

MEMORANDUM

DATE: August 1, 2023

TO: Mr. Danny Paisner
Scrub-A-Dub Auto Wash Centers, Inc.
172 Worcester Road
Natick, MA 01760

FROM: Robert J. Michaud, P.E. – Managing Principal
Daniel A. Dumais, P.E. – Senior Project Manager

RE: **Proposed ScrubaDub Carwash**
171 Pelham Street, Methuen, Massachusetts

MDM Transportation Consultants, Inc. (MDM) has conducted this traffic impact assessment (TIA) for a proposed ScrubaDub Car Wash development to be located at 171 Pelham Street in Methuen, Massachusetts. The location of the site relative to the adjacent roadway network is shown in **Figure 1**. This TIA provides a primary summary of the baseline traffic conditions at the Site and adjacent roadways/ intersections, evaluates historical and projected trip generation, site access/egress, provides an operational analysis of project impact, and provides a review of drive-through queue estimates for the car wash tunnel.

Key findings of the assessment are as follows:

- *Safety Characteristics.* A review of the crash data indicated that no immediate safety countermeasures are warranted based on the crash history at the study intersections. Likewise, available sight lines at the site driveway intersection with Pelham Street exceed the sight line requirements published by AASHTO.
- *Trip Generation.* Based on a review of ITE and empirical trip generation methodology the car wash development is estimated to generate approximately 50 vehicle trips during the weekday morning peak hour, 94 vehicle trips during the weekday midday peak hour, 117 vehicle trips during the weekday evening peak hour and 181 vehicle trips during the Saturday midday peak hour. MDM also notes that while a significant percentage of the trips are expected to be drawn from the existing traffic stream (pass-by-trips), no reduction was taken for analysis purposes. The proposed ScrubaDub use when compared to the recent historical use of the property, will result in approximately 43 additional vehicle trips during the weekday morning peak hour, 57 additional trips during the weekday midday peak hour, 67 additional trips during the weekday evening peak hour, and 135 additional trips during the Saturday midday peak hour.

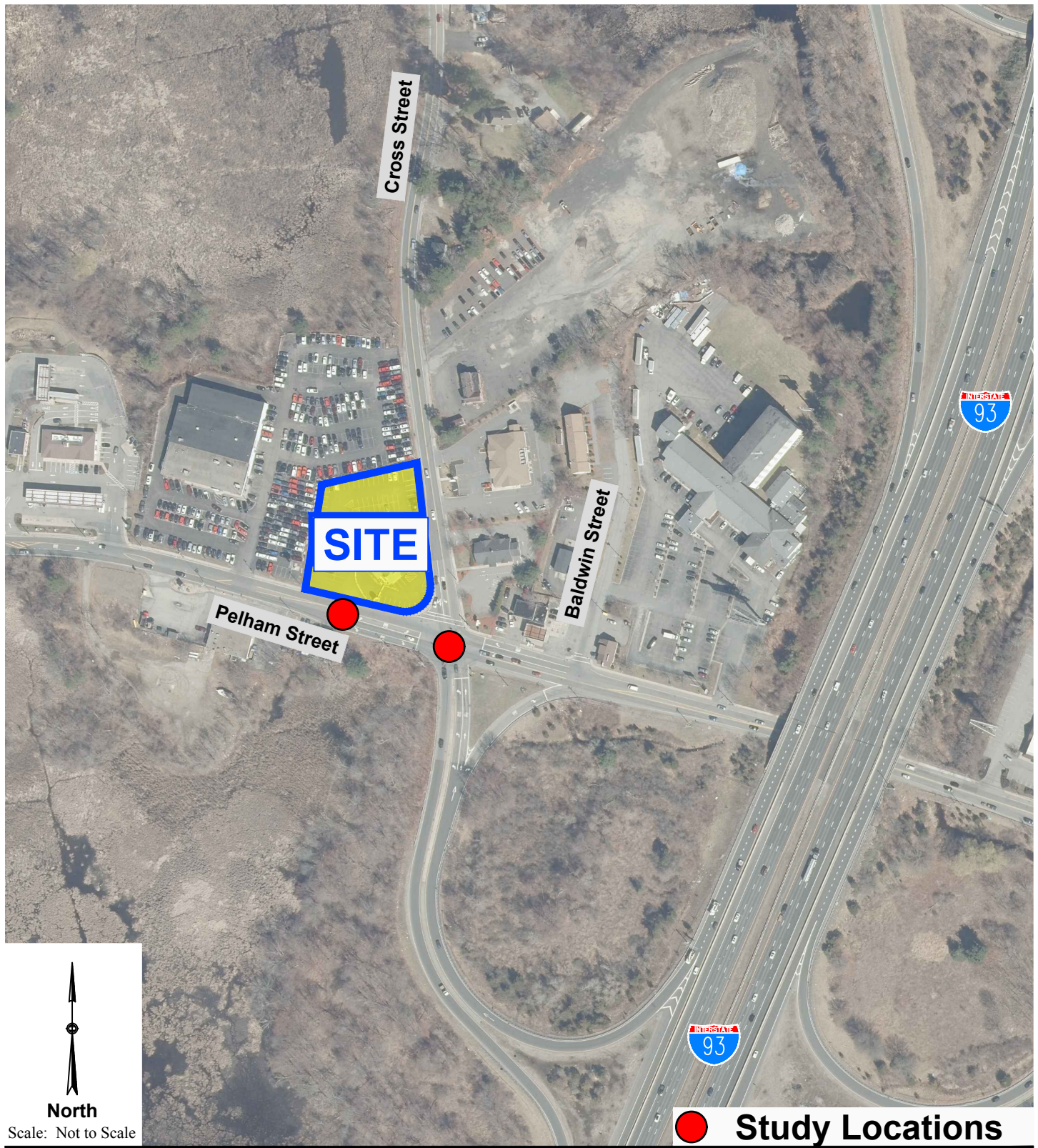


Figure 1

- *Adequate Capacity.* The proposed development does not result in any significant change in operations along Pelham Street compared to Baseline conditions. Any delay associated with the proposed site driveway will be onsite. Furthermore, improvements as outlined in the *Conclusions and Recommendations* section of this report will enhance safety and operations with regards to the development.
- *Adequate On-Site Queue Storage.* The projected peak hour car wash tunnel trip activity is estimated at approximately 91 trips under a theoretical peak season condition. The critical peak hour demand under this theoretical condition is estimated to result in a maximum estimated queue of 15 vehicles and an estimated queue of 7 cars under maximum efficiency conditions. The car wash tunnel configuration and queue lane can accommodate a 32-vehicle queue with no impact to site access, circulation or parking and would not impact Pelham Street.

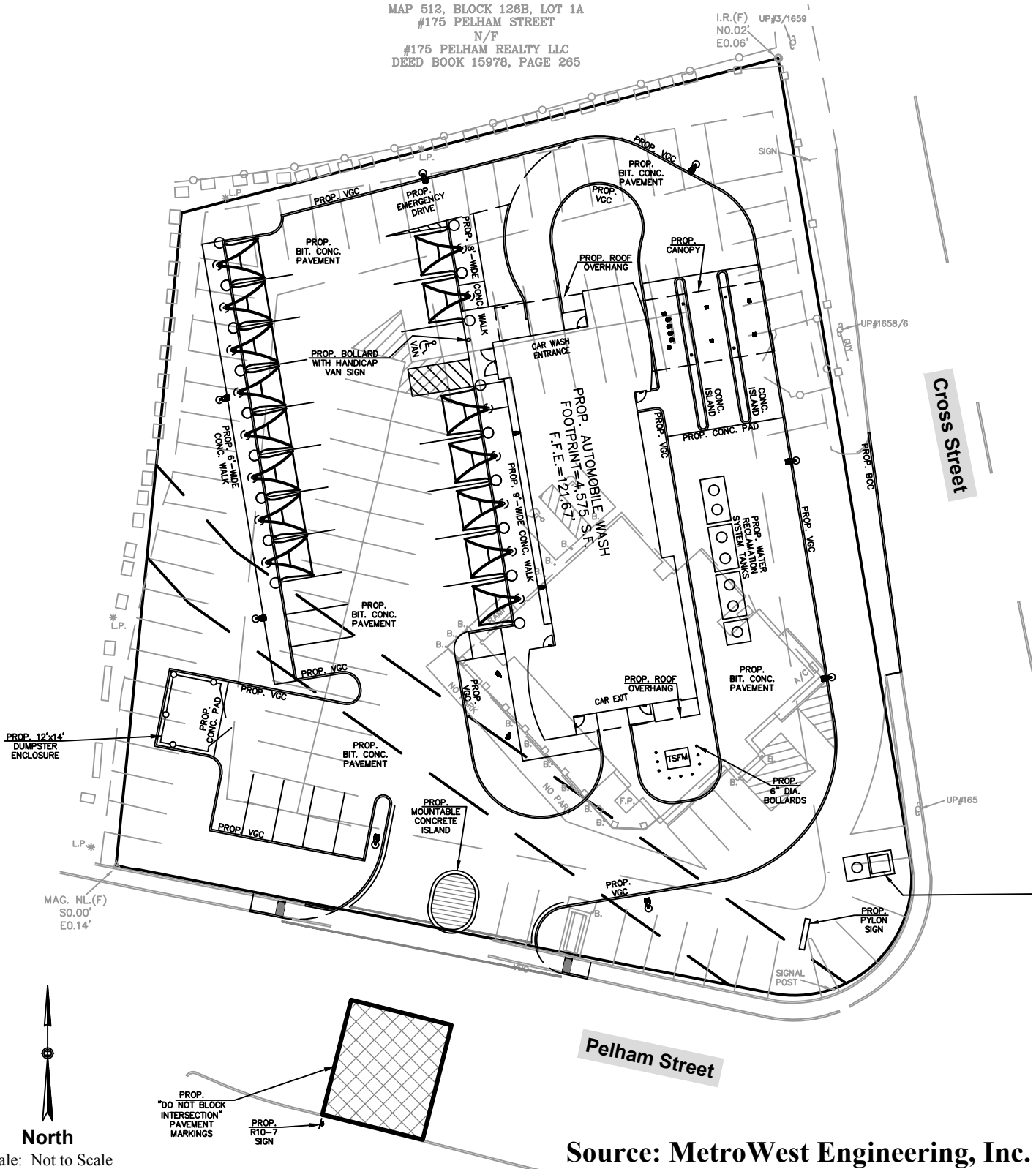
In summary, the projected traffic increases due to the proposed development will be nominal in the immediate study area (2 vehicles or less per minute during the peak periods) and adequate capacity is available under 2023 Design Year conditions along Pelham Street to accommodate the proposed site use. The project is not projected to materially change any reported operating levels compared to Baseline conditions. The car wash tunnel configuration and queue lanes can accommodate the projected maximum queues with limited impact to site access, circulation or parking and will not have any impact on Pelham Street. In addition, access/egress along Pelham Street will be designed to ensure that adequate sight lines are provided in accordance with recommended AASHTO criteria based on posted travel speeds.

PROJECT DESCRIPTION

The Site consists of approximately 1.13± acres of land located in the northwest corner of the Pelham Street intersection with Cross Street. The existing use of the Site is the Fireside Restaurant. Access/Egress to the existing restaurant use is provided via two (2) curb cuts; one driveway along Pelham Street and one driveway along Cross Street.

Under the proposed Site programming the existing Site use will be replaced with a modular single tunnel car wash building and fifteen (15) self-service vacuums. Access/egress to the Site will be consolidated to a single full access curb cut along Pelham Street. The Site will be supported by approximately 24 on-site parking spaces. The preliminary site layout prepared by MetroWest Engineering Inc. is presented in **Figure 2**.

MAP 512, BLOCK 126B, LOT 1A
#175 PELHAM STREET
N/F
#175 PELHAM REALTY LLC
DEED BOOK 15978, PAGE 265



Source: MetroWest Engineering, Inc.

Figure 2

MDM TRANSPORTATION CONSULTANTS, INC.
Planners & Engineers

Preliminary Site Plan

BASELINE TRAFFIC & SAFETY CHARACTERISTICS

An overview of roadway classification and geometric characteristics is provided below for the adjacent study roadway.

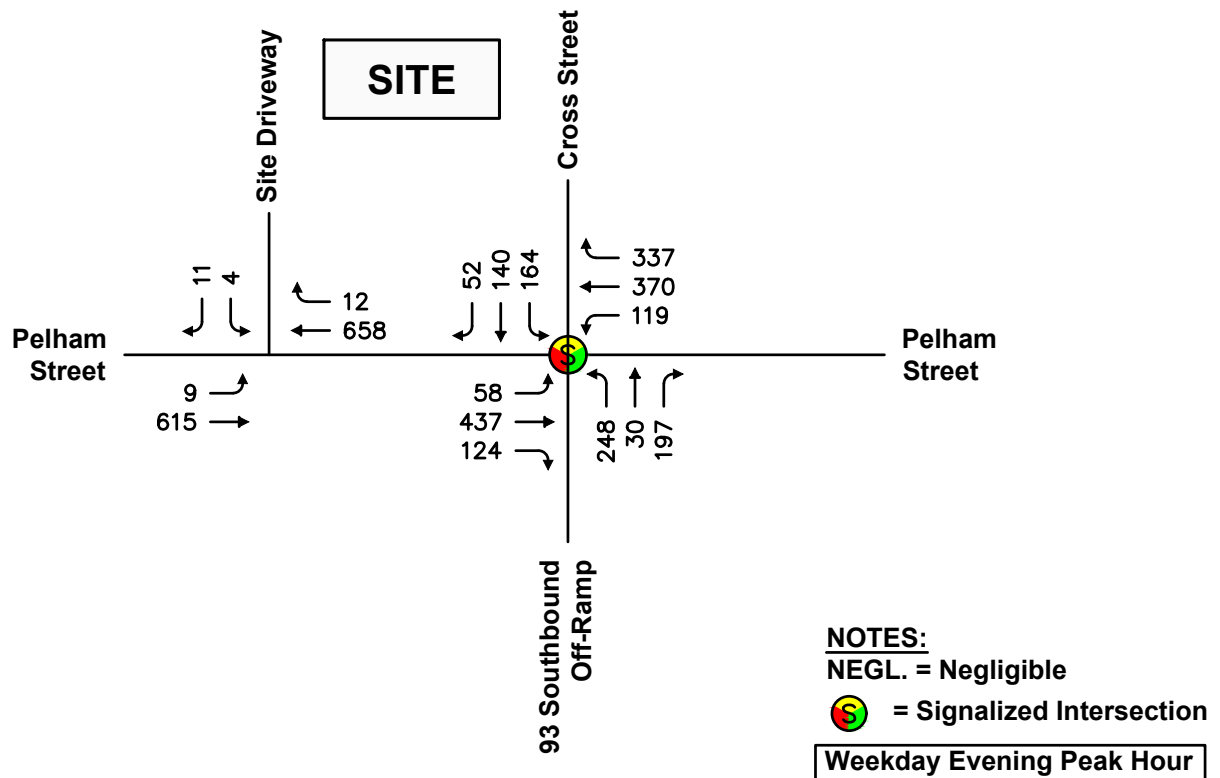
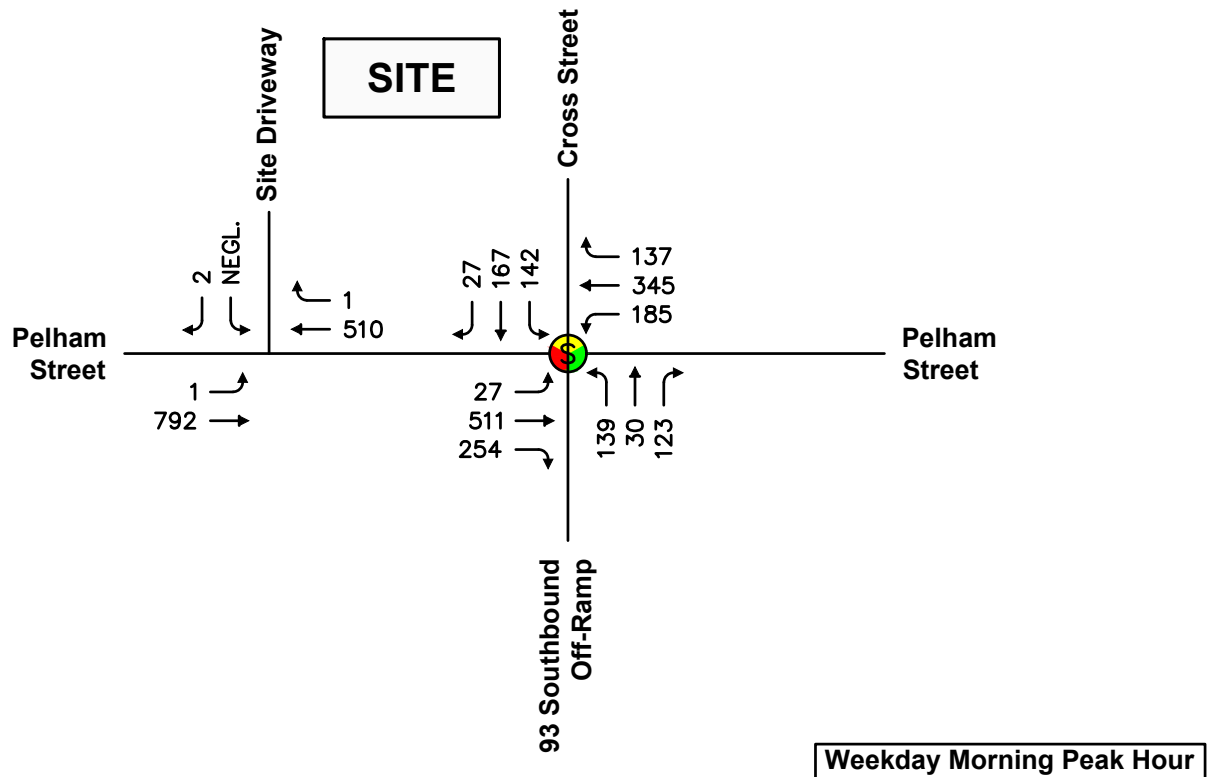
Pelham Street

Pelham Street is generally an east-west roadway under local jurisdiction adjacent to the site and under state jurisdiction within the I-93 Ramp intersections. Pelham Street is classified by the Massachusetts DOT as an Urban collector roadway to the west of I-93 and an Urban minor arterial roadway to the east of I-93, and it provides a connection between Route 113 to the east and Hampshire Road to the west. Pelham Street provides one travel lane in each direction within the study area with additional turn lanes provided at its major intersections. Sidewalks are provided along the northern side of Pelham Street within the study area. The posted (regulatory) speed limit on Pelham Street in the study area is 35 mph in both travel directions. Land use along Pelham Street in the study area is a mix of commercial uses including Dan O'Brien Chrysler, a gas station, McDonalds and a Shaw's and Star Market Distribution Center.

Baseline Traffic Data

Peak Hour Traffic Volumes

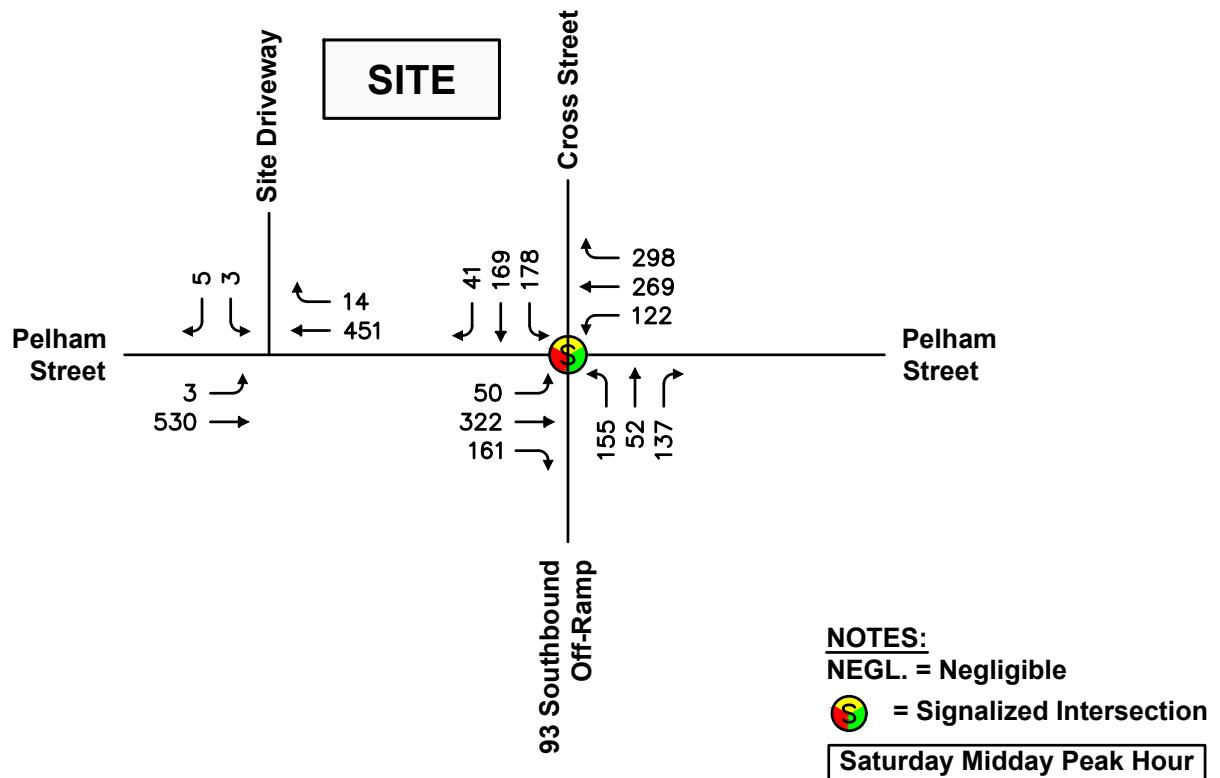
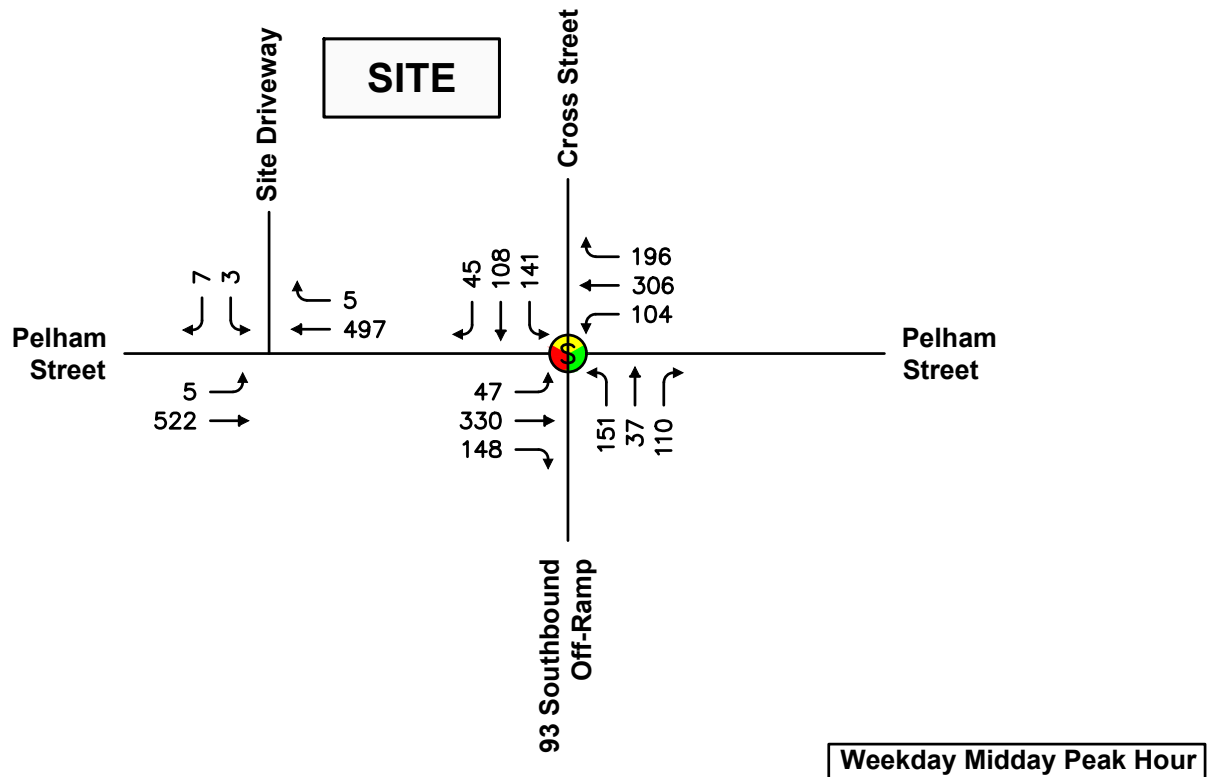
Peak-hour traffic volumes at the study area intersection were collected in June 2023. Comparison of the traffic count data maintained by MassDOT for nearby permanent count stations indicates that June traffic volumes are representative of above average volume conditions (approximately 4 percent above average month conditions). To remain conservative, no adjustment (reduction) for seasonal fluctuations was made to the traffic volume data. Manual turning movement counts (TMCs) were conducted during the weekday morning (7:00 AM - 9:00 AM), weekday midday (11:00 AM – 2:00 PM), weekday evening (4:00 PM – 6:00 PM), and Saturday midday (11:00 AM – 1:00 PM) periods to coincide with peak traffic activity of the proposed uses and the adjacent streets. Permanent count station data is provided in the **Attachments**. The resulting existing weekday morning and weekday evening peak hour traffic volumes for study intersections are depicted in **Figure 3** and the weekday midday and Saturday midday peak hour traffic volumes are shown in **Figure 4**.



North
Scale: Not to Scale

Figure 3

2023 Baseline Conditions Weekday Morning and Weekday Evening Peak Hour Traffic Volumes



North
Scale: Not to Scale

Figure 4

**2023 Baseline Conditions
Weekday Midday and Saturday Midday
Peak Hour Traffic Volumes**

Daily Traffic Volumes

Daily traffic volumes along Pelham Street in the site vicinity obtained for a weekday and Saturday in June 2023 are summarized in **Table 1** and included in the **Attachments**.

TABLE 1
BASELINE TRAFFIC VOLUME SUMMARY
PELHAM STREET WEST OF CROSS STREET

Time Period	Daily Volume (vpd) ¹	Percent Daily Traffic ²	Peak Hour Volume (vph) ³	Peak Flow Direction ⁴	Peak Hour Directional Volume (vph)
<i>Weekday Morning Peak Hour</i>	17,864	7%	1,254	59% EB	742
<i>Weekday Midday Peak Hour</i>	17,864	6%	1,013	51% EB	512
<i>Weekday Evening Peak Hour</i>	17,864	7%	1,294	52% WB	670
<i>Saturday Midday Peak Hour</i>	12,836	8%	1,001	55% EB	548

¹Two-way daily traffic expressed in vehicles per day without seasonal adjustment.

²The percent of daily traffic that occurs during the peak hour.

³Two-way peak-hour volume expressed in vehicles per hour.

⁴EB = Eastbound, WB = Westbound

As summarized in **Table 1**, the weekday daily traffic volume on Pelham Street to the west of Cross Street is approximately 17,864 vehicles per day (vpd) on a weekday and approximately 12,836 vehicles per day (vpd) on a Saturday. Peak hour traffic flow on Pelham Street ranges from approximately 1,001 to 1,294 vehicles per hour (vph) representing approximately 6 to 8 percent of daily traffic flow.

Intersection Crash History

In order to identify crash trends and safety characteristics for study area intersections, crash data were obtained from MassDOT for the City of Methuen for the five-year period covering 2018 through 2022 (the most recent data currently available). A summary of the crash data with crash rates for each study area intersection is detailed in **Table 2** with detailed data provided in the **Appendix**.

Crash rates were determined for each study area intersection. These rates quantify the number of crashes per million entering vehicles. MassDOT has determined the accident rates within the District 4 area (which includes the City of Methuen) to be 0.57 for unsignalized intersections and 0.73 for signalized intersections. These rates represent MassDOT's "average" crash experience for District 4 communities and serves as a basis for comparing reported crash rates for study area intersections which are located within the district. A review of vehicle crash data available from MassDOT on its HSIP Cluster Map indicates that there are no high crash locations within the study area.

TABLE 2
INTERSECTION CRASH SUMMARY¹

Data Category	Pelham Street at Cross Street
Traffic Control	Signalized
Crash Rate ²	0.38
MHD District 4 Avg ³	0.73
<i>Year:</i>	
2018	8
2019	4
2020	2
2021	1
<u>2022</u>	<u>5</u>
Total	20
<i>Type:</i>	
Angle	5
Rear-End	6
Head-On	1
Sideswipe	7
Single-Vehicle	1
Unknown	0
<i>Severity:</i>	
P. Damage Only	17
Personal Injury	3
Fatality	0
Not Reported	0
<i>Conditions:</i>	
Dry	17
Wet	2
Snow	0
Unknown	1
<i>Time:</i>	
7:00 to 9:00 AM	1
4:00 to 6:00 PM	6
Rest of Day	13

¹ Source: MassDOT Crash Database

² Crashes per million entering vehicles

³ District 4 Average Crash Rate

As summarized in **Table 2**:

- *Pelham Street at Cross Street*: Twenty (20) crashes were reported near the Pelham Street and Cross Street intersection resulting in a crash rate of 0.38. The crashes involved twelve (12) angle/sideswipe type collisions, six (6) rear-end type collisions, one (1) head-on type collision, and one (1) single vehicle type collision. The majority (85%) of the crashes resulted in property damage type collisions with no fatalities reported. Thirty-five percent (35%) occurred during the peak period travel times and the majority (85%) occurred under dry roadway conditions.
- *Site Driveways*. There were no reported crashes at the site driveways along Pelham Street and Cross Street during the study period.

In summary, a review of vehicle crash data available from MassDOT on its HSIP Cluster Map indicates that there are no high crash locations within the study area. As shown, the study intersections have crash rates below the average District 4 crash rates. No further safety measures are warranted based on the review of crash history in the study area.

Sight Line Evaluation

An evaluation of sight lines was conducted at the proposed site driveway location to ensure that minimum recommended sight lines are available to safely exit onto Pelham Street. The evaluation documents existing sight lines for vehicles as they relate to Pelham Street with comparison to recommended guidelines for the regulatory speed limit.

The American Association of State Highway and Transportation Officials' (AASHTO) standards¹ reference two types of sight distance which are relevant at the proposed site driveway intersection on Pelham Road: stopping sight distance (SSD) and intersection sight distance (ISD). Sight lines for critical vehicle movements at the proposed site driveway intersection with Pelham Street were compared to minimum SSD and ISD for the regulatory speed limit in the Site vicinity.

Stopping Sight Distance

Sight distance is the length of roadway visible to the motorist to a fixed object. The minimum sight distance available on a roadway should be sufficiently long enough to enable a below-average operator, traveling at or near a regulatory speed limit, to stop safely before reaching a stationary object in its path, in this case, a vehicle entering or exiting the site driveway onto Pelham Street. The SSD criteria are defined by AASHTO based on design and operating speeds, anticipated driver behavior and vehicle performance, as well as physical roadway conditions. SSD includes the length of roadway traveled during the perception and reaction time of a driver to an object, and the distance traveled during brake application on wet level pavement. Adjustment factors are applied to account for roadway grades where applicable.

SSD was estimated in the field using AASHTO standards for driver's eye (3.5 feet) and object height equivalent to the taillight height of a passenger car (2.0 feet) for the Pelham Street approaches to the intersection. **Table 3** presents a summary of the available SSD for the Pelham Street approaches to the proposed site driveway and AASHTO's recommended SSD for the regulatory speed limit.

¹ *A policy on Geometric Design of Highways and Streets*, American Association of State Highway and Transportation Officials (AASHTO), 2018.

TABLE 3
STOPPING SIGHT DISTANCE SUMMARY
PELHAM STREET APPROACHES TO SITE DRIVEWAY

Approach/ Travel Direction	Available SSD	AASHTO Recommended ¹	
		Regulatory Speed Limit ²	Criteria Satisfied
Eastbound	>500 Feet	250 Feet	Yes
Westbound	>500 Feet	250 Feet	Yes

¹Recommended sight distance based on AASHTO, A Policy on Geometric Design of Highways and Streets. Based on driver height of eye of 3.5 feet to object height of 2.0 feet and adjustments for roadway grade.

²Regulatory Speed Limit is 35 mph EB and WB.

As summarized in **Table 3**, analysis results indicate that the available sight lines exceed AASHTO's recommended SSD criteria for the proposed site driveway based on the regulatory travel speeds along Pelham Street.

Intersection Sight Distance

Clear sight lines provide sufficient sight distance for a stopped driver on a minor-road approach to depart from the intersection and enter or cross the major road. As stated under AASHTO's Intersection Sight Distance (ISD) considerations, "...If the available sight distance for an entering ...vehicle is at least equal to the appropriate stopping sight distance for the major road, then drivers have sufficient sight distance to avoid collisions...To enhance traffic operations, intersection sight distances that exceed stopping sight distances are desirable along the major road." AASHTO's ISD criteria are defined into several "cases". For the proposed unsignalized site driveway location, which is proposed to be under STOP sign control with right-only egress movements, the ISD in question relates to the ability to turn left or right from the proposed driveway at its intersection with Pelham Street.

Available ISD was estimated in the field using AASHTO standards for driver's eye (3.5 feet), object height (3.5 feet) and decision point (between 8 and 14.5 feet from the edge of the travel way) for the eastbound and westbound directions along Pelham Street. **Table 4** presents a summary of the available ISD for the departure from the proposed site driveway and AASHTO's minimum and ideal ISD recommendations.

TABLE 4
INTERSECTION SIGHT DISTANCE SUMMARY
PROPOSED SITE DRIVEWAY DEPARTURE TO PELHAM STREET

View Direction	Available ISD	AASHTO Minimum ¹	AASHTO Ideal ²
		Regulatory Speed Limit ²	Regulatory Speed Limit ²
<i>Looking East</i>	>500 Feet	250 Feet	390 Feet
<i>Looking West</i>	>500 Feet	250 Feet	335 Feet

¹Recommended sight distance based on AASHTO, A Policy on Geometric Design of Highways and Streets. Based on driver height of eye of 3.5 feet and an object height of 3.5 feet. Minimum value as noted represents SSD per AASHTO guidance. Adjustments for driveway grade have been made as needed.

²Regulatory Speed Limit is 35 mph.

The results of the ISD analysis presented in **Table 4** indicate that the available sight lines looking east and west from the proposed driveway onto Pelham Street will exceed the recommended minimum and ideal sight line criteria from AASHTO. MDM recommends that any new plantings (shrubs, bushes) or physical landscape features to be located within driveway sight lines should also be maintained at a height of 2 feet or less above the adjacent existing roadway grade to ensure unobstructed lines of sight.

DESIGN YEAR TRAFFIC VOLUMES

The following sections provide an overview of project trip generation, trip distribution and projected 2023 Design Year traffic volumes.

Trip Generation

The trip generation estimates for the proposed development are provided for the weekday morning, weekday midday, weekday evening, and Saturday midday peak periods, which correspond to the critical analysis periods for the proposed uses and adjacent street traffic flow. New traffic generated by the project was estimated using trip rates published in ITE's *Trip Generation*² for the Land Use Code (LUC) 948 – Automated Car Wash. In addition, empirical trip data based on transaction data for two comparable car wash facilities owned and operated by the Proponent are provided to show a comparative basis for ITE-based trip generation. Empirical trip data were collected at the Marlborough Scrub-A-Dub located at 216 Maple Street in Marlborough, MA which includes a single car wash tunnel, 4 detailing bays, and 10 vacuum stations and at the Shrewsbury Scrub-A-Dub located at 507 Boston Turnpike in Shrewsbury, MA – a facility with a single tunnel car wash, 4 detailing bays, 2 touch free laser car wash bays and 10 vacuum stations. For analysis purposes peak season trip generation estimates were used in this report. **Table 5** presents the trip-generation comparison for the proposed development based on ITE methodology and empirical data. A detailed summary of ITE and empirical trip rates is provided in the **Attachments**.

²*Trip Generation*, 1th Edition; Institute of Transportation Engineers; Washington, DC; 2021.

TABLE 5
TRIP-GENERATION SUMMARY

Peak Hour/ Direction	Site Trip Generation			Selected for Analysis
	ITE Basis ¹	ScrubaDub Empirical Data		
		Marlborough ²	Shrewsbury ³	
<i>Weekday Morning Peak Hour:</i>				
Entering	21	18	25	25
<u>Exiting</u>	<u>20</u>	<u>17</u>	<u>25</u>	<u>25</u>
Total	41	35	50	50
<i>Weekday Midday Peak Hour:</i>				
Entering	36	46	47	47
<u>Exiting</u>	<u>36</u>	<u>46</u>	<u>47</u>	<u>47</u>
Total	72	92	94	94
<i>Weekday Evening Peak Hour:</i>				
Entering	32	43	58	58
<u>Exiting</u>	<u>32</u>	<u>43</u>	<u>59</u>	<u>59</u>
Total	64	86	117	117
<i>Saturday Midday Peak Hour:</i>				
Entering	68	79	91	91
<u>Exiting</u>	<u>68</u>	<u>79</u>	<u>90</u>	<u>90</u>
Total	136	158	181	181

¹Based on ITE rates for LUC 948 Automated Car Wash applied to 4.475 ksf.

²Based on transaction data from ScrubaDub Marlborough located at 216 Maple St.

³Based on transaction data from ScrubaDub Shrewsbury located at 507 Boston Turnpike.

As summarized in **Table 5**, the highest observation (ITE or Empirical) was selected for analysis of the car wash development. Based on this methodology the project is estimated to generate approximately 50 vehicle trips (25 entering and 25 exiting) during the weekday morning peak hour, 94 vehicle trips (47 entering and 47 exiting) during the weekday midday peak hour, 117 vehicle trips (58 entering and 59 exiting) during the weekday evening peak hour, and 181 vehicle trips (91 entering and 90 exiting) during the Saturday midday peak hour. MDM notes that while a significant percentage of the trips are expected to be drawn from the existing traffic stream (i.e., pass-by trips) no reduction was taken for analysis purposes.

Comparison to Historical Use

Observed trip generation for the existing restaurant use of the site has been determined based on turning movement counts conducted at the site driveways along Pelham Street and Cross Street in June 2023. **Table 6** provides a trip-generation comparison between existing and proposed use of the Site.

TABLE 6
TRIP-GENERATION COMPARISON

Period/Direction	Existing Use ¹	Proposed Car Wash ²	Δ
<i>Weekday Morning Peak Hour:</i>			
Entering	4	25	+21
<u>Exiting</u>	<u>3</u>	<u>25</u>	+22
Total	7	50	+43
<i>Weekday Evening Peak Hour:</i>			
Entering	18	47	+29
<u>Exiting</u>	<u>19</u>	<u>47</u>	+28
Total	37	94	+57
<i>Weekday Evening Peak Hour:</i>			
Entering	27	58	+31
<u>Exiting</u>	<u>23</u>	<u>59</u>	+36
Total	50	117	+67
<i>Saturday Midday Peak Hour:</i>			
Entering	32	91	+59
<u>Exiting</u>	<u>14</u>	<u>90</u>	+76
Total	46	181	+135

¹Based on Count Data collected in June 2023.

²Based on **Table 5**.

As summarized in **Table 6**, the proposed ScrubaDub use when compared to the existing use of the property as a restaurant, will result in approximately 43 additional vehicle trips during the weekday morning peak hour, 57 additional trips during the weekday midday peak hour, 67 additional trips during the weekday evening peak hour, and 135 additional trips during the Saturday midday peak hour. This result in an increase of approximately 2 vehicle trips per minute during the critical design periods.

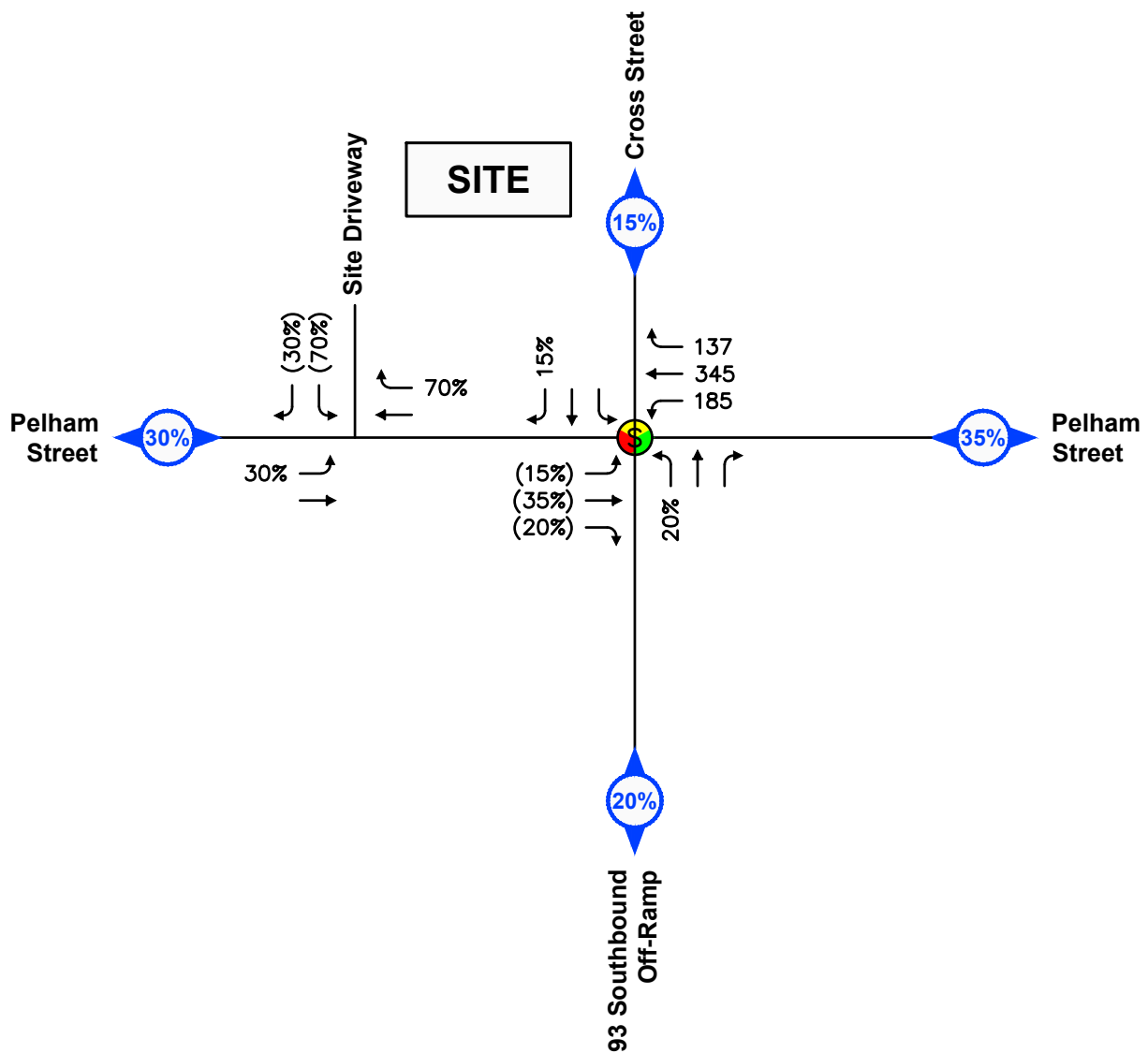
Design Year Traffic Volumes

The directional distribution of development-generated trips on the roadway network is a function of a number of variables including employment centers, residential neighborhood densities, and the efficiency of these roadways leading to the site. Existing travel patterns along area roadways serve as the primary basis for determining the trip distribution pattern for the proposed facility. The distribution of the site generated trips is displayed in **Figure 5**.

Development-related trips at the study intersection approach for the weekday morning and weekday evening peak hours are shown in **Figure 6** and the weekday midday and Saturday midday peak hour traffic volumes are shown in **Figure 7**.

Design Year Traffic Volumes

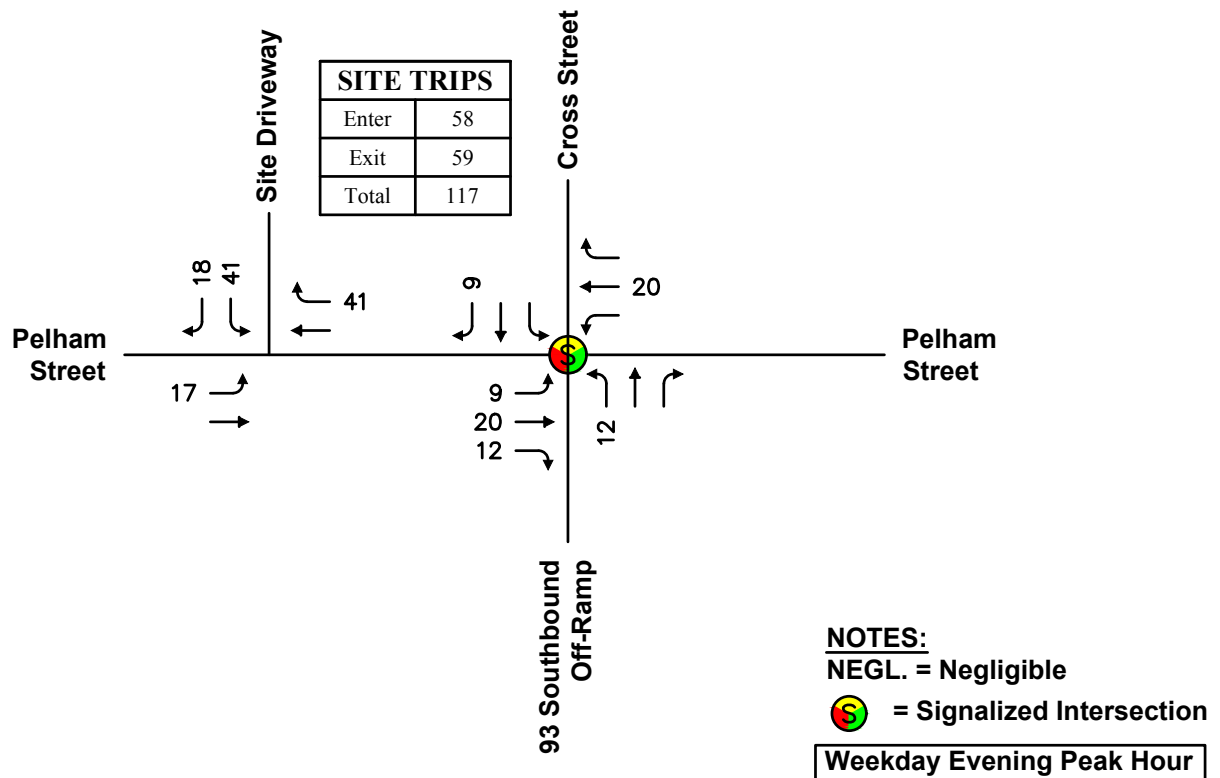
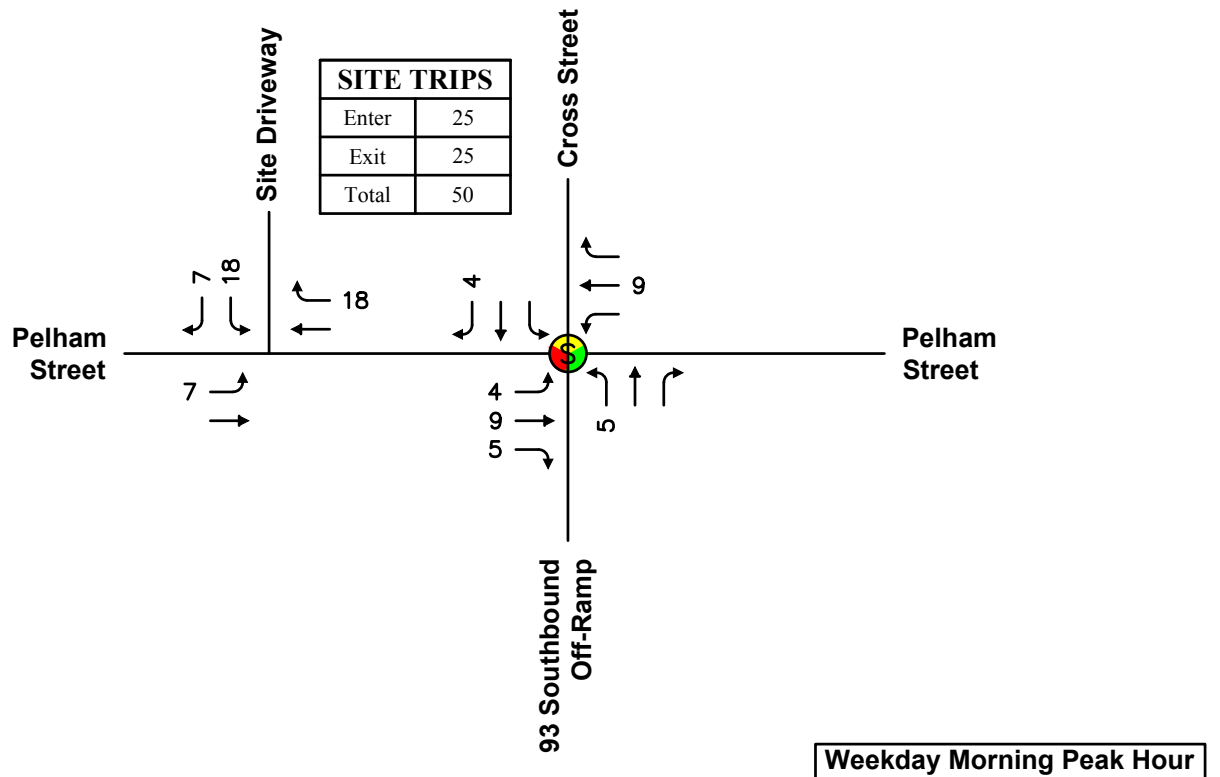
2023 Design Year condition traffic volumes are derived by first removing the historical trips for the Site from the Baseline traffic volume networks (see **Attachments**) and then adding the proposed ScrubaDub traffic to the Baseline traffic volume networks. The resulting 2023 Design Year condition traffic-volume networks for the weekday morning and weekday evening peak hours are shown in **Figure 8** and the weekday midday and Saturday midday peak hour traffic volumes are shown in **Figure 9**.



NOTES:

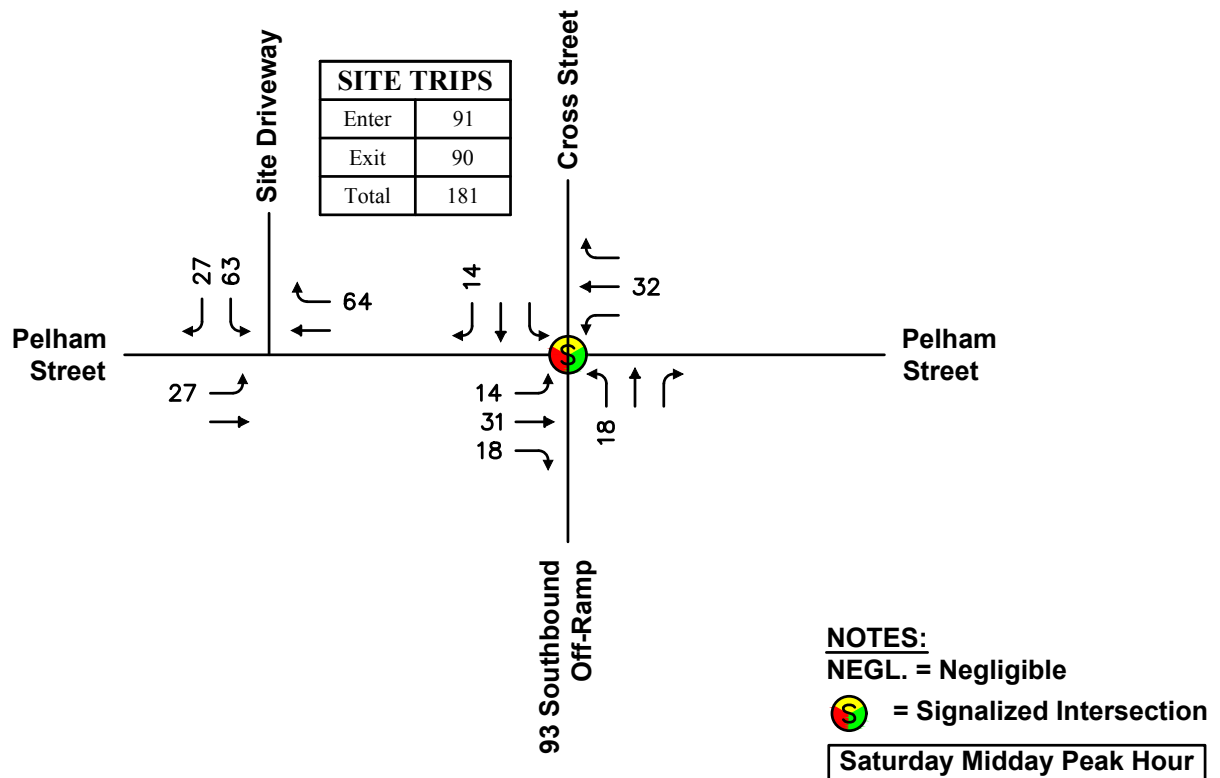
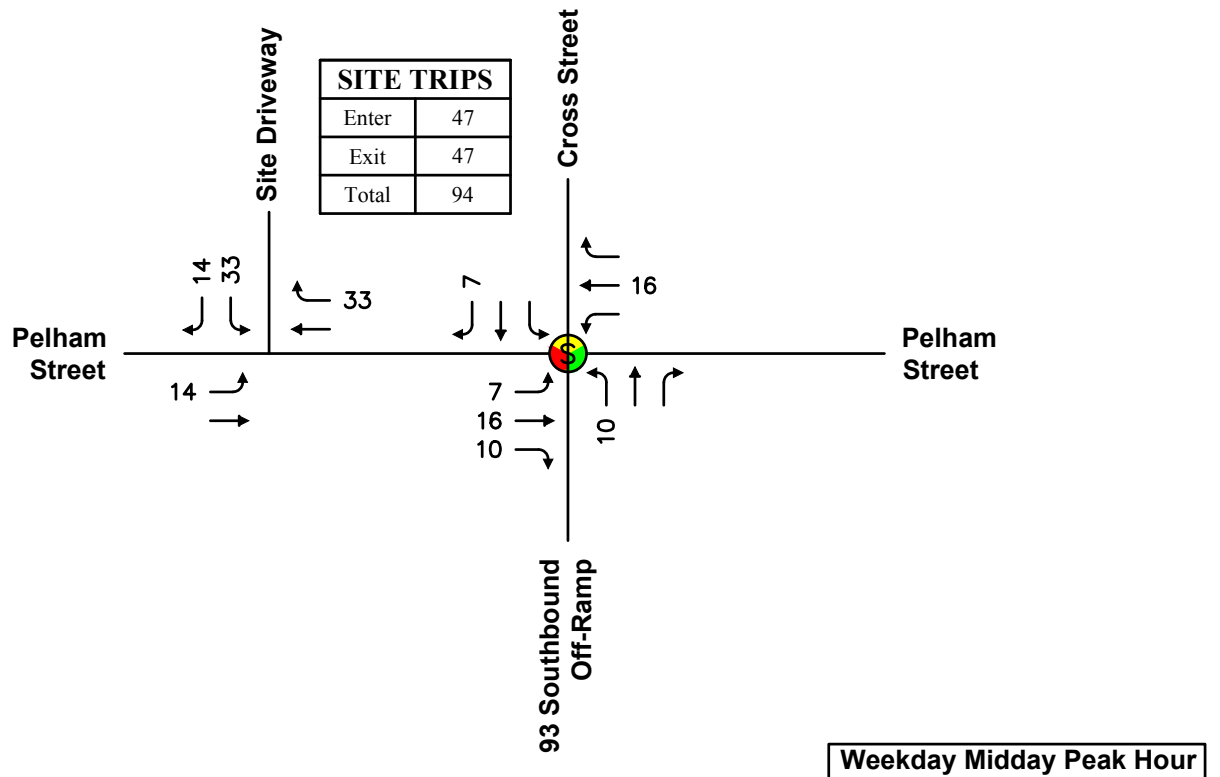
%(%) = Entering (Exiting)

 = Signalized Intersection



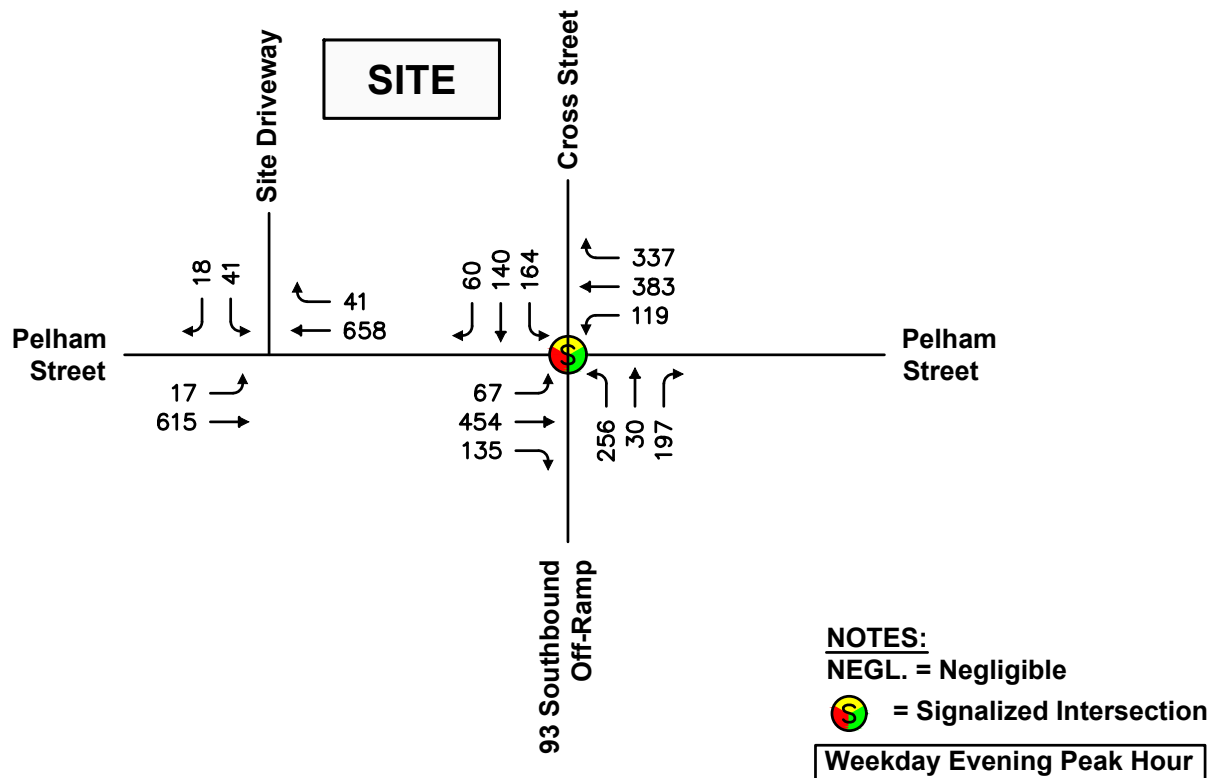
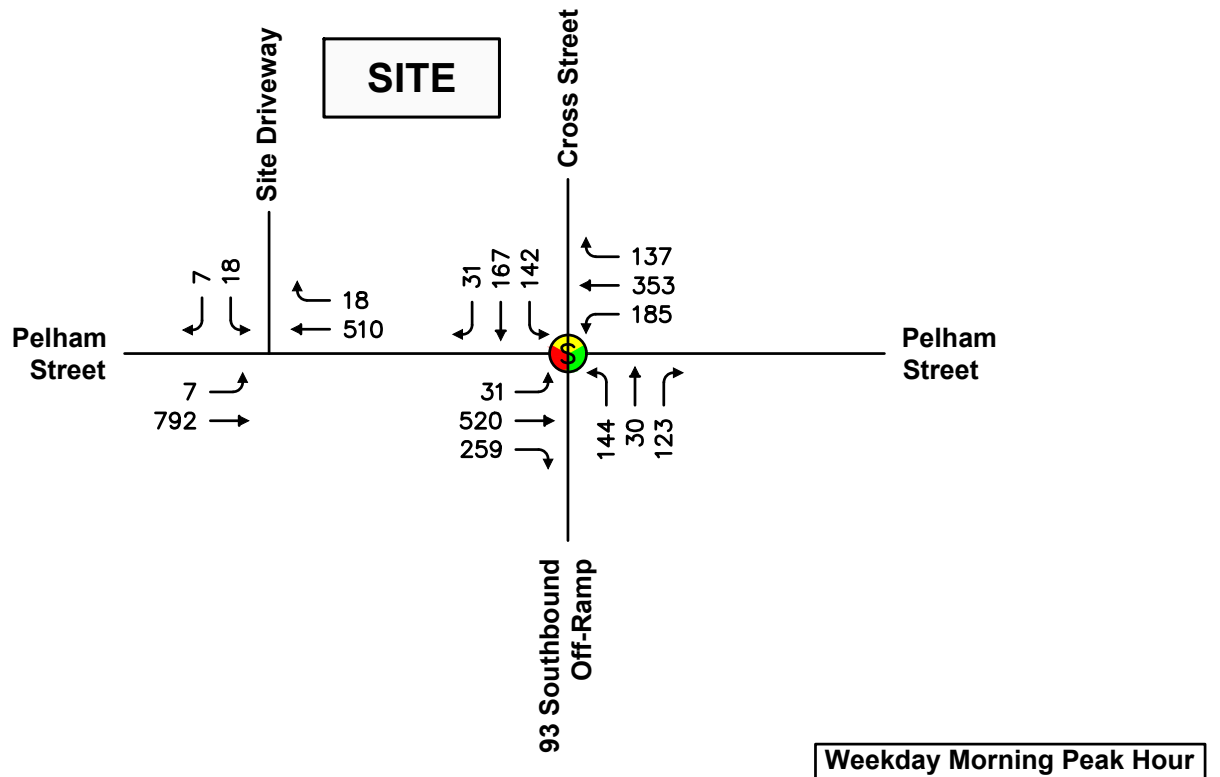
NOTES:
NEGL. = Negligible
⦿ = Signalized Intersection

North
Scale: Not to Scale



NOTES:
NEGL. = Negligible
 = Signalized Intersection

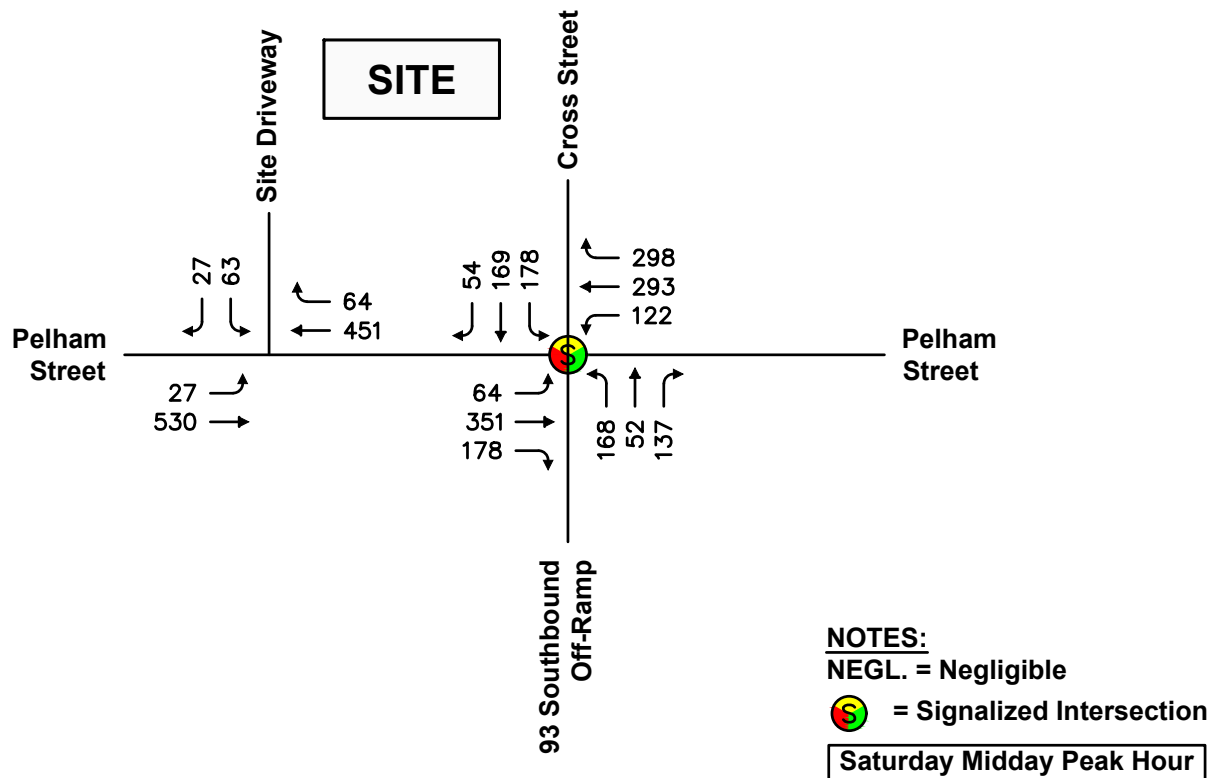
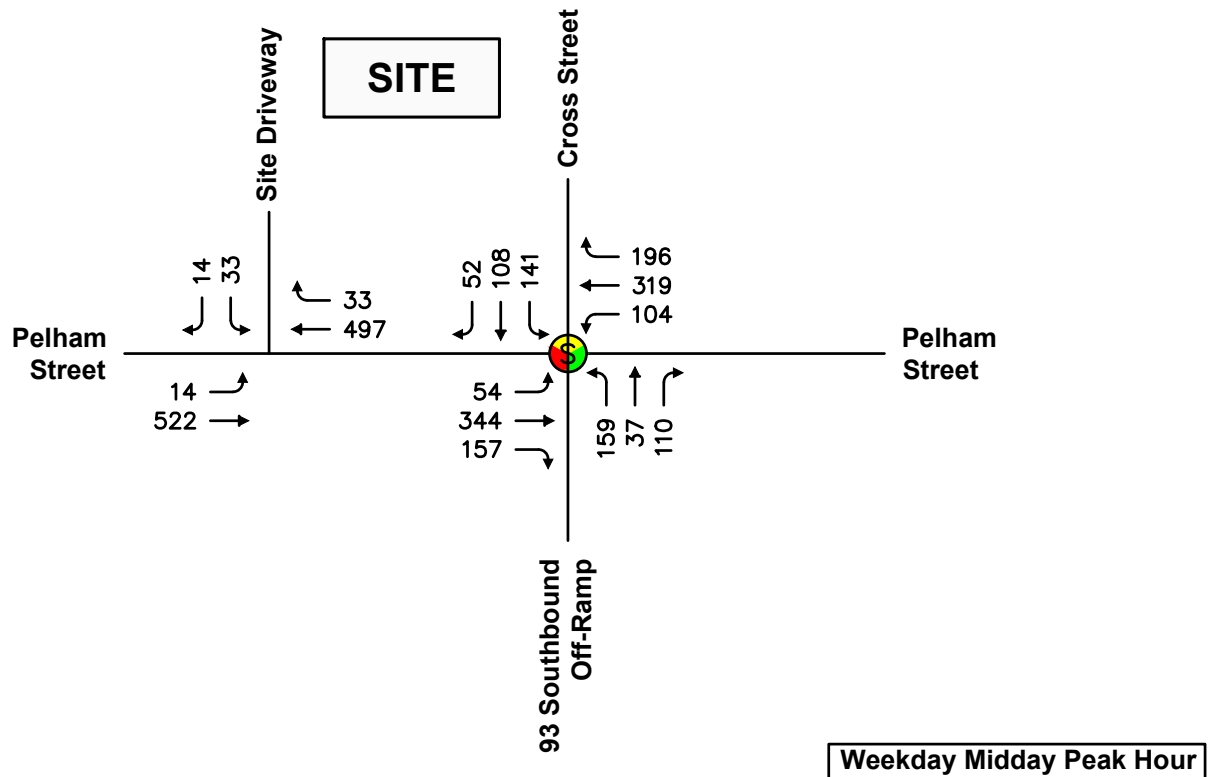
North
Scale: Not to Scale



North
Scale: Not to Scale

Figure 8

2023 Design Year Conditions Weekday Morning and Weekday Evening Peak Hour Traffic Volumes



North
Scale: Not to Scale

Figure 9
2023 Design Year Conditions
Weekday Midday and Saturday Midday
Peak Hour Traffic Volumes

TRAFFIC OPERATIONS ANALYSIS

Intersection capacity analyses for the primary study intersections are presented in this section for the Baseline and Design Year traffic-volume conditions. Capacity analyses provide an index of how well the roadway facilities serve the traffic demands placed upon them. The operational results provide the basis for recommended access and roadway improvements in the following section if required.

Capacity Analysis Procedures

Capacity analysis of intersections is developed using the Synchro® computer software, which implements the methods of the Highway Capacity Manual (HCM) 6th Edition. The resulting analysis presents a level-of-service (LOS) designation for individual intersection movements. The LOS is a letter designation that provides a qualitative measure of operating conditions based on several factors including roadway geometry, speeds, ambient traffic volumes, traffic controls, and driver characteristics. Since the LOS of a traffic facility is a function of the traffic flows placed upon it, such a facility may operate at a wide range of LOS, depending on the time of day, day of week, or period of year. A range of six levels of service are defined on the basis of average delay, ranging from LOS A (the least delay) to LOS F (delays greater than 50 seconds for unsignalized movements). The specific control delays and associated LOS designations are presented in the **Attachments**.

Intersection Capacity Analysis and Vehicle Queue Results

The capacity analysis results for the primary study intersections are summarized in **Table 7**, **Table 8**, **Table 9**, and **Table 10** for the peak hours. The queue results for the signalized Pelham Street intersection with Cross Street and I-93 Ramps are summarized in **Table 11** and **Table 12**. Detailed analysis is presented in the **Attachments**.

TABLE 7
WEEKDAY MORNING PEAK HOUR
INTERSECTION CAPACITY ANALYSIS RESULTS

Peak Hour	Approach	2023 Baseline Condition			2023 Design Year		
		v/c ¹	Delay ²	LOS ³	v/c	Delay	LOS
Weekday Morning Peak Hour							
Pelham Street at Cross Street/93 SB Ramp	Eastbound	0.81	29	C	0.82	30	C
	Westbound	0.71	29	C	0.72	30	C
	Northbound	0.41	16	B	0.43	16	B
	Southbound	0.61	49	D	0.63	49	D
	OVERALL	0.81	30	C	0.82	31	C
Pelham Street at Site Driveway	Eastbound	0.00	<5	A	0.01	<5	A
	Westbound	0.00	<5	A	0.00	<5	A
	Southbound ⁴	0.00	11	B	0.11	22	C

¹ Volume-to-capacity ratio

² Average control delay per vehicle (in seconds)

³ Level of service

⁴ Calibrated based on Delay Study

TABLE 8
WEEKDAY EVENING PEAK HOUR
INTERSECTION CAPACITY ANALYSIS RESULTS

Peak Hour	Approach	2023 Baseline Condition			2023 Design Year		
		v/c ¹	Delay ²	LOS ³	v/c	Delay	LOS
Weekday Morning Peak Hour							
Pelham Street at Cross Street/93 SB Ramp	Eastbound	0.71	30	C	0.73	31	C
	Westbound	0.51	21	C	0.53	22	C
	Northbound	0.56	16	B	0.59	17	B
	<u>Southbound</u>	<u>0.60</u>	<u>44</u>	<u>D</u>	<u>0.60</u>	<u>44</u>	<u>D</u>
	OVERALL	0.71	26	C	0.73	27	C
Pelham Street at Site Driveway	Eastbound	0.01	<5	A	0.02	<5	A
	Westbound	0.00	<5	A	0.00	<5	A
	Southbound ⁴	0.04	15	B	0.25	25	C

¹ Volume-to-capacity ratio

² Average control delay per vehicle (in seconds)

³ Level of service

⁴ Calibrated based on Delay Study

TABLE 9
WEEKDAY MIDDAY PEAK HOUR
INTERSECTION CAPACITY ANALYSIS RESULTS

Peak Hour	Approach	2023 Baseline Condition			2023 Design Year		
		v/c ¹	Delay ²	LOS ³	v/c	Delay	LOS
Weekday Morning Peak Hour							
Pelham Street at Cross Street/93 SB Ramp	Eastbound	0.67	26	C	0.68	27	C
	Westbound	0.55	23	C	0.57	24	C
	Northbound	0.39	14	B	0.42	15	B
	<u>Southbound</u>	<u>0.58</u>	<u>40</u>	<u>D</u>	<u>0.58</u>	<u>41</u>	<u>D</u>
	OVERALL	0.67	26	C	0.68	26	C
Pelham Street at Site Driveway	Eastbound	0.01	<5	A	0.02	<5	A
	Westbound	0.00	<5	A	0.00	<5	A
	Southbound ⁴	0.03	14	B	0.19	21	C

¹ Volume-to-capacity ratio

² Average control delay per vehicle (in seconds)

³ Level of service

⁴ Calibrated based on Delay Study

TABLE 10
SATURDAY MIDDAY PEAK HOUR
INTERSECTION CAPACITY ANALYSIS RESULTS

Peak Hour	Approach	2023 Baseline Condition			2023 Design Year		
		v/c ¹	Delay ²	LOS ³	v/c	Delay	LOS
Weekday Morning Peak Hour							
Pelham Street at Cross Street/93 SB Ramp	Eastbound	0.63	25	C	0.65	26	C
	Westbound	0.44	20	B	0.46	21	C
	Northbound	0.36	12	B	0.41	13	B
	<u>Southbound</u>	<u>0.62</u>	<u>38</u>	<u>D</u>	<u>0.62</u>	<u>41</u>	<u>D</u>
	OVERALL	0.63	24	C	0.65	25	C
Pelham Street at Site Driveway	Eastbound	0.00	<5	A	0.03	<5	A
	Westbound	0.00	<5	A	0.00	<5	A
	Southbound ⁴	0.02	14	B	0.34	23	C

¹ Volume-to-capacity ratio

² Average control delay per vehicle (in seconds)

³ Level of service

⁴ Calibrated based on Delay Study

TABLE 11
VEHICLE QUEUE ANALYSIS SUMMARY
PELHAM STREET AT CROSS STREET AND I-93 RAMPS

Approach	Storage Length (feet)	2023 Baseline		2023 Design Year	
		Average Queue Length ¹	95 th Percentile Queue Length ¹	Average Queue Length	95 th Percentile Queue Length
<i>Weekday Morning Peak Hour</i>					
Eastbound L	225±	<25	51	<25	57
Eastbound T	>1000	340	533	355	548
Eastbound R	200±	<25	38	<25	38
Westbound L	250±	139	278	142	278
Westbound T	>1000	179	311	190	323
Westbound R	200±	<25	40	<25	40
Northbound L	250±	75	129	80	133
Northbound T	>1000	<25	38	<25	38
Northbound R	275±	<25	<25	<25	<25
Southbound L	210±	101	180	104	180
Southbound T/R	>1000	136	226	142	230
<i>Weekday Evening Peak Hour</i>					
Eastbound L	225±	29	76	34	84
Eastbound T	>1000	191	316	203	330
Eastbound R	200±	<25	27	<25	28
Westbound L	250±	63	141	65	144
Westbound T	>1000	165	288	178	306
Westbound R	200±	<25	42	<25	42
Northbound L	250±	65	137	71	147
Northbound T	>1000	<25	42	<25	43
Northbound R	275±	<25	<25	<25	<25
Southbound L	210±	85	117	87	180
Southbound T/R	>1000	81	169	87	178

¹ Average and 95th percentile queue lengths are reported in feet per lane.

TABLE 12
VEHICLE QUEUE ANALYSIS SUMMARY
PELHAM STREET AT CROSS STREET AND I-93 RAMPS

Approach	Storage Length (feet)	2023 Baseline		2023 Design Year	
		Average Queue Length ¹	95 th Percentile Queue Length ¹	Average Queue Length	95 th Percentile Queue Length
<i>Weekday Midday Peak Hour</i>					
Eastbound L	225±	35	86	41	96
Eastbound T	>1000	249	399	263	417
Eastbound R	200±	<25	28	<25	29
Westbound L	250±	72	154	73	154
Westbound T	>1000	189	319	201	337
Westbound R	200±	<25	58	<25	59
Northbound L	250±	108	214	115	221
Northbound T	>1000	<25	50	<25	50
Northbound R	275±	<25	<25	<25	<25
Southbound L	210±	98	196	99	196
Southbound T/R	>1000	104	206	110	213
<i>Saturday Midday Peak Hour</i>					
Eastbound L	225±	27	75	37	93
Eastbound T	>1000	165	299	188	327
Eastbound R	200±	<25	33	<25	33
Westbound L	250±	66	150	69	156
Westbound T	>1000	124	236	143	263
Westbound R	200±	<25	58	<25	58
Northbound L	250±	57	124	66	142
Northbound T	>1000	<25	49	<25	52
Northbound R	275±	<25	<25	<25	<25
Southbound L	210±	95	203	99	210
Southbound T/R	>1000	105	217	117	238

¹ Average and 95th percentile queue lengths are reported in feet per lane.

As summarized in **Tables 7-12:**

- *Pelham Street at Cross Street/93 SB Ramps.* Under Design Year conditions, capacity analyses indicate the signalized intersection of Pelham Street with Cross Street and the I-93 Southbound ramps will continue to operate at level of service (LOS) C or better during the peak hours. With the project in place the average and 95th percentile vehicle queues will generally remain within the available storage areas. The queue impact from the project will result in 1 or fewer vehicles compared to Baseline conditions. Queues on the Pelham Street eastbound approach have been shown to extend beyond the proposed site driveway location but were shown to clear during the eastbound signal phase for the adjacent signal. Field observation indicate that existing left turn movements from the site onto Pelham Street generally occur unimpeded once the eastbound queue has cleared.

- *Pelham Street at Site Driveway:* Under Design Year conditions, the Site Driveway approach to Pelham Street will operate under capacity at LOS C or better during all study periods. Mainline travel along Pelham Street will continue to operate unimpeded with minimal delay at LOS A or better. Vehicle queues on the site driveway approaching Pelham Street have been shown in the analysis to be minimal (2 or fewer vehicles).

In summary, the proposed development does not result in any significant change in operations along Pelham Street compared to Baseline conditions. Furthermore, improvements as outlined in the *Conclusions and Recommendations* section of this report will enhance safety and operations and enhance on-site circulation with regards to the development.

SITE CIRCULATION

The Site has been designed to accommodate the largest anticipated delivery vehicle and should accommodate trash removal operations, delivery operations, and ladder truck vehicle types. AutoTurn® analysis has been conducted for a single unit (SU-30) delivery truck and the largest emergency vehicle (ladder truck). The analysis indicates that Site access/egress, circulation aisles and parking layout provide adequate maneuvering area for the design vehicles. Supporting AutoTurn® analysis and exhibits are provided to confirm this finding (refer to the **Attachments**).

CAR WASH QUEUE ANALYSIS

Under the proposed programming the car wash facility will have an upper throughput capacity of 130 cars per hour and use a flat belt trackless conveyor system that allows for multiple cars to be loaded in the tunnel closer together. Accordingly, the car wash tunnel system will have the ability to operate with processing times well below those estimated for a typical car wash facility that can only process one vehicle at a time. The ability to dial up the speed to 130 cars per hour if required allows the operator to better manage fluctuations in vehicle demand and manage resulting queues.

Queue projections for the facility are estimated using peak season trip generation for the critical Saturday midday period. An industry-standard queuing model was applied using a “normal” processing capacity of 110 vehicles per hour as observed at other ScrubaDub locations. The queue model was also applied using the “maximum efficiency” operation of 130 vph. The analysis Corresponding queue results for the peak hour periods are summarized in **Table 13**.

TABLE 13
PROJECTED CAR WASH QUEUE CHARACTERISTICS

Period	Car Wash Tunnel Volume (vph)	Average Queue (veh)	Maximum Queue (veh)
<i>Design Condition</i> ¹	91	3	15
<i>Maximum Efficiency</i> ²	91	1	7

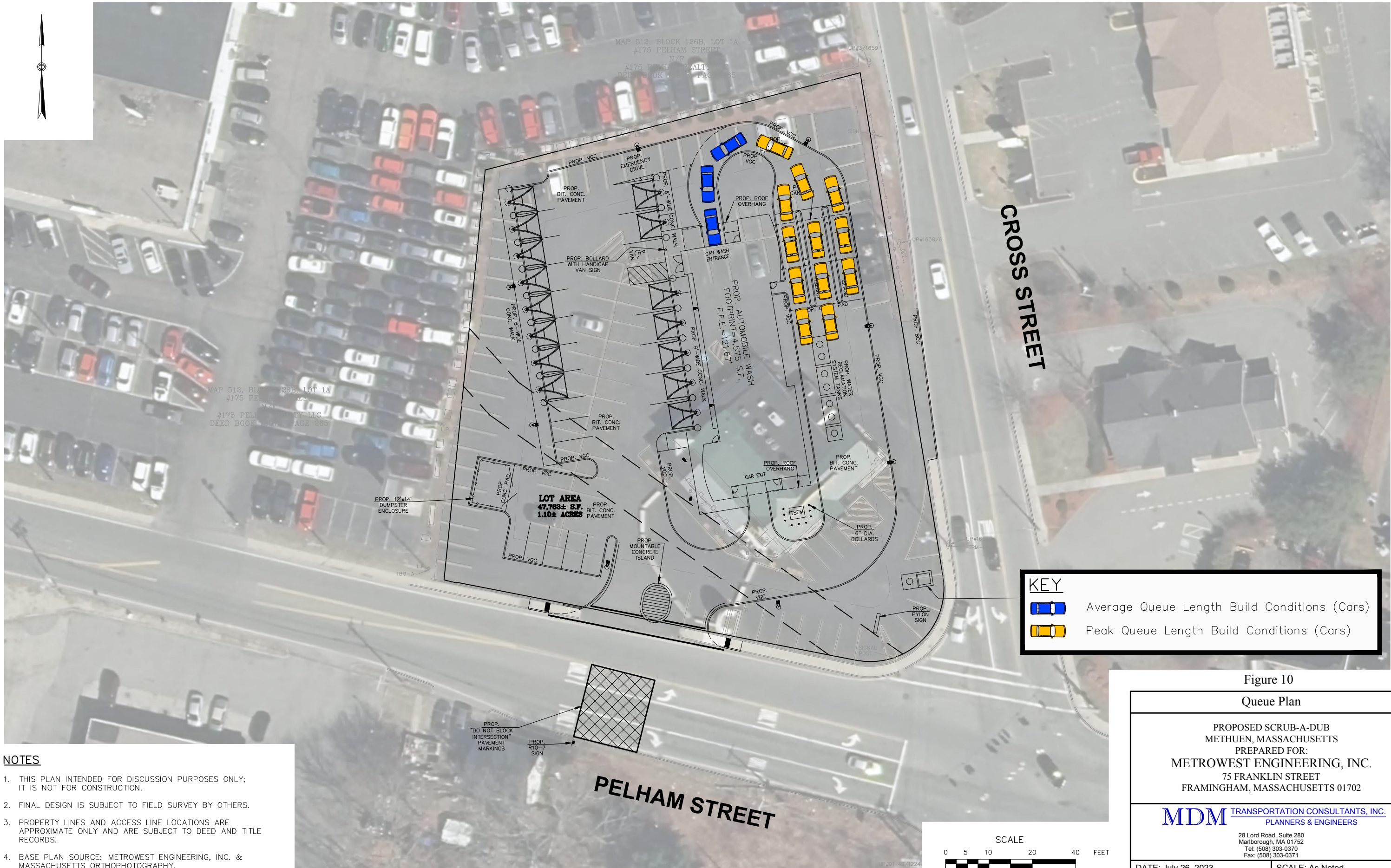
¹Based on a service rate of 110 vehicles per hour.

²Based on a service rate of 130 vehicles per hour.

As presented in **Table 13**,

- *Design Condition.* This scenario assumes a peak period demand of 91 vehicles, per peak season Saturday midday estimates assuming a normal operating service rate of 110 vehicles per hour. Projected queue results indicate an average queue of 3 vehicles and a maximum (95th percentile) queue of 15 vehicles using the “normal” processing capacity.
- *Maximum Efficiency.* This scenario assumes average peak period demand of 91 vehicles per peak season Saturday midday estimates assuming a normal operating service rate of 130 vehicles per hour. Projected queue results indicate an average queue of 1 vehicle and a maximum (95th percentile) queue of 7 vehicles using the “maximum efficiency” processing capacity.

The projected peak hour car wash tunnel trip activity is estimated at approximately 91 trips under a theoretical peak season condition. The critical peak hour demand under this theoretical condition is estimated to result in a maximum estimated queue of 15 vehicles and an estimated queue of 7 cars under maximum efficiency conditions. The car wash tunnel configuration and queue lane can accommodate a 32-vehicle queue with no impact to site access, circulation or parking and would not impact Pelham Street as shown in **Figure 10**.



- NOTES**
1. THIS PLAN INTENDED FOR DISCUSSION PURPOSES ONLY; IT IS NOT FOR CONSTRUCTION.
 2. FINAL DESIGN IS SUBJECT TO FIELD SURVEY BY OTHERS.
 3. PROPERTY LINES AND ACCESS LINE LOCATIONS ARE APPROXIMATE ONLY AND ARE SUBJECT TO DEED AND TITLE RECORDS.
 4. BASE PLAN SOURCE: METROWEST ENGINEERING, INC. & MASSACHUSETTS ORTHOPHOTOGRAPHY.

Figure 10

Queue Plan

PROPOSED SCRUB-A-DUB
METHUEN, MASSACHUSETTS
PREPARED FOR:
METROWEST ENGINEERING, INC.
75 FRANKLIN STREET
FRAMINGHAM, MASSACHUSETTS 01702

MDM TRANSPORTATION CONSULTANTS, INC.
PLANNERS & ENGINEERS

28 Lord Road, Suite 280
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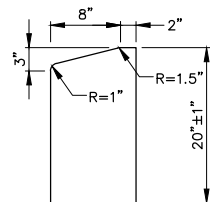
DATE: July 26, 2023	SCALE: As Noted
PROJECT No. 1289 File: 1289 Autoturn.dwg	Sheet 1 of 1

CONCLUSIONS AND RECOMMENDATIONS

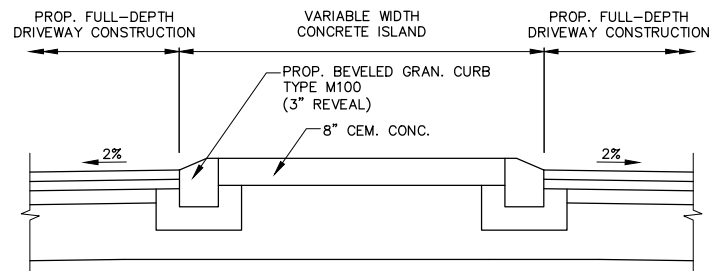
In summary, the projected traffic increases due to the proposed development will be nominal in the immediate study area (2 vehicles or less per minute during the peak periods) and adequate capacity is available under 2023 Design Year conditions along Pelham Street to accommodate the proposed site use. The project is not projected to materially change any reported operating levels compared to Baseline conditions. The car wash tunnel configuration and queue lanes can accommodate the projected maximum queues with limited impact to site access, circulation or parking and will not have any impact on Pelham Street. In addition, access/egress along Pelham Street will be designed to ensure that adequate sight lines are provided in accordance with recommended AASHTO criteria based on posted travel speeds.

MDM recommends the following design elements to accommodate site-generated traffic:

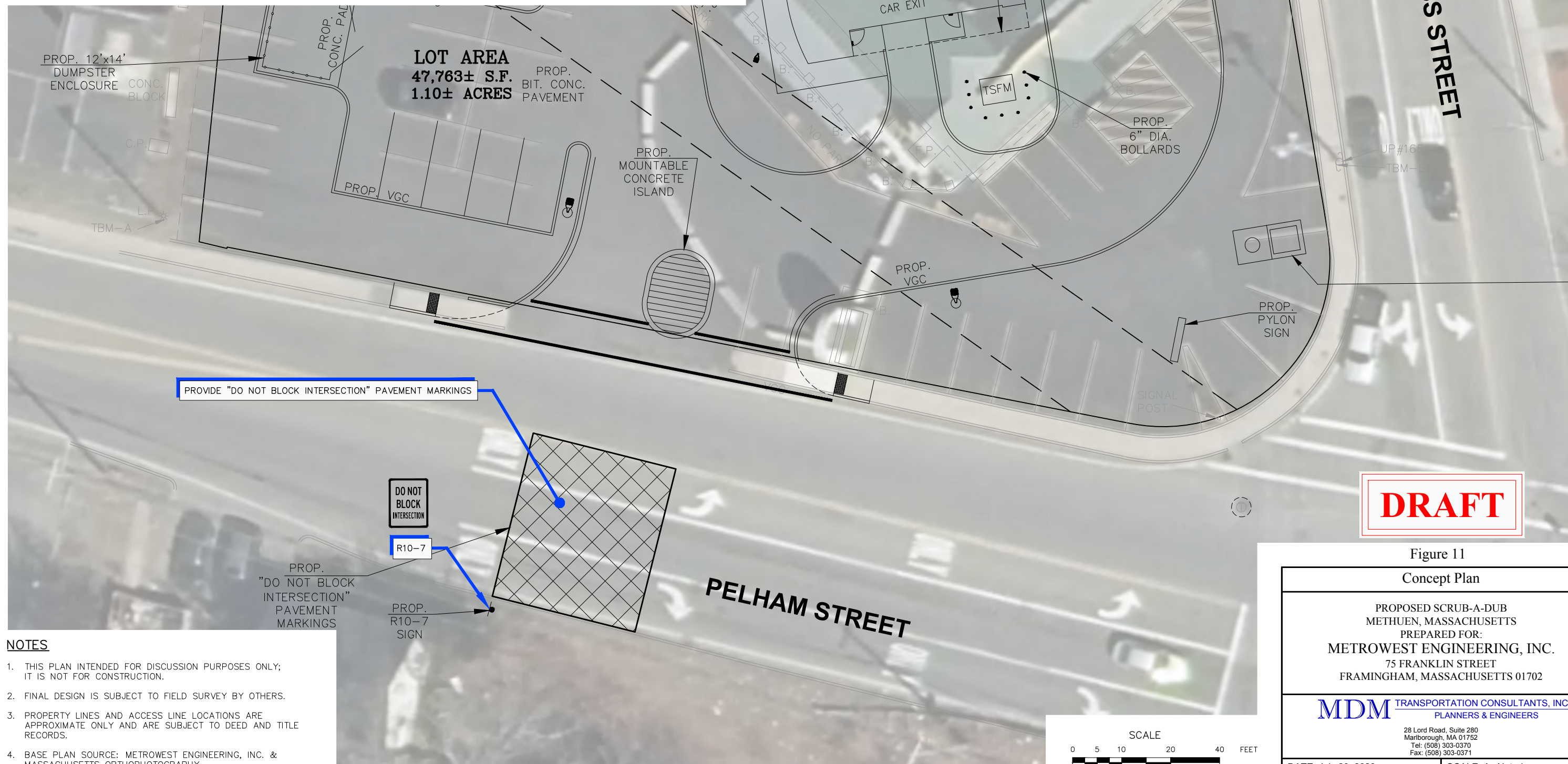
- *Signs and Pavement Markings.* The driveway alignment, widths and curb radii have been designed to achieve (a) approximate perpendicular orientation with Pelham Street; (b) curb radii as required to accommodate Town emergency vehicles and single unit/refuse truck design vehicles for the Site. A MUTCD compliant “STOP” sign (R1-1) and STOP line pavement markings are recommended on the proposed driveway approach to Pelham Street. On-site pavement markings and signage should be provided to promote the car wash tunnel lanes, escape lane, control on-site traffic, height limitations, and re-enforce driveway and on-site circulation restrictions. The signs and pavement markings shall conform to MUTCD standards.
- *Maintain Clear Driveway Sight Lines.* Existing and/or new plantings (shrubs, bushes) and structures (walls, fences, etc.) should be maintained at a height of 2 feet or less within the sight line triangles with respect to Pelham Street to provide unobstructed sight lines for vehicles entering and exiting the proposed site driveway.
- *“Do Not Block Intersection” Markings.* To improve left turn egress from the Site, “Do Not Block Intersection” signs (R10-7) and pavements markings are recommended as part of the project on the eastbound Pelham Street approach to the I-93 southbound on/off ramps/ Cross Street intersection across from the proposed site driveway. The conceptual markings plan is shown in **Figure 11**.
- *Escape Lane.* The Proponent has designed the Site to provide the ability to by-pass the car wash tunnel and exit to the vacuum area of the Site in case a vehicle enters the queue but does not fit into the tunnel or should the tunnel be shut down.



DETAIL FOR BEVELED GRANITE CURB
TYPE M100
NOT TO SCALE



DETAIL FOR MOUNTABLE CONCRETE ISLAND
NOT TO SCALE



- NOTES**
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 4. BASE PLAN SOURCE: METROWEST ENGINEERING, INC. & MASSACHUSETTS ORTHOPHOTOGRAPHY.

DRAFT

Figure 11
Concept Plan

PROPOSED SCRUB-A-DUB
METHUEN, MASSACHUSETTS
PREPARED FOR:
METROWEST ENGINEERING, INC.
75 FRANKLIN STREET
FRAMINGHAM, MASSACHUSETTS 01702

MDM TRANSPORTATION CONSULTANTS, INC.
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DATE: July 26, 2023	SCALE: As Noted
PROJECT No. 1289	File: 1289 Concept.dwg
Sheet 1 of 1	

ATTACHMENTS

- Traffic Volume Data
- Seasonal/Yearly Growth Data
- Crash Data
- Sight Distance Calculations
- Trip Generation
- Capacity Analysis
- AutoTURN® Analysis
- Queue Analysis

□ Traffic Volume Data

MDM TRANSPORTATION CONSULTANTS, INC.

Planners & Engineers

28 Lord Road, Suite 280
Marlborough, MA

N/S: Cross Street/I93 SB Ramp
E/W: Pelham Street
Methuen, MA

File Name : 1289_Pelham_at_Cross_Signal_06-01-2023
Site Code : 1289
Start Date : 6/1/2023
Page No : 1

Groups Printed- Lights - Mediums - Articulated Trucks

	Cross Street From North					Pelham Street From East					Rt 93 SB Ramps From South					Pelham Street From West					
Start Time	Right	Thru	Left	Peds	App. Total	Right	Thru	Left	Peds	App. Total	Right	Thru	Left	Peds	App. Total	Right	Thru	Left	Peds	App. Total	Int. Total
07:00 AM	5	33	32	0	70	23	47	55	0	125	24	4	27	0	55	71	106	5	0	182	432
07:15 AM	5	46	35	0	86	21	83	38	0	142	28	11	48	0	87	79	108	4	0	191	506
07:30 AM	5	41	41	0	87	36	94	60	0	190	34	10	34	0	78	65	139	2	0	206	561
07:45 AM	7	38	27	0	72	43	90	43	0	176	29	2	36	0	67	63	124	7	0	194	509
Total	22	158	135	0	315	123	314	196	0	633	115	27	145	0	287	278	477	18	0	773	2008
08:00 AM	10	42	37	0	89	37	75	44	0	156	33	7	21	0	61	47	131	14	0	192	498
08:15 AM	8	54	38	0	100	19	91	41	0	151	38	3	29	0	70	61	103	9	0	173	494
08:30 AM	10	38	50	0	98	31	70	42	0	143	35	8	39	0	82	44	102	9	0	155	478
08:45 AM	5	35	30	0	70	34	59	33	0	126	30	7	36	0	73	60	110	5	0	175	444
Total	33	169	155	0	357	121	295	160	0	576	136	25	125	0	286	212	446	37	0	695	1914
11:00 AM	5	20	34	0	59	59	54	29	0	142	19	5	24	0	48	29	76	5	0	110	359
11:15 AM	12	25	40	0	77	54	54	37	0	145	33	8	45	0	86	28	69	11	0	108	416
11:30 AM	15	25	35	0	75	49	69	24	0	142	23	9	44	0	76	31	90	9	0	130	423
11:45 AM	7	25	27	0	59	58	75	37	0	170	23	10	25	0	58	30	69	9	0	108	395
Total	39	95	136	0	270	220	252	127	0	599	98	32	138	0	268	118	304	34	0	456	1593
12:00 PM	13	28	39	0	80	53	62	33	0	148	25	7	34	0	66	30	78	7	0	115	409
12:15 PM	14	26	24	0	64	54	73	31	0	158	30	5	35	0	70	41	89	7	0	137	429
12:30 PM	10	31	27	0	68	60	69	35	0	164	27	7	26	0	60	28	72	13	0	113	405
12:45 PM	8	23	19	0	50	42	76	39	0	157	31	6	38	0	75	30	77	8	0	115	397
Total	45	108	109	0	262	209	280	138	0	627	113	25	133	0	271	129	316	35	0	480	1640
01:00 PM	8	28	34	0	70	50	62	17	0	129	21	6	34	0	61	40	76	6	0	122	382
01:15 PM	11	22	30	0	63	41	67	30	0	138	33	10	37	0	80	22	63	11	0	96	377
01:30 PM	13	31	23	0	67	49	91	25	0	165	22	8	25	0	55	49	102	16	0	167	454
01:45 PM	12	27	52	0	91	56	81	32	0	169	36	13	55	0	104	37	83	14	0	134	498
Total	44	108	139	0	291	196	301	104	0	601	112	37	151	0	300	148	324	47	0	519	1711
04:00 PM	17	31	28	0	76	92	97	33	0	222	45	9	59	0	113	41	114	21	0	176	587
04:15 PM	16	43	38	0	97	77	92	34	0	203	59	13	54	0	126	30	100	12	0	142	568
04:30 PM	9	39	46	0	94	93	87	32	0	212	51	16	56	0	123	29	114	15	0	158	587
04:45 PM	10	27	50	0	87	75	94	20	0	189	43	9	79	0	131	24	102	10	0	136	543
Total	52	140	162	0	354	337	370	119	0	826	198	47	248	0	493	124	430	58	0	612	2285
05:00 PM	18	25	34	0	77	75	96	32	0	203	34	5	64	0	103	35	105	17	0	157	540
05:15 PM	10	28	33	0	71	80	96	27	0	203	50	15	46	0	111	33	120	14	0	167	552
05:30 PM	10	31	24	0	65	85	79	22	0	186	32	14	67	0	113	43	112	18	0	173	537
05:45 PM	11	23	48	0	82	65	93	24	0	182	30	12	51	0	93	33	81	8	0	122	479
Total	49	107	139	0	295	305	364	105	0	774	146	46	228	0	420	144	418	57	0	619	2108
Grand Total	284	885	975	0	2144	1511	2176	949	0	4636	918	239	1168	0	2325	1153	2715	286	0	4154	13259
Apprch %	13.2	41.3	45.5	0		32.6	46.9	20.5	0		39.5	10.3	50.2	0		27.8	65.4	6.9	0		
Total %	2.1	6.7	7.4	0	16.2	11.4	16.4	7.2	0	35	6.9	1.8	8.8	0	17.5	8.7	20.5	2.2	0	31.3	
Lights	269	840	941	0	2050	1432	1984	896	0	4312	874	224	1092	0	2190	1024	2599	265	0	3888	12440
% Lights	94.7	94.9	96.5	0	95.6	94.8	91.2	94.4	0	93	95.2	93.7	93.5	0	94.2	88.8	95.7	92.7	0	93.6	93.8
Mediums	12	42	27	0	81	73	137	44	0	254	38	8	39	0	85	62	84	17	0	163	583
% Mediums	4.2	4.7	2.8	0	3.8	4.8	6.3	4.6	0	5.5	4.1	3.3	3.3	0	3.7	5.4	3.1	5.9	0	3.9	4.4
Articulated Trucks	3	3	7	0	13	6	55	9	0	70	6	7	37	0	50	67	32	4	0	103	236
% Articulated Trucks	1.1	0.3	0.7	0	0.6	0.4	2.5	0.9	0	1.5	0.7	2.9	3.2	0	2.2	5.8	1.2	1.4	0	2.5	1.8

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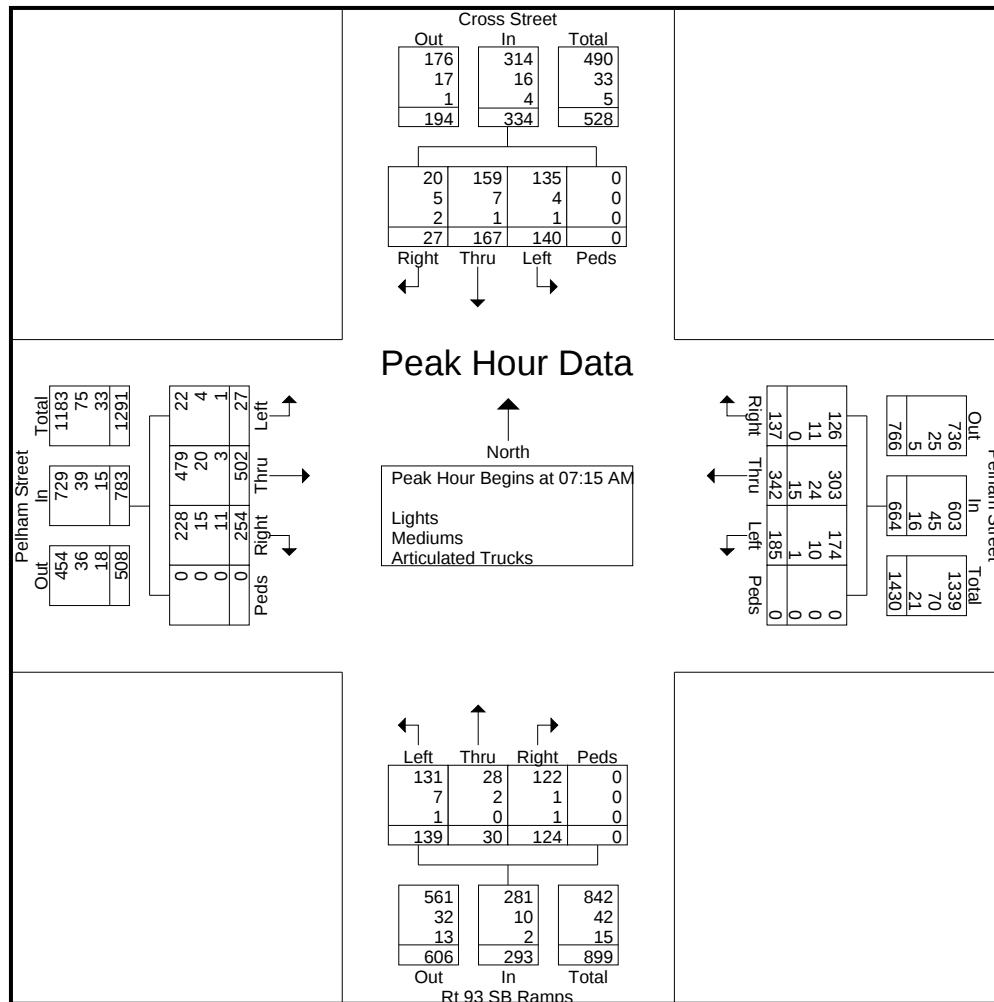
Planners & Engineers

28 Lord Road, Suite 280
Marlborough, MA

N/S: Cross Street/I93 SB Ramp
E/W: Pelham Street
Methuen, MA

File Name : 1289_Pelham_at_Cross_Signal_06-01-2023
Site Code : 1289
Start Date : 6/1/2023
Page No : 2

	Cross Street From North					Pelham Street From East					Rt 93 SB Ramps From South					Pelham Street From West					
Start Time	Right	Thru	Left	Peds	App. Total	Right	Thru	Left	Peds	App. Total	Right	Thru	Left	Peds	App. Total	Right	Thru	Left	Peds	App. Total	Int. Total
Peak Hour Analysis From 07:00 AM to 09:45 AM - Peak 1 of 1																					
Peak Hour for Entire Intersection Begins at 07:15 AM																					
07:15 AM	5	46	35	0	86	21	83	38	0	142	28	11	48	0	87	79					
07:30 AM	5	41	41	0	87	36	94	60	0	190	34	10	34	0	78	65	139	2	0	206	561
07:45 AM	7	38	27	0	72	43															
08:00 AM	10	42	37	0	89	37	75	44	0	156	33	7	21	0	61	47	131	14	0	192	498
Total Volume	27	167	140	0	334	137	342	185	0	664	124	30	139	0	293	254	502	27	0	783	2074
% App. Total	8.1	50	41.9	0		20.6	51.5	27.9	0		42.3	10.2	47.4	0		32.4	64.1	3.4	0		
PHF	.675	.908	.854	.000	.938	.797	.910	.771	.000	.874	.912	.682	.724	.000	.842	.804	.903	.482	.000	.950	.924
Lights	20	159	135	0	314	126	303	174	0	603	122	28	131	0	281	228	479	22	0	729	1927
% Lights	74.1	95.2	96.4	0	94.0	92.0	88.6	94.1	0	90.8	98.4	93.3	94.2	0	95.9	89.8	95.4	81.5	0	93.1	92.9
Mediums	5	7	4	0	16	11	24	10	0	45	1	2	7	0	10	15	20	4	0	39	110
% Mediums	18.5	4.2	2.9	0	4.8	8.0	7.0	5.4	0	6.8	0.8	6.7	5.0	0	3.4	5.9	4.0	14.8	0	5.0	5.3
Articulated Trucks	2	1	1	0	4	0	15	1	0	16	1	0	1	0	2	11	3	1	0	15	37
% Articulated Trucks	7.4	0.6	0.7	0	1.2	0	4.4	0.5	0	2.4	0.8	0	0.7	0	0.7	4.3	0.6	3.7	0	1.9	1.8

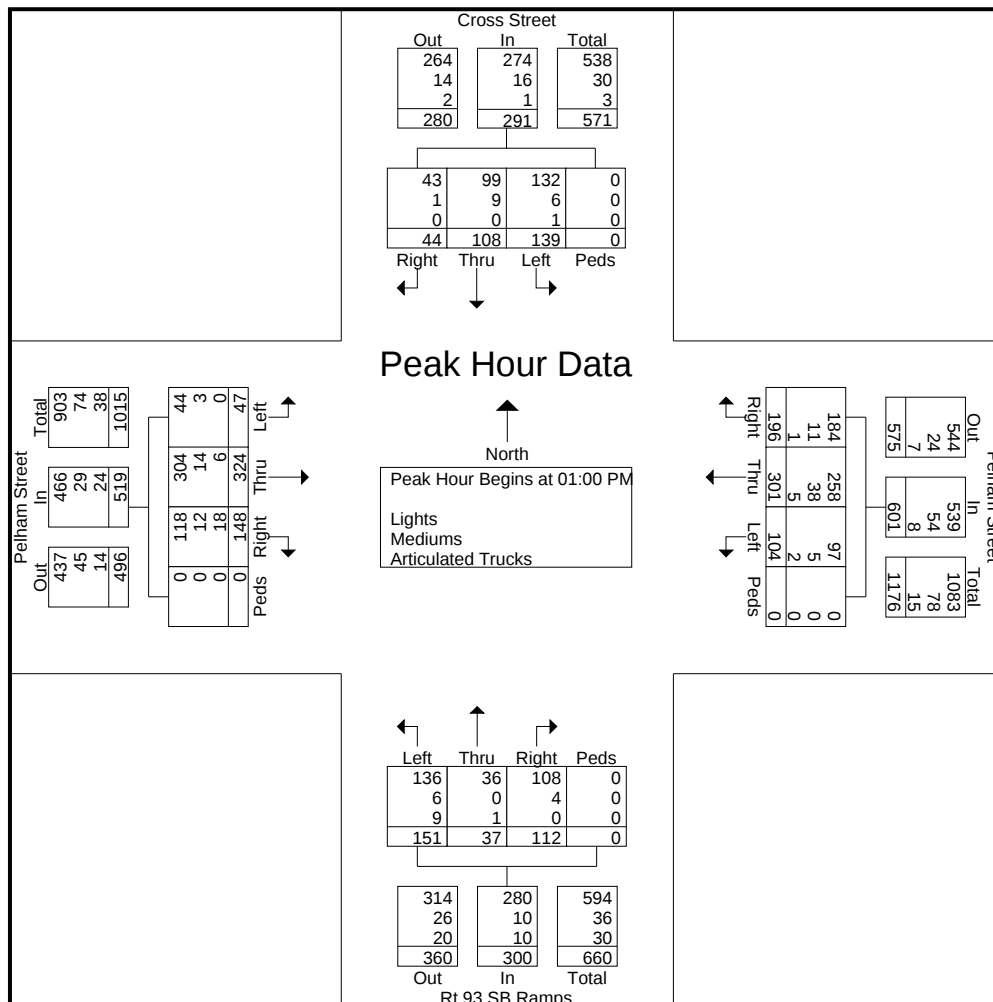


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Start Date : 6/1/2023
Page No : 3

	Cross Street From North					Pelham Street From East					Rt 93 SB Ramps From South					Pelham Street From West					
Start Time	Right	Thru	Left	Peds	App. Total	Right	Thru	Left	Peds	App. Total	Right	Thru	Left	Peds	App. Total	Right	Thru	Left	Peds	App. Total	Int. Total
Peak Hour Analysis From 10:00 AM to 01:45 PM - Peak 1 of 1																					
Peak Hour for Entire Intersection Begins at 01:00 PM																					
01:00 PM	8	28	34	0	70	50	62	17	0	129	21	6	34	0	61	40	76	6	0	122	382
01:15 PM	11	22	30	0	63	41	67	30	0	138	33	10	37	0	80	22	63	11	0	96	377
01:30 PM	13	31	23	0	67	49	91	25	0	165	22	8	25	0	55	49	102	16	0	167	454
01:45 PM	12	27	52	0	91	56		32	0	169	36	13	55	0	104	37	83	14	0	134	498
Total Volume	44	108	139	0	291	196	301	104	0	601	112	37	151	0	300	148	324	47	0	519	1711
% App. Total	15.1	37.1	47.8	0		32.6	50.1	17.3	0		37.3	12.3	50.3	0		28.5	62.4	9.1	0		
PHF	.846	.871	.668	.000	.799	.875	.827	.813	.000	.889	.778	.712	.686	.000	.721	.755	.794	.734	.000	.777	.859
Lights	43	99	132	0	274	184	258	97	0	539	108	36	136	0	280	118	304	44	0	466	1559
% Lights	97.7	91.7	95.0	0	94.2	93.9	85.7	93.3	0	89.7	96.4	97.3	90.1	0	93.3	79.7	93.8	93.6	0	89.8	91.1
Mediums	1	9	6	0	16	11	38	5	0	54	4	0	6	0	10	12	14	3	0	29	109
% Mediums	2.3	8.3	4.3	0	5.5	5.6	12.6	4.8	0	9.0	3.6	0	4.0	0	3.3	8.1	4.3	6.4	0	5.6	6.4
Articulated Trucks	0	0	1	0	1	1	5	2	0	8	0	1	9	0	10	18	6	0	0	24	43
% Articulated Trucks	0	0	0.7	0	0.3	0.5	1.7	1.9	0	1.3	0	2.7	6.0	0	3.3	12.2	1.9	0	0	4.6	2.5



MDM TRANSPORTATION CONSULTANTS, INC.

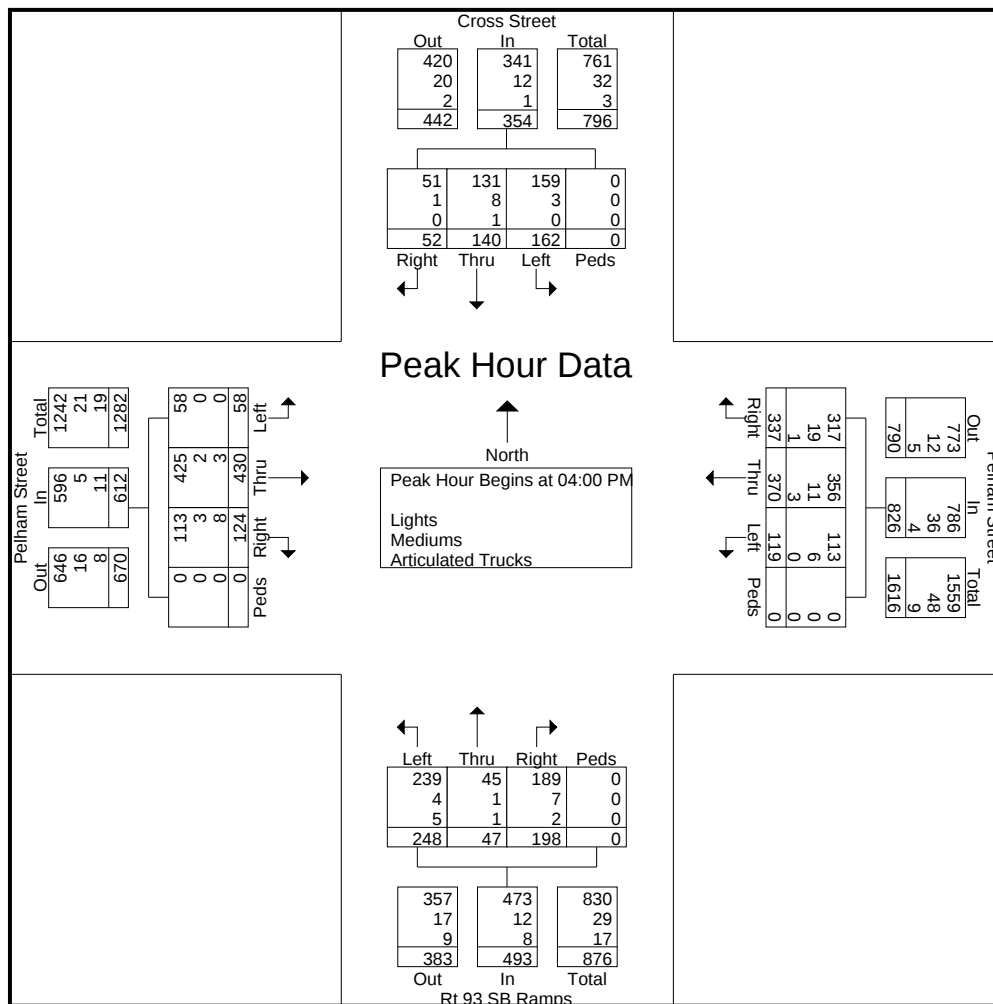
Planners & Engineers

28 Lord Road, Suite 280
Marlborough, MA

N/S: Cross Street/I93 SB Ramp
E/W: Pelham Street
Methuen, MA

File Name : 1289_Pelham_at_Cross_Signal_06-01-2023
Site Code : 1289
Start Date : 6/1/2023
Page No : 4

	Cross Street From North					Pelham Street From East					Rt 93 SB Ramps From South					Pelham Street From West					
Start Time	Right	Thru	Left	Peds	App. Total	Right	Thru	Left	Peds	App. Total	Right	Thru	Left	Peds	App. Total	Right	Thru	Left	Peds	App. Total	Int. Total
Peak Hour Analysis From 02:00 PM to 05:45 PM - Peak 1 of 1																					
Peak Hour for Entire Intersection Begins at 04:00 PM																					
04:00 PM	17					97	33	0	222		45	9	59	0	113	41	114	21		176	587
04:15 PM	16	43	38	0	97	77	92	34			59					29	114	15	0	158	587
04:30 PM	9	39	46	0	94	93	87	32	0	212	51	16	56	0	123						
04:45 PM	10	27	50										79		131	24	102	10	0	136	543
Total Volume	52	140	162	0	354	337	370	119	0	826	198	47	248	0	493	124	430	58	0	612	2285
% App. Total	14.7	39.5	45.8	0		40.8	44.8	14.4	0		40.2	9.5	50.3	0		20.3	70.3	9.5	0		
PHF	.765	.814	.810	.000	.912	.906	.954	.875	.000	.930	.839	.734	.785	.000	.941	.756	.943	.690	.000	.869	.973
Lights	51	131	159	0	341	317	356	113	0	786	189	45	239	0	473	113	425	58	0	596	2196
% Lights	98.1	93.6	98.1	0	96.3	94.1	96.2	95.0	0	95.2	95.5	95.7	96.4	0	95.9	91.1	98.8	100	0	97.4	96.1
Mediums	1	8	3	0	12	19	11	6	0	36	7	1	4	0	12	3	2	0	0	5	65
% Mediums	1.9	5.7	1.9	0	3.4	5.6	3.0	5.0	0	4.4	3.5	2.1	1.6	0	2.4	2.4	0.5	0	0	0.8	2.8
Articulated Trucks	0	1	0	0	1	1	3	0	0	4	2	1	5	0	8	8	3	0	0	11	24
% Articulated Trucks	0	0.7	0	0	0.3	0.3	0.8	0	0	0.5	1.0	2.1	2.0	0	1.6	6.5	0.7	0	0	1.8	1.1



MDM TRANSPORTATION CONSULTANTS, INC.

Planners & Engineers

28 Lord Road, Suite 280
Marlborough, MA

N/S: Cross Street/I93 SB Ramp
E/W: Pelham Street
Methuen, MA

File Name : 1289_Pelham_at_Cross_Signal_06-03-2023
Site Code : 1289
Start Date : 6/3/2023
Page No : 1

Groups Printed- Lights - Mediums - Articulated Trucks

	Cross Street From North					Pelham Street From East					93 SB Ramp From South					Pelham Street From West					
Start Time	Right	Thru	Left	Peds	App. Total	Right	Thru	Left	Peds	App. Total	Right	Thru	Left	Peds	App. Total	Right	Thru	Left	Peds	App. Total	Int. Total
11:00 AM	9	41	30	0	80	52	58	33	0	143	0	6	40	0	46	27	79	11	0	117	386
11:15 AM	11	40	43	0	94	79	56	30	0	165	0	13	41	0	54	28	70	9	0	107	420
11:30 AM	3	43	37	0	83	67	64	37	0	168	1	8	56	0	65	31	76	11	0	118	434
11:45 AM	16	42	38	0	96	78	65	29	0	172	0	12	36	0	48	39	79	15	0	133	449
Total	39	166	148	0	353	276	243	129	0	648	1	39	173	0	213	125	304	46	0	475	1689
12:00 PM	11	24	32	0	67	67	70	16	0	153	0	18	24	0	42	32	76	12	0	120	382
12:15 PM	11	48	39	0	98	81	71	32	0	184	0	14	42	0	56	42	80	10	0	132	470
12:30 PM	5	27	47	0	79	82	64	26	0	172	1	11	41	0	53	39	73	19	0	131	435
12:45 PM	14	43	48	0	105	82	60	37	0	179	1	15	29	0	45	41	103	14	0	158	487
Total	41	142	166	0	349	312	265	111	0	688	2	58	136	0	196	154	332	55	0	541	1774
01:00 PM	11	51	42	0	104	53	71	27	0	151	0	12	41	0	53	39	63	7	0	109	417
01:15 PM	11	45	43	0	99	69	49	19	0	137	0	16	40	0	56	29	74	15	0	118	410
01:30 PM	9	48	50	0	107	60	70	24	0	154	0	12	49	0	61	37	81	9	0	127	449
01:45 PM	15	64	44	0	123	60	62	28	0	150	0	15	48	0	63	36	76	7	0	119	455
Total	46	208	179	0	433	242	252	98	0	592	0	55	178	0	233	141	294	38	0	473	1731
Grand Total	126	516	493	0	1135	830	760	338	0	1928	3	152	487	0	642	420	930	139	0	1489	5194
Apprch %	11.1	45.5	43.4	0		43	39.4	17.5	0		0.5	23.7	75.9	0		28.2	62.5	9.3	0		
Total %	2.4	9.9	9.5	0	21.9	16	14.6	6.5	0	37.1	0.1	2.9	9.4	0	12.4	8.1	17.9	2.7	0	28.7	
Lights	125	513	488	0	1126	823	726	331	0	1880	3	148	461	0	612	385	913	138	0	1436	5054
% Lights	99.2	99.4	99	0	99.2	99.2	95.5	97.9	0	97.5	100	97.4	94.7	0	95.3	91.7	98.2	99.3	0	96.4	97.3
Mediums	1	3	5	0	9	6	24	6	0	36	0	2	15	0	17	12	9	1	0	22	84
% Mediums	0.8	0.6	1	0	0.8	0.7	3.2	1.8	0	1.9	0	1.3	3.1	0	2.6	2.9	1	0.7	0	1.5	1.6
Articulated Trucks	0	0	0	0	0	1	10	1	0	12	0	2	11	0	13	23	8	0	0	31	56
% Articulated Trucks	0	0	0	0	0	0.1	1.3	0.3	0	0.6	0	1.3	2.3	0	2	5.5	0.9	0	0	2.1	1.1

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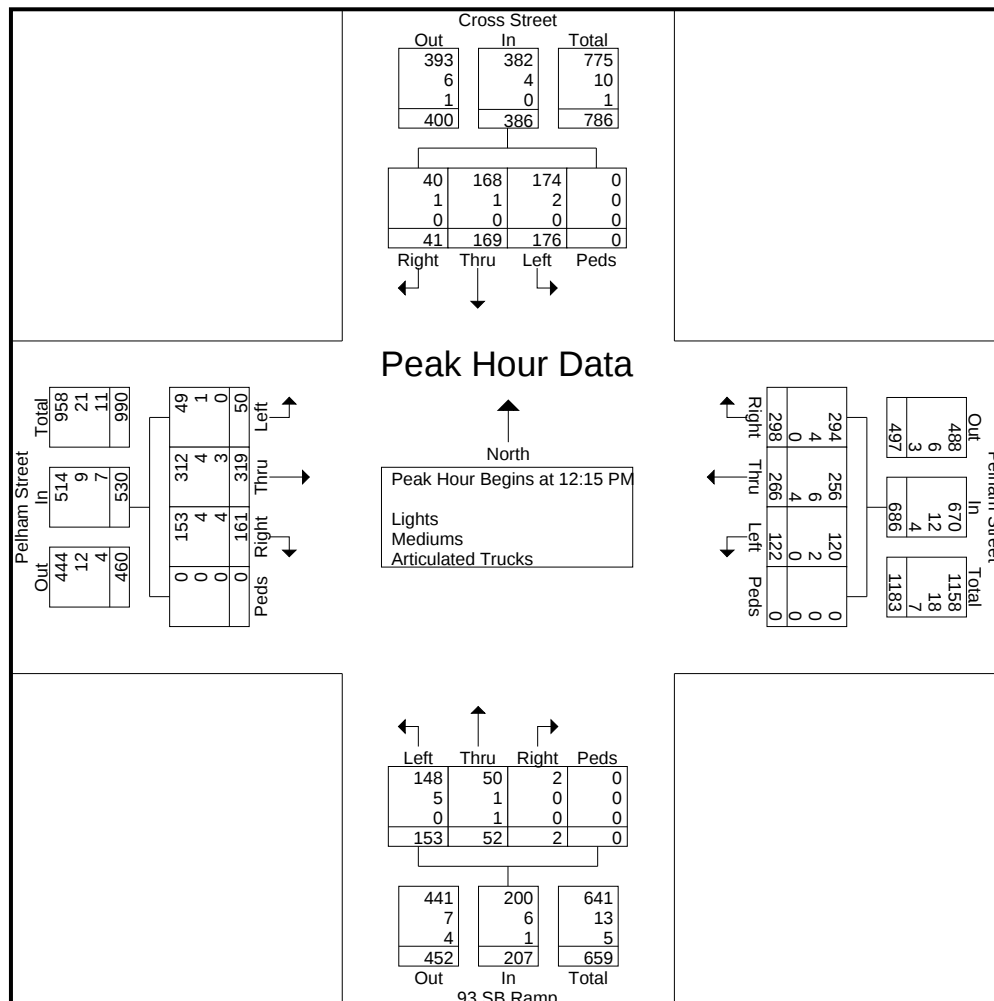
Planners & Engineers

28 Lord Road, Suite 280
Marlborough, MA

N/S: Cross Street/I93 SB Ramp
E/W: Pelham Street
Methuen, MA

File Name : 1289_Pelham_at_Cross_Signal_06-03-2023
Site Code : 1289
Start Date : 6/3/2023
Page No : 2

	Cross Street From North					Pelham Street From East					93 SB Ramp From South					Pelham Street From West					
Start Time	Right	Thru	Left	Peds	App. Total	Right	Thru	Left	Peds	App. Total	Right	Thru	Left	Peds	App. Total	Right	Thru	Left	Peds	App. Total	Int. Total
Peak Hour Analysis From 11:00 AM to 01:45 PM - Peak 1 of 1																					
Peak Hour for Entire Intersection Begins at 12:15 PM																					
12:15 PM	11	48	39	0	98	81	71	32	0	184	0	14	42	0	56	42					
12:30 PM	5	27	47	0	79	82	64	26	0	172	1	11	41	0	53	39	73	19	0	131	435
12:45 PM	14	43	48	0	105	82	60	37	0	179	1	15	29	0	45	41	103	14	0	158	487
01:00 PM	11	51	42	0	104	53	71	27	0	151	0	12	41	0	53	39	63	7	0	109	417
Total Volume	41	169	176	0	386	298	266	122	0	686	2	52	153	0	207	161	319	50	0	530	1809
% App. Total	10.6	43.8	45.6	0		43.4	38.8	17.8	0		1	25.1	73.9	0		30.4	60.2	9.4	0		
PHF	.732	.828	.917	.000	.919	.909	.937	.824	.000	.932	.500	.867	.911	.000	.924	.958	.774	.658	.000	.839	.929
Lights	40	168	174	0	382	294	256	120	0	670	2	50	148	0	200	153	312	49	0	514	1766
% Lights	97.6	99.4	98.9	0	99.0	98.7	96.2	98.4	0	97.7	100	96.2	96.7	0	96.6	95.0	97.8	98.0	0	97.0	97.6
Mediums	1	1	2	0	4	4	6	2	0	12	0	1	5	0	6	4	4	1	0	9	31
% Mediums	2.4	0.6	1.1	0	1.0	1.3	2.3	1.6	0	1.7	0	1.9	3.3	0	2.9	2.5	1.3	2.0	0	1.7	1.7
Articulated Trucks	0	0	0	0	0	0	4	0	0	4	0	1	0	0	1	4	3	0	0	7	12
% Articulated Trucks	0	0	0	0	0	0	1.5	0	0	0.6	0	1.9	0	0	0.5	2.5	0.9	0	0	1.3	0.7



MDM TRANSPORTATION CONSULTANTS, INC.

Planners & Engineers

28 Lord Road, Suite 280
Marlborough, MA

N/S: Site Driveway
E/W: Pelham Street
Methuen, MA

File Name : 1289_Pelham_at_West_Site_Drive_06-01-2023
Site Code : 1289
Start Date : 6/1/2023
Page No : 1

Groups Printed- Lights - Mediums - Articulated Trucks

	Fireside West Driveway From North				Pelham Street From East				Pelham Street From West				
Start Time	Right	Left	Peds	App. Total	Right	Thru	Peds	App. Total	Thru	Left	Peds	App. Total	Int. Total
07:00 AM	0	1	0	1	1	91	0	92	181	0	0	181	274
07:15 AM	0	0	0	0	0	132	0	132	199	1	0	200	332
07:30 AM	0	0	0	0	0	126	0	126	203	0	0	203	329
07:45 AM	0	0	0	0	1	144	0	145	198	0	0	198	343
Total	0	1	0	1	2	493	0	495	781	1	0	782	1278
08:00 AM	2	0	0	2	0	108	0	108	180	0	0	180	290
08:15 AM	1	0	0	1	0	137	0	137	161	0	0	161	299
08:30 AM	1	1	0	2	0	115	0	115	165	1	0	166	283
08:45 AM	3	0	0	3	2	94	0	96	176	1	0	177	276
Total	7	1	0	8	2	454	0	456	682	2	0	684	1148
11:00 AM	3	0	0	3	1	86	0	87	106	3	0	109	199
11:15 AM	2	1	0	3	2	109	0	111	117	4	0	121	235
11:30 AM	1	0	0	1	0	133	0	133	121	2	0	123	257
11:45 AM	2	0	0	2	3	102	0	105	113	1	0	114	221
Total	8	1	0	9	6	430	0	436	457	10	0	467	912
12:00 PM	4	0	0	4	1	117	0	118	117	2	0	119	241
12:15 PM	2	1	0	3	1	123	0	124	133	0	0	133	260
12:30 PM	1	0	0	1	1	113	0	114	112	6	0	118	233
12:45 PM	1	0	0	1	0	123	0	123	119	1	0	120	244
Total	8	1	0	9	3	476	0	479	481	9	0	490	978
01:00 PM	4	0	0	4	1	93	0	94	117	3	0	120	218
01:15 PM	1	0	0	1	0	129	0	129	98	1	0	99	229
01:30 PM	1	0	0	1	1	126	0	127	161	0	0	161	289
01:45 PM	1	3	0	4	3	147	0	150	123	1	0	124	278
Total	7	3	0	10	5	495	0	500	499	5	0	504	1014
04:00 PM	3	1	0	4	4	168	0	172	182	1	0	183	359
04:15 PM	1	1	0	2	5	66	0	71	130	2	0	132	205
04:30 PM	4	2	0	6	3	0	0	3	162	5	0	167	176
04:45 PM	3	0	0	3	0	0	0	0	131	1	0	132	135
Total	11	4	0	15	12	234	0	246	605	9	0	614	875
05:00 PM	3	2	0	5	1	183	0	184	168	4	0	172	361
05:15 PM	3	1	0	4	4	142	0	146	153	0	0	153	303
05:30 PM	4	3	0	7	1	156	0	157	160	5	0	165	329
05:45 PM	1	1	0	2	0	148	0	148	111	8	0	119	269
Total	11	7	0	18	6	629	0	635	592	17	0	609	1262
Grand Total	52	18	0	70	36	3211	0	3247	4097	53	0	4150	7467
Apprch %	74.3	25.7	0		1.1	98.9	0		98.7	1.3	0		
Total %	0.7	0.2	0	0.9	0.5	43	0	43.5	54.9	0.7	0	55.6	
Lights	50	16	0	66	34	2946	0	2980	3823	52	0	3875	6921
% Lights	96.2	88.9	0	94.3	94.4	91.7	0	91.8	93.3	98.1	0	93.4	92.7
Mediums	2	1	0	3	2	187	0	189	169	1	0	170	362
% Mediums	3.8	5.6	0	4.3	5.6	5.8	0	5.8	4.1	1.9	0	4.1	4.8
Articulated Trucks	0	1	0	1	0	78	0	78	105	0	0	105	184
% Articulated Trucks	0	5.6	0	1.4	0	2.4	0	2.4	2.6	0	0	2.5	2.5

MDM TRANSPORTATION CONSULTANTS, INC.

Planners & Engineers

28 Lord Road, Suite 280
Marlborough, MA

N/S: Site Driveway
E/W: Pelham Street
Methuen, MA

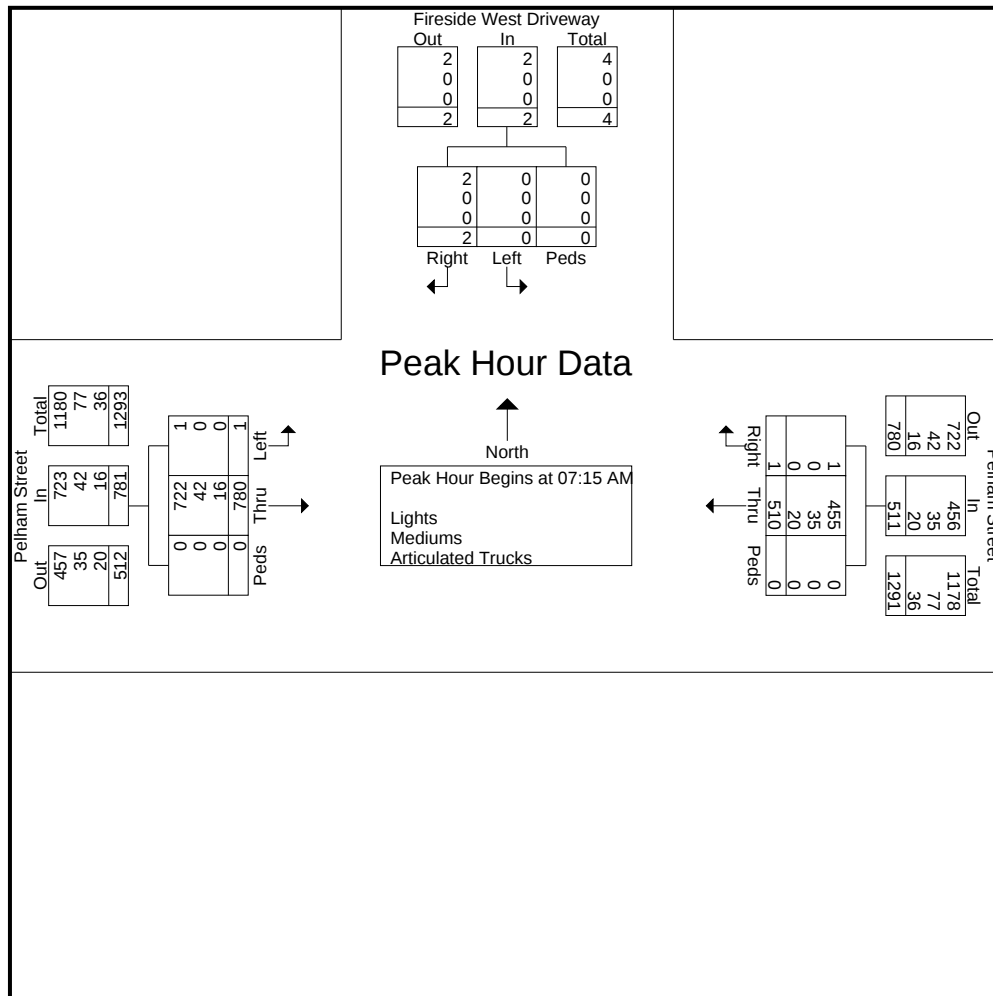
File Name : 1289_Pelham_at_West_Site_Drive_06-01-2023
Site Code : 1289
Start Date : 6/1/2023
Page No : 2

	Fireside West Driveway From North				Pelham Street From East				Pelham Street From West				
Start Time	Right	Left	Peds	App. Total	Right	Thru	Peds	App. Total	Thru	Left	Peds	App. Total	Int. Total

Peak Hour Analysis From 07:00 AM to 09:45 AM - Peak 1 of 1

Peak Hour for Entire Intersection Begins at 07:15 AM

07:15 AM	0	0	0	0	0	132	0	132	199	1	0	200	332
07:30 AM	0	0	0	0	0	126	0	126	203	0	0	203	329
07:45 AM	0	0	0	0	1	144	0	145	198	0	0	198	343
08:00 AM	2	0	0	2	0	108	0	108	180	0	0	180	290
Total Volume	2	0	0	2	1	510	0	511	780	1	0	781	1294
% App. Total	100	0	0		0.2	99.8	0		99.9	0.1	0		
PHF	.250	.000	.000	.250	.250	.885	.000	.881	.961	.250	.000	.962	.943
Lights	2	0	0	2	1	455	0	456	722	1	0	723	1181
% Lights	100	0	0	100	100	89.2	0	89.2	92.6	100	0	92.6	91.3
Mediums	0	0	0	0	0	35	0	35	42	0	0	42	77
% Mediums	0	0	0	0	0	6.9	0	6.8	5.4	0	0	5.4	6.0
Articulated Trucks	0	0	0	0	0	20	0	20	16	0	0	16	36
% Articulated Trucks	0	0	0	0	0	3.9	0	3.9	2.1	0	0	2.0	2.8



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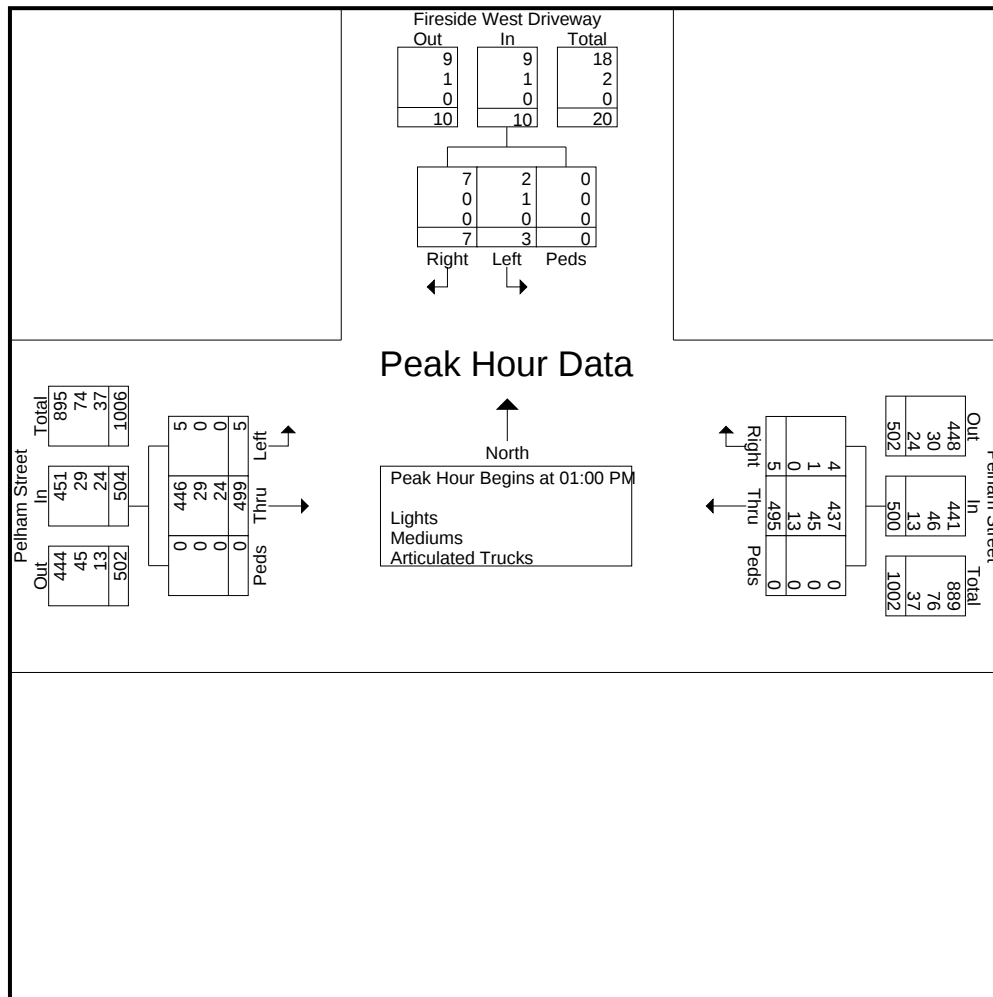
Planners & Engineers

28 Lord Road, Suite 280
Marlborough, MA

N/S: Site Driveway
E/W: Pelham Street
Methuen, MA

File Name : 1289_Pelham_at_West_Site_Drive_06-01-2023
Site Code : 1289
Start Date : 6/1/2023
Page No : 3

	Fireside West Driveway From North				Pelham Street From East				Pelham Street From West				
Start Time	Right	Left	Peds	App. Total	Right	Thru	Peds	App. Total	Thru	Left	Peds	App. Total	Int. Total
Peak Hour Analysis From 10:00 AM to 01:45 PM - Peak 1 of 1													
Peak Hour for Entire Intersection Begins at 01:00 PM													
01:00 PM	4	0	0	4	1	93	0	94	117	3	0	120	218
01:15 PM	1	0	0	1	0	129	0	129	98	1	0	99	229
01:30 PM	1	0	0	1	1	126	0	127	161	0	0	161	289
01:45 PM	1	3	0	4	3	147	0	150	123	1	0	124	278
Total Volume	7	3	0	10	5	495	0	500	499	5	0	504	1014
% App. Total	70	30	0		1	99	0		99	1	0		
PHF	.438	.250	.000	.625	.417	.842	.000	.833	.775	.417	.000	.783	.877
Lights	7	2	0	9	4	437	0	441	446	5	0	451	901
% Lights	100	66.7	0	90.0	80.0	88.3	0	88.2	89.4	100	0	89.5	88.9
Mediums	0	1	0	1	1	45	0	46	29	0	0	29	76
% Mediums	0	33.3	0	10.0	20.0	9.1	0	9.2	5.8	0	0	5.8	7.5
Articulated Trucks	0	0	0	0	0	13	0	13	24	0	0	24	37
% Articulated Trucks	0	0	0	0	0	2.6	0	2.6	4.8	0	0	4.8	3.6



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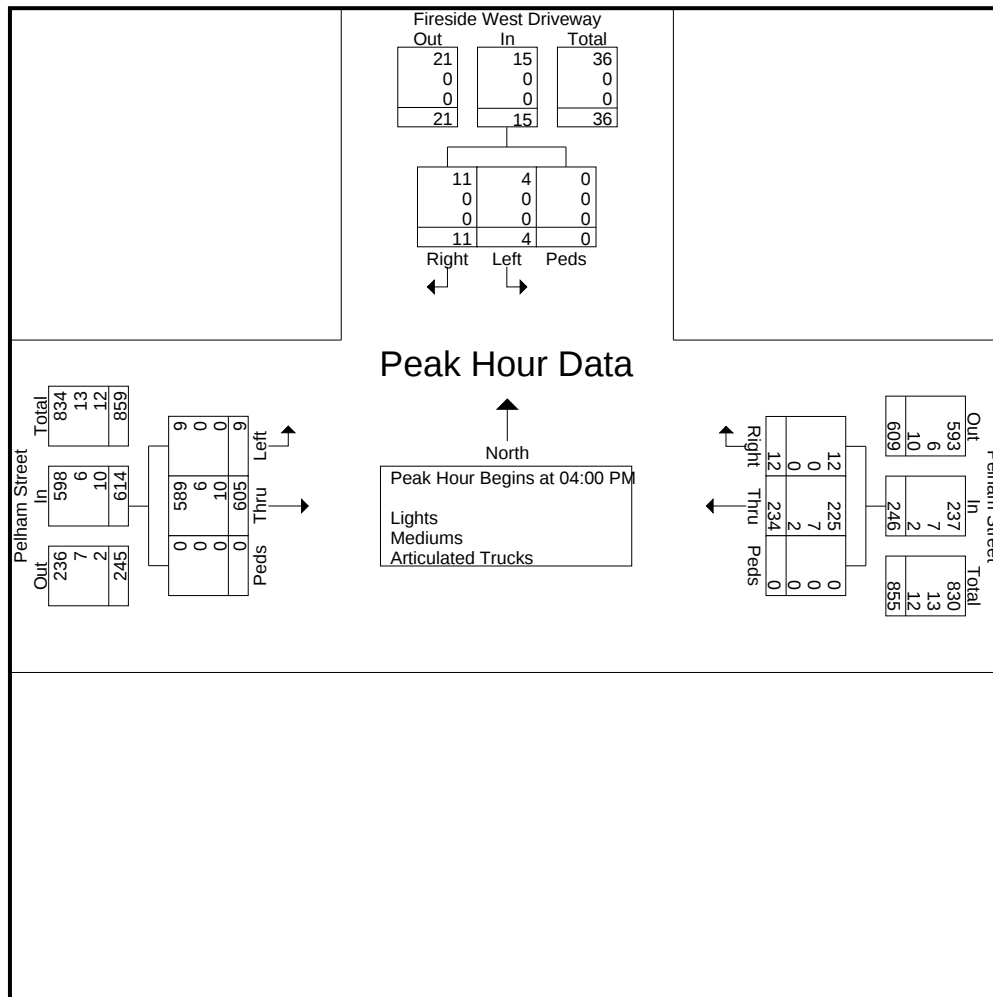
Planners & Engineers

28 Lord Road, Suite 280
Marlborough, MA

N/S: Site Driveway
E/W: Pelham Street
Methuen, MA

File Name : 1289_Pelham_at_West_Site_Drive_06-01-2023
Site Code : 1289
Start Date : 6/1/2023
Page No : 4

	Fireside West Driveway From North				Pelham Street From East				Pelham Street From West				
Start Time	Right	Left	Peds	App. Total	Right	Thru	Peds	App. Total	Thru	Left	Peds	App. Total	Int. Total
Peak Hour Analysis From 04:00 PM to 04:45 PM - Peak 1 of 1													
Peak Hour for Entire Intersection Begins at 04:00 PM													
04:00 PM	3	1	0	4	4	168	0	172	182	1	0	183	359
04:15 PM	1	1	0	2	5	66	0	71	130	2	0	132	205
04:30 PM	4	2	0	6	3	0	0	3	162	5	0	167	176
04:45 PM	3	0	0	3	0	0	0	0	131	1	0	132	135
Total Volume	11	4	0	15	12	234	0	246	605	9	0	614	875
% App. Total	73.3	26.7	0		4.9	95.1	0		98.5	1.5	0		
PHF	.688	.500	.000	.625	.600	.348	.000	.358	.831	.450	.000	.839	.609
Lights	11	4	0	15	12	225	0	237	589	9	0	598	850
% Lights	100	100	0	100	100	96.2	0	96.3	97.4	100	0	97.4	97.1
Mediums	0	0	0	0	0	7	0	7	6	0	0	6	13
% Mediums	0	0	0	0	0	3.0	0	2.8	1.0	0	0	1.0	1.5
Articulated Trucks	0	0	0	0	0	2	0	2	10	0	0	10	12
% Articulated Trucks	0	0	0	0	0	0.9	0	0.8	1.7	0	0	1.6	1.4



MDM TRANSPORTATION CONSULTANTS, INC.

Planners & Engineers

28 Lord Road, Suite 280
Marlborough, MA

N/S: Site Driveway
E/W: Pelham Street
Methuen, MA

File Name : 1289_Pelham_at_West_Site_Drive_06-03-2023
Site Code : 1289
Start Date : 6/3/2023
Page No : 1

Groups Printed- Lights - Mediums - Articulated Trucks

Start Time	Site Driveway From North				Pelham Street From East				Pelham Street From West				Int. Total
	Right	Left	Peds	App. Total	Right	Thru	Peds	App. Total	Thru	Left	Peds	App. Total	
11:00 AM	1	1	0	2	0	107	0	107	119	1	0	120	229
11:15 AM	0	1	0	1	1	105	0	106	117	2	0	119	226
11:30 AM	1	0	0	1	1	121	0	122	119	0	0	119	242
11:45 AM	1	1	0	2	2	117	0	119	124	0	0	124	245
Total	3	3	0	6	4	450	0	454	479	3	0	482	942
12:00 PM	1	0	0	1	5	109	0	114	126	0	0	126	241
12:15 PM	1	0	0	1	5	126	0	131	144	1	0	145	277
12:30 PM	1	1	0	2	4	111	0	115	124	1	0	125	242
12:45 PM	1	1	0	2	3	101	0	104	153	0	0	153	259
Total	4	2	0	6	17	447	0	464	547	2	0	549	1019
01:00 PM	2	1	0	3	2	113	0	115	100	1	0	101	219
01:15 PM	2	0	0	2	4	102	0	106	127	0	0	127	235
01:30 PM	4	4	0	8	3	122	0	125	126	2	0	128	261
01:45 PM	3	5	0	8	1	120	0	121	107	1	0	108	237
Total	11	10	0	21	10	457	0	467	460	4	0	464	952
Grand Total	18	15	0	33	31	1354	0	1385	1486	9	0	1495	2913
Apprch %	54.5	45.5	0		2.2	97.8	0		99.4	0.6	0		
Total %	0.6	0.5	0	1.1	1.1	46.5	0	47.5	51	0.3	0	51.3	
Lights	18	15	0	33	31	1294	0	1325	1428	9	0	1437	2795
% Lights	100	100	0	100	100	95.6	0	95.7	96.1	100	0	96.1	95.9
Mediums	0	0	0	0	0	35	0	35	25	0	0	25	60
% Mediums	0	0	0	0	0	2.6	0	2.5	1.7	0	0	1.7	2.1
Articulated Trucks	0	0	0	0	0	25	0	25	33	0	0	33	58
% Articulated Trucks	0	0	0	0	0	1.8	0	1.8	2.2	0	0	2.2	2

MDM TRANSPORTATION CONSULTANTS, INC.

Planners & Engineers

28 Lord Road, Suite 280
Marlborough, MA

N/S: Site Driveway
E/W: Pelham Street
Methuen, MA

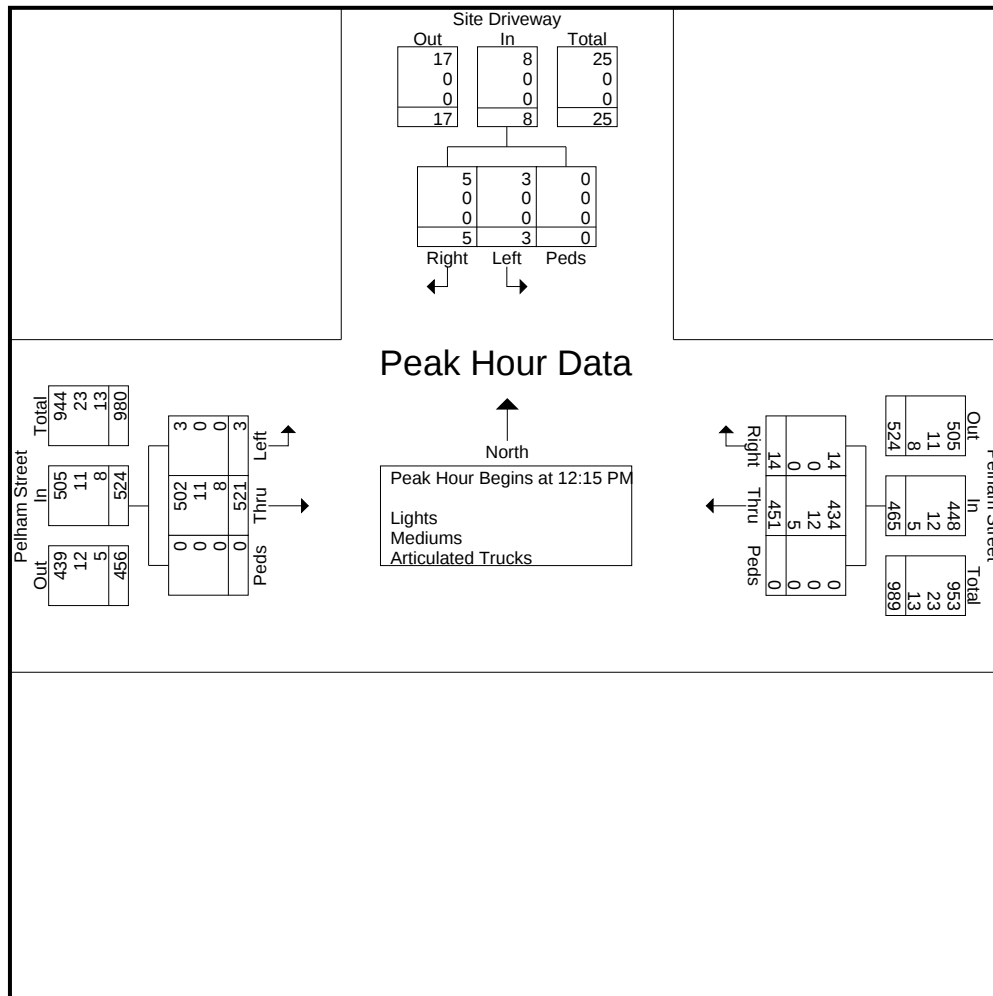
File Name : 1289_Pelham_at_West_Site_Drive_06-03-2023
Site Code : 1289
Start Date : 6/3/2023
Page No : 2

	Site Driveway From North				Pelham Street From East				Pelham Street From West				
Start Time	Right	Left	Peds	App. Total	Right	Thru	Peds	App. Total	Thru	Left	Peds	App. Total	Int. Total

Peak Hour Analysis From 12:15 PM to 01:45 PM - Peak 1 of 1

Peak Hour for Entire Intersection Begins at 12:15 PM

12:15 PM	1	0	0	1	5	126	0	131	144	1	0	145	277
12:30 PM	1	1	0	2	4	111	0	115	124	1	0	125	242
12:45 PM	1	1	0	2	3	101	0	104	153	0	0	153	259
01:00 PM	2	1	0	3	2	113	0	115	100	1	0	101	219
Total Volume	5	3	0	8	14	451	0	465	521	3	0	524	997
% App. Total	62.5	37.5	0		3	97	0		99.4	0.6	0		
PHF	.625	.750	.000	.667	.700	.895	.000	.887	.851	.750	.000	.856	.900
Lights	5	3	0	8	14	434	0	448	502	3	0	505	961
% Lights	100	100	0	100	100	96.2	0	96.3	96.4	100	0	96.4	96.4
Mediums	0	0	0	0	0	12	0	12	11	0	0	11	23
% Mediums	0	0	0	0	0	2.7	0	2.6	2.1	0	0	2.1	2.3
Articulated Trucks	0	0	0	0	0	5	0	5	8	0	0	8	13
% Articulated Trucks	0	0	0	0	0	1.1	0	1.1	1.5	0	0	1.5	1.3



□ Seasonal/Yearly Growth Data

SECTION I - CONTINUOUS COUNTING STATION MONTHLY AVERAGE DAILY TRAFFIC

STATION 4114 -CHELMSFORD - LOWELL CONNECTOR													
YR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	YEAR
07	23,503	24,074	25,046	24,685	25,137	24,905	23,225	24,568	24,868	26,610	24,930	24,633	24,682
	14%	3%	4%	5%	0%	0%	4%	-2%	3%	0%	-3%	-3%	2%
08	26,823	24,798	26,000	26,021	25,223	24,987	24,237	23,980	25,730	26,585	24,120	24,000	25,209
	-14%	1%	-3%	-1%	-2%	2%	2%	-1%	2%	2%	5%	4%	0%
09	23,134	24,965	25,163	25,832	24,792	25,548	24,720	23,857	26,189	27,028	25,256	24,945	25,119
	-3%	1%	7%	4%	9%	6%	2%	6%	3%	1%	3%	3%	3%
11	22,503	25,153	27,042	26,915	27,134	26,964	25,104	25,278	26,960	27,220	26,036	25,659	25,997
	17%	5%	2%	7%	0%	-2%	1%	0%	-2%	-1%	4%	-4%	2%
12	26,260	26,320	27,592	28,679	27,221	26,536	25,342	25,341	26,397	26,927	26,964	24,678	26,521
	-2%	-3%	-2%	-1%	-1%	1%	-1%	1%	2%	2%	0%	2%	0%
13	25,109	24,887	26,447	28,007	26,507	26,962	24,930	25,691	27,686	28,189	27,168	25,439	26,418
	1%	3%	4%	1%	5%	5%	7%	6%	4%	5%	2%	7%	4%
14	25,263	25,528	27,578	28,376	27,812	28,424	26,607	27,162	28,900	29,514	27,679	27,237	27,507
Seasonal Adjustment Factor (to average month)	1.08	1.05	0.98	0.95	0.98	0.98	1.04	1.03	0.97	0.95	0.99	1.03	
Growth													1.58%
STATION 4170 - LOWELL - I-495 NORTH OF ROUTE 4													
YR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	YEAR
07	91,950	94,873	94,099	95,258	103,802	109,192	113,808	120,103	106,428	105,467	95,598	88,019	101,550
	-10%	-6%	1%	1%	-4%	-4%	-5%	-7%	-3%	-3%	-3%	-2%	-4%
08	82,908	89,494	95,000	96,549	99,670	104,487	107,612	111,258	103,346	101,899	92,885	86,352	97,622
	4%	0%	-7%	1%	-1%	1%	3%	1%	0%	-1%	1%	4%	1%
09	86,006	89,523	88,806	97,307	98,894	105,468	111,003	112,512	103,316	100,554	94,083	90,186	98,138
	0%	-3%	6%	2%	3%	4%	2%	2%	1%	2%	4%	10%	3%
10	85,591	87,178	93,702	99,464	101,519	109,598	112,681	115,324	104,814	103,027	97,646	98,820	100,780
	-4%	-2%	-1%	-3%	0%	-1%	0%	-2%	-2%	-3%	-1%	-6%	-2%
11	82,383	85,318	93,109	96,656	101,366	108,157	112,317	113,437	103,226	100,380	97,023	92,622	98,833
	-7%	9%	-1%	-4%	-5%	-4%	1%	-5%	-4%	-5%	-23%	0%	-2%
13	88,346	78,578	94,139	101,106	106,485	112,500	111,699	118,956	107,642	105,330	125,424	92,497	103,558
	-5%	7%	-2%	-3%	-4%	-3%	-2%	-4%	-2%	0%	-22%	4%	-4%
14	83,620	83,908	92,374	98,264	101,814	109,006	109,672	113,815	105,976	105,164	97,446	96,137	99,766
	3%	16%	11%	7%	10%	10%	9%	8%	8%	7%	10%	2%	8%
16	86,344	97,440	102,384	105,122	111,678	119,439	119,430	122,475	114,026	112,740	107,278	97,630	107,999
	10%	-2%	-3%	-5%	4%	-17%	2%	2%	-13%	4%	2%	12%	-1%
17	95,398	95,078	99,617	99,617	115,915	99,617	121,449	125,471	99,617	117,494	109,854	109,224	107,363
	1%	4%	5%	12%	-7%	21%	1%	0%	18%	-1%	-2%	-10%	3%
19	96,139	98,741	104,956	111,442	107,961	120,272	122,184	125,116	117,255	116,129	107,277	98,439	110,493
Seasonal Adjustment Factor (to average month)	1.17	1.15	1.07	1.03	0.97	0.94	0.90	0.87	0.97	0.96	1.00	1.08	
Growth													-0.27%
Average Seasonal Adjustment Factor (to average month)	1.12	1.10	1.03	0.99	0.98	0.96	0.97	0.95	0.97	0.96	1.00	1.06	

Average Yearly Growth Calculated 0.7%
Yearly Growth Factor Used 1.0%

ITALICS = ESTIMATED DATA
MADT

□ Crash Data

INTERSECTION CRASH RATE WORKSHEET

CITY/TOWN : Methuen, MA COUNT DATE : Jun-23

DISTRICT : 4 UNSIGNALIZED : ☐ SIGNALIZED : ☒

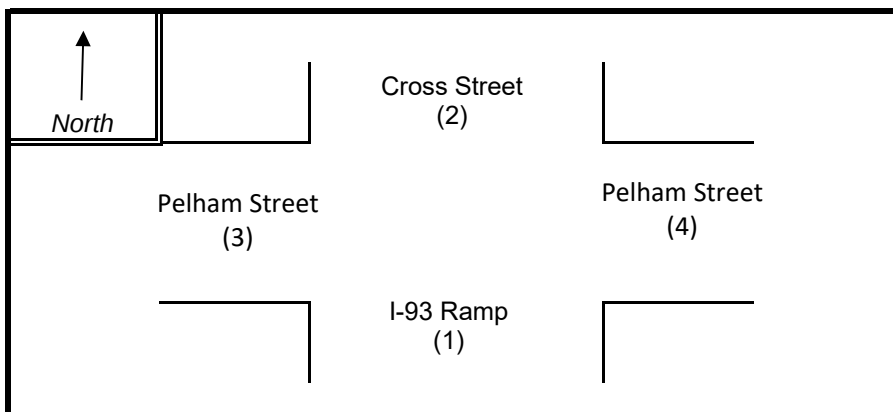
~ INTERSECTION DATA ~

MAJOR STREET : Pelham Street

MINOR STREET(S) : Cross Street

I-93 Southbound Off-Ramp

INTERSECTION
 DIAGRAM
 (Label Approaches)



PEAK HOUR VOLUMES

APPROACH :	1	2	3	4	5	Total Peak Hourly Approach Volume
DIRECTION :	NB	SB	EB	WB		
PEAK HOURLY VOLUMES (PM) :	496	354	612	826		2,288

"K" FACTOR :

0.080

INTERSECTION ADT (**V**) = TOTAL DAILY
 APPROACH VOLUME :

28,600

TOTAL # OF CRASHES :

20

OF
 YEARS :

5

AVERAGE # OF
 CRASHES PER YEAR (**A**) :

4.00

CRASH RATE CALCULATION :

0.38

$$\text{RATE} = \frac{(A * 1,000,000)}{(V * 365)}$$

Comments : MassDOT District 4 Avg: Signalized = 0.73; Unsignalized = 0.57

Project Title & Date: 1289 - Methuen

Crash Number	Crash Date	Crash Severity	Crash Time	Number of Vehicles	Light Conditions	Manner of Collision	Road Surface Condition	Total Fatalities	Total Non-Fatal Injuries	Vehicle Actions Prior to Crash (All Vehicles)	Vehicle Configuration (All Vehicles)	Vehicle Travel Directions (All Vehicles)	Weather Conditions	Most Harmful Event (All Vehicles)	X	Y	Roadway
4513069	03/09/2018	Property damage only (none injured)	1:16 PM	2	Daylight	Angle	Dry	0	0	V1: Travelling straight ahead / V2: 0 Travelling straight ahead	V1:(Passenger car) / V2:(Passenger car)	V1: W / V2: N	Cloudy/Cloudy	V1:(Collision with motor vehicle in traffic) / V2:(Collision with motor vehicle in traffic)	223937.6875	942069.0624	PELHAM ST / CROSS ST / RTE 93 OFF RAMP EXIT 46 SB
4516028	03/19/2018	Property damage only (none injured)	6:00 PM	2	Daylight	Angle	Dry	0	0	V1: Turning left / V2: Travelling 0 straight ahead	V1:(Light truck(van, mini-van, pickup, sport utility))	V1: S / V2: E	Cloudy/Cloudy	V1:(Collision with motor vehicle in traffic) / V2:(Collision with motor vehicle in traffic)	223937.6875	942069.0624	CROSS STREET / PELHAM STREET
4532559	04/30/2018	Property damage only (none injured)	3:08 PM	2	Daylight	Rear-end	Dry	0	0	V1: Slowing or stopped in traffic / 0 V2: Slowing or stopped in traffic	V1:(Passenger car) / V2:(Light truck(van, mini-van, pickup, sport utility))	V1: W / V2: W	Clear/Clear	V1:(Collision with motor vehicle in traffic) / V2:(Collision with motor vehicle in traffic)	223937.6875	942069.0624	PELHAM ST / CROSS ST
4601431	09/26/2018	Property damage only (none injured)	9:00 PM	2	Dark - lighted roadway	Rear-end	Dry	0	0	V1: Travelling straight ahead / 0 Travelling straight ahead	V1:(Light truck(van, mini-van, pickup, sport utility)) / V2:(Passenger car)	V1: S / V2: S	Clear/Clear	V1:(Collision with motor vehicle in traffic) / V2:(Collision with motor vehicle in traffic)	223937.6875	942069.0624	PELHAM ST / CROSS ST
4618652	11/03/2018	Property damage only (none injured)	6:05 PM	2	Dark - lighted roadway	Angle	Dry	0	0	V1: Turning left / V2: Travelling 0 straight ahead	V1:(Light truck(van, mini-van, pickup, sport utility)) / V2:(Light truck(van, mini-van, pickup, sport utility))	V1: E / V2: N	Clear/Clear	V1:(Collision with motor vehicle in traffic) / V2:(Collision with motor vehicle in traffic)	223937.6875	942069.0624	PELHAM STREET / CROSS STREET
4620974	11/12/2018	Property damage only (none injured)	4:00 PM	2	Daylight	Sideswipe, same direction	Dry	0	0	V1: Slowing or stopped in traffic / 0 V2: Travelling straight ahead	V1:(Passenger car) / V2:(Light truck(van, mini-van, pickup, sport utility))	V1: S / V2: S	Clear/Clear	V1:(Collision with motor vehicle in traffic) / V2:(Collision with motor vehicle in traffic)	223937.6875	942069.0624	PELHAM ST / CROSS ST
4631321	11/30/2018	Property damage only (none injured)	8:30 AM	2	Daylight	Angle	Dry	0	0	V1: Travelling straight ahead / 0 Turning left	V1:(Passenger car) / V2:(Light truck(van, mini-van, pickup, sport utility))	V1: W / V2: E	Clear/Clear	V1:(Collision with motor vehicle in traffic) / V2:(Collision with motor vehicle in traffic)	223937.63	942070.0329	PELHAM STREET / RAMP-RT 93 SB TO PELHAM ST / CROSS STREET
4640884	12/21/2018	Property damage only (none injured)	10:58 PM	2	Dark - lighted roadway	Rear-end	Water (standing, moving)	0	0	V1: Travelling straight ahead / V2: 0 Slowing or stopped in traffic	V1:(Passenger car) / V2:(Passenger car)	V1: W / V2: W	Rain/Rain	V1:(Collision with motor vehicle in traffic) / V2:(Collision with motor vehicle in traffic)	223937.6875	942069.0624	CROSS ST / PELHAM ST / CROSS ST
4729050	07/25/2019	Property damage only (none injured)	8:40 PM	2	Dark - lighted roadway	Sideswipe, same direction		0	0	V2: Travelling straight ahead / V1: 0 Slowing or stopped in traffic	V2:(Light truck(van, mini-van, pickup, sport utility)) / V1:(Single-unit truck (2-axle, 6-tires))	V2: W / V1: W	Clear/Clear	V2:(Collision with motor vehicle in traffic) / V1:(Collision with motor vehicle in traffic)	223937.6875	942069.0624	PELHAM STREET / CROSS STREET
4760569	10/12/2019	Property damage only (none injured)	12:17 PM	2	Daylight	Angle	Dry	0	0	V1: Turning left / V2: Travelling 0 straight ahead	V1:(Passenger car) / V2:(Single-unit truck (3-or-more axes))	V1: E / V2: N	Cloudy/Cloudy	V1:(Collision with motor vehicle in traffic) / V2:(Collision with motor vehicle in traffic)	223937.6875	942069.0624	PELHAM STREET / CROSS STREET
4775714	11/15/2019	Property damage only (none injured)	1:35 PM	2	Daylight	Sideswipe, same direction	Dry	0	0	V1: Changing lanes / V2: Travelling 0 straight ahead	V1:(Single-unit truck (2-axle, 6-tires)) / V2:(Light truck(van, mini-van, pickup, sport utility))	V1: W / V2: W	Clear/Clear	V1:(Collision with motor vehicle in traffic) / V2:(Collision with motor vehicle in traffic)	223937.6875	942069.0624	PELHAM STREET / CROSS STREET
4779074	11/22/2019	Non-fatal injury	12:48 PM	3	Daylight	Rear-end	Wet	0	0	V1: Slowing or stopped in traffic / V2: Slowing or stopped in traffic / 3 V3: Travelling straight ahead	V1:(Passenger car) / V2:(Passenger car) / V3:(Light truck(van, mini-van, pickup, sport utility))	V1: E / V2: E / V3: E	Rain/Rain	V1:(Collision with motor vehicle in traffic) / V2:(Collision with motor vehicle in traffic) / V3:(Collision with motor vehicle in traffic)	223937.6875	942069.0624	PELHAM ST / CROSS ST
4824145	03/02/2020	Property damage only (none injured)	5:34 PM	2	Dusk	Front to Rear	Dry	0	0	V1: Slowing or stopped in traffic / 0 V2: Travelling straight ahead	V1:(Passenger car) / V2:(Passenger car) / V1:(Passenger car)	V1: W / V2: W	Clear	V1:(Collision with motor vehicle in traffic) / V2:(Collision with motor vehicle in traffic)	223937.6875	942069.0624	CROSS ST / PELHAM ST / CROSS ST
4871388	08/21/2020	Non-fatal injury	3:20 PM	2	Daylight	Rear-end	Dry	0	0	V1: Slowing or stopped in traffic / 1 V2: Travelling straight ahead	V2:(Single-unit truck (2-axle, 6-tires)) / V1:(Single-unit truck (3-or-more axes))	V1: E / V2: E	Clear/Clear	V1:(Collision with motor vehicle in traffic) / V2:(Collision with motor vehicle in traffic)	223937.6875	942069.0624	PELHAM STREET / CROSS STREET
4936400	03/01/2021	Non-fatal injury	10:35 AM	1	Daylight	Single vehicle crash	Dry	0	0	1 V1: Travelling straight ahead		V1: E	Clear/Clear	V1:(Collision with bridge)	223965.0626	942062.5001	RT 93 SB
5107283	05/26/2022	Property damage only (none injured)	4:41 PM	2	Daylight	Sideswipe, opposite direction	Dry	0	0	V1: Travelling straight ahead / V2: 0 Other	V1:(Passenger car) / V2:(Motorcycle)	V1: S / V2: W	Clear/Clear	V1:(Other) / V2:(Collision with motor vehicle in traffic)	223937.6875	942069.0624	PELHAM ST / PELHAM / CROSS
5110524	05/31/2022	Property damage only (none injured)	3:47 PM	2	Daylight	Front to Front	Dry	0	0	V1: Travelling straight ahead / 0 Entering traffic lane	V1:(Passenger car) / V2:(Passenger car)	V1: E / V2: W	Clear/Clear	V1:(Collision with motor vehicle in traffic) / V2:(Collision with motor vehicle in traffic)	223964.9183	942062.535	PELHAM ST
5130869	07/21/2022	Property damage only (none injured)	5:09 PM	2	Daylight	Sideswipe, same direction	Dry	0	0	V1: Travelling straight ahead / V2: 0 Slowing or stopped in traffic	V1:(Light truck(van, mini-van, pickup, sport utility)) / V2:(Passenger car)	V1: N / V2: N	Clear	V1:(Collision with motor vehicle in traffic) / V2:(Collision with motor vehicle in traffic)	223937.63	942070.0329	RAMP-PELHAM ST TO RT 93 SB / PELHAM STREET / CROSS STREET
5143839	08/29/2022	Property damage only (none injured)	4:30 PM	2	Daylight	Sideswipe, opposite direction	Dry	0	0	V1: Turning left / V2: Travelling 0 straight ahead	V1:(Light truck(van, mini-van, pickup, sport utility)) / V2:(Light truck(van, mini-van, pickup, sport utility))	V1: N / V2: W	Clear/Clear	V1:(Collision with motor vehicle in traffic) / V2:(Collision with motor vehicle in traffic)	223964.9183	942062.535	PELHAM ST
5226277	12/14/2022	Property damage only (none injured)		2	Dark - lighted roadway	Sideswipe, opposite direction	Dry	0	0	V1: Turning right / V2: Turning left	V1:(Passenger car) / V2:(Passenger car)	V1: W / V2: E	Clear/Clear	V1:(Collision with motor vehicle in traffic) / V2:(Collision with motor vehicle in traffic)	223937.6875	942069.0624	PELHAM ST Rte N / CROSS ST Rte / PELHAM Rte

□ Sight Distance Calculations

Stopping Sight Distance - Posted Travel Speed

Pelham Street

		SPEED (MPH)	BRAKE REACTION DISTANCE (FT)	BRAKING DISTANCE (FT)	CALCULATED STOPPING SIGHT DISTANCE (FT)
Direction 1	EB	35	128.625	117.4	246.0
Direction 2	WB	35	128.625	117.4	246.0

INPUTS

Direction 1

Direction 2

Travel Direction
Speed
Grade
t
a

EB
35
0
2.5
11.2

WB
35
0
2.5
11.2

Stopping Sight Distance (SSD) - Source: AASHTO

SSD = Reaction Distance + Brake Distance

Reaction Distance = $1.47 \times t \times V$

Brake Distance = $V^2 / (30 \times ((a/32.2) + G))$

Where:

t = reaction time (sec)

V = travel speed (mph)

G= roadway grade

a - deceleration rate (ft/sec²)

Intersection Sight Distance Calculations

Source: *A Policy on Geometric Design of Highways and Street, 6th Edition*; AASHTO; 2011.

Passenger Car

$$ISD = 1.47 * V * t$$

V = speed

t = time gap

t = 7.5 s for a passenger car for Left Turn from a Stop

t = 6.5 s for a passenger car for Right Turn from a Stop

Pelham Street

Looking East

(left-turn from a stop)

	Average Speed		Ideal ISD
ISD = 1.47*	35	* 7.5 =	385.875

SAY

390 feet

Looking West

(right-turn from a stop)

	Average Speed		Ideal ISD
ISD = 1.47*	35	* 6.5 =	334.425

SAY

335 feet

□ Trip Generation

1289 Trip Generation

949 Carsh Wash & Detail Center			
Weekday		Total Trips	
ITE Time of Day Factor		4.475ksf	
12:00	0.0		
1:00	0.0		
2:00	0.0		
3:00	0.0		
4:00	0.1		
5:00	0.3		
6:00	0.1		
7:00	3.3		
8:00	5.5		
9:00	7.4		
10:00	7.6		
11:00	9.7		
12:00	9.7		
1:00	8.3		
2:00	9.9		
3:00	10.0		
4:00	8.7		
5:00	7.2		
6:00	8.1		
7:00	3.5		
8:00	0.5		
9:00	0.0		
10:00	0.1		
11:00	0.0		
		ITE Rates:	
		Weekday PM	
		Average Rate: 14.20	
		50% Entering, 50% Exiting	
		64	
		32 Entering/32 Exiting	
		Saturday Midday	
		Average Rate: 30.40	
		50% Entering, 50% Exiting	
		136	
		68 Entering/68 Exiting	

		Weekday AM	
		Average Rate = (5.5/8.7)*14.20	
		Average Rate = 8.98	
		41	
		50% Entering, 50% Exiting	
		21 Entering/20 Exiting	
		Weekday Midday	
		Average Rate = (9.7/8.7)*14.20	
		Average Rate = 15.8	
		72	
		50% Entering, 50% Exiting	
		36 Entering/36 Exiting	

Automated Car Wash (948)

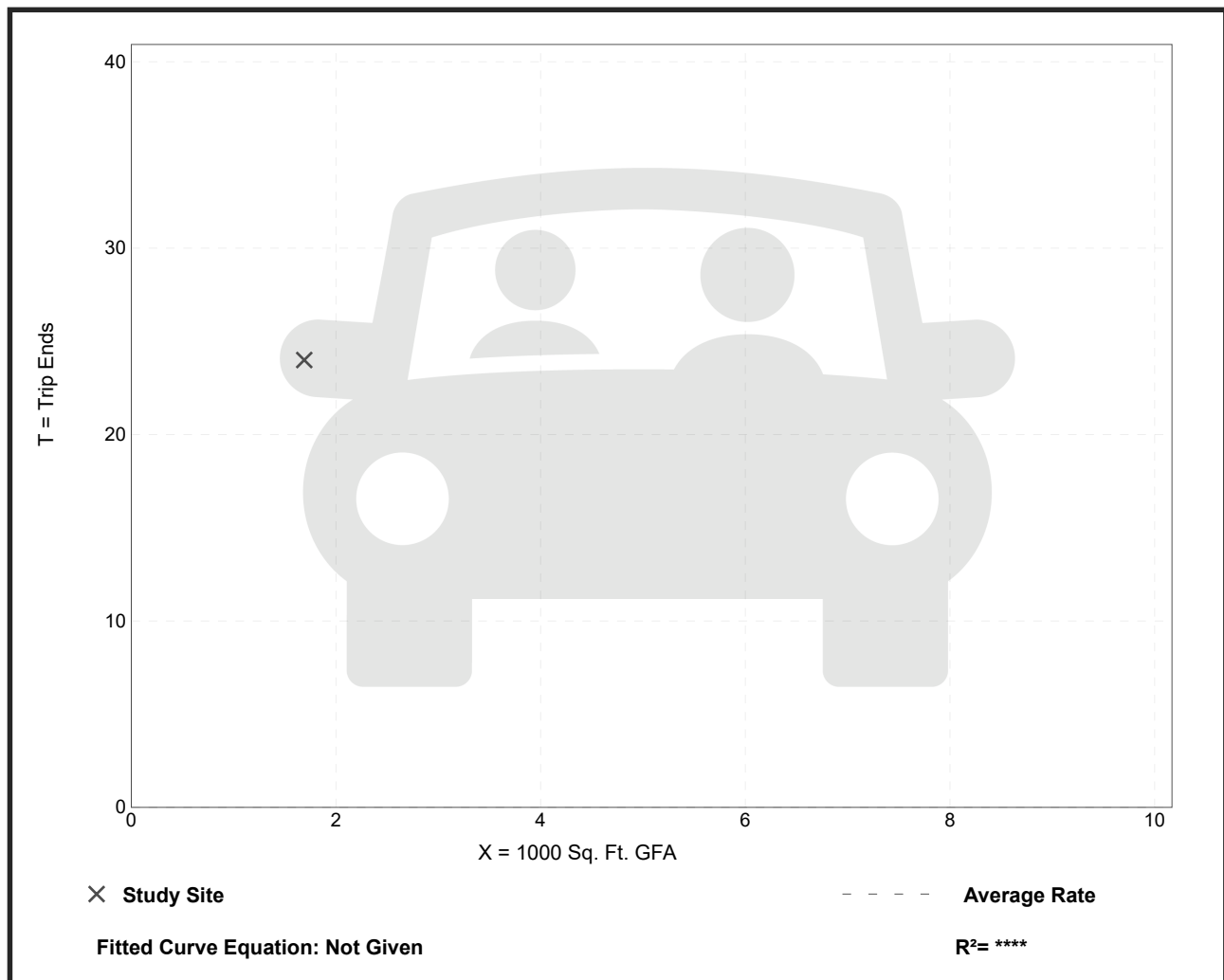
Vehicle Trip Ends vs: 1000 Sq. Ft. GFA
On a: Weekday,
Peak Hour of Adjacent Street Traffic,
One Hour Between 4 and 6 p.m.
Setting/Location: General Urban/Suburban
Number of Studies: 1
Avg. 1000 Sq. Ft. GFA: 2
Directional Distribution: 50% entering, 50% exiting

Vehicle Trip Generation per 1000 Sq. Ft. GFA

Average Rate	Range of Rates	Standard Deviation
14.20	14.20 - 14.20	*

Data Plot and Equation

Caution – Small Sample Size



Automated Car Wash (948)

Vehicle Trip Ends vs: 1000 Sq. Ft. GFA
On a: Saturday, Peak Hour of Generator

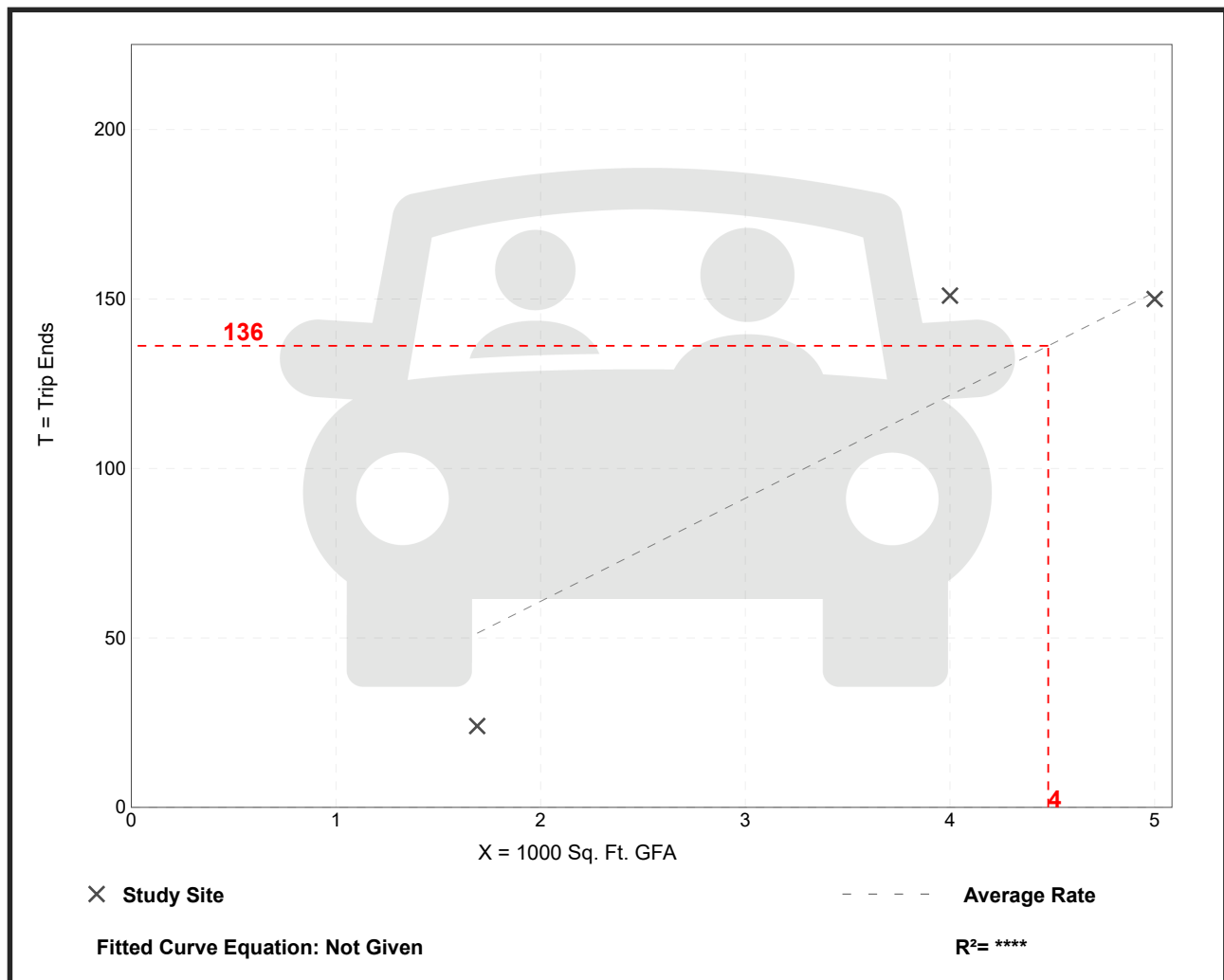
Setting/Location: General Urban/Suburban
Number of Studies: 3
Avg. 1000 Sq. Ft. GFA: 4
Directional Distribution: 50% entering, 50% exiting

Vehicle Trip Generation per 1000 Sq. Ft. GFA

Average Rate	Range of Rates	Standard Deviation
30.40	14.20 - 37.75	9.63

Data Plot and Equation

Caution – Small Sample Size



□ Capacity Analysis

Lanes, Volumes, Timings

1: 93 SB Off-Ramp/Cross Street & Pelham Street

2023 Baseline Condition

Weekday Morning Peak Hour

												
Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	27	511	254	185	345	137	139	30	123	142	167	27
Future Volume (vph)	27	511	254	185	345	137	139	30	123	142	167	27
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Storage Length (ft)	0		0	0		0	0		200	0		0
Storage Lanes	1		1	1		1	1		1	1		0
Taper Length (ft)	25			25			25			25		
Lane Util. Factor	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Frt			0.850			0.850			0.850		0.979	
Flt Protected	0.950			0.950			0.950			0.950		
Satd. Flow (prot)	1517	1810	1468	1703	1712	1495	1703	1776	1615	1736	1724	0
Flt Permitted	0.950			0.950			0.324			0.736		
Satd. Flow (perm)	1517	1810	1468	1703	1712	1495	581	1776	1615	1345	1724	0
Right Turn on Red			Yes			Yes			Yes			Yes
Satd. Flow (RTOR)			276			149			188		6	
Link Speed (mph)		30			30			30			30	
Link Distance (ft)		200			250			300			500	
Travel Time (s)		4.5			5.7			6.8			11.4	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Heavy Vehicles (%)	19%	5%	10%	6%	11%	8%	6%	7%	0%	4%	5%	26%
Adj. Flow (vph)	29	555	276	201	375	149	151	33	134	154	182	29
Shared Lane Traffic (%)												
Lane Group Flow (vph)	29	555	276	201	375	149	151	33	134	154	211	0
Enter Blocked Intersection	No	No	No	No	No	No	No	No	No	No	No	No
Lane Alignment	Left	Left	Right	Left	Left	Right	Left	Left	Right	Left	Left	Right
Median Width(ft)		12			12			12			12	
Link Offset(ft)		0			0			0			0	
Crosswalk Width(ft)		16			16			16			16	
Two way Left Turn Lane												
Headway Factor	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Turning Speed (mph)	15		9	15		9	15		9	15		9
Number of Detectors	1	2	1	1	2	1	1	2	1	1	2	
Detector Template	Left	Thru	Right	Left	Thru	Right	Left	Thru	Right	Left	Thru	
Leading Detector (ft)	20	100	20	20	100	20	20	100	20	20	100	
Trailing Detector (ft)	0	0	0	0	0	0	0	0	0	0	0	
Detector 1 Position(ft)	0	0	0	0	0	0	0	0	0	0	0	
Detector 1 Size(ft)	20	6	20	20	6	20	20	6	20	20	6	
Detector 1 Type	Cl+Ex	Cl+Ex	Cl+Ex	Cl+Ex	Cl+Ex	Cl+Ex	Cl+Ex	Cl+Ex	Cl+Ex	Cl+Ex	Cl+Ex	
Detector 1 Channel												
Detector 1 Extend (s)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Detector 1 Queue (s)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Detector 1 Delay (s)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Detector 2 Position(ft)		94			94			94			94	
Detector 2 Size(ft)		6			6			6			6	
Detector 2 Type		Cl+Ex			Cl+Ex			Cl+Ex			Cl+Ex	
Detector 2 Channel												
Detector 2 Extend (s)		0.0			0.0			0.0			0.0	
Turn Type	Prot	NA	pt+ov	Prot	NA	Prot	pm+pt	NA	Free	Perm	NA	
Protected Phases	5	2	2 3	1	6	6	3	8			4	

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MDM Transportation Consultants, Inc.

Lanes, Volumes, Timings
1: 93 SB Off-Ramp/Cross Street & Pelham Street

2023 Baseline Condition
Weekday Morning Peak Hour

												
Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Permitted Phases							8		Free	4		
Detector Phase	5	2	2 3	1	6	6	3	8		4	4	
Switch Phase												
Minimum Initial (s)	4.0	12.0		4.0	12.0	12.0	4.0	4.0		4.0	4.0	
Minimum Split (s)	10.0	18.0		10.0	18.0	18.0	10.0	10.0		10.0	10.0	
Total Split (s)	21.0	50.0		21.0	50.0	50.0	21.0	51.0		30.0	30.0	
Total Split (%)	17.2%	41.0%		17.2%	41.0%	41.0%	17.2%	41.8%		24.6%	24.6%	
Maximum Green (s)	15.0	44.0		15.0	44.0	44.0	15.0	45.0		24.0	24.0	
Yellow Time (s)	4.0	4.0		4.0	4.0	4.0	4.0	4.0		4.0	4.0	
All-Red Time (s)	2.0	2.0		2.0	2.0	2.0	2.0	2.0		2.0	2.0	
Lost Time Adjust (s)	-3.0	-3.0		-3.0	-3.0	-3.0	-3.0	-3.0		-3.0	-3.0	
Total Lost Time (s)	3.0	3.0		3.0	3.0	3.0	3.0	3.0		3.0	3.0	
Lead/Lag	Lead	Lag		Lead	Lag	Lag	Lead			Lag	Lag	
Lead-Lag Optimize?	Yes	Yes		Yes	Yes	Yes	Yes			Yes	Yes	
Vehicle Extension (s)	3.0	3.0		3.0	3.0	3.0	3.0	3.0		3.0	3.0	
Recall Mode	None	Min		None	Min	Min	None	None		None	None	
Act Effect Green (s)	10.8	39.9	57.8	17.5	52.4	52.4	38.7	38.7	105.3	20.8	20.8	
Actuated g/C Ratio	0.10	0.38	0.55	0.17	0.50	0.50	0.37	0.37	1.00	0.20	0.20	
v/c Ratio	0.19	0.81	0.30	0.71	0.44	0.18	0.41	0.05	0.08	0.58	0.61	
Control Delay	51.3	41.0	2.4	60.0	22.4	4.0	27.8	23.3	0.1	50.2	47.6	
Queue Delay	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Total Delay	51.3	41.0	2.4	60.0	22.4	4.0	27.8	23.3	0.1	50.2	47.6	
LOS	D	D	A	E	C	A	C	C	A	D	D	
Approach Delay		28.9			29.0			15.7			48.7	
Approach LOS		C			C			B			D	
90th %ile Green (s)	10.7	44.0		15.0	48.3	48.3	15.0	45.0		24.0	24.0	
90th %ile Term Code	Gap	Max		Max	Hold	Hold	Max	Hold		Max	Max	
70th %ile Green (s)	8.8	44.0		15.0	50.2	50.2	14.5	42.7		22.2	22.2	
70th %ile Term Code	Gap	Max		Max	Hold	Hold	Gap	Hold		Gap	Gap	
50th %ile Green (s)	7.6	41.4		15.0	48.8	48.8	12.4	37.1		18.7	18.7	
50th %ile Term Code	Gap	Gap		Max	Hold	Hold	Gap	Hold		Gap	Gap	
30th %ile Green (s)	0.0	33.1		15.0	54.1	54.1	10.1	31.0		14.9	14.9	
30th %ile Term Code	Skip	Gap		Max	Hold	Hold	Gap	Hold		Gap	Gap	
10th %ile Green (s)	0.0	23.3		11.2	40.5	40.5	7.4	23.8		10.4	10.4	
10th %ile Term Code	Skip	Gap		Gap	Hold	Hold	Gap	Hold		Gap	Gap	
Queue Length 50th (ft)	20	340	0	139	179	0	75	15	0	101	136	
Queue Length 95th (ft)	51	533	38	#278	311	40	129	38	0	180	226	
Internal Link Dist (ft)		120			170			220			420	
Turn Bay Length (ft)								200				
Base Capacity (vph)	267	832	971	299	867	831	411	834	1615	355	459	
Starvation Cap Reductn	0	0	0	0	0	0	0	0	0	0	0	
Spillback Cap Reductn	0	0	0	0	0	0	0	0	0	0	0	
Storage Cap Reductn	0	0	0	0	0	0	0	0	0	0	0	
Reduced v/c Ratio	0.11	0.67	0.28	0.67	0.43	0.18	0.37	0.04	0.08	0.43	0.46	

Intersection Summary

Area Type: Other

Cycle Length: 122

Actuated Cycle Length: 105.3

Lanes, Volumes, Timings

1: 93 SB Off-Ramp/Cross Street & Pelham Street

2023 Baseline Condition
Weekday Morning Peak Hour

Natural Cycle: 60

Control Type: Actuated-Uncoordinated

Maximum v/c Ratio: 0.81

Intersection Signal Delay: 30.3

Intersection LOS: C

Intersection Capacity Utilization 68.6%

ICU Level of Service C

Analysis Period (min) 15

90th %ile Actuated Cycle: 122

70th %ile Actuated Cycle: 119.7

50th %ile Actuated Cycle: 111.5

30th %ile Actuated Cycle: 97.1

10th %ile Actuated Cycle: 76.3

95th percentile volume exceeds capacity, queue may be longer.

Queue shown is maximum after two cycles.

Splits and Phases: 1: 93 SB Off-Ramp/Cross Street & Pelham Street

 Ø1	 Ø2	 Ø3	 Ø4
21 s	50 s	21 s	30 s
 Ø5	 Ø6	 Ø8	
21 s	50 s	51 s	

HCM 6th TWSC
3: Pelham Street & Site Driveway

2023 Baseline Condition
Weekday Morning Peak Hour

Intersection

Int Delay, s/veh 0

Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Traffic Vol, veh/h	1	792	510	1	0	2
Future Vol, veh/h	1	792	510	1	0	2
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Free	Free	Free	Free	Stop	Stop
RT Channelized	-	None	-	None	-	None
Storage Length	-	-	-	-	0	-
Veh in Median Storage, #	-	0	0	-	0	-
Grade, %	-	0	0	-	0	-
Peak Hour Factor	94	94	94	94	94	94
Heavy Vehicles, %	0	8	11	0	0	0
Mvmt Flow	1	843	543	1	0	2

Major/Minor	Major1	Major2	Minor2
Conflicting Flow All	544	0	0 1389 544
Stage 1	-	-	- 544 -
Stage 2	-	-	- 845 -
Critical Hdwy	4.1	-	- 5.8 5.8
Critical Hdwy Stg 1	-	-	- 5.4 -
Critical Hdwy Stg 2	-	-	- 5.4 -
Follow-up Hdwy	2.2	-	- 3.5 3.3
Pot Cap-1 Maneuver	1035	-	- 200 577
Stage 1	-	-	- 586 -
Stage 2	-	-	- 425 -
Platoon blocked, %		-	-
Mov Cap-1 Maneuver	1035	-	- 200 577
Mov Cap-2 Maneuver	-	-	- 200 -
Stage 1	-	-	- 585 -
Stage 2	-	-	- 425 -

Approach	EB	WB	SB
HCM Control Delay, s	0	0	11.3
HCM LOS			B

Minor Lane/Major Mvmt	EBL	EBT	WBT	WBR	SBLn1
Capacity (veh/h)	1035	-	-	-	577
HCM Lane V/C Ratio	0.001	-	-	-	0.004
HCM Control Delay (s)	8.5	0	-	-	11.3
HCM Lane LOS	A	A	-	-	B
HCM 95th %tile Q(veh)	0	-	-	-	0

Lanes, Volumes, Timings

1: 93 SB Off-Ramp/Cross Street & Pelham Street

2023 Baseline Condition

Weekday Midday Peak Hour

												
Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	47	330	148	104	306	196	151	37	110	141	108	45
Future Volume (vph)	47	330	148	104	306	196	151	37	110	141	108	45
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Storage Length (ft)	0		0	0		0	0		200	0		0
Storage Lanes	1		1	1		1	1		1	1		0
Taper Length (ft)	25			25			25			25		
Lane Util. Factor	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Frt			0.850			0.850			0.850		0.956	
Flt Protected	0.950			0.950			0.950			0.950		
Satd. Flow (prot)	1703	1792	1346	1687	1667	1524	1641	1845	1615	1719	1710	0
Flt Permitted	0.950			0.950			0.421			0.729		
Satd. Flow (perm)	1703	1792	1346	1687	1667	1524	727	1845	1615	1319	1710	0
Right Turn on Red			Yes			Yes			Yes			Yes
Satd. Flow (RTOR)			172			228			188		16	
Link Speed (mph)		30			30			30			30	
Link Distance (ft)		200			250			300			500	
Travel Time (s)		4.5			5.7			6.8			11.4	
Peak Hour Factor	0.86	0.86	0.86	0.86	0.86	0.86	0.86	0.86	0.86	0.86	0.86	0.86
Heavy Vehicles (%)	6%	6%	20%	7%	14%	6%	10%	3%	0%	5%	8%	2%
Adj. Flow (vph)	55	384	172	121	356	228	176	43	128	164	126	52
Shared Lane Traffic (%)												
Lane Group Flow (vph)	55	384	172	121	356	228	176	43	128	164	178	0
Enter Blocked Intersection	No	No	No	No	No	No	No	No	No	No	No	No
Lane Alignment	Left	Left	Right	Left	Left	Right	Left	Left	Right	Left	Left	Right
Median Width(ft)		12			12			12			12	
Link Offset(ft)		0			0			0			0	
Crosswalk Width(ft)		16			16			16			16	
Two way Left Turn Lane												
Headway Factor	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Turning Speed (mph)	15		9	15		9	15		9	15		9
Number of Detectors	1	2	1	1	2	1	1	2	1	1	2	
Detector Template	Left	Thru	Right	Left	Thru	Right	Left	Thru	Right	Left	Thru	
Leading Detector (ft)	20	100	20	20	100	20	20	100	20	20	100	
Trailing Detector (ft)	0	0	0	0	0	0	0	0	0	0	0	
Detector 1 Position(ft)	0	0	0	0	0	0	0	0	0	0	0	
Detector 1 Size(ft)	20	6	20	20	6	20	20	6	20	20	6	
Detector 1 Type	Cl+Ex	Cl+Ex	Cl+Ex	Cl+Ex	Cl+Ex	Cl+Ex	Cl+Ex	Cl+Ex	Cl+Ex	Cl+Ex	Cl+Ex	
Detector 1 Channel												
Detector 1 Extend (s)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Detector 1 Queue (s)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Detector 1 Delay (s)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Detector 2 Position(ft)		94			94			94			94	
Detector 2 Size(ft)		6			6			6			6	
Detector 2 Type		Cl+Ex			Cl+Ex			Cl+Ex			Cl+Ex	
Detector 2 Channel												
Detector 2 Extend (s)		0.0			0.0			0.0			0.0	
Turn Type	Prot	NA	pt+ov	Prot	NA	Prot	pm+pt	NA	Free	Perm	NA	
Protected Phases	5	2	2 3	1	6	6	3	8			4	

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MDM Transportation Consultants, Inc.

Lanes, Volumes, Timings
1: 93 SB Off-Ramp/Cross Street & Pelham Street

2023 Baseline Condition
Weekday Midday Peak Hour

												
Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Permitted Phases							8		Free	4		
Detector Phase	5	2	2 3	1	6	6	3	8		4	4	
Switch Phase												
Minimum Initial (s)	4.0	12.0		4.0	12.0	12.0	4.0	4.0		4.0	4.0	
Minimum Split (s)	10.0	18.0		10.0	18.0	18.0	10.0	10.0		10.0	10.0	
Total Split (s)	21.0	50.0		21.0	50.0	50.0	21.0	51.0		30.0	30.0	
Total Split (%)	17.2%	41.0%		17.2%	41.0%	41.0%	17.2%	41.8%		24.6%	24.6%	
Maximum Green (s)	15.0	44.0		15.0	44.0	44.0	15.0	45.0		24.0	24.0	
Yellow Time (s)	4.0	4.0		4.0	4.0	4.0	4.0	4.0		4.0	4.0	
All-Red Time (s)	2.0	2.0		2.0	2.0	2.0	2.0	2.0		2.0	2.0	
Lost Time Adjust (s)	-3.0	-3.0		-3.0	-3.0	-3.0	-3.0	-3.0		-3.0	-3.0	
Total Lost Time (s)	3.0	3.0		3.0	3.0	3.0	3.0	3.0		3.0	3.0	
Lead/Lag	Lead	Lag		Lead	Lag	Lag	Lead			Lag	Lag	
Lead-Lag Optimize?	Yes	Yes		Yes	Yes	Yes	Yes			Yes	Yes	
Vehicle Extension (s)	3.0	3.0		3.0	3.0	3.0	3.0	3.0		3.0	3.0	
Recall Mode	None	Min		None	Min	Min	None	None		None	None	
Act Effect Green (s)	11.9	29.4	47.4	14.9	35.8	35.8	37.8	37.8	91.6	19.7	19.7	
Actuated g/C Ratio	0.13	0.32	0.52	0.16	0.39	0.39	0.41	0.41	1.00	0.22	0.22	
v/c Ratio	0.25	0.67	0.22	0.44	0.55	0.31	0.39	0.06	0.08	0.58	0.47	
Control Delay	45.0	34.3	2.8	45.2	28.2	4.4	22.8	19.5	0.1	44.5	35.8	
Queue Delay	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Total Delay	45.0	34.3	2.8	45.2	28.2	4.4	22.8	19.5	0.1	44.5	35.8	
LOS	D	C	A	D	C	A	C	B	A	D	D	
Approach Delay		26.4			23.4			14.0			40.0	
Approach LOS		C			C			B			D	
90th %ile Green (s)	12.8	41.4		15.0	43.6	43.6	15.0	45.0		24.0	24.0	
90th %ile Term Code	Gap	Gap		Max	Hold	Hold	Max	Hold		Max	Max	
70th %ile Green (s)	10.3	33.5		15.0	38.2	38.2	15.0	42.6		21.6	21.6	
70th %ile Term Code	Gap	Gap		Max	Hold	Hold	Max	Hold		Gap	Gap	
50th %ile Green (s)	8.5	26.2		12.2	29.9	29.9	11.9	34.9		17.0	17.0	
50th %ile Term Code	Gap	Gap		Gap	Hold	Hold	Gap	Hold		Gap	Gap	
30th %ile Green (s)	7.1	19.9		9.7	22.5	22.5	9.5	28.6		13.1	13.1	
30th %ile Term Code	Gap	Gap		Gap	Hold	Hold	Gap	Hold		Gap	Gap	
10th %ile Green (s)	0.0	14.1		7.2	27.3	27.3	7.4	22.5		9.1	9.1	
10th %ile Term Code	Skip	Gap		Gap	Hold	Hold	Gap	Hold		Gap	Gap	
Queue Length 50th (ft)	29	191	0	63	165	0	65	14	0	85	81	
Queue Length 95th (ft)	76	316	27	141	288	42	137	42	0	177	169	
Internal Link Dist (ft)		120			170			220			420	
Turn Bay Length (ft)									200			
Base Capacity (vph)	354	973	876	351	905	932	490	1023	1615	411	544	
Starvation Cap Reductn	0	0	0	0	0	0	0	0	0	0	0	
Spillback Cap Reductn	0	0	0	0	0	0	0	0	0	0	0	
Storage Cap Reductn	0	0	0	0	0	0	0	0	0	0	0	
Reduced v/c Ratio	0.16	0.39	0.20	0.34	0.39	0.24	0.36	0.04	0.08	0.40	0.33	

Intersection Summary

Area Type: Other

Cycle Length: 122

Actuated Cycle Length: 91.6

Lanes, Volumes, Timings

1: 93 SB Off-Ramp/Cross Street & Pelham Street

2023 Baseline Condition
Weekday Midday Peak Hour

Natural Cycle: 60

Control Type: Actuated-Uncoordinated

Maximum v/c Ratio: 0.67

Intersection Signal Delay: 25.5

Intersection LOS: C

Intersection Capacity Utilization 53.3%

ICU Level of Service A

Analysis Period (min) 15

90th %ile Actuated Cycle: 119.4

70th %ile Actuated Cycle: 109.1

50th %ile Actuated Cycle: 91.3

30th %ile Actuated Cycle: 76.2

10th %ile Actuated Cycle: 61.8

Splits and Phases: 1: 93 SB Off-Ramp/Cross Street & Pelham Street

 Ø1	 Ø2	 Ø3	 Ø4
21 s	50 s	21 s	30 s
 Ø5	 Ø6	 Ø8	
21 s	50 s	51 s	

HCM 6th TWSC
3: Pelham Street & Site Driveway

2023 Baseline Condition
Weekday Midday Peak Hour

Intersection

Int Delay, s/veh 0.2

Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Traffic Vol, veh/h	5	522	497	5	3	7
Future Vol, veh/h	5	522	497	5	3	7
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Free	Free	Free	Free	Stop	Stop
RT Channelized	-	None	-	None	-	None
Storage Length	-	-	-	-	0	-
Veh in Median Storage, #	-	0	0	-	0	-
Grade, %	-	0	0	-	0	-
Peak Hour Factor	88	88	88	88	88	88
Heavy Vehicles, %	0	11	12	20	33	0
Mvmt Flow	6	593	565	6	3	8

Major/Minor	Major1	Major2	Minor2
Conflicting Flow All	571	0	0 1173 568
Stage 1	-	-	- 568 -
Stage 2	-	-	- 605 -
Critical Hdwy	4.1	-	- 5.8 5.8
Critical Hdwy Stg 1	-	-	- 5.73 -
Critical Hdwy Stg 2	-	-	- 5.73 -
Follow-up Hdwy	2.2	-	- 3.797 3.3
Pot Cap-1 Maneuver	1012	-	- 250 560
Stage 1	-	-	- 510 -
Stage 2	-	-	- 490 -
Platoon blocked, %		-	-
Mov Cap-1 Maneuver	1012	-	- 248 560
Mov Cap-2 Maneuver	-	-	- 248 -
Stage 1	-	-	- 505 -
Stage 2	-	-	- 490 -

Approach	EB	WB	SB
HCM Control Delay, s	0.1	0	14.1
HCM LOS			B

Minor Lane/Major Mvmt	EBL	EBT	WBT	WBR	SBLn1
Capacity (veh/h)	1012	-	-	-	407
HCM Lane V/C Ratio	0.006	-	-	-	0.028
HCM Control Delay (s)	8.6	0	-	-	14.1
HCM Lane LOS	A	A	-	-	B
HCM 95th %tile Q(veh)	0	-	-	-	0.1

Lanes, Volumes, Timings

1: 93 SB Off-Ramp/Cross Street & Pelham Street

2023 Baseline Condition

Weekday Evening Peak Hour

												
Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	58	437	124	119	370	337	248	47	197	164	140	52
Future Volume (vph)	58	437	124	119	370	337	248	47	197	164	140	52
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Storage Length (ft)	0		0	0		0	0		200	0		0
Storage Lanes	1		1	1		1	1		1	1		0
Taper Length (ft)	25			25			25			25		
Lane Util. Factor	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Frt			0.850			0.850			0.850		0.959	
Flt Protected	0.950			0.950			0.950			0.950		
Satd. Flow (prot)	1805	1881	1482	1719	1845	1524	1736	1827	1538	1770	1737	0
Flt Permitted	0.950			0.950			0.375			0.726		
Satd. Flow (perm)	1805	1881	1482	1719	1845	1524	685	1827	1538	1352	1737	0
Right Turn on Red			Yes			Yes			Yes			Yes
Satd. Flow (RTOR)			128			347			203		14	
Link Speed (mph)		30			30			30			30	
Link Distance (ft)		200			250			300			500	
Travel Time (s)		4.5			5.7			6.8			11.4	
Peak Hour Factor	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97
Heavy Vehicles (%)	0%	1%	9%	5%	3%	6%	4%	4%	5%	2%	6%	2%
Adj. Flow (vph)	60	451	128	123	381	347	256	48	203	169	144	54
Shared Lane Traffic (%)												
Lane Group Flow (vph)	60	451	128	123	381	347	256	48	203	169	198	0
Enter Blocked Intersection	No	No	No	No	No	No	No	No	No	No	No	No
Lane Alignment	Left	Left	Right	Left	Left	Right	Left	Left	Right	Left	Left	Right
Median Width(ft)		12			12			12			12	
Link Offset(ft)		0			0			0			0	
Crosswalk Width(ft)		16			16			16			16	
Two way Left Turn Lane												
Headway Factor	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Turning Speed (mph)	15		9	15		9	15		9	15		9
Number of Detectors	1	2	1	1	2	1	1	2	1	1	2	
Detector Template	Left	Thru	Right	Left	Thru	Right	Left	Thru	Right	Left	Thru	
Leading Detector (ft)	20	100	20	20	100	20	20	100	20	20	100	
Trailing Detector (ft)	0	0	0	0	0	0	0	0	0	0	0	
Detector 1 Position(ft)	0	0	0	0	0	0	0	0	0	0	0	
Detector 1 Size(ft)	20	6	20	20	6	20	20	6	20	20	6	
Detector 1 Type	Cl+Ex	Cl+Ex	Cl+Ex	Cl+Ex	Cl+Ex	Cl+Ex	Cl+Ex	Cl+Ex	Cl+Ex	Cl+Ex	Cl+Ex	
Detector 1 Channel												
Detector 1 Extend (s)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Detector 1 Queue (s)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Detector 1 Delay (s)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Detector 2 Position(ft)		94			94			94			94	
Detector 2 Size(ft)		6			6			6			6	
Detector 2 Type		Cl+Ex			Cl+Ex			Cl+Ex			Cl+Ex	
Detector 2 Channel												
Detector 2 Extend (s)		0.0			0.0			0.0			0.0	
Turn Type	Prot	NA	pt+ov	Prot	NA	Prot	pm+pt	NA	Free	Perm	NA	
Protected Phases	5	2	2 3	1	6	6	3	8			4	

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MDM Transportation Consultants, Inc.

Lanes, Volumes, Timings
1: 93 SB Off-Ramp/Cross Street & Pelham Street

2023 Baseline Condition
Weekday Evening Peak Hour

												
Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Permitted Phases							8		Free	4		
Detector Phase	5	2	2 3	1	6	6	3	8		4	4	
Switch Phase												
Minimum Initial (s)	4.0	12.0		4.0	12.0	12.0	4.0	4.0		4.0	4.0	
Minimum Split (s)	10.0	18.0		10.0	18.0	18.0	10.0	10.0		10.0	10.0	
Total Split (s)	21.0	50.0		21.0	50.0	50.0	21.0	51.0		30.0	30.0	
Total Split (%)	17.2%	41.0%		17.2%	41.0%	41.0%	17.2%	41.8%		24.6%	24.6%	
Maximum Green (s)	15.0	44.0		15.0	44.0	44.0	15.0	45.0		24.0	24.0	
Yellow Time (s)	4.0	4.0		4.0	4.0	4.0	4.0	4.0		4.0	4.0	
All-Red Time (s)	2.0	2.0		2.0	2.0	2.0	2.0	2.0		2.0	2.0	
Lost Time Adjust (s)	-3.0	-3.0		-3.0	-3.0	-3.0	-3.0	-3.0		-3.0	-3.0	
Total Lost Time (s)	3.0	3.0		3.0	3.0	3.0	3.0	3.0		3.0	3.0	
Lead/Lag	Lead	Lag		Lead	Lag	Lag	Lead			Lag	Lag	
Lead-Lag Optimize?	Yes	Yes		Yes	Yes	Yes	Yes			Yes	Yes	
Vehicle Extension (s)	3.0	3.0		3.0	3.0	3.0	3.0	3.0		3.0	3.0	
Recall Mode	None	Min		None	Min	Min	None	None		None	None	
Act Effect Green (s)	12.1	32.8	52.4	15.0	39.2	39.2	39.9	39.9	97.2	20.3	20.3	
Actuated g/C Ratio	0.12	0.34	0.54	0.15	0.40	0.40	0.41	0.41	1.00	0.21	0.21	
v/c Ratio	0.27	0.71	0.15	0.46	0.51	0.42	0.56	0.06	0.13	0.60	0.53	
Control Delay	47.5	35.9	2.7	48.3	27.2	4.2	27.0	20.7	0.2	47.6	40.0	
Queue Delay	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Total Delay	47.5	35.9	2.7	48.3	27.2	4.2	27.0	20.7	0.2	47.6	40.0	
LOS	D	D	A	D	C	A	C	C	A	D	D	
Approach Delay		30.3			20.9			15.7			43.5	
Approach LOS		C			C			B			D	
90th %ile Green (s)	13.0	44.0		15.0	46.0	46.0	15.0	45.0		24.0	24.0	
90th %ile Term Code	Gap	Max		Max	Hold	Hold	Max	Hold		Max	Max	
70th %ile Green (s)	10.5	37.4		15.0	41.9	41.9	15.0	43.4		22.4	22.4	
70th %ile Term Code	Gap	Gap		Max	Hold	Hold	Max	Hold		Gap	Gap	
50th %ile Green (s)	8.8	30.2		12.6	34.0	34.0	15.0	38.9		17.9	17.9	
50th %ile Term Code	Gap	Gap		Gap	Hold	Hold	Max	Hold		Gap	Gap	
30th %ile Green (s)	7.3	24.1		10.1	26.9	26.9	12.2	32.1		13.9	13.9	
30th %ile Term Code	Gap	Gap		Gap	Hold	Hold	Gap	Hold		Gap	Gap	
10th %ile Green (s)	0.0	16.2		7.3	29.5	29.5	9.0	24.5		9.5	9.5	
10th %ile Term Code	Skip	Gap		Gap	Hold	Hold	Gap	Hold		Gap	Gap	
Queue Length 50th (ft)	35	249	0	72	189	0	108	18	0	98	104	
Queue Length 95th (ft)	86	399	28	154	319	58	214	50	0	196	206	
Internal Link Dist (ft)		120			170			220			420	
Turn Bay Length (ft)									200			
Base Capacity (vph)	351	955	919	334	942	948	485	947	1538	394	516	
Starvation Cap Reductn	0	0	0	0	0	0	0	0	0	0	0	
Spillback Cap Reductn	0	0	0	0	0	0	0	0	0	0	0	
Storage Cap Reductn	0	0	0	0	0	0	0	0	0	0	0	
Reduced v/c Ratio	0.17	0.47	0.14	0.37	0.40	0.37	0.53	0.05	0.13	0.43	0.38	

Intersection Summary

Area Type: Other

Cycle Length: 122

Actuated Cycle Length: 97.2

Lanes, Volumes, Timings

1: 93 SB Off-Ramp/Cross Street & Pelham Street

2023 Baseline Condition
Weekday Evening Peak Hour

Natural Cycle: 55

Control Type: Actuated-Uncoordinated

Maximum v/c Ratio: 0.71

Intersection Signal Delay: 25.8

Intersection LOS: C

Intersection Capacity Utilization 67.2%

ICU Level of Service C

Analysis Period (min) 15

90th %ile Actuated Cycle: 122

70th %ile Actuated Cycle: 113.8

50th %ile Actuated Cycle: 99.7

30th %ile Actuated Cycle: 84.3

10th %ile Actuated Cycle: 66

Splits and Phases: 1: 93 SB Off-Ramp/Cross Street & Pelham Street

 Ø1	 Ø2	 Ø3	 Ø4
21 s	50 s	21 s	30 s
 Ø5	 Ø6	 Ø8	
21 s	50 s	51 s	

HCM 6th TWSC
3: Pelham Street & Site Driveway

2023 Baseline Condition
Weekday Evening Peak Hour

Intersection

Int Delay, s/veh 0.2

Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Traffic Vol, veh/h	9	615	658	12	4	11
Future Vol, veh/h	9	615	658	12	4	11
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Free	Free	Free	Free	Stop	Stop
RT Channelized	-	None	-	None	-	None
Storage Length	-	-	-	-	0	-
Veh in Median Storage, #	-	0	0	-	0	-
Grade, %	-	0	0	-	0	-
Peak Hour Factor	97	97	97	97	97	97
Heavy Vehicles, %	0	3	4	0	0	0
Mvmt Flow	9	634	678	12	4	11

Major/Minor	Major1	Major2	Minor2
Conflicting Flow All	690	0	0 1336 684
Stage 1	-	-	- 684 -
Stage 2	-	-	- 652 -
Critical Hdwy	4.1	-	- 5.8 5.8
Critical Hdwy Stg 1	-	-	- 5.4 -
Critical Hdwy Stg 2	-	-	- 5.4 -
Follow-up Hdwy	2.2	-	- 3.5 3.3
Pot Cap-1 Maneuver	914	-	- 213 488
Stage 1	-	-	- 505 -
Stage 2	-	-	- 522 -
Platoon blocked, %	-	-	-
Mov Cap-1 Maneuver	914	-	- 210 488
Mov Cap-2 Maneuver	-	-	- 210 -
Stage 1	-	-	- 497 -
Stage 2	-	-	- 522 -

Approach	EB	WB	SB
HCM Control Delay, s	0.1	0	15.4
HCM LOS			C

Minor Lane/Major Mvmt	EBL	EBT	WBT	WBR	SBLn1
Capacity (veh/h)	914	-	-	-	361
HCM Lane V/C Ratio	0.01	-	-	-	0.043
HCM Control Delay (s)	9	0	-	-	15.4
HCM Lane LOS	A	A	-	-	C
HCM 95th %tile Q(veh)	0	-	-	-	0.1

Lanes, Volumes, Timings

1: 93 SB Off-Ramp/Cross Street & Pelham Street

2023 Baseline Condition

Saturday Midday Peak Hour

												
Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	50	322	161	122	269	298	155	52	137	178	169	41
Future Volume (vph)	50	322	161	122	269	298	155	52	137	178	169	41
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Storage Length (ft)	0		0	0		0	0		200	0		0
Storage Lanes	1		1	1		1	1		1	1		0
Taper Length (ft)	25			25			25			25		
Lane Util. Factor	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Frt			0.850			0.850			0.850		0.971	
Flt Protected	0.950			0.950			0.950			0.950		
Satd. Flow (prot)	1770	1863	1538	1770	1827	1599	1752	1827	1615	1787	1823	0
Flt Permitted	0.950			0.950			0.364			0.720		
Satd. Flow (perm)	1770	1863	1538	1770	1827	1599	671	1827	1615	1354	1823	0
Right Turn on Red			Yes			Yes			Yes			Yes
Satd. Flow (RTOR)			173			320			188		9	
Link Speed (mph)		30			30			30			30	
Link Distance (ft)		200			250			300			500	
Travel Time (s)		4.5			5.7			6.8			11.4	
Peak Hour Factor	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93
Heavy Vehicles (%)	2%	2%	5%	2%	4%	1%	3%	4%	0%	1%	1%	2%
Adj. Flow (vph)	54	346	173	131	289	320	167	56	147	191	182	44
Shared Lane Traffic (%)												
Lane Group Flow (vph)	54	346	173	131	289	320	167	56	147	191	226	0
Enter Blocked Intersection	No	No	No	No	No	No	No	No	No	No	No	No
Lane Alignment	Left	Left	Right	Left	Left	Right	Left	Left	Right	Left	Left	Right
Median Width(ft)		12			12			12			12	
Link Offset(ft)		0			0			0			0	
Crosswalk Width(ft)		16			16			16			16	
Two way Left Turn Lane												
Headway Factor	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Turning Speed (mph)	15		9	15		9	15		9	15		9
Number of Detectors	1	2	1	1	2	1	1	2	1	1	2	
Detector Template	Left	Thru	Right	Left	Thru	Right	Left	Thru	Right	Left	Thru	
Leading Detector (ft)	20	100	20	20	100	20	20	100	20	20	100	
Trailing Detector (ft)	0	0	0	0	0	0	0	0	0	0	0	
Detector 1 Position(ft)	0	0	0	0	0	0	0	0	0	0	0	
Detector 1 Size(ft)	20	6	20	20	6	20	20	6	20	20	6	
Detector 1 Type	Cl+Ex	Cl+Ex	Cl+Ex	Cl+Ex	Cl+Ex	Cl+Ex	Cl+Ex	Cl+Ex	Cl+Ex	Cl+Ex	Cl+Ex	
Detector 1 Channel												
Detector 1 Extend (s)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Detector 1 Queue (s)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Detector 1 Delay (s)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Detector 2 Position(ft)		94			94			94			94	
Detector 2 Size(ft)		6			6			6			6	
Detector 2 Type		Cl+Ex			Cl+Ex			Cl+Ex			Cl+Ex	
Detector 2 Channel												
Detector 2 Extend (s)		0.0			0.0			0.0			0.0	
Turn Type	Prot	NA	pt+ov	Prot	NA	Prot	pm+pt	NA	Free	Perm	NA	
Protected Phases	5	2	2 3	1	6	6	3	8			4	

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MDM Transportation Consultants, Inc.

Lanes, Volumes, Timings
1: 93 SB Off-Ramp/Cross Street & Pelham Street

2023 Baseline Condition
Saturday Midday Peak Hour

												
Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Permitted Phases							8		Free	4		
Detector Phase	5	2	2 3	1	6	6	3	8		4	4	
Switch Phase												
Minimum Initial (s)	4.0	12.0		4.0	12.0	12.0	4.0	4.0		4.0	4.0	
Minimum Split (s)	10.0	18.0		10.0	18.0	18.0	10.0	10.0		10.0	10.0	
Total Split (s)	21.0	50.0		21.0	50.0	50.0	21.0	51.0		30.0	30.0	
Total Split (%)	17.2%	41.0%		17.2%	41.0%	41.0%	17.2%	41.8%		24.6%	24.6%	
Maximum Green (s)	15.0	44.0		15.0	44.0	44.0	15.0	45.0		24.0	24.0	
Yellow Time (s)	4.0	4.0		4.0	4.0	4.0	4.0	4.0		4.0	4.0	
All-Red Time (s)	2.0	2.0		2.0	2.0	2.0	2.0	2.0		2.0	2.0	
Lost Time Adjust (s)	-3.0	-3.0		-3.0	-3.0	-3.0	-3.0	-3.0		-3.0	-3.0	
Total Lost Time (s)	3.0	3.0		3.0	3.0	3.0	3.0	3.0		3.0	3.0	
Lead/Lag	Lead	Lag		Lead	Lag	Lag	Lead			Lag	Lag	
Lead-Lag Optimize?	Yes	Yes		Yes	Yes	Yes	Yes			Yes	Yes	
Vehicle Extension (s)	3.0	3.0		3.0	3.0	3.0	3.0	3.0		3.0	3.0	
Recall Mode	None	Min		None	Min	Min	None	None		None	None	
Act Effect Green (s)	11.6	25.9	43.0	14.9	32.5	32.5	37.8	37.8	88.0	20.7	20.7	
Actuated g/C Ratio	0.13	0.29	0.49	0.17	0.37	0.37	0.43	0.43	1.00	0.24	0.24	
v/c Ratio	0.23	0.63	0.21	0.44	0.43	0.40	0.36	0.07	0.09	0.60	0.52	
Control Delay	42.6	34.1	2.9	42.3	26.1	4.5	20.0	17.4	0.1	41.6	35.3	
Queue Delay	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Total Delay	42.6	34.1	2.9	42.3	26.1	4.5	20.0	17.4	0.1	41.6	35.3	
LOS	D	C	A	D	C	A	C	B	A	D	D	
Approach Delay		25.4			19.6			11.7			38.2	
Approach LOS		C			B			B			D	
90th %ile Green (s)	12.0	35.1		15.0	38.1	38.1	15.0	45.0		24.0	24.0	
90th %ile Term Code	Gap	Gap		Max	Hold	Hold	Max	Hold		Max	Max	
70th %ile Green (s)	9.7	27.9		14.8	33.0	33.0	13.1	42.5		23.4	23.4	
70th %ile Term Code	Gap	Gap		Gap	Hold	Hold	Gap	Hold		Gap	Gap	
50th %ile Green (s)	8.3	23.3		12.2	27.2	27.2	10.8	34.8		18.0	18.0	
50th %ile Term Code	Gap	Gap		Gap	Hold	Hold	Gap	Hold		Gap	Gap	
30th %ile Green (s)	6.9	17.7		9.8	20.6	20.6	8.9	29.0		14.1	14.1	
30th %ile Term Code	Gap	Gap		Gap	Hold	Hold	Gap	Hold		Gap	Gap	
10th %ile Green (s)	0.0	12.7		7.3	26.0	26.0	7.1	23.0		9.9	9.9	
10th %ile Term Code	Skip	Gap		Gap	Hold	Hold	Gap	Hold		Gap	Gap	
Queue Length 50th (ft)	27	165	0	66	124	0	57	18	0	95	105	
Queue Length 95th (ft)	75	299	33	150	236	58	124	49	0	203	217	
Internal Link Dist (ft)		120			170			220			420	
Turn Bay Length (ft)									200			
Base Capacity (vph)	380	1045	981	380	1024	1037	520	1046	1615	436	593	
Starvation Cap Reductn	0	0	0	0	0	0	0	0	0	0	0	
Spillback Cap Reductn	0	0	0	0	0	0	0	0	0	0	0	
Storage Cap Reductn	0	0	0	0	0	0	0	0	0	0	0	
Reduced v/c Ratio	0.14	0.33	0.18	0.34	0.28	0.31	0.32	0.05	0.09	0.44	0.38	

Intersection Summary

Area Type: Other

Cycle Length: 122

Actuated Cycle Length: 88

Lanes, Volumes, Timings

1: 93 SB Off-Ramp/Cross Street & Pelham Street

2023 Baseline Condition
Saturday Midday Peak Hour

Natural Cycle: 55

Control Type: Actuated-Uncoordinated

Maximum v/c Ratio: 0.63

Intersection Signal Delay: 23.5

Intersection LOS: C

Intersection Capacity Utilization 57.0%

ICU Level of Service B

Analysis Period (min) 15

90th %ile Actuated Cycle: 113.1

70th %ile Actuated Cycle: 103.2

50th %ile Actuated Cycle: 88.3

30th %ile Actuated Cycle: 74.5

10th %ile Actuated Cycle: 61

Splits and Phases: 1: 93 SB Off-Ramp/Cross Street & Pelham Street

 Ø1	 Ø2	 Ø3	 Ø4
21 s	50 s	21 s	30 s
 Ø5	 Ø6	 Ø8	
21 s	50 s	51 s	

HCM 6th TWSC
3: Pelham Street & Site Driveway

2023 Baseline Condition
Saturday Midday Peak Hour

Intersection

Int Delay, s/veh 0.1

Movement EBL EBT WBT WBR SBL SBR

Lane Configurations						
Traffic Vol, veh/h	3	530	451	14	3	5
Future Vol, veh/h	3	530	451	14	3	5
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Free	Free	Free	Free	Stop	Stop
RT Channelized	-	None	-	None	-	None
Storage Length	-	-	-	-	0	-
Veh in Median Storage, #	-	0	0	-	0	-
Grade, %	-	0	0	-	0	-
Peak Hour Factor	90	90	90	90	90	90
Heavy Vehicles, %	0	4	4	0	0	0
Mvmt Flow	3	589	501	16	3	6

Major/Minor Major1 Major2 Minor2

Conflicting Flow All	517	0	-	0	1104	509
Stage 1	-	-	-	-	509	-
Stage 2	-	-	-	-	595	-
Critical Hdwy	4.1	-	-	-	5.8	5.8
Critical Hdwy Stg 1	-	-	-	-	5.4	-
Critical Hdwy Stg 2	-	-	-	-	5.4	-
Follow-up Hdwy	2.2	-	-	-	3.5	3.3
Pot Cap-1 Maneuver	1059	-	-	-	283	601
Stage 1	-	-	-	-	608	-
Stage 2	-	-	-	-	555	-
Platoon blocked, %		-	-	-		
Mov Cap-1 Maneuver	1059	-	-	-	282	601
Mov Cap-2 Maneuver	-	-	-	-	282	-
Stage 1	-	-	-	-	606	-
Stage 2	-	-	-	-	555	-

Approach EB WB SB

HCM Control Delay, s	0	0	13.7
HCM LOS			B

Minor Lane/Major Mvmt EBL EBT WBT WBR SBLn1

Capacity (veh/h)	1059	-	-	-	422
HCM Lane V/C Ratio	0.003	-	-	-	0.021
HCM Control Delay (s)	8.4	0	-	-	13.7
HCM Lane LOS	A	A	-	-	B
HCM 95th %tile Q(veh)	0	-	-	-	0.1

Lanes, Volumes, Timings

1: 93 SB Off-Ramp/Cross Street & Pelham Street

2023 Design Year Condition

Weekday Morning Peak Hour

												
Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	31	520	259	185	353	137	144	30	123	142	167	31
Future Volume (vph)	31	520	259	185	353	137	144	30	123	142	167	31
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Storage Length (ft)	0		0	0		0	0		200	0		0
Storage Lanes	1		1	1		1	1		1	1		0
Taper Length (ft)	25			25			25			25		
Lane Util. Factor	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Frt			0.850			0.850			0.850		0.976	
Flt Protected	0.950			0.950			0.950			0.950		
Satd. Flow (prot)	1517	1810	1468	1703	1712	1495	1703	1776	1615	1736	1712	0
Flt Permitted	0.950			0.950			0.315			0.736		
Satd. Flow (perm)	1517	1810	1468	1703	1712	1495	565	1776	1615	1345	1712	0
Right Turn on Red			Yes			Yes			Yes			Yes
Satd. Flow (RTOR)			282			149			188		7	
Link Speed (mph)		30			30			30			30	
Link Distance (ft)		200			250			300			500	
Travel Time (s)		4.5			5.7			6.8			11.4	
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Heavy Vehicles (%)	19%	5%	10%	6%	11%	8%	6%	7%	0%	4%	5%	26%
Adj. Flow (vph)	34	565	282	201	384	149	157	33	134	154	182	34
Shared Lane Traffic (%)												
Lane Group Flow (vph)	34	565	282	201	384	149	157	33	134	154	216	0
Enter Blocked Intersection	No	No	No	No	No	No	No	No	No	No	No	No
Lane Alignment	Left	Left	Right	Left	Left	Right	Left	Left	Right	Left	Left	Right
Median Width(ft)		12			12			12			12	
Link Offset(ft)		0			0			0			0	
Crosswalk Width(ft)		16			16			16			16	
Two way Left Turn Lane												
Headway Factor	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Turning Speed (mph)	15		9	15		9	15		9	15		9
Number of Detectors	1	2	1	1	2	1	1	2	1	1	2	
Detector Template	Left	Thru	Right	Left	Thru	Right	Left	Thru	Right	Left	Thru	
Leading Detector (ft)	20	100	20	20	100	20	20	100	20	20	100	
Trailing Detector (ft)	0	0	0	0	0	0	0	0	0	0	0	
Detector 1 Position(ft)	0	0	0	0	0	0	0	0	0	0	0	
Detector 1 Size(ft)	20	6	20	20	6	20	20	6	20	20	6	
Detector 1 Type	Cl+Ex	Cl+Ex	Cl+Ex	Cl+Ex	Cl+Ex	Cl+Ex	Cl+Ex	Cl+Ex	Cl+Ex	Cl+Ex	Cl+Ex	
Detector 1 Channel												
Detector 1 Extend (s)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Detector 1 Queue (s)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Detector 1 Delay (s)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Detector 2 Position(ft)		94			94			94			94	
Detector 2 Size(ft)		6			6			6			6	
Detector 2 Type		Cl+Ex			Cl+Ex			Cl+Ex			Cl+Ex	
Detector 2 Channel												
Detector 2 Extend (s)		0.0			0.0			0.0			0.0	
Turn Type	Prot	NA	pt+ov	Prot	NA	Prot	pm+pt	NA	Free	Perm	NA	
Protected Phases	5	2	2 3	1	6	6	3	8			4	

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MDM Transportation Consultants, Inc.

Lanes, Volumes, Timings
1: 93 SB Off-Ramp/Cross Street & Pelham Street

2023 Design Year Condition
Weekday Morning Peak Hour

												
Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Permitted Phases							8		Free	4		
Detector Phase	5	2	2 3	1	6	6	3	8		4	4	
Switch Phase												
Minimum Initial (s)	4.0	12.0		4.0	12.0	12.0	4.0	4.0		4.0	4.0	
Minimum Split (s)	10.0	18.0		10.0	18.0	18.0	10.0	10.0		10.0	10.0	
Total Split (s)	21.0	50.0		21.0	50.0	50.0	21.0	51.0		30.0	30.0	
Total Split (%)	17.2%	41.0%		17.2%	41.0%	41.0%	17.2%	41.8%		24.6%	24.6%	
Maximum Green (s)	15.0	44.0		15.0	44.0	44.0	15.0	45.0		24.0	24.0	
Yellow Time (s)	4.0	4.0		4.0	4.0	4.0	4.0	4.0		4.0	4.0	
All-Red Time (s)	2.0	2.0		2.0	2.0	2.0	2.0	2.0		2.0	2.0	
Lost Time Adjust (s)	-3.0	-3.0		-3.0	-3.0	-3.0	-3.0	-3.0		-3.0	-3.0	
Total Lost Time (s)	3.0	3.0		3.0	3.0	3.0	3.0	3.0		3.0	3.0	
Lead/Lag	Lead	Lag		Lead	Lag	Lag	Lead			Lag	Lag	
Lead-Lag Optimize?	Yes	Yes		Yes	Yes	Yes	Yes			Yes	Yes	
Vehicle Extension (s)	3.0	3.0		3.0	3.0	3.0	3.0	3.0		3.0	3.0	
Recall Mode	None	Min		None	Min	Min	None	None		None	None	
Act Effect Green (s)	11.2	40.6	58.8	17.5	52.8	52.8	39.3	39.3	106.7	21.1	21.1	
Actuated g/C Ratio	0.10	0.38	0.55	0.16	0.49	0.49	0.37	0.37	1.00	0.20	0.20	
v/c Ratio	0.22	0.82	0.30	0.72	0.45	0.18	0.43	0.05	0.08	0.58	0.63	
Control Delay	51.9	41.9	2.4	61.3	23.1	4.1	28.3	23.4	0.1	50.3	48.3	
Queue Delay	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Total Delay	51.9	41.9	2.4	61.3	23.1	4.1	28.3	23.4	0.1	50.3	48.3	
LOS	D	D	A	E	C	A	C	C	A	D	D	
Approach Delay		29.7			29.7			16.1			49.2	
Approach LOS		C			C			B			D	
90th %ile Green (s)	11.3	44.0		15.0	47.7	47.7	15.0	45.0		24.0	24.0	
90th %ile Term Code	Gap	Max		Max	Hold	Hold	Max	Hold		Max	Max	
70th %ile Green (s)	9.4	44.0		15.0	49.6	49.6	14.9	43.7		22.8	22.8	
70th %ile Term Code	Gap	Max		Max	Hold	Hold	Gap	Hold		Gap	Gap	
50th %ile Green (s)	8.0	42.9		15.0	49.9	49.9	12.9	38.1		19.2	19.2	
50th %ile Term Code	Gap	Gap		Max	Hold	Hold	Gap	Hold		Gap	Gap	
30th %ile Green (s)	0.0	34.2		15.0	55.2	55.2	10.4	31.7		15.3	15.3	
30th %ile Term Code	Skip	Gap		Max	Hold	Hold	Gap	Hold		Gap	Gap	
10th %ile Green (s)	0.0	24.2		11.3	41.5	41.5	7.6	24.3		10.7	10.7	
10th %ile Term Code	Skip	Gap		Gap	Hold	Hold	Gap	Hold		Gap	Gap	
Queue Length 50th (ft)	23	355	0	142	190	0	80	16	0	104	142	
Queue Length 95th (ft)	57	#548	38	#278	323	40	133	38	0	180	230	
Internal Link Dist (ft)		120			170			220			420	
Turn Bay Length (ft)									200			
Base Capacity (vph)	263	820	969	295	858	824	405	821	1615	350	450	
Starvation Cap Reductn	0	0	0	0	0	0	0	0	0	0	0	
Spillback Cap Reductn	0	0	0	0	0	0	0	0	0	0	0	
Storage Cap Reductn	0	0	0	0	0	0	0	0	0	0	0	
Reduced v/c Ratio	0.13	0.69	0.29	0.68	0.45	0.18	0.39	0.04	0.08	0.44	0.48	

Intersection Summary

Area Type: Other

Cycle Length: 122

Actuated Cycle Length: 106.7

Lanes, Volumes, Timings

1: 93 SB Off-Ramp/Cross Street & Pelham Street

2023 Design Year Condition
Weekday Morning Peak Hour

Natural Cycle: 60

Control Type: Actuated-Uncoordinated

Maximum v/c Ratio: 0.82

Intersection Signal Delay: 30.9

Intersection LOS: C

Intersection Capacity Utilization 69.6%

ICU Level of Service C

Analysis Period (min) 15

90th %ile Actuated Cycle: 122

70th %ile Actuated Cycle: 120.7

50th %ile Actuated Cycle: 114

30th %ile Actuated Cycle: 98.9

10th %ile Actuated Cycle: 77.8

95th percentile volume exceeds capacity, queue may be longer.

Queue shown is maximum after two cycles.

Splits and Phases: 1: 93 SB Off-Ramp/Cross Street & Pelham Street

 Ø1	 Ø2	 Ø3	 Ø4
21 s	50 s	21 s	30 s
 Ø5	 Ø6	 Ø8	
21 s	50 s	51 s	

HCM 6th TWSC
3: Pelham Street & Site Driveway

2023 Design Year Condition
Weekday Morning Peak Hour

Intersection

Int Delay, s/veh 0.5

Movement EBL EBT WBT WBR SBL SBR

Lane Configurations						
Traffic Vol, veh/h	7	792	510	18	18	7
Future Vol, veh/h	7	792	510	18	18	7
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Free	Free	Free	Free	Stop	Stop
RT Channelized	-	None	-	None	-	None
Storage Length	-	-	-	-	0	-
Veh in Median Storage, #	-	0	0	-	0	-
Grade, %	-	0	0	-	0	-
Peak Hour Factor	94	94	94	94	94	94
Heavy Vehicles, %	0	8	11	0	0	0
Mvmt Flow	7	843	543	19	19	7

Major/Minor Major1 Major2 Minor2

Conflicting Flow All	562	0	-	0	1410	553
Stage 1	-	-	-	-	553	-
Stage 2	-	-	-	-	857	-
Critical Hdwy	4.1	-	-	-	5.8	5.8
Critical Hdwy Stg 1	-	-	-	-	5.4	-
Critical Hdwy Stg 2	-	-	-	-	5.4	-
Follow-up Hdwy	2.2	-	-	-	3.5	3.3
Pot Cap-1 Maneuver	1019	-	-	-	195	571
Stage 1	-	-	-	-	580	-
Stage 2	-	-	-	-	419	-
Platoon blocked, %		-	-	-		
Mov Cap-1 Maneuver	1019	-	-	-	192	571
Mov Cap-2 Maneuver	-	-	-	-	192	-
Stage 1	-	-	-	-	572	-
Stage 2	-	-	-	-	419	-

Approach EB WB SB

HCM Control Delay, s	0.1	0	22.2
HCM LOS			C

Minor Lane/Major Mvmt EBL EBT WBT WBR SBLn1

Capacity (veh/h)	1019	-	-	-	236
HCM Lane V/C Ratio	0.007	-	-	-	0.113
HCM Control Delay (s)	8.6	0	-	-	22.2
HCM Lane LOS	A	A	-	-	C
HCM 95th %tile Q(veh)	0	-	-	-	0.4

Lanes, Volumes, Timings
1: 93 SB Off-Ramp/Cross Street & Pelham Street

2023 Design Year Condition
Weekday Midday Peak Hour

												
Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	54	344	157	104	319	196	159	37	110	141	108	52
Future Volume (vph)	54	344	157	104	319	196	159	37	110	141	108	52
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Storage Length (ft)	0		0	0		0	0		200	0		0
Storage Lanes	1		1	1		1	1		1	1		0
Taper Length (ft)	25			25			25			25		
Lane Util. Factor	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Frt			0.850			0.850			0.850		0.952	
Flt Protected	0.950			0.950			0.950			0.950		
Satd. Flow (prot)	1703	1792	1346	1687	1667	1524	1641	1845	1615	1719	1705	0
Flt Permitted	0.950			0.950			0.403			0.729		
Satd. Flow (perm)	1703	1792	1346	1687	1667	1524	696	1845	1615	1319	1705	0
Right Turn on Red			Yes			Yes			Yes			Yes
Satd. Flow (RTOR)			183			228			188		18	
Link Speed (mph)		30			30			30			30	
Link Distance (ft)		200			250			300			500	
Travel Time (s)		4.5			5.7			6.8			11.4	
Peak Hour Factor	0.86	0.86	0.86	0.86	0.86	0.86	0.86	0.86	0.86	0.86	0.86	0.86
Heavy Vehicles (%)	6%	6%	20%	7%	14%	6%	10%	3%	0%	5%	8%	2%
Adj. Flow (vph)	63	400	183	121	371	228	185	43	128	164	126	60
Shared Lane Traffic (%)												
Lane Group Flow (vph)	63	400	183	121	371	228	185	43	128	164	186	0
Enter Blocked Intersection	No	No	No	No	No	No	No	No	No	No	No	No
Lane Alignment	Left	Left	Right	Left	Left	Right	Left	Left	Right	Left	Left	Right
Median Width(ft)		12			12			12			12	
Link Offset(ft)		0			0			0			0	
Crosswalk Width(ft)		16			16			16			16	
Two way Left Turn Lane												
Headway Factor	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Turning Speed (mph)	15		9	15		9	15		9	15		9
Number of Detectors	1	2	1	1	2	1	1	2	1	1	2	
Detector Template	Left	Thru	Right	Left	Thru	Right	Left	Thru	Right	Left	Thru	
Leading Detector (ft)	20	100	20	20	100	20	20	100	20	20	100	
Trailing Detector (ft)	0	0	0	0	0	0	0	0	0	0	0	
Detector 1 Position(ft)	0	0	0	0	0	0	0	0	0	0	0	
Detector 1 Size(ft)	20	6	20	20	6	20	20	6	20	20	6	
Detector 1 Type	Cl+Ex	Cl+Ex	Cl+Ex	Cl+Ex	Cl+Ex	Cl+Ex	Cl+Ex	Cl+Ex	Cl+Ex	Cl+Ex	Cl+Ex	
Detector 1 Channel												
Detector 1 Extend (s)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Detector 1 Queue (s)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Detector 1 Delay (s)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Detector 2 Position(ft)		94			94			94			94	
Detector 2 Size(ft)		6			6			6			6	
Detector 2 Type		Cl+Ex			Cl+Ex			Cl+Ex			Cl+Ex	
Detector 2 Channel												
Detector 2 Extend (s)		0.0			0.0			0.0			0.0	
Turn Type	Prot	NA	pt+ov	Prot	NA	Prot	pm+pt	NA	Free	Perm	NA	
Protected Phases	5	2	2 3	1	6	6	3	8			4	

Lanes, Volumes, Timings

1: 93 SB Off-Ramp/Cross Street & Pelham Street

2023 Design Year Condition

Weekday Midday Peak Hour

												
Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Permitted Phases							8		Free	4		
Detector Phase	5	2	2 3	1	6	6	3	8		4	4	
Switch Phase												
Minimum Initial (s)	4.0	12.0		4.0	12.0	12.0	4.0	4.0		4.0	4.0	
Minimum Split (s)	10.0	18.0		10.0	18.0	18.0	10.0	10.0		10.0	10.0	
Total Split (s)	21.0	50.0		21.0	50.0	50.0	21.0	51.0		30.0	30.0	
Total Split (%)	17.2%	41.0%		17.2%	41.0%	41.0%	17.2%	41.8%		24.6%	24.6%	
Maximum Green (s)	15.0	44.0		15.0	44.0	44.0	15.0	45.0		24.0	24.0	
Yellow Time (s)	4.0	4.0		4.0	4.0	4.0	4.0	4.0		4.0	4.0	
All-Red Time (s)	2.0	2.0		2.0	2.0	2.0	2.0	2.0		2.0	2.0	
Lost Time Adjust (s)	-3.0	-3.0		-3.0	-3.0	-3.0	-3.0	-3.0		-3.0	-3.0	
Total Lost Time (s)	3.0	3.0		3.0	3.0	3.0	3.0	3.0		3.0	3.0	
Lead/Lag	Lead	Lag		Lead	Lag	Lag	Lead			Lag	Lag	
Lead-Lag Optimize?	Yes	Yes		Yes	Yes	Yes	Yes			Yes	Yes	
Vehicle Extension (s)	3.0	3.0		3.0	3.0	3.0	3.0	3.0		3.0	3.0	
Recall Mode	None	Min		None	Min	Min	None	None		None	None	
Act Effect Green (s)	12.4	30.7	49.0	15.0	36.8	36.8	38.2	38.2	93.4	19.9	19.9	
Actuated g/C Ratio	0.13	0.33	0.52	0.16	0.39	0.39	0.41	0.41	1.00	0.21	0.21	
v/c Ratio	0.28	0.68	0.23	0.45	0.57	0.31	0.42	0.06	0.08	0.58	0.49	
Control Delay	45.8	34.6	2.7	46.4	28.9	4.4	23.9	20.1	0.1	45.7	36.8	
Queue Delay	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Total Delay	45.8	34.6	2.7	46.4	28.9	4.4	23.9	20.1	0.1	45.7	36.8	
LOS	D	C	A	D	C	A	C	C	A	D	D	
Approach Delay		26.7			24.1			14.9			41.0	
Approach LOS		C			C			B			D	
90th %ile Green (s)	13.6	43.1		15.0	44.5	44.5	15.0	45.0		24.0	24.0	
90th %ile Term Code	Gap	Gap		Max	Hold	Hold	Max	Hold		Max	Max	
70th %ile Green (s)	11.0	34.8		15.0	38.8	38.8	15.0	42.9		21.9	21.9	
70th %ile Term Code	Gap	Gap		Max	Hold	Hold	Max	Hold		Gap	Gap	
50th %ile Green (s)	9.0	27.4		12.3	30.7	30.7	12.4	35.6		17.2	17.2	
50th %ile Term Code	Gap	Gap		Gap	Hold	Hold	Gap	Hold		Gap	Gap	
30th %ile Green (s)	7.4	21.8		9.9	24.3	24.3	10.0	29.3		13.3	13.3	
30th %ile Term Code	Gap	Gap		Gap	Hold	Hold	Gap	Hold		Gap	Gap	
10th %ile Green (s)	0.0	14.7		7.2	27.9	27.9	7.6	22.8		9.2	9.2	
10th %ile Term Code	Skip	Gap		Gap	Hold	Hold	Gap	Hold		Gap	Gap	
Queue Length 50th (ft)	34	203	0	65	178	0	71	15	0	87	87	
Queue Length 95th (ft)	84	330	28	144	306	42	147	43	0	180	178	
Internal Link Dist (ft)		120			170			220			420	
Turn Bay Length (ft)									200			
Base Capacity (vph)	347	953	872	343	888	918	477	1003	1615	403	533	
Starvation Cap Reductn	0	0	0	0	0	0	0	0	0	0	0	
Spillback Cap Reductn	0	0	0	0	0	0	0	0	0	0	0	
Storage Cap Reductn	0	0	0	0	0	0	0	0	0	0	0	
Reduced v/c Ratio	0.18	0.42	0.21	0.35	0.42	0.25	0.39	0.04	0.08	0.41	0.35	

Intersection Summary

Area Type: Other

Cycle Length: 122

Actuated Cycle Length: 93.4

Lanes, Volumes, Timings 1: 93 SB Off-Ramp/Cross Street & Pelham Street

2023 Design Year Condition
Weekday Midday Peak Hour

Natural Cycle: 60
Control Type: Actuated-Uncoordinated
Maximum v/c Ratio: 0.68
Intersection Signal Delay: 26.2
Intersection Capacity Utilization 54.9%
Analysis Period (min) 15
90th %ile Actuated Cycle: 121.1
70th %ile Actuated Cycle: 110.7
50th %ile Actuated Cycle: 93.3
30th %ile Actuated Cycle: 79
10th %ile Actuated Cycle: 62.7

Intersection LOS: C
ICU Level of Service A

Splits and Phases: 1: 93 SB Off-Ramp/Cross Street & Pelham Street

 Ø1	 Ø2	 Ø3	 Ø4
21 s	50 s	21 s	30 s
 Ø5	 Ø6	 Ø8	
21 s	50 s	51 s	

HCM 6th TWSC
3: Pelham Street & Site Driveway

2023 Design Year Condition
Weekday Midday Peak Hour

Intersection

Int Delay, s/veh 1

Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Traffic Vol, veh/h	14	522	497	33	33	14
Future Vol, veh/h	14	522	497	33	33	14
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Free	Free	Free	Free	Stop	Stop
RT Channelized	-	None	-	None	-	None
Storage Length	-	-	-	-	0	-
Veh in Median Storage, #	-	0	0	-	0	-
Grade, %	-	0	0	-	0	-
Peak Hour Factor	88	88	88	88	88	88
Heavy Vehicles, %	0	11	12	20	33	0
Mvmt Flow	16	593	565	38	38	16

Major/Minor	Major1	Major2	Minor2
Conflicting Flow All	603	0	0 1209 584
Stage 1	-	-	- 584 -
Stage 2	-	-	- 625 -
Critical Hdwy	4.1	-	- 5.8 5.8
Critical Hdwy Stg 1	-	-	- 5.73 -
Critical Hdwy Stg 2	-	-	- 5.73 -
Follow-up Hdwy	2.2	-	- 3.797 3.3
Pot Cap-1 Maneuver	984	-	- 239 550
Stage 1	-	-	- 501 -
Stage 2	-	-	- 479 -
Platoon blocked, %		-	-
Mov Cap-1 Maneuver	984	-	- 233 550
Mov Cap-2 Maneuver	-	-	- 233 -
Stage 1	-	-	- 489 -
Stage 2	-	-	- 479 -

Approach	EB	WB	SB
HCM Control Delay, s	0.2	0	20.8
HCM LOS			C

Minor Lane/Major Mvmt	EBL	EBT	WBT	WBR	SBLn1
Capacity (veh/h)	984	-	-	-	281
HCM Lane V/C Ratio	0.016	-	-	-	0.19
HCM Control Delay (s)	8.7	0	-	-	20.8
HCM Lane LOS	A	A	-	-	C
HCM 95th %tile Q(veh)	0	-	-	-	0.7

Lanes, Volumes, Timings
1: 93 SB Off-Ramp/Cross Street & Pelham Street

2023 Design Condition
Weekday Evening Peak Hour

												
Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	67	454	135	119	383	337	256	47	197	164	140	60
Future Volume (vph)	67	454	135	119	383	337	256	47	197	164	140	60
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Storage Length (ft)	0		0	0		0	0		200	0		0
Storage Lanes	1		1	1		1	1		1	1		0
Taper Length (ft)	25			25			25			25		
Lane Util. Factor	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Frt			0.850			0.850			0.850		0.955	
Flt Protected	0.950			0.950			0.950			0.950		
Satd. Flow (prot)	1805	1881	1482	1719	1845	1524	1736	1827	1538	1770	1731	0
Flt Permitted	0.950			0.950			0.357			0.726		
Satd. Flow (perm)	1805	1881	1482	1719	1845	1524	652	1827	1538	1352	1731	0
Right Turn on Red			Yes			Yes			Yes			Yes
Satd. Flow (RTOR)			139			347			203		16	
Link Speed (mph)		30			30			30			30	
Link Distance (ft)		200			250			300			500	
Travel Time (s)		4.5			5.7			6.8			11.4	
Peak Hour Factor	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97
Heavy Vehicles (%)	0%	1%	9%	5%	3%	6%	4%	4%	5%	2%	6%	2%
Adj. Flow (vph)	69	468	139	123	395	347	264	48	203	169	144	62
Shared Lane Traffic (%)												
Lane Group Flow (vph)	69	468	139	123	395	347	264	48	203	169	206	0
Enter Blocked Intersection	No	No	No	No	No	No	No	No	No	No	No	No
Lane Alignment	Left	Left	Right	Left	Left	Right	Left	Left	Right	Left	Left	Right
Median Width(ft)		12			12			12			12	
Link Offset(ft)		0			0			0			0	
Crosswalk Width(ft)		16			16			16			16	
Two way Left Turn Lane												
Headway Factor	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Turning Speed (mph)	15		9	15		9	15		9	15		9
Number of Detectors	1	2	1	1	2	1	1	2	1	1	2	
Detector Template	Left	Thru	Right	Left	Thru	Right	Left	Thru	Right	Left	Thru	
Leading Detector (ft)	20	100	20	20	100	20	20	100	20	20	100	
Trailing Detector (ft)	0	0	0	0	0	0	0	0	0	0	0	
Detector 1 Position(ft)	0	0	0	0	0	0	0	0	0	0	0	
Detector 1 Size(ft)	20	6	20	20	6	20	20	6	20	20	6	
Detector 1 Type	Cl+Ex	Cl+Ex	Cl+Ex	Cl+Ex	Cl+Ex	Cl+Ex	Cl+Ex	Cl+Ex	Cl+Ex	Cl+Ex	Cl+Ex	
Detector 1 Channel												
Detector 1 Extend (s)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Detector 1 Queue (s)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Detector 1 Delay (s)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Detector 2 Position(ft)		94			94			94			94	
Detector 2 Size(ft)		6			6			6			6	
Detector 2 Type		Cl+Ex			Cl+Ex			Cl+Ex			Cl+Ex	
Detector 2 Channel												
Detector 2 Extend (s)		0.0			0.0			0.0			0.0	
Turn Type	Prot	NA	pt+ov	Prot	NA	Prot	pm+pt	NA	Free	Perm	NA	
Protected Phases	5	2	2 3	1	6	6	3	8			4	

Lanes, Volumes, Timings
1: 93 SB Off-Ramp/Cross Street & Pelham Street

2023 Design Condition
Weekday Evening Peak Hour

												
Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Permitted Phases							8		Free	4		
Detector Phase	5	2	2 3	1	6	6	3	8		4	4	
Switch Phase												
Minimum Initial (s)	4.0	12.0		4.0	12.0	12.0	4.0	4.0		4.0	4.0	
Minimum Split (s)	10.0	18.0		10.0	18.0	18.0	10.0	10.0		10.0	10.0	
Total Split (s)	21.0	50.0		21.0	50.0	50.0	21.0	51.0		30.0	30.0	
Total Split (%)	17.2%	41.0%		17.2%	41.0%	41.0%	17.2%	41.8%		24.6%	24.6%	
Maximum Green (s)	15.0	44.0		15.0	44.0	44.0	15.0	45.0		24.0	24.0	
Yellow Time (s)	4.0	4.0		4.0	4.0	4.0	4.0	4.0		4.0	4.0	
All-Red Time (s)	2.0	2.0		2.0	2.0	2.0	2.0	2.0		2.0	2.0	
Lost Time Adjust (s)	-3.0	-3.0		-3.0	-3.0	-3.0	-3.0	-3.0		-3.0	-3.0	
Total Lost Time (s)	3.0	3.0		3.0	3.0	3.0	3.0	3.0		3.0	3.0	
Lead/Lag	Lead	Lag		Lead	Lag	Lag	Lead			Lag	Lag	
Lead-Lag Optimize?	Yes	Yes		Yes	Yes	Yes	Yes			Yes	Yes	
Vehicle Extension (s)	3.0	3.0		3.0	3.0	3.0	3.0	3.0		3.0	3.0	
Recall Mode	None	Min		None	Min	Min	None	None		None	None	
Act Effect Green (s)	12.6	33.6	53.4	15.1	39.6	39.6	40.2	40.2	98.3	20.4	20.4	
Actuated g/C Ratio	0.13	0.34	0.54	0.15	0.40	0.40	0.41	0.41	1.00	0.21	0.21	
v/c Ratio	0.30	0.73	0.16	0.47	0.53	0.42	0.59	0.06	0.13	0.60	0.56	
Control Delay	47.9	36.6	2.6	48.9	28.0	4.3	28.3	21.0	0.2	48.2	40.9	
Queue Delay	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Total Delay	47.9	36.6	2.6	48.9	28.0	4.3	28.3	21.0	0.2	48.2	40.9	
LOS	D	D	A	D	C	A	C	C	A	D	D	
Approach Delay		30.8			21.5			16.5			44.2	
Approach LOS		C			C			B			D	
90th %ile Green (s)	13.8	44.0		15.0	45.2	45.2	15.0	45.0		24.0	24.0	
90th %ile Term Code	Gap	Max		Max	Hold	Hold	Max	Hold		Max	Max	
70th %ile Green (s)	11.3	38.8		15.0	42.5	42.5	15.0	43.6		22.6	22.6	
70th %ile Term Code	Gap	Gap		Max	Hold	Hold	Max	Hold		Gap	Gap	
50th %ile Green (s)	9.4	31.4		12.7	34.7	34.7	15.0	39.1		18.1	18.1	
50th %ile Term Code	Gap	Gap		Gap	Hold	Hold	Max	Hold		Gap	Gap	
30th %ile Green (s)	7.7	25.1		10.2	27.6	27.6	12.7	32.8		14.1	14.1	
30th %ile Term Code	Gap	Gap		Gap	Hold	Hold	Gap	Hold		Gap	Gap	
10th %ile Green (s)	0.0	16.9		7.4	30.3	30.3	9.2	24.7		9.5	9.5	
10th %ile Term Code	Skip	Gap		Gap	Hold	Hold	Gap	Hold		Gap	Gap	
Queue Length 50th (ft)	41	263	0	73	201	0	115	18	0	99	110	
Queue Length 95th (ft)	96	417	29	154	337	59	221	50	0	196	213	
Internal Link Dist (ft)		120			170			220			420	
Turn Bay Length (ft)									200			
Base Capacity (vph)	346	942	923	329	927	938	474	934	1538	388	509	
Starvation Cap Reductn	0	0	0	0	0	0	0	0	0	0	0	
Spillback Cap Reductn	0	0	0	0	0	0	0	0	0	0	0	
Storage Cap Reductn	0	0	0	0	0	0	0	0	0	0	0	
Reduced v/c Ratio	0.20	0.50	0.15	0.37	0.43	0.37	0.56	0.05	0.13	0.44	0.40	

Intersection Summary

Area Type: Other

Cycle Length: 122

Actuated Cycle Length: 98.3

Lanes, Volumes, Timings 1: 93 SB Off-Ramp/Cross Street & Pelham Street

2023 Design Condition
Weekday Evening Peak Hour

Natural Cycle: 55

Control Type: Actuated-Uncoordinated

Maximum v/c Ratio: 0.73

Intersection Signal Delay: 26.5

Intersection LOS: C

Intersection Capacity Utilization 69.0%

ICU Level of Service C

Analysis Period (min) 15

90th %ile Actuated Cycle: 122

70th %ile Actuated Cycle: 115.4

50th %ile Actuated Cycle: 101.2

30th %ile Actuated Cycle: 86.1

10th %ile Actuated Cycle: 67

Splits and Phases: 1: 93 SB Off-Ramp/Cross Street & Pelham Street

 Ø1	 Ø2	 Ø3	 Ø4
21 s	50 s	21 s	30 s
 Ø5	 Ø6	 Ø8	
21 s	50 s	51 s	

HCM 6th TWSC 3: Pelham Street & Site Driveway

2023 Design Condition
Weekday Evening Peak Hour

Intersection

Int Delay, s/veh 1.1

Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Traffic Vol, veh/h	17	615	658	41	41	18
Future Vol, veh/h	17	615	658	41	41	18
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Free	Free	Free	Free	Stop	Stop
RT Channelized	-	None	-	None	-	None
Storage Length	-	-	-	-	0	-
Veh in Median Storage, #	-	0	0	-	0	-
Grade, %	-	0	0	-	0	-
Peak Hour Factor	97	97	97	97	97	97
Heavy Vehicles, %	0	3	4	0	0	0
Mvmt Flow	18	634	678	42	42	19

Major/Minor	Major1	Major2	Minor2
Conflicting Flow All	720	0	0 1369 699
Stage 1	-	-	- 699 -
Stage 2	-	-	- 670 -
Critical Hdwy	4.1	-	- 5.8 5.8
Critical Hdwy Stg 1	-	-	- 5.4 -
Critical Hdwy Stg 2	-	-	- 5.4 -
Follow-up Hdwy	2.2	-	- 3.5 3.3
Pot Cap-1 Maneuver	891	-	- 205 479
Stage 1	-	-	- 497 -
Stage 2	-	-	- 512 -
Platoon blocked, %	-	-	-
Mov Cap-1 Maneuver	891	-	- 199 479
Mov Cap-2 Maneuver	-	-	- 199 -
Stage 1	-	-	- 482 -
Stage 2	-	-	- 512 -

Approach	EB	WB	SB
HCM Control Delay, s	0.2	0	24.8
HCM LOS			C

Minor Lane/Major Mvmt	EBL	EBT	WBT	WBR	SBLn1
Capacity (veh/h)	891	-	-	-	242
HCM Lane V/C Ratio	0.02	-	-	-	0.251
HCM Control Delay (s)	9.1	0	-	-	24.8
HCM Lane LOS	A	A	-	-	C
HCM 95th %tile Q(veh)	0.1	-	-	-	1

Lanes, Volumes, Timings
1: 93 SB Off-Ramp/Cross Street & Pelham Street

2023 Design Condition
Saturday Midday Peak Hour

												
Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	64	351	178	122	293	298	168	52	137	178	169	54
Future Volume (vph)	64	351	178	122	293	298	168	52	137	178	169	54
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Storage Length (ft)	0		0	0		0	0		200	0		0
Storage Lanes	1		1	1		1	1		1	1		0
Taper Length (ft)	25			25			25			25		
Lane Util. Factor	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Frt			0.850			0.850			0.850		0.964	
Flt Protected	0.950			0.950			0.950			0.950		
Satd. Flow (prot)	1770	1863	1538	1770	1827	1599	1752	1827	1615	1787	1809	0
Flt Permitted	0.950			0.950			0.333			0.720		
Satd. Flow (perm)	1770	1863	1538	1770	1827	1599	614	1827	1615	1354	1809	0
Right Turn on Red			Yes			Yes			Yes			Yes
Satd. Flow (RTOR)			191			320			188		12	
Link Speed (mph)		30			30			30			30	
Link Distance (ft)		200			250			300			500	
Travel Time (s)		4.5			5.7			6.8			11.4	
Peak Hour Factor	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93
Heavy Vehicles (%)	2%	2%	5%	2%	4%	1%	3%	4%	0%	1%	1%	2%
Adj. Flow (vph)	69	377	191	131	315	320	181	56	147	191	182	58
Shared Lane Traffic (%)												
Lane Group Flow (vph)	69	377	191	131	315	320	181	56	147	191	240	0
Enter Blocked Intersection	No	No	No	No	No	No	No	No	No	No	No	No
Lane Alignment	Left	Left	Right	Left	Left	Right	Left	Left	Right	Left	Left	Right
Median Width(ft)		12			12			12			12	
Link Offset(ft)		0			0			0			0	
Crosswalk Width(ft)		16			16			16			16	
Two way Left Turn Lane												
Headway Factor	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Turning Speed (mph)	15		9	15		9	15		9	15		9
Number of Detectors	1	2	1	1	2	1	1	2	1	1	2	
Detector Template	Left	Thru	Right	Left	Thru	Right	Left	Thru	Right	Left	Thru	
Leading Detector (ft)	20	100	20	20	100	20	20	100	20	20	100	
Trailing Detector (ft)	0	0	0	0	0	0	0	0	0	0	0	
Detector 1 Position(ft)	0	0	0	0	0	0	0	0	0	0	0	
Detector 1 Size(ft)	20	6	20	20	6	20	20	6	20	20	6	
Detector 1 Type	Cl+Ex	Cl+Ex	Cl+Ex	Cl+Ex	Cl+Ex	Cl+Ex	Cl+Ex	Cl+Ex	Cl+Ex	Cl+Ex	Cl+Ex	
Detector 1 Channel												
Detector 1 Extend (s)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Detector 1 Queue (s)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Detector 1 Delay (s)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Detector 2 Position(ft)		94			94			94			94	
Detector 2 Size(ft)		6			6			6			6	
Detector 2 Type		Cl+Ex			Cl+Ex			Cl+Ex			Cl+Ex	
Detector 2 Channel												
Detector 2 Extend (s)		0.0			0.0			0.0			0.0	
Turn Type	Prot	NA	pt+ov	Prot	NA	Prot	pm+pt	NA	Free	Perm	NA	
Protected Phases	5	2	2 3	1	6	6	3	8			4	

Lanes, Volumes, Timings
1: 93 SB Off-Ramp/Cross Street & Pelham Street

2023 Design Condition
Saturday Midday Peak Hour

												
Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Permitted Phases							8		Free	4		
Detector Phase	5	2	2 3	1	6	6	3	8		4	4	
Switch Phase												
Minimum Initial (s)	4.0	12.0		4.0	12.0	12.0	4.0	4.0		4.0	4.0	
Minimum Split (s)	10.0	18.0		10.0	18.0	18.0	10.0	10.0		10.0	10.0	
Total Split (s)	21.0	50.0		21.0	50.0	50.0	21.0	51.0		30.0	30.0	
Total Split (%)	17.2%	41.0%		17.2%	41.0%	41.0%	17.2%	41.8%		24.6%	24.6%	
Maximum Green (s)	15.0	44.0		15.0	44.0	44.0	15.0	45.0		24.0	24.0	
Yellow Time (s)	4.0	4.0		4.0	4.0	4.0	4.0	4.0		4.0	4.0	
All-Red Time (s)	2.0	2.0		2.0	2.0	2.0	2.0	2.0		2.0	2.0	
Lost Time Adjust (s)	-3.0	-3.0		-3.0	-3.0	-3.0	-3.0	-3.0		-3.0	-3.0	
Total Lost Time (s)	3.0	3.0		3.0	3.0	3.0	3.0	3.0		3.0	3.0	
Lead/Lag	Lead	Lag		Lead	Lag	Lag	Lead			Lag	Lag	
Lead-Lag Optimize?	Yes	Yes		Yes	Yes	Yes	Yes			Yes	Yes	
Vehicle Extension (s)	3.0	3.0		3.0	3.0	3.0	3.0	3.0		3.0	3.0	
Recall Mode	None	Min		None	Min	Min	None	None		None	None	
Act Effect Green (s)	12.5	28.5	46.2	15.0	34.5	34.5	38.7	38.7	91.7	21.0	21.0	
Actuated g/C Ratio	0.14	0.31	0.50	0.16	0.38	0.38	0.42	0.42	1.00	0.23	0.23	
v/c Ratio	0.29	0.65	0.22	0.45	0.46	0.40	0.41	0.07	0.09	0.62	0.57	
Control Delay	44.4	34.4	2.7	44.6	27.1	4.4	22.1	18.7	0.1	44.3	38.0	
Queue Delay	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Total Delay	44.4	34.4	2.7	44.6	27.1	4.4	22.1	18.7	0.1	44.3	38.0	
LOS	D	C	A	D	C	A	C	B	A	D	D	
Approach Delay		26.0			20.6			13.2			40.8	
Approach LOS		C			C			B			D	
90th %ile Green (s)	13.6	39.0		15.0	40.4	40.4	15.0	45.0		24.0	24.0	
90th %ile Term Code	Gap	Gap		Max	Hold	Hold	Max	Hold		Max	Max	
70th %ile Green (s)	11.0	31.5		15.0	35.5	35.5	14.2	44.2		24.0	24.0	
70th %ile Term Code	Gap	Gap		Max	Hold	Hold	Gap	Hold		Max	Max	
50th %ile Green (s)	9.2	25.4		12.4	28.6	28.6	11.5	36.0		18.5	18.5	
50th %ile Term Code	Gap	Gap		Gap	Hold	Hold	Gap	Hold		Gap	Gap	
30th %ile Green (s)	7.6	20.3		10.0	22.7	22.7	9.5	30.0		14.5	14.5	
30th %ile Term Code	Gap	Gap		Gap	Hold	Hold	Gap	Hold		Gap	Gap	
10th %ile Green (s)	0.0	13.8		7.4	27.2	27.2	7.3	23.3		10.0	10.0	
10th %ile Term Code	Skip	Gap		Gap	Hold	Hold	Gap	Hold		Gap	Gap	
Queue Length 50th (ft)	37	188	0	69	143	0	66	19	0	99	117	
Queue Length 95th (ft)	93	327	33	156	263	58	142	52	0	210	238	
Internal Link Dist (ft)		120			170			220			420	
Turn Bay Length (ft)									200			
Base Capacity (vph)	365	1005	982	365	985	1010	494	1007	1615	419	569	
Starvation Cap Reductn	0	0	0	0	0	0	0	0	0	0	0	
Spillback Cap Reductn	0	0	0	0	0	0	0	0	0	0	0	
Storage Cap Reductn	0	0	0	0	0	0	0	0	0	0	0	
Reduced v/c Ratio	0.19	0.38	0.19	0.36	0.32	0.32	0.37	0.06	0.09	0.46	0.42	

Intersection Summary

Area Type: Other

Cycle Length: 122

Actuated Cycle Length: 91.7

Lanes, Volumes, Timings

1: 93 SB Off-Ramp/Cross Street & Pelham Street

2023 Design Condition
Saturday Midday Peak Hour

Natural Cycle: 60

Control Type: Actuated-Uncoordinated

Maximum v/c Ratio: 0.65

Intersection Signal Delay: 24.8

Intersection Capacity Utilization 60.1%

Analysis Period (min) 15

Intersection LOS: C

ICU Level of Service B

90th %ile Actuated Cycle: 117

70th %ile Actuated Cycle: 108.7

50th %ile Actuated Cycle: 91.8

30th %ile Actuated Cycle: 78.3

10th %ile Actuated Cycle: 62.5

Splits and Phases: 1: 93 SB Off-Ramp/Cross Street & Pelham Street

 Ø1	 Ø2	 Ø3	 Ø4
21 s	50 s	21 s	30 s
 Ø5	 Ø6	 Ø8	
21 s	50 s	51 s	

HCM 6th TWSC
3: Pelham Street & Site Driveway

2023 Design Condition
Saturday Midday Peak Hour

Intersection

Int Delay, s/veh 2

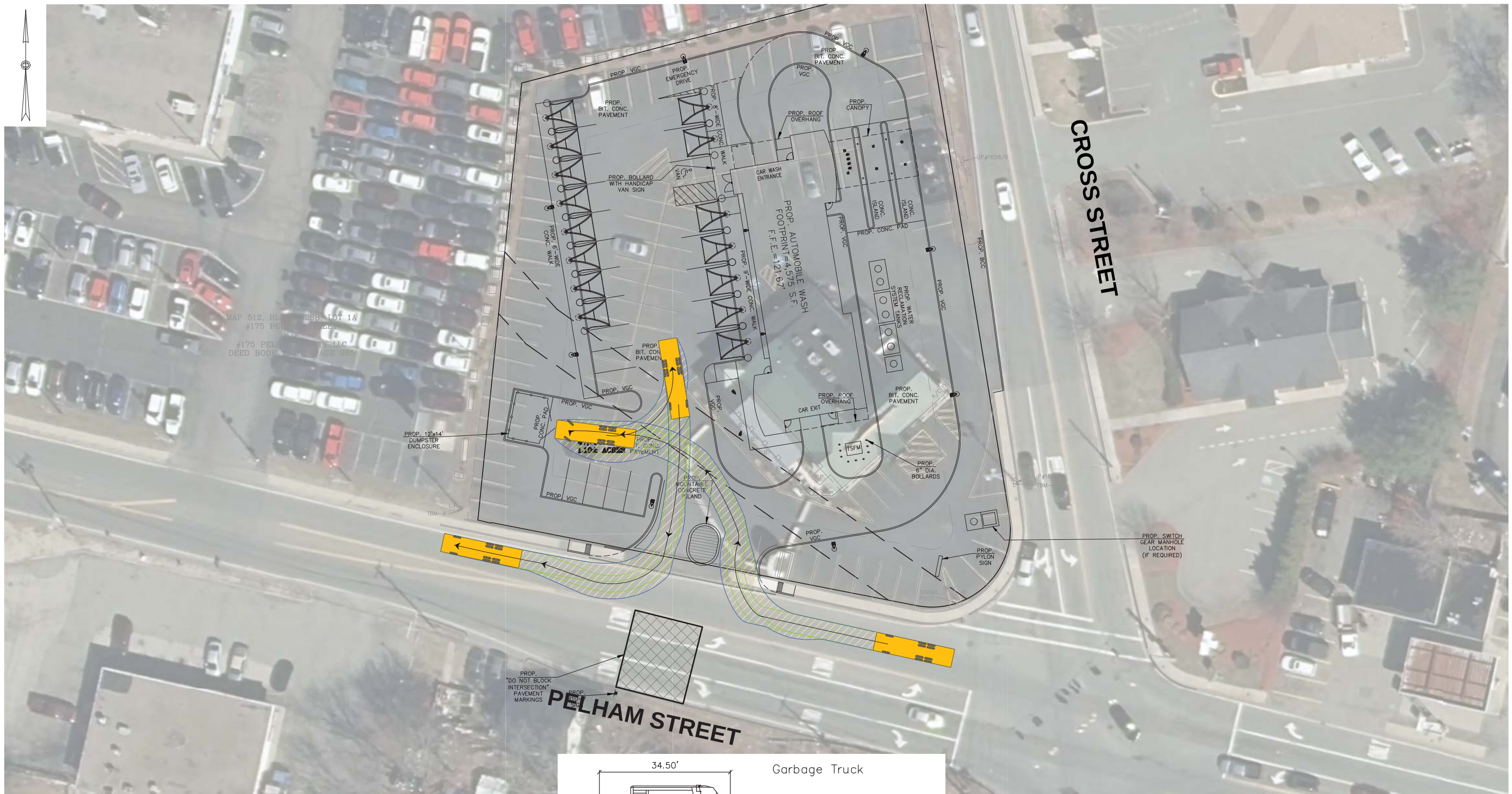
Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Traffic Vol, veh/h	27	530	451	64	63	27
Future Vol, veh/h	27	530	451	64	63	27
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Free	Free	Free	Free	Stop	Stop
RT Channelized	-	None	-	None	-	None
Storage Length	-	-	-	-	0	-
Veh in Median Storage, #	-	0	0	-	0	-
Grade, %	-	0	0	-	0	-
Peak Hour Factor	90	90	90	90	90	90
Heavy Vehicles, %	0	4	4	0	0	0
Mvmt Flow	30	589	501	71	70	30

Major/Minor	Major1	Major2	Minor2
Conflicting Flow All	572	0	0 1186 537
Stage 1	-	-	- 537 -
Stage 2	-	-	- 649 -
Critical Hdwy	4.1	-	- 5.8 5.8
Critical Hdwy Stg 1	-	-	- 5.4 -
Critical Hdwy Stg 2	-	-	- 5.4 -
Follow-up Hdwy	2.2	-	- 3.5 3.3
Pot Cap-1 Maneuver	1011	-	- 256 582
Stage 1	-	-	- 590 -
Stage 2	-	-	- 524 -
Platoon blocked, %	-	-	-
Mov Cap-1 Maneuver	1011	-	- 245 582
Mov Cap-2 Maneuver	-	-	- 245 -
Stage 1	-	-	- 564 -
Stage 2	-	-	- 524 -

Approach	EB	WB	SB
HCM Control Delay, s	0.4	0	23.2
HCM LOS			C

Minor Lane/Major Mvmt	EBL	EBT	WBT	WBR	SBLn1
Capacity (veh/h)	1011	-	-	-	297
HCM Lane V/C Ratio	0.03	-	-	-	0.337
HCM Control Delay (s)	8.7	0	-	-	23.2
HCM Lane LOS	A	A	-	-	C
HCM 95th %tile Q(veh)	0.1	-	-	-	1.4

□ AutoTURN® Analysis



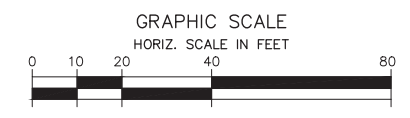
- NOTES**
1. THIS PLAN INTENDED FOR DISCUSSION PURPOSES ONLY; IT IS NOT INTENDED FOR CONSTRUCTION.
 2. BASE PLANS PROVIDED BY METROWEST ENGINEERING, INC. & MASSACHUSETTS ORTHOPHOTOGRAPHY.

Site Plan Source: MetroWest Engineering, Inc.

MDM TRANSPORTATION CONSULTANTS, INC.
Planners & Engineers
28 Lord Road, Suite 280
Marlborough, MA 01752

Proposed Development

Methuen, Massachusetts

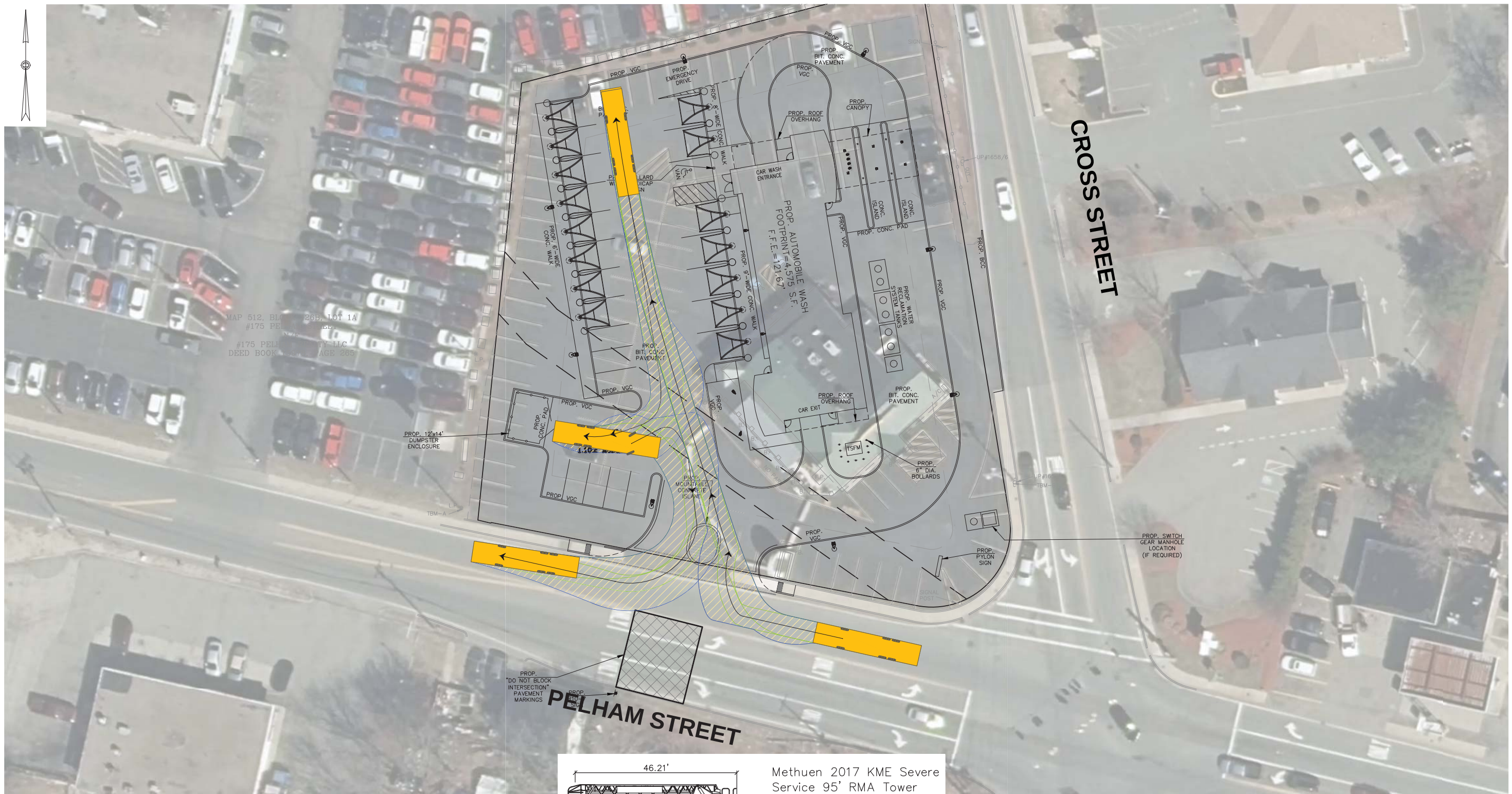


Attachment

Autoturn Analysis

Garbage Truck

Scale: As Noted
DWG No. 1289 Autoturn.dwg
Date: July 2023
Project No. 1289



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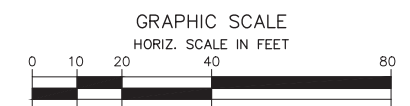


Site Plan Source: MetroWest Engineering, Inc.

MDM TRANSPORTATION CONSULTANTS, INC.
Planners & Engineers
28 Lord Road, Suite 280
Marlborough, MA 01752

Proposed Development

Methuen, Massachusetts



Attachment

Autoturn Analysis

Fire Truck

□ Queue Analysis

**Drive-Through Queue Analysis: Car Wash
Methuen, MA**

Period: PM Peak Hour
 Scenario: (Peak Facility Condition) - Maximum Service Capacity
 Input Rate (q) 91 Vehicles/hour
 Service Rate (u) 110 Vehicles/hour = 33 Seconds
 Windows 1
 k 100

<u>n</u>	<u>p(n)</u>	<u>Cdist</u>	
0	0.173212	-	
1	0.143294	0.316506	
2	0.118543	0.435049	
3	0.098067	0.533116	Avg. Q
4	0.081128	0.614245	
5	0.067115	0.68136	
6	0.055523	0.736883	
7	0.045932	0.782815	
8	0.037999	0.820814	
9	0.031435	0.852249	
10	0.026006	0.878255	
11	0.021514	0.899768	
12	0.017798	0.917566	
13	0.014724	0.93229	
14	0.01218	0.94447	
15	0.010076	0.954546	95th Percentile Q
16	0.008336	0.962882	
17	0.006896	0.969779	
18	0.005705	0.975484	
19	0.00472	0.980203	
20	0.003904	0.984108	

N= Number of Queued Vehicles

P(n)= probability of n queued vehicles

Cdist= Cumulative probability of n queued vehicles or less

Assumptions

1. Average arrival for peak hour is approximately 78 auto-related arrivals per hour during peak hours.
2. Queuing algorithm based on M/M/S model, per Introduction to Operations Research, 6th Ed., Hillier & Lieberman, 1995 P. 686-689.

**Drive-Through Queue Analysis: Car Wash
Methuen, MA**

Period: PM Peak Hour
 Scenario: (Peak Facility Condition) - Maximum Service Capacity
 Input Rate (q) 91 Vehicles/hour
 Service Rate (u) 130 Vehicles/hour = 28 Seconds
 Windows 1
 k 100

<u>n</u>	<u>p(n)</u>	<u>Cdist</u>	
0	0.300005	-	
1	0.210003	0.510008	Avg. Q
2	0.147002	0.65701	
3	0.102902	0.759912	
4	0.072031	0.831943	
5	0.050422	0.882365	
6	0.035295	0.91766	
7	0.024707	0.942367	95th Percentile Q
8	0.017295	0.959662	
9	0.012106	0.971768	
10	0.008474	0.980242	
11	0.005932	0.986174	
12	0.004152	0.990327	
13	0.002907	0.993233	
14	0.002035	0.995268	
15	0.001424	0.996692	
16	0.000997	0.997689	
17	0.000698	0.998387	
18	0.000489	0.998876	
19	0.000342	0.999218	
20	0.000239	0.999457	

N= Number of Queued Vehicles

P(n)= probability of n queued vehicles

Cdist= Cumulative probability of n queued vehicles or less

Assumptions

1. Average arrival for peak hour is approximately 78 auto-related arrivals per hour during peak hours.
2. Queuing algorithm based on M/M/S model, per Introduction to Operations Research, 6th Ed., Hillier & Lieberman, 1995 P. 686-689.