peak Hour Exit	4.86	0.00	1.00	97
7-9 AM Peak Hour Total	10.81	6.59	1.00	216
4-6 PM Peak Hour Enter	5.91	0.00	1.00	118
4-6 PM Peak Hour Exit	3.94	0.00	1.00	78
4-6 PM Peak Hour Total	9.85	8.54	1.00	197
Saturday 2-way Volume	158.37	--	1.00	3167
Saturday Peak Hour Enter	7.46	0.00	1.00	149
Saturday Peak Hour Exit	6.61	0.00	1.00	131
Saturday Peak Hour Total	14.07	12.19	1.00	281

**\*\*The above rates were based upon those found in the ITE Trip Generation Manual, 9TH Edition.**

Average Weekday 2-way Volume	Not Given – Use ITE Rates		
7-9 AM Peak Hour Total	Not Given – Use ITE Rates	Enter Exit	0.55 0.45
4-6 PM Peak Hour Total	Not Given – Use ITE Rates	Enter Exit	0.60 0.40
Saturday 2-way Volume	Not Given – Use ITE Rates		
Saturday Peak Hour Volume	Not Given – Use ITE Rates	Enter Exit	0.53 0.47

Source: Institute of Transportation Engineers  
Trip Generation, 9th Edition, 2012.

**HOTEL**  
**ITE CODE = 310**  
**Orange South - Phase 1**

Date: **9/3/2015**

Trip Generation based on: **Rooms**

Size of Analysis Area: **170.00 Rooms**

	Average Rate	Standard Deviation	Adjustment factor	Driveway Volume
Average Weekday 2-way Volume	8.17	3.38	1.00	1389
7-9 AM Peak Hour Enter	0.31	0.00	1.00	53
7-9 AM Peak Hour Exit	0.22	0.00	1.00	37
7-9 AM Peak Hour Total	0.53	0.76	1.00	90
4-6 PM Peak Hour Enter	0.31	0.00	1.00	52
4-6 PM Peak Hour Exit	0.29	0.00	1.00	50
4-6 PM Peak Hour Total	0.60	0.81	1.00	102
Saturday 2-way Volume	8.19	3.13	1.00	1392
Saturday Peak Hour Enter	0.36	0.00	1.00	61
Saturday Peak Hour Exit	0.36	0.00	1.00	61
Saturday Peak Hour Total	0.72	12.19	1.00	122

**\*\*The above rates were based upon those found in the ITE Trip Generation Manual, 9TH Edition.**

Average Weekday 2-way Volume	<i>Not Given – Use ITE Rates</i>		
7-9 AM Peak Hour Total	<i>Not Given – Use ITE Rates</i>	Enter Exit	0.59 0.41
4-6 PM Peak Hour Total	<i>Not Given – Use ITE Rates</i>	Enter Exit	0.51 0.49
Saturday 2-way Volume	<i>Not Given – Use ITE Rates</i>		
Saturday Peak Hour Volume	<i>Not Given – Use ITE Rates</i>	Enter Exit	0.50 0.50

Source: Institute of Transportation Engineers  
Trip Generartion, 9th Edition, 2012.

# GENERAL OFFICE BUILDING

ITE CODE = 710

Orange South - Phase 3

Date:

9/3/2015

Trip Generation based on:

Size of Analysis Area:

250.00

1000 Sq Ft

1,000 Square Feet Gross Floor Area

	Average Rate	Standard Deviation	Adjustment factor	Driveway Volume
Average Weekday 2-way Volume	8.63	0.00	1.00	2157
7-9 AM Peak Hour Enter	1.40	0.00	1.00	350
7-9 AM Peak Hour Exit	0.19	0.00	1.00	48
7-9 AM Peak Hour Total	1.59	0.00	1.00	398
4-6 PM Peak Hour Enter	0.24	0.00	1.00	61
4-6 PM Peak Hour Exit	1.19	0.00	1.00	297
4-6 PM Peak Hour Total	1.43	0.00	1.00	358
Saturday 2-way Volume	2.16	0.00	1.00	539
Saturday Peak Hour Enter	0.23	0.00	1.00	58
Saturday Peak Hour Exit	0.20	0.00	1.00	49
Saturday Peak Hour Total	0.43	0.00	1.00	108

**\*\*The above rates were calculated from the equations shown below:**

Average Weekday 2-way Volume	$Ln(T) = 0.76 * Ln(X) + 3.48$		
7-9 AM Peak Hour Total	$Ln(T) = 0.80 * Ln(X) + 1.57$	Enter	0.88
		Exit	0.12
4-6 PM Peak Hour Total	$T = 1.12 (X) + 78.45$	Enter	0.17
		Exit	0.83
Saturday 2-way Volume	$T = 20.3 (X) + 31.75$		
Saturday Peak Hour Volume	Not Given – Use ITE Rates	Enter	0.54
		Exit	0.46

Source: Institute of Transportation Engineers  
Trip Generation, 9th Edition, 2012.

# GENERAL OFFICE BUILDING

ITE CODE = 710

Orange South - Phase 3

Date:

9/3/2015

Trip Generation based on:

Size of Analysis Area:

450.00

1000 Sq Ft

1,000 Square Feet Gross Floor Area

	Average Rate	Standard Deviation	Adjustment factor	Driveway Volume
Average Weekday 2-way Volume	7.49	0.00	1.00	3371
7-9 AM Peak Hour Enter	1.25	0.00	1.00	561
7-9 AM Peak Hour Exit	0.17	0.00	1.00	76
7-9 AM Peak Hour Total	1.42	0.00	1.00	637
4-6 PM Peak Hour Enter	0.22	0.00	1.00	99
4-6 PM Peak Hour Exit	1.07	0.00	1.00	482
4-6 PM Peak Hour Total	1.29	0.00	1.00	582
Saturday 2-way Volume	2.10	0.00	1.00	945
Saturday Peak Hour Enter	0.23	0.00	1.00	104
Saturday Peak Hour Exit	0.20	0.00	1.00	89
Saturday Peak Hour Total	0.43	0.00	1.00	194

**\*\*The above rates were calculated from the equations shown below:**

Average Weekday 2-way Volume	$Ln(T) = 0.76 * Ln(X) + 3.48$		
7-9 AM Peak Hour Total	$Ln(T) = 0.80 * Ln(X) + 1.57$	Enter	0.88
		Exit	0.12
4-6 PM Peak Hour Total	$T = 1.12 (X) + 78.45$	Enter	0.17
		Exit	0.83
Saturday 2-way Volume	$T = 20.3 (X) + 31.75$		
Saturday Peak Hour Volume	<i>Not Given – Use ITE Rates</i>	Enter	0.54
		Exit	0.46

Source: Institute of Transportation Engineers  
Trip Generation, 9th Edition, 2012.

# RESIDENTIAL CONDOMINIUM/TOWNHOUSE

ITE CODE = 230

Ornage South (Weintraub - Residential)

Date:

9/3/2015

Trip Generation based on:

Dwelling Units

Size of Analysis Area:

320

units

	Average Rate	Standard Deviation	Adjustment factor	Driveway Volume
Average Weekday 2-way Volume	5.53	0.00	1.00	1769
7-9 AM Peak Hour Enter	0.07	0.00	1.00	22
7-9 AM Peak Hour Exit	0.34	0.00	1.00	108
7-9 AM Peak Hour Total	0.41	0.00	1.00	131
4-6 PM Peak Hour Enter	0.33	0.00	1.00	105
4-6 PM Peak Hour Exit	0.16	0.00	1.00	50
4-6 PM Peak Hour Total	0.49	0.00	1.00	156
Saturday 2-way Volume	4.96	0.00	1.00	1586
Saturday Peak Hour Enter	0.23	0.00	1.00	73
Saturday Peak Hour Exit	0.20	0.00	1.00	63
Saturday Peak Hour Total	0.42	0.00	1.00	135

**\*\*The above rates were calculated from the equations shown below:**

Average Weekday 2-way Volume	$Ln(T) = 0.87 * Ln(X) + 2.46$		
7-9 AM Peak Hour Total	$Ln(T) = 0.80 * Ln(X) + 0.26$	Enter	0.17
		Exit	0.83
4-6 PM Peak Hour Total	$Ln(T) = 0.82 * Ln(X) + 0.32$	Enter	0.67
		Exit	0.33
Saturday 2-way Volume	$T = 3.62(X) + 427.93$		
Saturday Peak Hour Volume	$T = .29(X) + 42.63$	Enter	0.54
		Exit	0.46

Source: Institute of Transportation Engineers  
Trip Generation, 9th Edition, 2012.



NCHRP 8-51 Internal Trip Capture Estimation Tool					
Project Name:	Orange South			Organization:	TMS Engineers, Inc.
Project Location:	Orange, Ohio			Performed By:	ABC
Scenario Description:	Opening Year Analysis			Date:	9/3/2015
Analysis Year:	2016			Checked By:	
Analysis Period:	AM Street Peak Hour			Date:	

Table 1-A: Base Vehicle-Trip Generation Estimates (Single-Use Site Estimate)						
Land Use	Development Data (For Information Only)			Estimated Vehicle-Trips		
	ITE LUCs <sup>1</sup>	Quantity	Units	Total	Entering	Exiting
Office						
Retail						
Restaurant	932	20,000	Square Feet	216	119	97
Cinema/Entertainment						
Residential						
Hotel	310	170	Rooms	90	53	37
All Other Land Uses <sup>2</sup>						
Total				306	172	134

Table 2-A: Mode Split and Vehicle Occupancy Estimates						
Land Use	Entering Trips			Exiting Trips		
	Veh. Occ.	% Transit	% Non-Motorized	Veh. Occ.	% Transit	% Non-Motorized
Office						
Retail						
Restaurant						
Cinema/Entertainment						
Residential						
Hotel						
All Other Land Uses <sup>2</sup>						

Table 3-A: Average Land Use Interchange Distances (Feet Walking Distance)						
Origin (From)	Destination (To)					
	Office	Retail	Restaurant	Cinema/Entertainment	Residential	Hotel
Office						
Retail						
Restaurant						
Cinema/Entertainment						
Residential						
Hotel						

Table 4-A: Internal Person-Trip Origin-Destination Matrix*						
Origin (From)	Destination (To)					
	Office	Retail	Restaurant	Cinema/Entertainment	Residential	Hotel
Office		0	0	0	0	0
Retail	0		0	0	0	0
Restaurant	0	0		0	0	2
Cinema/Entertainment	0	0	0		0	0
Residential	0	0	0	0		0
Hotel	0	0	3	0	0	

Table 5-A: Computations Summary			
	Total	Entering	Exiting
All Person-Trips	306	172	134
Internal Capture Percentage	3%	3%	4%
External Vehicle-Trips <sup>3</sup>	296	167	129
External Transit-Trips <sup>4</sup>	0	0	0
External Non-Motorized Trips <sup>4</sup>	0	0	0

Table 6-A: Internal Trip Capture Percentages by Land Use		
Land Use	Entering Trips	Exiting Trips
Office	N/A	N/A
Retail	N/A	N/A
Restaurant	3%	2%
Cinema/Entertainment	N/A	N/A
Residential	N/A	N/A
Hotel	4%	8%

<sup>1</sup>Land Use Codes (LUCs) from *Trip Generation Informational Report*, published by the Institute of Transportation Engineers.

<sup>2</sup>Total estimate for all other land uses at mixed-use development site-not subject to internal trip capture computations in this estimator

<sup>3</sup>Vehicle-trips computed using the mode split and vehicle occupancy values provided in Table 2-A

<sup>4</sup>Person-Trips

\*Indicates computation that has been rounded to the nearest whole number.

*Estimation Tool Developed by the Texas Transportation Institute*

<b>Project Name:</b>	Orange South
<b>Analysis Period:</b>	AM Street Peak Hour

Table 7-A: Conversion of Vehicle-Trip Ends to Person-Trip Ends						
Land Use	Table 7-A (D): Entering Trips			Table 7-A (O): Exiting Trips		
	Veh. Occ.	Vehicle-Trips	Person-Trips*	Veh. Occ.	Vehicle-Trips	Person-Trips*
Office	1.00	0	0	1.00	0	0
Retail	1.00	0	0	1.00	0	0
Restaurant	1.00	119	119	1.00	97	97
Cinema/Entertainment	1.00	0	0	1.00	0	0
Residential	1.00	0	0	1.00	0	0
Hotel	1.00	53	53	1.00	37	37

Table 8-A (O): Internal Person-Trip Origin-Destination Matrix (Computed at Origin)						
Origin (From)	Destination (To)					
	Office	Retail	Restaurant	Cinema/Entertainment	Residential	Hotel
Office		0	0	0	0	0
Retail	0		0	0	0	0
Restaurant	30	14		0	4	3
Cinema/Entertainment	0	0	0		0	0
Residential	0	0	0	0		0
Hotel	28	5	3	0	0	

Table 8-A (D): Internal Person-Trip Origin-Destination Matrix (Computed at Destination)						
Origin (From)	Destination (To)					
	Office	Retail	Restaurant	Cinema/Entertainment	Residential	Hotel
Office		0	27	0	0	0
Retail	0		60	0	0	0
Restaurant	0	0		0	0	2
Cinema/Entertainment	0	0	0		0	0
Residential	0	0	24	0		0
Hotel	0	0	7	0	0	

Table 9-A (D): Internal and External Trips Summary (Entering Trips)						
Destination Land Use	Person-Trip Estimates			External Trips by Mode*		
	Internal	External	Total	Vehicles <sup>1</sup>	Transit <sup>2</sup>	Non-Motorized <sup>2</sup>
Office	0	0	0	0	0	0
Retail	0	0	0	0	0	0
Restaurant	3	116	119	116	0	0
Cinema/Entertainment	0	0	0	0	0	0
Residential	0	0	0	0	0	0
Hotel	2	51	53	51	0	0
All Other Land Uses <sup>3</sup>	0	0	0	0	0	0

Table 9-A (O): Internal and External Trips Summary (Exiting Trips)						
Origin Land Use	Person-Trip Estimates			External Trips by Mode*		
	Internal	External	Total	Vehicles <sup>1</sup>	Transit <sup>2</sup>	Non-Motorized <sup>2</sup>
Office	0	0	0	0	0	0
Retail	0	0	0	0	0	0
Restaurant	2	95	97	95	0	0
Cinema/Entertainment	0	0	0	0	0	0
Residential	0	0	0	0	0	0
Hotel	3	34	37	34	0	0
All Other Land Uses <sup>3</sup>	0	0	0	0	0	0

<sup>1</sup>Vehicle-trips computed using the mode split and vehicle occupancy values provided in Table 2-A

<sup>2</sup>Person-Trips

<sup>3</sup>Total estimate for all other land uses at mixed-use development site-not subject to internal trip capture computations in this estimator

\*Indicates computation that has been rounded to the nearest whole number.

NCHRP 8-51 Internal Trip Capture Estimation Tool					
Project Name:	Orange South			Organization:	TMS Engineers, Inc.
Project Location:	Orange, Ohio			Performed By:	ABC
Scenario Description:	Opening Year Analysis			Date:	9/3/2015
Analysis Year:	2016			Checked By:	
Analysis Period:	PM Street Peak Hour			Date:	

Table 1-P: Base Vehicle-Trip Generation Estimates (Single-Use Site Estimate)						
Land Use	Development Data (For Information Only)			Estimated Vehicle-Trips		
	ITE LUCs <sup>1</sup>	Quantity	Units	Total	Entering	Exiting
Office						
Retail						
Restaurant	932	20,000	Square Feet	196	118	78
Cinema/Entertainment						
Residential						
Hotel	310	170	Rooms	102	52	50
All Other Land Uses <sup>2</sup>						
Total				298	170	128

Table 2-P: Mode Split and Vehicle Occupancy Estimates						
Land Use	Entering Trips			Exiting Trips		
	Veh. Occ.	% Transit	% Non-Motorized	Veh. Occ.	% Transit	% Non-Motorized
Office						
Retail						
Restaurant						
Cinema/Entertainment						
Residential						
Hotel						
All Other Land Uses <sup>2</sup>						

Table 3-P: Average Land Use Interchange Distances (Feet Walking Distance)						
Origin (From)	Destination (To)					
	Office	Retail	Restaurant	Cinema/Entertainment	Residential	Hotel
Office						
Retail						
Restaurant						
Cinema/Entertainment						
Residential						
Hotel						

Table 4-P: Internal Person-Trip Origin-Destination Matrix*						
Origin (From)	Destination (To)					
	Office	Retail	Restaurant	Cinema/Entertainment	Residential	Hotel
Office		0	0	0	0	0
Retail	0		0	0	0	0
Restaurant	0	0		0	0	5
Cinema/Entertainment	0	0	0		0	0
Residential	0	0	0	0		0
Hotel	0	0	6	0	0	

Table 5-P: Computations Summary			
	Total	Entering	Exiting
All Person-Trips	298	170	128
Internal Capture Percentage	7%	6%	9%
External Vehicle-Trips <sup>3</sup>	276	159	117
External Transit-Trips <sup>4</sup>	0	0	0
External Non-Motorized Trips <sup>4</sup>	0	0	0

Table 6-P: Internal Trip Capture Percentages by Land Use		
Land Use	Entering Trips	Exiting Trips
Office	N/A	N/A
Retail	N/A	N/A
Restaurant	5%	6%
Cinema/Entertainment	N/A	N/A
Residential	N/A	N/A
Hotel	10%	12%

<sup>1</sup>Land Use Codes (LUCs) from *Trip Generation Informational Report*, published by the Institute of Transportation Engineers.

<sup>2</sup>Total estimate for all other land uses at mixed-use development site-not subject to internal trip capture computations in this estimator

<sup>3</sup>Vehicle-trips computed using the mode split and vehicle occupancy values provided in Table 2-P

<sup>4</sup>Person-Trips

\*Indicates computation that has been rounded to the nearest whole number.

*Estimation Tool Developed by the Texas Transportation Institute*

<b>Project Name:</b>	Orange South
<b>Analysis Period:</b>	PM Street Peak Hour

Table 7-P: Conversion of Vehicle-Trip Ends to Person-Trip Ends						
Land Use	Table 7-P (D): Entering Trips			Table 7-P (O): Exiting Trips		
	Veh. Occ.	Vehicle-Trips	Person-Trips*	Veh. Occ.	Vehicle-Trips	Person-Trips*
Office	1.00	0	0	1.00	0	0
Retail	1.00	0	0	1.00	0	0
Restaurant	1.00	118	118	1.00	78	78
Cinema/Entertainment	1.00	0	0	1.00	0	0
Residential	1.00	0	0	1.00	0	0
Hotel	1.00	52	52	1.00	50	50

Table 8-P (O): Internal Person-Trip Origin-Destination Matrix (Computed at Origin)						
Origin (From)	Destination (To)					
	Office	Retail	Restaurant	Cinema/Entertainment	Residential	Hotel
Office		0	0	0	0	0
Retail	0		0	0	0	0
Restaurant	2	32		6	14	5
Cinema/Entertainment	0	0	0		0	0
Residential	0	0	0	0		0
Hotel	0	8	34	0	1	

Table 8-P (D): Internal Person-Trip Origin-Destination Matrix (Computed at Destination)						
Origin (From)	Destination (To)					
	Office	Retail	Restaurant	Cinema/Entertainment	Residential	Hotel
Office		0	2	0	0	0
Retail	0		34	0	0	9
Restaurant	0	0		0	0	37
Cinema/Entertainment	0	0	4		0	1
Residential	0	0	17	0		6
Hotel	0	0	6	0	0	

Table 9-P (D): Internal and External Trips Summary (Entering Trips)						
Destination Land Use	Person-Trip Estimates			External Trips by Mode*		
	Internal	External	Total	Vehicles <sup>1</sup>	Transit <sup>2</sup>	Non-Motorized <sup>2</sup>
Office	0	0	0	0	0	0
Retail	0	0	0	0	0	0
Restaurant	6	112	118	112	0	0
Cinema/Entertainment	0	0	0	0	0	0
Residential	0	0	0	0	0	0
Hotel	5	47	52	47	0	0
All Other Land Uses <sup>3</sup>	0	0	0	0	0	0

Table 9-P (O): Internal and External Trips Summary (Exiting Trips)						
Origin Land Use	Person-Trip Estimates			External Trips by Mode*		
	Internal	External	Total	Vehicles <sup>1</sup>	Transit <sup>2</sup>	Non-Motorized <sup>2</sup>
Office	0	0	0	0	0	0
Retail	0	0	0	0	0	0
Restaurant	5	73	78	73	0	0
Cinema/Entertainment	0	0	0	0	0	0
Residential	0	0	0	0	0	0
Hotel	6	44	50	44	0	0
All Other Land Uses <sup>3</sup>	0	0	0	0	0	0

<sup>1</sup>Vehicle-trips computed using the mode split and vehicle occupancy values provided in Table 2-P

<sup>2</sup>Person-Trips

<sup>3</sup>Total estimate for all other land uses at mixed-use development site-not subject to internal trip capture computations in this estimator

\*Indicates computation that has been rounded to the nearest whole number.

NCHRP 8-51 Internal Trip Capture Estimation Tool					
Project Name:	Orange South			Organization:	TMS Engineers, Inc.
Project Location:	Orange, Ohio			Performed By:	ABC
Scenario Description:	Phase 2 Analysis			Date:	9/3/2015
Analysis Year:	2018			Checked By:	
Analysis Period:	AM Street Peak Hour			Date:	

Table 1-A: Base Vehicle-Trip Generation Estimates (Single-Use Site Estimate)						
Land Use	Development Data (For Information Only)			Estimated Vehicle-Trips		
	ITE LUCs <sup>1</sup>	Quantity	Units	Total	Entering	Exiting
Office	710	250,000	Square Feet	398	350	48
Retail						
Restaurant	932	20,000	Square Feet	216	119	97
Cinema/Entertainment						
Residential						
Hotel	310	170	Rooms	90	53	37
All Other Land Uses <sup>2</sup>						
Total				704	522	182

Table 2-A: Mode Split and Vehicle Occupancy Estimates						
Land Use	Entering Trips			Exiting Trips		
	Veh. Occ.	% Transit	% Non-Motorized	Veh. Occ.	% Transit	% Non-Motorized
Office						
Retail						
Restaurant						
Cinema/Entertainment						
Residential						
Hotel						
All Other Land Uses <sup>2</sup>						

Table 3-A: Average Land Use Interchange Distances (Feet Walking Distance)						
Origin (From)	Destination (To)					
	Office	Retail	Restaurant	Cinema/Entertainment	Residential	Hotel
Office						
Retail						
Restaurant						
Cinema/Entertainment						
Residential						
Hotel						

Table 4-A: Internal Person-Trip Origin-Destination Matrix*						
Origin (From)	Destination (To)					
	Office	Retail	Restaurant	Cinema/Entertainment	Residential	Hotel
Office		0	27	0	0	0
Retail	0		0	0	0	0
Restaurant	30	0		0	0	2
Cinema/Entertainment	0	0	0		0	0
Residential	0	0	0	0		0
Hotel	11	0	3	0	0	

Table 5-A: Computations Summary			
	Total	Entering	Exiting
All Person-Trips	704	522	182
Internal Capture Percentage	21%	14%	40%
External Vehicle-Trips <sup>3</sup>	558	449	109
External Transit-Trips <sup>4</sup>	0	0	0
External Non-Motorized Trips <sup>4</sup>	0	0	0

Table 6-A: Internal Trip Capture Percentages by Land Use		
Land Use	Entering Trips	Exiting Trips
Office	12%	56%
Retail	N/A	N/A
Restaurant	25%	33%
Cinema/Entertainment	N/A	N/A
Residential	N/A	N/A
Hotel	4%	38%

<sup>1</sup>Land Use Codes (LUCs) from *Trip Generation Informational Report*, published by the Institute of Transportation Engineers.

<sup>2</sup>Total estimate for all other land uses at mixed-use development site-not subject to internal trip capture computations in this estimator

<sup>3</sup>Vehicle-trips computed using the mode split and vehicle occupancy values provided in Table 2-A

<sup>4</sup>Person-Trips

\*Indicates computation that has been rounded to the nearest whole number.

<b>Project Name:</b>	Orange South
<b>Analysis Period:</b>	AM Street Peak Hour

Table 7-A: Conversion of Vehicle-Trip Ends to Person-Trip Ends						
Land Use	Table 7-A (D): Entering Trips			Table 7-A (O): Exiting Trips		
	Veh. Occ.	Vehicle-Trips	Person-Trips*	Veh. Occ.	Vehicle-Trips	Person-Trips*
Office	1.00	350	350	1.00	48	48
Retail	1.00	0	0	1.00	0	0
Restaurant	1.00	119	119	1.00	97	97
Cinema/Entertainment	1.00	0	0	1.00	0	0
Residential	1.00	0	0	1.00	0	0
Hotel	1.00	53	53	1.00	37	37

Table 8-A (O): Internal Person-Trip Origin-Destination Matrix (Computed at Origin)						
Origin (From)	Destination (To)					
	Office	Retail	Restaurant	Cinema/Entertainment	Residential	Hotel
Office		13	30	0	0	0
Retail	0		0	0	0	0
Restaurant	30	14		0	4	3
Cinema/Entertainment	0	0	0		0	0
Residential	0	0	0	0		0
Hotel	28	5	3	0	0	

Table 8-A (D): Internal Person-Trip Origin-Destination Matrix (Computed at Destination)						
Origin (From)	Destination (To)					
	Office	Retail	Restaurant	Cinema/Entertainment	Residential	Hotel
Office		0	27	0	0	0
Retail	14		60	0	0	0
Restaurant	49	0		0	0	2
Cinema/Entertainment	0	0	0		0	0
Residential	11	0	24	0		0
Hotel	11	0	7	0	0	

Table 9-A (D): Internal and External Trips Summary (Entering Trips)						
Destination Land Use	Person-Trip Estimates			External Trips by Mode*		
	Internal	External	Total	Vehicles <sup>1</sup>	Transit <sup>2</sup>	Non-Motorized <sup>2</sup>
Office	41	309	350	309	0	0
Retail	0	0	0	0	0	0
Restaurant	30	89	119	89	0	0
Cinema/Entertainment	0	0	0	0	0	0
Residential	0	0	0	0	0	0
Hotel	2	51	53	51	0	0
All Other Land Uses <sup>3</sup>	0	0	0	0	0	0

Table 9-A (O): Internal and External Trips Summary (Exiting Trips)						
Origin Land Use	Person-Trip Estimates			External Trips by Mode*		
	Internal	External	Total	Vehicles <sup>1</sup>	Transit <sup>2</sup>	Non-Motorized <sup>2</sup>
Office	27	21	48	21	0	0
Retail	0	0	0	0	0	0
Restaurant	32	65	97	65	0	0
Cinema/Entertainment	0	0	0	0	0	0
Residential	0	0	0	0	0	0
Hotel	14	23	37	23	0	0
All Other Land Uses <sup>3</sup>	0	0	0	0	0	0

<sup>1</sup>Vehicle-trips computed using the mode split and vehicle occupancy values provided in Table 2-A

<sup>2</sup>Person-Trips

<sup>3</sup>Total estimate for all other land uses at mixed-use development site-not subject to internal trip capture computations in this estimator

\*Indicates computation that has been rounded to the nearest whole number.

NCHRP 8-51 Internal Trip Capture Estimation Tool					
Project Name:	Orange South			Organization:	TMS Engineers, Inc.
Project Location:	Orange, Ohio			Performed By:	ABC
Scenario Description:	Phase 2 Analysis			Date:	9/3/2015
Analysis Year:	2018			Checked By:	
Analysis Period:	PM Street Peak Hour			Date:	

Table 1-P: Base Vehicle-Trip Generation Estimates (Single-Use Site Estimate)						
Land Use	Development Data (For Information Only)			Estimated Vehicle-Trips		
	ITE LUCs <sup>1</sup>	Quantity	Units	Total	Entering	Exiting
Office	710	250,000	Square Feet	358	61	297
Retail						
Restaurant	932	20,000	Square Feet	196	118	78
Cinema/Entertainment						
Residential						
Hotel	310	170	Rooms	102	52	50
All Other Land Uses <sup>2</sup>						
Total				656	231	425

Table 2-P: Mode Split and Vehicle Occupancy Estimates						
Land Use	Entering Trips			Exiting Trips		
	Veh. Occ.	% Transit	% Non-Motorized	Veh. Occ.	% Transit	% Non-Motorized
Office						
Retail						
Restaurant						
Cinema/Entertainment						
Residential						
Hotel						
All Other Land Uses <sup>2</sup>						

Table 3-P: Average Land Use Interchange Distances (Feet Walking Distance)						
Origin (From)	Destination (To)					
	Office	Retail	Restaurant	Cinema/Entertainment	Residential	Hotel
Office						
Retail						
Restaurant						
Cinema/Entertainment						
Residential						
Hotel						

Table 4-P: Internal Person-Trip Origin-Destination Matrix*						
Origin (From)	Destination (To)					
	Office	Retail	Restaurant	Cinema/Entertainment	Residential	Hotel
Office		0	2	0	0	0
Retail	0		0	0	0	0
Restaurant	2	0		0	0	5
Cinema/Entertainment	0	0	0		0	0
Residential	0	0	0	0		0
Hotel	0	0	6	0	0	

Table 5-P: Computations Summary			
	Total	Entering	Exiting
All Person-Trips	656	231	425
Internal Capture Percentage	5%	6%	4%
External Vehicle-Trips <sup>3</sup>	626	216	410
External Transit-Trips <sup>4</sup>	0	0	0
External Non-Motorized Trips <sup>4</sup>	0	0	0

Table 6-P: Internal Trip Capture Percentages by Land Use		
Land Use	Entering Trips	Exiting Trips
Office	3%	1%
Retail	N/A	N/A
Restaurant	7%	9%
Cinema/Entertainment	N/A	N/A
Residential	N/A	N/A
Hotel	10%	12%

<sup>1</sup>Land Use Codes (LUCs) from *Trip Generation Informational Report*, published by the Institute of Transportation Engineers.

<sup>2</sup>Total estimate for all other land uses at mixed-use development site-not subject to internal trip capture computations in this estimator

<sup>3</sup>Vehicle-trips computed using the mode split and vehicle occupancy values provided in Table 2-P

<sup>4</sup>Person-Trips

\*Indicates computation that has been rounded to the nearest whole number.

<b>Project Name:</b>	Orange South
<b>Analysis Period:</b>	PM Street Peak Hour

Table 7-P: Conversion of Vehicle-Trip Ends to Person-Trip Ends						
Land Use	Table 7-P (D): Entering Trips			Table 7-P (O): Exiting Trips		
	Veh. Occ.	Vehicle-Trips	Person-Trips*	Veh. Occ.	Vehicle-Trips	Person-Trips*
Office	1.00	61	61	1.00	297	297
Retail	1.00	0	0	1.00	0	0
Restaurant	1.00	118	118	1.00	78	78
Cinema/Entertainment	1.00	0	0	1.00	0	0
Residential	1.00	0	0	1.00	0	0
Hotel	1.00	52	52	1.00	50	50

Table 8-P (O): Internal Person-Trip Origin-Destination Matrix (Computed at Origin)						
Origin (From)	Destination (To)					
	Office	Retail	Restaurant	Cinema/Entertainment	Residential	Hotel
Office		59	12	0	6	0
Retail	0		0	0	0	0
Restaurant	2	32		6	14	5
Cinema/Entertainment	0	0	0		0	0
Residential	0	0	0	0		0
Hotel	0	8	34	0	1	

Table 8-P (D): Internal Person-Trip Origin-Destination Matrix (Computed at Destination)						
Origin (From)	Destination (To)					
	Office	Retail	Restaurant	Cinema/Entertainment	Residential	Hotel
Office		0	2	0	0	0
Retail	19		34	0	0	9
Restaurant	18	0		0	0	37
Cinema/Entertainment	4	0	4		0	1
Residential	35	0	17	0		6
Hotel	0	0	6	0	0	

Table 9-P (D): Internal and External Trips Summary (Entering Trips)						
Destination Land Use	Person-Trip Estimates			External Trips by Mode*		
	Internal	External	Total	Vehicles <sup>1</sup>	Transit <sup>2</sup>	Non-Motorized <sup>2</sup>
Office	2	59	61	59	0	0
Retail	0	0	0	0	0	0
Restaurant	8	110	118	110	0	0
Cinema/Entertainment	0	0	0	0	0	0
Residential	0	0	0	0	0	0
Hotel	5	47	52	47	0	0
All Other Land Uses <sup>3</sup>	0	0	0	0	0	0

Table 9-P (O): Internal and External Trips Summary (Exiting Trips)						
Origin Land Use	Person-Trip Estimates			External Trips by Mode*		
	Internal	External	Total	Vehicles <sup>1</sup>	Transit <sup>2</sup>	Non-Motorized <sup>2</sup>
Office	2	295	297	295	0	0
Retail	0	0	0	0	0	0
Restaurant	7	71	78	71	0	0
Cinema/Entertainment	0	0	0	0	0	0
Residential	0	0	0	0	0	0
Hotel	6	44	50	44	0	0
All Other Land Uses <sup>3</sup>	0	0	0	0	0	0

<sup>1</sup>Vehicle-trips computed using the mode split and vehicle occupancy values provided in Table 2-P

<sup>2</sup>Person-Trips

<sup>3</sup>Total estimate for all other land uses at mixed-use development site-not subject to internal trip capture computations in this estimator

\*Indicates computation that has been rounded to the nearest whole number.



NCHRP 8-51 Internal Trip Capture Estimation Tool					
<b>Project Name:</b>	Orange South			<b>Organization:</b>	TMS Engineers, Inc.
<b>Project Location:</b>	Orange, Ohio			<b>Performed By:</b>	ABC
<b>Scenario Description:</b>	Future Analysis			<b>Date:</b>	9/3/2015
<b>Analysis Year:</b>	2036			<b>Checked By:</b>	
<b>Analysis Period:</b>	AM Street Peak Hour			<b>Date:</b>	

Table 1-A: Base Vehicle-Trip Generation Estimates (Single-Use Site Estimate)						
Land Use	Development Data (For Information Only)			Estimated Vehicle-Trips		
	ITE LUCs <sup>1</sup>	Quantity	Units	Total	Entering	Exiting
Office	710	450,000	Square Feet	637	561	76
Retail						
Restaurant	932	20,000	Square Feet	216	119	97
Cinema/Entertainment						
Residential	230	320	Units	130	22	108
Hotel	310	170	Rooms	90	53	37
All Other Land Uses <sup>2</sup>						
<b>Total</b>				<b>1073</b>	<b>755</b>	<b>318</b>

Table 2-A: Mode Split and Vehicle Occupancy Estimates						
Land Use	Entering Trips			Exiting Trips		
	Veh. Occ.	% Transit	% Non-Motorized	Veh. Occ.	% Transit	% Non-Motorized
Office						
Retail						
Restaurant						
Cinema/Entertainment						
Residential						
Hotel						
All Other Land Uses <sup>2</sup>						

Table 3-A: Average Land Use Interchange Distances (Feet Walking Distance)						
Origin (From)	Destination (To)					
	Office	Retail	Restaurant	Cinema/Entertainment	Residential	Hotel
Office						
Retail						
Restaurant						
Cinema/Entertainment						
Residential						
Hotel						

Table 4-A: Internal Person-Trip Origin-Destination Matrix*						
Origin (From)	Destination (To)					
	Office	Retail	Restaurant	Cinema/Entertainment	Residential	Hotel
Office		0	27	0	0	0
Retail	0		0	0	0	0
Restaurant	30	0		0	1	2
Cinema/Entertainment	0	0	0		0	0
Residential	2	0	22	0		0
Hotel	17	0	3	0	0	

Table 5-A: Computations Summary			
	Total	Entering	Exiting
All Person-Trips	1,073	755	318
Internal Capture Percentage	19%	14%	33%
External Vehicle-Trips <sup>3</sup>	865	651	214
External Transit-Trips <sup>4</sup>	0	0	0
External Non-Motorized Trips <sup>4</sup>	0	0	0

Table 6-A: Internal Trip Capture Percentages by Land Use		
Land Use	Entering Trips	Exiting Trips
Office	9%	36%
Retail	N/A	N/A
Restaurant	44%	34%
Cinema/Entertainment	N/A	N/A
Residential	5%	22%
Hotel	4%	54%

<sup>1</sup>Land Use Codes (LUCs) from *Trip Generation Informational Report*, published by the Institute of Transportation Engineers.

<sup>2</sup>Total estimate for all other land uses at mixed-use development site-not subject to internal trip capture computations in this estimator

<sup>3</sup>Vehicle-trips computed using the mode split and vehicle occupancy values provided in Table 2-A

<sup>4</sup>Person-Trips

\*Indicates computation that has been rounded to the nearest whole number.

<b>Project Name:</b>	Orange South
<b>Analysis Period:</b>	AM Street Peak Hour

Table 7-A: Conversion of Vehicle-Trip Ends to Person-Trip Ends						
Land Use	Table 7-A (D): Entering Trips			Table 7-A (O): Exiting Trips		
	Veh. Occ.	Vehicle-Trips	Person-Trips*	Veh. Occ.	Vehicle-Trips	Person-Trips*
Office	1.00	561	561	1.00	76	76
Retail	1.00	0	0	1.00	0	0
Restaurant	1.00	119	119	1.00	97	97
Cinema/Entertainment	1.00	0	0	1.00	0	0
Residential	1.00	22	22	1.00	108	108
Hotel	1.00	53	53	1.00	37	37

Table 8-A (O): Internal Person-Trip Origin-Destination Matrix (Computed at Origin)						
Origin (From)	Destination (To)					
	Office	Retail	Restaurant	Cinema/Entertainment	Residential	Hotel
Office		21	48	0	1	0
Retail	0		0	0	0	0
Restaurant	30	14		0	4	3
Cinema/Entertainment	0	0	0		0	0
Residential	2	1	22	0		0
Hotel	28	5	3	0	0	

Table 8-A (D): Internal Person-Trip Origin-Destination Matrix (Computed at Destination)						
Origin (From)	Destination (To)					
	Office	Retail	Restaurant	Cinema/Entertainment	Residential	Hotel
Office		0	27	0	0	0
Retail	22		60	0	0	0
Restaurant	79	0		0	1	2
Cinema/Entertainment	0	0	0		0	0
Residential	17	0	24	0		0
Hotel	17	0	7	0	0	

Table 9-A (D): Internal and External Trips Summary (Entering Trips)						
Destination Land Use	Person-Trip Estimates			External Trips by Mode*		
	Internal	External	Total	Vehicles <sup>1</sup>	Transit <sup>2</sup>	Non-Motorized <sup>2</sup>
Office	49	512	561	512	0	0
Retail	0	0	0	0	0	0
Restaurant	52	67	119	67	0	0
Cinema/Entertainment	0	0	0	0	0	0
Residential	1	21	22	21	0	0
Hotel	2	51	53	51	0	0
All Other Land Uses <sup>3</sup>	0	0	0	0	0	0

Table 9-A (O): Internal and External Trips Summary (Exiting Trips)						
Origin Land Use	Person-Trip Estimates			External Trips by Mode*		
	Internal	External	Total	Vehicles <sup>1</sup>	Transit <sup>2</sup>	Non-Motorized <sup>2</sup>
Office	27	49	76	49	0	0
Retail	0	0	0	0	0	0
Restaurant	33	64	97	64	0	0
Cinema/Entertainment	0	0	0	0	0	0
Residential	24	84	108	84	0	0
Hotel	20	17	37	17	0	0
All Other Land Uses <sup>3</sup>	0	0	0	0	0	0

<sup>1</sup>Vehicle-trips computed using the mode split and vehicle occupancy values provided in Table 2-A

<sup>2</sup>Person-Trips

<sup>3</sup>Total estimate for all other land uses at mixed-use development site-not subject to internal trip capture computations in this estimator

\*Indicates computation that has been rounded to the nearest whole number.

NCHRP 8-51 Internal Trip Capture Estimation Tool					
<b>Project Name:</b>	Orange South			<b>Organization:</b>	TMS Engineers, Inc.
<b>Project Location:</b>	Orange, Ohio			<b>Performed By:</b>	ABC
<b>Scenario Description:</b>	Future Analysis			<b>Date:</b>	9/3/2015
<b>Analysis Year:</b>	2036			<b>Checked By:</b>	
<b>Analysis Period:</b>	PM Street Peak Hour			<b>Date:</b>	

Table 1-P: Base Vehicle-Trip Generation Estimates (Single-Use Site Estimate)						
Land Use	Development Data (For Information Only)			Estimated Vehicle-Trips		
	ITE LUCs <sup>1</sup>	Quantity	Units	Total	Entering	Exiting
Office	710	450,000	Square Feet	581	99	482
Retail						
Restaurant	932	20,000	Square Feet	196	118	78
Cinema/Entertainment						
Residential	230	320	Units	155	105	50
Hotel	310	170	Rooms	102	52	50
All Other Land Uses <sup>2</sup>						
<b>Total</b>				<b>1034</b>	<b>374</b>	<b>660</b>

Table 2-P: Mode Split and Vehicle Occupancy Estimates						
Land Use	Entering Trips			Exiting Trips		
	Veh. Occ.	% Transit	% Non-Motorized	Veh. Occ.	% Transit	% Non-Motorized
Office						
Retail						
Restaurant						
Cinema/Entertainment						
Residential						
Hotel						
All Other Land Uses <sup>2</sup>						

Table 3-P: Average Land Use Interchange Distances (Feet Walking Distance)						
Origin (From)	Destination (To)					
	Office	Retail	Restaurant	Cinema/Entertainment	Residential	Hotel
Office						
Retail						
Restaurant						
Cinema/Entertainment						
Residential						
Hotel						

Table 4-P: Internal Person-Trip Origin-Destination Matrix*						
Origin (From)	Destination (To)					
	Office	Retail	Restaurant	Cinema/Entertainment	Residential	Hotel
Office		0	2	0	4	0
Retail	0		0	0	0	0
Restaurant	2	0		0	14	5
Cinema/Entertainment	0	0	0		0	0
Residential	2	0	11	0		2
Hotel	0	0	6	0	0	

Table 5-P: Computations Summary			
	Total	Entering	Exiting
All Person-Trips	1,034	374	660
Internal Capture Percentage	9%	13%	7%
External Vehicle-Trips <sup>3</sup>	938	326	612
External Transit-Trips <sup>4</sup>	0	0	0
External Non-Motorized Trips <sup>4</sup>	0	0	0

Table 6-P: Internal Trip Capture Percentages by Land Use		
Land Use	Entering Trips	Exiting Trips
Office	4%	1%
Retail	N/A	N/A
Restaurant	16%	27%
Cinema/Entertainment	N/A	N/A
Residential	17%	30%
Hotel	13%	12%

<sup>1</sup>Land Use Codes (LUCs) from *Trip Generation Informational Report*, published by the Institute of Transportation Engineers.

<sup>2</sup>Total estimate for all other land uses at mixed-use development site-not subject to internal trip capture computations in this estimator

<sup>3</sup>Vehicle-trips computed using the mode split and vehicle occupancy values provided in Table 2-P

<sup>4</sup>Person-Trips

\*Indicates computation that has been rounded to the nearest whole number.

<b>Project Name:</b>	Orange South
<b>Analysis Period:</b>	PM Street Peak Hour

Table 7-P: Conversion of Vehicle-Trip Ends to Person-Trip Ends						
Land Use	Table 7-P (D): Entering Trips			Table 7-P (O): Exiting Trips		
	Veh. Occ.	Vehicle-Trips	Person-Trips*	Veh. Occ.	Vehicle-Trips	Person-Trips*
Office	1.00	99	99	1.00	482	482
Retail	1.00	0	0	1.00	0	0
Restaurant	1.00	118	118	1.00	78	78
Cinema/Entertainment	1.00	0	0	1.00	0	0
Residential	1.00	105	105	1.00	50	50
Hotel	1.00	52	52	1.00	50	50

Table 8-P (O): Internal Person-Trip Origin-Destination Matrix (Computed at Origin)						
Origin (From)	Destination (To)					
	Office	Retail	Restaurant	Cinema/Entertainment	Residential	Hotel
Office		96	19	0	10	0
Retail	0		0	0	0	0
Restaurant	2	32		6	14	5
Cinema/Entertainment	0	0	0		0	0
Residential	2	21	11	0		2
Hotel	0	8	34	0	1	

Table 8-P (D): Internal Person-Trip Origin-Destination Matrix (Computed at Destination)						
Origin (From)	Destination (To)					
	Office	Retail	Restaurant	Cinema/Entertainment	Residential	Hotel
Office		0	2	0	4	0
Retail	31		34	0	48	9
Restaurant	30	0		0	17	37
Cinema/Entertainment	6	0	4		4	1
Residential	56	0	17	0		6
Hotel	0	0	6	0	0	

Table 9-P (D): Internal and External Trips Summary (Entering Trips)						
Destination Land Use	Person-Trip Estimates			External Trips by Mode*		
	Internal	External	Total	Vehicles <sup>1</sup>	Transit <sup>2</sup>	Non-Motorized <sup>2</sup>
Office	4	95	99	95	0	0
Retail	0	0	0	0	0	0
Restaurant	19	99	118	99	0	0
Cinema/Entertainment	0	0	0	0	0	0
Residential	18	87	105	87	0	0
Hotel	7	45	52	45	0	0
All Other Land Uses <sup>3</sup>	0	0	0	0	0	0

Table 9-P (O): Internal and External Trips Summary (Exiting Trips)						
Origin Land Use	Person-Trip Estimates			External Trips by Mode*		
	Internal	External	Total	Vehicles <sup>1</sup>	Transit <sup>2</sup>	Non-Motorized <sup>2</sup>
Office	6	476	482	476	0	0
Retail	0	0	0	0	0	0
Restaurant	21	57	78	57	0	0
Cinema/Entertainment	0	0	0	0	0	0
Residential	15	35	50	35	0	0
Hotel	6	44	50	44	0	0
All Other Land Uses <sup>3</sup>	0	0	0	0	0	0

<sup>1</sup>Vehicle-trips computed using the mode split and vehicle occupancy values provided in Table 2-P

<sup>2</sup>Person-Trips

<sup>3</sup>Total estimate for all other land uses at mixed-use development site-not subject to internal trip capture computations in this estimator

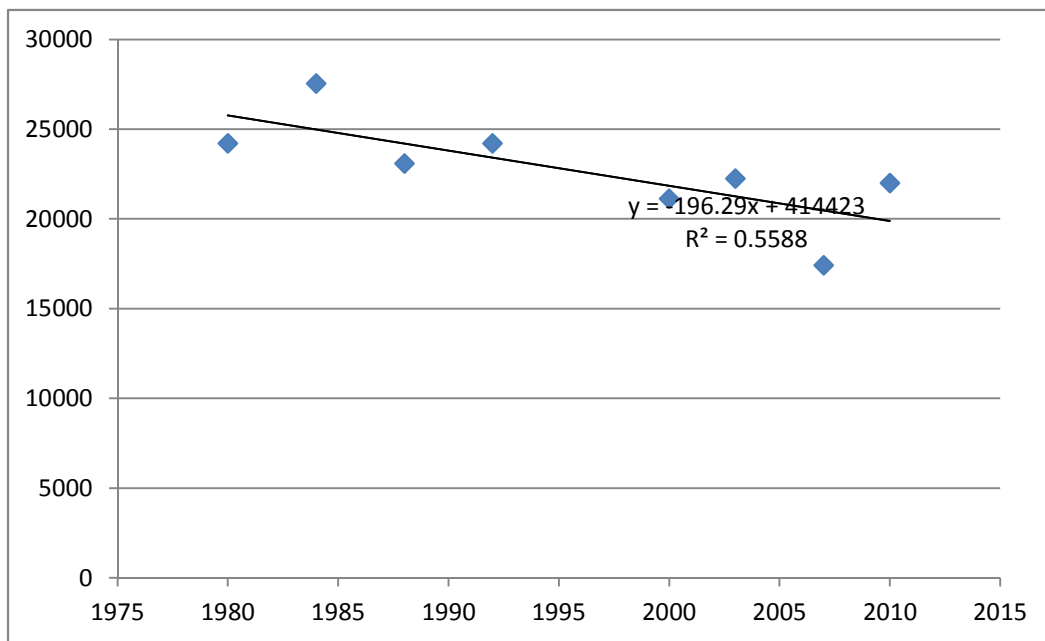
\*Indicates computation that has been rounded to the nearest whole number.

## **APPENDIX C**

### **Growth Rate Calculations**

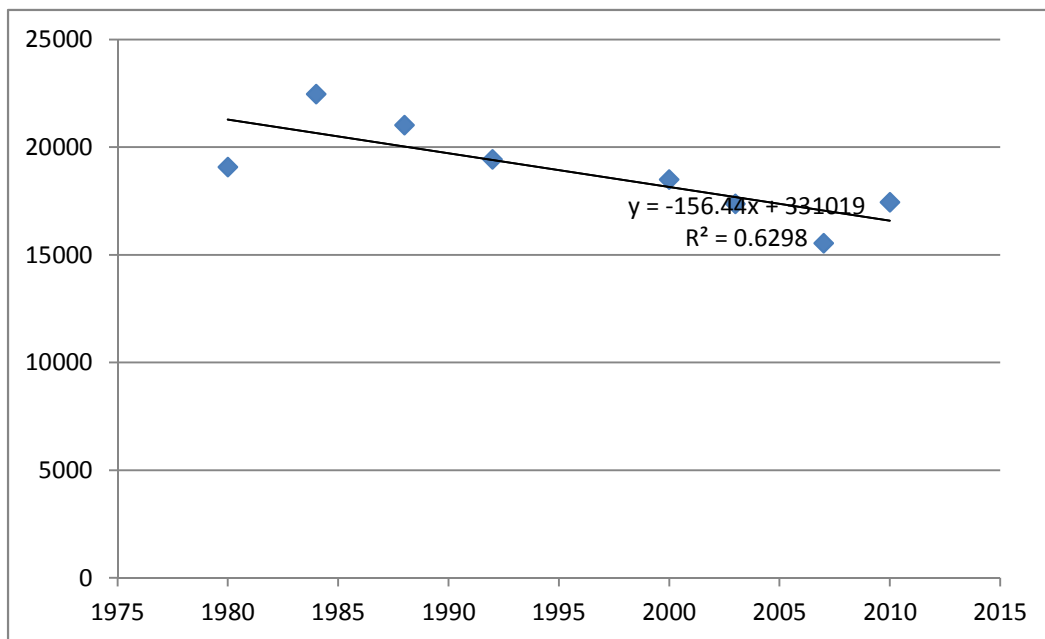
# **SR87/422 @ I-271 COUNT DATA FROM ODOT WEBSITE/TRAFFIC COUNT DATA**

Year	Volume	% Diff per Yr to Prev Yr Count	% Diff per Yr Since 2010	AVG/YEAR Since 1980 <i>-0.30%</i>
2010	21990	8.77%		
2007	17410	-5.43%	8.77%	
2003	22240	1.77%	-0.16%	
2000	21120	-1.60%	0.41%	
1992	24210	1.21%	-0.51%	
1988	23090	-4.04%	-0.22%	
1984	27540	3.45%	-0.78%	
1980	24200		-0.30%	
				AVG/YEAR Since 1988 <i>-0.22%</i>
				AVG/YEAR Since 1992 <i>-0.51%</i>
				AVG/YEAR Since 2000 <i>0.41%</i>



# **SR87/422 @ WEST BRAINNARD COUNT DATA FROM ODOT WEBSITE/TRAFFIC COUNT DATA**

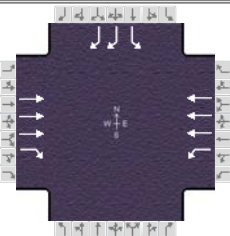
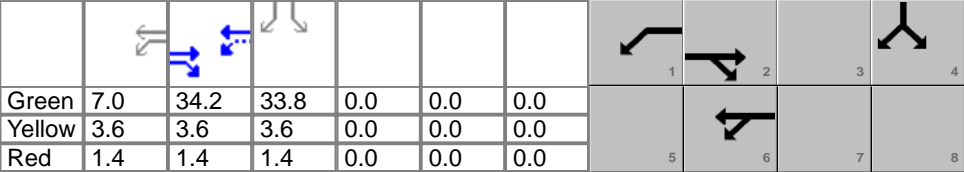
Year	Volume	% Diff per Yr to Prev Yr Count	% Diff per Yr Since 2010	AVG/YEAR Since 1980 -0.28%
2010	17440	4.08%		
2007	15540	-2.62%	4.08%	
2003	17360	-2.04%	0.07%	
2000	18490	-0.60%	-0.57%	
1992	19430	-1.89%	-0.57%	
1988	21020	-1.60%	-0.77%	
1984	22460	4.44%	-0.86%	
1980	19070		-0.28%	
				AVG/YEAR Since 1988 -0.77%
				AVG/YEAR Since 1992 -0.57%
				AVG/YEAR Since 2000 -0.57%



**APPENDIX D**  
**Existing Capacity Analysis Worksheets**  
**2015**

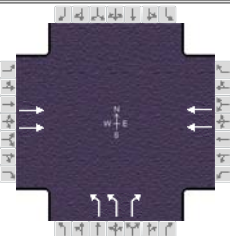


# HCS 2010 Signalized Intersection Results Summary

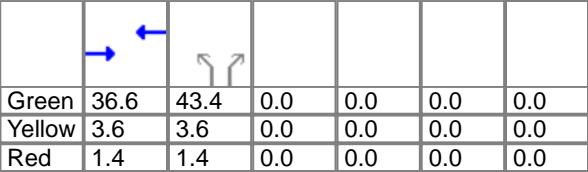
General Information					Intersection Information														
Agency		TMS Engineers, Inc.					Duration, h		0.25										
Analyst		ABC		Analysis Date		Sep 16, 2015		Area Type						Other					
Jurisdiction		Orange, OH		Time Period		AM Peak		PHF						0.92					
Urban Street		Harvard Road		Analysis Year		2015		Analysis Period						1> 7:00					
Intersection		@ I-271 SB Ramps		File Name		AM EX 271SB.xus													
Project Description		Existing Conditions																	
Demand Information																			
Approach Movement				EB			WB			NB			SB						
				L	T	R	L	T	R	L	T	R	L	T	R				
Demand ( v ), veh/h					289	229	277	1300					89		539				
Signal Information																			
Cycle, s	90.0	Reference Phase	2																
Offset, s	0	Reference Point	End																
Uncoordinated	No	Simult. Gap E/W	On																
Force Mode	Fixed	Simult. Gap N/S	On																
				Green	7.0	34.2	33.8	0.0	0.0	0.0									
				Yellow	3.6	3.6	3.6	0.0	0.0	0.0									
				Red	1.4	1.4	1.4	0.0	0.0	0.0									
Timer Results				EBL		EBT		WBL		WBT		NBL		NBT		SBL		SBT	
Assigned Phase						2		1		6								4	
Case Number						7.3		1.0		4.0								9.0	
Phase Duration, s						39.2		12.0		51.2								38.8	
Change Period, ( Y+R c ), s						5.0		5.0		5.0								5.0	
Max Allow Headway ( MAH ), s						0.0		3.1		0.0								3.3	
Queue Clearance Time ( g s ), s								9.0										16.9	
Green Extension Time ( g e ), s						0.0		0.0		0.0								1.8	
Phase Call Probability								1.00										1.00	
Max Out Probability								1.00										0.00	
Movement Group Results				EB			WB			NB			SB						
Approach Movement				L	T	R	L	T	R	L	T	R	L	T	R				
Assigned Movement					2	12	1	6					7		14				
Adjusted Flow Rate ( v ), veh/h					314	249	301	1413					97		586				
Adjusted Saturation Flow Rate ( s ), veh/h/ln					1691	1579	1774	1691					1774		1397				
Queue Service Time ( g s ), s					3.7	10.4	7.0	16.9					3.2		14.9				
Cycle Queue Clearance Time ( g c ), s					3.7	10.4	7.0	16.9					3.2		14.9				
Green Ratio ( g/C )					0.38	0.38	0.48	0.51					0.38		0.38				
Capacity ( c ), veh/h					1928	600	578	2605					666		1049				
Volume-to-Capacity Ratio ( X )					0.163	0.415	0.521	0.542					0.145		0.558				
Available Capacity ( c a ), veh/h					1928	600	578	2605					666		1049				
Back of Queue ( Q ), veh/ln ( 50 th percentile)					1.4	4.0	0.9	6.1					1.3		4.7				
Queue Storage Ratio ( RQ ) ( 50 th percentile)					0.00	0.00	0.00	0.00					0.00		0.00				
Uniform Delay ( d 1 ), s/veh					18.4	20.5	16.2	14.8					18.6		22.2				
Incremental Delay ( d 2 ), s/veh					0.2	2.1	0.4	0.8					0.0		0.4				
Initial Queue Delay ( d 3 ), s/veh					0.0	0.0	0.0	0.0					0.0		0.0				
Control Delay ( d ), s/veh					18.6	22.6	16.6	15.6					18.6		22.6				
Level of Service (LOS)					B	C	B	B					B		C				
Approach Delay, s/veh / LOS				20.4		C		15.8		B		0.0				22.0		C	
Intersection Delay, s/veh / LOS				18.1										B					
Multimodal Results				EB			WB			NB			SB						
Pedestrian LOS Score / LOS				1.9		A		1.9		A		3.3		C		3.3		C	
Bicycle LOS Score / LOS				0.8		A		1.4		A								F	

# HCS 2010 Signalized Intersection Results Summary

General Information					Intersection Information				
Agency		TMS Engineers, Inc.			Duration, h		0.25		
Analyst		ABC	Analysis Date	Sep 16, 2015	Area Type		Other		
Jurisdiction		Orange, OH	Time Period	AM Peak	PHF		0.92		
Urban Street		Harvard Road	Analysis Year	2015	Analysis Period		1> 7:00		
Intersection		@ I-271 NB Exit	File Name	AM EX 271NB.xus					
Project Description		Existing Conditions							



Demand Information				EB			WB			NB			SB		
Approach Movement				L	T	R	L	T	R	L	T	R	L	T	R
Demand ( v ), veh/h					216			533		1092		366			

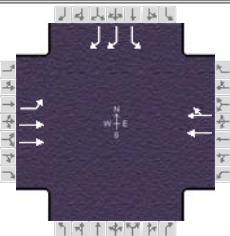
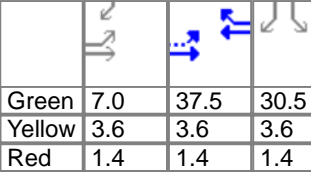
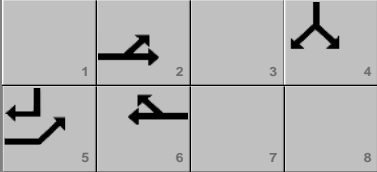
Signal Information															
Cycle, s	90.0	Reference Phase	2												
Offset, s	0	Reference Point	End												
Uncoordinated	No	Simult. Gap E/W	On												
Force Mode	Fixed	Simult. Gap N/S	On												
Green	36.6	43.4	0.0	0.0	0.0	0.0									
Yellow	3.6	3.6	0.0	0.0	0.0	0.0									
Red	1.4	1.4	0.0	0.0	0.0	0.0									

Timer Results		EBL	EBT	WBL	WBT	NBL	NBT	SBL	SBT
Assigned Phase			2		6		8		
Case Number			8.0		8.0		9.0		
Phase Duration, s			41.6		41.6		48.4		
Change Period, ( Y+R c ), s			5.0		5.0		5.0		
Max Allow Headway ( MAH ), s			0.0		0.0		3.2		
Queue Clearance Time ( g s ), s							26.5		
Green Extension Time ( g e ), s			0.0		0.0		4.3		
Phase Call Probability							1.00		
Max Out Probability							0.07		

Movement Group Results		EB			WB			NB			SB		
Approach Movement		L	T	R	L	T	R	L	T	R	L	T	R
Assigned Movement			2			6		3		18			
Adjusted Flow Rate ( v ), veh/h			235			579		1187		398			
Adjusted Saturation Flow Rate ( s ), veh/h/ln			1773			1791		1723		1579			
Queue Service Time ( g s ), s			3.8			10.3		24.5		15.7			
Cycle Queue Clearance Time ( g c ), s			3.8			10.3		24.5		15.7			
Green Ratio ( g/C )			0.41			0.41		0.48		0.48			
Capacity ( c ), veh/h			1442			1457		1661		761			
Volume-to-Capacity Ratio ( X )			0.163			0.398		0.714		0.523			
Available Capacity ( c a ), veh/h			1442			1457		1661		761			
Back of Queue ( Q ), veh/ln ( 50 th percentile)			1.5			4.2		9.2		5.3			
Queue Storage Ratio ( RQ ) ( 50 th percentile)			0.00			0.00		0.00		0.00			
Uniform Delay ( d 1 ), s/veh			17.0			18.9		18.4		16.1			
Incremental Delay ( d 2 ), s/veh			0.2			0.8		1.3		0.3			
Initial Queue Delay ( d 3 ), s/veh			0.0			0.0		0.0		0.0			
Control Delay ( d ), s/veh			17.2			19.7		19.7		16.4			
Level of Service (LOS)			B			B		B		B			
Approach Delay, s/veh / LOS		17.2	B	19.7	B	18.9	B	0.0					
Intersection Delay, s/veh / LOS		18.9						B					

Multimodal Results		EB		WB		NB		SB	
Pedestrian LOS Score / LOS		1.9	A	0.7	A	2.7	B	2.7	B
Bicycle LOS Score / LOS		0.7	A	1.0	A		F		

# HCS 2010 Signalized Intersection Results Summary

General Information					Intersection Information														
Agency		TMS Engineers, Inc.			Duration, h		0.25												
Analyst		ABC	Analysis Date	Sep 16, 2015		Area Type		Other											
Jurisdiction		Orange Village, OH	Time Period	AM Peak Period		PHF		0.92											
Urban Street		Harvard Road	Analysis Year	2015		Analysis Period		1> 7:00											
Intersection		Harvard & Orange Place	File Name	AM EX HarvardOrange.xus															
Project Description		Existing Conditions																	
Demand Information																			
				EB			WB			NB			SB						
Approach Movement				L	T	R	L	T	R	L	T	R	L	T	R				
Demand ( v ), veh/h				244	347			516	43				11		112				
Signal Information																			
Cycle, s	90.0	Reference Phase	2																
Offset, s	0	Reference Point	End																
Uncoordinated	No	Simult. Gap E/W	On																
Force Mode	Fixed	Simult. Gap N/S	On																
				Green	7.0	37.5	30.5	0.0	0.0	0.0									
				Yellow	3.6	3.6	3.6	0.0	0.0	0.0									
				Red	1.4	1.4	1.4	0.0	0.0	0.0									
Timer Results				EBL		EBT		WBL		WBT		NBL		NBT		SBL		SBT	
Assigned Phase				5		2				6								4	
Case Number				1.0		4.0				8.3								9.0	
Phase Duration, s				12.0		54.5				42.5								35.5	
Change Period, ( Y+R c ), s				5.0		5.0				5.0								5.0	
Max Allow Headway ( MAH ), s				3.1		0.0				0.0								3.3	
Queue Clearance Time ( g s ), s				9.0														4.4	
Green Extension Time ( g e ), s				0.0		0.0				0.0								0.3	
Phase Call Probability				1.00														1.00	
Max Out Probability				1.00														0.00	
Movement Group Results				EB			WB			NB			SB						
Approach Movement				L	T	R	L	T	R	L	T	R	L	T	R				
Assigned Movement				5	2			6	16				7		14				
Adjusted Flow Rate ( v ), veh/h				265	377			307	300				12		122				
Adjusted Saturation Flow Rate ( s ), veh/h/ln				1774	1773			1863	1812				1774		1397				
Queue Service Time ( g s ), s				7.0	4.8			10.4	10.4				0.4		2.4				
Cycle Queue Clearance Time ( g c ), s				7.0	4.8			10.4	10.4				0.4		2.4				
Green Ratio ( g/C )				0.52	0.55			0.42	0.42				0.34		0.42				
Capacity ( c ), veh/h				462	1951			776	755				601		1164				
Volume-to-Capacity Ratio ( X )				0.575	0.193			0.396	0.398				0.020		0.105				
Available Capacity ( c a ), veh/h				462	1951			776	755				601		1164				
Back of Queue ( Q ), veh/ln ( 50 th percentile)				2.9	1.8			4.5	4.5				0.2		0.7				
Queue Storage Ratio ( RQ ) ( 50 th percentile)				0.00	0.00			0.00	0.00				0.00		0.00				
Uniform Delay ( d 1 ), s/veh				14.4	10.2			18.3	18.4				19.8		16.0				
Incremental Delay ( d 2 ), s/veh				1.1	0.2			1.5	1.6				0.0		0.0				
Initial Queue Delay ( d 3 ), s/veh				0.0	0.0			0.0	0.0				0.0		0.0				
Control Delay ( d ), s/veh				15.6	10.4			19.9	19.9				19.8		16.0				
Level of Service (LOS)				B	B			B	B				B		B				
Approach Delay, s/veh / LOS				12.5		B		19.9		B		0.0				16.4		B	
Intersection Delay, s/veh / LOS				16.1						B									
Multimodal Results				EB			WB			NB			SB						
Pedestrian LOS Score / LOS				0.7		A		2.4		B		2.7		B		2.9		C	
Bicycle LOS Score / LOS				1.0		A		1.0		A								F	

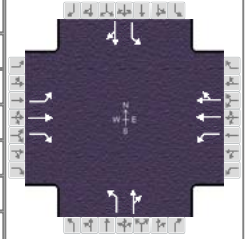
# HCS 2010 Signalized Intersection Results Summary

## General Information

Agency	TMS Engineers, Inc.
Analyst	ABC
Jurisdiction	Orange Village, OH
Urban Street	Harvard Road
Intersection	Harvard & Brainard
Project Description	Existing Conditions

## Intersection Information

Duration, h	0.25
Area Type	Other
PHF	0.92
Analysis Period	1 > 7:00
File Name	AM EX HarvardBrainard.xus



## Demand Information

	EB			WB			NB			SB		
Approach Movement	L	T	R	L	T	R	L	T	R	L	T	R
Demand ( $v$ ), veh/h	92	190	47	11	377	31	145	133	11	12	47	33

## Signal Information

Cycle, s	90.0	Reference Phase	2
Offset, s	0	Reference Point	End
Uncoordinated	No	Simult. Gap E/W	On
Force Mode	Fixed	Simult. Gap N/S	On

## Timer Results

	EBL	EBT	WBL	WBT	NBL	NBT	SBL	SBT
Assigned Phase	5	2		6	3	8		4
Case Number	1.0	3.0		6.3	1.0	4.0		6.3
Phase Duration, s	12.0	47.2		35.2	12.0	42.8		30.8
Change Period, ( $Y+R_c$ ), s	5.0	5.0		5.0	5.0	5.0		5.0
Max Allow Headway ( $MAH$ ), s	3.1	0.0		0.0	3.1	3.1		3.1
Queue Clearance Time ( $g_s$ ), s	5.0				7.3	6.8		5.4
Green Extension Time ( $g_e$ ), s	0.0	0.0		0.0	0.0	0.5		0.4
Phase Call Probability	1.00				1.00	1.00		1.00
Max Out Probability	1.00				1.00	0.00		0.00

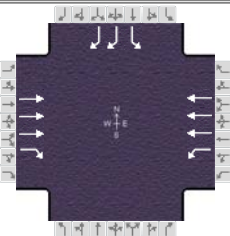
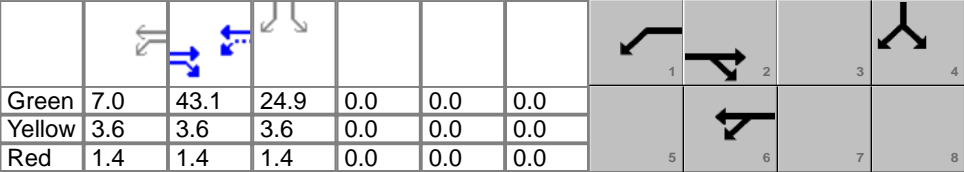
## Movement Group Results

	EB			WB			NB			SB		
Approach Movement	L	T	R	L	T	R	L	T	R	L	T	R
Assigned Movement	5	2	12	1	6	16	3	8	18	7	4	14
Adjusted Flow Rate ( $v$ ), veh/h	100	207	51	12	224	220	158	157		13	87	
Adjusted Saturation Flow Rate ( $s$ ), veh/h/ln	1792	1881	1594	1128	1881	1831	1792	1856		1237	1751	
Queue Service Time ( $g_s$ ), s	3.0	5.9	1.6	0.6	8.1	8.2	5.3	4.8		0.7	3.4	
Cycle Queue Clearance Time ( $g_c$ ), s	3.0	5.9	1.6	0.6	8.1	8.2	5.3	4.8		0.7	3.4	
Green Ratio ( $g/C$ )	0.44	0.47	0.47	0.34	0.34	0.34	0.39	0.42		0.29	0.29	
Capacity ( $c$ ), veh/h	452	882	748	459	631	614	548	779		435	502	
Volume-to-Capacity Ratio ( $X$ )	0.221	0.234	0.068	0.026	0.355	0.357	0.288	0.201		0.030	0.173	
Available Capacity ( $c_a$ ), veh/h	452	882	748	459	631	614	548	779		435	502	
Back of Queue ( $Q$ ), veh/ln ( 50 th percentile)	1.2	2.5	0.6	0.2	3.7	3.7	2.1	2.0		0.2	1.4	
Queue Storage Ratio ( $RQ$ ) ( 50 th percentile)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	
Uniform Delay ( $d_1$ ), s/veh	15.8	14.3	13.1	20.1	22.6	22.6	18.7	16.5		23.1	24.1	
Incremental Delay ( $d_2$ ), s/veh	0.1	0.6	0.2	0.1	1.6	1.6	0.1	0.0		0.0	0.1	
Initial Queue Delay ( $d_3$ ), s/veh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		0.0	0.0	
Control Delay ( $d$ ), s/veh	15.9	14.9	13.3	20.2	24.1	24.2	18.8	16.6		23.2	24.2	
Level of Service (LOS)	B	B	B	C	C	C	B	B		C	C	
Approach Delay, s/veh / LOS	14.9		B	24.0		C	17.7		B	24.0		C
Intersection Delay, s/veh / LOS	19.8						B					

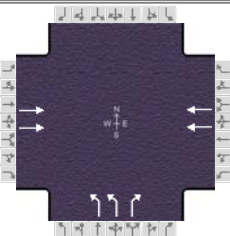
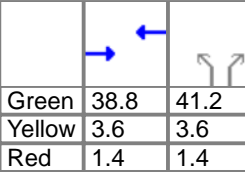
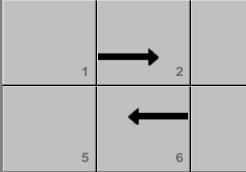
## Multimodal Results

	EB			WB			NB			SB		
Pedestrian LOS Score / LOS	2.3		B	2.3		B	2.4		B	2.8		C
Bicycle LOS Score / LOS	1.1		A	0.9		A	1.0		A	0.7		A

# HCS 2010 Signalized Intersection Results Summary

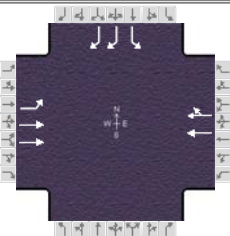
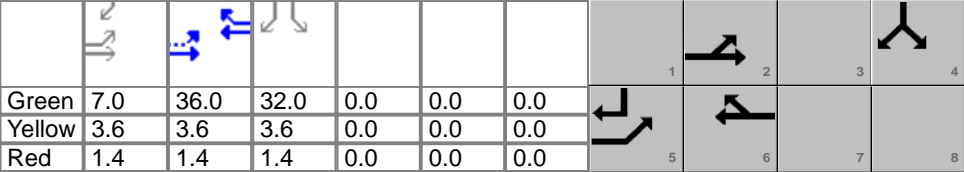
General Information						Intersection Information															
Agency		TMS Engineers, Inc.				Duration, h		0.25													
Analyst		ABC		Analysis Date		Sep 16, 2015		Area Type		Other											
Jurisdiction		Orange, OH		Time Period		PM Peak		PHF		0.92											
Urban Street		Harvard Road		Analysis Year		2015		Analysis Period		1> 7:00											
Intersection		@ I-271 SB Ramps		File Name		PM EX 271SB.xus															
Project Description		Existing Conditions																			
Demand Information						EB			WB			NB			SB						
Approach Movement						L	T	R	L	T	R	L	T	R	L	T	R				
Demand ( v ), veh/h							907	655	278	733					265		633				
Signal Information																					
Cycle, s	90.0	Reference Phase	2																		
Offset, s	0	Reference Point	End																		
Uncoordinated	No	Simult. Gap E/W	On																		
Force Mode	Fixed	Simult. Gap N/S	On																		
						Green	7.0	43.1	24.9	0.0	0.0	0.0									
						Yellow	3.6	3.6	3.6	0.0	0.0	0.0									
						Red	1.4	1.4	1.4	0.0	0.0	0.0									
Timer Results						EBL		EBT		WBL		WBT		NBL		NBT		SBL		SBT	
Assigned Phase								2		1		6								4	
Case Number								7.3		1.0		4.0								9.0	
Phase Duration, s								48.1		12.0		60.1								29.9	
Change Period, ( Y+R c ), s								5.0		5.0		5.0								5.0	
Max Allow Headway ( MAH ), s								0.0		3.1		0.0								3.3	
Queue Clearance Time ( g s ), s										9.0										23.3	
Green Extension Time ( g e ), s								0.0		0.0		0.0								0.6	
Phase Call Probability										1.00										1.00	
Max Out Probability										1.00										1.00	
Movement Group Results						EB			WB			NB			SB						
Approach Movement						L	T	R	L	T	R	L	T	R	L	T	R				
Assigned Movement							2	12	1	6					7		14				
Adjusted Flow Rate ( v ), veh/h							986	712	302	797					288		688				
Adjusted Saturation Flow Rate ( s ), veh/h/ln							1691	1579	1774	1691					1774		1397				
Queue Service Time ( g s ), s							11.3	38.5	7.0	6.5					12.6		21.3				
Cycle Queue Clearance Time ( g c ), s							11.3	38.5	7.0	6.5					12.6		21.3				
Green Ratio ( g/C )							0.48	0.48	0.58	0.61					0.28		0.28				
Capacity ( c ), veh/h							2430	756	419	3106					491		773				
Volume-to-Capacity Ratio ( X )							0.406	0.942	0.721	0.256					0.587		0.890				
Available Capacity ( c a ), veh/h							2430	756	419	3106					491		773				
Back of Queue ( Q ), veh/ln ( 50 th percentile)							4.2	17.3	3.3	2.1					5.3		8.1				
Queue Storage Ratio ( RQ ) ( 50 th percentile)							0.00	0.00	0.00	0.00					0.00		0.00				
Uniform Delay ( d 1 ), s/veh							15.2	22.3	13.0	8.0					28.1		31.2				
Incremental Delay ( d 2 ), s/veh							0.5	21.3	5.2	0.2					1.2		12.1				
Initial Queue Delay ( d 3 ), s/veh							0.0	0.0	0.0	0.0					0.0		0.0				
Control Delay ( d ), s/veh							15.7	43.5	18.2	8.2					29.4		43.3				
Level of Service (LOS)							B	D	B	A					C		D				
Approach Delay, s/veh / LOS						27.3		C		11.0		B		0.0				39.2		D	
Intersection Delay, s/veh / LOS						25.6						C									
Multimodal Results						EB			WB			NB			SB						
Pedestrian LOS Score / LOS						1.9		A		1.9		A		3.3		C		3.3		C	
Bicycle LOS Score / LOS						1.4		A		1.1		A								F	

# HCS 2010 Signalized Intersection Results Summary

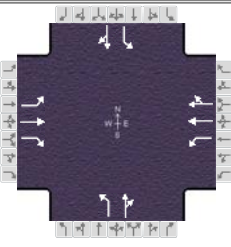
General Information					Intersection Information															
Agency		TMS Engineers, Inc.			Duration, h		0.25													
Analyst		ABC	Analysis Date	Sep 16, 2015		Area Type		Other												
Jurisdiction		Orange, OH	Time Period	PM Peak		PHF		0.92												
Urban Street		Harvard Road	Analysis Year	2015		Analysis Period		1> 7:00												
Intersection		@ I-271 NB Exit	File Name	PM EX 271NB.xus																
Project Description		Existing Conditions																		
Demand Information					EB			WB			NB			SB						
Approach Movement					L	T	R	L	T	R	L	T	R	L	T	R				
Demand ( v ), veh/h						672			526		455		406							
Signal Information																				
Cycle, s	90.0	Reference Phase	2																	
Offset, s	0	Reference Point	End																	
Uncoordinated	No	Simult. Gap E/W	On																	
Force Mode	Fixed	Simult. Gap N/S	On																	
					Green	38.8	41.2	0.0	0.0	0.0	0.0									
					Yellow	3.6	3.6	0.0	0.0	0.0	0.0									
					Red	1.4	1.4	0.0	0.0	0.0	0.0									
Timer Results					EBL		EBT		WBL		WBT		NBL		NBT		SBL		SBT	
Assigned Phase							2				6				8					
Case Number							8.0				8.0				9.0					
Phase Duration, s							43.8				43.8				46.2					
Change Period, ( Y+R c ), s							5.0				5.0				5.0					
Max Allow Headway ( MAH ), s							0.0				0.0				3.2					
Queue Clearance Time ( g s ), s															20.9					
Green Extension Time ( g e ), s							0.0				0.0				2.3					
Phase Call Probability															1.00					
Max Out Probability															0.00					
Movement Group Results					EB			WB			NB			SB						
Approach Movement					L	T	R	L	T	R	L	T	R	L	T	R				
Assigned Movement						2			6		3		18							
Adjusted Flow Rate ( v ), veh/h						730			572		495		441							
Adjusted Saturation Flow Rate ( s ), veh/h/ln						1773			1791		1723		1579							
Queue Service Time ( g s ), s						13.3			9.7		8.2		18.9							
Cycle Queue Clearance Time ( g c ), s						13.3			9.7		8.2		18.9							
Green Ratio ( g/C )						0.43			0.43		0.46		0.46							
Capacity ( c ), veh/h						1529			1544		1577		723							
Volume-to-Capacity Ratio ( X )						0.478			0.370		0.314		0.611							
Available Capacity ( c a ), veh/h						1529			1544		1577		723							
Back of Queue ( Q ), veh/ln ( 50 th percentile)						5.3			3.9		3.0		6.6							
Queue Storage Ratio ( RQ ) ( 50 th percentile)						0.00			0.00		0.00		0.00							
Uniform Delay ( d 1 ), s/veh						18.3			17.3		15.4		18.4							
Incremental Delay ( d 2 ), s/veh						1.1			0.7		0.0		1.1							
Initial Queue Delay ( d 3 ), s/veh						0.0			0.0		0.0		0.0							
Control Delay ( d ), s/veh						19.4			18.0		15.5		19.5							
Level of Service (LOS)						B			B		B		B							
Approach Delay, s/veh / LOS					19.4		B		18.0		B		17.4		B		0.0			
Intersection Delay, s/veh / LOS					18.2									B						
Multimodal Results					EB			WB			NB			SB						
Pedestrian LOS Score / LOS					1.9		A		0.7		A		2.7		B		2.7		B	
Bicycle LOS Score / LOS					1.1		A		1.0		A				F					



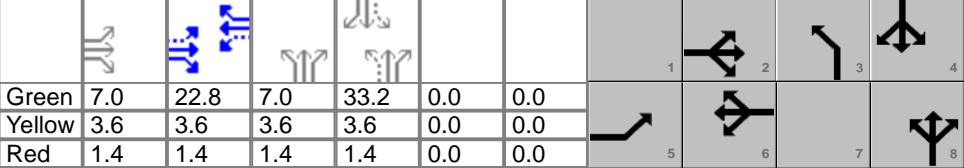
# HCS 2010 Signalized Intersection Results Summary

General Information					Intersection Information															
Agency		TMS Engineers, Inc.			Duration, h		0.25													
Analyst		ABC	Analysis Date	Sep 16, 2015	Area Type		Other													
Jurisdiction		Orange Village, OH	Time Period	PM Peak Period	PHF		0.92													
Urban Street		Harvard Road	Analysis Year	2015	Analysis Period		1> 7:00													
Intersection		Harvard & Orange Place	File Name	PM EX HarvardOrange.xus																
Project Description		Existing Conditions																		
Demand Information					EB			WB			NB			SB						
Approach Movement					L	T	R	L	T	R	L	T	R	L	T	R				
Demand ( v ), veh/h					202	848			423	29				99		215				
Signal Information																				
Cycle, s	90.0	Reference Phase	2	Green		7.0	36.0	32.0	0.0	0.0	0.0									
Offset, s	0	Reference Point	End	Yellow		3.6	3.6	3.6	0.0	0.0	0.0									
Uncoordinated	No	Simult. Gap E/W	On	Red		1.4	1.4	1.4	0.0	0.0	0.0									
Force Mode	Fixed	Simult. Gap N/S	On																	
Timer Results					EBL		EBT		WBL		WBT		NBL		NBT		SBL		SBT	
Assigned Phase					5		2				6								4	
Case Number					1.0		4.0				8.3								9.0	
Phase Duration, s					12.0		53.0				41.0								37.0	
Change Period, ( Y+R c ), s					5.0		5.0				5.0								5.0	
Max Allow Headway ( MAH ), s					3.1		0.0				0.0								3.3	
Queue Clearance Time ( g s ), s					8.4														6.7	
Green Extension Time ( g e ), s					0.0		0.0				0.0								0.8	
Phase Call Probability					1.00														1.00	
Max Out Probability					1.00														0.00	
Movement Group Results					EB			WB			NB			SB						
Approach Movement					L	T	R	L	T	R	L	T	R	L	T	R				
Assigned Movement					5	2			6	16				7		14				
Adjusted Flow Rate ( v ), veh/h					220	922			248	244				108		234				
Adjusted Saturation Flow Rate ( s ), veh/h/ln					1774	1773			1863	1820				1774		1397				
Queue Service Time ( g s ), s					6.4	14.7			8.3	8.3				3.7		4.7				
Cycle Queue Clearance Time ( g c ), s					6.4	14.7			8.3	8.3				3.7		4.7				
Green Ratio ( g/C )					0.50	0.53			0.40	0.40				0.36		0.43				
Capacity ( c ), veh/h					495	1892			745	728				631		1211				
Volume-to-Capacity Ratio ( X )					0.443	0.487			0.333	0.334				0.171		0.193				
Available Capacity ( c a ), veh/h					495	1892			745	728				631		1211				
Back of Queue ( Q ), veh/ln ( 50 th percentile)					2.4	5.6			3.6	3.6				1.5		1.4				
Queue Storage Ratio ( RQ ) ( 50 th percentile)					0.00	0.00			0.00	0.00				0.00		0.00				
Uniform Delay ( d 1 ), s/veh					13.6	13.2			18.7	18.7				19.9		15.8				
Incremental Delay ( d 2 ), s/veh					0.2	0.9			1.2	1.2				0.0		0.0				
Initial Queue Delay ( d 3 ), s/veh					0.0	0.0			0.0	0.0				0.0		0.0				
Control Delay ( d ), s/veh					13.9	14.1			19.9	19.9				19.9		15.8				
Level of Service (LOS)					B	B			B	B				B		B				
Approach Delay, s/veh / LOS					14.1	B		19.9	B		0.0			17.1		B				
Intersection Delay, s/veh / LOS					16.1						B									
Multimodal Results					EB			WB			NB			SB						
Pedestrian LOS Score / LOS					0.7	A		2.4	B		2.7	B		2.9		C				
Bicycle LOS Score / LOS					1.4	A		0.9	A							F				

# HCS 2010 Signalized Intersection Results Summary

General Information				Intersection Information		
Agency	TMS Engineers, Inc.			Duration, h	0.25	
Analyst	ABC	Analysis Date	Sep 16, 2015	Area Type	Other	
Jurisdiction	Orange Village, OH	Time Period	PM Peak Period	PHF	0.92	
Urban Street	Harvard Road	Analysis Year	2015	Analysis Period	1 > 7:00	
Intersection	Harvard & Brainard	File Name	PM EX HarvardBrainard.xus			
Project Description	Existing Conditions					

Demand Information	EB			WB			NB			SB		
Approach Movement	L	T	R	L	T	R	L	T	R	L	T	R
Demand ( $v$ ), veh/h	98	415	280	20	265	35	84	157	11	49	385	100

Signal Information											
Cycle, s	90.0	Reference Phase	2								
Offset, s	0	Reference Point	End								
Uncoordinated	No	Simult. Gap E/W	On								
Force Mode	Fixed	Simult. Gap N/S	On	Green	7.0	22.8	7.0	33.2	0.0	0.0	
				Yellow	3.6	3.6	3.6	3.6	0.0	0.0	
				Red	1.4	1.4	1.4	1.4	0.0	0.0	

Timer Results	EBL	EBT	WBL	WBT	NBL	NBT	SBL	SBT
Assigned Phase	5	2		6	3	8		4
Case Number	1.0	3.0		6.3	1.0	4.0		6.3
Phase Duration, s	12.0	39.8		27.8	12.0	50.2		38.2
Change Period, ( $Y+R_c$ ), s	5.0	5.0		5.0	5.0	5.0		5.0
Max Allow Headway ( $MAH$ ), s	3.1	0.0		0.0	3.1	3.1		3.1
Queue Clearance Time ( $g_s$ ), s	5.7				4.6	6.9		25.3
Green Extension Time ( $g_e$ ), s	0.0	0.0		0.0	0.0	1.5		1.2
Phase Call Probability	1.00				1.00	1.00		1.00
Max Out Probability	1.00				1.00	0.00		0.13

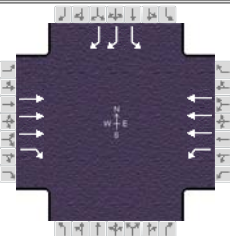
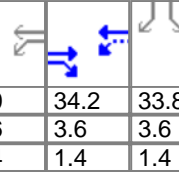









Movement Group Results	EB			WB			NB			SB		
Approach Movement	L	T	R	L	T	R	L	T	R	L	T	R
Assigned Movement	5	2	12	1	6	16	3	8	18	7	4	14
Adjusted Flow Rate ( $v$ ), veh/h	107	451	304	22	165	161	91	183		53	527	
Adjusted Saturation Flow Rate ( $s$ ), veh/h/ln	1792	1881	1594	713	1881	1805	1792	1859		1208	1814	
Queue Service Time ( $g_s$ ), s	3.7	17.4	13.0	2.3	6.5	6.6	2.6	4.9		2.6	23.3	
Cycle Queue Clearance Time ( $g_c$ ), s	3.7	17.4	13.0	7.7	6.5	6.6	2.6	4.9		2.6	23.3	
Green Ratio ( $g/C$ )	0.35	0.39	0.39	0.25	0.25	0.25	0.47	0.50		0.37	0.37	
Capacity ( $c$ ), veh/h	410	727	616	218	477	457	317	934		526	669	
Volume-to-Capacity Ratio ( $X$ )	0.260	0.620	0.494	0.100	0.346	0.352	0.288	0.196		0.101	0.788	
Available Capacity ( $c_a$ ), veh/h	410	727	616	218	477	457	317	934		526	669	
Back of Queue ( $Q$ ), veh/ln ( 50 th percentile)	1.5	8.0	5.1	0.4	3.1	3.0	1.0	1.9		0.7	10.5	
Queue Storage Ratio ( $RQ$ ) ( 50 th percentile)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	
Uniform Delay ( $d_1$ ), s/veh	20.5	22.3	20.9	30.2	27.5	27.5	17.3	12.4		18.8	25.3	
Incremental Delay ( $d_2$ ), s/veh	0.1	3.9	2.8	0.9	2.0	2.1	0.2	0.0		0.0	5.7	
Initial Queue Delay ( $d_3$ ), s/veh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		0.0	0.0	
Control Delay ( $d$ ), s/veh	20.6	26.2	23.7	31.1	29.5	29.7	17.5	12.4		18.8	31.0	
Level of Service (LOS)	C	C	C	C	C	C	B	B		B	C	
Approach Delay, s/veh / LOS	24.6	C		29.7	C		14.1	B		29.9	C	
Intersection Delay, s/veh / LOS	25.6						C					

Multimodal Results	EB		WB		NB		SB	
Pedestrian LOS Score / LOS	2.3	B	2.3	B	2.4	B	2.8	C
Bicycle LOS Score / LOS	1.9	A	0.8	A	0.9	A	1.4	A



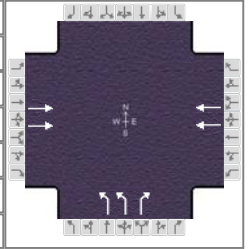
**APPENDIX E**  
**No-Build Capacity Analysis Worksheets**  
**2016**

# HCS 2010 Signalized Intersection Results Summary

General Information					Intersection Information														
Agency		TMS Engineers, Inc.					Duration, h		0.25										
Analyst		ABC		Analysis Date		Sep 16, 2015		Area Type						Other					
Jurisdiction		Orange, OH		Time Period		AM Peak		PHF						0.92					
Urban Street		Harvard Road		Analysis Year		2016		Analysis Period						1> 7:00					
Intersection		@ I-271 SB Ramps		File Name		AM 16NB 271SB.xus													
Project Description		No Build Conditions																	
Demand Information				EB			WB			NB			SB						
Approach Movement				L	T	R	L	T	R	L	T	R	L	T	R				
Demand ( v ), veh/h					460	230	305	1431					142		540				
Signal Information																			
Cycle, s	90.0	Reference Phase	2																
Offset, s	0	Reference Point	End																
Uncoordinated	No	Simult. Gap E/W	On																
Force Mode	Fixed	Simult. Gap N/S	On																
				Green	7.0	34.2	33.8	0.0	0.0	0.0									
				Yellow	3.6	3.6	3.6	0.0	0.0	0.0									
				Red	1.4	1.4	1.4	0.0	0.0	0.0									
Timer Results				EBL		EBT		WBL		WBT		NBL		NBT		SBL		SBT	
Assigned Phase						2		1		6								4	
Case Number						7.3		1.0		4.0								9.0	
Phase Duration, s						39.2		12.0		51.2								38.8	
Change Period, ( Y+R <sub>c</sub> ), s						5.0		5.0		5.0								5.0	
Max Allow Headway ( MAH ), s						0.0		3.1		0.0								3.3	
Queue Clearance Time ( g <sub>s</sub> ), s								9.0										16.9	
Green Extension Time ( g <sub>e</sub> ), s						0.0		0.0		0.0								1.9	
Phase Call Probability								1.00										1.00	
Max Out Probability								1.00										0.00	
Movement Group Results				EB			WB			NB			SB						
Approach Movement				L	T	R	L	T	R	L	T	R	L	T	R				
Assigned Movement					2	12	1	6					7		14				
Adjusted Flow Rate ( v ), veh/h					500	250	332	1555					154		587				
Adjusted Saturation Flow Rate ( s ), veh/h/ln					1691	1579	1774	1691					1774		1397				
Queue Service Time ( g <sub>s</sub> ), s					6.1	10.5	7.0	19.4					5.4		14.9				
Cycle Queue Clearance Time ( g <sub>c</sub> ), s					6.1	10.5	7.0	19.4					5.4		14.9				
Green Ratio ( g/C )					0.38	0.38	0.48	0.51					0.38		0.38				
Capacity ( c ), veh/h					1928	600	497	2605					666		1049				
Volume-to-Capacity Ratio ( X )					0.259	0.417	0.667	0.597					0.232		0.559				
Available Capacity ( c <sub>a</sub> ), veh/h					1928	600	497	2605					666		1049				
Back of Queue ( Q ), veh/ln ( 50 th percentile)					2.3	4.0	2.3	7.0					2.1		4.7				
Queue Storage Ratio ( RQ ) ( 50 th percentile)					0.00	0.00	0.00	0.00					0.00		0.00				
Uniform Delay ( d <sub>1</sub> ), s/veh					19.2	20.6	18.4	15.4					19.2		22.2				
Incremental Delay ( d <sub>2</sub> ), s/veh					0.3	2.1	2.8	1.0					0.1		0.4				
Initial Queue Delay ( d <sub>3</sub> ), s/veh					0.0	0.0	0.0	0.0					0.0		0.0				
Control Delay ( d ), s/veh					19.5	22.7	21.2	16.4					19.3		22.6				
Level of Service ( LOS )					B	C	C	B					B		C				
Approach Delay, s/veh / LOS				20.6		C		17.2		B		0.0				21.9		C	
Intersection Delay, s/veh / LOS				19.0										B					
Multimodal Results				EB			WB			NB			SB						
Pedestrian LOS Score / LOS				1.9		A		1.9		A		3.3		C		3.3		C	
Bicycle LOS Score / LOS				0.9		A		1.5		A								F	

# HCS 2010 Signalized Intersection Results Summary

General Information				Intersection Information	
Agency	TMS Engineers, Inc.			Duration, h	0.25
Analyst	ABC	Analysis Date	Sep 16, 2015	Area Type	Other
Jurisdiction	Orange, OH	Time Period	AM Peak	PHF	0.92
Urban Street	Harvard Road	Analysis Year	2016	Analysis Period	1> 7:00
Intersection	@ I-271 NB Exit	File Name	AM 16NB 271NB.xus		
Project Description	No Build Conditions				



Demand Information	EB			WB			NB			SB		
Approach Movement	L	T	R	L	T	R	L	T	R	L	T	R
Demand ( $v$ ), veh/h		341			641		1095		584			

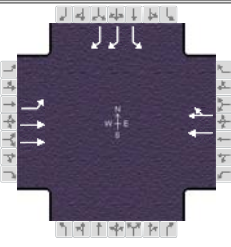
Signal Information											
Cycle, s	90.0	Reference Phase	2								
Offset, s	0	Reference Point	End								
Uncoordinated	No	Simult. Gap E/W	On	Green	34.1	45.9	0.0	0.0	0.0	0.0	
Force Mode	Fixed	Simult. Gap N/S	On	Yellow	3.6	3.6	0.0	0.0	0.0	0.0	
				Red	1.4	1.4	0.0	0.0	0.0	0.0	

Timer Results	EBL	EBT	WBL	WBT	NBL	NBT	SBL	SBT
Assigned Phase		2		6		8		
Case Number		8.0		8.0		9.0		
Phase Duration, s		39.1		39.1		50.9		
Change Period, ( $Y+R_c$ ), s		5.0		5.0		5.0		
Max Allow Headway ( $MAH$ ), s		0.0		0.0		3.2		
Queue Clearance Time ( $g_s$ ), s						31.7		
Green Extension Time ( $g_e$ ), s		0.0		0.0		4.9		
Phase Call Probability						1.00		
Max Out Probability						0.19		

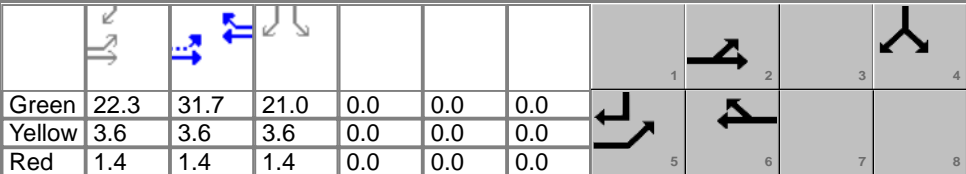











Movement Group Results	EB			WB			NB			SB		
Approach Movement	L	T	R	L	T	R	L	T	R	L	T	R
Assigned Movement		2			6		3		18			
Adjusted Flow Rate ( $v$ ), veh/h		371			697		1190		635			
Adjusted Saturation Flow Rate ( $s$ ), veh/h/ln		1773			1791		1723		1579			
Queue Service Time ( $g_s$ ), s		6.5			13.5		23.3		29.7			
Cycle Queue Clearance Time ( $g_c$ ), s		6.5			13.5		23.3		29.7			
Green Ratio ( $g/C$ )		0.38			0.38		0.51		0.51			
Capacity ( $c$ ), veh/h		1344			1357		1757		805			
Volume-to-Capacity Ratio ( $X$ )		0.276			0.513		0.677		0.788			
Available Capacity ( $c_a$ ), veh/h		1344			1357		1757		805			
Back of Queue ( $Q$ ), veh/ln ( 50 th percentile)		2.7			5.6		8.5		10.8			
Queue Storage Ratio ( $RQ$ ) ( 50 th percentile)		0.00			0.00		0.00		0.00			
Uniform Delay ( $d_1$ ), s/veh		19.4			21.6		16.5		18.1			
Incremental Delay ( $d_2$ ), s/veh		0.5			1.4		0.9		4.8			
Initial Queue Delay ( $d_3$ ), s/veh		0.0			0.0		0.0		0.0			
Control Delay ( $d$ ), s/veh		19.9			22.9		17.4		22.9			
Level of Service (LOS)		B			C		B		C			
Approach Delay, s/veh / LOS	19.9	B		22.9	C		19.3	B		0.0		
Intersection Delay, s/veh / LOS	20.3						C					

Multimodal Results	EB		WB		NB		SB	
Pedestrian LOS Score / LOS	1.9	A	0.7	A	2.7	B	2.7	B
Bicycle LOS Score / LOS	0.8	A	1.1	A		F		

# HCS 2010 Signalized Intersection Results Summary

General Information				Intersection Information		
Agency	TMS Engineers, Inc.			Duration, h	0.25	
Analyst	ABC	Analysis Date	Sep 16, 2015	Area Type	Other	
Jurisdiction	Orange Village, OH	Time Period	AM Peak Period	PHF	0.92	
Urban Street	Harvard Road	Analysis Year	2016	Analysis Period	1 > 7:00	
Intersection	Harvard & Orange Place	File Name	AM 16NB HarvardOrange.xus			
Project Description	No Build Conditions					

Demand Information	EB			WB			NB			SB		
Approach Movement	L	T	R	L	T	R	L	T	R	L	T	R
Demand ( $v$ ), veh/h	540	388			570	84				25		185

Signal Information													
Cycle, s	90.0	Reference Phase	2										
Offset, s	0	Reference Point	End	Green	22.3	31.7	21.0	0.0	0.0	0.0			
Uncoordinated	No	Simult. Gap E/W	On	Yellow	3.6	3.6	3.6	0.0	0.0	0.0			
Force Mode	Fixed	Simult. Gap N/S	On	Red	1.4	1.4	1.4	0.0	0.0	0.0			

Timer Results	EBL	EBT	WBL	WBT	NBL	NBT	SBL	SBT
Assigned Phase	5	2		6				4
Case Number	1.0	4.0		8.3				9.0
Phase Duration, s	27.3	64.0		36.7				26.0
Change Period, ( $Y+R_c$ ), s	5.0	5.0		5.0				5.0
Max Allow Headway ( $MAH$ ), s	3.1	0.0		0.0				3.3
Queue Clearance Time ( $g_s$ ), s	18.8							5.6
Green Extension Time ( $g_e$ ), s	0.6	0.0		0.0				0.5
Phase Call Probability	1.00							1.00
Max Out Probability	0.83							0.00

Movement Group Results	EB			WB			NB			SB			
Approach Movement	L	T	R	L	T	R	L	T	R	L	T	R	
Assigned Movement	5	2			6	16				7		14	
Adjusted Flow Rate ( $v$ ), veh/h	587	422			363	348				27		201	
Adjusted Saturation Flow Rate ( $s$ ), veh/h/ln	1774	1773			1863	1779				1774		1397	
Queue Service Time ( $g_s$ ), s	16.8	4.2			14.1	14.2				1.1		3.6	
Cycle Queue Clearance Time ( $g_c$ ), s	16.8	4.2			14.1	14.2				1.1		3.6	
Green Ratio ( $g/C$ )	0.62	0.66			0.35	0.35				0.23		0.48	
Capacity ( $c$ ), veh/h	663	2325			656	627				414		1344	
Volume-to-Capacity Ratio ( $X$ )	0.886	0.181			0.553	0.555				0.066		0.150	
Available Capacity ( $c_a$ ), veh/h	663	2325			656	627				414		1344	
Back of Queue ( $Q$ ), veh/ln ( 50 th percentile)	8.0	1.4			6.5	6.3				0.4		1.1	
Queue Storage Ratio ( $RQ$ ) ( 50 th percentile)	0.00	0.00			0.00	0.00				0.00		0.00	
Uniform Delay ( $d_1$ ), s/veh	13.8	6.1			23.5	23.5				26.9		13.1	
Incremental Delay ( $d_2$ ), s/veh	13.2	0.2			3.3	3.5				0.0		0.0	
Initial Queue Delay ( $d_3$ ), s/veh	0.0	0.0			0.0	0.0				0.0		0.0	
Control Delay ( $d$ ), s/veh	27.0	6.2			26.8	27.0				26.9		13.1	
Level of Service (LOS)	C	A			C	C				C		B	
Approach Delay, s/veh / LOS	18.3		B		26.9		C		0.0		14.7		B
Intersection Delay, s/veh / LOS	21.0						C						

Multimodal Results	EB		WB		NB		SB	
Pedestrian LOS Score / LOS	0.7	A	2.4	B	2.7	B	2.9	C
Bicycle LOS Score / LOS	1.3	A	1.1	A				F

# HCS 2010 Signalized Intersection Results Summary

General Information						Intersection Information							
Agency		TMS Engineers, Inc.				Duration, h		0.25					
Analyst		ABC		Analysis Date		Sep 16, 2015		Area Type		Other			
Jurisdiction		Orange Village, OH		Time Period		AM Peak Period		PHF		0.92			
Urban Street		Harvard Road		Analysis Year		2016		Analysis Period		1> 7:00			
Intersection		Harvard & Brainard		File Name		AM 16NB HarvardBrainard.xus							
Project Description		No Build Conditions											

Demand Information				EB			WB			NB			SB		
Approach Movement				L	T	R	L	T	R	L	T	R	L	T	R
Demand ( v ), veh/h				139	216	58	11	437	31	173	144	11	12	74	68

Signal Information				
Cycle, s	90.0	Reference Phase	2	
Offset, s	0	Reference Point	End	
Uncoordinated	No	Simult. Gap E/W	On	
Force Mode	Fixed	Simult. Gap N/S	On	

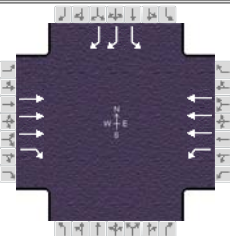
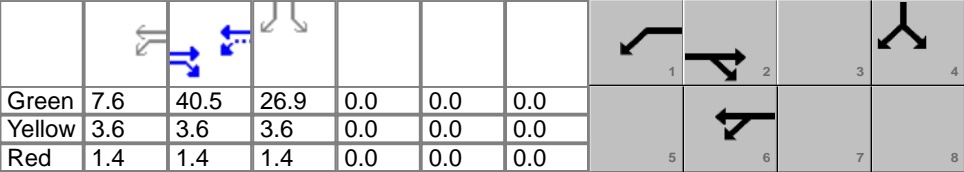
Green				7.0	30.0	7.0	26.0	0.0	0.0
Yellow				3.6	3.6	3.6	3.6	0.0	0.0
Red				1.4	1.4	1.4	1.4	0.0	0.0

Timer Results		EBL	EBT	WBL	WBT	NBL	NBT	SBL	SBT
Assigned Phase		5	2		6	3	8		4
Case Number		1.0	3.0		6.3	1.0	4.0		6.3
Phase Duration, s		12.0	47.0		35.0	12.0	43.0		31.0
Change Period, ( Y+R c ), s		5.0	5.0		5.0	5.0	5.0		5.0
Max Allow Headway ( MAH ), s		3.1	0.0		0.0	3.1	3.1		3.1
Queue Clearance Time ( g s ), s		6.7				8.4	7.2		8.3
Green Extension Time ( g e ), s		0.0	0.0		0.0	0.0	0.6		0.6
Phase Call Probability		1.00				1.00	1.00		1.00
Max Out Probability		1.00				1.00	0.00		0.00

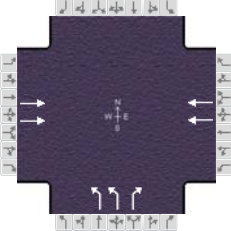
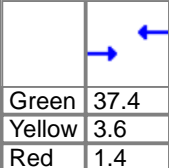
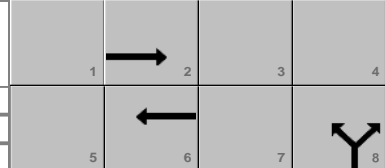
Movement Group Results		EB			WB			NB			SB		
Approach Movement		L	T	R	L	T	R	L	T	R	L	T	R
Assigned Movement		5	2	12	1	6	16	3	8	18	7	4	14
Adjusted Flow Rate ( v ), veh/h		151	235	63	12	257	252	188	168		13	154	
Adjusted Saturation Flow Rate ( s ), veh/h/ln		1792	1881	1594	1088	1881	1837	1792	1857		1224	1732	
Queue Service Time ( g s ), s		4.7	6.8	2.0	0.7	9.5	9.5	6.4	5.2		0.7	6.3	
Cycle Queue Clearance Time ( g c ), s		4.7	6.8	2.0	0.7	9.5	9.5	6.4	5.2		0.7	6.3	
Green Ratio ( g/C )		0.43	0.47	0.47	0.33	0.33	0.33	0.39	0.42		0.29	0.29	
Capacity ( c ), veh/h		423	878	744	443	627	612	491	784		434	500	
Volume-to-Capacity Ratio ( X )		0.357	0.267	0.085	0.027	0.409	0.412	0.383	0.215		0.030	0.308	
Available Capacity ( c a ), veh/h		423	878	744	443	627	612	491	784		434	500	
Back of Queue ( Q ), veh/ln ( 50 th percentile)		1.8	2.9	0.7	0.2	4.4	4.3	2.6	2.1		0.2	2.5	
Queue Storage Ratio ( RQ ) ( 50 th percentile)		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	
Uniform Delay ( d 1 ), s/veh		16.7	14.6	13.3	20.2	23.2	23.2	19.2	16.5		23.0	25.0	
Incremental Delay ( d 2 ), s/veh		0.2	0.7	0.2	0.1	2.0	2.0	0.2	0.1		0.0	0.1	
Initial Queue Delay ( d 3 ), s/veh		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		0.0	0.0	
Control Delay ( d ), s/veh		16.9	15.4	13.6	20.3	25.1	25.2	19.4	16.6		23.0	25.1	
Level of Service (LOS)		B	B	B	C	C	C	B	B		C	C	
Approach Delay, s/veh / LOS		15.6		B	25.1		C	18.1		B	24.9		C
Intersection Delay, s/veh / LOS		20.5						C					

Multimodal Results		EB			WB			NB			SB		
Pedestrian LOS Score / LOS		2.3		B	2.3		B	2.4		B	2.8		C
Bicycle LOS Score / LOS		1.2		A	0.9		A	1.1		A	0.8		A

# HCS 2010 Signalized Intersection Results Summary

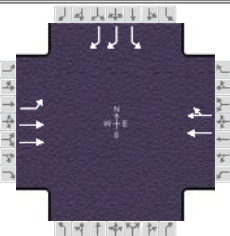
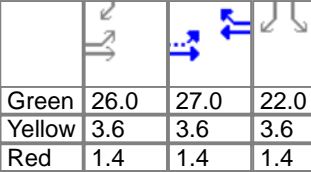
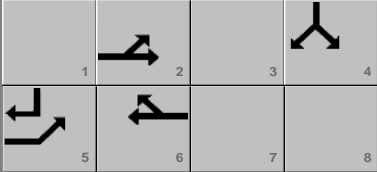
General Information					Intersection Information															
Agency		TMS Engineers, Inc.					Duration, h		0.25											
Analyst		ABC		Analysis Date		Sep 16, 2015		Area Type						Other						
Jurisdiction		Orange, OH		Time Period		PM Peak		PHF						0.92						
Urban Street		Harvard Road		Analysis Year		2016		Analysis Period						1> 7:00						
Intersection		@ I-271 SB Ramps		File Name		PM 16NB 271SB.xus														
Project Description		No Build Conditions																		
Demand Information					EB			WB			NB			SB						
Approach Movement					L	T	R	L	T	R	L	T	R	L	T	R				
Demand ( v ), veh/h						1134	657	356	938					331		635				
Signal Information																				
Cycle, s	90.0	Reference Phase	2																	
Offset, s	0	Reference Point	End																	
Uncoordinated	No	Simult. Gap E/W	On																	
Force Mode	Fixed	Simult. Gap N/S	On																	
Green					7.6	40.5	26.9	0.0	0.0	0.0	1					2	3	4		
Yellow					3.6	3.6	3.6	0.0	0.0	0.0	5					6	7	8		
Red					1.4	1.4	1.4	0.0	0.0	0.0										
Timer Results					EBL		EBT		WBL		WBT		NBL		NBT		SBL		SBT	
Assigned Phase							2		1		6								4	
Case Number							7.3		1.0		4.0								9.0	
Phase Duration, s							45.5		12.6		58.1								31.9	
Change Period, ( Y+R c ), s							5.0		5.0		5.0								5.0	
Max Allow Headway ( MAH ), s							0.0		3.1		0.0								3.3	
Queue Clearance Time ( g s ), s									9.6										22.7	
Green Extension Time ( g e ), s							0.0		0.0		0.0								1.4	
Phase Call Probability									1.00										1.00	
Max Out Probability									1.00										0.75	
Movement Group Results					EB			WB			NB			SB						
Approach Movement					L	T	R	L	T	R	L	T	R	L	T	R				
Assigned Movement						2	12	1	6					7		14				
Adjusted Flow Rate ( v ), veh/h						1233	714	387	1020					360		690				
Adjusted Saturation Flow Rate ( s ), veh/h/ln						1691	1579	1774	1691					1774		1397				
Queue Service Time ( g s ), s						15.9	40.5	7.6	9.3					16.1		20.7				
Cycle Queue Clearance Time ( g c ), s						15.9	40.5	7.6	9.3					16.1		20.7				
Green Ratio ( g/C )						0.45	0.45	0.56	0.59					0.30		0.30				
Capacity ( c ), veh/h						2283	710	353	2994					530		835				
Volume-to-Capacity Ratio ( X )						0.540	1.005	1.096	0.341					0.679		0.826				
Available Capacity ( c a ), veh/h						2283	710	353	2994					530		835				
Back of Queue ( Q ), veh/ln ( 50 th percentile)						6.0	20.7	11.5	3.1					6.9		7.4				
Queue Storage Ratio ( RQ ) ( 50 th percentile)						0.00	0.00	0.00	0.00					0.00		0.00				
Uniform Delay ( d 1 ), s/veh						18.0	24.8	21.1	9.5					27.7		29.4				
Incremental Delay ( d 2 ), s/veh						0.9	35.1	76.4	0.3					2.9		6.5				
Initial Queue Delay ( d 3 ), s/veh						0.0	0.0	0.0	0.0					0.0		0.0				
Control Delay ( d ), s/veh						18.9	59.8	97.4	9.8					30.6		35.8				
Level of Service ( LOS)						B	F	F	A					C		D				
Approach Delay, s/veh / LOS					33.9		C		33.9		C		0.0				34.0		C	
Intersection Delay, s/veh / LOS					33.9										C					
Multimodal Results					EB			WB			NB			SB						
Pedestrian LOS Score / LOS					1.9		A		1.9		A		3.3		C		3.3		C	
Bicycle LOS Score / LOS					1.6		A		1.3		A								F	

# HCS 2010 Signalized Intersection Results Summary

General Information					Intersection Information															
Agency		TMS Engineers, Inc.			Duration, h		0.25													
Analyst		ABC	Analysis Date	Sep 16, 2015		Area Type		Other												
Jurisdiction		Orange, OH	Time Period	PM Peak		PHF		0.92												
Urban Street		Harvard Road	Analysis Year	2016		Analysis Period		1> 7:00												
Intersection		@ I-271 NB Exit	File Name	PM 16NB 271NB.xus																
Project Description		No Build Conditions																		
Demand Information					EB			WB			NB			SB						
Approach Movement					L	T	R	L	T	R	L	T	R	L	T	R				
Demand ( v ), veh/h						840			838		456		507							
Signal Information																				
Cycle, s	90.0	Reference Phase	2																	
Offset, s	0	Reference Point	End																	
Uncoordinated	No	Simult. Gap E/W	On																	
Force Mode	Fixed	Simult. Gap N/S	On																	
Green	37.4	42.6	0.0	0.0	0.0	0.0														
Yellow	3.6	3.6	0.0	0.0	0.0	0.0														
Red	1.4	1.4	0.0	0.0	0.0	0.0														
Timer Results					EBL		EBT		WBL		WBT		NBL		NBT		SBL		SBT	
Assigned Phase							2				6				8					
Case Number							8.0				8.0				9.0					
Phase Duration, s							42.4				42.4				47.6					
Change Period, ( Y+R c ), s							5.0				5.0				5.0					
Max Allow Headway ( MAH ), s							0.0				0.0				3.3					
Queue Clearance Time ( g s ), s															27.4					
Green Extension Time ( g e ), s							0.0				0.0				2.5					
Phase Call Probability															1.00					
Max Out Probability															0.03					
Movement Group Results					EB			WB			NB			SB						
Approach Movement					L	T	R	L	T	R	L	T	R	L	T	R				
Assigned Movement						2			6		3		18							
Adjusted Flow Rate ( v ), veh/h						913			911		496		551							
Adjusted Saturation Flow Rate ( s ), veh/h/ln						1773			1791		1723		1579							
Queue Service Time ( g s ), s						18.2			17.9		8.0		25.4							
Cycle Queue Clearance Time ( g c ), s						18.2			17.9		8.0		25.4							
Green Ratio ( g/C )						0.42			0.42		0.47		0.47							
Capacity ( c ), veh/h						1474			1488		1631		747							
Volume-to-Capacity Ratio ( X )						0.620			0.612		0.304		0.738							
Available Capacity ( c a ), veh/h						1474			1488		1631		747							
Back of Queue ( Q ), veh/ln ( 50 th percentile)						7.5			7.4		2.9		9.2							
Queue Storage Ratio ( RQ ) ( 50 th percentile)						0.00			0.00		0.00		0.00							
Uniform Delay ( d 1 ), s/veh						20.7			20.6		14.6		19.2							
Incremental Delay ( d 2 ), s/veh						2.0			1.9		0.0		3.4							
Initial Queue Delay ( d 3 ), s/veh						0.0			0.0		0.0		0.0							
Control Delay ( d ), s/veh						22.7			22.5		14.6		22.6							
Level of Service (LOS)						C			C		B		C							
Approach Delay, s/veh / LOS					22.7	C		22.5	C		18.8	B		0.0						
Intersection Delay, s/veh / LOS					21.2						C									
Multimodal Results					EB			WB			NB			SB						
Pedestrian LOS Score / LOS					1.9	A		0.7	A		2.7	B		2.7	B					
Bicycle LOS Score / LOS					1.2	A		1.2	A			F								




# HCS 2010 Signalized Intersection Results Summary


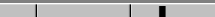



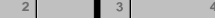



General Information					Intersection Information											
Agency		TMS Engineers, Inc.			Duration, h		0.25									
Analyst		ABC	Analysis Date	Sep 16, 2015	Area Type		Other									
Jurisdiction		Orange Village, OH	Time Period	PM Peak Period	PHF		0.92									
Urban Street		Harvard Road	Analysis Year	2016	Analysis Period		1> 7:00									
Intersection		Harvard & Orange Place	File Name	PM 16NB HarvardOrange.xus												
Project Description		No Build Conditions														
Demand Information					EB			WB			NB			SB		
Approach Movement					L	T	R	L	T	R	L	T	R	L	T	R
Demand ( v ), veh/h					609	738			449	98				213		568
Signal Information											1	2	3	4		
Cycle, s	90.0	Reference Phase	2													
Offset, s	0	Reference Point	End													
Uncoordinated	No	Simult. Gap E/W	On													
Force Mode	Fixed	Simult. Gap N/S	On													
Green	26.0	27.0	22.0	0.0	0.0	0.0	5	6	7	8						
Yellow	3.6	3.6	3.6	0.0	0.0	0.0										
Red	1.4	1.4	1.4	0.0	0.0	0.0										
Timer Results					EBL	EBT	WBL	WBT	NBL	NBT	SBL	SBT				
Assigned Phase					5	2		6				4				
Case Number					1.0	4.0		8.3				9.0				
Phase Duration, s					31.0	63.0		32.0				27.0				
Change Period, ( Y+R c ), s					5.0	5.0		5.0				5.0				
Max Allow Headway ( MAH ), s					3.1	0.0		0.0				3.3				
Queue Clearance Time ( g s ), s					22.9							13.9				
Green Extension Time ( g e ), s					0.6	0.0		0.0				1.7				
Phase Call Probability					1.00							1.00				
Max Out Probability					1.00							0.15				
Movement Group Results					EB			WB			NB			SB		
Approach Movement					L	T	R	L	T	R	L	T	R	L	T	R
Assigned Movement					5	2			6	16				7		14
Adjusted Flow Rate ( v ), veh/h					662	802		305	289				232		617	
Adjusted Saturation Flow Rate ( s ), veh/h/ln					1774	1773		1863	1747				1774		1397	
Queue Service Time ( g s ), s					20.9	9.4		12.3	12.5				10.2		11.9	
Cycle Queue Clearance Time ( g c ), s					20.9	9.4		12.3	12.5				10.2		11.9	
Green Ratio ( g/C )					0.61	0.64		0.30	0.30				0.24		0.53	
Capacity ( c ), veh/h					725	2286		559	524				434		1490	
Volume-to-Capacity Ratio ( X )					0.914	0.351		0.547	0.552				0.534		0.414	
Available Capacity ( c a ), veh/h					725	2286		559	524				434		1490	
Back of Queue ( Q ), veh/ln ( 50 th percentile)					10.2	3.1		5.8	5.6				4.3		3.4	
Queue Storage Ratio ( RQ ) ( 50 th percentile)					0.00	0.00		0.00	0.00				0.00		0.00	
Uniform Delay ( d 1 ), s/veh					14.2	7.4		26.4	26.4				29.5		12.6	
Incremental Delay ( d 2 ), s/veh					15.7	0.4		3.8	4.1				0.7		0.1	
Initial Queue Delay ( d 3 ), s/veh					0.0	0.0		0.0	0.0				0.0		0.0	
Control Delay ( d ), s/veh					29.9	7.8		30.2	30.6				30.2		12.6	
Level of Service (LOS)					C	A		C	C				C		B	
Approach Delay, s/veh / LOS					17.8	B	30.4	C	0.0			17.4	B			
Intersection Delay, s/veh / LOS					20.3					C						
Multimodal Results					EB			WB			NB			SB		
Pedestrian LOS Score / LOS					0.7	A	2.4	B	2.7	B	2.9	C				
Bicycle LOS Score / LOS					1.7	A	1.0	A				F				



# HCS 2010 Signalized Intersection Results Summary

General Information				Intersection Information		
Agency	TMS Engineers, Inc.			Duration, h	0.25	
Analyst	ABC	Analysis Date	Sep 16, 2015	Area Type	Other	
Jurisdiction	Orange Village, OH	Time Period	PM Peak Period	PHF	0.92	
Urban Street	Harvard Road	Analysis Year	2016	Analysis Period	1 > 7:00	
Intersection	Harvard & Brainard	File Name	PM 16NB HarvardBrainard.xus			
Project Description	No Build Conditions					

Demand Information	EB			WB			NB			SB		
Approach Movement	L	T	R	L	T	R	L	T	R	L	T	R
Demand ( $v$ ), veh/h	143	429	293	20	300	35	97	167	16	49	386	146

Signal Information												
Cycle, s	90.0	Reference Phase	2									
Offset, s	0	Reference Point	End									
Uncoordinated	No	Simult. Gap E/W	On	Green	7.0	21.0	7.0	35.0	0.0	0.0		
				Yellow	3.6	3.6	3.6	3.6	0.0	0.0		
Force Mode	Fixed	Simult. Gap N/S	On	Red	1.4	1.4	1.4	1.4	0.0	0.0		
												
												
												

Timer Results	EBL	EBT	WBL	WBT	NBL	NBT	SBL	SBT
Assigned Phase	5	2		6	3	8		4
Case Number	1.0	3.0		6.3	1.0	4.0		6.3
Phase Duration, s	12.0	38.0		26.0	12.0	52.0		40.0
Change Period, ( $Y+R_c$ ), s	5.0	5.0		5.0	5.0	5.0		5.0
Max Allow Headway ( $MAH$ ), s	3.1	0.0		0.0	3.1	3.1		3.1
Queue Clearance Time ( $g_s$ ), s	7.7				4.9	7.2		28.2
Green Extension Time ( $g_e$ ), s	0.0	0.0		0.0	0.0	1.7		1.2
Phase Call Probability	1.00				1.00	1.00		1.00
Max Out Probability	1.00				1.00	0.00		0.24

Movement Group Results	EB			WB			NB			SB		
Approach Movement	L	T	R	L	T	R	L	T	R	L	T	R
Assigned Movement	5	2	12	1	6	16	3	8	18	7	4	14
Adjusted Flow Rate ( $\nu$ ), veh/h	155	466	318	22	184	180	105	199		53	578	
Adjusted Saturation Flow Rate ( $s$ ), veh/h/ln	1792	1881	1594	693	1881	1812	1792	1852		1190	1793	
Queue Service Time ( $g_s$ ), s	5.7	18.8	14.2	2.5	7.5	7.6	2.9	5.2		2.6	26.2	
Cycle Queue Clearance Time ( $g_c$ ), s	5.7	18.8	14.2	9.2	7.5	7.6	2.9	5.2		2.6	26.2	
Green Ratio ( $g/C$ )	0.33	0.37	0.37	0.23	0.23	0.23	0.49	0.52		0.39	0.39	
Capacity ( $c$ ), veh/h	372	690	585	190	439	423	302	967		543	697	
Volume-to-Capacity Ratio ( $X$ )	0.418	0.676	0.545	0.115	0.420	0.426	0.350	0.206		0.098	0.829	
Available Capacity ( $c_a$ ), veh/h	372	690	585	190	439	423	302	967		543	697	
Back of Queue ( $Q$ ), veh/ln ( 50 th percentile)	2.3	8.9	5.6	0.5	3.6	3.6	1.1	2.0		0.7	11.9	
Queue Storage Ratio ( $RQ$ ) ( 50 th percentile)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	
Uniform Delay ( $d_1$ ), s/veh	22.5	24.0	22.6	32.9	29.3	29.4	17.5	11.5		17.6	24.8	
Incremental Delay ( $d_2$ ), s/veh	0.3	5.3	3.6	1.2	2.9	3.1	0.3	0.0		0.0	7.8	
Initial Queue Delay ( $d_3$ ), s/veh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		0.0	0.0	
Control Delay ( $d$ ), s/veh	22.8	29.3	26.2	34.2	32.3	32.5	17.8	11.5		17.6	32.6	
Level of Service (LOS)	C	C	C	C	C	C	B	B		B	C	
Approach Delay, s/veh / LOS	27.1	C		32.5	C		13.7	B		31.4	C	
Intersection Delay, s/veh / LOS	27.4						C					

Multimodal Results	EB		WB		NB		SB	
Pedestrian LOS Score / LOS	2.3	B	2.3	B	2.4	B	2.8	C
Bicycle LOS Score / LOS	2.0	B	0.8	A	1.0	A	1.5	A

**APPENDIX F**  
**No-Build Capacity Analysis Worksheets**  
**2018**

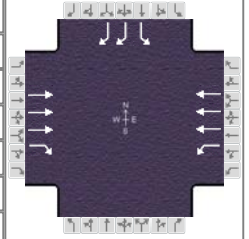
# HCS 2010 Signalized Intersection Results Summary

## General Information

Agency	TMS Engineers, Inc.
Analyst	ABC
Jurisdiction	Orange, OH
Urban Street	Harvard Road
Intersection	@ I-271 SB Ramps
Project Description	No Build Conditions

## Intersection Information

Duration, h	0.25
Area Type	Other
PHF	0.92
Analysis Period	1> 7:00



## Demand Information

	EB			WB			NB			SB		
Approach Movement	L	T	R	L	T	R	L	T	R	L	T	R
Demand ( $v$ ), veh/h		462	231	307	1438					143		543

## Signal Information

Cycle, s	90.0	Reference Phase	2									
Offset, s	0	Reference Point	End									
Uncoordinated	No	Simult. Gap E/W	On	Green	7.0	34.2	33.8	0.0	0.0	0.0		
Force Mode	Fixed	Simult. Gap N/S	On	Yellow	3.6	3.6	3.6	0.0	0.0	0.0		
				Red	1.4	1.4	1.4	0.0	0.0	0.0		

## Timer Results

	EBL	EBT	WBL	WBT	NBL	NBT	SBL	SBT
Assigned Phase		2	1	6				4
Case Number		7.3	1.0	4.0				9.0
Phase Duration, s		39.2	12.0	51.2				38.8
Change Period, ( $Y+R_c$ ), s		5.0	5.0	5.0				5.0
Max Allow Headway ( $MAH$ ), s		0.0	3.1	0.0				3.3
Queue Clearance Time ( $g_s$ ), s			9.0					17.1
Green Extension Time ( $g_e$ ), s		0.0	0.0	0.0				1.9
Phase Call Probability			1.00					1.00
Max Out Probability			1.00					0.00

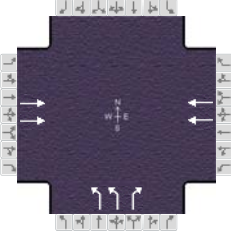
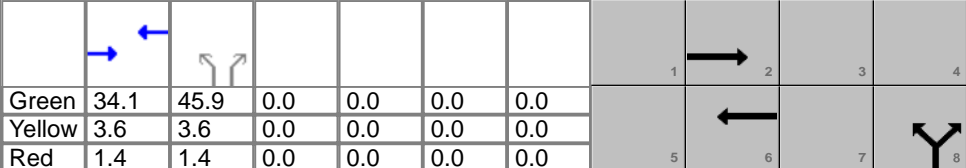
## Movement Group Results

	EB			WB			NB			SB		
Approach Movement	L	T	R	L	T	R	L	T	R	L	T	R
Assigned Movement		2	12	1	6					7		14
Adjusted Flow Rate ( $v$ ), veh/h		502	251	334	1563					155		590
Adjusted Saturation Flow Rate ( $s$ ), veh/h/ln		1691	1579	1774	1691					1774		1397
Queue Service Time ( $g_s$ ), s		6.1	10.6	7.0	19.5					5.4		15.1
Cycle Queue Clearance Time ( $g_c$ ), s		6.1	10.6	7.0	19.5					5.4		15.1
Green Ratio ( $g/C$ )		0.38	0.38	0.48	0.51					0.38		0.38
Capacity ( $c$ ), veh/h		1928	600	496	2605					666		1049
Volume-to-Capacity Ratio ( $X$ )		0.260	0.419	0.672	0.600					0.233		0.562
Available Capacity ( $c_a$ ), veh/h		1928	600	496	2605					666		1049
Back of Queue ( $Q$ ), veh/ln ( 50 th percentile)		2.4	4.1	2.4	7.1					2.1		4.7
Queue Storage Ratio ( $RQ$ ) ( 50 th percentile)		0.00	0.00	0.00	0.00					0.00		0.00
Uniform Delay ( $d_1$ ), s/veh		19.2	20.6	18.5	15.4					19.2		22.2
Incremental Delay ( $d_2$ ), s/veh		0.3	2.1	2.9	1.0					0.1		0.4
Initial Queue Delay ( $d_3$ ), s/veh		0.0	0.0	0.0	0.0					0.0		0.0
Control Delay ( $d$ ), s/veh		19.5	22.7	21.4	16.4					19.3		22.7
Level of Service (LOS)		B	C	C	B					B		C
Approach Delay, s/veh / LOS	20.6		C	17.3		B	0.0			22.0		C
Intersection Delay, s/veh / LOS	19.1						B					

## Multimodal Results

	EB			WB			NB			SB		
Pedestrian LOS Score / LOS	1.9		A	1.9		A	3.3		C	3.3		C
Bicycle LOS Score / LOS	0.9		A	1.5		A						F

# HCS 2010 Signalized Intersection Results Summary

General Information					Intersection Information															
Agency		TMS Engineers, Inc.			Duration, h		0.25													
Analyst		ABC	Analysis Date	Sep 16, 2015		Area Type		Other												
Jurisdiction		Orange, OH	Time Period	AM Peak		PHF		0.92												
Urban Street		Harvard Road	Analysis Year	2018		Analysis Period		1> 7:00												
Intersection		@ I-271 NB Exit	File Name	AM 18NB 271NB.xus																
Project Description		No Build Conditions																		
Demand Information					EB			WB			NB			SB						
Approach Movement					L	T	R	L	T	R	L	T	R	L	T	R				
Demand ( v ), veh/h						346			644		1100		587							
Signal Information																				
Cycle, s	90.0	Reference Phase	2																	
Offset, s	0	Reference Point	End																	
Uncoordinated	No	Simult. Gap E/W	On	Green					34.1	45.9	0.0	0.0	0.0	0.0						
Force Mode	Fixed	Simult. Gap N/S	On	Yellow					3.6	3.6	0.0	0.0	0.0	0.0						
				Red	1.4	1.4	0.0	0.0	0.0	0.0										
Timer Results					EBL		EBT		WBL		WBT		NBL		NBT		SBL		SBT	
Assigned Phase							2				6				8					
Case Number							8.0				8.0				9.0					
Phase Duration, s							39.1				39.1				50.9					
Change Period, ( Y+R c ), s							5.0				5.0				5.0					
Max Allow Headway ( MAH ), s							0.0				0.0				3.2					
Queue Clearance Time ( g s ), s															31.9					
Green Extension Time ( g e ), s							0.0				0.0				4.9					
Phase Call Probability															1.00					
Max Out Probability															0.20					
Movement Group Results					EB			WB			NB			SB						
Approach Movement					L	T	R	L	T	R	L	T	R	L	T	R				
Assigned Movement						2			6		3		18							
Adjusted Flow Rate ( v ), veh/h						376			700		1196		638							
Adjusted Saturation Flow Rate ( s ), veh/h/ln						1773			1791		1723		1579							
Queue Service Time ( g s ), s						6.6			13.6		23.4		29.9							
Cycle Queue Clearance Time ( g c ), s						6.6			13.6		23.4		29.9							
Green Ratio ( g/C )						0.38			0.38		0.51		0.51							
Capacity ( c ), veh/h						1344			1357		1757		805							
Volume-to-Capacity Ratio ( X )						0.280			0.516		0.680		0.793							
Available Capacity ( c a ), veh/h						1344			1357		1757		805							
Back of Queue ( Q ), veh/ln ( 50 th percentile)						2.7			5.7		8.6		10.9							
Queue Storage Ratio ( RQ ) ( 50 th percentile)						0.00			0.00		0.00		0.00							
Uniform Delay ( d 1 ), s/veh						19.4			21.6		16.5		18.1							
Incremental Delay ( d 2 ), s/veh						0.5			1.4		0.9		5.0							
Initial Queue Delay ( d 3 ), s/veh						0.0			0.0		0.0		0.0							
Control Delay ( d ), s/veh						19.9			23.0		17.4		23.1							
Level of Service (LOS)						B			C		B		C							
Approach Delay, s/veh / LOS					19.9	B	23.0	C	19.4	B	0.0									
Intersection Delay, s/veh / LOS					20.3						C									
Multimodal Results					EB			WB			NB			SB						
Pedestrian LOS Score / LOS					1.9	A	0.7	A	2.7	B	2.7	B								
Bicycle LOS Score / LOS					0.8	A	1.1	A			F									

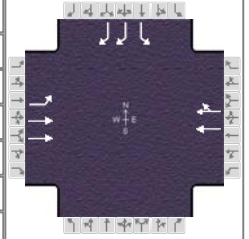
# HCS 2010 Signalized Intersection Results Summary

## General Information

Agency	TMS Engineers, Inc.
Analyst	ABC
Jurisdiction	Orange Village, OH
Urban Street	Harvard Road
Intersection	Harvard & Orange Place
Project Description	No Build Conditions

## Intersection Information

Duration, h	0.25
Area Type	Other
PHF	0.92
Analysis Period	1> 7:00
File Name	AM 18NB HarvardOrange.xus



## Demand Information

	EB			WB			NB			SB		
Approach Movement	L	T	R	L	T	R	L	T	R	L	T	R
Demand ( $v$ ), veh/h	540	390			573	84				25		185

## Signal Information

Cycle, s	90.0	Reference Phase	2										
Offset, s	0	Reference Point	End	Green	22.3	31.7	21.0	0.0	0.0	0.0			
Uncoordinated	No	Simult. Gap E/W	On	Yellow	3.6	3.6	3.6	0.0	0.0	0.0			
Force Mode	Fixed	Simult. Gap N/S	On	Red	1.4	1.4	1.4	0.0	0.0	0.0			

## Timer Results

	EBL	EBT	WBL	WBT	NBL	NBT	SBL	SBT
Assigned Phase	5	2		6				4
Case Number	1.0	4.0		8.3				9.0
Phase Duration, s	27.3	64.0		36.7				26.0
Change Period, ( $Y+R_c$ ), s	5.0	5.0		5.0				5.0
Max Allow Headway ( $MAH$ ), s	3.1	0.0		0.0				3.3
Queue Clearance Time ( $g_s$ ), s	18.8							5.6
Green Extension Time ( $g_e$ ), s	0.6	0.0		0.0				0.5
Phase Call Probability	1.00							1.00
Max Out Probability	0.83							0.00


## Movement Group Results

Approach Movement	L	T	R	L	T	R	L	T	R	L	T	R	
Assigned Movement	5	2			6	16				7		14	
Adjusted Flow Rate ( $v$ ), veh/h	587	424			365	349				27		201	
Adjusted Saturation Flow Rate ( $s$ ), veh/h/ln	1774	1773			1863	1779				1774		1397	
Queue Service Time ( $g_s$ ), s	16.8	4.2			14.2	14.2				1.1		3.6	
Cycle Queue Clearance Time ( $g_c$ ), s	16.8	4.2			14.2	14.2				1.1		3.6	
Green Ratio ( $g/C$ )	0.62	0.66			0.35	0.35				0.23		0.48	
Capacity ( $c$ ), veh/h	662	2325			656	627				414		1344	
Volume-to-Capacity Ratio ( $X$ )	0.887	0.182			0.556	0.558				0.066		0.150	
Available Capacity ( $c_a$ ), veh/h	662	2325			656	627				414		1344	
Back of Queue ( $Q$ ), veh/ln ( 50 th percentile)	8.0	1.4			6.6	6.3				0.4		1.1	
Queue Storage Ratio ( $RQ$ ) ( 50 th percentile)	0.00	0.00			0.00	0.00				0.00		0.00	
Uniform Delay ( $d_1$ ), s/veh	13.8	6.1			23.5	23.5				26.9		13.1	
Incremental Delay ( $d_2$ ), s/veh	13.4	0.2			3.4	3.6				0.0		0.0	
Initial Queue Delay ( $d_3$ ), s/veh	0.0	0.0			0.0	0.0				0.0		0.0	
Control Delay ( $d$ ), s/veh	27.2	6.2			26.9	27.1				26.9		13.1	
Level of Service (LOS)	C	A			C	C				C		B	
Approach Delay, s/veh / LOS	18.4		B		27.0		C		0.0		14.7		B
Intersection Delay, s/veh / LOS	21.1						C						

## Multimodal Results

	EB			WB			NB			SB		
Pedestrian LOS Score / LOS	0.7		A	2.4		B	2.7		B	2.9		C
Bicycle LOS Score / LOS	1.3		A	1.1		A						F

# HCS 2010 Signalized Intersection Results Summary

General Information				Intersection Information		
Agency	TMS Engineers, Inc.			Duration, h	0.25	
Analyst	ABC	Analysis Date	Sep 16, 2015	Area Type	Other	
Jurisdiction	Orange Village, OH	Time Period	AM Peak Period	PHF	0.92	
Urban Street	Harvard Road	Analysis Year	2018	Analysis Period	1 > 7:00	
Intersection	Harvard & Brainard	File Name	AM 18NB HarvardBrainard.xus			
Project Description	No Build Conditions					

Demand Information	EB			WB			NB			SB		
Approach Movement	L	T	R	L	T	R	L	T	R	L	T	R
Demand ( $v$ ), veh/h	140	217	58	11	440	31	174	145	11	12	74	68

Signal Information													
Cycle, s	90.0	Reference Phase	2										
Offset, s	0	Reference Point	End										
Uncoordinated	No	Simult. Gap E/W	On										
Force Mode	Fixed	Simult. Gap N/S	On										

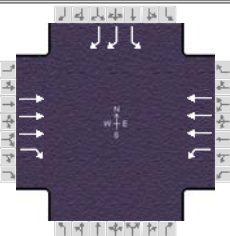
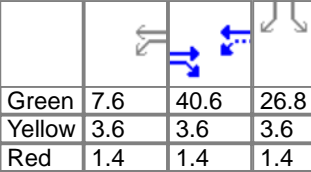
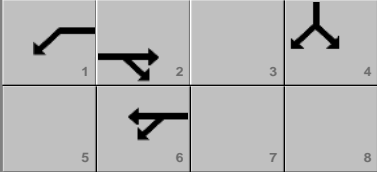
Green	7.0	30.0	7.0	26.0	0.0	0.0		
Yellow	3.6	3.6	3.6	3.6	0.0	0.0		
Red	1.4	1.4	1.4	1.4	0.0	0.0		

Timer Results	EBL	EBT	WBL	WBT	NBL	NBT	SBL	SBT
Assigned Phase	5	2		6	3	8		4
Case Number	1.0	3.0		6.3	1.0	4.0		6.3
Phase Duration, s	12.0	47.0		35.0	12.0	43.0		31.0
Change Period, ( $Y+R_c$ ), s	5.0	5.0		5.0	5.0	5.0		5.0
Max Allow Headway ( $MAH$ ), s	3.1	0.0		0.0	3.1	3.1		3.1
Queue Clearance Time ( $g_s$ ), s	6.7				8.5	7.2		8.3
Green Extension Time ( $g_e$ ), s	0.0	0.0		0.0	0.0	0.6		0.6
Phase Call Probability	1.00				1.00	1.00		1.00
Max Out Probability	1.00				1.00	0.00		0.00

Movement Group Results	EB			WB			NB			SB		
Approach Movement	L	T	R	L	T	R	L	T	R	L	T	R
Assigned Movement	5	2	12	1	6	16	3	8	18	7	4	14
Adjusted Flow Rate ( $\nu$ ), veh/h	152	236	63	12	258	254	189	170		13	154	
Adjusted Saturation Flow Rate ( $s$ ), veh/h/ln	1792	1881	1594	1087	1881	1837	1792	1858		1223	1732	
Queue Service Time ( $g_s$ ), s	4.7	6.9	2.0	0.7	9.6	9.6	6.5	5.2		0.7	6.3	
Cycle Queue Clearance Time ( $g_c$ ), s	4.7	6.9	2.0	0.7	9.6	9.6	6.5	5.2		0.7	6.3	
Green Ratio ( $g/C$ )	0.43	0.47	0.47	0.33	0.33	0.33	0.39	0.42		0.29	0.29	
Capacity ( $c$ ), veh/h	422	878	744	442	627	612	491	784		433	500	
Volume-to-Capacity Ratio ( $X$ )	0.361	0.269	0.085	0.027	0.412	0.414	0.385	0.216		0.030	0.308	
Available Capacity ( $c_a$ ), veh/h	422	878	744	442	627	612	491	784		433	500	
Back of Queue ( $Q$ ), veh/ln ( 50 th percentile)	1.8	2.9	0.7	0.2	4.4	4.3	2.6	2.1		0.2	2.5	
Queue Storage Ratio ( $RQ$ ) ( 50 th percentile)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	
Uniform Delay ( $d_1$ ), s/veh	16.7	14.6	13.3	20.2	23.2	23.2	19.2	16.5		23.0	25.0	
Incremental Delay ( $d_2$ ), s/veh	0.2	0.8	0.2	0.1	2.0	2.1	0.2	0.1		0.0	0.1	
Initial Queue Delay ( $d_3$ ), s/veh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		0.0	0.0	
Control Delay ( $d$ ), s/veh	16.9	15.4	13.6	20.3	25.2	25.3	19.4	16.6		23.0	25.1	
Level of Service (LOS)	B	B	B	C	C	C	B	B		C	C	
Approach Delay, s/veh / LOS	15.6	B		25.1	C		18.1	B		24.9	C	
Intersection Delay, s/veh / LOS	20.6						C					

Multimodal Results	EB			WB			NB			SB		
Pedestrian LOS Score / LOS	2.3	B		2.3	B		2.4	B		2.8	C	
Bicycle LOS Score / LOS	1.2	A		0.9	A		1.1	A		0.8	A	

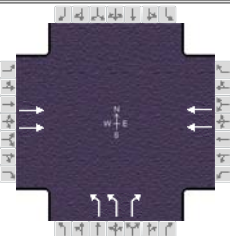
# HCS 2010 Signalized Intersection Results Summary

General Information					Intersection Information															
Agency		TMS Engineers, Inc.			Duration, h		0.25													
Analyst		ABC	Analysis Date	Sep 16, 2015	Area Type		Other													
Jurisdiction		Orange, OH	Time Period	PM Peak	PHF		0.92													
Urban Street		Harvard Road	Analysis Year	2018	Analysis Period		1> 7:00													
Intersection		@ I-271 SB Ramps	File Name	PM 18NB 271SB.xus																
Project Description		No Build Conditions																		
Demand Information					EB			WB			NB			SB						
Approach Movement					L	T	R	L	T	R	L	T	R	L	T	R				
Demand ( v ), veh/h						1140	660	358	943					333		638				
Signal Information																				
Cycle, s		90.0	Reference Phase	2																
Offset, s		0	Reference Point	End																
Uncoordinated		No	Simult. Gap E/W	On																
Force Mode		Fixed	Simult. Gap N/S	On																
Green					7.6	40.6	26.8	0.0	0.0	0.0	0.0									
Yellow					3.6	3.6	3.6	0.0	0.0	0.0	0.0									
Red					1.4	1.4	1.4	0.0	0.0	0.0	0.0									
Timer Results					EBL		EBT		WBL		WBT		NBL		NBT		SBL		SBT	
Assigned Phase							2		1		6								4	
Case Number							7.3		1.0		4.0								9.0	
Phase Duration, s							45.6		12.6		58.2								31.8	
Change Period, ( Y+R c ), s							5.0		5.0		5.0								5.0	
Max Allow Headway ( MAH ), s							0.0		3.1		0.0								3.3	
Queue Clearance Time ( g s ), s									9.6										22.9	
Green Extension Time ( g e ), s							0.0		0.0		0.0								1.3	
Phase Call Probability									1.00										1.00	
Max Out Probability									1.00										0.82	
Movement Group Results					EB			WB			NB			SB						
Approach Movement					L	T	R	L	T	R	L	T	R	L	T	R				
Assigned Movement						2	12	1	6					7		14				
Adjusted Flow Rate ( v ), veh/h						1239	717	389	1025					362		693				
Adjusted Saturation Flow Rate ( s ), veh/h/ln						1691	1579	1774	1691					1774		1397				
Queue Service Time ( g s ), s						16.0	40.6	7.6	9.3					16.2		20.9				
Cycle Queue Clearance Time ( g c ), s						16.0	40.6	7.6	9.3					16.2		20.9				
Green Ratio ( g/C )						0.45	0.45	0.56	0.59					0.30		0.30				
Capacity ( c ), veh/h						2289	712	352	2999					528		832				
Volume-to-Capacity Ratio ( X )						0.541	1.007	1.105	0.342					0.685		0.833				
Available Capacity ( c a ), veh/h						2289	712	352	2999					528		832				
Back of Queue ( Q ), veh/ln ( 50 th percentile)						6.0	20.8	16.4	3.1					7.0		7.5				
Queue Storage Ratio ( RQ ) ( 50 th percentile)						0.00	0.00	0.00	0.00					0.00		0.00				
Uniform Delay ( d 1 ), s/veh						17.9	24.7	21.0	9.4					27.9		29.5				
Incremental Delay ( d 2 ), s/veh						0.9	35.6	79.2	0.3					3.1		6.9				
Initial Queue Delay ( d 3 ), s/veh						0.0	0.0	0.0	0.0					0.0		0.0				
Control Delay ( d ), s/veh						18.9	60.3	100.2	9.7					30.9		36.4				
Level of Service (LOS)						B	F	F	A					C		D				
Approach Delay, s/veh / LOS					34.0		C		34.6		C		0.0				34.5		C	
Intersection Delay, s/veh / LOS					34.3									C						
Multimodal Results					EB			WB			NB			SB						
Pedestrian LOS Score / LOS					1.9		A		1.9		A		3.3		C		3.3		C	
Bicycle LOS Score / LOS					1.6		A		1.3		A								F	

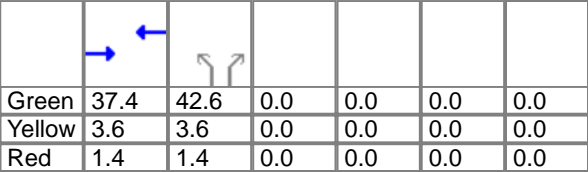
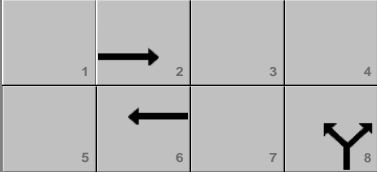


# HCS 2010 Signalized Intersection Results Summary

General Information					Intersection Information				
Agency		TMS Engineers, Inc.			Duration, h		0.25		
Analyst		ABC	Analysis Date	Sep 16, 2015	Area Type		Other		
Jurisdiction		Orange, OH	Time Period	PM Peak	PHF		0.92		
Urban Street		Harvard Road	Analysis Year	2018	Analysis Period		1> 7:00		
Intersection		@ I-271 NB Exit	File Name	PM 18NB 271NB.xus					
Project Description		No Build Conditions							



Demand Information				EB			WB			NB			SB		
Approach Movement				L	T	R	L	T	R	L	T	R	L	T	R
Demand ( v ), veh/h					844			842		458		510			

Signal Information						
Cycle, s	90.0	Reference Phase	2			
Offset, s	0	Reference Point	End			
Uncoordinated	No	Simult. Gap E/W	On			
Force Mode	Fixed	Simult. Gap N/S	On			
Green	37.4	42.6	0.0	0.0	0.0	0.0
Yellow	3.6	3.6	0.0	0.0	0.0	0.0
Red	1.4	1.4	0.0	0.0	0.0	0.0

Timer Results		EBL	EBT	WBL	WBT	NBL	NBT	SBL	SBT
Assigned Phase			2		6		8		
Case Number			8.0		8.0		9.0		
Phase Duration, s			42.4		42.4		47.6		
Change Period, ( Y+R c ), s			5.0		5.0		5.0		
Max Allow Headway ( MAH ), s			0.0		0.0		3.3		
Queue Clearance Time ( g s ), s							27.7		
Green Extension Time ( g e ), s			0.0		0.0		2.5		
Phase Call Probability							1.00		
Max Out Probability							0.03		

Movement Group Results		EB			WB			NB			SB		
Approach Movement		L	T	R	L	T	R	L	T	R	L	T	R
Assigned Movement			2			6		3		18			
Adjusted Flow Rate ( v ), veh/h			917			915		498		554			
Adjusted Saturation Flow Rate ( s ), veh/h/ln			1773			1791		1723		1579			
Queue Service Time ( g s ), s			18.4			18.1		8.0		25.7			
Cycle Queue Clearance Time ( g c ), s			18.4			18.1		8.0		25.7			
Green Ratio ( g/C )			0.42			0.42		0.47		0.47			
Capacity ( c ), veh/h			1474			1488		1631		747			
Volume-to-Capacity Ratio ( X )			0.622			0.615		0.305		0.742			
Available Capacity ( c a ), veh/h			1474			1488		1631		747			
Back of Queue ( Q ), veh/ln ( 50 th percentile)			7.5			7.5		2.9		9.3			
Queue Storage Ratio ( RQ ) ( 50 th percentile)			0.00			0.00		0.00		0.00			
Uniform Delay ( d 1 ), s/veh			20.7			20.6		14.6		19.2			
Incremental Delay ( d 2 ), s/veh			2.0			1.9		0.0		3.5			
Initial Queue Delay ( d 3 ), s/veh			0.0			0.0		0.0		0.0			
Control Delay ( d ), s/veh			22.7			22.6		14.6		22.8			
Level of Service (LOS)			C			C		B		C			
Approach Delay, s/veh / LOS		22.7	C		22.6	C		18.9	B		0.0		
Intersection Delay, s/veh / LOS		21.3							C				

Multimodal Results		EB		WB		NB		SB	
Pedestrian LOS Score / LOS		1.9	A	0.7	A	2.7	B	2.7	B
Bicycle LOS Score / LOS		1.2	A	1.2	A		F		



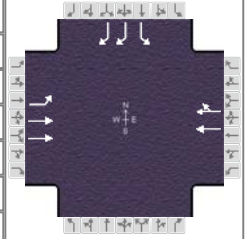
# HCS 2010 Signalized Intersection Results Summary

## General Information

Agency	TMS Engineers, Inc.
Analyst	ABC
Jurisdiction	Orange Village, OH
Urban Street	Harvard Road
Intersection	Harvard & Orange Place
Project Description	No Build Conditions

## Intersection Information

Duration, h	0.25
Area Type	Other
PHF	0.92
Analysis Period	1 > 7:00
File Name	PM 18NB HarvardOrange.xus



## Demand Information

	EB			WB			NB			SB		
Approach Movement	L	T	R	L	T	R	L	T	R	L	T	R
Demand ( $v$ ), veh/h	609	742			451	98				213		568

## Signal Information

Cycle, s	90.0	Reference Phase	2
Offset, s	0	Reference Point	End
Uncoordinated	No	Simult. Gap E/W	On
Force Mode	Fixed	Simult. Gap N/S	On

## Timer Results

	EBL	EBT	WBL	WBT	NBL	NBT	SBL	SBT
Assigned Phase	5	2		6				4
Case Number	1.0	4.0		8.3				9.0
Phase Duration, s	31.0	63.0		32.0				27.0
Change Period, ( $Y+R_c$ ), s	5.0	5.0		5.0				5.0
Max Allow Headway ( $MAH$ ), s	3.1	0.0		0.0				3.3
Queue Clearance Time ( $g_s$ ), s	23.0							13.9
Green Extension Time ( $g_e$ ), s	0.6	0.0		0.0				1.7
Phase Call Probability	1.00							1.00
Max Out Probability	1.00							0.15

## Movement Group Results

	EB			WB			NB			SB		
Approach Movement	L	T	R	L	T	R	L	T	R	L	T	R
Assigned Movement	5	2			6	16				7		14
Adjusted Flow Rate ( $v$ ), veh/h	662	807			307	290				232		617
Adjusted Saturation Flow Rate ( $s$ ), veh/h/ln	1774	1773			1863	1747				1774		1397
Queue Service Time ( $g_s$ ), s	21.0	9.4			12.4	12.5				10.2		11.9
Cycle Queue Clearance Time ( $g_c$ ), s	21.0	9.4			12.4	12.5				10.2		11.9
Green Ratio ( $g/C$ )	0.61	0.64			0.30	0.30				0.24		0.53
Capacity ( $c$ ), veh/h	724	2286			559	524				434		1490
Volume-to-Capacity Ratio ( $X$ )	0.915	0.353			0.549	0.554				0.534		0.414
Available Capacity ( $c_a$ ), veh/h	724	2286			559	524				434		1490
Back of Queue ( $Q$ ), veh/ln ( 50 th percentile)	10.3	3.1			5.9	5.6				4.3		3.4
Queue Storage Ratio ( $RQ$ ) ( 50 th percentile)	0.00	0.00			0.00	0.00				0.00		0.00
Uniform Delay ( $d_1$ ), s/veh	14.3	7.4			26.4	26.4				29.5		12.6
Incremental Delay ( $d_2$ ), s/veh	15.9	0.4			3.8	4.2				0.7		0.1
Initial Queue Delay ( $d_3$ ), s/veh	0.0	0.0			0.0	0.0				0.0		0.0
Control Delay ( $d$ ), s/veh	30.1	7.8			30.2	30.6				30.2		12.6
Level of Service (LOS)	C	A			C	C				C		B
Approach Delay, s/veh / LOS	17.9	B		30.4	C		0.0			17.4	B	
Intersection Delay, s/veh / LOS	20.3						C					

## Multimodal Results

	EB			WB			NB			SB		
Pedestrian LOS Score / LOS	0.7	A		2.4	B		2.7	B		2.9	C	
Bicycle LOS Score / LOS	1.7	A		1.0	A						F	

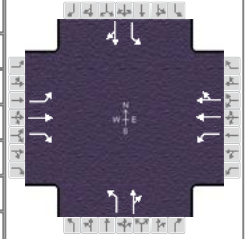
# HCS 2010 Signalized Intersection Results Summary

## General Information

Agency	TMS Engineers, Inc.
Analyst	ABC
Jurisdiction	Orange Village, OH
Urban Street	Harvard Road
Intersection	Harvard & Brainard
Project Description	No Build Conditions

## Intersection Information

Duration, h	0.25
Area Type	Other
PHF	0.92
Analysis Period	1> 7:00
File Name	PM 18NB HarvardBrainard.xus



## Demand Information

	EB			WB			NB			SB		
Approach Movement	L	T	R	L	T	R	L	T	R	L	T	R
Demand ( $v$ ), veh/h	144	431	294	20	302	35	97	168	16	49	388	147

## Signal Information

Cycle, s	90.0	Reference Phase	2
Offset, s	0	Reference Point	End
Uncoordinated	No	Simult. Gap E/W	On
Force Mode	Fixed	Simult. Gap N/S	On

## Timer Results

	EBL	EBT	WBL	WBT	NBL	NBT	SBL	SBT
Assigned Phase	5	2		6	3	8		4
Case Number	1.0	3.0		6.3	1.0	4.0		6.3
Phase Duration, s	12.0	38.0		26.0	12.0	52.0		40.0
Change Period, ( $Y+R_c$ ), s	5.0	5.0		5.0	5.0	5.0		5.0
Max Allow Headway ( $MAH$ ), s	3.1	0.0		0.0	3.1	3.1		3.1
Queue Clearance Time ( $g_s$ ), s	7.7				4.9	7.2		28.4
Green Extension Time ( $g_e$ ), s	0.0	0.0		0.0	0.0	1.8		1.2
Phase Call Probability	1.00				1.00	1.00		1.00
Max Out Probability	1.00				1.00	0.00		0.26

## Movement Group Results

	EB			WB			NB			SB		
Approach Movement	L	T	R	L	T	R	L	T	R	L	T	R
Assigned Movement	5	2	12	1	6	16	3	8	18	7	4	14
Adjusted Flow Rate ( $v$ ), veh/h	157	468	320	22	185	181	105	200		53	582	
Adjusted Saturation Flow Rate ( $s$ ), veh/h/ln	1792	1881	1594	691	1881	1813	1792	1852		1189	1793	
Queue Service Time ( $g_s$ ), s	5.7	18.9	14.3	2.5	7.5	7.7	2.9	5.2		2.6	26.4	
Cycle Queue Clearance Time ( $g_c$ ), s	5.7	18.9	14.3	9.4	7.5	7.7	2.9	5.2		2.6	26.4	
Green Ratio ( $g/C$ )	0.33	0.37	0.37	0.23	0.23	0.23	0.49	0.52		0.39	0.39	
Capacity ( $c$ ), veh/h	371	690	585	188	439	423	299	967		542	697	
Volume-to-Capacity Ratio ( $X$ )	0.422	0.679	0.547	0.115	0.422	0.428	0.352	0.207		0.098	0.834	
Available Capacity ( $c_a$ ), veh/h	371	690	585	188	439	423	299	967		542	697	
Back of Queue ( $Q$ ), veh/ln ( 50 th percentile)	2.3	8.9	5.7	0.5	3.7	3.6	1.1	2.0		0.7	12.0	
Queue Storage Ratio ( $RQ$ ) ( 50 th percentile)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	
Uniform Delay ( $d_1$ ), s/veh	22.5	24.0	22.6	33.0	29.3	29.4	17.6	11.5		17.6	24.9	
Incremental Delay ( $d_2$ ), s/veh	0.3	5.3	3.6	1.2	3.0	3.1	0.3	0.0		0.0	8.1	
Initial Queue Delay ( $d_3$ ), s/veh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		0.0	0.0	
Control Delay ( $d$ ), s/veh	22.8	29.4	26.2	34.3	32.3	32.5	17.9	11.6		17.6	33.0	
Level of Service (LOS)	C	C	C	C	C	C	B	B		B	C	
Approach Delay, s/veh / LOS	27.2	C		32.5	C		13.7	B		31.7	C	
Intersection Delay, s/veh / LOS	27.6						C					

## Multimodal Results

	EB			WB			NB			SB		
Pedestrian LOS Score / LOS	2.3	B		2.3	B		2.4	B		2.8	C	
Bicycle LOS Score / LOS	2.0	B		0.8	A		1.0	A		1.5	A	

**APPENDIX G**  
**No-Build Capacity Analysis Worksheets**  
**2036**

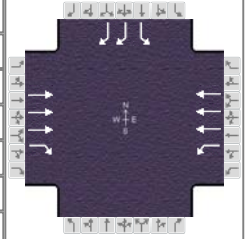
# HCS 2010 Signalized Intersection Results Summary

## General Information

Agency	TMS Engineers, Inc.
Analyst	ABC
Jurisdiction	Orange, OH
Urban Street	Harvard Road
Intersection	@ I-271 SB Ramps
Project Description	No Build Conditions

## Intersection Information

Duration, h	0.25
Area Type	Other
PHF	0.92
Analysis Period	1> 7:00



## Demand Information

	EB			WB			NB			SB		
Approach Movement	L	T	R	L	T	R	L	T	R	L	T	R
Demand ( $v$ ), veh/h		483	242	320	1503					149		567

## Signal Information

Cycle, s	90.0	Reference Phase	2									
Offset, s	0	Reference Point	End									
Uncoordinated	No	Simult. Gap E/W	On	Green	7.0	34.4	33.6	0.0	0.0	0.0		
Force Mode	Fixed	Simult. Gap N/S	On	Yellow	3.6	3.6	3.6	0.0	0.0	0.0		
				Red	1.4	1.4	1.4	0.0	0.0	0.0		

## Timer Results

	EBL	EBT	WBL	WBT	NBL	NBT	SBL	SBT
Assigned Phase		2	1	6				4
Case Number		7.3	1.0	4.0				9.0
Phase Duration, s		39.4	12.0	51.4				38.6
Change Period, ( $Y+R_c$ ), s		5.0	5.0	5.0				5.0
Max Allow Headway ( $MAH$ ), s		0.0	3.1	0.0				3.3
Queue Clearance Time ( $g_s$ ), s			9.0					18.0
Green Extension Time ( $g_e$ ), s		0.0	0.0	0.0				2.0
Phase Call Probability			1.00					1.00
Max Out Probability			1.00					0.01

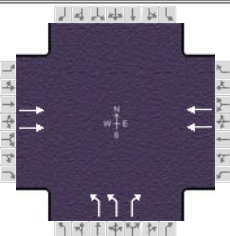
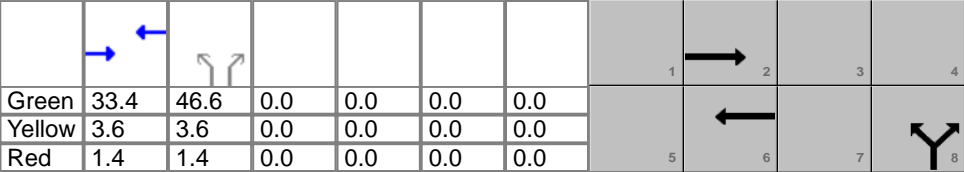
## Movement Group Results

Approach Movement	L	T	R	L	T	R	L	T	R	L	T	R
Assigned Movement		2	12	1	6					7		14
Adjusted Flow Rate ( $\nu$ ), veh/h		525	263	348	1634					162		616
Adjusted Saturation Flow Rate ( $s$ ), veh/h/ln		1691	1579	1774	1691					1774		1397
Queue Service Time ( $g_s$ ), s		6.4	11.1	7.0	20.7					5.7		16.0
Cycle Queue Clearance Time ( $g_c$ ), s		6.4	11.1	7.0	20.7					5.7		16.0
Green Ratio ( $g/C$ )		0.38	0.38	0.48	0.52					0.37		0.37
Capacity ( $c$ ), veh/h		1939	603	490	2616					662		1043
Volume-to-Capacity Ratio ( $X$ )		0.271	0.436	0.710	0.625					0.245		0.591
Available Capacity ( $c_a$ ), veh/h		1939	603	490	2616					662		1043
Back of Queue ( $Q$ ), veh/ln ( 50 th percentile)		2.5	4.3	3.0	7.5					2.2		5.0
Queue Storage Ratio ( $RQ$ ) ( 50 th percentile)		0.00	0.00	0.00	0.00					0.00		0.00
Uniform Delay ( $d_1$ ), s/veh		19.2	20.6	19.2	15.6					19.4		22.7
Incremental Delay ( $d_2$ ), s/veh		0.3	2.3	4.1	1.1					0.1		0.6
Initial Queue Delay ( $d_3$ ), s/veh		0.0	0.0	0.0	0.0					0.0		0.0
Control Delay ( $d$ ), s/veh		19.5	22.9	23.3	16.7					19.5		23.3
Level of Service (LOS)		B	C	C	B					B		C
Approach Delay, s/veh / LOS	20.6	C		17.9	B		0.0			22.5	C	
Intersection Delay, s/veh / LOS	19.5						B					

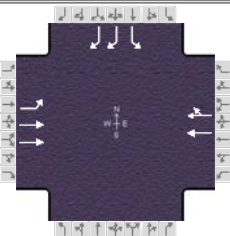
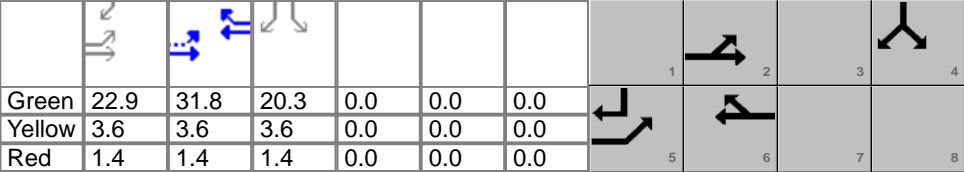
## Multimodal Results

	EB		WB		NB		SB	
Pedestrian LOS Score / LOS	1.9	A	1.9	A	3.3	C	3.3	C
Bicycle LOS Score / LOS	0.9	A	1.6	A				F

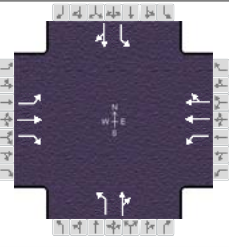
# HCS 2010 Signalized Intersection Results Summary

General Information					Intersection Information															
Agency		TMS Engineers, Inc.			Duration, h		0.25													
Analyst		ABC	Analysis Date	Sep 16, 2015		Area Type		Other												
Jurisdiction		Orange, OH	Time Period	AM Peak		PHF		0.92												
Urban Street		Harvard Road	Analysis Year	2036		Analysis Period		1> 7:00												
Intersection		@ I-271 NB Exit	File Name	AM 36NB 271NB.xus																
Project Description		No Build Conditions																		
Demand Information					EB			WB			NB			SB						
Approach Movement					L	T	R	L	T	R	L	T	R	L	T	R				
Demand ( v ), veh/h						361			673		1150		613							
Signal Information																				
Cycle, s	90.0	Reference Phase	2																	
Offset, s	0	Reference Point	End																	
Uncoordinated	No	Simult. Gap E/W	On																	
Force Mode	Fixed	Simult. Gap N/S	On																	
					Green	33.4	46.6	0.0	0.0	0.0	0.0									
					Yellow	3.6	3.6	0.0	0.0	0.0	0.0									
					Red	1.4	1.4	0.0	0.0	0.0	0.0									
Timer Results					EBL		EBT		WBL		WBT		NBL		NBT		SBL		SBT	
Assigned Phase							2				6				8					
Case Number							8.0				8.0				9.0					
Phase Duration, s							38.4				38.4				51.6					
Change Period, ( Y+R c ), s							5.0				5.0				5.0					
Max Allow Headway ( MAH ), s							0.0				0.0				3.2					
Queue Clearance Time ( g s ), s															33.7					
Green Extension Time ( g e ), s							0.0				0.0				5.0					
Phase Call Probability															1.00					
Max Out Probability															0.26					
Movement Group Results					EB			WB			NB			SB						
Approach Movement					L	T	R	L	T	R	L	T	R	L	T	R				
Assigned Movement						2			6		3		18							
Adjusted Flow Rate ( v ), veh/h						392			732		1250		666							
Adjusted Saturation Flow Rate ( s ), veh/h/ln						1773			1791		1723		1579							
Queue Service Time ( g s ), s						7.0			14.5		24.7		31.7							
Cycle Queue Clearance Time ( g c ), s						7.0			14.5		24.7		31.7							
Green Ratio ( g/C )						0.37			0.37		0.52		0.52							
Capacity ( c ), veh/h						1316			1329		1784		817							
Volume-to-Capacity Ratio ( X )						0.298			0.550		0.701		0.815							
Available Capacity ( c a ), veh/h						1316			1329		1784		817							
Back of Queue ( Q ), veh/ln ( 50 th percentile)						2.9			6.1		9.0		11.7							
Queue Storage Ratio ( RQ ) ( 50 th percentile)						0.00			0.00		0.00		0.00							
Uniform Delay ( d 1 ), s/veh						20.0			22.4		16.4		18.1							
Incremental Delay ( d 2 ), s/veh						0.6			1.6		1.1		6.0							
Initial Queue Delay ( d 3 ), s/veh						0.0			0.0		0.0		0.0							
Control Delay ( d ), s/veh						20.6			24.0		17.5		24.1							
Level of Service (LOS)						C			C		B		C							
Approach Delay, s/veh / LOS					20.6	C	24.0	C	19.8	B	0.0									
Intersection Delay, s/veh / LOS					20.9						C									
Multimodal Results					EB			WB			NB			SB						
Pedestrian LOS Score / LOS					1.9	A	0.7	A	2.7	B	2.7	B								
Bicycle LOS Score / LOS					0.8	A	1.1	A		F										

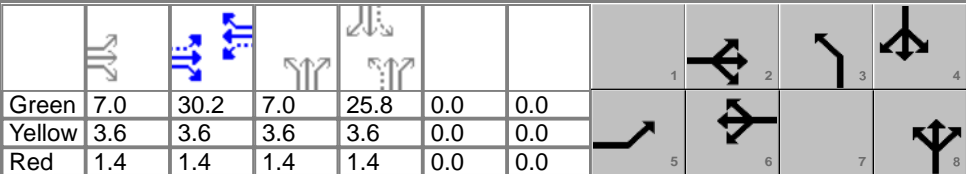









# HCS 2010 Signalized Intersection Results Summary

General Information					Intersection Information															
Agency		TMS Engineers, Inc.			Duration, h		0.25													
Analyst		ABC	Analysis Date	Sep 16, 2015	Area Type		Other													
Jurisdiction		Orange Village, OH	Time Period	AM Peak Period	PHF		0.92													
Urban Street		Harvard Road	Analysis Year	2036	Analysis Period		1> 7:00													
Intersection		Harvard & Orange Place	File Name	AM 36NB HarvardOrange.xus																
Project Description		No Build Conditions																		
Demand Information					EB			WB			NB			SB						
Approach Movement					L	T	R	L	T	R	L	T	R	L	T	R				
Demand ( v ), veh/h					539	407			608	84				30		219				
Signal Information																				
Cycle, s	90.0	Reference Phase	2																	
Offset, s	0	Reference Point	End																	
Uncoordinated	No	Simult. Gap E/W	On																	
Force Mode	Fixed	Simult. Gap N/S	On																	
					Green	22.9	31.8	20.3	0.0	0.0	0.0									
					Yellow	3.6	3.6	3.6	0.0	0.0	0.0									
					Red	1.4	1.4	1.4	0.0	0.0	0.0									
Timer Results					EBL		EBT		WBL		WBT		NBL		NBT		SBL		SBT	
Assigned Phase					5		2				6								4	
Case Number					1.0		4.0				8.3								9.0	
Phase Duration, s					27.9		64.7				36.8								25.3	
Change Period, ( Y+R c ), s					5.0		5.0				5.0								5.0	
Max Allow Headway ( MAH ), s					3.1		0.0				0.0								3.3	
Queue Clearance Time ( g s ), s					19.1														6.4	
Green Extension Time ( g e ), s					0.6		0.0				0.0								0.6	
Phase Call Probability					1.00														1.00	
Max Out Probability					0.71														0.00	
Movement Group Results					EB			WB			NB			SB						
Approach Movement					L	T	R	L	T	R	L	T	R	L	T	R				
Assigned Movement					5	2			6	16				7		14				
Adjusted Flow Rate ( v ), veh/h					586	442			384	368				33		238				
Adjusted Saturation Flow Rate ( s ), veh/h/ln					1774	1773			1863	1783				1774		1397				
Queue Service Time ( g s ), s					17.1	4.3			15.1	15.1				1.3		4.4				
Cycle Queue Clearance Time ( g c ), s					17.1	4.3			15.1	15.1				1.3		4.4				
Green Ratio ( g/C )					0.63	0.66			0.35	0.35				0.23		0.48				
Capacity ( c ), veh/h					662	2353			658	630				400		1341				
Volume-to-Capacity Ratio ( X )					0.885	0.188			0.583	0.585				0.081		0.177				
Available Capacity ( c a ), veh/h					662	2353			658	630				400		1341				
Back of Queue ( Q ), veh/ln ( 50 th percentile)					14.4	1.4			7.0	6.7				0.5		1.3				
Queue Storage Ratio ( RQ ) ( 50 th percentile)					0.00	0.00			0.00	0.00				0.00		0.00				
Uniform Delay ( d 1 ), s/veh					14.5	5.8			23.7	23.7				27.5		13.3				
Incremental Delay ( d 2 ), s/veh					13.1	0.2			3.8	3.9				0.0		0.0				
Initial Queue Delay ( d 3 ), s/veh					0.0	0.0			0.0	0.0				0.0		0.0				
Control Delay ( d ), s/veh					27.6	6.0			27.5	27.7				27.5		13.3				
Level of Service (LOS)					C	A			C	C				C		B				
Approach Delay, s/veh / LOS					18.3		B		27.6		C		0.0				15.0		B	
Intersection Delay, s/veh / LOS					21.3									C						
Multimodal Results					EB			WB			NB			SB						
Pedestrian LOS Score / LOS					0.7		A		2.4		B		2.7		B		2.9		C	
Bicycle LOS Score / LOS					1.3		A		1.1		A								F	

# HCS 2010 Signalized Intersection Results Summary

General Information						Intersection Information		
Agency	TMS Engineers, Inc.					Duration, h	0.25	
Analyst	ABC	Analysis Date	Sep 16, 2015			Area Type	Other	
Jurisdiction	Orange Village, OH	Time Period	AM Peak Period			PHF	0.92	
Urban Street	Harvard Road	Analysis Year	2036			Analysis Period	1 > 7:00	
Intersection	Harvard & Brainard	File Name	AM 36NB HarvardBrainard.xus					
Project Description	No Build Conditions							

Demand Information	EB			WB			NB			SB		
Approach Movement	L	T	R	L	T	R	L	T	R	L	T	R
Demand ( $v$ ), veh/h	145	230	62	11	459	32	180	175	11	12	78	70

Signal Information														
Cycle, s	90.0	Reference Phase	2											
Offset, s	0	Reference Point	End	Green	7.0	30.2	7.0	25.8	0.0	0.0				
Uncoordinated	No	Simult. Gap E/W	On	Yellow	3.6	3.6	3.6	3.6	0.0	0.0				
Force Mode	Fixed	Simult. Gap N/S	On	Red	1.4	1.4	1.4	1.4	0.0	0.0				

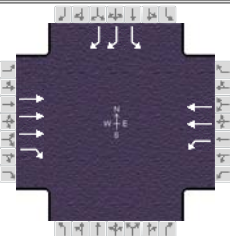



Timer Results	EBL	EBT	WBL	WBT	NBL	NBT	SBL	SBT
Assigned Phase	5	2		6	3	8		4
Case Number	1.0	3.0		6.3	1.0	4.0		6.3
Phase Duration, s	12.0	47.2		35.2	12.0	42.8		30.8
Change Period, ( $Y+R_c$ ), s	5.0	5.0		5.0	5.0	5.0		5.0
Max Allow Headway ( $MAH$ ), s	3.1	0.0		0.0	3.1	3.1		3.1
Queue Clearance Time ( $g_s$ ), s	6.9				8.8	8.4		8.6
Green Extension Time ( $g_e$ ), s	0.0	0.0		0.0	0.0	0.7		0.6
Phase Call Probability	1.00				1.00	1.00		1.00
Max Out Probability	1.00				1.00	0.00		0.00

Movement Group Results	EB			WB			NB			SB		
Approach Movement	L	T	R	L	T	R	L	T	R	L	T	R
Assigned Movement	5	2	12	1	6	16	3	8	18	7	4	14
Adjusted Flow Rate ( $\nu$ ), veh/h	158	250	67	12	269	264	196	202		13	161	
Adjusted Saturation Flow Rate ( $s$ ), veh/h/ln	1792	1881	1594	1068	1881	1838	1792	1861		1187	1734	
Queue Service Time ( $g_s$ ), s	4.9	7.3	2.1	0.7	10.0	10.0	6.8	6.4		0.7	6.6	
Cycle Queue Clearance Time ( $g_c$ ), s	4.9	7.3	2.1	0.7	10.0	10.0	6.8	6.4		0.7	6.6	
Green Ratio ( $g/C$ )	0.44	0.47	0.47	0.34	0.34	0.34	0.39	0.42		0.29	0.29	
Capacity ( $c$ ), veh/h	415	882	748	438	631	617	483	782		420	497	
Volume-to-Capacity Ratio ( $X$ )	0.379	0.283	0.090	0.027	0.427	0.429	0.405	0.259		0.031	0.324	
Available Capacity ( $c_a$ ), veh/h	415	882	748	438	631	617	483	782		420	497	
Back of Queue ( $Q$ ), veh/ln ( 50 th percentile)	1.9	3.1	0.8	0.2	4.6	4.5	2.7	2.6		0.2	2.6	
Queue Storage Ratio ( $RQ$ ) ( 50 th percentile)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	
Uniform Delay ( $d_1$ ), s/veh	16.7	14.6	13.3	20.1	23.2	23.2	19.5	17.0		23.2	25.2	
Incremental Delay ( $d_2$ ), s/veh	0.2	0.8	0.2	0.1	2.1	2.2	0.2	0.1		0.0	0.1	
Initial Queue Delay ( $d_3$ ), s/veh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		0.0	0.0	
Control Delay ( $d$ ), s/veh	16.9	15.4	13.5	20.2	25.3	25.4	19.7	17.0		23.2	25.4	
Level of Service (LOS)	B	B	B	C	C	C	B	B		C	C	
Approach Delay, s/veh / LOS	15.7	B		25.2	C		18.3	B		25.2	C	
Intersection Delay, s/veh / LOS	20.6						C					

Multimodal Results	EB		WB		NB		SB	
Pedestrian LOS Score / LOS	2.3	B	2.3	B	2.4	B	2.8	C
Bicycle LOS Score / LOS	1.3	A	0.9	A	1.1	A	0.8	A

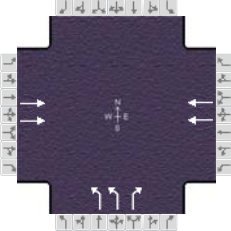
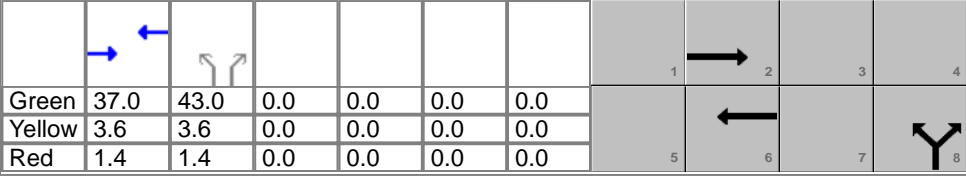


# HCS 2010 Signalized Intersection Results Summary

General Information					Intersection Information															
Agency		TMS Engineers, Inc.			Duration, h		0.25													
Analyst		ABC	Analysis Date	Sep 16, 2015	Area Type		Other													
Jurisdiction		Orange, OH	Time Period	PM Peak	PHF		0.92													
Urban Street		Harvard Road	Analysis Year	2036	Analysis Period		1> 7:00													
Intersection		@ I-271 SB Ramps	File Name	PM 36NB 271SB.xus																
Project Description		No Build Conditions																		
Demand Information					EB			WB			NB			SB						
Approach Movement					L	T	R	L	T	R	L	T	R	L	T	R				
Demand ( v ), veh/h						1191	690	374	985					348		667				
Signal Information																				
Cycle, s		90.0	Reference Phase	2																
Offset, s		0	Reference Point	End																
Uncoordinated		No	Simult. Gap E/W	On				Green	8.1	40.9	26.0	0.0	0.0	0.0						
Force Mode		Fixed	Simult. Gap N/S	On				Yellow	3.6	3.6	3.6	0.0	0.0	0.0						
					Red	1.4	1.4	1.4	0.0	0.0	0.0									
Timer Results					EBL		EBT		WBL		WBT		NBL		NBT		SBL		SBT	
Assigned Phase							2		1		6								4	
Case Number							7.3		1.0		4.0								9.0	
Phase Duration, s							45.9		13.1		59.0								31.0	
Change Period, ( Y+R c ), s							5.0		5.0		5.0								5.0	
Max Allow Headway ( MAH ), s							0.0		3.1		0.0								3.3	
Queue Clearance Time ( g s ), s									10.1										24.4	
Green Extension Time ( g e ), s							0.0		0.0		0.0								0.7	
Phase Call Probability									1.00										1.00	
Max Out Probability									1.00										1.00	
Movement Group Results					EB			WB			NB			SB						
Approach Movement					L	T	R	L	T	R	L	T	R	L	T	R				
Assigned Movement						2	12	1	6					7		14				
Adjusted Flow Rate ( v ), veh/h						1295	750	407	1071					378		725				
Adjusted Saturation Flow Rate ( s ), veh/h/ln						1691	1579	1774	1773					1774		1397				
Queue Service Time ( g s ), s						16.8	40.9	8.1	15.6					17.3		22.4				
Cycle Queue Clearance Time ( g c ), s						16.8	40.9	8.1	15.6					17.3		22.4				
Green Ratio ( g/C )						0.45	0.45	0.57	0.60					0.29		0.29				
Capacity ( c ), veh/h						2306	717	353	2128					513		807				
Volume-to-Capacity Ratio ( X )						0.561	1.045	1.151	0.503					0.738		0.898				
Available Capacity ( c a ), veh/h						2306	717	353	2128					513		807				
Back of Queue ( Q ), veh/ln ( 50 th percentile)						6.3	23.1	13.1	5.5					7.8		8.6				
Queue Storage Ratio ( RQ ) ( 50 th percentile)						0.00	0.00	0.00	0.00					0.00		0.00				
Uniform Delay ( d 1 ), s/veh						18.0	24.6	19.9	10.3					28.9		30.7				
Incremental Delay ( d 2 ), s/veh						1.0	46.1	95.6	0.9					4.9		12.5				
Initial Queue Delay ( d 3 ), s/veh						0.0	0.0	0.0	0.0					0.0		0.0				
Control Delay ( d ), s/veh						19.0	70.6	115.5	11.2					33.8		43.3				
Level of Service (LOS)						B	F	F	B					C		D				
Approach Delay, s/veh / LOS					37.9		D		39.9		D		0.0				40.0		D	
Intersection Delay, s/veh / LOS					39.1					D										
Multimodal Results					EB			WB			NB			SB						
Pedestrian LOS Score / LOS					1.9		A		1.9		A		3.2		C		3.0		C	
Bicycle LOS Score / LOS					1.6		A		1.7		A								F	

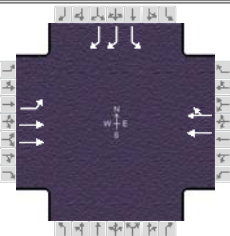


# HCS 2010 Signalized Intersection Results Summary

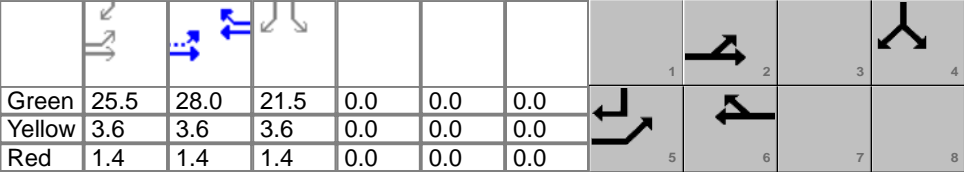
General Information					Intersection Information															
Agency		TMS Engineers, Inc.			Duration, h		0.25													
Analyst		ABC	Analysis Date	Sep 16, 2015		Area Type		Other												
Jurisdiction		Orange, OH	Time Period	PM Peak		PHF		0.92												
Urban Street		Harvard Road	Analysis Year	2036		Analysis Period		1> 7:00												
Intersection		@ I-271 NB Exit	File Name	PM 36NB 271NB.xus																
Project Description		No Build Conditions																		
Demand Information					EB			WB			NB			SB						
Approach Movement					L	T	R	L	T	R	L	T	R	L	T	R				
Demand ( v ), veh/h						882			880		479		532							
Signal Information																				
Cycle, s	90.0	Reference Phase	2																	
Offset, s	0	Reference Point	End																	
Uncoordinated	No	Simult. Gap E/W	On	Green					37.0	43.0	0.0	0.0	0.0	0.0						
Force Mode	Fixed	Simult. Gap N/S	On	Yellow					3.6	3.6	0.0	0.0	0.0	0.0						
				Red	1.4	1.4	0.0	0.0	0.0	0.0										
Timer Results					EBL		EBT		WBL		WBT		NBL		NBT		SBL		SBT	
Assigned Phase							2				6				8					
Case Number							8.0				8.0				9.0					
Phase Duration, s							42.0				42.0				48.0					
Change Period, ( Y+R c ), s							5.0				5.0				5.0					
Max Allow Headway ( MAH ), s							0.0				0.0				3.3					
Queue Clearance Time ( g s ), s															29.2					
Green Extension Time ( g e ), s							0.0				0.0				2.6					
Phase Call Probability															1.00					
Max Out Probability															0.05					
Movement Group Results					EB			WB			NB			SB						
Approach Movement					L	T	R	L	T	R	L	T	R	L	T	R				
Assigned Movement						2			6		3		18							
Adjusted Flow Rate ( v ), veh/h						959			957		521		578							
Adjusted Saturation Flow Rate ( s ), veh/h/ln						1773			1791		1723		1579							
Queue Service Time ( g s ), s						19.6			19.3		8.4		27.2							
Cycle Queue Clearance Time ( g c ), s						19.6			19.3		8.4		27.2							
Green Ratio ( g/C )						0.41			0.41		0.48		0.48							
Capacity ( c ), veh/h						1458			1473		1646		754							
Volume-to-Capacity Ratio ( X )						0.658			0.650		0.316		0.767							
Available Capacity ( c a ), veh/h						1458			1473		1646		754							
Back of Queue ( Q ), veh/ln ( 50 th percentile)						8.1			8.0		3.1		10.0							
Queue Storage Ratio ( RQ ) ( 50 th percentile)						0.00			0.00		0.00		0.00							
Uniform Delay ( d 1 ), s/veh						21.4			21.3		14.5		19.4							
Incremental Delay ( d 2 ), s/veh						2.3			2.2		0.0		4.3							
Initial Queue Delay ( d 3 ), s/veh						0.0			0.0		0.0		0.0							
Control Delay ( d ), s/veh						23.7			23.5		14.5		23.7							
Level of Service (LOS)						C			C		B		C							
Approach Delay, s/veh / LOS					23.7	C		23.5	C		19.3	B		0.0						
Intersection Delay, s/veh / LOS					22.1						C									
Multimodal Results					EB			WB			NB			SB						
Pedestrian LOS Score / LOS					1.9	A		0.7	A		2.7	B		2.7	B					
Bicycle LOS Score / LOS					1.3	A		1.3	A			F								

# HCS 2010 Signalized Intersection Results Summary

General Information						Intersection Information					
Agency		TMS Engineers, Inc.				Duration, h		0.25			
Analyst		ABC		Analysis Date		Sep 16, 2015		Area Type		Other	
Jurisdiction		Orange Village, OH		Time Period		PM Peak Period		PHF		0.92	
Urban Street		Harvard Road		Analysis Year		2036		Analysis Period		1> 7:00	
Intersection		Harvard & Orange Place		File Name		PM 36NB HarvardOrange.xus					
Project Description		No Build Conditions									



Demand Information				EB			WB			NB			SB		
Approach Movement				L	T	R	L	T	R	L	T	R	L	T	R
Demand ( v ), veh/h				604	775			469	98				201		558

Signal Information						
Cycle, s	90.0	Reference Phase	2			
Offset, s	0	Reference Point	End			
Uncoordinated	No	Simult. Gap E/W	On			
Force Mode	Fixed	Simult. Gap N/S	On			
Green	25.5	28.0	21.5	0.0	0.0	0.0
Yellow	3.6	3.6	3.6	0.0	0.0	0.0
Red	1.4	1.4	1.4	0.0	0.0	0.0

Timer Results		EBL	EBT	WBL	WBT	NBL	NBT	SBL	SBT
Assigned Phase		5	2		6				4
Case Number		1.0	4.0		8.3				9.0
Phase Duration, s		30.5	63.5		33.0				26.5
Change Period, ( Y+R c ), s		5.0	5.0		5.0				5.0
Max Allow Headway ( MAH ), s		3.1	0.0		0.0				3.3
Queue Clearance Time ( g s ), s		22.5							13.9
Green Extension Time ( g e ), s		0.6	0.0		0.0				1.6
Phase Call Probability		1.00							1.00
Max Out Probability		1.00							0.18

Movement Group Results		EB			WB			NB			SB		
Approach Movement		L	T	R	L	T	R	L	T	R	L	T	R
Assigned Movement		5	2			6	16				7		14
Adjusted Flow Rate ( v ), veh/h		657	842			316	300				218		607
Adjusted Saturation Flow Rate ( s ), veh/h/ln		1774	1773			1863	1751				1774		1397
Queue Service Time ( g s ), s		20.5	9.8			12.6	12.8				9.6		11.9
Cycle Queue Clearance Time ( g c ), s		20.5	9.8			12.6	12.8				9.6		11.9
Green Ratio ( g/C )		0.62	0.65			0.31	0.31				0.24		0.52
Capacity ( c ), veh/h		718	2305			580	545				424		1459
Volume-to-Capacity Ratio ( X )		0.914	0.365			0.546	0.550				0.516		0.416
Available Capacity ( c a ), veh/h		718	2305			580	545				424		1459
Back of Queue ( Q ), veh/ln ( 50 th percentile)		10.1	3.3			6.0	5.7				4.0		3.4
Queue Storage Ratio ( RQ ) ( 50 th percentile)		0.00	0.00			0.00	0.00				0.00		0.00
Uniform Delay ( d 1 ), s/veh		14.2	7.2			25.7	25.8				29.7		13.1
Incremental Delay ( d 2 ), s/veh		15.9	0.4			3.7	4.0				0.5		0.1
Initial Queue Delay ( d 3 ), s/veh		0.0	0.0			0.0	0.0				0.0		0.0
Control Delay ( d ), s/veh		30.1	7.7			29.4	29.7				30.2		13.2
Level of Service (LOS)		C	A			C	C				C		B
Approach Delay, s/veh / LOS		17.5	B		29.6	C		0.0			17.7		B
Intersection Delay, s/veh / LOS		20.1						C					

Multimodal Results		EB		WB		NB		SB	
Pedestrian LOS Score / LOS		0.7	A	2.4	B	2.7	B	2.9	C
Bicycle LOS Score / LOS		1.7	A	1.0	A				F

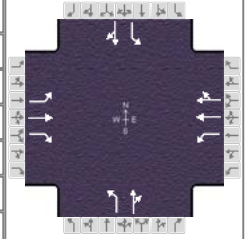
# HCS 2010 Signalized Intersection Results Summary

## General Information

Agency	TMS Engineers, Inc.
Analyst	ABC
Jurisdiction	Orange Village, OH
Urban Street	Harvard Road
Intersection	Harvard & Brainard
Project Description	No Build Conditions

## Intersection Information

Duration, h	0.25
Area Type	Other
PHF	0.92
Analysis Period	1> 7:00
File Name	PM 36NB HarvardBrainard.xus



## Demand Information

	EB			WB			NB			SB		
Approach Movement	L	T	R	L	T	R	L	T	R	L	T	R
Demand ( $v$ ), veh/h	150	446	308	21	315	37	101	175	17	51	405	151

## Signal Information

Cycle, s	90.0	Reference Phase	2
Offset, s	0	Reference Point	End
Uncoordinated	No	Simult. Gap E/W	On
Force Mode	Fixed	Simult. Gap N/S	On

## Timer Results

	EBL	EBT	WBL	WBT	NBL	NBT	SBL	SBT
Assigned Phase	5	2		6	3	8		4
Case Number	1.0	3.0		6.3	1.0	4.0		6.3
Phase Duration, s	12.0	37.8		25.8	12.0	52.2		40.2
Change Period, ( $Y+R_c$ ), s	5.0	5.0		5.0	5.0	5.0		5.0
Max Allow Headway ( $MAH$ ), s	3.1	0.0		0.0	3.1	3.1		3.1
Queue Clearance Time ( $g_s$ ), s	8.0				5.0	7.4		29.9
Green Extension Time ( $g_e$ ), s	0.0	0.0		0.0	0.0	1.8		1.1
Phase Call Probability	1.00				1.00	1.00		1.00
Max Out Probability	1.00				1.00	0.00		0.43

## Movement Group Results

	EB			WB			NB			SB		
Approach Movement	L	T	R	L	T	R	L	T	R	L	T	R
Assigned Movement	5	2	12	1	6	16	3	8	18	7	4	14
Adjusted Flow Rate ( $v$ ), veh/h	163	485	335	23	194	189	110	209		55	604	
Adjusted Saturation Flow Rate ( $s$ ), veh/h/ln	1792	1881	1594	671	1881	1812	1792	1852		1180	1794	
Queue Service Time ( $g_s$ ), s	6.0	19.9	15.2	2.7	7.9	8.1	3.0	5.4		2.7	27.9	
Cycle Queue Clearance Time ( $g_c$ ), s	6.0	19.9	15.2	10.6	7.9	8.1	3.0	5.4		2.7	27.9	
Green Ratio ( $g/C$ )	0.33	0.36	0.36	0.23	0.23	0.23	0.49	0.52		0.39	0.39	
Capacity ( $c$ ), veh/h	362	686	581	177	435	419	286	971		541	701	
Volume-to-Capacity Ratio ( $X$ )	0.451	0.707	0.576	0.129	0.445	0.451	0.383	0.215		0.102	0.862	
Available Capacity ( $c_a$ ), veh/h	362	686	581	177	435	419	286	971		541	701	
Back of Queue ( $Q$ ), veh/ln ( 50 th percentile)	2.5	9.5	6.1	0.5	3.9	3.8	1.1	2.1		0.7	13.1	
Queue Storage Ratio ( $RQ$ ) ( 50 th percentile)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	
Uniform Delay ( $d_1$ ), s/veh	22.8	24.5	23.0	34.2	29.7	29.7	18.1	11.5		17.5	25.2	
Incremental Delay ( $d_2$ ), s/veh	0.3	6.1	4.1	1.5	3.3	3.5	0.3	0.0		0.0	10.2	
Initial Queue Delay ( $d_3$ ), s/veh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		0.0	0.0	
Control Delay ( $d$ ), s/veh	23.1	30.5	27.1	35.7	32.9	33.2	18.4	11.5		17.5	35.4	
Level of Service (LOS)	C	C	C	D	C	C	B	B		B	D	
Approach Delay, s/veh / LOS	28.2	C		33.2	C		13.9	B		33.9	C	
Intersection Delay, s/veh / LOS	28.7						C					

## Multimodal Results

	EB			WB			NB			SB		
Pedestrian LOS Score / LOS	2.3	B		2.3	B		2.4	B		2.8	C	
Bicycle LOS Score / LOS	2.1	B		0.8	A		1.0	A		1.6	A	

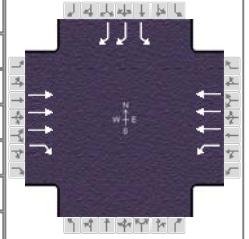
**APPENDIX H**  
**Build Capacity Analysis Worksheets**  
**2016**

# HCS 2010 Signalized Intersection Results Summary

## General Information

Agency	TMS Engineers, Inc.		
Analyst	ABC	Analysis Date	Sep 16, 2015
Jurisdiction	Orange, OH	Time Period	AM Peak
Urban Street	Harvard Road	Analysis Year	2016
Intersection	@ I-271 SB Ramps	File Name	AM 16 271SB.xus
Project Description	Build Conditions		

## Intersection Information



## Demand Information

	EB			WB			NB			SB		
Approach Movement	L	T	R	L	T	R	L	T	R	L	T	R
Demand ( $v$ ), veh/h		486	230	325	1499					172		540

## Signal Information

Cycle, s	90.0	Reference Phase	2									
Offset, s	0	Reference Point	End									
Uncoordinated	No	Simult. Gap E/W	On	Green	7.1	34.7	33.2	0.0	0.0	0.0		
Force Mode	Fixed	Simult. Gap N/S	On	Yellow	3.6	3.6	3.6	0.0	0.0	0.0		
				Red	1.4	1.4	1.4	0.0	0.0	0.0		

## Timer Results

	EBL	EBT	WBL	WBT	NBL	NBT	SBL	SBT
Assigned Phase		2	1	6				4
Case Number		7.3	1.0	4.0				9.0
Phase Duration, s		39.7	12.1	51.8				38.2
Change Period, ( $Y+R_c$ ), s		5.0	5.0	5.0				5.0
Max Allow Headway ( $MAH$ ), s		0.0	3.1	0.0				3.3
Queue Clearance Time ( $g_s$ ), s			9.1					17.1
Green Extension Time ( $g_e$ ), s		0.0	0.0	0.0				2.0
Phase Call Probability			1.00					1.00
Max Out Probability			1.00					0.00

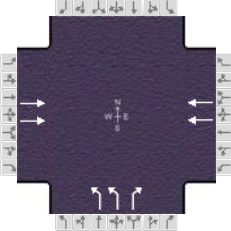
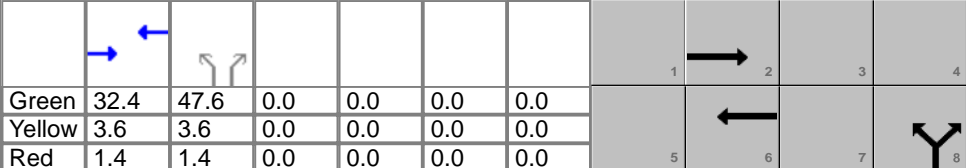
## Movement Group Results

Approach Movement	L	T	R	L	T	R	L	T	R	L	T	R
Assigned Movement		2	12	1	6					7		14
Adjusted Flow Rate ( $\nu$ ), veh/h		528	250	353	1629					187		587
Adjusted Saturation Flow Rate ( $s$ ), veh/h/ln		1691	1579	1774	1691					1774		1397
Queue Service Time ( $g_s$ ), s		6.4	10.4	7.1	20.4					6.7		15.1
Cycle Queue Clearance Time ( $g_c$ ), s		6.4	10.4	7.1	20.4					6.7		15.1
Green Ratio ( $g/C$ )		0.39	0.39	0.49	0.52					0.37		0.37
Capacity ( $c$ ), veh/h		1956	609	494	2639					654		1031
Volume-to-Capacity Ratio ( $X$ )		0.270	0.411	0.716	0.618					0.286		0.569
Available Capacity ( $c_a$ ), veh/h		1956	609	494	2639					654		1031
Back of Queue ( $Q$ ), veh/ln ( 50 th percentile)		2.5	4.0	3.0	7.4					2.7		4.8
Queue Storage Ratio ( $RQ$ ) ( 50 th percentile)		0.00	0.00	0.00	0.00					0.00		0.00
Uniform Delay ( $d_1$ ), s/veh		19.0	20.2	19.0	15.3					20.0		22.7
Incremental Delay ( $d_2$ ), s/veh		0.3	2.0	4.2	1.1					0.1		0.5
Initial Queue Delay ( $d_3$ ), s/veh		0.0	0.0	0.0	0.0					0.0		0.0
Control Delay ( $d$ ), s/veh		19.3	22.2	23.2	16.4					20.1		23.2
Level of Service (LOS)		B	C	C	B					C		C
Approach Delay, s/veh / LOS	20.2	C		17.6	B		0.0			22.4	C	
Intersection Delay, s/veh / LOS	19.2						B					

## Multimodal Results

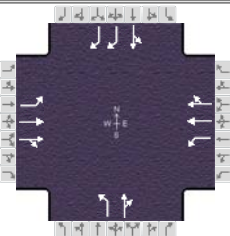
	EB		WB		NB		SB	
Pedestrian LOS Score / LOS	1.9	A	1.9	A	3.3	C	3.3	C
Bicycle LOS Score / LOS	0.9	A	1.6	A				F

# HCS 2010 Signalized Intersection Results Summary

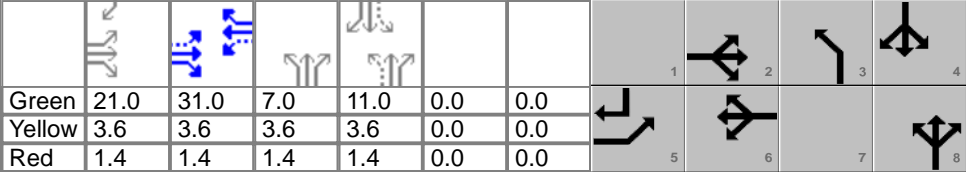
General Information						Intersection Information													
Agency		TMS Engineers, Inc.				Duration, h		0.25											
Analyst		ABC		Analysis Date		Sep 16, 2015		Area Type		Other									
Jurisdiction		Orange, OH		Time Period		AM Peak		PHF		0.92									
Urban Street		Harvard Road		Analysis Year		2016		Analysis Period		1> 7:00									
Intersection		@ I-271 NB Exit		File Name		AM 16 271NB.xus													
Project Description		Build Conditions																	
Demand Information																			
Approach Movement				EB			WB			NB			SB						
				L	T	R	L	T	R	L	T	R	L	T	R				
Demand ( v ), veh/h					400			729		1095		652							
Signal Information																			
Cycle, s	90.0	Reference Phase	2																
Offset, s	0	Reference Point	End																
Uncoordinated	No	Simult. Gap E/W	On																
Force Mode	Fixed	Simult. Gap N/S	On																
				Green	32.4	47.6	0.0	0.0	0.0	0.0									
				Yellow	3.6	3.6	0.0	0.0	0.0	0.0									
				Red	1.4	1.4	0.0	0.0	0.0	0.0									
Timer Results				EBL		EBT		WBL		WBT		NBL		NBT		SBL		SBT	
Assigned Phase						2				6				8					
Case Number						8.0				8.0				9.0					
Phase Duration, s						37.4				37.4				52.6					
Change Period, ( Y+R c ), s						5.0				5.0				5.0					
Max Allow Headway ( MAH ), s						0.0				0.0				3.2					
Queue Clearance Time ( g s ), s														36.5					
Green Extension Time ( g e ), s						0.0				0.0				4.6					
Phase Call Probability														1.00					
Max Out Probability														0.34					
Movement Group Results				EB			WB			NB			SB						
Approach Movement				L	T	R	L	T	R	L	T	R	L	T	R				
Assigned Movement					2			6		3		18							
Adjusted Flow Rate ( v ), veh/h					435			792		1190		709							
Adjusted Saturation Flow Rate ( s ), veh/h/ln					1773			1791		1723		1579							
Queue Service Time ( g s ), s					8.0			16.4		22.4		34.5							
Cycle Queue Clearance Time ( g c ), s					8.0			16.4		22.4		34.5							
Green Ratio ( g/C )					0.36			0.36		0.53		0.53							
Capacity ( c ), veh/h					1277			1289		1822		835							
Volume-to-Capacity Ratio ( X )					0.341			0.615		0.653		0.849							
Available Capacity ( c a ), veh/h					1277			1289		1822		835							
Back of Queue ( Q ), veh/ln ( 50 th percentile)					3.3			7.0		8.0		13.0							
Queue Storage Ratio ( RQ ) ( 50 th percentile)					0.00			0.00		0.00		0.00							
Uniform Delay ( d 1 ), s/veh					21.0			23.7		15.3		18.1							
Incremental Delay ( d 2 ), s/veh					0.7			2.2		0.7		7.8							
Initial Queue Delay ( d 3 ), s/veh					0.0			0.0		0.0		0.0							
Control Delay ( d ), s/veh					21.7			25.9		15.9		26.0							
Level of Service (LOS)					C			C		B		C							
Approach Delay, s/veh / LOS				21.7	C	25.9	C	19.7	B	0.0									
Intersection Delay, s/veh / LOS				21.5						C									
Multimodal Results				EB			WB			NB			SB						
Pedestrian LOS Score / LOS				1.9	A	0.7	A	2.7	B	2.7	B								
Bicycle LOS Score / LOS				0.8	A	1.1	A		F										

# HCS 2010 Signalized Intersection Results Summary

General Information						Intersection Information							
Agency		TMS Engineers, Inc.				Duration, h		0.25					
Analyst		ABC		Analysis Date		Sep 16, 2015		Area Type		Other			
Jurisdiction		Orange Village, OH		Time Period		AM Peak Period		PHF		0.92			
Urban Street		Harvard Road		Analysis Year		2016		Analysis Period		1> 7:00			
Intersection		Harvard & Orange Place		File Name		AM 16 HarvardOrange.xus							
Project Description		Build Conditions											



Demand Information				EB			WB			NB			SB		
Approach Movement				L	T	R	L	T	R	L	T	R	L	T	R
Demand ( v ), veh/h				540	388	124	38	570	84	98	10	21	25	3	185

Signal Information						
Cycle, s	90.0	Reference Phase	2			
Offset, s	0	Reference Point	End			
Uncoordinated	No	Simult. Gap E/W	On			
Force Mode	Fixed	Simult. Gap N/S	On			
Green	21.0	31.0	7.0	11.0	0.0	0.0
Yellow	3.6	3.6	3.6	3.6	0.0	0.0
Red	1.4	1.4	1.4	1.4	0.0	0.0

Timer Results		EBL		EBT		WBL		WBT		NBL		NBT		SBL		SBT	
Assigned Phase		5		2				6		3		8				4	
Case Number		1.0		4.0				6.3		1.0		4.0				7.3	
Phase Duration, s		26.0		62.0				36.0		12.0		28.0				16.0	
Change Period, ( Y+R c ), s		5.0		5.0				5.0		5.0		5.0				5.0	
Max Allow Headway ( MAH ), s		3.1		0.0				0.0		3.1		3.3				3.3	
Queue Clearance Time ( g s ), s		19.8								6.5		3.4				6.5	
Green Extension Time ( g e ), s		0.2		0.0				0.0		0.0		0.6				0.3	
Phase Call Probability		1.00								1.00		1.00				1.00	
Max Out Probability		1.00								1.00		0.00				0.35	

Movement Group Results		EB			WB			NB			SB						
Approach Movement		L	T	R	L	T	R	L	T	R	L	T	R				
Assigned Movement		5	2	12	1	6	16	3	8	18	7	4	14				
Adjusted Flow Rate ( v ), veh/h		587	288	268	41	363	348	107	34			30	201				
Adjusted Saturation Flow Rate ( s ), veh/h/ln		1774	1863	1708	849	1863	1779	1774	1660			1419	1397				
Queue Service Time ( g s ), s		17.8	6.0	6.1	3.0	14.3	14.3	4.5	1.4			1.4	4.5				
Cycle Queue Clearance Time ( g c ), s		17.8	6.0	6.1	3.0	14.3	14.3	4.5	1.4			1.7	4.5				
Green Ratio ( g/C )		0.60	0.63	0.63	0.34	0.34	0.34	0.22	0.26			0.12	0.36				
Capacity ( c ), veh/h		630	1180	1082	372	642	613	340	424			249	993				
Volume-to-Capacity Ratio ( X )		0.932	0.244	0.248	0.111	0.566	0.568	0.314	0.079			0.122	0.202				
Available Capacity ( c a ), veh/h		630	1180	1082	372	642	613	340	424			249	993				
Back of Queue ( Q ), veh/ln ( 50 th percentile)		9.6	2.2	2.1	0.6	6.6	6.4	1.9	0.5			0.6	1.4				
Queue Storage Ratio ( RQ ) ( 50 th percentile)		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00			0.00	0.00				
Uniform Delay ( d 1 ), s/veh		14.9	7.2	7.2	20.3	24.0	24.0	29.0	25.5			35.4	20.1				
Incremental Delay ( d 2 ), s/veh		20.4	0.5	0.5	0.6	3.6	3.8	0.2	0.0			0.1	0.0				
Initial Queue Delay ( d 3 ), s/veh		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0			0.0	0.0				
Control Delay ( d ), s/veh		35.3	7.6	7.7	20.9	27.6	27.8	29.2	25.5			35.5	20.2				
Level of Service (LOS)		D	A	A	C	C	C	C	C			D	C				
Approach Delay, s/veh / LOS		21.9		C		27.3		C		28.3		C		22.2		C	
Intersection Delay, s/veh / LOS		24.1												C			

Multimodal Results		EB		WB		NB		SB									
Pedestrian LOS Score / LOS		2.2		B		2.4		B		2.8		C		2.8		C	
Bicycle LOS Score / LOS		1.4		A		1.1		A		0.7		A		0.9		A	



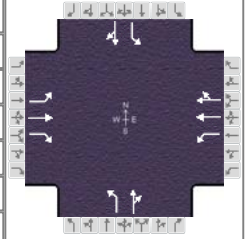
# HCS 2010 Signalized Intersection Results Summary

## General Information

Agency	TMS Engineers, Inc.
Analyst	ABC
Jurisdiction	Orange Village, OH
Urban Street	Harvard Road
Intersection	Harvard & Brainard
Project Description	Build Conditions

## Intersection Information

Duration, h	0.25
Area Type	Other
PHF	0.92
Analysis Period	1 > 7:00
File Name	AM 16 HarvardBrainard.xus

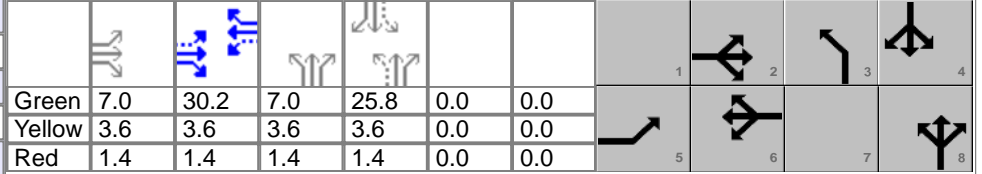


## Demand Information

	EB			WB			NB			SB		
Approach Movement	L	T	R	L	T	R	L	T	R	L	T	R
Demand ( $v$ ), veh/h	148	224	61	11	457	31	186	144	11	12	74	73

## Signal Information

Cycle, s	90.0	Reference Phase	2
Offset, s	0	Reference Point	End
Uncoordinated	No	Simult. Gap E/W	On
Force Mode	Fixed	Simult. Gap N/S	On



## Timer Results

	EBL	EBT	WBL	WBT	NBL	NBT	SBL	SBT
Assigned Phase	5	2		6	3	8		4
Case Number	1.0	3.0		6.3	1.0	4.0		6.3
Phase Duration, s	12.0	47.2		35.2	12.0	42.8		30.8
Change Period, ( $Y+R_c$ ), s	5.0	5.0		5.0	5.0	5.0		5.0
Max Allow Headway ( $MAH$ ), s	3.1	0.0		0.0	3.1	3.1		3.1
Queue Clearance Time ( $g_s$ ), s	7.0				9.0	7.2		8.5
Green Extension Time ( $g_e$ ), s	0.0	0.0		0.0	0.0	0.6		0.6
Phase Call Probability	1.00				1.00	1.00		1.00
Max Out Probability	1.00				1.00	0.00		0.00

## Movement Group Results

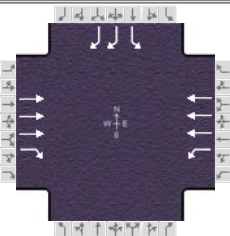
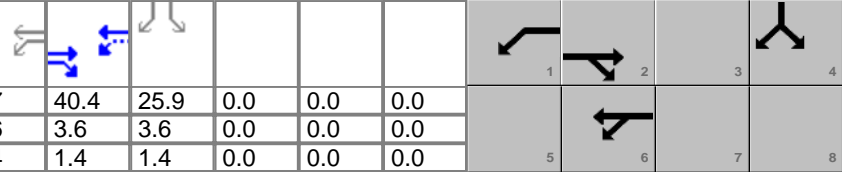
	EB			WB			NB			SB		
Approach Movement	L	T	R	L	T	R	L	T	R	L	T	R
Assigned Movement	5	2	12	1	6	16	3	8	18	7	4	14
Adjusted Flow Rate ( $v$ ), veh/h	161	243	66	12	268	263	202	168		13	160	
Adjusted Saturation Flow Rate ( $s$ ), veh/h/ln	1792	1881	1594	1076	1881	1839	1792	1857		1224	1727	
Queue Service Time ( $g_s$ ), s	5.0	7.1	2.1	0.7	9.9	10.0	7.0	5.2		0.7	6.5	
Cycle Queue Clearance Time ( $g_c$ ), s	5.0	7.1	2.1	0.7	9.9	10.0	7.0	5.2		0.7	6.5	
Green Ratio ( $g/C$ )	0.44	0.47	0.47	0.34	0.34	0.34	0.39	0.42		0.29	0.29	
Capacity ( $c$ ), veh/h	417	882	748	441	631	617	483	780		431	495	
Volume-to-Capacity Ratio ( $X$ )	0.386	0.276	0.089	0.027	0.424	0.426	0.418	0.216		0.030	0.323	
Available Capacity ( $c_a$ ), veh/h	417	882	748	441	631	617	483	780		431	495	
Back of Queue ( $Q$ ), veh/ln ( 50 th percentile)	2.0	3.0	0.8	0.2	4.6	4.5	2.8	2.1		0.2	2.6	
Queue Storage Ratio ( $RQ$ ) ( 50 th percentile)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	
Uniform Delay ( $d_1$ ), s/veh	16.7	14.6	13.2	20.1	23.2	23.2	19.6	16.6		23.1	25.2	
Incremental Delay ( $d_2$ ), s/veh	0.2	0.8	0.2	0.1	2.1	2.1	0.2	0.1		0.0	0.1	
Initial Queue Delay ( $d_3$ ), s/veh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		0.0	0.0	
Control Delay ( $d$ ), s/veh	16.9	15.4	13.5	20.2	25.2	25.3	19.8	16.7		23.2	25.4	
Level of Service (LOS)	B	B	B	C	C	C	B	B		C	C	
Approach Delay, s/veh / LOS	15.6		B	25.2		C	18.4		B	25.2		C
Intersection Delay, s/veh / LOS	20.7						C					

## Multimodal Results

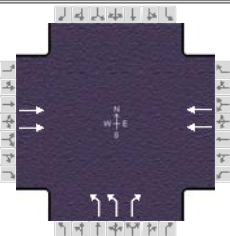
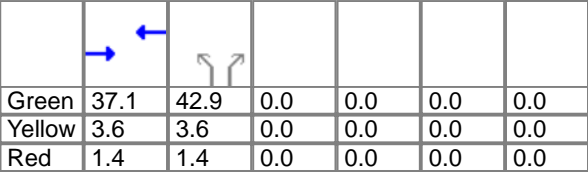
	EB			WB			NB			SB		
Pedestrian LOS Score / LOS	2.3		B	2.3		B	2.4		B	2.8		C
Bicycle LOS Score / LOS	1.3		A	0.9		A	1.1		A	0.8		A



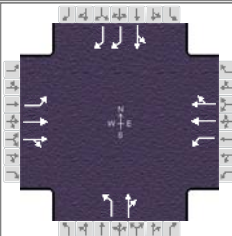
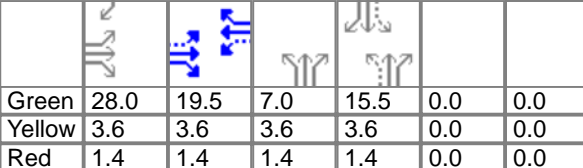
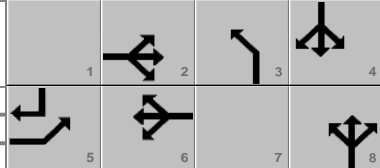
# HCS 2010 Signalized Intersection Results Summary

General Information					Intersection Information															
Agency		TMS Engineers, Inc.			Duration, h		0.25													
Analyst		ABC	Analysis Date	Sep 16, 2015	Area Type		Other													
Jurisdiction		Orange, OH	Time Period	PM Peak	PHF		0.92													
Urban Street		Harvard Road	Analysis Year	2016	Analysis Period		1> 7:00													
Intersection		@ I-271 SB Ramps	File Name	PM 16 271SB.xus																
Project Description		Build Conditions																		
Demand Information					EB			WB			NB			SB						
Approach Movement					L	T	R	L	T	R	L	T	R	L	T	R				
Demand ( v ), veh/h						1186	657	380	973					360		635				
Signal Information																				
Cycle, s		90.0	Reference Phase			2														
Offset, s		0	Reference Point			End														
Uncoordinated		No	Simult. Gap E/W			On														
Force Mode		Fixed	Simult. Gap N/S			On														
					Green	8.7	40.4	25.9	0.0	0.0	0.0									
					Yellow	3.6	3.6	3.6	0.0	0.0	0.0									
					Red	1.4	1.4	1.4	0.0	0.0	0.0									
Timer Results					EBL		EBT		WBL		WBT		NBL		NBT		SBL		SBT	
Assigned Phase							2		1		6								4	
Case Number							7.3		1.0		4.0								9.0	
Phase Duration, s							45.4		13.7		59.1								30.9	
Change Period, ( Y+R c ), s							5.0		5.0		5.0								5.0	
Max Allow Headway ( MAH ), s							0.0		3.1		0.0								3.3	
Queue Clearance Time ( g s ), s									10.7										23.0	
Green Extension Time ( g e ), s							0.0		0.0		0.0								1.1	
Phase Call Probability									1.00										1.00	
Max Out Probability									1.00										1.00	
Movement Group Results					EB			WB			NB			SB						
Approach Movement					L	T	R	L	T	R	L	T	R	L	T	R				
Assigned Movement						2	12	1	6					7		14				
Adjusted Flow Rate ( v ), veh/h						1289	714	413	1058					391		690				
Adjusted Saturation Flow Rate ( s ), veh/h/ln						1691	1579	1774	1691					1774		1397				
Queue Service Time ( g s ), s						16.9	40.4	8.7	9.5					18.1		21.0				
Cycle Queue Clearance Time ( g c ), s						16.9	40.4	8.7	9.5					18.1		21.0				
Green Ratio ( g/C )						0.45	0.45	0.57	0.60					0.29		0.29				
Capacity ( c ), veh/h						2278	709	363	3050					511		804				
Volume-to-Capacity Ratio ( X )						0.566	1.008	1.138	0.347					0.766		0.858				
Available Capacity ( c a ), veh/h						2278	709	363	3050					511		804				
Back of Queue ( Q ), veh/ln ( 50 th percentile)						6.4	20.8	12.8	3.1					8.3		7.7				
Queue Storage Ratio ( RQ ) ( 50 th percentile)						0.00	0.00	0.00	0.00					0.00		0.00				
Uniform Delay ( d 1 ), s/veh						18.3	24.8	19.3	9.0					29.3		30.3				
Incremental Delay ( d 2 ), s/veh						1.0	35.7	90.3	0.3					6.2		8.8				
Initial Queue Delay ( d 3 ), s/veh						0.0	0.0	0.0	0.0					0.0		0.0				
Control Delay ( d ), s/veh						19.3	60.5	109.6	9.4					35.5		39.1				
Level of Service (LOS)						B	F	F	A					D		D				
Approach Delay, s/veh / LOS					34.0		C		37.5		D		0.0				37.8		D	
Intersection Delay, s/veh / LOS					36.1									D						
Multimodal Results					EB			WB			NB			SB						
Pedestrian LOS Score / LOS					1.9		A		1.9		A		3.3		C		3.3		C	
Bicycle LOS Score / LOS					1.6		A		1.3		A								F	

# HCS 2010 Signalized Intersection Results Summary

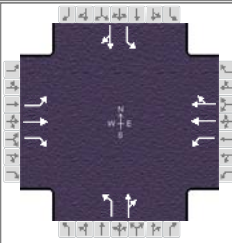
General Information					Intersection Information														
Agency		TMS Engineers, Inc.			Duration, h		0.25												
Analyst		ABC	Analysis Date	Sep 16, 2015		Area Type		Other											
Jurisdiction		Orange, OH	Time Period	PM Peak		PHF		0.92											
Urban Street		Harvard Road	Analysis Year	2016		Analysis Period		1> 7:00											
Intersection		@ I-271 NB Exit	File Name	PM 16 271NB.xus															
Project Description		Build Conditions																	
Demand Information																			
Approach Movement				EB			WB			NB			SB						
				L	T	R	L	T	R	L	T	R	L	T	R				
Demand ( v ), veh/h					921			897		456		537							
Signal Information																			
Cycle, s	90.0	Reference Phase	2																
Offset, s	0	Reference Point	End																
Uncoordinated	No	Simult. Gap E/W	On																
Force Mode	Fixed	Simult. Gap N/S	On																
				Green	37.1	42.9	0.0	0.0	0.0	0.0									
				Yellow	3.6	3.6	0.0	0.0	0.0	0.0									
				Red	1.4	1.4	0.0	0.0	0.0	0.0									
Timer Results				EBL		EBT		WBL		WBT		NBL		NBT		SBL		SBT	
Assigned Phase						2				6				8					
Case Number						8.0				8.0				9.0					
Phase Duration, s						42.1				42.1				47.9					
Change Period, ( Y+R c ), s						5.0				5.0				5.0					
Max Allow Headway ( MAH ), s						0.0				0.0				3.3					
Queue Clearance Time ( g s ), s														29.6					
Green Extension Time ( g e ), s						0.0				0.0				2.5					
Phase Call Probability														1.00					
Max Out Probability														0.05					
Movement Group Results				EB			WB			NB			SB						
Approach Movement				L	T	R	L	T	R	L	T	R	L	T	R				
Assigned Movement					2			6		3		18							
Adjusted Flow Rate ( v ), veh/h					1001			975		496		584							
Adjusted Saturation Flow Rate ( s ), veh/h/ln					1773			1791		1723		1579							
Queue Service Time ( g s ), s					20.8			19.8		7.9		27.6							
Cycle Queue Clearance Time ( g c ), s					20.8			19.8		7.9		27.6							
Green Ratio ( g/C )					0.41			0.41		0.48		0.48							
Capacity ( c ), veh/h					1462			1476		1642		752							
Volume-to-Capacity Ratio ( X )					0.685			0.660		0.302		0.776							
Available Capacity ( c a ), veh/h					1462			1476		1642		752							
Back of Queue ( Q ), veh/ln ( 50 th percentile)					8.6			8.2		2.9		10.2							
Queue Storage Ratio ( RQ ) ( 50 th percentile)					0.00			0.00		0.00		0.00							
Uniform Delay ( d 1 ), s/veh					21.7			21.4		14.4		19.6							
Incremental Delay ( d 2 ), s/veh					2.6			2.3		0.0		4.6							
Initial Queue Delay ( d 3 ), s/veh					0.0			0.0		0.0		0.0							
Control Delay ( d ), s/veh					24.3			23.7		14.4		24.2							
Level of Service (LOS)					C			C		B		C							
Approach Delay, s/veh / LOS				24.3		C		23.7		C		19.7		B		0.0			
Intersection Delay, s/veh / LOS				22.5						C									
Multimodal Results				EB			WB			NB			SB						
Pedestrian LOS Score / LOS				1.9		A		0.7		A		2.7		B		2.7		B	
Bicycle LOS Score / LOS				1.3		A		1.3		A				F					

# HCS 2010 Signalized Intersection Results Summary

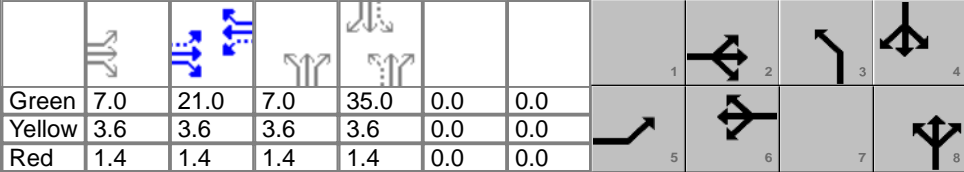
General Information						Intersection Information													
Agency		TMS Engineers, Inc.				Duration, h		0.25											
Analyst		ABC		Analysis Date		Sep 16, 2015		Area Type						Other					
Jurisdiction		Orange Village, OH		Time Period		PM Peak Period		PHF						0.92					
Urban Street		Harvard Road		Analysis Year		2016		Analysis Period						1> 7:00					
Intersection		Harvard & Orange Place		File Name		PM 16 HarvardOrange.xus													
Project Description		Build Conditions																	
Demand Information				EB			WB			NB			SB						
Approach Movement				L	T	R	L	T	R	L	T	R	L	T	R				
Demand ( v ), veh/h				609	738	111	37	449	98	74	6	37	213	7	568				
Signal Information																			
Cycle, s	90.0	Reference Phase	2																
Offset, s	0	Reference Point	End																
Uncoordinated	No	Simult. Gap E/W	On																
Force Mode	Fixed	Simult. Gap N/S	On																
				Green	28.0	19.5	7.0	15.5	0.0	0.0									
				Yellow	3.6	3.6	3.6	3.6	0.0	0.0									
				Red	1.4	1.4	1.4	1.4	0.0	0.0									
Timer Results				EBL		EBT		WBL		WBT		NBL		NBT		SBL		SBT	
Assigned Phase				5		2				6		3		8				4	
Case Number				1.0		4.0				6.3		1.0		4.0				7.3	
Phase Duration, s				33.0		57.5				24.5		12.0		32.5				20.5	
Change Period, ( Y+R c ), s				5.0		5.0				5.0		5.0		5.0				5.0	
Max Allow Headway ( MAH ), s				3.1		0.0				0.0		3.1		3.3				3.3	
Queue Clearance Time ( g s ), s				28.4								5.1		3.9				17.5	
Green Extension Time ( g e ), s				0.0		0.0				0.0		0.0		2.4				0.0	
Phase Call Probability				1.00								1.00		1.00				1.00	
Max Out Probability				1.00								1.00		0.00				1.00	
Movement Group Results				EB			WB			NB			SB						
Approach Movement				L	T	R	L	T	R	L	T	R	L	T	R				
Assigned Movement				5	2	12	1	6	16	3	8	18	7	4	14				
Adjusted Flow Rate ( v ), veh/h				662	472	451	40	305	289	80	47			239	617				
Adjusted Saturation Flow Rate ( s ), veh/h/ln				1774	1863	1777	603	1863	1747	1774	1613			1365	1397				
Queue Service Time ( g s ), s				26.4	12.7	12.7	5.0	13.8	14.0	3.1	1.9			15.5	13.2				
Cycle Queue Clearance Time ( g c ), s				26.4	12.7	12.7	5.0	13.8	14.0	3.1	1.9			15.5	13.2				
Green Ratio ( g/C )				0.55	0.58	0.58	0.22	0.22	0.22	0.27	0.31			0.17	0.48				
Capacity ( c ), veh/h				682	1087	1037	211	404	379	218	493			314	1350				
Volume-to-Capacity Ratio ( X )				0.970	0.435	0.435	0.191	0.757	0.764	0.369	0.095			0.762	0.457				
Available Capacity ( c a ), veh/h				682	1087	1037	211	404	379	218	493			314	1350				
Back of Queue ( Q ), veh/ln ( 50 th percentile)				14.8	5.0	4.8	0.8	7.4	7.1	1.3	0.7			5.9	3.9				
Queue Storage Ratio ( RQ ) ( 50 th percentile)				0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00			0.00	0.00				
Uniform Delay ( d 1 ), s/veh				19.7	10.5	10.5	29.6	33.0	33.1	26.7	22.3			37.4	15.4				
Incremental Delay ( d 2 ), s/veh				27.0	1.3	1.3	2.0	12.5	13.6	0.4	0.0			9.5	0.1				
Initial Queue Delay ( d 3 ), s/veh				0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0			0.0	0.0				
Control Delay ( d ), s/veh				46.7	11.7	11.8	31.6	45.5	46.7	27.1	22.4			46.9	15.5				
Level of Service ( LOS )				D	B	B	C	D	D	C	C			D	B				
Approach Delay, s/veh / LOS				26.3		C		45.2		D		25.3		C		24.3		C	
Intersection Delay, s/veh / LOS				29.5						C									
Multimodal Results				EB			WB			NB			SB						
Pedestrian LOS Score / LOS				2.2		B		2.4		B		2.8		C		2.8		C	
Bicycle LOS Score / LOS				1.8		A		1.0		A		0.7		A		1.9		A	

# HCS 2010 Signalized Intersection Results Summary

General Information						Intersection Information							
Agency		TMS Engineers, Inc.				Duration, h		0.25					
Analyst		ABC		Analysis Date		Sep 16, 2015		Area Type		Other			
Jurisdiction		Orange Village, OH		Time Period		PM Peak Period		PHF		0.92			
Urban Street		Harvard Road		Analysis Year		2016		Analysis Period		1> 7:00			
Intersection		Harvard & Brainard		File Name		PM 16 HarvardBrainard.xus							
Project Description		Build Conditions											



Demand Information				EB			WB			NB			SB		
Approach Movement				L	T	R	L	T	R	L	T	R	L	T	R
Demand ( v ), veh/h				149	442	311	20	311	35	106	167	16	49	386	163

Signal Information						
Cycle, s	90.0	Reference Phase	2			
Offset, s	0	Reference Point	End			
Uncoordinated	No	Simult. Gap E/W	On			
Force Mode	Fixed	Simult. Gap N/S	On			
Green	7.0	21.0	7.0	35.0	0.0	0.0
Yellow	3.6	3.6	3.6	3.6	0.0	0.0
Red	1.4	1.4	1.4	1.4	0.0	0.0

Timer Results		EBL		EBT		WBL		WBT		NBL		NBT		SBL		SBT	
Assigned Phase		5		2				6		3		8				4	
Case Number		1.0		3.0				6.3		1.0		4.0				6.3	
Phase Duration, s		12.0		38.0				26.0		12.0		52.0				40.0	
Change Period, ( Y+R c ), s		5.0		5.0				5.0		5.0		5.0				5.0	
Max Allow Headway ( MAH ), s		3.1		0.0				0.0		3.1		3.1				3.1	
Queue Clearance Time ( g s ), s		8.0								5.2		7.2				29.6	
Green Extension Time ( g e ), s		0.0		0.0				0.0		0.0		1.8				1.1	
Phase Call Probability		1.00								1.00		1.00				1.00	
Max Out Probability		1.00								1.00		0.00				0.42	

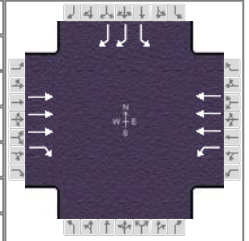
Movement Group Results		EB			WB			NB			SB						
Approach Movement		L	T	R	L	T	R	L	T	R	L	T	R				
Assigned Movement		5	2	12	1	6	16	3	8	18	7	4	14				
Adjusted Flow Rate ( v ), veh/h		162	480	338	22	190	186	115	199		53	597					
Adjusted Saturation Flow Rate ( s ), veh/h/ln		1792	1881	1594	672	1881	1814	1792	1852		1190	1786					
Queue Service Time ( g s ), s		6.0	19.6	15.3	2.6	7.8	7.9	3.2	5.2		2.6	27.6					
Cycle Queue Clearance Time ( g c ), s		6.0	19.6	15.3	10.1	7.8	7.9	3.2	5.2		2.6	27.6					
Green Ratio ( g/C )		0.33	0.37	0.37	0.23	0.23	0.23	0.49	0.52		0.39	0.39					
Capacity ( c ), veh/h		367	690	585	180	439	423	287	967		543	694					
Volume-to-Capacity Ratio ( X )		0.441	0.697	0.578	0.120	0.433	0.439	0.401	0.206		0.098	0.859					
Available Capacity ( c a ), veh/h		367	690	585	180	439	423	287	967		543	694					
Back of Queue ( Q ), veh/ln ( 50 th percentile)		2.4	9.3	6.1	0.5	3.8	3.7	1.2	2.0		0.7	12.8					
Queue Storage Ratio ( RQ ) ( 50 th percentile)		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00					
Uniform Delay ( d 1 ), s/veh		22.6	24.2	22.9	33.6	29.4	29.5	18.2	11.5		17.6	25.2					
Incremental Delay ( d 2 ), s/veh		0.3	5.7	4.1	1.4	3.1	3.3	0.3	0.0		0.0	10.1					
Initial Queue Delay ( d 3 ), s/veh		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		0.0	0.0					
Control Delay ( d ), s/veh		22.9	30.0	27.0	35.0	32.5	32.8	18.6	11.5		17.6	35.4					
Level of Service (LOS)		C	C	C	D	C	C	B	B		B	D					
Approach Delay, s/veh / LOS		27.8		C		32.8		C		14.1		B		33.9		C	
Intersection Delay, s/veh / LOS		28.5												C			

Multimodal Results		EB		WB		NB		SB									
Pedestrian LOS Score / LOS		2.3		B		2.3		B		2.4		B		2.8		C	
Bicycle LOS Score / LOS		2.1		B		0.8		A		1.0		A		1.6		A	

**APPENDIX I**  
**Build Capacity Analysis Worksheets**  
**2018**

# HCS 2010 Signalized Intersection Results Summary

General Information				Intersection Information	
Agency	TMS Engineers, Inc.			Duration, h	0.25
Analyst	ABC	Analysis Date	Sep 16, 2015	Area Type	Other
Jurisdiction	Orange, OH	Time Period	AM Peak	PHF	0.92
Urban Street	Harvard Road	Analysis Year	2018	Analysis Period	1> 7:00
Intersection	@ I-271 SB Ramps	File Name	AM 18 271SB.xus		
Project Description	Build Conditions				



Demand Information	EB			WB			NB			SB		
Approach Movement	L	T	R	L	T	R	L	T	R	L	T	R
Demand ( $v$ ), veh/h		529	231	323	1496					224		543

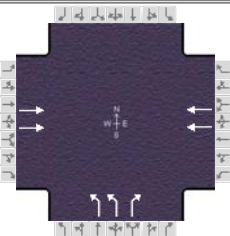
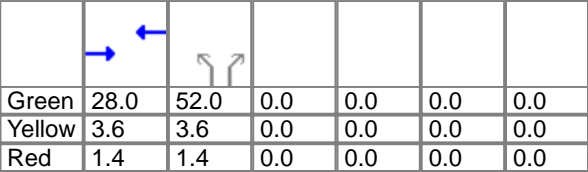
Signal Information											
Cycle, s	90.0	Reference Phase	2								
Offset, s	0	Reference Point	End								
Uncoordinated	No	Simult. Gap E/W	On	Green	8.0	33.8	33.2	0.0	0.0	0.0	
Force Mode	Fixed	Simult. Gap N/S	On	Yellow	3.6	3.6	3.6	0.0	0.0	0.0	
				Red	1.4	1.4	1.4	0.0	0.0	0.0	

Timer Results	EBL	EBT	WBL	WBT	NBL	NBT	SBL	SBT
Assigned Phase		2	1	6				4
Case Number		7.3	1.0	4.0				9.0
Phase Duration, s		38.8	13.0	51.8				38.2
Change Period, ( $Y+R_c$ ), s		5.0	5.0	5.0				5.0
Max Allow Headway ( $MAH$ ), s		0.0	3.1	0.0				3.3
Queue Clearance Time ( $g_s$ ), s			10.0					17.2
Green Extension Time ( $g_e$ ), s		0.0	0.0	0.0				2.1
Phase Call Probability			1.00					1.00
Max Out Probability			1.00					0.01

Movement Group Results	EB			WB			NB			SB		
Approach Movement	L	T	R	L	T	R	L	T	R	L	T	R
Assigned Movement		2	12	1	6					7		14
Adjusted Flow Rate ( $\nu$ ), veh/h		575	251	351	1626					243		590
Adjusted Saturation Flow Rate ( $s$ ), veh/h/ln		1691	1579	1774	1691					1774		1397
Queue Service Time ( $g_s$ ), s		7.2	10.6	8.0	20.4					9.0		15.2
Cycle Queue Clearance Time ( $g_c$ ), s		7.2	10.6	8.0	20.4					9.0		15.2
Green Ratio ( $g/C$ )		0.38	0.38	0.49	0.52					0.37		0.37
Capacity ( $c$ ), veh/h		1906	593	485	2639					654		1031
Volume-to-Capacity Ratio ( $X$ )		0.302	0.424	0.725	0.616					0.372		0.573
Available Capacity ( $c_a$ ), veh/h		1906	593	485	2639					654		1031
Back of Queue ( $Q$ ), veh/ln ( 50 th percentile)		2.8	4.1	2.6	7.3					3.6		4.8
Queue Storage Ratio ( $RQ$ ) ( 50 th percentile)		0.00	0.00	0.00	0.00					0.00		0.00
Uniform Delay ( $d_1$ ), s/veh		19.8	20.9	18.5	15.3					20.8		22.7
Incremental Delay ( $d_2$ ), s/veh		0.4	2.2	4.6	1.1					0.1		0.5
Initial Queue Delay ( $d_3$ ), s/veh		0.0	0.0	0.0	0.0					0.0		0.0
Control Delay ( $d$ ), s/veh		20.2	23.1	23.2	16.3					20.9		23.2
Level of Service (LOS)		C	C	C	B					C		C
Approach Delay, s/veh / LOS	21.1	C		17.6	B		0.0			22.5	C	
Intersection Delay, s/veh / LOS	19.5						B					

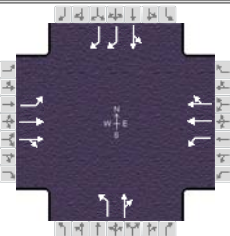
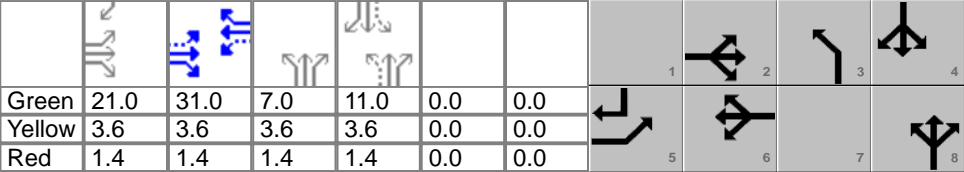
Multimodal Results	EB		WB		NB		SB	
Pedestrian LOS Score / LOS	1.9	A	1.9	A	3.3	C	3.3	C
Bicycle LOS Score / LOS	0.9	A	1.6	A				F

# HCS 2010 Signalized Intersection Results Summary

General Information					Intersection Information														
Agency		TMS Engineers, Inc.			Duration, h		0.25												
Analyst		ABC	Analysis Date	Sep 16, 2015		Area Type		Other											
Jurisdiction		Orange, OH	Time Period	AM Peak		PHF		0.92											
Urban Street		Harvard Road	Analysis Year	2018		Analysis Period		1> 7:00											
Intersection		@ I-271 NB Exit	File Name	AM 18 271NB.xus															
Project Description		Build Conditions																	
Demand Information																			
Approach Movement				L		T	R	L		T	R	L		T	R				
Demand ( v ), veh/h						494				718		1100			771				
Signal Information																			
Cycle, s	90.0	Reference Phase	2																
Offset, s	0	Reference Point	End																
Uncoordinated	No	Simult. Gap E/W	On																
Force Mode	Fixed	Simult. Gap N/S	On																
Green				28.0	52.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0			
Yellow				3.6	3.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0			
Red				1.4	1.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0			
Timer Results				EBL		EBT		WBL		WBT		NBL		NBT		SBL		SBT	
Assigned Phase						2				6				8					
Case Number						8.0				8.0				9.0					
Phase Duration, s						33.0				33.0				57.0					
Change Period, ( Y+R c ), s						5.0				5.0				5.0					
Max Allow Headway ( MAH ), s						0.0				0.0				3.2					
Queue Clearance Time ( g s ), s														45.0					
Green Extension Time ( g e ), s						0.0				0.0				3.8					
Phase Call Probability														1.00					
Max Out Probability														0.64					
Movement Group Results				EB		WB		NB		SB									
Approach Movement				L	T	R	L	T	R	L	T	R	L	T	R				
Assigned Movement					2			6		3		18							
Adjusted Flow Rate ( v ), veh/h					537			780		1196		838							
Adjusted Saturation Flow Rate ( s ), veh/h/ln					1773			1791		1723		1579							
Queue Service Time ( g s ), s					11.1			17.3		20.2		43.0							
Cycle Queue Clearance Time ( g c ), s					11.1			17.3		20.2		43.0							
Green Ratio ( g/C )					0.31			0.31		0.58		0.58							
Capacity ( c ), veh/h					1103			1114		1991		912							
Volume-to-Capacity Ratio ( X )					0.487			0.700		0.601		0.919							
Available Capacity ( c a ), veh/h					1103			1114		1991		912							
Back of Queue ( Q ), veh/ln ( 50 th percentile)					4.7			7.6		6.9		16.8							
Queue Storage Ratio ( RQ ) ( 50 th percentile)					0.00			0.00		0.00		0.00							
Uniform Delay ( d 1 ), s/veh					25.2			27.3		12.3		17.1							
Incremental Delay ( d 2 ), s/veh					1.5			3.7		0.4		13.8							
Initial Queue Delay ( d 3 ), s/veh					0.0			0.0		0.0		0.0							
Control Delay ( d ), s/veh					26.7			31.0		12.6		30.9							
Level of Service (LOS)					C			C		B		C							
Approach Delay, s/veh / LOS				26.7		C		31.0		C		20.2		C		0.0			
Intersection Delay, s/veh / LOS				23.7						C									
Multimodal Results				EB		WB		NB		SB									
Pedestrian LOS Score / LOS				1.9	A	0.7	A	2.7	B	2.7	B								
Bicycle LOS Score / LOS				0.9	A	1.1	A		F										



# HCS 2010 Signalized Intersection Results Summary

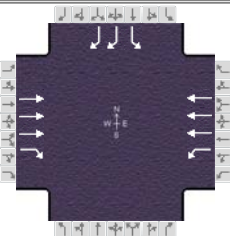
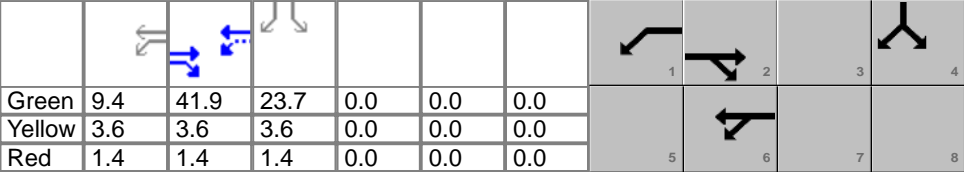
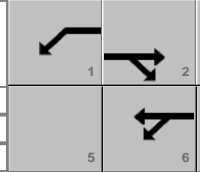
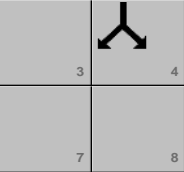

General Information						Intersection Information													
Agency		TMS Engineers, Inc.				Duration, h		0.25											
Analyst		ABC		Analysis Date		Sep 16, 2015		Area Type						Other					
Jurisdiction		Orange Village, OH		Time Period		AM Peak Period		PHF						0.92					
Urban Street		Harvard Road		Analysis Year		2018		Analysis Period						1> 7:00					
Intersection		Harvard & Orange Place		File Name		AM 18 HarvardOrange.xus													
Project Description		Build Conditions																	
Demand Information				EB			WB			NB			SB						
Approach Movement				L	T	R	L	T	R	L	T	R	L	T	R				
Demand ( v ), veh/h				540	390	332	103	573	84	83	9	17	25	14	185				
Signal Information																			
Cycle, s	90.0	Reference Phase	2																
Offset, s	0	Reference Point	End																
Uncoordinated	No	Simult. Gap E/W	On																
Force Mode	Fixed	Simult. Gap N/S	On																
				Green	21.0	31.0	7.0	11.0	0.0	0.0									
				Yellow	3.6	3.6	3.6	3.6	0.0	0.0									
				Red	1.4	1.4	1.4	1.4	0.0	0.0									
Timer Results				EBL		EBT		WBL		WBT		NBL		NBT		SBL		SBT	
Assigned Phase				5		2				6		3		8				4	
Case Number				1.0		4.0				6.3		1.0		4.0				7.3	
Phase Duration, s				26.0		62.0				36.0		12.0		28.0				16.0	
Change Period, ( Y+R c ), s				5.0		5.0				5.0		5.0		5.0				5.0	
Max Allow Headway ( MAH ), s				3.1		0.0				0.0		3.1		3.3				3.3	
Queue Clearance Time ( g s ), s				19.8								5.8		3.2				6.5	
Green Extension Time ( g e ), s				0.2		0.0				0.0		0.0		0.6				0.3	
Phase Call Probability				1.00								1.00		1.00				1.00	
Max Out Probability				1.00								1.00		0.00				0.35	
Movement Group Results				EB			WB			NB			SB						
Approach Movement				L	T	R	L	T	R	L	T	R	L	T	R				
Assigned Movement				5	2	12	1	6	16	3	8	18	7	4	14				
Adjusted Flow Rate ( v ), veh/h				587	424	361	112	365	349	90	28			42	201				
Adjusted Saturation Flow Rate ( s ), veh/h/ln				1774	1863	1579	687	1863	1779	1774	1667			1553	1397				
Queue Service Time ( g s ), s				17.8	9.7	9.8	11.5	14.4	14.4	3.8	1.2			0.9	4.5				
Cycle Queue Clearance Time ( g c ), s				17.8	9.7	9.8	11.5	14.4	14.4	3.8	1.2			2.0	4.5				
Green Ratio ( g/C )				0.60	0.63	0.63	0.34	0.34	0.34	0.22	0.26			0.12	0.36				
Capacity ( c ), veh/h				629	1180	1000	316	642	613	334	426			256	993				
Volume-to-Capacity Ratio ( X )				0.933	0.359	0.361	0.354	0.568	0.570	0.270	0.066			0.166	0.202				
Available Capacity ( c a ), veh/h				629	1180	1000	316	642	613	334	426			256	993				
Back of Queue ( Q ), veh/ln ( 50 th percentile)				9.6	3.6	3.1	2.0	6.7	6.4	1.6	0.4			0.8	1.4				
Queue Storage Ratio ( RQ ) ( 50 th percentile)				0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00			0.00	0.00				
Uniform Delay ( d 1 ), s/veh				14.9	7.8	7.8	23.1	24.0	24.1	28.8	25.4			35.5	20.1				
Incremental Delay ( d 2 ), s/veh				20.7	0.9	1.0	3.1	3.6	3.8	0.2	0.0			0.1	0.0				
Initial Queue Delay ( d 3 ), s/veh				0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0			0.0	0.0				
Control Delay ( d ), s/veh				35.6	8.7	8.9	26.2	27.7	27.9	28.9	25.4			35.6	20.2				
Level of Service (LOS)				D	A	A	C	C	C	C	C			D	C				
Approach Delay, s/veh / LOS				20.3		C		27.6		C		28.1		C		22.9		C	
Intersection Delay, s/veh / LOS				23.2						C									
Multimodal Results				EB			WB			NB			SB						
Pedestrian LOS Score / LOS				2.2		B		2.4		B		2.8		C		2.8		C	
Bicycle LOS Score / LOS				1.6		A		1.2		A		0.7		A		0.9		A	



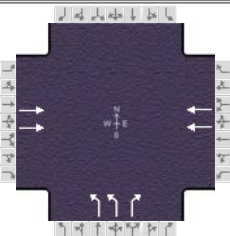
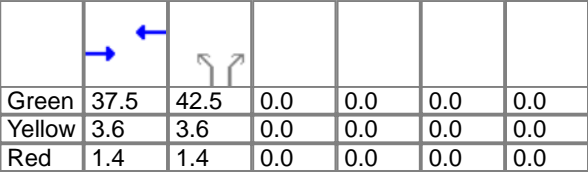
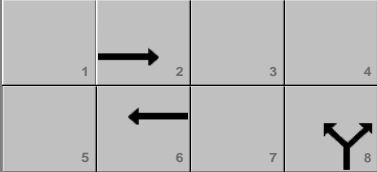
# HCS 2010 Signalized Intersection Results Summary

General Information						Intersection Information													
Agency		TMS Engineers, Inc.				Duration, h		0.25											
Analyst		ABC		Analysis Date		Sep 16, 2015		Area Type		Other									
Jurisdiction		Orange Village, OH		Time Period		AM Peak Period		PHF		0.92									
Urban Street		Harvard Road		Analysis Year		2018		Analysis Period		1> 7:00									
Intersection		Harvard & Brainard		File Name		AM 18 HarvardBrainard.xus													
Project Description		Build Conditions																	
Demand Information																			
				EB			WB			NB			SB						
Approach Movement				L	T	R	L	T	R	L	T	R	L	T	R				
Demand ( v ), veh/h				148	223	61	11	494	31	209	145	11	12	74	82				
Signal Information																			
Cycle, s		90.0	Reference Phase		2														
Offset, s		0	Reference Point		End														
Uncoordinated		No	Simult. Gap E/W		On														
Force Mode		Fixed	Simult. Gap N/S		On														
				Green	7.0	30.3	7.0	25.7	0.0	0.0									
				Yellow	3.6	3.6	3.6	3.6	0.0	0.0									
				Red	1.4	1.4	1.4	1.4	0.0	0.0									
Timer Results				EBL		EBT		WBL		WBT		NBL		NBT		SBL		SBT	
Assigned Phase				5		2				6		3		8				4	
Case Number				1.0		3.0				6.3		1.0		4.0				6.3	
Phase Duration, s				12.0		47.3				35.3		12.0		42.7				30.7	
Change Period, ( Y+R c ), s				5.0		5.0				5.0		5.0		5.0				5.0	
Max Allow Headway ( MAH ), s				3.1		0.0				0.0		3.1		3.1				3.1	
Queue Clearance Time ( g s ), s				7.0								9.0		7.3				9.0	
Green Extension Time ( g e ), s				0.0		0.0				0.0		0.0		0.7				0.6	
Phase Call Probability				1.00								1.00		1.00				1.00	
Max Out Probability				1.00								1.00		0.00				0.00	
Movement Group Results				EB			WB			NB			SB						
Approach Movement				L	T	R	L	T	R	L	T	R	L	T	R				
Assigned Movement				5	2	12	1	6	16	3	8	18	7	4	14				
Adjusted Flow Rate ( v ), veh/h				161	242	66	12	288	283	227	170		13	170					
Adjusted Saturation Flow Rate ( s ), veh/h/ln				1792	1881	1594	1077	1881	1842	1792	1858		1223	1719					
Queue Service Time ( g s ), s				5.0	7.1	2.1	0.7	10.8	10.8	7.0	5.3		0.7	7.0					
Cycle Queue Clearance Time ( g c ), s				5.0	7.1	2.1	0.7	10.8	10.8	7.0	5.3		0.7	7.0					
Green Ratio ( g/C )				0.44	0.47	0.47	0.34	0.34	0.34	0.39	0.42		0.29	0.29					
Capacity ( c ), veh/h				402	884	749	443	633	620	473	778		429	491					
Volume-to-Capacity Ratio ( X )				0.400	0.274	0.088	0.027	0.454	0.456	0.480	0.218		0.030	0.346					
Available Capacity ( c a ), veh/h				402	884	749	443	633	620	473	778		429	491					
Back of Queue ( Q ), veh/ln ( 50 th percentile)				2.0	3.0	0.7	0.2	5.0	4.9	3.2	2.1		0.2	2.8					
Queue Storage Ratio ( RQ ) ( 50 th percentile)				0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00					
Uniform Delay ( d 1 ), s/veh				16.8	14.5	13.2	20.0	23.4	23.4	20.9	16.7		23.2	25.5					
Incremental Delay ( d 2 ), s/veh				0.2	0.8	0.2	0.1	2.3	2.4	0.3	0.1		0.0	0.2					
Initial Queue Delay ( d 3 ), s/veh				0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		0.0	0.0					
Control Delay ( d ), s/veh				17.1	15.3	13.4	20.1	25.7	25.8	21.2	16.8		23.2	25.6					
Level of Service (LOS)				B	B	B	C	C	C	C	B		C	C					
Approach Delay, s/veh / LOS				15.6		B		25.6		C		19.3		B		25.5		C	
Intersection Delay, s/veh / LOS				21.2						C									
Multimodal Results				EB			WB			NB			SB						
Pedestrian LOS Score / LOS				2.3		B		2.3		B		2.4		B		2.8		C	
Bicycle LOS Score / LOS				1.3		A		1.0		A		1.1		A		0.8		A	

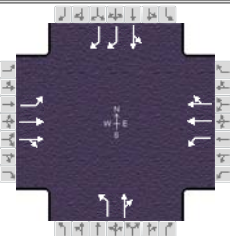
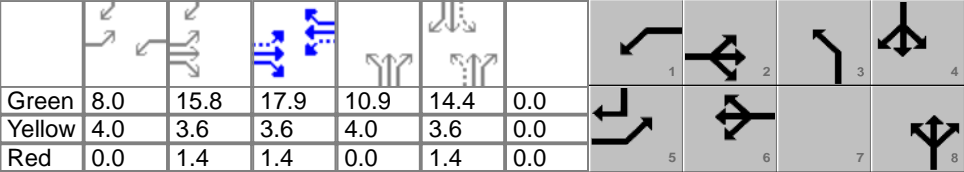
# HCS 2010 Signalized Intersection Results Summary

General Information					Intersection Information															
Agency		TMS Engineers, Inc.			Duration, h		0.25													
Analyst		ABC	Analysis Date	Sep 16, 2015	Area Type		Other													
Jurisdiction		Orange, OH	Time Period	PM Peak	PHF		0.92													
Urban Street		Harvard Road	Analysis Year	2018	Analysis Period		1> 7:00													
Intersection		@ I-271 SB Ramps	File Name	PM 18 271SB.xus																
Project Description		Build Conditions																		
Demand Information					EB			WB			NB			SB						
Approach Movement					L	T	R	L	T	R	L	T	R	L	T	R				
Demand ( v ), veh/h						1211	660	440	1066					372		638				
Signal Information						Green	9.4	41.9	23.7	0.0	0.0	0.0								
Cycle, s		90.0	Reference Phase														2			
Offset, s		0	Reference Point														End			
Uncoordinated		No	Simult. Gap E/W														On			
Force Mode		Fixed	Simult. Gap N/S														On			
Timer Results					EBL		EBT		WBL		WBT		NBL		NBT		SBL		SBT	
Assigned Phase							2		1		6								4	
Case Number							7.3		1.0		4.0								9.0	
Phase Duration, s							46.9		14.4		61.3								28.7	
Change Period, ( Y+R <sub>c</sub> ), s							5.0		5.0		5.0								5.0	
Max Allow Headway ( MAH ), s							0.0		3.1		0.0								3.3	
Queue Clearance Time ( g <sub>s</sub> ), s									11.4										23.9	
Green Extension Time ( g <sub>e</sub> ), s							0.0		0.0		0.0								0.0	
Phase Call Probability									1.00										1.00	
Max Out Probability									1.00										1.00	
Movement Group Results					EB			WB			NB			SB						
Approach Movement					L	T	R	L	T	R	L	T	R	L	T	R				
Assigned Movement						2	12	1	6					7		14				
Adjusted Flow Rate ( v ), veh/h						1316	717	478	1159					404		693				
Adjusted Saturation Flow Rate ( s ), veh/h/ln						1691	1579	1774	1691					1774		1397				
Queue Service Time ( g <sub>s</sub> ), s						16.8	40.1	9.4	10.0					19.6		21.9				
Cycle Queue Clearance Time ( g <sub>c</sub> ), s						16.8	40.1	9.4	10.0					19.6		21.9				
Green Ratio ( g/C )						0.47	0.47	0.59	0.63					0.26		0.26				
Capacity ( c ), veh/h						2362	735	381	3174					467		736				
Volume-to-Capacity Ratio ( X )						0.557	0.976	1.255	0.365					0.866		0.943				
Available Capacity ( c <sub>a</sub> ), veh/h						2362	735	381	3174					467		736				
Back of Queue ( Q ), veh/ln ( 50 th percentile)						6.3	19.2	18.0	3.2					10.0		9.1				
Queue Storage Ratio ( RQ ) ( 50 th percentile)						0.00	0.00	0.00	0.00					0.00		0.00				
Uniform Delay ( d <sub>1</sub> ), s/veh						17.4	23.6	17.6	8.2					31.6		32.5				
Incremental Delay ( d <sub>2</sub> ), s/veh						1.0	27.9	134.7	0.3					15.0		20.2				
Initial Queue Delay ( d <sub>3</sub> ), s/veh						0.0	0.0	0.0	0.0					0.0		0.0				
Control Delay ( d ), s/veh						18.3	51.4	152.3	8.5					46.6		52.6				
Level of Service (LOS)						B	D	F	A					D		D				
Approach Delay, s/veh / LOS					30.0		C		50.5		D		0.0				50.4		D	
Intersection Delay, s/veh / LOS					41.7									D						
Multimodal Results					EB			WB			NB			SB						
Pedestrian LOS Score / LOS					1.9		A		1.9		A		3.3		C		3.3		C	
Bicycle LOS Score / LOS					1.6		A		1.4		A								F	

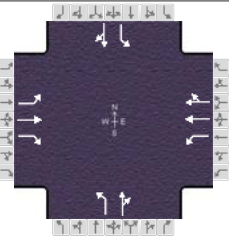
# HCS 2010 Signalized Intersection Results Summary

General Information					Intersection Information																
Agency		TMS Engineers, Inc.			Duration, h		0.25														
Analyst		ABC	Analysis Date	Sep 16, 2015		Area Type		Other													
Jurisdiction		Orange, OH	Time Period	PM Peak		PHF		0.92													
Urban Street		Harvard Road	Analysis Year	2018		Analysis Period		1> 7:00													
Intersection		@ I-271 NB Exit	File Name	PM 18 271NB.xus																	
Project Description		Build Conditions																			
Demand Information																					
Approach Movement				L		T		R		L		T		R							
Demand ( v ), veh/h						954				1047				458							
Signal Information																					
Cycle, s		90.0	Reference Phase									2									
Offset, s		0	Reference Point									End									
Uncoordinated		No	Simult. Gap E/W									On									
Force Mode		Fixed	Simult. Gap N/S									On									
Green				37.5	42.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0							
Yellow				3.6	3.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0							
Red				1.4	1.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0							
Timer Results				EBL		EBT		WBL		WBT		NBL		NBT		SBL		SBT			
Assigned Phase						2				6				8							
Case Number						8.0				8.0				9.0							
Phase Duration, s						42.5				42.5				47.5							
Change Period, ( Y+R c ), s						5.0				5.0				5.0							
Max Allow Headway ( MAH ), s						0.0				0.0				3.3							
Queue Clearance Time ( g s ), s														31.0							
Green Extension Time ( g e ), s						0.0				0.0				2.5							
Phase Call Probability														1.00							
Max Out Probability														0.09							
Movement Group Results				EB		WB		NB		SB											
Approach Movement				L		T		R		L		T		R		L		T		R	
Assigned Movement						2				6				3		18					
Adjusted Flow Rate ( v ), veh/h						1037				1138				498		599					
Adjusted Saturation Flow Rate ( s ), veh/h/ln						1773				1791				1723		1579					
Queue Service Time ( g s ), s						21.7				24.4				8.0		29.0					
Cycle Queue Clearance Time ( g c ), s						21.7				24.4				8.0		29.0					
Green Ratio ( g/C )						0.42				0.42				0.47		0.47					
Capacity ( c ), veh/h						1478				1492				1627		745					
Volume-to-Capacity Ratio ( X )						0.702				0.763				0.306		0.803					
Available Capacity ( c a ), veh/h						1478				1492				1627		745					
Back of Queue ( Q ), veh/ln ( 50 th percentile)						9.0				10.3				2.9		10.9					
Queue Storage Ratio ( RQ ) ( 50 th percentile)						0.00				0.00				0.00		0.00					
Uniform Delay ( d 1 ), s/veh						21.6				22.4				14.7		20.2					
Incremental Delay ( d 2 ), s/veh						2.8				3.7				0.0		5.9					
Initial Queue Delay ( d 3 ), s/veh						0.0				0.0				0.0		0.0					
Control Delay ( d ), s/veh						24.4				26.2				14.7		26.1					
Level of Service (LOS)						C				C				B		C					
Approach Delay, s/veh / LOS				24.4		C		26.2		C		20.9		C		0.0					
Intersection Delay, s/veh / LOS				23.9								C									
Multimodal Results				EB		WB		NB		SB											
Pedestrian LOS Score / LOS				1.9		A		0.7		A		2.7		B		2.7		B			
Bicycle LOS Score / LOS				1.3		A		1.4		A				F							

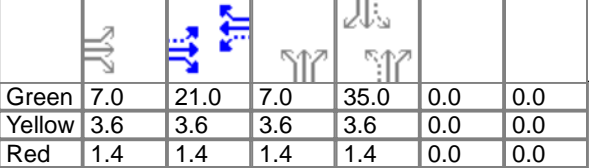
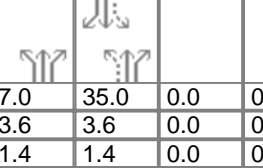
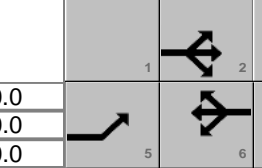
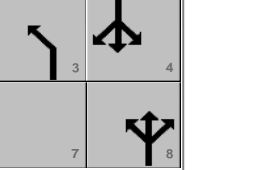
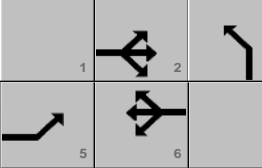
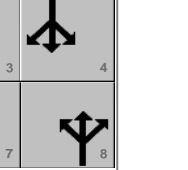
# HCS 2010 Signalized Intersection Results Summary

General Information						Intersection Information													
Agency		TMS Engineers, Inc.				Duration, h		0.25											
Analyst		ABC		Analysis Date		Sep 16, 2015		Area Type						Other					
Jurisdiction		Orange Village, OH		Time Period		PM Peak Period		PHF						0.92					
Urban Street		Harvard Road		Analysis Year		2018		Analysis Period						1> 7:00					
Intersection		Harvard & Orange Place		File Name		PM 18 HarvardOrange.xus													
Project Description		Build Conditions																	
Demand Information				EB			WB			NB			SB						
Approach Movement				L	T	R	L	T	R	L	T	R	L	T	R				
Demand ( v ), veh/h				609	742	151	50	451	98	258	21	131	213	15	568				
Signal Information																			
Cycle, s	90.0	Reference Phase	2																
Offset, s	0	Reference Point	End																
Uncoordinated	No	Simult. Gap E/W	On																
Force Mode	Fixed	Simult. Gap N/S	On																
				Green	8.0	15.8	17.9	10.9	14.4	0.0									
				Yellow	4.0	3.6	3.6	4.0	3.6	0.0									
				Red	0.0	1.4	1.4	0.0	1.4	0.0									
Timer Results				EBL		EBT		WBL		WBT		NBL		NBT		SBL		SBT	
Assigned Phase				5		2		1		6		3		8				4	
Case Number				1.1		4.0		1.1		4.0		1.0		4.0				7.3	
Phase Duration, s				32.8		43.7		12.0		22.9		14.9		34.3				19.4	
Change Period, ( Y+R c ), s				5.0		5.0		4.0		5.0		4.0		5.0				5.0	
Max Allow Headway ( MAH ), s				3.1		0.0		3.1		0.0		3.1		3.4				3.4	
Queue Clearance Time ( g s ), s				29.4				4.0				12.9		8.8				16.4	
Green Extension Time ( g e ), s				0.0		0.0		0.0		0.0		0.0		2.8				0.0	
Phase Call Probability				1.00				1.00				1.00		1.00				1.00	
Max Out Probability				1.00				0.23				1.00		0.01				1.00	
Movement Group Results				EB			WB			NB			SB						
Approach Movement				L	T	R	L	T	R	L	T	R	L	T	R				
Assigned Movement				5	2	12	1	6	16	3	8	18	7	4	14				
Adjusted Flow Rate ( v ), veh/h				662	500	471	54	307	290	280	165			248	617				
Adjusted Saturation Flow Rate ( s ), veh/h/ln				1792	1881	1770	1810	1881	1765	1810	1645			1269	1397				
Queue Service Time ( g s ), s				27.4	18.6	18.6	2.0	14.0	14.2	10.9	6.8			14.4	13.6				
Cycle Queue Clearance Time ( g c ), s				27.4	18.6	18.6	2.0	14.0	14.2	10.9	6.8			14.4	13.6				
Green Ratio ( g/C )				0.53	0.43	0.43	0.29	0.20	0.20	0.30	0.33			0.16	0.47				
Capacity ( c ), veh/h				667	809	761	358	374	351	299	535			280	1310				
Volume-to-Capacity Ratio ( X )				0.992	0.618	0.618	0.152	0.819	0.827	0.937	0.309			0.884	0.471				
Available Capacity ( c a ), veh/h				667	809	761	358	374	351	299	535			280	1310				
Back of Queue ( Q ), veh/ln ( 50 th percentile)				20.4	8.4	7.9	0.8	8.1	7.8	7.7	2.5			7.4	4.0				
Queue Storage Ratio ( RQ ) ( 50 th percentile)				0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00			0.00	0.00				
Uniform Delay ( d 1 ), s/veh				21.2	19.9	19.9	23.5	34.5	34.6	27.9	22.8			39.1	16.3				
Incremental Delay ( d 2 ), s/veh				32.6	3.5	3.7	0.1	17.9	19.6	35.4	0.1			25.8	0.1				
Initial Queue Delay ( d 3 ), s/veh				0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0			0.0	0.0				
Control Delay ( d ), s/veh				53.8	23.4	23.7	23.6	52.4	54.1	63.3	22.9			64.9	16.4				
Level of Service (LOS)				D	C	C	C	D	D	E	C			E	B				
Approach Delay, s/veh / LOS				35.8		D		50.8		D		48.3		D		30.3		C	
Intersection Delay, s/veh / LOS				38.7						D									
Multimodal Results				EB			WB			NB			SB						
Pedestrian LOS Score / LOS				2.3		B		2.4		B		2.8		C		2.8		C	
Bicycle LOS Score / LOS				1.8		A		1.0		A		1.2		A		1.9		A	

# HCS 2010 Signalized Intersection Results Summary

General Information						Intersection Information		
Agency	TMS Engineers, Inc.					Duration, h	0.25	
Analyst	ABC	Analysis Date	Sep 16, 2015			Area Type	Other	
Jurisdiction	Orange Village, OH	Time Period	PM Peak Period			PHF	0.92	
Urban Street	Harvard Road	Analysis Year	2018			Analysis Period	1 > 7:00	
Intersection	Harvard & Brainard	File Name	PM 18 HarvardBrainard.xus					
Project Description	Build Conditions							

Demand Information	EB			WB			NB			SB		
Approach Movement	L	T	R	L	T	R	L	T	R	L	T	R
Demand ( $v$ ), veh/h	168	476	356	20	317	35	108	168	16	49	388	171

Signal Information											
Cycle, s	90.0	Reference Phase	2								
Offset, s	0	Reference Point	End								
Uncoordinated	No	Simult. Gap E/W	On								
Force Mode	Fixed	Simult. Gap N/S	On								

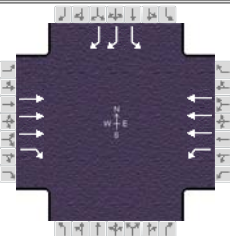
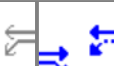

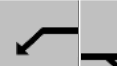
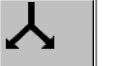
Timer Results	EBL	EBT	WBL	WBT	NBL	NBT	SBL	SBT
Assigned Phase	5	2		6	3	8		4
Case Number	1.0	3.0		6.3	1.0	4.0		6.3
Phase Duration, s	12.0	38.0		26.0	12.0	52.0		40.0
Change Period, ( $Y+R_c$ ), s	5.0	5.0		5.0	5.0	5.0		5.0
Max Allow Headway ( $MAH$ ), s	3.1	0.0		0.0	3.1	3.1		3.1
Queue Clearance Time ( $g_s$ ), s	8.8				5.2	7.2		30.4
Green Extension Time ( $g_e$ ), s	0.0	0.0		0.0	0.0	1.8		1.0
Phase Call Probability	1.00				1.00	1.00		1.00
Max Out Probability	1.00				1.00	0.00		0.58

Movement Group Results	EB			WB			NB			SB		
Approach Movement	L	T	R	L	T	R	L	T	R	L	T	R
Assigned Movement	5	2	12	1	6	16	3	8	18	7	4	14
Adjusted Flow Rate ( $\nu$ ), veh/h	183	517	387	22	193	189	117	200		53	608	
Adjusted Saturation Flow Rate ( $s$ ), veh/h/ln	1792	1881	1594	620	1881	1815	1792	1852		1189	1783	
Queue Service Time ( $g_s$ ), s	6.8	21.6	18.3	2.9	7.9	8.0	3.2	5.2		2.6	28.4	
Cycle Queue Clearance Time ( $g_c$ ), s	6.8	21.6	18.3	12.5	7.9	8.0	3.2	5.2		2.6	28.4	
Green Ratio ( $g/C$ )	0.33	0.37	0.37	0.23	0.23	0.23	0.49	0.52		0.39	0.39	
Capacity ( $c$ ), veh/h	364	690	585	158	439	424	279	967		542	693	
Volume-to-Capacity Ratio ( $X$ )	0.501	0.750	0.662	0.137	0.441	0.446	0.421	0.207		0.098	0.876	
Available Capacity ( $c_a$ ), veh/h	364	690	585	158	439	424	279	967		542	693	
Back of Queue ( $Q$ ), veh/ln ( 50 th percentile)	2.8	10.5	7.4	0.5	3.9	3.8	1.2	2.0		0.7	13.5	
Queue Storage Ratio ( $RQ$ ) ( 50 th percentile)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	
Uniform Delay ( $d_1$ ), s/veh	23.0	24.9	23.8	35.6	29.5	29.5	18.6	11.5		17.6	25.5	
Incremental Delay ( $d_2$ ), s/veh	0.4	7.4	5.8	1.8	3.2	3.4	0.4	0.0		0.0	11.7	
Initial Queue Delay ( $d_3$ ), s/veh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		0.0	0.0	
Control Delay ( $d$ ), s/veh	23.4	32.2	29.6	37.4	32.7	32.9	19.0	11.6		17.6	37.2	
Level of Service (LOS)	C	C	C	D	C	C	B	B		B	D	
Approach Delay, s/veh / LOS	29.8	C		33.0	C		14.3	B		35.6	D	
Intersection Delay, s/veh / LOS	29.9						C					

Multimodal Results	EB		WB		NB		SB	
Pedestrian LOS Score / LOS	2.3	B	2.3	B	2.4	B	2.8	C
Bicycle LOS Score / LOS	2.3	B	0.8	A	1.0	A	1.6	A

**APPENDIX J**  
**Build Capacity Analysis Worksheets**  
**2036**

# HCS 2010 Signalized Intersection Results Summary

General Information					Intersection Information															
Agency		TMS Engineers, Inc.			Duration, h		0.25													
Analyst		ABC	Analysis Date	Sep 16, 2015	Area Type		Other													
Jurisdiction		Orange, OH	Time Period	AM Peak	PHF		0.92													
Urban Street		Harvard Road	Analysis Year	2036	Analysis Period		1> 7:00													
Intersection		@ I-271 SB Ramps	File Name	AM 36 271SB.xus																
Project Description		Build Conditions																		
Demand Information					EB			WB			NB			SB						
Approach Movement					L	T	R	L	T	R	L	T	R	L	T	R				
Demand ( v ), veh/h						581	242	353	1616					266		567				
Signal Information																				
Cycle, s		90.0	Reference Phase	2																
Offset, s		0	Reference Point	End																
Uncoordinated		No	Simult. Gap E/W	On																
Force Mode		Fixed	Simult. Gap N/S	On	Green	10.1	32.7	32.2	0.0	0.0	0.0									
					Yellow	3.6	3.6	3.6	0.0	0.0	0.0									
					Red	1.4	1.4	1.4	0.0	0.0	0.0									
Timer Results					EBL		EBT		WBL		WBT		NBL		NBT		SBL		SBT	
Assigned Phase							2		1		6								4	
Case Number							7.3		1.0		4.0								9.0	
Phase Duration, s							37.7		15.1		52.8								37.2	
Change Period, ( Y+R c ), s							5.0		5.0		5.0								5.0	
Max Allow Headway ( MAH ), s							0.0		3.1		0.0								3.3	
Queue Clearance Time ( g s ), s									12.1										18.4	
Green Extension Time ( g e ), s							0.0		0.0		0.0								2.2	
Phase Call Probability									1.00										1.00	
Max Out Probability									1.00										0.02	
Movement Group Results					EB			WB			NB			SB						
Approach Movement					L	T	R	L	T	R	L	T	R	L	T	R				
Assigned Movement						2	12	1	6					7		14				
Adjusted Flow Rate ( v ), veh/h						632	263	384	1757					289		616				
Adjusted Saturation Flow Rate ( s ), veh/h/ln						1691	1579	1774	1691					1774		1397				
Queue Service Time ( g s ), s						8.1	11.5	10.1	22.3					11.3		16.4				
Cycle Queue Clearance Time ( g c ), s						8.1	11.5	10.1	22.3					11.3		16.4				
Green Ratio ( g/C )						0.36	0.36	0.50	0.53					0.36		0.36				
Capacity ( c ), veh/h						1844	574	495	2695					635		1000				
Volume-to-Capacity Ratio ( X )						0.343	0.459	0.775	0.652					0.456		0.617				
Available Capacity ( c a ), veh/h						1844	574	495	2695					635		1000				
Back of Queue ( Q ), veh/ln ( 50 th percentile)						3.2	4.5	5.5	8.0					4.5		5.2				
Queue Storage Ratio ( RQ ) ( 50 th percentile)						0.00	0.00	0.00	0.00					0.00		0.00				
Uniform Delay ( d 1 ), s/veh						20.8	21.9	17.7	15.1					22.2		23.8				
Incremental Delay ( d 2 ), s/veh						0.5	2.6	6.9	1.2					0.2		0.8				
Initial Queue Delay ( d 3 ), s/veh						0.0	0.0	0.0	0.0					0.0		0.0				
Control Delay ( d ), s/veh						21.3	24.5	24.6	16.4					22.4		24.7				
Level of Service (LOS)						C	C	C	B					C		C				
Approach Delay, s/veh / LOS					22.3		C		17.8		B		0.0				23.9		C	
Intersection Delay, s/veh / LOS					20.3									C						
Multimodal Results					EB			WB			NB			SB						
Pedestrian LOS Score / LOS					1.9		A		1.9		A		3.3		C		3.3		C	
Bicycle LOS Score / LOS					1.0		A		1.7		A								F	

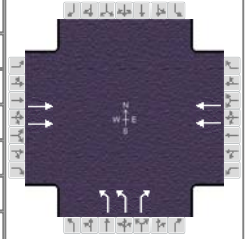


# HCS 2010 Signalized Intersection Results Summary

## General Information

Agency	TMS Engineers, Inc.		
Analyst	ABC	Analysis Date	Sep 16, 2015
Jurisdiction	Orange, OH	Time Period	AM Peak
Urban Street	Harvard Road	Analysis Year	2036
Intersection	@ I-271 NB Exit	File Name	AM 36 271NB.xus
Project Description	Build Conditions		

## Intersection Information



## Demand Information

	EB			WB			NB			SB		
Approach Movement	L	T	R	L	T	R	L	T	R	L	T	R
Demand ( $\nu$ ), veh/h		576			819		1150		880			

## Signal Information

Cycle, s	90.0	Reference Phase	2									
Offset, s	0	Reference Point	End									
Uncoordinated	No	Simult. Gap E/W	On	Green	24.9	55.1	0.0	0.0	0.0	0.0		
Force Mode	Fixed	Simult. Gap N/S	On	Yellow	3.6	3.6	0.0	0.0	0.0	0.0		
				Red	1.4	1.4	0.0	0.0	0.0	0.0		

## Timer Results

	EBL	EBT	WBL	WBT	NBL	NBT	SBL	SBT
Assigned Phase		2		6		8		
Case Number		8.0		8.0		9.0		
Phase Duration, s		29.9		29.9		60.1		
Change Period, ( $Y+R_c$ ), s		5.0		5.0		5.0		
Max Allow Headway ( $MAH$ ), s		0.0		0.0		3.2		
Queue Clearance Time ( $g_s$ ), s						55.7		
Green Extension Time ( $g_e$ ), s		0.0		0.0		0.0		
Phase Call Probability						1.00		
Max Out Probability						1.00		

## Movement Group Results

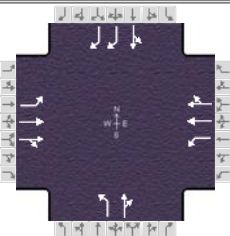
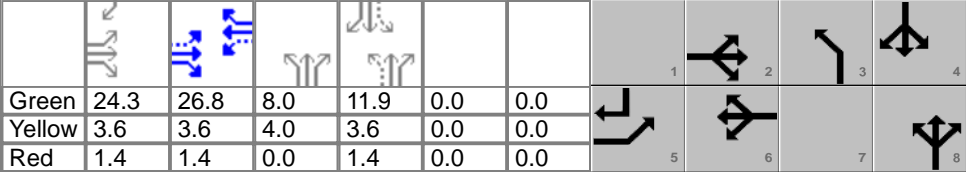
	EB			WB			NB			SB		
Approach Movement	L	T	R	L	T	R	L	T	R	L	T	R
Assigned Movement		2			6		3		18			
Adjusted Flow Rate ( $\nu$ ), veh/h		626			890		1250		957			
Adjusted Saturation Flow Rate ( $s$ ), veh/h/ln		1773			1791		1723		1579			
Queue Service Time ( $g_s$ ), s		14.0			21.5		19.9		53.7			
Cycle Queue Clearance Time ( $g_c$ ), s		14.0			21.5		19.9		53.7			
Green Ratio ( $g/C$ )		0.28			0.28		0.61		0.61			
Capacity ( $c$ ), veh/h		981			991		2109		966			
Volume-to-Capacity Ratio ( $X$ )		0.638			0.898		0.593		0.990			
Available Capacity ( $c_a$ ), veh/h		981			991		2109		966			
Back of Queue ( $Q$ ), veh/ln ( 50 th percentile)		6.1			10.6		6.5		23.0			
Queue Storage Ratio ( $RQ$ ) ( 50 th percentile)		0.00			0.00		0.00		0.00			
Uniform Delay ( $d_1$ ), s/veh		28.6			31.3		10.6		17.2			
Incremental Delay ( $d_2$ ), s/veh		3.2			12.6		0.3		26.3			
Initial Queue Delay ( $d_3$ ), s/veh		0.0			0.0		0.0		0.0			
Control Delay ( $d$ ), s/veh		31.8			43.9		10.9		43.5			
Level of Service (LOS)		C			D		B		D			
Approach Delay, s/veh / LOS	31.8	C		43.9	D		25.0	C		0.0		
Intersection Delay, s/veh / LOS	30.7						C					

## Multimodal Results

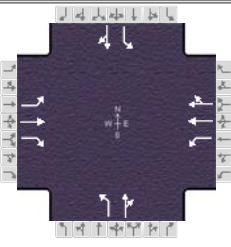
	EB			WB			NB			SB		
Pedestrian LOS Score / LOS	1.9	A		0.7	A		2.7	B		2.7	B	
Bicycle LOS Score / LOS	1.0	A		1.2	A			F				



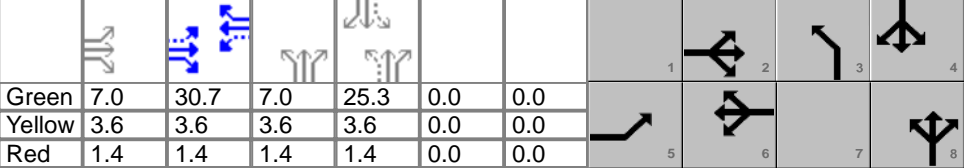
# HCS 2010 Signalized Intersection Results Summary

General Information						Intersection Information													
Agency		TMS Engineers, Inc.				Duration, h		0.25											
Analyst		ABC		Analysis Date		Sep 16, 2015		Area Type		Other									
Jurisdiction		Orange Village, OH		Time Period		AM Peak Period		PHF		0.92									
Urban Street		Harvard Road		Analysis Year		2036		Analysis Period		1> 7:00									
Intersection		Harvard & Orange Place		File Name		AM 36 HarvardOrange.xus													
Project Description		Build Conditions																	
Demand Information				EB			WB			NB			SB						
Approach Movement				L	T	R	L	T	R	L	T	R	L	T	R				
Demand ( v ), veh/h				539	407	482	150	608	84	163	17	34	30	19	219				
Signal Information																			
Cycle, s	90.0	Reference Phase	2																
Offset, s	0	Reference Point	End																
Uncoordinated	No	Simult. Gap E/W	On																
Force Mode	Fixed	Simult. Gap N/S	On																
				Green	24.3	26.8	8.0	11.9	0.0	0.0									
				Yellow	3.6	3.6	4.0	3.6	0.0	0.0									
				Red	1.4	1.4	0.0	1.4	0.0	0.0									
Timer Results				EBL		EBT		WBL		WBT		NBL		NBT		SBL		SBT	
Assigned Phase				5		2				6		3		8				4	
Case Number				1.0		4.0				6.3		1.0		4.0				7.3	
Phase Duration, s				29.3		61.1				31.8		12.0		28.9				16.9	
Change Period, ( Y+R c ), s				5.0		5.0				5.0		4.0		5.0				5.0	
Max Allow Headway ( MAH ), s				3.1		0.0				0.0		3.1		3.3				3.3	
Queue Clearance Time ( g s ), s				22.2								9.6		4.3				7.0	
Green Extension Time ( g e ), s				0.4		0.0				0.0		0.0		0.8				0.4	
Phase Call Probability				1.00								1.00		1.00				1.00	
Max Out Probability				1.00								1.00		0.00				0.30	
Movement Group Results				EB			WB			NB			SB						
Approach Movement				L	T	R	L	T	R	L	T	R	L	T	R				
Assigned Movement				5	2	12	1	6	16	3	8	18	7	4	14				
Adjusted Flow Rate ( v ), veh/h				586	442	524	163	384	368	177	55			53	238				
Adjusted Saturation Flow Rate ( s ), veh/h/ln				1774	1863	1579	591	1863	1783	1774	1663			1544	1397				
Queue Service Time ( g s ), s				20.2	10.6	16.8	24.1	16.4	16.5	7.6	2.3			1.3	5.0				
Cycle Queue Clearance Time ( g c ), s				20.2	10.6	16.8	24.1	16.4	16.5	7.6	2.3			2.6	5.0				
Green Ratio ( g/C )				0.59	0.62	0.62	0.30	0.30	0.30	0.24	0.27			0.13	0.40				
Capacity ( c ), veh/h				640	1161	984	256	555	531	354	442			269	1124				
Volume-to-Capacity Ratio ( X )				0.915	0.381	0.532	0.637	0.692	0.694	0.501	0.126			0.198	0.212				
Available Capacity ( c a ), veh/h				640	1161	984	256	555	531	354	442			269	1124				
Back of Queue ( Q ), veh/ln ( 50 th percentile)				10.3	4.0	5.5	4.1	8.0	7.8	3.1	0.9			1.0	1.5				
Queue Storage Ratio ( RQ ) ( 50 th percentile)				0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00			0.00	0.00				
Uniform Delay ( d 1 ), s/veh				17.7	8.4	9.6	30.7	28.0	28.0	28.8	25.1			34.9	17.6				
Incremental Delay ( d 2 ), s/veh				17.5	1.0	2.1	11.5	6.9	7.3	0.4	0.0			0.1	0.0				
Initial Queue Delay ( d 3 ), s/veh				0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0			0.0	0.0				
Control Delay ( d ), s/veh				35.2	9.3	11.6	42.2	34.9	35.3	29.2	25.2			35.1	17.6				
Level of Service (LOS)				D	A	B	D	C	D	C	C			D	B				
Approach Delay, s/veh / LOS				19.9		B		36.3		D		28.2		C		20.8		C	
Intersection Delay, s/veh / LOS				25.6						C									
Multimodal Results				EB			WB			NB			SB						
Pedestrian LOS Score / LOS				2.2		B		2.4		B		2.8		C		2.8		C	
Bicycle LOS Score / LOS				1.8		A		1.2		A		0.9		A		1.0		A	

# HCS 2010 Signalized Intersection Results Summary

General Information				Intersection Information		
Agency	TMS Engineers, Inc.			Duration, h	0.25	
Analyst	ABC	Analysis Date	Sep 16, 2015	Area Type	Other	
Jurisdiction	Orange Village, OH	Time Period	AM Peak Period	PHF	0.92	
Urban Street	Harvard Road	Analysis Year	2036	Analysis Period	1> 7:00	
Intersection	Harvard & Brainard	File Name	AM 36 HarvardBrainard.xus			
Project Description	Build Conditions					

Demand Information	EB			WB			NB			SB		
Approach Movement	L	T	R	L	T	R	L	T	R	L	T	R
Demand ( $v$ ), veh/h	160	243	68	11	537	32	233	175	11	12	78	89

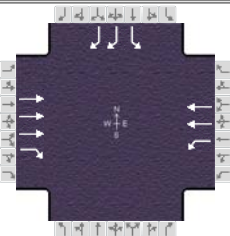
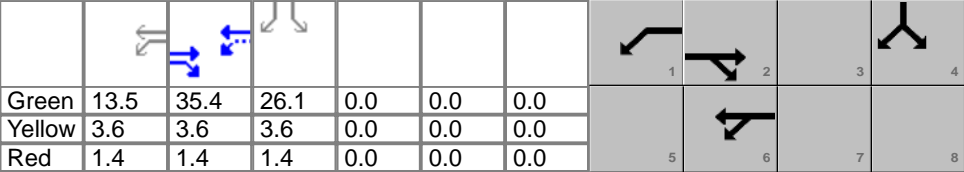
Signal Information											
Cycle, s	90.0	Reference Phase	2								
Offset, s	0	Reference Point	End								
Uncoordinated	No	Simult. Gap E/W	On								
Force Mode	Fixed	Simult. Gap N/S	On	Green	7.0	30.7	7.0	25.3	0.0	0.0	
				Yellow	3.6	3.6	3.6	3.6	0.0	0.0	
				Red	1.4	1.4	1.4	1.4	0.0	0.0	

Timer Results	EBL	EBT	WBL	WBT	NBL	NBT	SBL	SBT
Assigned Phase	5	2		6	3	8		4
Case Number	1.0	3.0		6.3	1.0	4.0		6.3
Phase Duration, s	12.0	47.7		35.7	12.0	42.3		30.3
Change Period, ( $Y+R_c$ ), s	5.0	5.0		5.0	5.0	5.0		5.0
Max Allow Headway ( $MAH$ ), s	3.1	0.0		0.0	3.1	3.1		3.1
Queue Clearance Time ( $g_s$ ), s	7.4				9.0	8.4		9.7
Green Extension Time ( $g_e$ ), s	0.0	0.0		0.0	0.0	0.7		0.7
Phase Call Probability	1.00				1.00	1.00		1.00
Max Out Probability	1.00				1.00	0.00		0.00

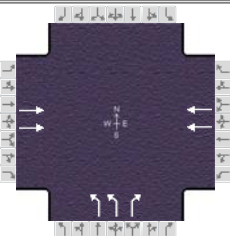
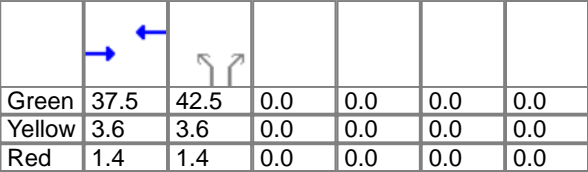
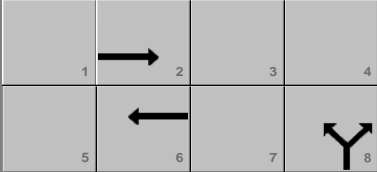
Movement Group Results	EB			WB			NB			SB		
Approach Movement	L	T	R	L	T	R	L	T	R	L	T	R
Assigned Movement	5	2	12	1	6	16	3	8	18	7	4	14
Adjusted Flow Rate ( $\nu$ ), veh/h	174	264	74	12	312	307	253	202		13	182	
Adjusted Saturation Flow Rate ( $s$ ), veh/h/ln	1792	1881	1594	1048	1881	1844	1792	1861		1187	1717	
Queue Service Time ( $g_s$ ), s	5.4	7.7	2.3	0.7	11.8	11.8	7.0	6.4		0.7	7.7	
Cycle Queue Clearance Time ( $g_c$ ), s	5.4	7.7	2.3	0.7	11.8	11.8	7.0	6.4		0.7	7.7	
Green Ratio ( $g/C$ )	0.44	0.47	0.47	0.34	0.34	0.34	0.38	0.41		0.28	0.28	
Capacity ( $c$ ), veh/h	389	893	756	438	642	629	457	771		414	483	
Volume-to-Capacity Ratio ( $X$ )	0.447	0.296	0.098	0.027	0.486	0.487	0.555	0.262		0.032	0.376	
Available Capacity ( $c_a$ ), veh/h	389	893	756	438	642	629	457	771		414	483	
Back of Queue ( $Q$ ), veh/ln ( 50 th percentile)	2.1	3.3	0.8	0.2	5.5	5.4	1.1	2.6		0.2	3.0	
Queue Storage Ratio ( $RQ$ ) ( 50 th percentile)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	
Uniform Delay ( $d_1$ ), s/veh	16.9	14.5	13.0	19.8	23.4	23.4	22.6	17.3		23.5	26.0	
Incremental Delay ( $d_2$ ), s/veh	0.3	0.8	0.3	0.1	2.6	2.7	0.9	0.1		0.0	0.2	
Initial Queue Delay ( $d_3$ ), s/veh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		0.0	0.0	
Control Delay ( $d$ ), s/veh	17.2	15.3	13.3	19.9	26.0	26.1	23.5	17.4		23.5	26.2	
Level of Service (LOS)	B	B	B	B	C	C	C	B		C	C	
Approach Delay, s/veh / LOS	15.7	B		26.0	C		20.8	C		26.0	C	
Intersection Delay, s/veh / LOS	21.7						C					

Multimodal Results	EB			WB			NB			SB		
Pedestrian LOS Score / LOS	2.3	B		2.3	B		2.4	B		2.8	C	
Bicycle LOS Score / LOS	1.3	A		1.0	A		1.2	A		0.8	A	

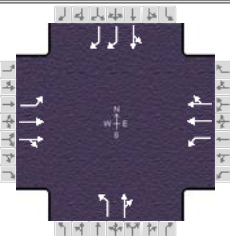
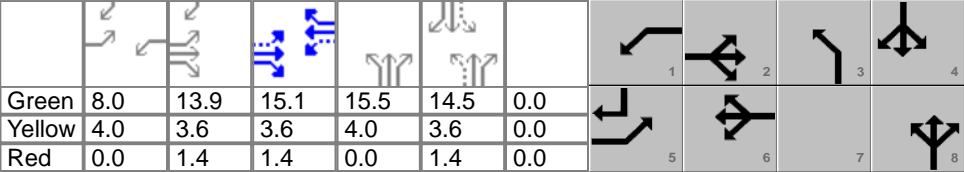
# HCS 2010 Signalized Intersection Results Summary

General Information					Intersection Information															
Agency		TMS Engineers, Inc.					Duration, h		0.25											
Analyst		ABC		Analysis Date		Sep 16, 2015		Area Type						Other						
Jurisdiction		Orange, OH		Time Period		PM Peak		PHF						0.92						
Urban Street		Harvard Road		Analysis Year		2036		Analysis Period						1> 7:00						
Intersection		@ I-271 SB Ramps		File Name		PM 36 271SB.xus														
Project Description		Build Conditions																		
Demand Information					EB			WB			NB			SB						
Approach Movement					L	T	R	L	T	R	L	T	R	L	T	R				
Demand ( v ), veh/h						1299	690	496	1169					506		667				
Signal Information																				
Cycle, s	90.0	Reference Phase	2																	
Offset, s	0	Reference Point	End																	
Uncoordinated	No	Simult. Gap E/W	On																	
Force Mode	Fixed	Simult. Gap N/S	On																	
					Green	13.5	35.4	26.1	0.0	0.0	0.0									
					Yellow	3.6	3.6	3.6	0.0	0.0	0.0									
					Red	1.4	1.4	1.4	0.0	0.0	0.0									
Timer Results					EBL		EBT		WBL		WBT		NBL		NBT		SBL		SBT	
Assigned Phase							2		1		6								4	
Case Number							7.3		1.0		4.0								9.0	
Phase Duration, s							40.4		18.5		58.9								31.1	
Change Period, ( Y+R c ), s							5.0		5.0		5.0								5.0	
Max Allow Headway ( MAH ), s							0.0		3.1		0.0								3.3	
Queue Clearance Time ( g s ), s									15.5										28.1	
Green Extension Time ( g e ), s							0.0		0.0		0.0								0.0	
Phase Call Probability									1.00										1.00	
Max Out Probability									1.00										1.00	
Movement Group Results					EB			WB			NB			SB						
Approach Movement					L	T	R	L	T	R	L	T	R	L	T	R				
Assigned Movement						2	12	1	6					7		14				
Adjusted Flow Rate ( v ), veh/h						1412	750	539	1271					550		725				
Adjusted Saturation Flow Rate ( s ), veh/h/ln						1691	1579	1774	1773					1774		1397				
Queue Service Time ( g s ), s						21.1	35.4	13.5	20.2					26.1		22.4				
Cycle Queue Clearance Time ( g c ), s						21.1	35.4	13.5	20.2					26.1		22.4				
Green Ratio ( g/C )						0.39	0.39	0.57	0.60					0.29		0.29				
Capacity ( c ), veh/h						1996	621	407	2124					514		810				
Volume-to-Capacity Ratio ( X )						0.707	1.208	1.326	0.598					1.069		0.895				
Available Capacity ( c a ), veh/h						1996	621	407	2124					514		810				
Back of Queue ( Q ), veh/ln ( 50 th percentile)						8.3	31.0	22.5	7.2					19.1		8.5				
Queue Storage Ratio ( RQ ) ( 50 th percentile)						0.00	0.00	0.00	0.00					0.00		0.00				
Uniform Delay ( d 1 ), s/veh						22.9	27.3	21.3	11.3					32.0		30.6				
Incremental Delay ( d 2 ), s/veh						2.1	108.1	162.9	1.3					59.4		12.1				
Initial Queue Delay ( d 3 ), s/veh						0.0	0.0	0.0	0.0					0.0		0.0				
Control Delay ( d ), s/veh						25.1	135.4	184.3	12.5					91.4		42.8				
Level of Service (LOS)						C	F	F	B					F		D				
Approach Delay, s/veh / LOS					63.4		E		63.7		E		0.0				63.7		E	
Intersection Delay, s/veh / LOS					63.6										E					
Multimodal Results					EB			WB			NB			SB						
Pedestrian LOS Score / LOS					1.9		A		1.9		A		3.2		C		3.0		C	
Bicycle LOS Score / LOS					1.7		A		2.0		A								F	

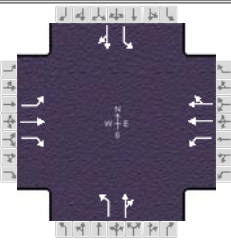
# HCS 2010 Signalized Intersection Results Summary

General Information					Intersection Information														
Agency		TMS Engineers, Inc.			Duration, h		0.25												
Analyst		ABC	Analysis Date	Sep 16, 2015		Area Type		Other											
Jurisdiction		Orange, OH	Time Period	PM Peak		PHF		0.92											
Urban Street		Harvard Road	Analysis Year	2036		Analysis Period		1> 7:00											
Intersection		@ I-271 NB Exit	File Name	PM 36 271NB.xus															
Project Description		Build Conditions																	
Demand Information																			
Approach Movement				L		T	R	L		T	R	L		T	R				
Demand ( v ), veh/h						1048				1186		479			592				
Signal Information																			
Cycle, s		90.0	Reference Phase									2							
Offset, s		0	Reference Point									End							
Uncoordinated		No	Simult. Gap E/W									On							
Force Mode		Fixed	Simult. Gap N/S									On							
				Green	37.5	42.5	0.0	0.0	0.0	0.0									
				Yellow	3.6	3.6	0.0	0.0	0.0	0.0									
				Red	1.4	1.4	0.0	0.0	0.0	0.0									
Timer Results				EBL		EBT		WBL		WBT		NBL		NBT		SBL		SBT	
Assigned Phase						2				6				8					
Case Number						8.0				8.0				9.0					
Phase Duration, s						42.5				42.5				47.5					
Change Period, ( Y+R c ), s						5.0				5.0				5.0					
Max Allow Headway ( MAH ), s						0.0				0.0				3.3					
Queue Clearance Time ( g s ), s														34.7					
Green Extension Time ( g e ), s						0.0				0.0				2.2					
Phase Call Probability														1.00					
Max Out Probability														0.30					
Movement Group Results				EB			WB			NB			SB						
Approach Movement				L	T	R	L	T	R	L	T	R	L	T	R				
Assigned Movement					2			6		3		18							
Adjusted Flow Rate ( v ), veh/h					1139			1289		521		643							
Adjusted Saturation Flow Rate ( s ), veh/h/ln					1773			1791		1723		1579							
Queue Service Time ( g s ), s					24.8			29.5		8.5		32.7							
Cycle Queue Clearance Time ( g c ), s					24.8			29.5		8.5		32.7							
Green Ratio ( g/C )					0.42			0.42		0.47		0.47							
Capacity ( c ), veh/h					1478			1492		1627		745							
Volume-to-Capacity Ratio ( X )					0.771			0.864		0.320		0.863							
Available Capacity ( c a ), veh/h					1478			1492		1627		745							
Back of Queue ( Q ), veh/ln ( 50 th percentile)					10.4			13.0		3.1		13.0							
Queue Storage Ratio ( RQ ) ( 50 th percentile)					0.00			0.00		0.00		0.00							
Uniform Delay ( d 1 ), s/veh					22.6			23.9		14.8		21.2							
Incremental Delay ( d 2 ), s/veh					3.9			6.9		0.0		9.8							
Initial Queue Delay ( d 3 ), s/veh					0.0			0.0		0.0		0.0							
Control Delay ( d ), s/veh					26.5			30.8		14.8		31.0							
Level of Service (LOS)					C			C		B		C							
Approach Delay, s/veh / LOS				26.5		C	30.8		C	23.8		C	0.0						
Intersection Delay, s/veh / LOS				27.2						C									
Multimodal Results				EB			WB			NB			SB						
Pedestrian LOS Score / LOS				1.9		A	0.7		A	2.7		B	2.7		B				
Bicycle LOS Score / LOS				1.4		A	1.6		A			F							

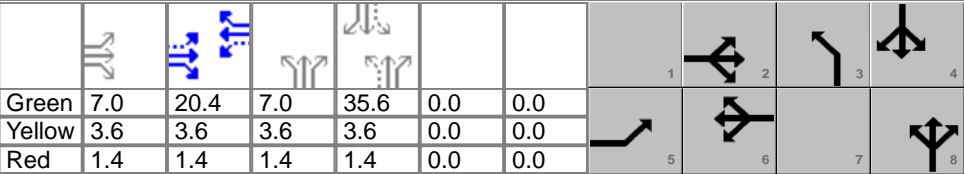
# HCS 2010 Signalized Intersection Results Summary

General Information						Intersection Information													
Agency		TMS Engineers, Inc.				Duration, h		0.25											
Analyst		ABC		Analysis Date		Sep 16, 2015		Area Type					Other						
Jurisdiction		Orange Village, OH		Time Period		PM Peak Period		PHF					0.92						
Urban Street		Harvard Road		Analysis Year		2036		Analysis Period					1> 7:00						
Intersection		Harvard & Orange Place		File Name		PM 36 HarvardOrange.xus													
Project Description		Build Conditions																	
Demand Information																			
				EB			WB			NB			SB						
Approach Movement				L	T	R	L	T	R	L	T	R	L	T	R				
Demand ( v ), veh/h				604	775	228	75	468	98	386	30	196	201	23	558				
Signal Information																			
Cycle, s	90.0	Reference Phase	2																
Offset, s	0	Reference Point	End																
Uncoordinated	No	Simult. Gap E/W	On																
Force Mode	Fixed	Simult. Gap N/S	On																
				Green	8.0	13.9	15.1	15.5	14.5	0.0									
				Yellow	4.0	3.6	3.6	4.0	3.6	0.0									
				Red	0.0	1.4	1.4	0.0	1.4	0.0									
Timer Results				EBL		EBT		WBL		WBT		NBL		NBT		SBL		SBT	
Assigned Phase				5		2		1		6		3		8				4	
Case Number				1.1		4.0		1.1		4.0		1.0		4.0				7.3	
Phase Duration, s				30.9		39.0		12.0		20.1		19.5		39.0				19.5	
Change Period, ( Y+R c ), s				5.0		5.0		4.0		5.0		4.0		5.0				5.0	
Max Allow Headway ( MAH ), s				3.1		0.0		3.1		0.0		3.1		3.4				3.4	
Queue Clearance Time ( g s ), s				27.9				5.2				17.5		11.8				16.5	
Green Extension Time ( g e ), s				0.0		0.0		0.0		0.0		0.0		3.1				0.0	
Phase Call Probability				1.00				1.00				1.00		1.00				1.00	
Max Out Probability				1.00				1.00				1.00		0.01				1.00	
Movement Group Results				EB			WB			NB			SB						
Approach Movement				L	T	R	L	T	R	L	T	R	L	T	R				
Assigned Movement				5	2	12	1	6	16	3	8	18	7	4	14				
Adjusted Flow Rate ( v ), veh/h				657	567	523	82	316	299	420	246			243	607				
Adjusted Saturation Flow Rate ( s ), veh/h/ln				1792	1881	1733	1810	1881	1768	1810	1643			1201	1397				
Queue Service Time ( g s ), s				25.9	24.2	24.2	3.2	15.1	15.1	15.5	9.8			14.5	13.8				
Cycle Queue Clearance Time ( g c ), s				25.9	24.2	24.2	3.2	15.1	15.1	15.5	9.8			14.5	13.8				
Green Ratio ( g/C )				0.48	0.38	0.38	0.26	0.17	0.17	0.36	0.38			0.16	0.45				
Capacity ( c ), veh/h				596	711	655	286	316	297	392	621			269	1254				
Volume-to-Capacity Ratio ( X )				1.102	0.798	0.799	0.285	1.001	1.009	1.071	0.396			0.904	0.484				
Available Capacity ( c a ), veh/h				596	711	655	286	316	297	392	621			269	1254				
Back of Queue ( Q ), veh/ln ( 50 th percentile)				21.4	11.9	11.1	1.3	11.2	10.8	13.6	3.6			7.6	4.1				
Queue Storage Ratio ( RQ ) ( 50 th percentile)				0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00			0.00	0.00				
Uniform Delay ( d 1 ), s/veh				24.0	24.9	25.0	26.4	37.5	37.5	25.7	20.5			39.2	17.5				
Incremental Delay ( d 2 ), s/veh				68.1	9.1	9.8	0.2	50.9	54.6	65.8	0.2			30.4	0.1				
Initial Queue Delay ( d 3 ), s/veh				0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0			0.0	0.0				
Control Delay ( d ), s/veh				92.1	34.0	34.8	26.6	88.3	92.0	91.5	20.6			69.6	17.6				
Level of Service (LOS)				F	C	C	C	F	F	F	C			E	B				
Approach Delay, s/veh / LOS				56.1		E		82.7		F		65.3		E		32.5		C	
Intersection Delay, s/veh / LOS				57.2						E									
Multimodal Results				EB			WB			NB			SB						
Pedestrian LOS Score / LOS				2.3		B		2.4		B		2.8		C		2.8		C	
Bicycle LOS Score / LOS				1.9		A		1.1		A		1.6		A		1.9		A	

# HCS 2010 Signalized Intersection Results Summary

General Information				Intersection Information		
Agency	TMS Engineers, Inc.			Duration, h	0.25	
Analyst	ABC	Analysis Date	Sep 16, 2015	Area Type	Other	
Jurisdiction	Orange Village, OH	Time Period	PM Peak Period	PHF	0.92	
Urban Street	Harvard Road	Analysis Year	2036	Analysis Period	1 > 7:00	
Intersection	Harvard & Brainard	File Name	PM 36 HarvardBrainard.xus			
Project Description	Build Conditions					

Demand Information	EB			WB			NB			SB		
Approach Movement	L	T	R	L	T	R	L	T	R	L	T	R
Demand ( $v$ ), veh/h	187	513	400	21	338	37	117	175	17	51	405	187

Signal Information											
Cycle, s	90.0	Reference Phase	2								
Offset, s	0	Reference Point	End								
Uncoordinated	No	Simult. Gap E/W	On								
Force Mode	Fixed	Simult. Gap N/S	On	Green	7.0	20.4	7.0	35.6	0.0	0.0	
				Yellow	3.6	3.6	3.6	3.6	0.0	0.0	
				Red	1.4	1.4	1.4	1.4	0.0	0.0	

Timer Results	EBL	EBT	WBL	WBT	NBL	NBT	SBL	SBT
Assigned Phase	5	2		6	3	8		4
Case Number	1.0	3.0		6.3	1.0	4.0		6.3
Phase Duration, s	12.0	37.4		25.4	12.0	52.6		40.6
Change Period, ( $Y+R_c$ ), s	5.0	5.0		5.0	5.0	5.0		5.0
Max Allow Headway ( $MAH$ ), s	3.1	0.0		0.0	3.1	3.1		3.1
Queue Clearance Time ( $g_s$ ), s	9.0				5.5	7.4		32.8
Green Extension Time ( $g_e$ ), s	0.0	0.0		0.0	0.0	2.0		0.8
Phase Call Probability	1.00				1.00	1.00		1.00
Max Out Probability	1.00				1.00	0.00		1.00

Movement Group Results	EB			WB			NB			SB		
Approach Movement	L	T	R	L	T	R	L	T	R	L	T	R
Assigned Movement	5	2	12	1	6	16	3	8	18	7	4	14
Adjusted Flow Rate ( $\nu$ ), veh/h	203	558	435	23	206	201	127	209		55	643	
Adjusted Saturation Flow Rate ( $s$ ), veh/h/ln	1792	1881	1594	571	1881	1816	1792	1852		1180	1780	
Queue Service Time ( $g_s$ ), s	7.0	24.3	21.6	3.4	8.6	8.7	3.5	5.4		2.7	30.8	
Cycle Queue Clearance Time ( $g_c$ ), s	7.0	24.3	21.6	15.7	8.6	8.7	3.5	5.4		2.7	30.8	
Green Ratio ( $g/C$ )	0.33	0.36	0.36	0.23	0.23	0.23	0.50	0.53		0.40	0.40	
Capacity ( $c$ ), veh/h	347	677	574	132	426	412	262	979		547	704	
Volume-to-Capacity Ratio ( $X$ )	0.585	0.823	0.758	0.173	0.484	0.489	0.486	0.213		0.101	0.914	
Available Capacity ( $c_a$ ), veh/h	347	677	574	132	426	412	262	979		547	704	
Back of Queue ( $Q$ ), veh/ln ( 50 th percentile)	3.3	12.3	9.1	0.6	4.2	4.1	1.6	2.0		0.7	15.2	
Queue Storage Ratio ( $RQ$ ) ( 50 th percentile)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	
Uniform Delay ( $d_1$ ), s/veh	24.7	26.2	25.3	38.8	30.2	30.3	19.4	11.3		17.3	25.7	
Incremental Delay ( $d_2$ ), s/veh	1.7	10.9	9.0	2.8	3.9	4.1	0.5	0.0		0.0	16.1	
Initial Queue Delay ( $d_3$ ), s/veh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		0.0	0.0	
Control Delay ( $d$ ), s/veh	26.4	37.1	34.4	41.6	34.1	34.4	19.9	11.3		17.3	41.9	
Level of Service (LOS)	C	D	C	D	C	C	B	B		B	D	
Approach Delay, s/veh / LOS	34.3	C		34.6	C		14.6	B		39.9	D	
Intersection Delay, s/veh / LOS	33.3						C					

Multimodal Results	EB		WB		NB		SB	
Pedestrian LOS Score / LOS	2.3	B	2.3	B	2.4	B	2.8	C
Bicycle LOS Score / LOS	2.5	B	0.8	A	1.0	A	1.6	A

**APPENDIX K**  
**Build Capacity Analysis Worksheets**  
**2036 w/ Improvements**



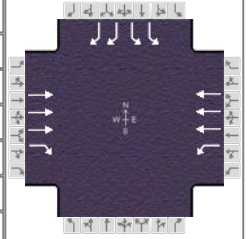
# HCS 2010 Signalized Intersection Results Summary

## General Information

Agency	TMS Engineers, Inc.		
Analyst	ABC	Analysis Date	Sep 16, 2015
Jurisdiction	Orange, OH	Time Period	AM Peak
Urban Street	Harvard Road	Analysis Year	2036
Intersection	@ I-271 SB Ramps	File Name	AM 36 271SB-IMP.xus
Project Description	Recommended Improvements		

## Intersection Information

Duration, h	0.25
Area Type	Other
PHF	0.92
Analysis Period	1> 7:00



## Demand Information

	EB			WB			NB			SB		
Approach Movement	L	T	R	L	T	R	L	T	R	L	T	R
Demand ( v ), veh/h		581	242	353	1616					266		567

## Signal Information

Cycle, s	90.0	Reference Phase	2									
Offset, s	0	Reference Point	End									
Uncoordinated	No	Simult. Gap E/W	On	Green	10.1	32.7	32.2	0.0	0.0	0.0		
Force Mode	Fixed	Simult. Gap N/S	On	Yellow	3.6	3.6	3.6	0.0	0.0	0.0		
				Red	1.4	1.4	1.4	0.0	0.0	0.0		

## Timer Results

	EBL	EBT	WBL	WBT	NBL	NBT	SBL	SBT
Assigned Phase		2	1	6				4
Case Number		7.3	1.0	4.0				9.0
Phase Duration, s		37.7	15.1	52.8				37.2
Change Period, ( Y+R <sub>c</sub> ), s		5.0	5.0	5.0				5.0
Max Allow Headway ( MAH ), s		0.0	3.1	0.0				3.3
Queue Clearance Time ( g <sub>s</sub> ), s			12.1					18.4
Green Extension Time ( g <sub>e</sub> ), s		0.0	0.0	0.0				2.3
Phase Call Probability			1.00					1.00
Max Out Probability			1.00					0.02

## Movement Group Results

Approach Movement	L	T	R	L	T	R	L	T	R	L	T	R
Assigned Movement		2	12	1	6					7		14
Adjusted Flow Rate ( $v$ ), veh/h		632	263	384	1757					289		616
Adjusted Saturation Flow Rate ( $s$ ), veh/h/ln		1691	1579	1774	1691					1723		1397
Queue Service Time ( $g_s$ ), s		8.1	11.5	10.1	22.3					5.3		16.4
Cycle Queue Clearance Time ( $g_c$ ), s		8.1	11.5	10.1	22.3					5.3		16.4
Green Ratio ( $g/C$ )		0.36	0.36	0.50	0.53					0.36		0.36
Capacity ( $c$ ), veh/h		1844	574	495	2695					1233		1000
Volume-to-Capacity Ratio ( $X$ )		0.343	0.459	0.775	0.652					0.235		0.617
Available Capacity ( $c_a$ ), veh/h		1844	574	495	2695					1233		1000
Back of Queue ( $Q$ ), veh/ln ( 50 th percentile)		3.2	4.5	5.5	8.0					2.1		5.2
Queue Storage Ratio ( $RQ$ ) ( 50 th percentile)		0.00	0.00	0.00	0.00					0.00		0.00
Uniform Delay ( $d_1$ ), s/veh		20.8	21.9	17.7	15.1					20.3		23.8
Incremental Delay ( $d_2$ ), s/veh		0.5	2.6	6.9	1.2					0.0		0.8
Initial Queue Delay ( $d_3$ ), s/veh		0.0	0.0	0.0	0.0					0.0		0.0
Control Delay ( $d$ ), s/veh		21.3	24.5	24.6	16.4					20.3		24.7
Level of Service (LOS)		C	C	C	B					C		C
Approach Delay, s/veh / LOS	22.3	C		17.8	B		0.0			23.3	C	
Intersection Delay, s/veh / LOS	20.1						C					

## Multimodal Results

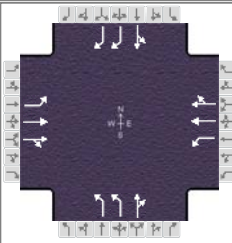
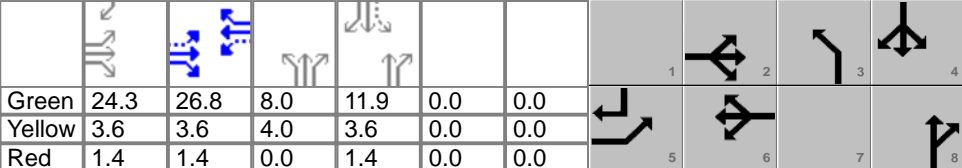
	EB			WB			NB			SB		
Pedestrian LOS Score / LOS	1.9	A		2.1	B		3.3	C		3.3	C	
Bicycle LOS Score / LOS	1.0	A		1.7	A							F



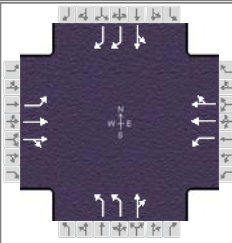
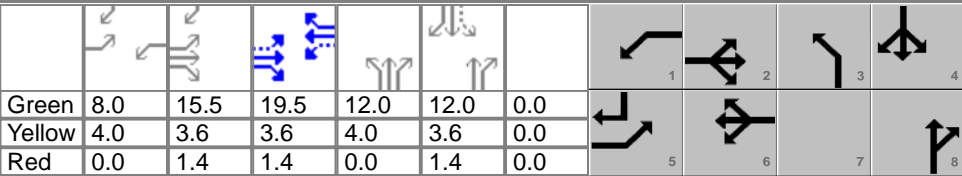
# HCS 2010 Signalized Intersection Results Summary

General Information					Intersection Information														
Agency		TMS Engineers, Inc.			Duration, h		0.25												
Analyst		ABC	Analysis Date	Sep 16, 2015		Area Type		Other											
Jurisdiction		Orange, OH	Time Period	PM Peak		PHF		0.92											
Urban Street		Harvard Road	Analysis Year	2036		Analysis Period		1> 7:00											
Intersection		@ I-271 SB Ramps	File Name	PM 36 271SB-IMP.xus															
Project Description		Recommended Improvement																	
Demand Information				EB			WB			NB			SB						
Approach Movement				L	T	R	L	T	R	L	T	R	L	T	R				
Demand ( v ), veh/h					1299	690	496	1169					506		667				
Signal Information																			
Cycle, s	90.0	Reference Phase	2																
Offset, s	0	Reference Point	End																
Uncoordinated	No	Simult. Gap E/W	On																
Force Mode	Fixed	Simult. Gap N/S	On	Green	14.2	37.6	23.2	0.0	0.0	0.0									
				Yellow	3.6	3.6	3.6	0.0	0.0	0.0									
				Red	1.4	1.4	1.4	0.0	0.0	0.0									
Timer Results				EBL		EBT		WBL		WBT		NBL		NBT		SBL		SBT	
Assigned Phase						2		1		6								4	
Case Number						7.3		1.0		4.0								9.0	
Phase Duration, s						42.6		19.2		61.8								28.2	
Change Period, ( Y+R c ), s						5.0		5.0		5.0								5.0	
Max Allow Headway ( MAH ), s						0.0		3.1		0.0								3.3	
Queue Clearance Time ( g s ), s								16.2										25.2	
Green Extension Time ( g e ), s						0.0		0.0		0.0								0.0	
Phase Call Probability								1.00										1.00	
Max Out Probability								1.00										1.00	
Movement Group Results				EB			WB			NB			SB						
Approach Movement				L	T	R	L	T	R	L	T	R	L	T	R				
Assigned Movement					2	12	1	6					7		14				
Adjusted Flow Rate ( v ), veh/h					1412	750	539	1271					550		725				
Adjusted Saturation Flow Rate ( s ), veh/h/ln					1691	1579	1774	1773					1723		1397				
Queue Service Time ( g s ), s					20.2	37.6	14.2	18.5					12.7		23.2				
Cycle Queue Clearance Time ( g c ), s					20.2	37.6	14.2	18.5					12.7		23.2				
Green Ratio ( g/C )					0.42	0.42	0.60	0.63					0.26		0.26				
Capacity ( c ), veh/h					2120	660	433	2238					888		720				
Volume-to-Capacity Ratio ( X )					0.666	1.137	1.244	0.568					0.619		1.007				
Available Capacity ( c a ), veh/h					2120	660	433	2238					888		720				
Back of Queue ( Q ), veh/ln ( 50 th percentile)					7.8	27.5	24.9	6.4					5.2		11.0				
Queue Storage Ratio ( RQ ) ( 50 th percentile)					0.00	0.00	0.00	0.00					0.00		0.00				
Uniform Delay ( d 1 ), s/veh					21.1	26.2	21.1	9.5					29.5		33.4				
Incremental Delay ( d 2 ), s/veh					1.7	79.4	128.2	1.1					1.0		35.2				
Initial Queue Delay ( d 3 ), s/veh					0.0	0.0	0.0	0.0					0.0		0.0				
Control Delay ( d ), s/veh					22.8	105.6	149.3	10.6					30.5		68.6				
Level of Service (LOS)					C	F	F	B					C		F				
Approach Delay, s/veh / LOS				51.5		D		51.9		D		0.0				52.1		D	
Intersection Delay, s/veh / LOS				51.8						D									
Multimodal Results				EB			WB			NB			SB						
Pedestrian LOS Score / LOS				1.9		A		2.1		B		3.2		C		3.0		C	
Bicycle LOS Score / LOS				1.7		A		2.0		A								F	

# HCS 2010 Signalized Intersection Results Summary

General Information						Intersection Information													
Agency		TMS Engineers, Inc.				Duration, h		0.25											
Analyst		ABC		Analysis Date		Sep 16, 2015		Area Type						Other					
Jurisdiction		Orange Village, OH		Time Period		AM Peak Period		PHF						0.92					
Urban Street		Harvard Road		Analysis Year		2036		Analysis Period						1> 7:00					
Intersection		Harvard & Orange Place		File Name		AM 36 HarvardOrange.xus													
Project Description		Recommended Improvements																	
Demand Information				EB			WB			NB			SB						
Approach Movement				L	T	R	L	T	R	L	T	R	L	T	R				
Demand ( v ), veh/h				539	407	482	150	608	84	163	17	34	30	19	219				
Signal Information																			
Cycle, s	90.0	Reference Phase	2																
Offset, s	0	Reference Point	End																
Uncoordinated	No	Simult. Gap E/W	On																
Force Mode	Fixed	Simult. Gap N/S	On																
				Green	24.3	26.8	8.0	11.9	0.0	0.0									
				Yellow	3.6	3.6	4.0	3.6	0.0	0.0									
				Red	1.4	1.4	0.0	1.4	0.0	0.0									
Timer Results				EBL		EBT		WBL		WBT		NBL		NBT		SBL		SBT	
Assigned Phase				5		2				6		3		8				4	
Case Number				1.0		4.0				6.3		2.0		4.0				7.3	
Phase Duration, s				29.3		61.1				31.8		12.0		28.9				16.9	
Change Period, ( Y+R c ), s				5.0		5.0				5.0		4.0		5.0				5.0	
Max Allow Headway ( MAH ), s				3.1		0.0				0.0		3.1		3.3				3.3	
Queue Clearance Time ( g s ), s				22.2								6.4		4.3				7.0	
Green Extension Time ( g e ), s				0.4		0.0				0.0		0.1		0.8				0.4	
Phase Call Probability				1.00								1.00		1.00				1.00	
Max Out Probability				1.00								1.00		0.00				0.30	
Movement Group Results				EB			WB			NB			SB						
Approach Movement				L	T	R	L	T	R	L	T	R	L	T	R				
Assigned Movement				5	2	12	1	6	16	3	8	18	7	4	14				
Adjusted Flow Rate ( v ), veh/h				586	442	524	163	384	368	177	55			53	238				
Adjusted Saturation Flow Rate ( s ), veh/h/ln				1774	1863	1579	591	1863	1783	1723	1663			1544	1397				
Queue Service Time ( g s ), s				20.2	10.6	16.8	24.1	16.4	16.5	4.4	2.3			1.3	5.0				
Cycle Queue Clearance Time ( g c ), s				20.2	10.6	16.8	24.1	16.4	16.5	4.4	2.3			2.6	5.0				
Green Ratio ( g/C )				0.59	0.62	0.62	0.30	0.30	0.30	0.35	0.27			0.13	0.40				
Capacity ( c ), veh/h				640	1161	984	256	555	531	306	442			269	1124				
Volume-to-Capacity Ratio ( X )				0.915	0.381	0.532	0.637	0.692	0.694	0.579	0.126			0.198	0.212				
Available Capacity ( c a ), veh/h				640	1161	984	256	555	531	306	442			269	1124				
Back of Queue ( Q ), veh/ln ( 50 th percentile)				10.3	4.0	5.5	4.1	8.0	7.8	1.9	0.9			1.0	1.5				
Queue Storage Ratio ( RQ ) ( 50 th percentile)				0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00			0.00	0.00				
Uniform Delay ( d 1 ), s/veh				17.7	8.4	9.6	30.7	28.0	28.0	39.4	25.1			34.9	17.6				
Incremental Delay ( d 2 ), s/veh				17.5	1.0	2.1	11.5	6.9	7.3	1.8	0.0			0.1	0.0				
Initial Queue Delay ( d 3 ), s/veh				0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0			0.0	0.0				
Control Delay ( d ), s/veh				35.2	9.3	11.6	42.2	34.9	35.3	41.2	25.2			35.1	17.6				
Level of Service (LOS)				D	A	B	D	C	D	D	C			D	B				
Approach Delay, s/veh / LOS				19.9		B		36.3		D		37.4		D		20.8		C	
Intersection Delay, s/veh / LOS				26.4						C									
Multimodal Results				EB			WB			NB			SB						
Pedestrian LOS Score / LOS				2.4		B		2.4		B		2.8		C		2.8		C	
Bicycle LOS Score / LOS				1.8		A		1.2		A		0.9		A		1.0		A	

# HCS 2010 Signalized Intersection Results Summary

General Information						Intersection Information													
Agency		TMS Engineers, Inc.				Duration, h		0.25											
Analyst		ABC		Analysis Date		Sep 16, 2015		Area Type					Other						
Jurisdiction		Orange Village, OH		Time Period		PM Peak Period		PHF					0.92						
Urban Street		Harvard Road		Analysis Year		2036		Analysis Period					1> 7:00						
Intersection		Harvard & Orange Place		File Name		PM 36 HarvardOrange-IMP.xus													
Project Description		Recommended Improvements																	
Demand Information				EB			WB			NB			SB						
Approach Movement				L	T	R	L	T	R	L	T	R	L	T	R				
Demand ( v ), veh/h				604	775	228	75	468	98	386	30	196	201	23	558				
Signal Information																			
Cycle, s	90.0	Reference Phase	2																
Offset, s	0	Reference Point	End																
Uncoordinated	No	Simult. Gap E/W	On																
Force Mode	Fixed	Simult. Gap N/S	On																
Green				8.0	15.5	19.5	12.0	12.0	0.0										
Yellow				4.0	3.6	3.6	4.0	3.6	0.0										
Red				0.0	1.4	1.4	0.0	1.4	0.0										
Timer Results				EBL		EBT		WBL		WBT		NBL		NBT		SBL		SBT	
Assigned Phase				5		2		1		6		3		8				4	
Case Number				1.1		4.0		1.1		4.0		2.0		4.0				7.3	
Phase Duration, s				32.5		45.0		12.0		24.5		16.0		33.0				17.0	
Change Period, ( Y+R c ), s				5.0		5.0		4.0		5.0		4.0		5.0				5.0	
Max Allow Headway ( MAH ), s				3.1		0.0		3.1		0.0		3.1		3.4				3.4	
Queue Clearance Time ( g s ), s				28.1				4.9				12.6		12.9				14.0	
Green Extension Time ( g e ), s				0.0		0.0		0.0		0.0		0.0		2.8				0.0	
Phase Call Probability				1.00				1.00				1.00		1.00				1.00	
Max Out Probability				1.00				1.00				1.00		0.04				1.00	
Movement Group Results				EB			WB			NB			SB						
Approach Movement				L	T	R	L	T	R	L	T	R	L	T	R				
Assigned Movement				5	2	12	1	6	16	3	8	18	7	4	14				
Adjusted Flow Rate ( v ), veh/h				657	567	523	82	316	299	420	246			243	607				
Adjusted Saturation Flow Rate ( s ), veh/h/ln				1792	1881	1733	1810	1881	1768	1757	1643			1201	1397				
Queue Service Time ( g s ), s				26.1	21.6	21.6	2.9	14.2	14.4	10.6	10.9			12.0	12.0				
Cycle Queue Clearance Time ( g c ), s				26.1	21.6	21.6	2.9	14.2	14.4	10.6	10.9			12.0	12.0				
Green Ratio ( g/C )				0.54	0.44	0.44	0.31	0.22	0.22	0.13	0.31			0.13	0.44				
Capacity ( c ), veh/h				674	836	770	337	408	383	469	511			236	1226				
Volume-to-Capacity Ratio ( X )				0.974	0.678	0.679	0.242	0.775	0.781	0.895	0.480			1.032	0.495				
Available Capacity ( c a ), veh/h				674	836	770	337	408	383	469	511			236	1226				
Back of Queue ( Q ), veh/ln ( 50 th percentile)				15.0	9.8	9.1	1.2	7.8	7.5	5.7	4.1			9.6	4.2				
Queue Storage Ratio ( RQ ) ( 50 th percentile)				0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00			0.00	0.00				
Uniform Delay ( d 1 ), s/veh				20.2	19.9	19.9	22.8	33.2	33.2	38.4	25.1			40.9	18.1				
Incremental Delay ( d 2 ), s/veh				28.2	4.4	4.8	0.1	13.4	14.6	18.9	0.3			67.1	0.1				
Initial Queue Delay ( d 3 ), s/veh				0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0			0.0	0.0				
Control Delay ( d ), s/veh				48.3	24.3	24.7	22.9	46.6	47.9	57.3	25.4			108.0	18.2				
Level of Service (LOS)				D	C	C	C	D	D	E	C			F	B				
Approach Delay, s/veh / LOS				33.4		C		44.4		D		45.5		D		43.9		D	
Intersection Delay, s/veh / LOS				39.7						D									
Multimodal Results				EB			WB			NB			SB						
Pedestrian LOS Score / LOS				2.4		B		2.4		B		2.8		C		2.8		C	
Bicycle LOS Score / LOS				1.9		A		1.1		A		1.6		A		1.9		A	

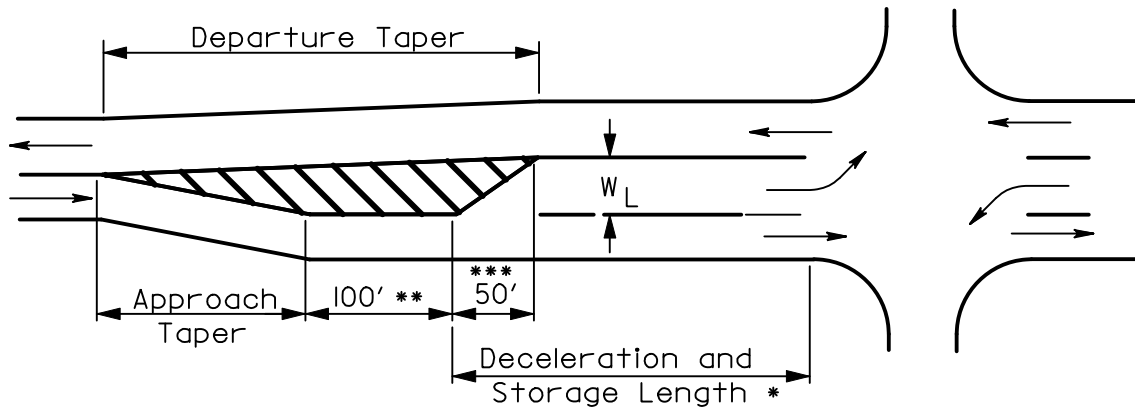
# **APPENDIX L**

## **ODOT Turn Lane Design Criteria**

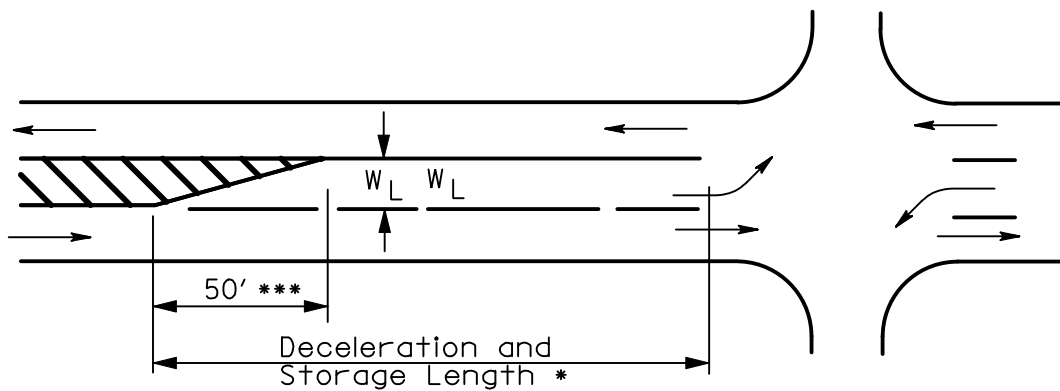
# TURNING LANE DESIGN

**401-7E**

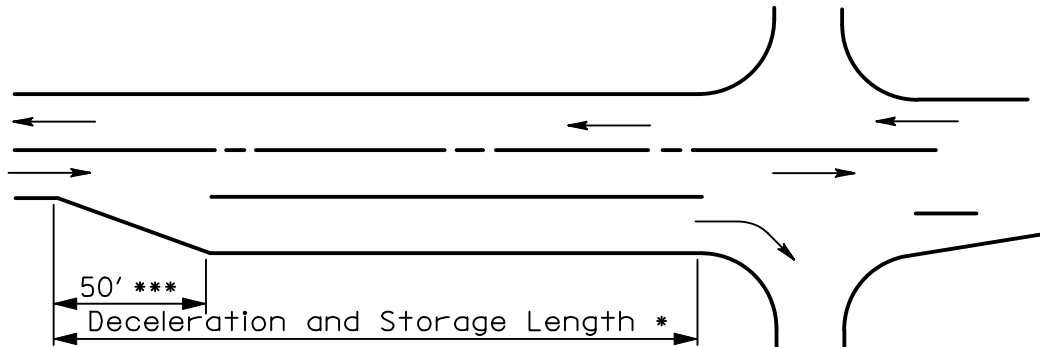
REFERENCE SECTIONS  
401.6.1, 401.6.3



LEFT TURN LANE - NO MEDIAN OR MEDIAN WIDTH  $< W_L$



LEFT TURN LANE - MEDIAN WIDTH  $\geq W_L$



RIGHT TURN LANE

- \* See **Figures 401-9 and 401-10** to compute length.
  - \*\* May be reduced or eliminated in urban areas if intersection spacing or storage is constraining
  - \*\*\* Diverging taper
- $W_L$  = Turn Lane Width

October 2004

# BASIS FOR COMPUTING LENGTH OF TURN LANES

401-9E

REFERENCE SECTIONS  
401.6.1, 401.6.3

TYPE OF TRAFFIC CONTROL	DESIGN SPEED (mph)					
	30 - 35		40 - 45		50 - 60	
	TURN DEMAND VOLUME					
	HIGH	LOW*	HIGH	LOW*	HIGH	LOW*
SIGNALIZED	(A)	(A)	** (B) or (C)	** (B) or (C)	** (B) or (C)	** (B) or (C)
UNSIGNALIZED STOPPED CROSSROAD	(A)	(A)	(A)	(A)	(A)	(A)
UNSIGNALIZED THROUGH ROAD	(A)	(A)	(C)	(B)	** (B) or (C)	(B)

\* LOW is considered 10% or less of approach traffic volume.

\*\* Whichever is greater

## CONDITION (A) STORAGE ONLY

Length = 50' (diverging taper) + Storage Length (Figure 401-10)

## CONDITION (B) HIGH SPEED DECELERATION ONLY

**Design Speed**

**Length (Including 50' Diverging Taper)**

40	125
45	175
50	225
55	285
60	345

## CONDITION (C) MODERATE SPEED DECELERATION AND STORAGE

**Design Speed**

**Length (Including 50' Diverging Taper)**  
III + Storage Length (Figure 401-10)

40	125	"
45	143	"
50	164	"
55	181	"
60		"

For Explanation, See Turn Lane Design Example

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# STORAGE LENGTH AT INTERSECTIONS

**401-10E**

**REFERENCE SECTIONS**  
**401.6.1, 401.6.3**

* AVERAGE No. OF VEHICLES/CYCLE	REQUIRED LENGTH	* AVERAGE No. OF VEHICLES/CYCLE	REQUIRED LENGTH
1	50 ft	17	600 ft
2	100 ft	18	625 ft
3	150 ft	19	650 ft
4	175 ft	20	675 ft
5	200 ft	21	725 ft
6	250 ft	22	750 ft
7	275 ft	23	775 ft
8	325 ft	24	800 ft
9	350 ft	25	825 ft
10	375 ft	30	975 ft
11	400 ft	35	1125 ft
12	450 ft	40	1250 ft
13	475 ft	45	1400 ft
14	500 ft	50	1550 ft
15	525 ft	55	1700 ft
16	550 ft	60	1850 ft

\* Average Vehicles per Cycle =  $\frac{\text{DHV (TURNING LANE)}}{\text{CYCLES/HOUR}}$

If Cycles are unknown, assume:

UNSIGNALIZED OR 2 PHASE - 60 CYCLES/HR

3 PHASE - 40 CYCLES/HR

4 PHASE - 30 CYCLES/HR

**October 2004**

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## Example - Turn Lane Design Using Figures 401-9 and 401-10

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### Problem

Calculate the length of an exclusive left-turn lane on a signalized intersection approach of a rural arterial highway (Design Speed - 55 mph). The intersection approach has three comprised on an exclusive left turn lane and two through lanes with 200 left turning vehicles and 680 through vehicles, respectively. The traffic signal has a 90 second cycle length.

### Determine Lane Length

Refer to the matrix in **Figure 401-9**. First, using the given design speed of 55 mph, enter the column with the design speed "50-60". Next, determine if the left turn demand volume is "high" or "low". "Low" is considered 10% or less of the approach traffic flow. The demand is  $200/(680 + 200) = 22.7\%$ . Therefore, the left turn demand is considered "high". Based on a "signalized" intersection, the matrix indicates that Method B or C (whichever is greater) should be used to calculate the length of the left turn lane.

Method B, for the 55 mph design speed, requires a left turn lane length of 285 ft.

Method C is calculated by adding the 164 ft. (for the 55 mph design speed) to the storage length determined from **Figure 401-10**. To determine the storage length, first, calculate the number of cycles/hour ( $3,600 \text{ seconds/hour} \times 1 \text{ cycle/90 seconds} = 40 \text{ cycles/hour}$ ). Next, divide the hourly left turn approach volume by the number of cycles/hour ( $200 \text{ left turning vehicles divided by } 40 \text{ cycles/hour} = 5$ ). Using **Figure 401-10**, the required storage length is 200 ft. Adding the 200 ft. storage length to the 164 ft. (moderate speed deceleration length) noted above equals 364 ft. A comparison of the values from Method B and Method C yields 285 ft. and 364 ft., respectively. Therefore, use the greater value of 364 ft.

### Check Length for Backup

Next, check to determine if backups from the through movements will block left turning vehicles from entering the left turn lane. **Figure 401-10** is also used for this purpose. Using the value of 40 cycles/hour (determined above), calculate the average number of through vehicles per cycle ( $680/40 = 17$ ). Based on **Figure 401-10**, this will result in backups of 600 ft. in a single lane. However, since the through traffic volume is in two through lanes, the backup of through vehicles is only one-half the 600 ft., or 300 ft.

Therefore, the through vehicle backup of 300 ft. per lane will not block left turning vehicles desiring to enter the left turn lane which extends back 364 ft.



# TRAFFIC IMPACT STUDY

PROPOSED ORANGE SOUTH  
ORANGE VILLAGE, OHIO

OCTOBER 9, 2015

Prepared For:  
PINE ORANGE, LLC  
1138 WEST 9<sup>TH</sup> STREET, 2<sup>ND</sup> FLOOR  
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Prepared By:  
TMS ENGINEERS, INC.  
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REGISTERED ENGINEER NO. E56982  
CERTIFICATION NO. 2234

"This document was prepared consistent with local agency requirements  
and/or applicable guidelines contained in this report."

