



***Ron Müller & Associates***  
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Ref.: 17041

June 7, 2018

Mr. David R. Consigli  
Zoning Board of Appeals  
Town of Milford  
52 Main Street  
Milford, MA 01757

Reg.: Response to Peer Review Comments  
Proposed Apartment Development  
Birch Street, Milford, MA

Dear Mr. Consigli:

***Ron Müller & Associates*** (RMA) has prepared this letter to respond to the peer review comments by BSC Group in their review of the Traffic Impact and Access Study submitted by our office for the above-referenced project. Some of the comments were related to the site plan and the responses to those comments will be submitted under separate cover by Allen Engineering. The BSC comments are listed in their letter dated May 30, 2018 and are re-written below for ease of reading, followed by our responses.

*Comment 1: “The Traffic Impact and Access Study (TIAS) noted that three intersections, including the proposed driveway were analyzed, and that the project was expected to have minimal impacts beyond the selected study area. The intersection of Medway Road (Route 109) and Beaver Street is a major intersection through which more than half of the project site trips would travel either to or from the site. BSC recommends that the Proponent evaluate impacts of the project at this location.”*

Response 1: Traffic counts were collected at the Route 109 and Beaver Street intersection on Wednesday June 6, 2018 during the weekday AM peak period (7:00 to 9:00 AM) and the weekday PM peak period (4:00 to 6:00 PM). The count data are attached for reference. Based on the seasonal count data provided in the original traffic

study, traffic during the month of June is approximately 8 percent higher than the annual average. Therefore, no adjustments were made and the collected data represent above average-month conditions. The counted volumes were then upwardly adjusted to reflect a 7-year design horizon by applying a 1.0 percent per year traffic growth rate and adding the volumes from the other known development projects listed in the original traffic study. The only project not included was the Stop & Shop supermarket development at the corner of this intersection, as this project is now completed and occupied. Project-generated traffic was then added to the intersection based on the distribution pattern identified in the original traffic study. It should be noted that the trip estimates for the project were based on 162 apartment units and using the latest edition of the Institute of Transportation Engineers (ITE) *Trip Generation Manual* as described in response to Comment No. 10. The projected No-Build and Build condition peak hour traffic volumes for the intersection are attached to this letter.

Level-of-service (LOS) analyses were conducted at the intersection under projected volume conditions to determine the effects that site generated traffic will have on traffic operations. The capacity analysis methodology is based on the concepts and procedures of the *Highway Capacity Manual* as described in the original study. The results of the analyses are summarized in Table 1 and the analysis worksheets are attached to this letter. The analyses show that the Route 109 and Beaver Street intersection is projected to operate at LOS B during the weekday AM peak hour under both No-Build and Build volume conditions, with all movements through the intersection operating at acceptable levels (LOS D or better). During the weekday PM peak hour, the intersection is projected to operate at LOS E under both No-Build and Build volume conditions. The critical movements during this time period are the Beaver Street southbound left turns and the Beaver Street northbound right turns. These movements are projected to operate at or above capacity at LOS E to F. All other movements through the intersection operate at acceptable levels (LOS D or better). As described in response to Comment No. 12, the project will add 32 to 40 vehicle trips through the Route 109 and Beaver Street intersection during the weekday AM and PM peak hours, respectively. These increases will not have a noticeable effect on traffic operations with increases in overall intersection delay of 0.5 seconds during the weekday AM peak hour and 3.3 seconds during the weekday PM peak hour.

*Comment 2: "Turning movement counts were collected in August 2017, and November 2016 during the weekday morning (7-9 AM) and afternoon (4-6 PM) commuter peak hours. These times are consistent with standard procedures. The November 2016 traffic volumes were seasonally adjusted and grown by one percent to 2017 existing conditions; BSC concurs with this action."*

Response 2: No response required.

*Comment 3: “The TIAS provides crash information for the study area intersections of Route 109 at Birch Street and Beaver Street at Birch Street and states that the calculated crash rates at these locations are below the statewide and district-wide averages. BSC agrees with this finding, but requests that the Proponent review crash data at the intersection of Route 109 at Beaver Street.”*

Response 3: Crash data for the Route 109 and Beaver Street intersection were obtained from MassDOT for the period between 2013 and 2015, the most recent three-year period available. A summary of the MassDOT accident data along with the calculated crash rate is provided in Table 1. The crash rate worksheet is attached for reference.

**Table 1**  
**Accident Summary**

Location	Number of Accidents			Severity <sup>a</sup>			Accident Type <sup>b</sup>						% During Wet/Icy Conditions
	Total	Avg./Year	Accident Rate <sup>c</sup>	PD	PI	F	CM	RE	HO	FO	Ped	Other	
Route 109 at Beaver Street	52	17.3	1.20	39	13	0	27	24	1	0	0	0	17%

Source: MassDOT Traffic Operations Safety Management System – 2013 through 2015 data.

<sup>a</sup> PD = property damage only; PI = personal injury; F = fatality.

<sup>b</sup> CM = cross movement/angle; RE = rear end; HO = head on; FO = fixed object; Ped = pedestrian.

<sup>c</sup> Measured in accidents per million entering vehicles.

As shown in Table 2, the Route 109 and Beaver Street intersection has experienced a significant number of accidents, averaging over 17 per year and has a calculated crash rate higher than both the statewide average (0.77 acc/mev) and district-wide average (0.90 acc/mev). The intersection is listed as a Highway Safety Improvement Program (HSIP) High Crash Cluster, indicating that the intersection falls within the top 5 percent of High Crash Locations within the Central Massachusetts Regional Planning Commission (CMRPC) area. The vast majority of accidents (75 percent) involved property damage only and almost all of the accidents were either cross movement or rear-end type collisions. No fatalities were reported during the three-year analysis period.

*Comment 4: “During the field visit on May 18, 2018, BSC performed independent sight distance measurements at the approximate location of the proposed driveway, to be located adjacent to the Birchler Automotive driveway. BSC measured stopping sight distances (SSD) of over 500 feet on each approach to the proposed site drive location, and concurs with SSD measurements by Ron Muller and Associates.”*

Response 4: No response required.

*Comment 5: “BSC recommends that the minimum intersection sight distance (ISD) requirements be recalculated based upon the 85th percentile speeds recorded (43 mph northbound, and 41 mph southbound) on Birch Street. BSC also recommends that sight triangles for the driveway at Birch Street be shown on the site plan.”*

Response 5: The intersection sight distance for the 85<sup>th</sup> percentile speeds of up to 43 mph is 475 feet. The sight triangles based on this distance have been added to the site plan.

*Comment 6: “The Proponent should show how existing guard rails near the site driveway would be reconstructed so as not to impact the available ISD for drivers exiting the project site.”*

Response 6: Response to be provided by Allen Engineering under separate cover.

*Comment 7: “The future conditions were projected under a seven-year planning horizon. BSC concurs with this timeline, which is consistent with current MassDOT standards.”*

Response 7: No response required.

*Comment 8: “Future No Build conditions were estimated by applying a one-percent annual growth rate and adding vehicle trips from specific known developments in the area. BSC concurs with this methodology.”*

Response 8: No response required.

*Comment 9: “Table 5 summarizes the estimated number of vehicle trips for the proposed development. Trips for the proposed development were estimated using rates from the Institute of Transportation Engineers (ITE) Trip Generation, which is the standard methodology used by traffic engineers to estimate trips.”*

Response 9: No response required.

*Comment 10: "Please review and resolve the discrepancy between number of proposed apartments. The Comprehensive Permit application stated that the project would comprise of 162 units, while the TIAS used 159 units in the trip generation calculation."*

Response 10: At the time the traffic study was prepared, 159 apartment units were proposed. The difference in site traffic generation between 159 and 162 apartment units using the methodology employed in the traffic study is only one to two additional trips during the weekday morning and afternoon peak hours, respectively. As described in response to Comment No. 1, the trip estimates in the traffic study were based on the 9<sup>th</sup> Edition of the ITE *Trip Generation Manual*, which was the most recent edition available at the time the study was prepared. In September 2017, the ITE issued the 10<sup>th</sup> Edition of the *Trip Generation Manual*. Using Land Use Code 221 (Multifamily Housing - Mid Rise) trip rates from the 10<sup>th</sup> Edition manual would actually yield a 33% reduction in peak hour site traffic generation from the numbers used in the traffic study.

*Comment 11: "BSC generally concurs with the Journey-to-Work methodology and existing roadway network used to estimate the trip distribution patterns."*

Response 11: No response required.

*Comment 12: "The intersection of Route 109 and Beaver Street would experience the largest increase in project traffic. As noted earlier, the Proponent should evaluate traffic impacts at this intersection."*

Response 12: As documented in response to Comment No. 1 and based on the trip estimates using the most recent edition of the ITE *Trip Generation Manual*, the project would add 32 to 40 vehicle trips to the Route 109 and Beaver Street intersection during the weekday AM and PM peak hours, respectively. These increases represent one additional vehicle through the intersection every 1.5 to two minutes, on average.

*Comment 13: "The project site driveway is on Birch Street south of the Birchler's Automotive driveway. The TIAS indicates that an emergency access would be located on an easement on the Fire Department's property. The Proponent should show this on the site plans."*

Response 13: Response to be provided by Allen Engineering under separate cover.

*Comment 14: "BSC agrees with the methodology used to evaluate the operating conditions at the study area intersections. The TIAS has identified capacity deficiencies at Route 109 westbound left onto Birch Street, and Birch Street left turn onto Beaver Street."*

Response 14: Comment acknowledged. The proponent has committed to implement traffic signal timing changes at this intersection to improve traffic operations and mitigate the impacts of the project.

*Comment 15: "As part of the mitigation for the project, the Proponent proposes to modify traffic signal timing for Route 109 westbound left-turn traffic onto Birch Street. Please confirm if the changes would affect pedestrian signal timing at the intersection."*

Response 15: As part of the signal timing changes at this intersection, the proponent will also update the signal clearance intervals (yellow and all-red times) for vehicular traffic as well as the pedestrian phase times in accordance with current MassDOT standards. In addition to these improvements, the proponent has agreed to widen and restripe the Birch Street approach to Beaver Street to provide two approach lanes. This will allow the heavy right-turning traffic on Birch Street to bypass any traffic that is waiting to turn left onto Beaver Street.

*Comment 16: "The Proponent is proposing a sidewalk along the project driveway, terminating at Birch Street. Additionally, a bus shelter is proposed on the south side of the site driveway."*

Response 16: Comment acknowledged.

*Comment 17: "Please consider extending proposed sidewalk along the site driveway northwards along Birch Street."*

Response 17: Response to be provided by Allen Engineering under separate cover.

*Comment 18: "Street sign legend is provided on Sheet 13 of 14 but no signs are shown on the site plans. Please show proposed signs on the site plans."*

Response 18: Response to be provided by Allen Engineering under separate cover.

*Comment 19: "Please provide detail of how the site driveway will connect to Birch Street."*

Response 19: Response to be provided by Allen Engineering under separate cover.

*Comment 20: "It is not clear if the three parallel parking spaces on the south side of Building #2 are of standard length. Please show dimensions on the plans and confirm if the spaces provided are adequate for three vehicles to park along that section of the building."*

Response 20: Response to be provided by Allen Engineering under separate cover.

Please feel free to contact me if you have any questions or comments regarding these responses.

Sincerely,

***Ron Müller & Associates***



Ronald Müller, P.E.  
Principal

Attachments

cc: Mark Allen  
Kevin Lobisser  
Ed Marchant

File Name : 17041 Beaver-Rte 109 AM

Site Code : 17041

Start Date : 6/6/2018

Page No : 1

E-W Street: Medway Road/Rte 109

N-S Street: Beaver Street

**Groups Printed- Cars - Trucks**

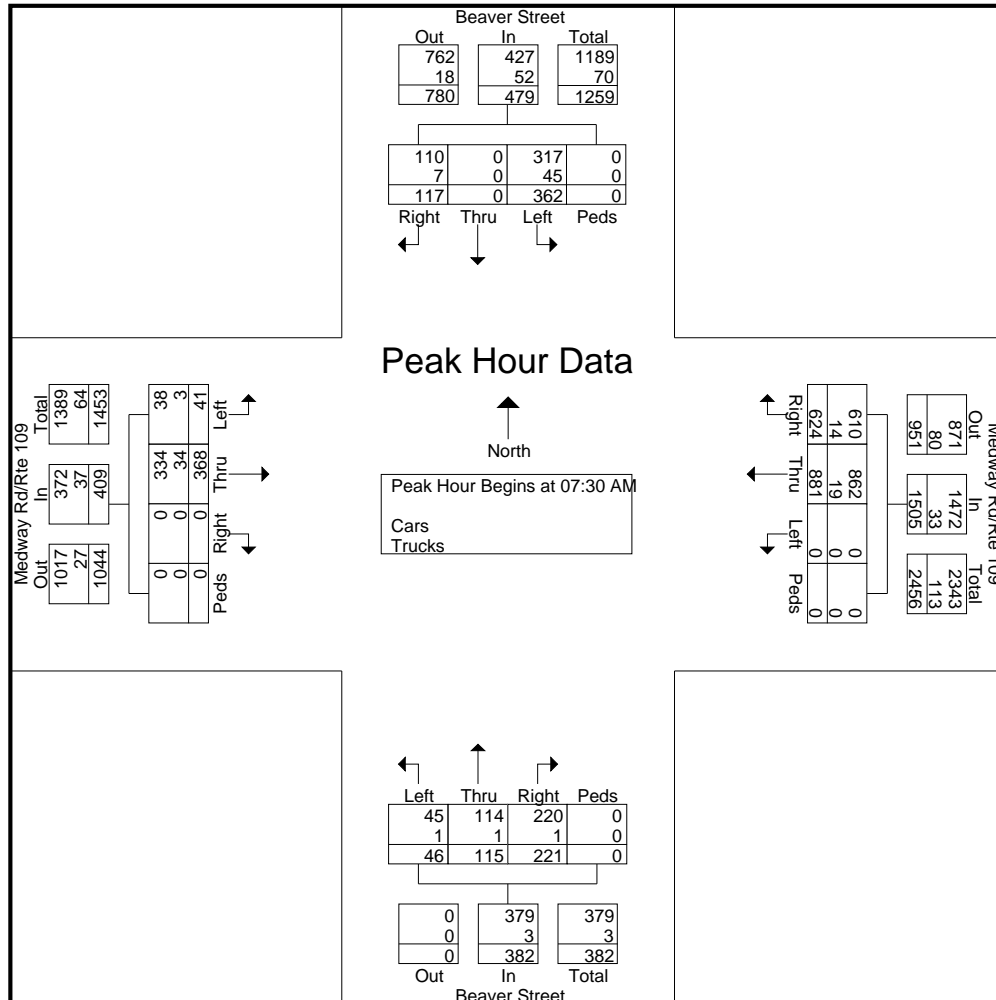
	<b>Beaver Street From North</b>					<b>Medway Rd/Rte 109 From East</b>					<b>Beaver Street From South</b>					<b>Medway Rd/Rte 109 From West</b>					
Start Time	Left	Thru	Right	Peds	App. Total	Left	Thru	Right	Peds	App. Total	Left	Thru	Right	Peds	App. Total	Left	Thru	Right	Peds	App. Total	Int. Total
07:00 AM	69	0	15	0	84	0	136	112	0	248	5	12	58	0	75	19	76	0	0	95	502
07:15 AM	72	0	24	0	96	0	196	111	0	307	7	17	44	0	68	11	91	0	0	102	573
07:30 AM	99	0	28	0	127	0	194	133	0	327	9	27	64	0	100	12	104	0	0	116	670
07:45 AM	94	0	25	0	119	0	281	155	0	436	11	30	78	0	119	7	89	0	0	96	770
Total	334	0	92	0	426	0	807	511	0	1318	32	86	244	0	362	49	360	0	0	409	2515
08:00 AM	65	0	35	0	100	0	202	165	0	367	18	30	44	0	92	16	88	0	0	104	663
08:15 AM	104	0	29	0	133	0	204	171	0	375	8	28	35	0	71	6	87	0	0	93	672
08:30 AM	82	0	23	0	105	0	212	140	0	352	13	15	42	0	70	12	58	0	0	70	597
08:45 AM	67	0	22	0	89	0	197	123	0	320	14	28	33	0	75	24	84	0	0	108	592
Total	318	0	109	0	427	0	815	599	0	1414	53	101	154	0	308	58	317	0	0	375	2524
Grand Total	652	0	201	0	853	0	1622	1110	0	2732	85	187	398	0	670	107	677	0	0	784	5039
Apprch %	76.4	0	23.6	0		0	59.4	40.6	0		12.7	27.9	59.4	0		13.6	86.4	0	0		
Total %	12.9	0	4	0	16.9	0	32.2	22	0	54.2	1.7	3.7	7.9	0	13.3	2.1	13.4	0	0	15.6	
Cars	570	0	186	0	756	0	1575	1067	0	2642	84	185	390	0	659	102	613	0	0	715	4772
% Cars	87.4	0	92.5	0	88.6	0	97.1	96.1	0	96.7	98.8	98.9	98	0	98.4	95.3	90.5	0	0	91.2	94.7
Trucks	82	0	15	0	97	0	47	43	0	90	1	2	8	0	11	5	64	0	0	69	267
% Trucks	12.6	0	7.5	0	11.4	0	2.9	3.9	0	3.3	1.2	1.1	2	0	1.6	4.7	9.5	0	0	8.8	5.3



File Name : 17041 Beaver-Rte 109 AM  
 Site Code : 17041  
 Start Date : 6/6/2018  
 Page No : 2

E-W Street: Medway Road/Rte 109  
 N-S Street: Beaver Street

	Beaver Street From North					Medway Rd/Rte 109 From East					Beaver Street From South					Medway Rd/Rte 109 From West					
Start Time	Left	Thru	Right	Peds	App. Total	Left	Thru	Right	Peds	App. Total	Left	Thru	Right	Peds	App. Total	Left	Thru	Right	Peds	App. Total	Int. Total
Peak Hour Analysis From 07:00 AM to 08:45 AM - Peak 1 of 1																					
Peak Hour for Entire Intersection Begins at 07:30 AM																					
07:30 AM	99	0	28	0	127	0	194	133	0	327	9	27	64	0	100	12	<b>104</b>	0	0	<b>116</b>	670
07:45 AM	94	0	25	0	119	0	<b>281</b>	155	0	<b>436</b>	11	<b>30</b>	<b>78</b>	0	<b>119</b>	7	89	0	0	96	<b>770</b>
08:00 AM	65	0	<b>35</b>	0	100	0	202	165	0	367	<b>18</b>	30	44	0	92	<b>16</b>	88	0	0	104	663
08:15 AM	<b>104</b>	0	29	0	<b>133</b>	0	204	<b>171</b>	0	375	8	28	35	0	71	6	87	0	0	93	672
Total Volume	362	0	117	0	479	0	881	624	0	1505	46	115	221	0	382	41	368	0	0	409	2775
% App. Total	75.6	0	24.4	0		0	58.5	41.5	0		12	30.1	57.9	0		10	90	0	0		
PHF	.870	.000	.836	.000	.900	.000	.784	.912	.000	.863	.639	.958	.708	.000	.803	.641	.885	.000	.000	.881	.901
Cars	317	0	110	0	427	0	862	610	0	1472	45	114	220	0	379	38	334	0	0	372	2650
% Cars	87.6	0	94.0	0	89.1	0	97.8	97.8	0	97.8	97.8	99.1	99.5	0	99.2	92.7	90.8	0	0	91.0	95.5
Trucks	45	0	7	0	52	0	19	14	0	33	1	1	1	0	3	3	34	0	0	37	125
% Trucks	12.4	0	6.0	0	10.9	0	2.2	2.2	0	2.2	2.2	0.9	0.5	0	0.8	7.3	9.2	0	0	9.0	4.5



File Name : 17041 Beaver-Rte 109 PM

Site Code : 17041

Start Date : 6/6/2018

Page No : 1

E-W Street: Medway Road/Rte 109  
N-S Street: Beaver Street

**Groups Printed- Cars - Trucks**

	<b>Beaver Street From North</b>					<b>Medway Road/Rte 109 From East</b>					<b>Beaver Street From South</b>					<b>Medway Road/Rte 109 From West</b>					
Start Time	Left	Thru	Right	Peds	App. Total	Left	Thru	Right	Peds	App. Total	Left	Thru	Right	Peds	App. Total	Left	Thru	Right	Peds	App. Total	Int. Total
04:00 PM	170	0	34	0	204	0	163	104	0	267	18	27	107	0	152	41	140	0	0	181	804
04:15 PM	136	0	42	0	178	0	172	106	0	278	12	25	109	0	146	38	125	0	0	163	765
04:30 PM	162	0	38	0	200	0	154	108	0	262	11	43	87	0	141	31	153	0	0	184	787
04:45 PM	176	0	39	0	215	0	130	116	0	246	11	46	112	0	169	27	138	0	0	165	795
Total	644	0	153	0	797	0	619	434	0	1053	52	141	415	0	608	137	556	0	0	693	3151
05:00 PM	170	0	34	0	204	0	171	134	0	305	22	42	80	0	144	41	218	0	0	259	912
05:15 PM	150	0	39	0	189	0	177	134	0	311	13	36	108	0	157	28	145	0	0	173	830
05:30 PM	153	0	45	0	198	0	168	112	0	280	3	23	94	1	121	24	132	0	0	156	755
05:45 PM	132	0	49	1	182	0	170	116	0	286	8	27	70	0	105	39	112	0	0	151	724
Total	605	0	167	1	773	0	686	496	0	1182	46	128	352	1	527	132	607	0	0	739	3221
Grand Total	1249	0	320	1	1570	0	1305	930	0	2235	98	269	767	1	1135	269	1163	0	0	1432	6372
Apprch %	79.6	0	20.4	0.1		0	58.4	41.6	0		8.6	23.7	67.6	0.1		18.8	81.2	0	0		
Total %	19.6	0	5	0	24.6	0	20.5	14.6	0	35.1	1.5	4.2	12	0	17.8	4.2	18.3	0	0	22.5	
Cars	1213	0	315	1	1529	0	1282	913	0	2195	98	268	763	1	1130	266	1131	0	0	1397	6251
% Cars	97.1	0	98.4	100	97.4	0	98.2	98.2	0	98.2	100	99.6	99.5	100	99.6	98.9	97.2	0	0	97.6	98.1
Trucks	36	0	5	0	41	0	23	17	0	40	0	1	4	0	5	3	32	0	0	35	121
% Trucks	2.9	0	1.6	0	2.6	0	1.8	1.8	0	1.8	0	0.4	0.5	0	0.4	1.1	2.8	0	0	2.4	1.9

File Name : 17041 Beaver-Rte 109 PM

Site Code : 17041

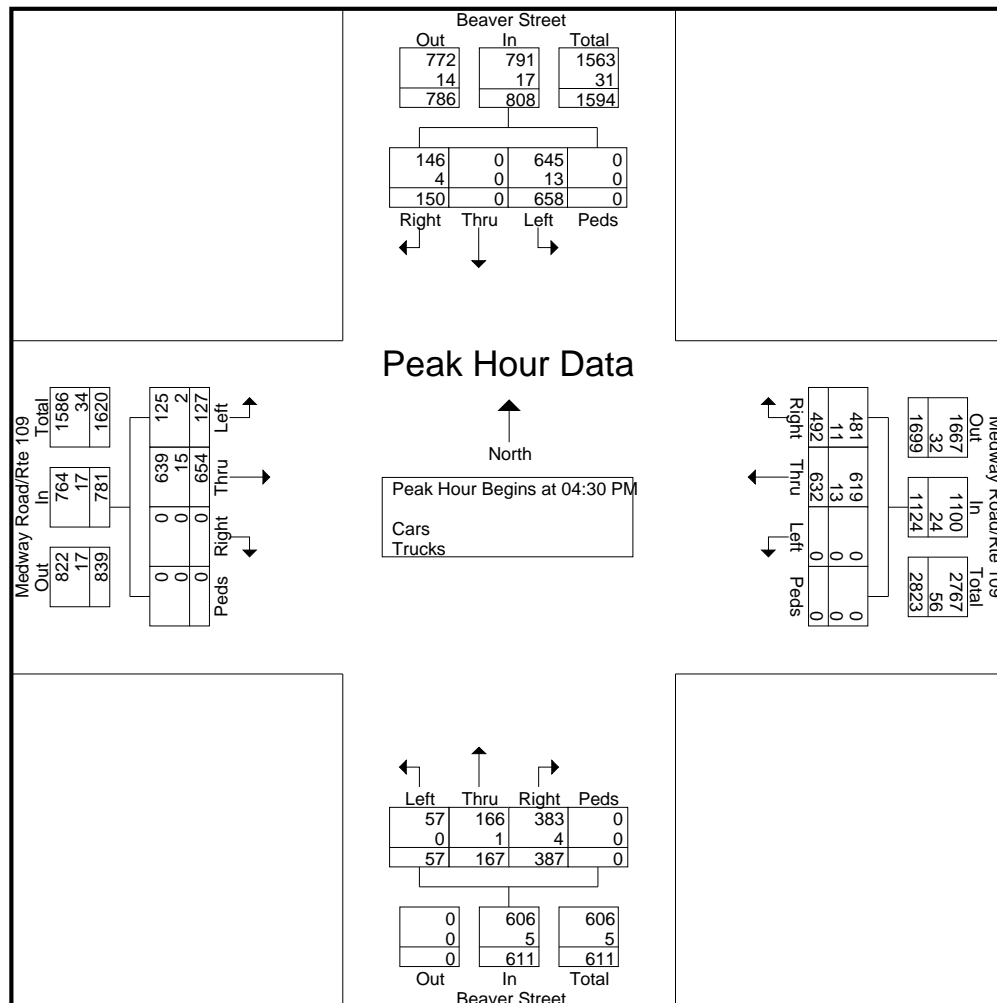
Start Date : 6/6/2018

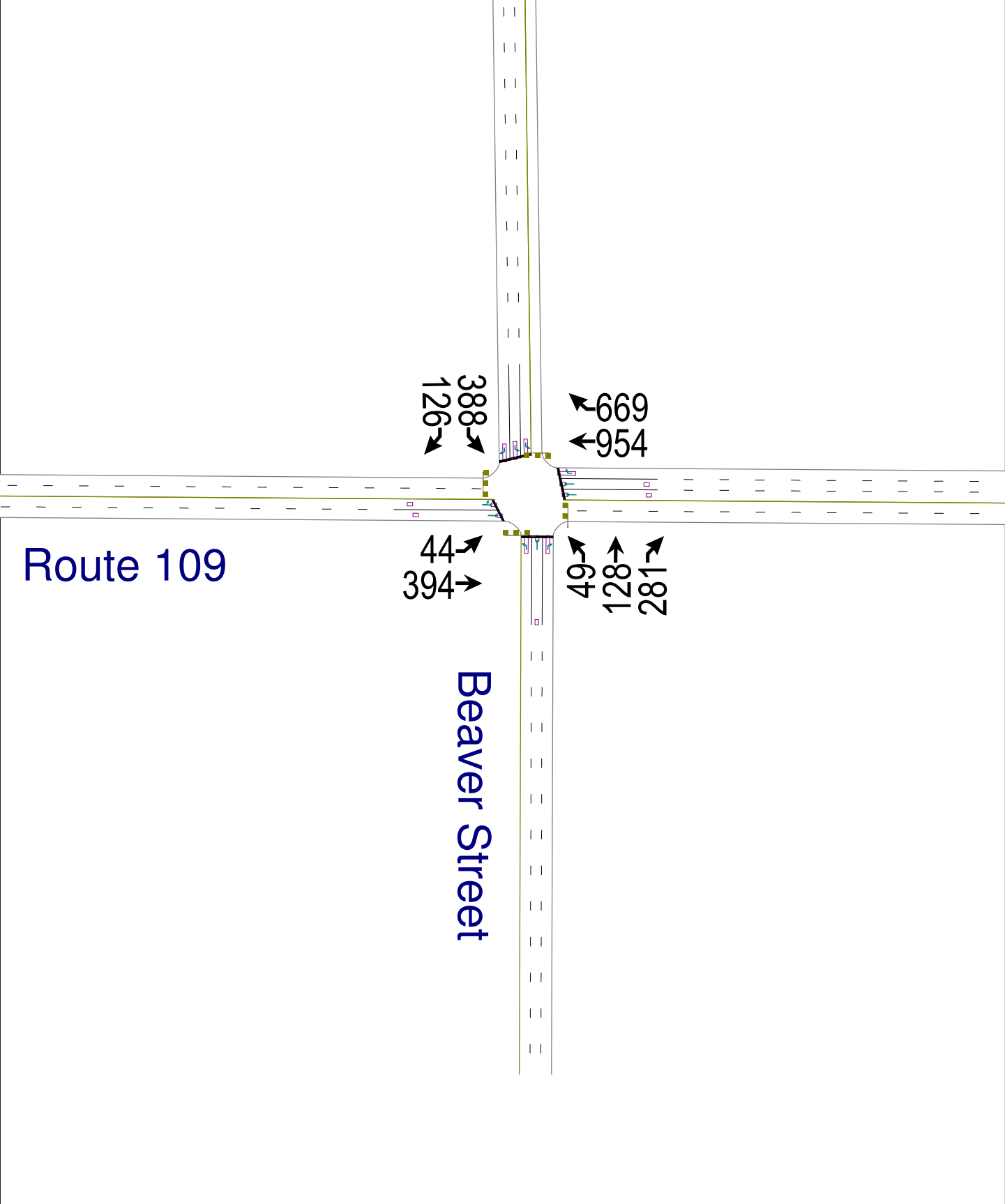
Page No : 2

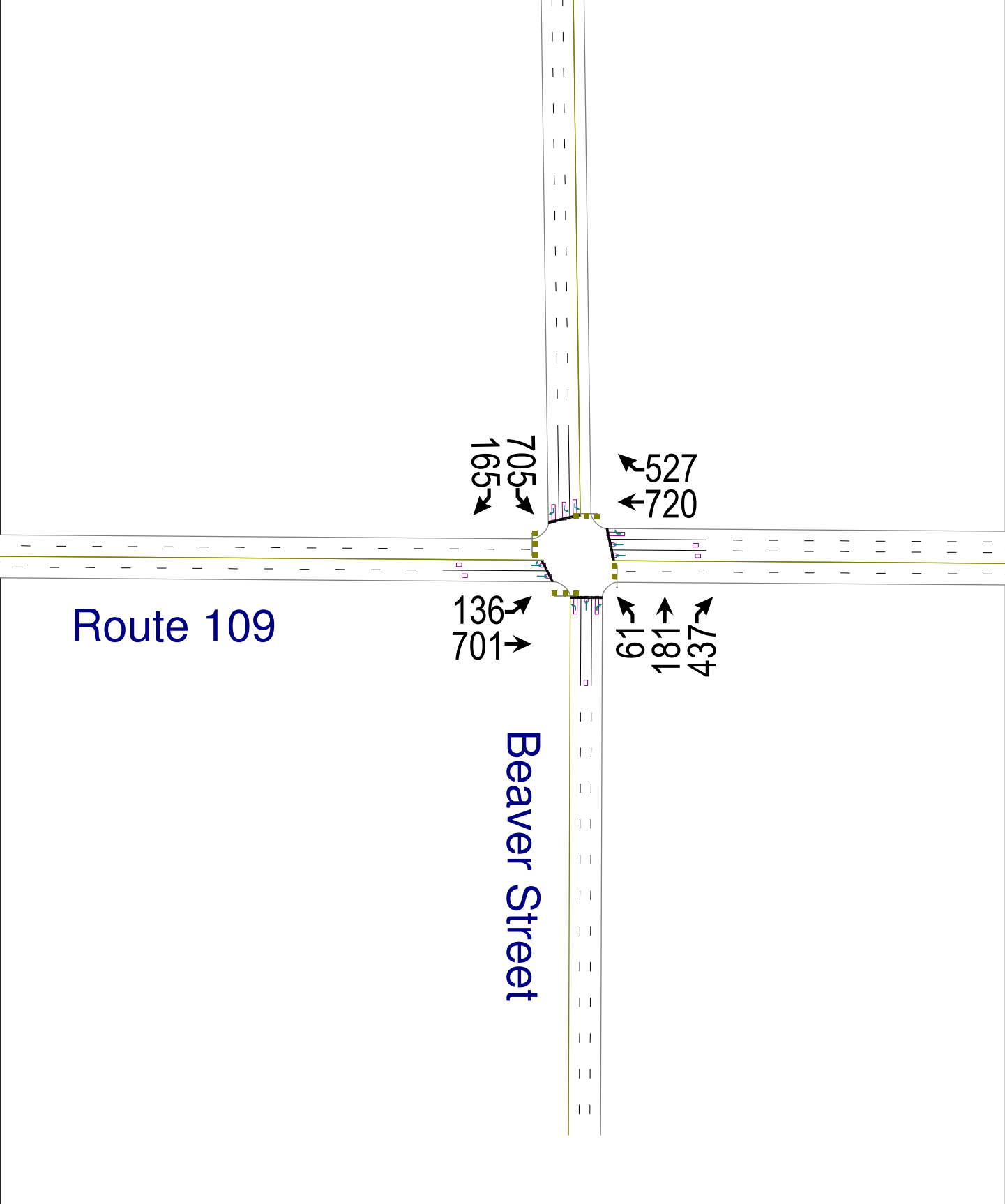
E-W Street: Medway Road/Rte 109

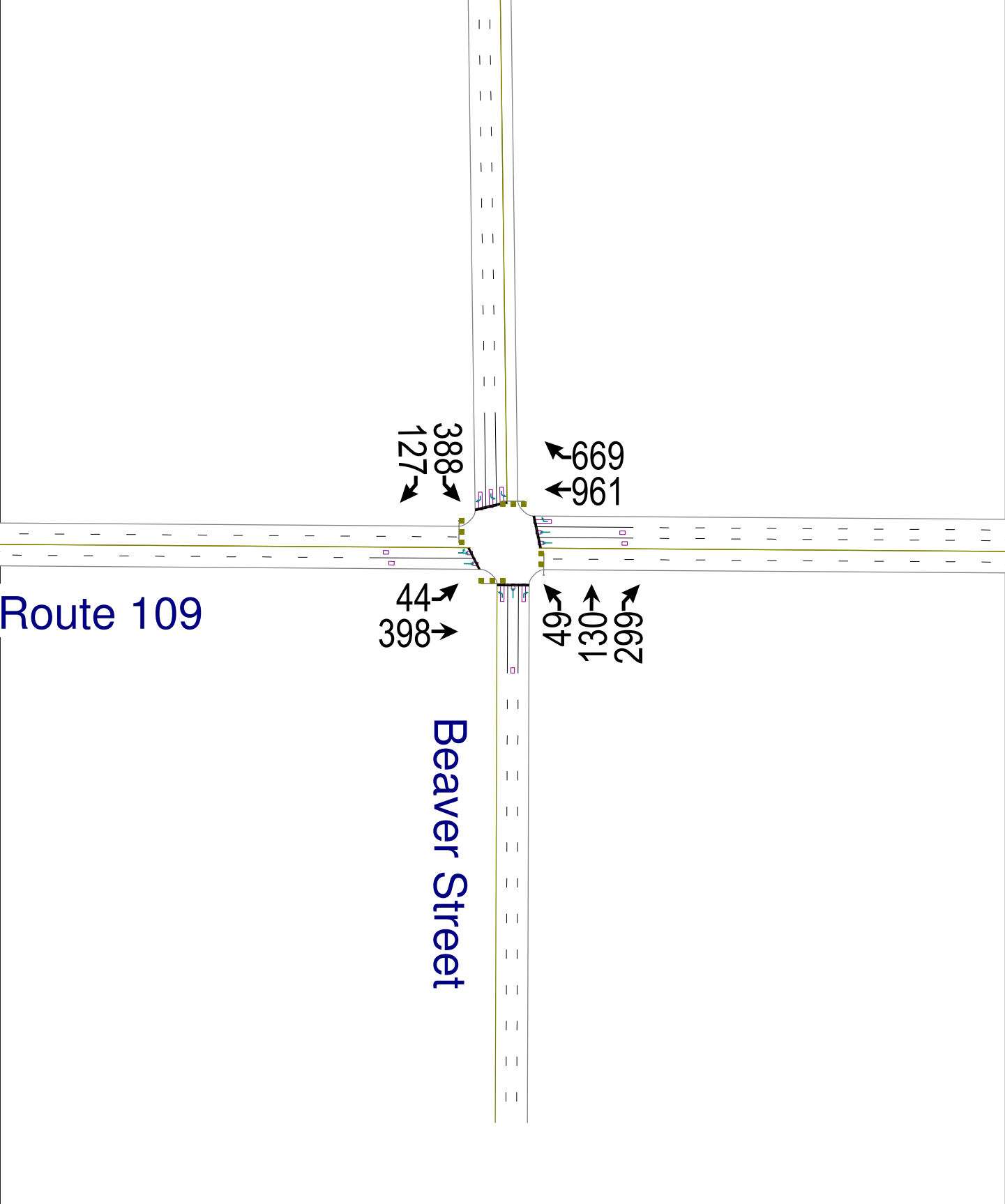
N-S Street: Beaver Street

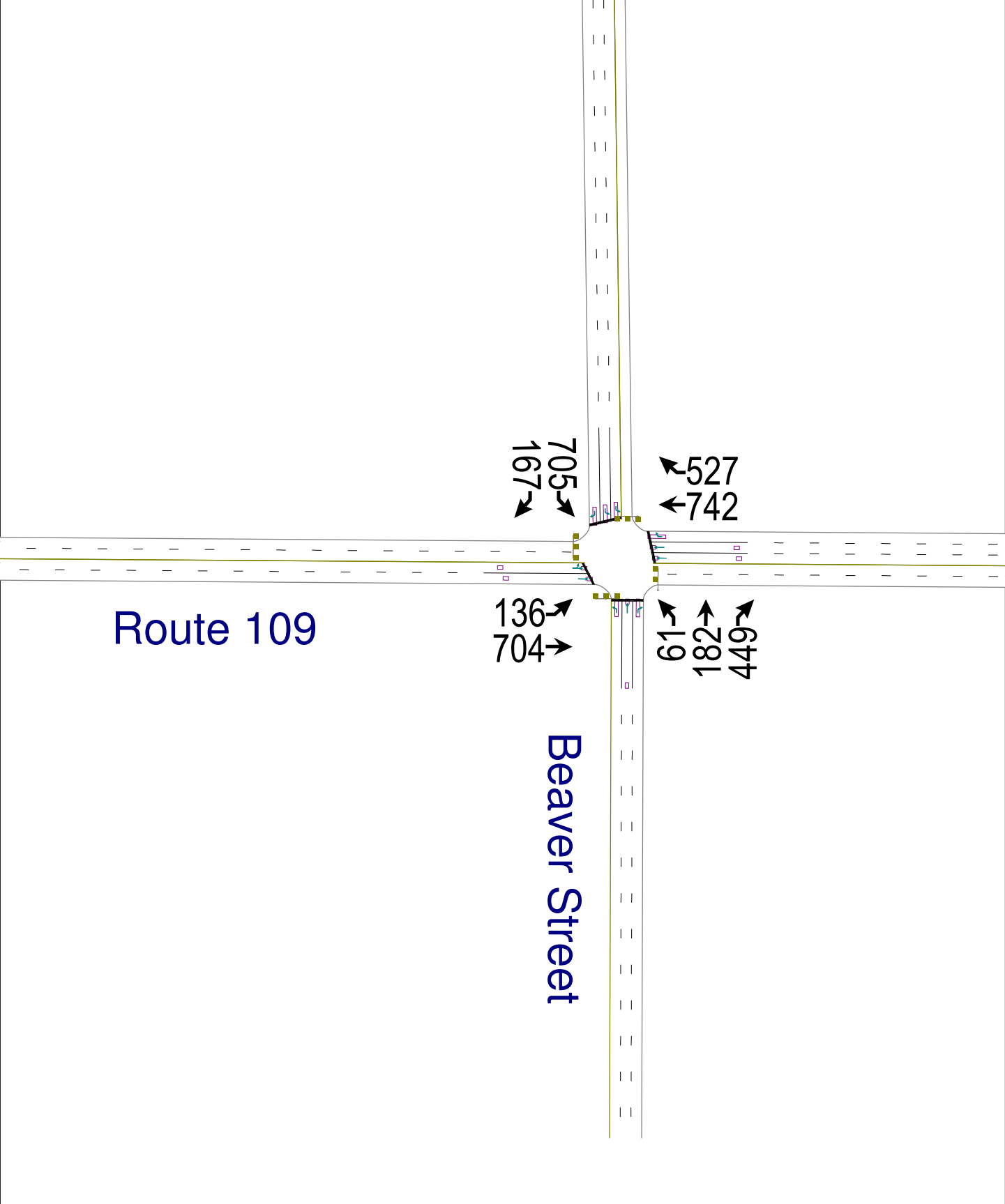
	Beaver Street From North					Medway Road/Rte 109 From East					Beaver Street From South					Medway Road/Rte 109 From West					
Start Time	Left	Thru	Right	Peds	App. Total	Left	Thru	Right	Peds	App. Total	Left	Thru	Right	Peds	App. Total	Left	Thru	Right	Peds	App. Total	Int. Total
Peak Hour Analysis From 04:00 PM to 05:45 PM - Peak 1 of 1																					
Peak Hour for Entire Intersection Begins at 04:30 PM																					
04:30 PM	162	0	38	0	200	0	154	108	0	262	11	43	87	0	141	31	153	0	0	184	787
04:45 PM	<b>176</b>	0	<b>39</b>	0	<b>215</b>	0	130	116	0	246	11	<b>46</b>	<b>112</b>	0	<b>169</b>	27	138	0	0	165	795
05:00 PM	170	0	34	0	204	0	171	<b>134</b>	0	305	<b>22</b>	42	80	0	144	<b>41</b>	<b>218</b>	0	0	<b>259</b>	<b>912</b>
05:15 PM	150	0	39	0	189	0	<b>177</b>	134	0	<b>311</b>	13	36	108	0	157	28	145	0	0	173	830
Total Volume	658	0	150	0	808	0	632	492	0	1124	57	167	387	0	611	127	654	0	0	781	3324
% App. Total	81.4	0	18.6	0		0	56.2	43.8	0		9.3	27.3	63.3	0		16.3	83.7	0	0		
PHF	.935	.000	.962	.000	.940	.000	.893	.918	.000	.904	.648	.908	.864	.000	.904	.774	.750	.000	.000	.754	.911
Cars	645	0	146	0	791	0	619	481	0	1100	57	166	383	0	606	125	639	0	0	764	3261
% Cars	98.0	0	97.3	0	97.9	0	97.9	97.8	0	97.9	100	99.4	99.0	0	99.2	98.4	97.7	0	0	97.8	98.1
Trucks	13	0	4	0	17	0	13	11	0	24	0	1	4	0	5	2	15	0	0	17	63
% Trucks	2.0	0	2.7	0	2.1	0	2.1	2.2	0	2.1	0	0.6	1.0	0	0.8	1.6	2.3	0	0	2.2	1.9


































# Lanes, Volumes, Timings

## 3: Beaver Street & Route 109

2025 No-Build AM

6/7/2018

												
Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations		 			 					 		
Volume (vph)	44	394	0	0	954	669	49	128	281	388	0	126
Satd. Flow (prot)	0	3295	0	0	3539	1583	1626	1712	1455	3467	0	1599
Flt Permitted		0.743					0.950			0.950		
Satd. Flow (perm)	0	2461	0	0	3539	1583	1626	1712	1455	3467	0	1599
Satd. Flow (RTOR)						727			273			137
Lane Group Flow (vph)	0	476	0	0	1037	727	53	139	305	422	0	137
Turn Type	Perm	NA			NA	Perm	Split	NA	Prot	Prot		Prot
Protected Phases		2			6		8	8	8	7		7
Permitted Phases	2					6						
Total Split (s)	54.0	54.0			54.0	54.0	18.0	18.0	18.0	27.0		27.0
Total Lost Time (s)		5.0			5.0	5.0	5.0	5.0	5.0	5.0		5.0
Act Effct Green (s)		49.0			49.0	49.0	13.0	13.0	13.0	22.0		22.0
Actuated g/C Ratio		0.49			0.49	0.49	0.13	0.13	0.13	0.22		0.22
v/c Ratio		0.39			0.59	0.63	0.25	0.62	0.71	0.55		0.30
Control Delay		16.9			19.6	3.9	42.0	53.8	17.6	37.2		7.5
Queue Delay		0.0			0.0	0.0	0.0	0.0	0.0	0.0		0.0
Total Delay		16.9			19.6	3.9	42.0	53.8	17.6	37.2		7.5
LOS		B			B	A	D	D	B	D		A
Approach Delay		16.9			13.2			30.3				
Approach LOS		B			B			C				
Queue Length 50th (ft)		94			235	0	30	84	18	122		0
Queue Length 95th (ft)		134			300	57	68	#155	#110	170		48
Internal Link Dist (ft)		765			783			564			584	
Turn Bay Length (ft)												
Base Capacity (vph)		1218			1751	1150	213	224	428	770		461
Starvation Cap Reductn		0			0	0	0	0	0	0		0
Spillback Cap Reductn		0			0	0	0	0	0	0		0
Storage Cap Reductn		0			0	0	0	0	0	0		0
Reduced v/c Ratio		0.39			0.59	0.63	0.25	0.62	0.71	0.55		0.30

### Intersection Summary

Cycle Length: 99

Actuated Cycle Length: 99

Offset: 0 (0%), Referenced to phase 2:EBTL and 6:WBT, Start of Green

Control Type: Pretimed

Maximum v/c Ratio: 0.71

Intersection Signal Delay: 19.1

Intersection LOS: B

Intersection Capacity Utilization 72.8%

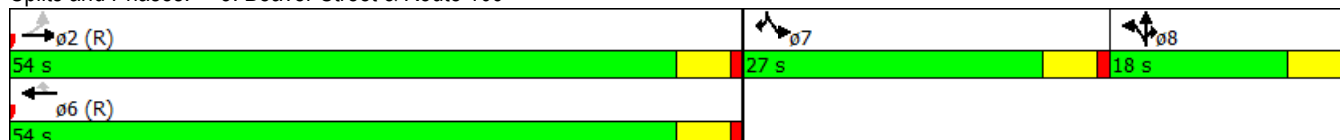
ICU Level of Service C

Analysis Period (min) 15

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

Queue shown is maximum after two cycles.

Splits and Phases: 3: Beaver Street & Route 109




























# Lanes, Volumes, Timings

## 3: Beaver Street & Route 109

2025 No-Build PM

6/7/2018

												
Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations		 			 					 		
Volume (vph)	136	701	0	0	720	527	61	181	437	705	0	165
Satd. Flow (prot)	0	3511	0	0	3539	1583	1787	1881	1599	3433	0	1583
Flt Permitted		0.623					0.950			0.950		
Satd. Flow (perm)	0	2205	0	0	3539	1583	1787	1881	1599	3433	0	1583
Satd. Flow (RTOR)						573			102			179
Lane Group Flow (vph)	0	910	0	0	783	573	66	197	475	766	0	179
Turn Type	Perm	NA			NA	Perm	Split	NA	Prot	Prot		Prot
Protected Phases		2			6		8	8	8	7		7
Permitted Phases	2					6						
Total Split (s)	54.0	54.0			54.0	54.0	18.0	18.0	18.0	27.0		27.0
Total Lost Time (s)		5.0			5.0	5.0	5.0	5.0	5.0	5.0		5.0
Act Effct Green (s)		49.0			49.0	49.0	13.0	13.0	13.0	22.0		22.0
Actuated g/C Ratio		0.49			0.49	0.49	0.13	0.13	0.13	0.22		0.22
v/c Ratio		0.83			0.45	0.53	0.28	0.80	1.59	1.01		0.36
Control Delay		29.9			17.2	3.3	42.4	65.9	307.8	73.3		7.2
Queue Delay		0.0			0.0	0.0	0.0	0.0	0.0	0.0		0.0
Total Delay		29.9			17.2	3.3	42.4	65.9	307.8	73.3		7.2
LOS		C			B	A	D	E	F	E		A
Approach Delay		29.9			11.3			219.5				
Approach LOS		C			B			F				
Queue Length 50th (ft)		249			162	0	38	122	~374	~252		0
Queue Length 95th (ft)		345			210	53	79	#236	#572	#377		54
Internal Link Dist (ft)		765			783			564			584	
Turn Bay Length (ft)												
Base Capacity (vph)		1091			1751	1072	234	247	298	762		491
Starvation Cap Reductn		0			0	0	0	0	0	0		0
Spillback Cap Reductn		0			0	0	0	0	0	0		0
Storage Cap Reductn		0			0	0	0	0	0	0		0
Reduced v/c Ratio		0.83			0.45	0.53	0.28	0.80	1.59	1.01		0.36

### Intersection Summary

Cycle Length: 99

Actuated Cycle Length: 99

Offset: 0 (0%), Referenced to phase 2:EBTL and 6:WBT, Start of Green

Control Type: Pretimed

Maximum v/c Ratio: 1.59

Intersection Signal Delay: 66.4

Intersection LOS: E

Intersection Capacity Utilization 88.7%

ICU Level of Service E

Analysis Period (min) 15

~ Volume exceeds capacity, queue is theoretically infinite.

Queue shown is maximum after two cycles.

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

Queue shown is maximum after two cycles.

Splits and Phases: 3: Beaver Street & Route 109


























# Lanes, Volumes, Timings

## 3: Beaver Street & Route 109

2025 Build AM

6/7/2018

												
Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations		 			 					 		
Volume (vph)	44	398	0	0	961	669	49	130	299	388	0	127
Satd. Flow (prot)	0	3295	0	0	3539	1583	1626	1712	1455	3467	0	1599
Flt Permitted		0.742					0.950			0.950		
Satd. Flow (perm)	0	2457	0	0	3539	1583	1626	1712	1455	3467	0	1599
Satd. Flow (RTOR)						727			270			138
Lane Group Flow (vph)	0	481	0	0	1045	727	53	141	325	422	0	138
Turn Type	Perm	NA			NA	Perm	Split	NA	Prot	Prot		Prot
Protected Phases		2			6		8	8	8	7		7
Permitted Phases	2					6						
Total Split (s)	54.0	54.0			54.0	54.0	18.0	18.0	18.0	27.0		27.0
Total Lost Time (s)		5.0			5.0	5.0	5.0	5.0	5.0	5.0		5.0
Act Effct Green (s)		49.0			49.0	49.0	13.0	13.0	13.0	22.0		22.0
Actuated g/C Ratio		0.49			0.49	0.49	0.13	0.13	0.13	0.22		0.22
v/c Ratio		0.40			0.60	0.63	0.25	0.63	0.76	0.55		0.30
Control Delay		16.9			19.7	3.9	42.0	54.3	22.0	37.2		7.5
Queue Delay		0.0			0.0	0.0	0.0	0.0	0.0	0.0		0.0
Total Delay		16.9			19.7	3.9	42.0	54.3	22.0	37.2		7.5
LOS		B			B	A	D	D	C	D		A
Approach Delay		16.9			13.2			32.8				
Approach LOS		B			B			C				
Queue Length 50th (ft)		96			238	0	30	85	32	122		0
Queue Length 95th (ft)		135			303	57	68	#159	#158	170		48
Internal Link Dist (ft)		765			783			564			584	
Turn Bay Length (ft)												
Base Capacity (vph)		1216			1751	1150	213	224	425	770		462
Starvation Cap Reductn		0			0	0	0	0	0	0		0
Spillback Cap Reductn		0			0	0	0	0	0	0		0
Storage Cap Reductn		0			0	0	0	0	0	0		0
Reduced v/c Ratio		0.40			0.60	0.63	0.25	0.63	0.76	0.55		0.30

### Intersection Summary

Cycle Length: 99

Actuated Cycle Length: 99

Offset: 0 (0%), Referenced to phase 2:EBTL and 6:WBT, Start of Green

Control Type: Pretimed

Maximum v/c Ratio: 0.76

Intersection Signal Delay: 19.6

Intersection LOS: B

Intersection Capacity Utilization 73.0%

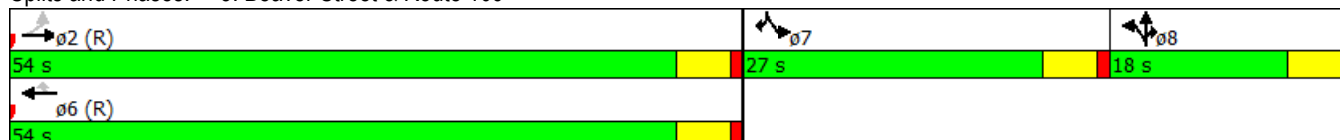
ICU Level of Service D

Analysis Period (min) 15

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

Queue shown is maximum after two cycles.

Splits and Phases: 3: Beaver Street & Route 109


























# Lanes, Volumes, Timings

## 3: Beaver Street & Route 109

2025 Build PM

6/7/2018

												
Lane Group	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations		 			 					 		
Volume (vph)	136	704	0	0	742	527	61	182	449	705	0	167
Satd. Flow (prot)	0	3511	0	0	3539	1583	1787	1881	1599	3433	0	1583
Flt Permitted		0.615					0.950			0.950		
Satd. Flow (perm)	0	2177	0	0	3539	1583	1787	1881	1599	3433	0	1583
Satd. Flow (RTOR)						573			101			182
Lane Group Flow (vph)	0	913	0	0	807	573	66	198	488	766	0	182
Turn Type	Perm	NA			NA	Perm	Split	NA	Prot	Prot		Prot
Protected Phases		2			6		8	8	8	7		7
Permitted Phases	2					6						
Total Split (s)	54.0	54.0			54.0	54.0	18.0	18.0	18.0	27.0		27.0
Total Lost Time (s)		5.0			5.0	5.0	5.0	5.0	5.0	5.0		5.0
Act Effct Green (s)		49.0			49.0	49.0	13.0	13.0	13.0	22.0		22.0
Actuated g/C Ratio		0.49			0.49	0.49	0.13	0.13	0.13	0.22		0.22
v/c Ratio		0.85			0.46	0.53	0.28	0.80	1.64	1.01		0.37
Control Delay		31.0			17.4	3.3	42.4	66.4	328.9	73.3		7.3
Queue Delay		0.0			0.0	0.0	0.0	0.0	0.0	0.0		0.0
Total Delay		31.0			17.4	3.3	42.4	66.4	328.9	73.3		7.3
LOS		C			B	A	D	E	F	E		A
Approach Delay		31.0			11.6			234.6				
Approach LOS		C			B			F				
Queue Length 50th (ft)		253			168	0	38	123	~393	~252		0
Queue Length 95th (ft)		#362			217	53	79	#238	#592	#377		54
Internal Link Dist (ft)		765			783			564			584	
Turn Bay Length (ft)												
Base Capacity (vph)		1077			1751	1072	234	247	297	762		493
Starvation Cap Reductn		0			0	0	0	0	0	0		0
Spillback Cap Reductn		0			0	0	0	0	0	0		0
Storage Cap Reductn		0			0	0	0	0	0	0		0
Reduced v/c Ratio		0.85			0.46	0.53	0.28	0.80	1.64	1.01		0.37

### Intersection Summary

Cycle Length: 99

Actuated Cycle Length: 99

Offset: 0 (0%), Referenced to phase 2:EBTL and 6:WBT, Start of Green

Control Type: Pretimed

Maximum v/c Ratio: 1.64

Intersection Signal Delay: 69.7

Intersection LOS: E

Intersection Capacity Utilization 89.4%

ICU Level of Service E

Analysis Period (min) 15

~ Volume exceeds capacity, queue is theoretically infinite.

Queue shown is maximum after two cycles.

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

Queue shown is maximum after two cycles.

Splits and Phases: 3: Beaver Street & Route 109



## INTERSECTION CRASH RATE WORKSHEET

CITY/TOWN : Milford COUNT DATE : August 2017

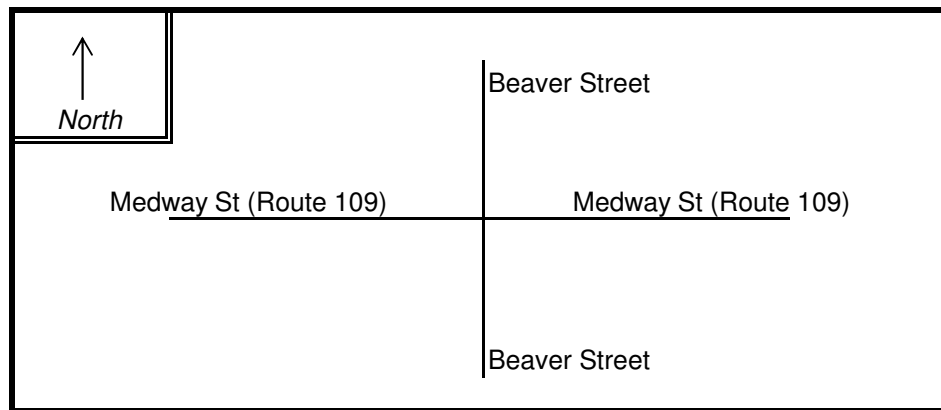
DISTRICT : 3 UNSIGNALIZED : ☒ SIGNALIZED : ☒

### ~ INTERSECTION DATA ~

MAJOR STREET : Medway Street (Route 109)

MINOR STREET(S) : Beaver Street

**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 (AM/PM) :	611	808	781	1,124		3,324

" K " FACTOR : 0.084 INTERSECTION ADT ( V ) = TOTAL DAILY APPROACH VOLUME : 39,571

TOTAL # OF CRASHES : 52 # OF YEARS : 3 AVERAGE # OF CRASHES PER YEAR ( A ) : 17.33

CRASH RATE CALCULATION :

1.20

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

Comments : K-Factor obtained from Stop & Shop traffic study. Volumes represent PM peak hour.

Project Title & Date : Proposed Apartment Development - Milford MA, June 2018

***Institute of Transportation Engineers (ITE); 10th Edition***  
**Land Use Code (LUC) 221 - Multifamily Housing (Mid-Rise)**

Average Vehicle Trips Ends vs: Dwelling Units  
Independent Variable (X): 162

**AVERAGE WEEKDAY DAILY (21-494 Units)**

$T = 5.45 * (X) - 1.75$   
 $T = 881.15$   
 $T = 880$  vehicle trips  
with 50% ( 440 vpd) entering and 50% ( 440 vpd) exiting.

**WEEKDAY AM PEAK HOUR OF ADJACENT STREET TRAFFIC (26-703 Units)**

$\text{Ln } T = 0.98 \text{ Ln } (X) - 0.98$   
 $\text{Ln } T = 4.01$   
 $T = 54.92$   
 $T = 55$  vehicle trips  
with 26% ( 14 vph) entering and 74% ( 41 vph) exiting.

**WEEKDAY PM PEAK HOUR OF ADJACENT STREET TRAFFIC (26-703 Units)**

$\text{Ln } T = 0.96 \text{ Ln } (X) - 0.63$   
 $\text{Ln } T = 4.25$   
 $T = 70.39$   
 $T = 70$  vehicle trips  
with 61% ( 43 vph) entering and 39% ( 27 vph) exiting.

**SATURDAY DAILY (111-336 Units)**

$T = 3.04 * (X) + 417.11$   
 $T = 909.59$   
 $T = 910$  vehicle trips  
with 50% ( 455 vpd) entering and 50% ( 455 vpd) exiting.

**SATURDAY MIDDAY PEAK HOUR OF GENERATOR (111-462 Units)**

$T = 0.42 * (X) + 6.73$   
 $T = 74.77$   
 $T = 75$  vehicle trips  
with 49% ( 37 vph) entering and 51% ( 38 vph) exiting.

**Weekday Daily Average Rate**

$T = 5.44 * (X)$   
 $T = 881.28$   
 $T = 880$  vehicle trips  
with 440 vpd entering and 440 vpd exiting.

**Weekday AM Peak Hour Average Rate**

$T = 0.36 * (X)$   
 $T = 58.32$   
 $T = 58$  vehicle trips  
with 15 vph entering and 43 vph exiting.

**Weekday PM Peak Hour Average Rate**

$T = 0.44 * (X)$   
 $T = 72.25$   
 $T = 72$  vehicle trips  
with 44 vph entering and 28 vph exiting.

**Saturday Daily Average Rate**

$T = 4.91 * (X)$   
 $T = 795.42$   
 $T = 800$  vehicle trips  
with 400 vpd entering and 400 vpd exiting.

**Saturday Midday Peak Hour Average Rate**

$T = 0.44 * (X)$   
 $T = 71.28$   
 $T = 71$  vehicle trips  
with 35 vph entering and 36 vph exiting.