

February 5, 2019

Ms. Amanda Lessard, AICP, Assistant Town Planner
Town of Windham
Planning Department
8 School Road
Windham, ME 04062

**Preliminary Subdivision & Site Plan Application, Cook Road Retirement Community –
Traffic Study**

Dear Amanda,

Enclosed please find the Traffic Impact Study for this project, prepared as required by the Subdivision Ordinance Section 910.C.1.c.5.

We are hopeful that this project can be placed on the February 25, 2019 Planning Board meeting agenda for consideration of Preliminary approval. Please contact us if you have any questions as you review the enclosed information.

Submitted by:

Terradyn Consultants, LLC



Larry Bastian, P.E.

Cc: Jim Cummings

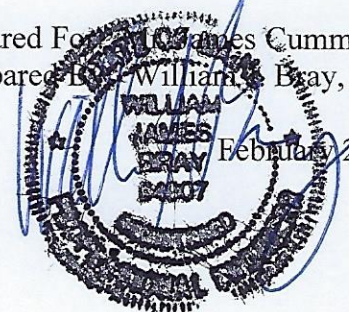
TRAFFIC IMPACT STUDY

FOR

PROPOSED

Cook Road Retirement Community

Prepared For: James Cummings
Prepared By: William S. Bray, P.E.



INTRODUCTION

James Cummings is proposing to construct 46 senior condominium units on a 12.88-acre parcel of property on the Gray Road (a.k.a. U.S. Route 202/State Route 4) in the Town of Windham. The proposed site is a “corner” lot located on the westside of Gray Road at the intersection with Cook Road. Access to the site is proposed with construction of full-service entrance(s) from both Gray Road and Cook Road.

The purpose of this study is to examine existing traffic conditions in the general vicinity of the proposed project, estimate the total number of site trips generated by the project and, make a determination as to whether the existing transportation system can safely and operationally accommodate the added traffic demand generated by the project.

EXISTING CONDITIONS

Existing Design Hour Traffic: A manual turning movement count was conducted at the Gray Road (a.k.a. U.S. Route 202/State Route 4) and Cook Road intersection on Tuesday, January 22, 2019. All traffic entering and exiting the intersection was recorded in 15-minute intervals between 7:00 and 9:00 AM and, again, between 3:00 and 6:00 PM (Copies of the traffic data is attached as an appendix to the report). From a summary of the data, it was determined that the “morning” peak hour occurs between 7:00 and 8:00 AM and the “evening” peak hour falls between 4:00 and 5:00 PM at the study intersection.

Traffic data collected during time periods other than the summer months of July and August require adjustment to reflect “peak” travel conditions. MaineDOT provides factors for adjusting traffic data collected during other periods of time. MaineDOT utilizes highway classifications of I, II, or III for all State and Local roadways. Group I roadways are defined as urban roadways or those roads that typically see commuter traffic and experience little fluctuation from week to week throughout the year. Group II roadways or arterial roads are those that see a combination of commuter and recreational traffic and, therefore, experience moderate fluctuations during the year. Group III roads or recreational roadways are typically used for recreational purposes and experience significant seasonal fluctuations. MaineDOT has designated the noted section of Gray Road a Group I roadway, which requires an adjustment of 1.18 to approximate “peak” summer travel conditions. The 2019 design hour traffic forecast for the study intersection is illustratively presented on Figure 1.

Roadway Safety Conditions: The Maine Department of Transportation’s (MaineDOT) Accident Records Section provided the latest three-year (2015 through 2017) crash data for the section of the Gray Road between Fall Ridge Road and Swett Road, a distance of approximately 0.79 miles. Their report is presented as follows:

2015 -2017 Traffic Accident Summary

<u>Location</u>	<u>Total Crashes</u>	<u>Critical Rate Factor</u>
1. Gray Road @ Cook Road	1	0.29
2. Gray Road btw. Webb Road and Cook Road	7	0.90
3. Gray Road btw. Cook Road and Swett Road	2	0.22

The MaineDOT considers any roadway intersection or segment a high crash location if both of the following criteria are met:

- **8 or more accidents**
- **A Critical Rate Factor greater than 1.00**

As the data presented in the chart shows, there are no high crash locations within the defined study area.

SITE TRAFFIC

Site trip estimates: Daily and peak hour trip generation was determined for the proposed project based upon trip tables presented in the ninth edition of the Institute of Transportation Engineers (ITE) “**TRIP GENERATION**” handbook. The ITE publication provides numerous land use categories and the average volume of trips generated by each category. Land Use #252: Senior Adult Housing – Attached with the following written description appropriately describes the proposed Cook Road Retirement Project, “*Senior adult housing consists of attached independently living developments, including retirement communities, age-restricted housing and active adult communities. These developments may include limited social or recreational services. However, they generally lack centralized dining and on-site medical facilities. Residents in these communities live independently, are typically active and may or may not be retired.*”

The following trip rates were used to calculate trip generation for the proposed project:

Land Use #252 – Senior Adult Housing-Attached

Weekday	= 3.44 trips per dwelling unit
AM Peak Hour	= 0.20 trips per dwelling unit
PM Peak Hour	= 0.25 trips per dwelling unit
Saturday Peak Hour	= 0.31 trips per dwelling unit

Accordingly, the proposed 46 senior housing units can be expected to generate a total of 158 trips during a typical weekday; 9 trips in the weekday morning peak hour, 12 trips in the evening peak hour and 14 trips in the Saturday peak hour.

Site Trip Distribution: The Institute of Transportation Engineers handbook also provides the following directional distribution rates for senior adult housing units:

AM Peak Hour	= 34% enter site and 66% exit site
PM Peak Hour	= 54% enter site and 46% exit site
Saturday Peak Hour	= 57% enter site and 43% exit site

Based upon the noted directional distribution patterns, 6 trips during the morning peak hour, 6 trips in the evening peak hour and 6 trips on Saturday will exit the site and the remaining trips (3 AM trips, 6 PM trips and 8 Saturday trips) will enter the site.

Vehicle Trip Composition: This report has assumed all vehicle trips generated by the proposed project are “*primary*” or “*new*” vehicle trips to the area street network.

Vehicle Trip Assignment: Separate vehicle trip assignment models were prepared for both the AM and PM peak hour travel conditions based upon existing vehicle splits measured along Gray Road and the Consultant’s knowledge of travel patterns in the Greater Portland area. Approximately 65% of the site trips are expected to travel westerly towards the River Road in the AM peak hour with the remaining 35% traveling easterly. A reverse pattern occurs in the evening peak hour with the majority of the site trips (approximately 65%) traveling easterly with the remaining trips oriented westerly.

Figure 2 is a “*stick*” diagram that presents the assignment of the site trips to the study intersection.

FUTURE TRAFFIC

2022 Pre-Development Traffic: The Traffic Impact Study has been prepared based upon a projected build-out year of 2022. MaineDOT's historical traffic data for the section of the Gray Road near the "rotary" shows very minor growth in average annual daily traffic along the Gray Road between the years of 2013 through 2016. The MaineDOT report notes an average annual growth of less than 1% per year. To conservatively project future traffic growth at the study intersection a growth rate of 1% per year was applied.

The forecast 2022 design hour traffic conditions are highlighted on Figure 3.

Other Development Traffic: Traffic generated by projects that have been approved by the Local Planning Board and/or the Maine Department of Transportation, yet are not opened, must be included in the estimate of pre-development traffic. Peak hour trips generated by the following projects were appropriately considered in developing an estimate of Other Development trips:

1. 360 Gray Village 14-unit retirement community
2. 375 Gray Road Sports Facility Expansion Project

Figure 4 provides an assignment of the trips generated by the noted projects through the study intersection.

2022 Pre-Development Traffic: 2022 Pre-Development traffic forecasts were prepared for the study intersection by combining the estimated 2022 design hour traffic volumes highlighted on Figure 3 and the Other Development traffic values displayed on Figure 4. Figure 5 presents the 2022 pre-development traffic forecasts for the study intersection.

2022 Post-Development Traffic: 2022 Post-Development traffic forecasts were prepared for the study intersection by combining the 2022 Pre-Development travel forecasts illustrated on Figure 5 with the estimated site generated trips highlighted on Figure 2. Figure 6 presents the estimated 2022 post-development traffic forecasts for the study intersection.

MOBILITY ANALYSIS

Capacity analyses of both 2022 Pre- and Post-Development traffic conditions were performed for the study intersection and both proposed site driveway intersections utilizing the Synchro and SimTraffic computer models. Level of Service rankings are similar to the academic grading system, where an "A" is very good with little delay and "F" represents very poor conditions. The following table summarizes the relationship between delay and Level of Service for an unsignalized intersection:

Level of Service Criteria for Unsignalized Intersections

<u>Level of Service</u>	<u>Total Control Delay (sec/veh)</u>
A	Up to 10.0
B	10.1 to 15.0
C	15.1 to 25.0
D	25.1 to 35.0
E	35.1 to 50.0
F	Greater than 50.0

The results of the capacity analyses are presented in the following table:

Level of Service Summary
2022 Pre- and Post-Development Conditions

Intersection/Approach	2022 Pre-Development				2022 Post-Development			
	AM Peak Hour		PM Peak Hour		AM Peak Hour		PM Peak Hour	
	Delay (sec.)	LOS	Delay (sec.)	LOS	Delay (sec.)	LOS	Delay (sec.)	LOS
Gray Road @ Cook Road								
- Gray Road EB	2 sec.	A	2 sec.	A	2 sec.	A	2 sec.	A
- Gray Road WB	1 sec.	A	1 sec.	A	1 sec.	A	1 sec.	A
- Cook Road SB	6 sec.	A	6 sec.	A	6 sec.	A	6 sec.	A
- Overall Intersection	1 sec.	A	2 sec.	A	1 sec.	A	2 sec.	A
Gray Road @ Site Driveway								
- Gray Road EB	n/a		n/a		1 sec.	A	1 sec.	A
- Gray Road WB	n/a		n/a		1 sec.	A	1 sec.	A
- Site Driveway	n/a		n/a		5 sec.	A	4 sec.	A
- Overall Intersection	n/a		n/a		1 sec.	A	2 sec.	A
Cook Road @ Site Driveway								
- Cook Road SB	n/a		n/a		1 sec.	A	1 sec.	A
- Cook Road NB	n/a		n/a		1 sec.	A	1 sec.	A
- Site Driveway EB	n/a		n/a		1 sec.	A	2 sec.	A
- Overall Intersection	n/a		n/a		1 sec.	A	1 sec.	A

The study intersection of Gray Road/Cook Road and both site driveway intersections are projected to operate at the highest or “best” level of service (LOS A) under both 2022 Pre- and Post-development travel conditions.

VEHICLE SIGHT DISTANCE

Vehicle sight distance measurements for both site driveway intersections are noted on the project Site Plan. The measured distances exceed by a considerable margin MaineDOT’s Sight Distance Standards.

AUXILIARY LANE WARRANT ANALYSIS

The Maine Department of Transportation has published a warrant for auxiliary left-turn lanes in their December 2004 Highway Design Manual. The warrant is predicated upon the volume of two-way traffic traveling on the designated highway and the volume of left-turning vehicles. Figure 8-18 (Posted Speed Limit of 50 mph) from MaineDOT’s referenced design manual was used in conducting the analysis (A copy of the chart with the superimposed traffic values is attached as an appendix to the report). Separate analyses were completed for both peak travel periods to determine if predicted “build” left-turn entry volumes to Cook Road from the eastbound approach of Gray Road meet MaineDOT’s design guidelines for a dedicated left-turn lane. The values used in the analyses are noted as follows:

<u>AM Peak Hour</u>		<u>PM Peak Hour</u>	
Va	= 265	Va	= 480
Vo	= 446	Vo	= 250
Lt %	= 0%	Lt %	= 1.7%

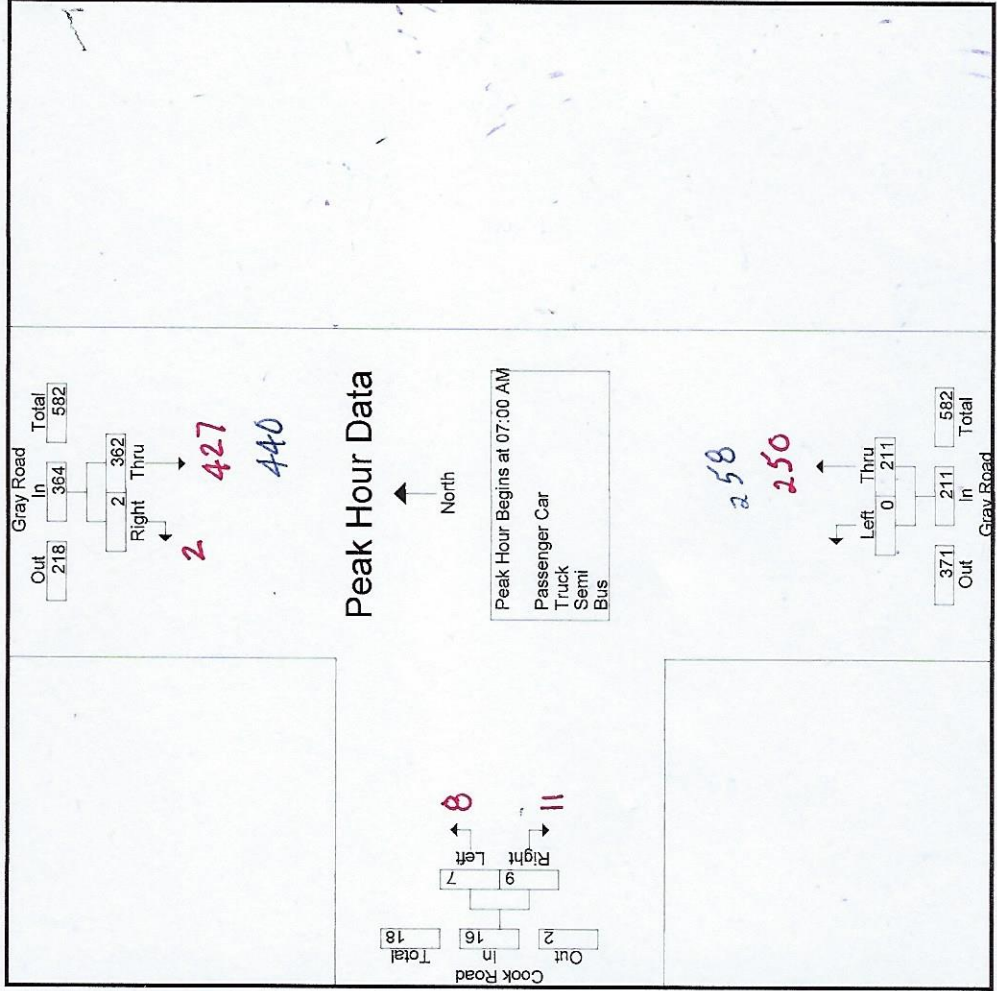
The analysis suggests that a dedicated left-turn lane from the eastbound approach of Gray Road is not warranted.

CONCLUSIONS/RECOMMENDATIONS

- The 46 senior condominium units can be expected to generate **158** daily trips; nine (**9**) trips in the morning peak hour, **12** trips during the afternoon weekday peak commuter hour and **14** trips during a typical Saturday peak hour.
- The Maine Department of Transportation's most recent three-year (2015 to 2017) accident safety audit shows the vehicle crash history is below MaineDOT's criteria for identification of a high crash location.
- Traffic operations of the existing Gray Road/Cook Road intersection was assessed based upon both 2022 Pre- and Post-development travel conditions to measure the level of traffic impact to the intersection created by the proposed development project. The intersection is expected to operate, overall, at the highest or best level of service under both travel conditions.
- Operationally, the proposed site access driveways with both Gray Road and Cook Road are also projected to operate at the highest or best level of service with very minimal delay under projected 2022 post-development travel conditions.
- Sightline measurements recorded at the centerline of the proposed subdivision intersection with Oak Hill Road meet and exceed MaineDOT's sight distance standards by a considerable margin at both proposed site driveway intersections.
- Zero left-turn movements are projected to turn left from the Gray Road to Cook Road in the morning peak hour, and a volume of 8 left-turn movements are forecast for the evening peak hour; both left-turn traffic projections do not meet the minimum volume requirements, whereby a dedicated left-turn lane is warranted.

Windham Gray Road & Cook Road
January 22, 2019 AM
Sunny
Count by Jen Gilbert

File Name : Windham Gray Road & Cook Road 1-22-19 AM
Site Code : 00122191
Start Date : 1/22/2019
Page No : 6

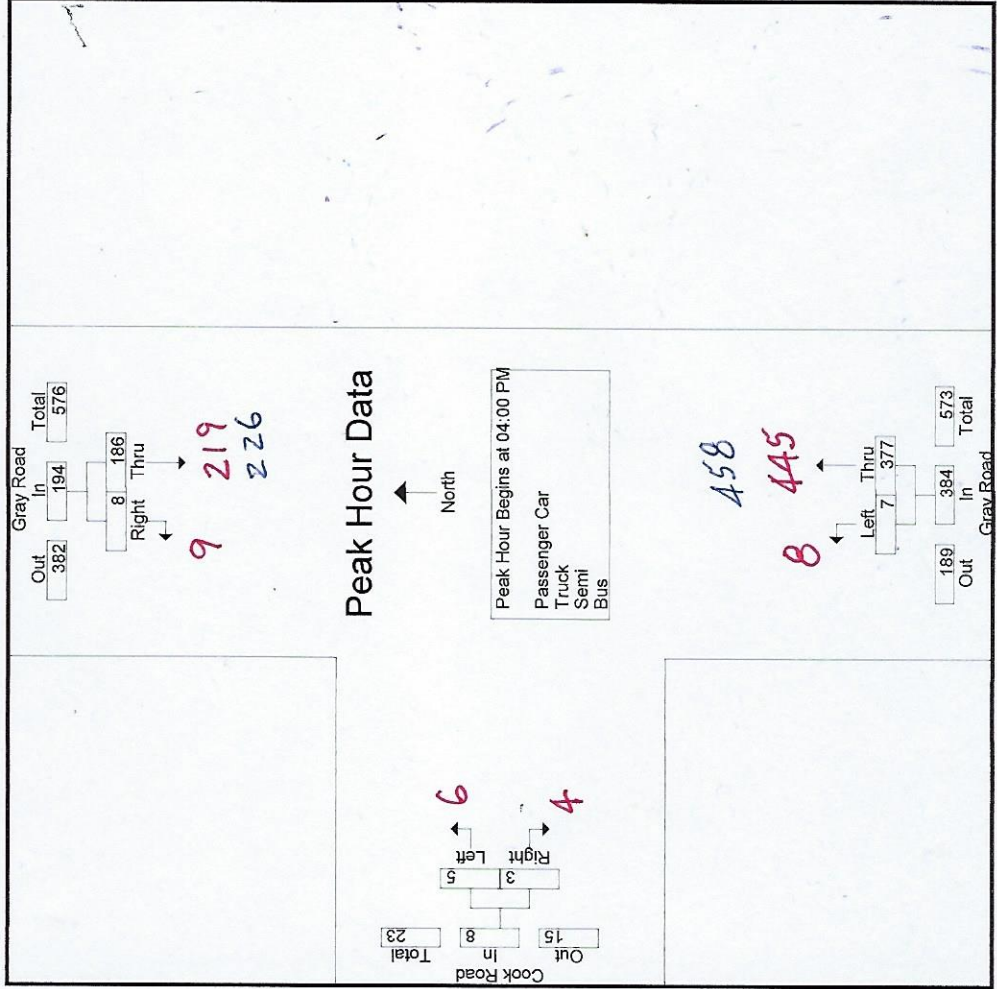


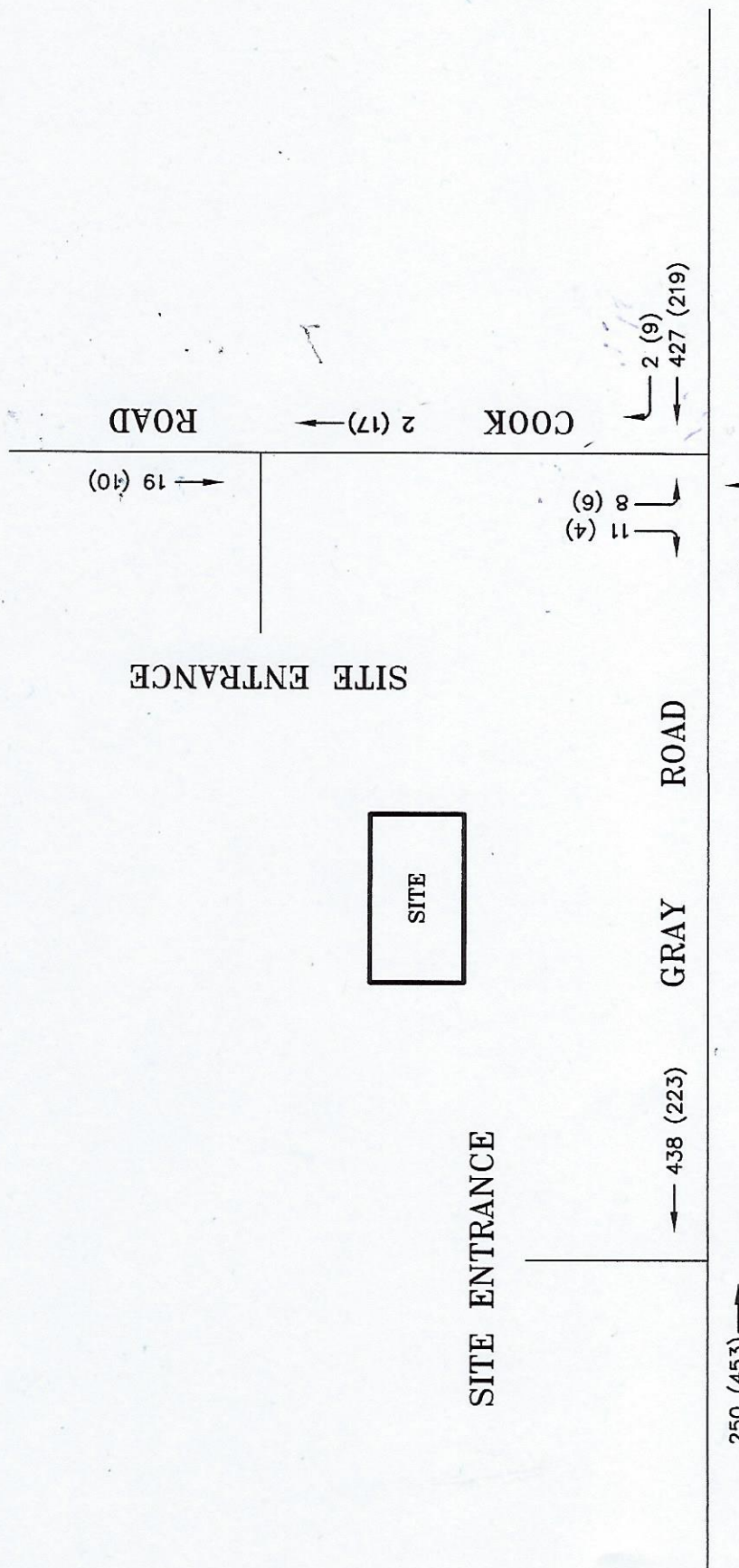
Estimated 2022 DHU = 1.03
1.03

Conversion Factor = 1.18

Windham Gray Road & Cook Road
January 22, 2019 PM
Sunny
Count by Jen Gilbert

File Name : Windham Gray Road & Cook Road 1-22-19 PM
Site Code : 00122192
Start Date : 1/22/2019
Page No : 6

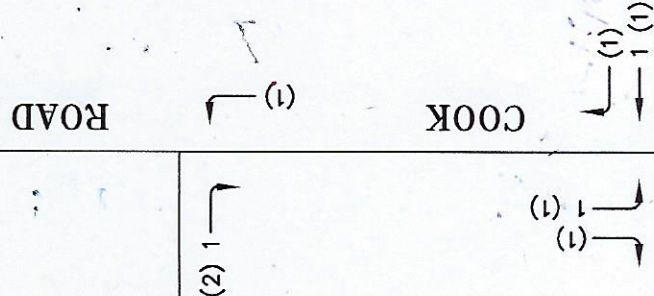




LEGEND
 XX = AM PEAK HOUR
 (XX) = PM PEAK HOUR

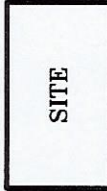
2019 DESIGN HOUR TRAFFIC

FIGURE 1



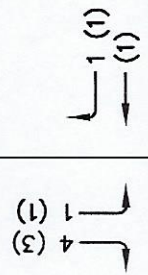
SITE ENTRANCE

COOK ROAD



SITE

GRAY ROAD



SITE ENTRANCE

(1) 1 →

(4) 2 →

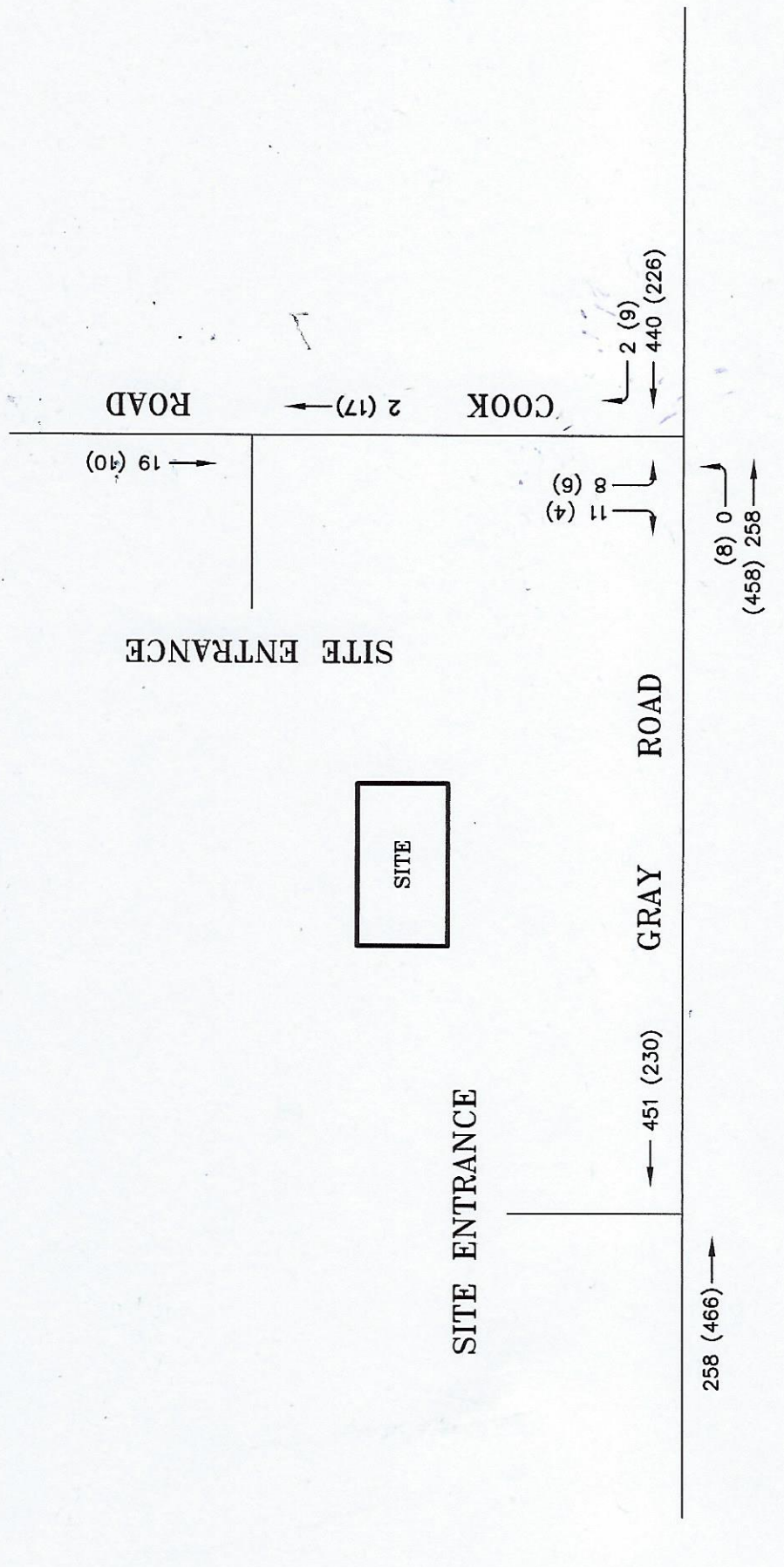
LEGEND

XX = AM PEAK HOUR

(XX) = PM PEAK HOUR

SITE TRAFFIC ASSIGNMENT

FIGURE 2



LEGEND

XX = AM PEAK HOUR
 (XX) = PM PEAK HOUR

2022 DESIGN HOUR TRAFFIC

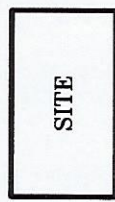
FIGURE 3

ROAD

COOK

← 3 (13)

SITE ENTRANCE



SITE

GRAY ROAD

← 3 (13)

(13) 6 →

(13) 6 →

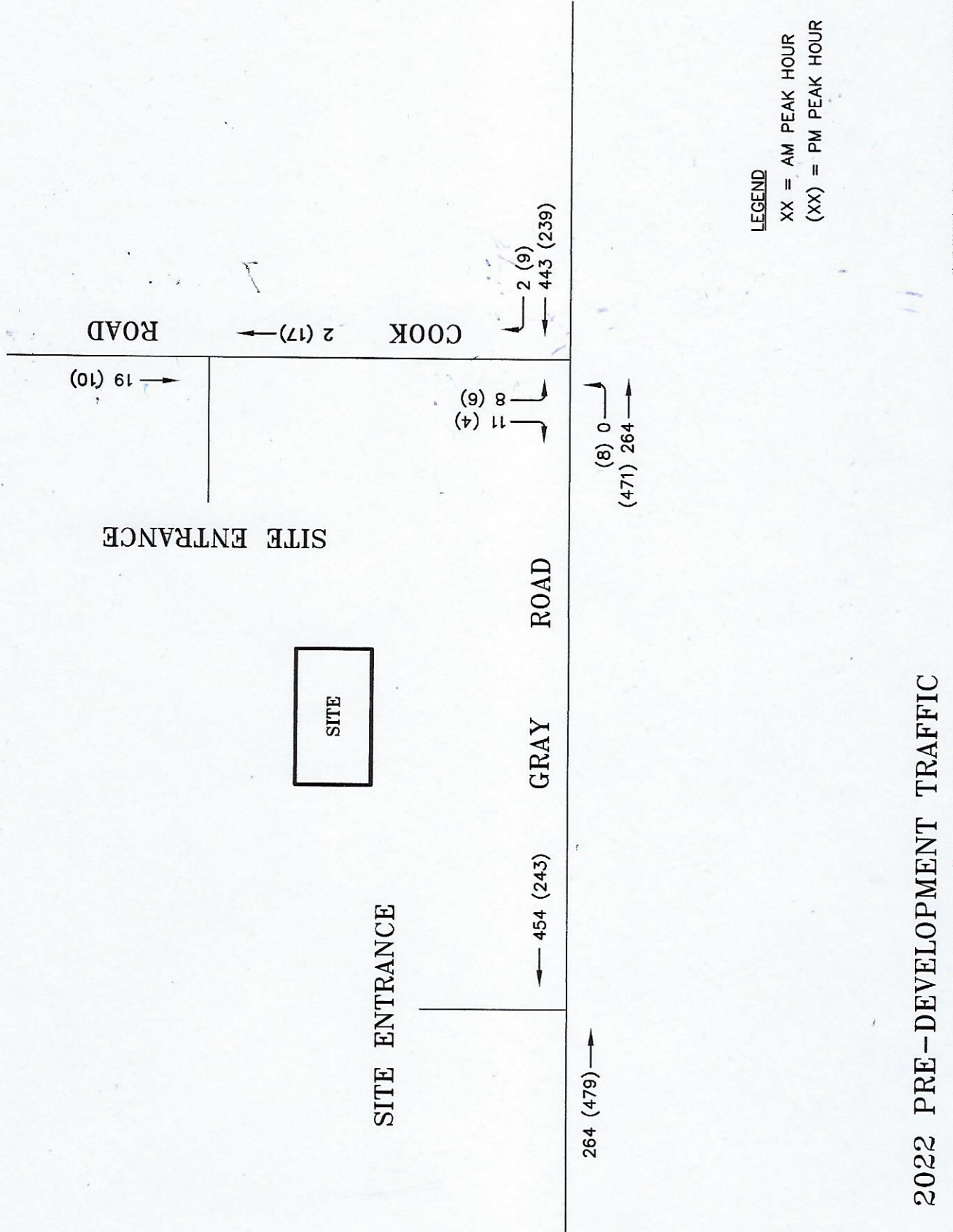
LEGEND

XX = AM PEAK HOUR

(XX) = PM PEAK HOUR

OTHER DEVELOPMENT TRAFFIC

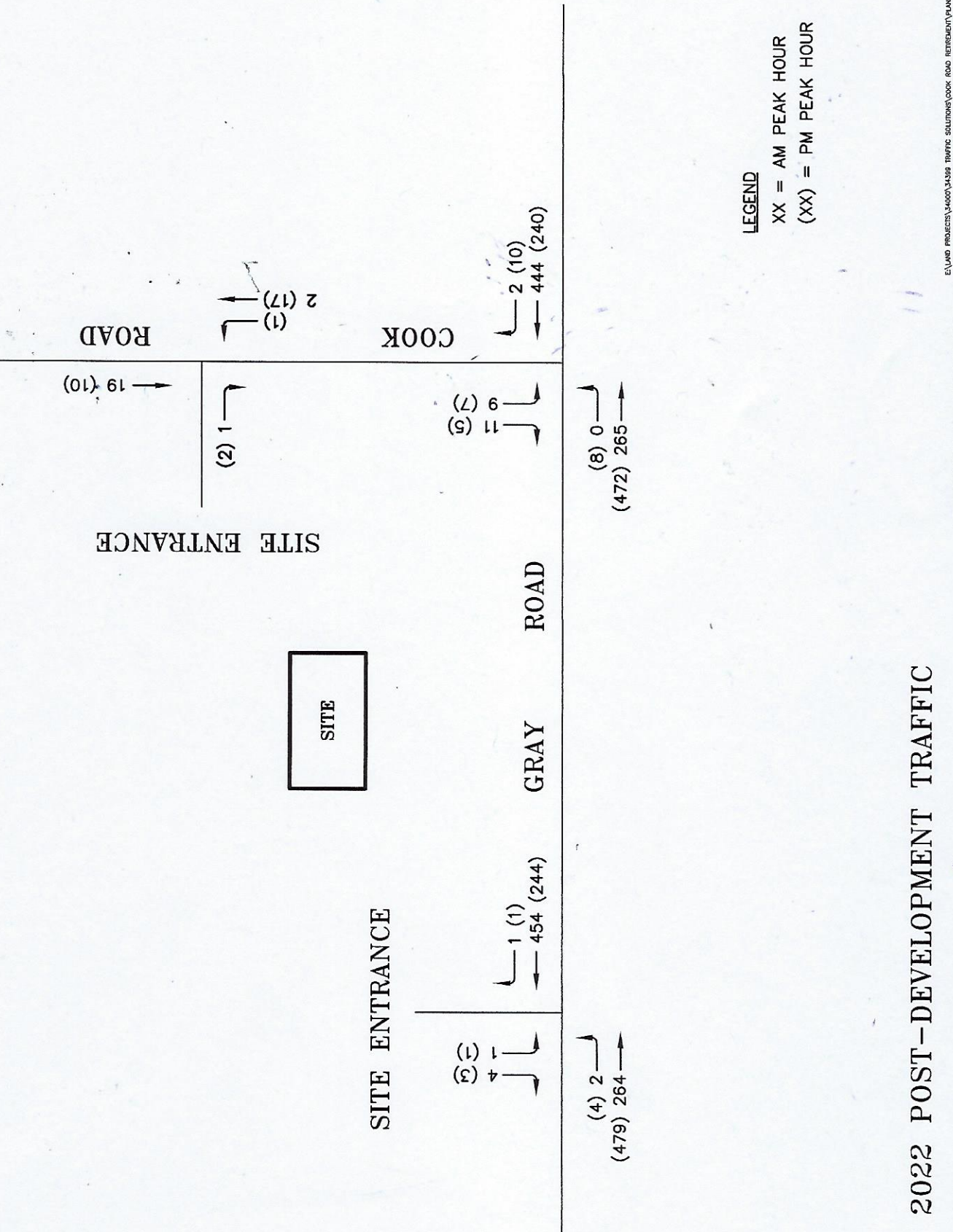
FIGURE 4



LEGEND
 XX = AM PEAK HOUR
 (XX) = PM PEAK HOUR

2022 PRE-DEVELOPMENT TRAFFIC

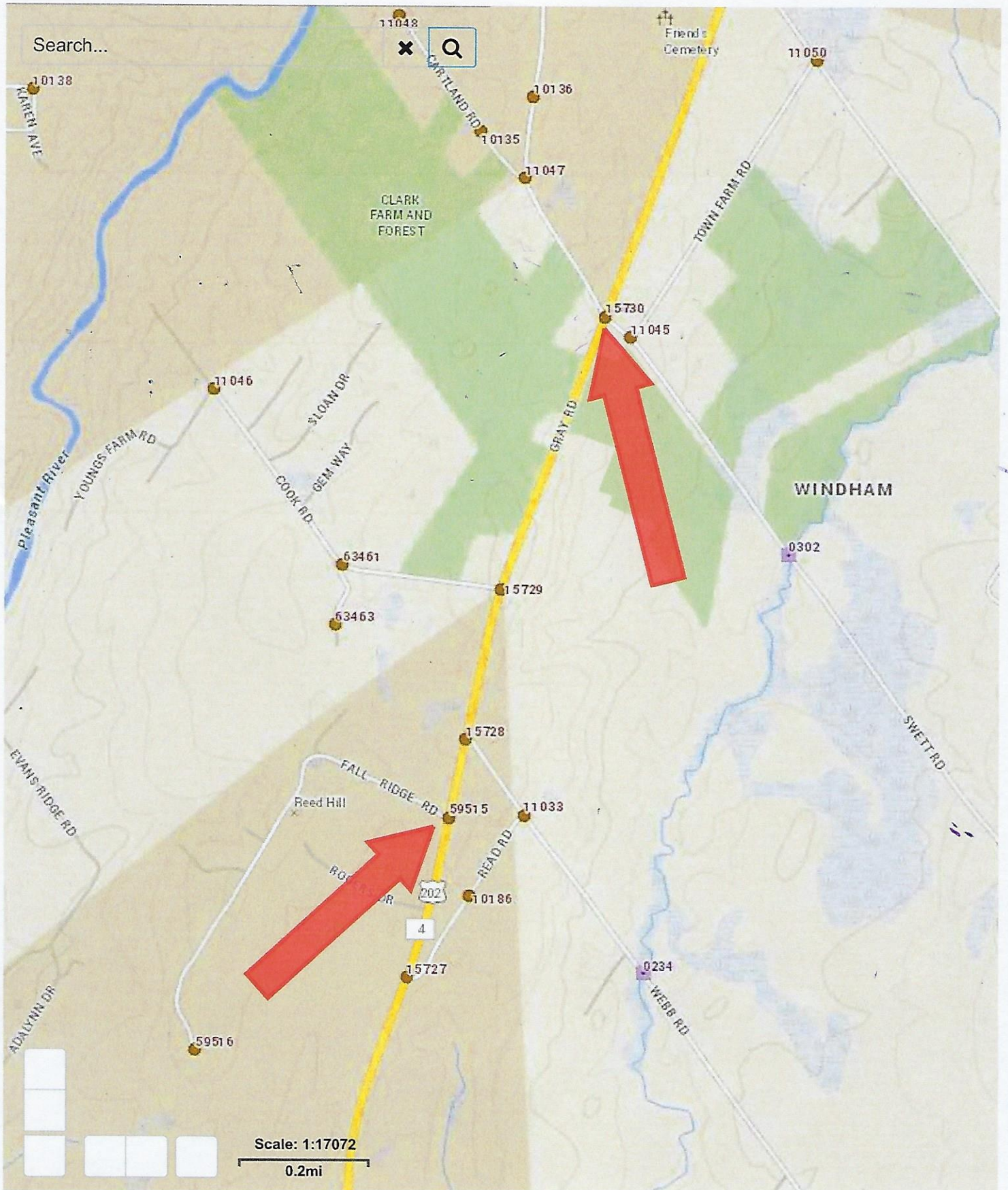
FIGURE 5



LEGEND
 XX = AM PEAK HOUR
 (XX) = PM PEAK HOUR

2022 POST-DEVELOPMENT TRAFFIC

FIGURE 6



Crash Summary Report

Report Selections and Input Parameters

REPORT SELECTIONS

Crash Summary I Section Detail Crash Summary II 1320 Public 1320 Private 1320 Summary

REPORT DESCRIPTION

Windham
Rte. 202/Gray Rd. from Falls Ridge Rd. to Swett Rd.

REPORT PARAMETERS

Year 2015, Start Month 1 through Year 2017 End Month: 12

Route: **0202X**

Start Node: **59515**

Start Offset: **0**

End Node: **15730**

End Offset: **0**

Exclude First Node

Exclude Last Node

Crash Summary I

Nodes

Node	Route - MP	Node Description	U/R	Total Crashes	K	A	B	C	PD	Injury	Percent Annual M Ent-Veh	Crash Rate	Critical Rate	CRF	
15728	0202X - 46.47	Int of GRAY RD WEBB RD	2	0	0	0	0	0	0	0.0	2.333	0.00	0.48	0.00	
												Statewide Crash Rate: 0.16			
15730	0202X - 47.14	Int of GRAY RD SWETT RD	2	0	0	0	0	0	0	0.0	2.371	0.00	0.48	0.00	
												Statewide Crash Rate: 0.16			
15729	0202X - 46.70	Int of COOK RD GRAY RD	2	1	0	0	0	0	1	0.0	2.317	0.14	0.48	0.00	
												Statewide Crash Rate: 0.16			
59515	0202X - 46.35	Int of FALL RIDGE RD GRAY RD	2	0	0	0	0	0	0	0.0	2.269	0.00	0.48	0.00	
												Statewide Crash Rate: 0.16			
Study Years: 3.00															
NODE TOTALS:				1	0	0	0	0	1	0.0	9.290	0.04	0.34	0.11	

Crash Summary I

Sections

Start Node	End Node	Element	Offset Begin - End	Route - MP	Section U/R Length	Total Crashes	K	A	B	C	PD	Injury Crashes	Percent Injury	Annual HMVM	Crash Rate	Critical Rate	CRF
59515	15728	3115030	0 - 0.12	0202X - 46.35 US 202	0.12	2	0	0	0	0	0	0	0.0	0.00271	0.00	579.46	0.00
		Int of FALL RIDGE RD GRAY RD													Statewide Crash Rate: 218.54		
15728	15729	3131625	0 - 0.23	0202X - 46.47 US 202	0.23	2	7	0	0	1	6	0	14.3	0.00526	443.36	489.94	0.00
		Int of GRAY RD WEBB RD													Statewide Crash Rate: 218.54		
15729	15730	3105845	0 - 0.44	0202X - 46.70 US 202	0.44	1	2	0	0	0	2	0	0.0	0.01015	65.66	304.40	0.00
		Int of COOK RD GRAY RD													Statewide Crash Rate: 143.81		
Study Years: 3.00					Section Totals:	0.79	9	0	0	1	8	0	11.1	0.01812	165.52	314.32	0.53
					Grand Totals:	0.79	10	0	0	1	9	0	10.0	0.01812	183.91	406.64	0.45

Summary of All Intervals

Run Number	1	2	5	6	7	Avg
Start Time	6:57	6:57	6:57	6:57	6:57	6:57
End Time	8:00	8:00	8:00	8:00	8:00	8:00
Total Time (min)	63	63	63	63	63	63
Time Recorded (min)	60	60	60	60	60	60
# of Intervals	2	2	2	2	2	2
# of Recorded Intervals	1	1	1	1	1	1
Vehs Entered	697	794	651	679	766	717
Vehs Exited	701	790	650	683	762	717
Starting Vehs	8	4	6	9	7	7
Ending Vehs	4	8	7	5	11	6
Travel Distance (mi)	191	216	177	186	208	196
Travel Time (hr)	6.3	7.1	5.8	6.1	6.9	6.5
Total Delay (hr)	0.4	0.4	0.3	0.3	0.4	0.4
Total Stops	16	22	13	18	19	18
Fuel Used (gal)	5.3	6.0	4.9	5.1	5.8	5.4

Interval #0 Information Seeding

Start Time	6:57
End Time	7:00
Total Time (min)	3
Volumes adjusted by Growth Factors.	
No data recorded this interval.	

Interval #1 Information Recording

Start Time	7:00
End Time	8:00
Total Time (min)	60
Volumes adjusted by Growth Factors.	

Run Number	1	2	5	6	7	Avg
Vehs Entered	697	794	651	679	766	717
Vehs Exited	701	790	650	683	762	717
Starting Vehs	8	4	6	9	7	7
Ending Vehs	4	8	7	5	11	6
Travel Distance (mi)	191	216	177	186	208	196
Travel Time (hr)	6.3	7.1	5.8	6.1	6.9	6.5
Total Delay (hr)	0.4	0.4	0.3	0.3	0.4	0.4
Total Stops	16	22	13	18	19	18
Fuel Used (gal)	5.3	6.0	4.9	5.1	5.8	5.4

4: Gray Road & Cook Road Performance by approach

Approach	EB	WB	SB	All
Denied Del/Veh (s)	0.2	0.4	0.1	0.3
Total Del/Veh (s)	1.6	0.5	5.5	1.0

Total Network Performance

Denied Del/Veh (s)	0.3
Total Del/Veh (s)	1.5

Intersection: 4: Gray Road & Cook Road

Movement	SB
Directions Served	LR
Maximum Queue (ft)	64
Average Queue (ft)	15
95th Queue (ft)	45
Link Distance (ft)	469
Upstream Blk Time (%)	
Queuing Penalty (veh)	
Storage Bay Dist (ft)	
Storage Blk Time (%)	
Queuing Penalty (veh)	

Network Summary

Network wide Queuing Penalty: 0

Summary of All Intervals

Run Number	1	2	5	6	7	Avg
Start Time	6:57	6:57	6:57	6:57	6:57	6:57
End Time	8:00	8:00	8:00	8:00	8:00	8:00
Total Time (min)	63	63	63	63	63	63
Time Recorded (min)	60	60	60	60	60	60
# of Intervals	2	2	2	2	2	2
# of Recorded Intervals	1	1	1	1	1	1
Vehs Entered	741	760	725	736	762	746
Vehs Exited	739	759	731	740	762	747
Starting Vehs	6	10	12	10	9	9
Ending Vehs	8	11	6	6	9	8
Travel Distance (mi)	296	306	291	295	304	298
Travel Time (hr)	9.6	9.9	9.4	9.6	9.8	9.6
Total Delay (hr)	0.5	0.5	0.5	0.5	0.5	0.5
Total Stops	24	32	29	19	29	28
Fuel Used (gal)	8.3	8.5	7.9	8.1	8.3	8.2

Interval #0 Information Seeding

Start Time	6:57
End Time	7:00
Total Time (min)	3
Volumes adjusted by Growth Factors.	
No data recorded this interval.	

Interval #1 Information Recording

Start Time	7:00
End Time	8:00
Total Time (min)	60
Volumes adjusted by Growth Factors.	

Run Number	1	2	5	6	7	Avg
Vehs Entered	741	760	725	736	762	746
Vehs Exited	739	759	731	740	762	747
Starting Vehs	6	10	12	10	9	9
Ending Vehs	8	11	6	6	9	8
Travel Distance (mi)	296	306	291	295	304	298
Travel Time (hr)	9.6	9.9	9.4	9.6	9.8	9.6
Total Delay (hr)	0.5	0.5	0.5	0.5	0.5	0.5
Total Stops	24	32	29	19	29	28
Fuel Used (gal)	8.3	8.5	7.9	8.1	8.3	8.2

4: Gray Road & Cook Road Performance by approach

Approach	EB	WB	SB	All
Denied Del/Veh (s)	0.0	0.4	0.0	0.2
Total Del/Veh (s)	1.3	0.5	5.1	0.9

7: Cook Road & Driveway North Performance by approach

Approach	EB	NB	SB	All
Denied Del/Veh (s)	0.1	0.0	0.1	0.1
Total Del/Veh (s)	1.3	0.1	0.0	0.1

10: Gray Road & Driveway East Performance by approach

Approach	EB	WB	SB	All
Denied Del/Veh (s)	0.2	0.0	0.1	0.1
Total Del/Veh (s)	0.3	0.4	5.2	0.4

Total Network Performance

Denied Del/Veh (s)			0.3	
Total Del/Veh (s)			2.1	

Intersection: 4: Gray Road & Cook Road

Movement	SB
Directions Served	LR
Maximum Queue (ft)	53
Average Queue (ft)	16
95th Queue (ft)	45
Link Distance (ft)	301
Upstream Blk Time (%)	
Queuing Penalty (veh)	
Storage Bay Dist (ft)	
Storage Blk Time (%)	
Queuing Penalty (veh)	

Intersection: 7: Cook Road & Driveway North

Movement	EB
Directions Served	LR
Maximum Queue (ft)	17
Average Queue (ft)	1
95th Queue (ft)	7
Link Distance (ft)	254
Upstream Blk Time (%)	
Queuing Penalty (veh)	
Storage Bay Dist (ft)	
Storage Blk Time (%)	
Queuing Penalty (veh)	

Intersection: 10: Gray Road & Driveway East

Movement	EB	SB
Directions Served	LT	LR
Maximum Queue (ft)	21	30
Average Queue (ft)	1	6
95th Queue (ft)	9	24
Link Distance (ft)	975	275
Upstream Blk Time (%)		
Queuing Penalty (veh)		
Storage Bay Dist (ft)		
Storage Blk Time (%)		
Queuing Penalty (veh)		

Network Summary

Network wide Queuing Penalty: 0

Summary of All Intervals

Run Number	1	2	5	6	7	Avg
Start Time	4:57	4:57	4:57	4:57	4:57	4:57
End Time	6:00	6:00	6:00	6:00	6:00	6:00
Total Time (min)	63	63	63	63	63	63
Time Recorded (min)	60	60	60	60	60	60
# of Intervals	2	2	2	2	2	2
# of Recorded Intervals	1	1	1	1	1	1
Vehs Entered	745	786	689	723	735	735
Vehs Exited	746	786	692	725	735	737
Starting Vehs	7	4	6	10	6	7
Ending Vehs	6	4	3	8	6	6
Travel Distance (mi)	202	214	188	198	200	200
Travel Time (hr)	6.4	6.8	6.0	6.3	6.4	6.4
Total Delay (hr)	0.5	0.5	0.5	0.5	0.4	0.5
Total Stops	21	10	15	10	10	13
Fuel Used (gal)	5.4	5.6	5.0	5.2	5.3	5.3

Interval #0 Information Seeding

Start Time	4:57
End Time	5:00
Total Time (min)	3
Volumes adjusted by Growth Factors.	
No data recorded this interval.	

Interval #1 Information Recording

Start Time	5:00
End Time	6:00
Total Time (min)	60
Volumes adjusted by Growth Factors.	

Run Number	1	2	5	6	7	Avg
Vehs Entered	745	786	689	723	735	735
Vehs Exited	746	786	692	725	735	737
Starting Vehs	7	4	6	10	6	7
Ending Vehs	6	4	3	8	6	6
Travel Distance (mi)	202	214	188	198	200	200
Travel Time (hr)	6.4	6.8	6.0	6.3	6.4	6.4
Total Delay (hr)	0.5	0.5	0.5	0.5	0.4	0.5
Total Stops	21	10	15	10	10	13
Fuel Used (gal)	5.4	5.6	5.0	5.2	5.3	5.3

4: Gray Road & Cook Road Performance by approach

Approach	EB	WB	SB	All
Denied Del/Veh (s)	0.4	0.2	0.1	0.3
Total Del/Veh (s)	2.1	0.3	6.4	1.6

Total Network Performance

Denied Del/Veh (s)	0.3
Total Del/Veh (s)	1.9

Intersection: 4: Gray Road & Cook Road

Movement	EB	SB
Directions Served	LT	LR
Maximum Queue (ft)	48	31
Average Queue (ft)	3	8
95th Queue (ft)	24	31
Link Distance (ft)	714	469
Upstream Blk Time (%)		
Queuing Penalty (veh)		
Storage Bay Dist (ft)		
Storage Blk Time (%)		
Queuing Penalty (veh)		

Network Summary

Network wide Queuing Penalty: 0

Summary of All Intervals

Run Number	1	2	3	4	7	Avg
Start Time	4:57	4:57	4:57	4:57	4:57	4:57
End Time	6:00	6:00	6:00	6:00	6:00	6:00
Total Time (min)	63	63	63	63	63	63
Time Recorded (min)	60	60	60	60	60	60
# of Intervals	2	2	2	2	2	2
# of Recorded Intervals	1	1	1	1	1	1
Vehs Entered	710	739	782	714	786	745
Vehs Exited	706	741	783	714	790	747
Starting Vehs	9	10	14	6	15	11
Ending Vehs	13	8	13	6	11	10
Travel Distance (mi)	284	297	315	286	317	300
Travel Time (hr)	8.6	8.9	9.4	8.6	9.5	9.0
Total Delay (hr)	0.5	0.5	0.6	0.5	0.6	0.5
Total Stops	27	21	14	23	19	21
Fuel Used (gal)	7.5	7.9	8.1	7.4	8.3	7.8

Interval #0 Information Seeding

Start Time	4:57
End Time	5:00
Total Time (min)	3
Volumes adjusted by Growth Factors.	
No data recorded this interval.	

Interval #1 Information Recording

Start Time	5:00
End Time	6:00
Total Time (min)	60
Volumes adjusted by Growth Factors.	

Run Number	1	2	3	4	7	Avg
Vehs Entered	710	739	782	714	786	745
Vehs Exited	706	741	783	714	790	747
Starting Vehs	9	10	14	6	15	11
Ending Vehs	13	8	13	6	11	10
Travel Distance (mi)	284	297	315	286	317	300
Travel Time (hr)	8.6	8.9	9.4	8.6	9.5	9.0
Total Delay (hr)	0.5	0.5	0.6	0.5	0.6	0.5
Total Stops	27	21	14	23	19	21
Fuel Used (gal)	7.5	7.9	8.1	7.4	8.3	7.8

4: Gray Road & Cook Road Performance by approach

Approach	EB	WB	SB	All
Denied Del/Veh (s)	0.0	0.2	0.0	0.1
Total Del/Veh (s)	1.6	0.3	6.4	1.3

5: Cook Road & Driveway North Performance by approach

Approach	EB	NB	SB	All
Denied Del/Veh (s)	0.1	0.0	0.1	0.0
Total Del/Veh (s)	2.3	0.2	0.0	0.3

8: Gray Road & Driveway East Performance by approach

Approach	EB	WB	SB	All
Denied Del/Veh (s)	0.4	0.0	0.1	0.2
Total Del/Veh (s)	0.7	0.2	4.0	0.6

Total Network Performance

Denied Del/Veh (s)			0.3	
Total Del/Veh (s)			2.3	

Intersection: 4: Gray Road & Cook Road

Movement	EB	SB
Directions Served	LT	LR
Maximum Queue (ft)	16	40
Average Queue (ft)	1	10
95th Queue (ft)	7	34
Link Distance (ft)	367	301
Upstream Blk Time (%)		
Queuing Penalty (veh)		
Storage Bay Dist (ft)		
Storage Blk Time (%)		
Queuing Penalty (veh)		

Intersection: 5: Cook Road & Driveway North

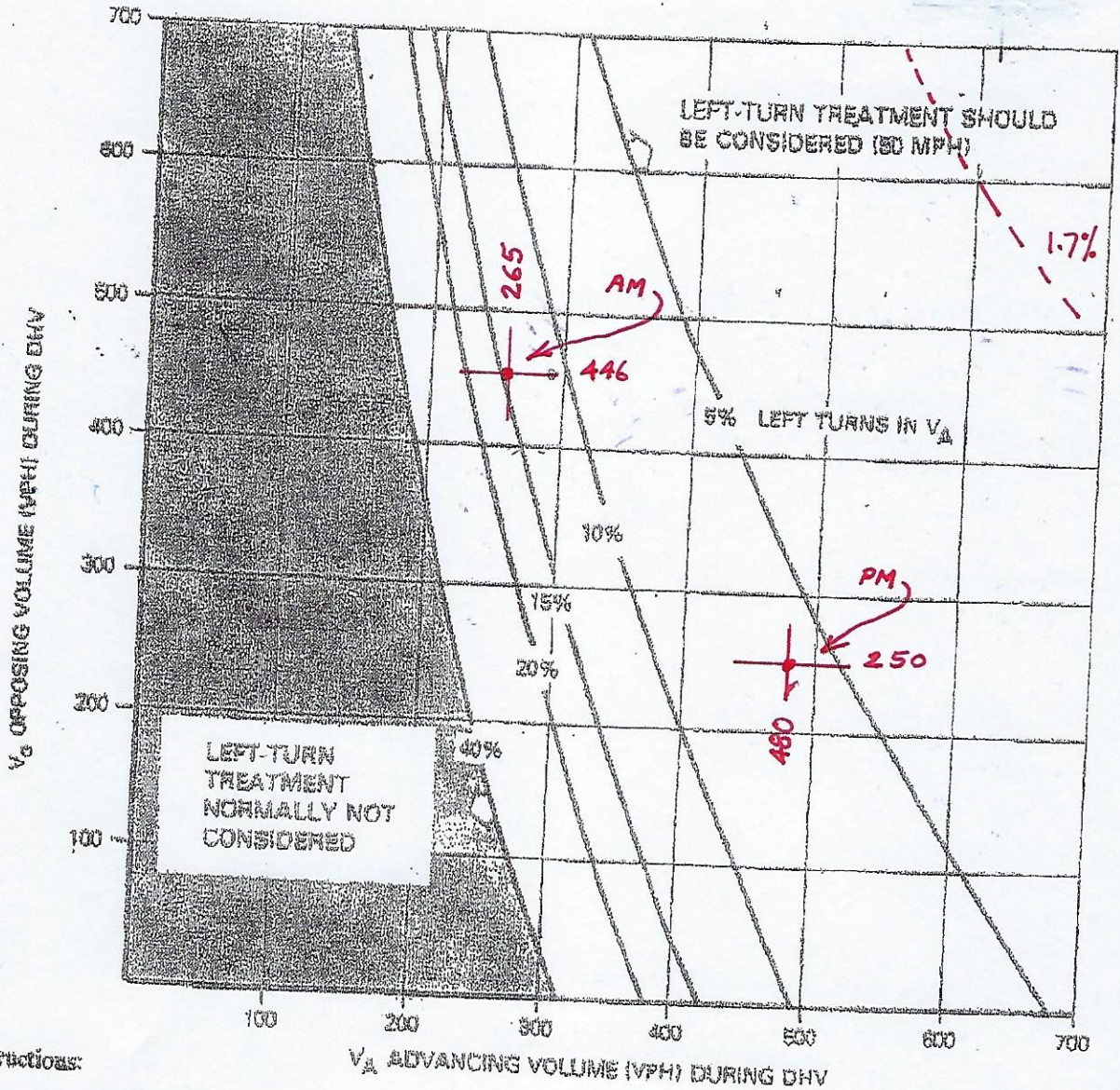
Movement	EB
Directions Served	LR
Maximum Queue (ft)	30
Average Queue (ft)	2
95th Queue (ft)	14
Link Distance (ft)	254
Upstream Blk Time (%)	
Queuing Penalty (veh)	
Storage Bay Dist (ft)	
Storage Blk Time (%)	
Queuing Penalty (veh)	

Intersection: 8: Gray Road & Driveway East

Movement	EB	SB
Directions Served	LT	LR
Maximum Queue (ft)	20	35
Average Queue (ft)	1	4
95th Queue (ft)	10	22
Link Distance (ft)	975	275
Upstream Blk Time (%)		
Queuing Penalty (veh)		
Storage Bay Dist (ft)		
Storage Blk Time (%)		
Queuing Penalty (veh)		

Network Summary

Network wide Queuing Penalty: 0



Instructions:

1. The family of curves represent the percent of left turns in the advancing volumes (V_A). The designer should locate the curve for the actual percentage of left turns. When this is not an even increment of 5, the designer should estimate where the curve lies.
2. Read V_A and V_O into the chart and locate the intersection of the two volumes.
3. Note the location of the point in #2 relative to the line in #1. If the point is to the right of the line, then a left-turn lane is warranted. If the point is to the left of the line, then a left-turn is not warranted based on traffic volumes.

VOLUME WARRANTS FOR LEFT-TURN LANES
 AT UNSIGNALIZED INTERSECTIONS ON 2-LANE HIGHWAYS
 (50 mph)

Figure 8-18