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**Subject:** Lake Street Corridor Study

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Attached is the "Lake Street Corridor Project ? Manual Signal Simulation Test Report" for the Lake Street agenda item for the Board's February 20 meeting. The Arlington Transportation Advisory Committee (TAC) presented the results of the Lake Street Corridor Transportation Analysis Report (December 2014) to the Board of Selectmen on February 5, 2015. The study was completed to identify potential improvements to safety and vehicle delay along the Lake Street corridor. The TAC report recommended the installation of a new traffic/pedestrian/bicycle signal at the intersection of Lake Street and the Minuteman Bikeway to improve operations and safety. The Board voted to have the TAC conduct a field test simulating a traffic signal with police officer control at the Lake Street/Bikeway intersection. In response to this request, the TAC collected transportation data in the study area for approximately two weeks between Thursday, June 4 and Friday, June 19, 2015 both with and without police officer control simulating a signal. The attached report summarizes the study methodology and results.

Howard, Muise, Chair Arlington Transportation Advisory Committee  
Jeff Maxtutis, Vice Chair and TAC Lake Street Working Group Lead

**Attachments:**

File: [LAKE STREET  
Corridor Signal  
Simulation Memo Final  
1-13-16.docx](#)

Size: 415k Content Type: application/vnd.openxmlformats-officedocument.wordprocessingml.document

**LAKE STREET CORRIDOR PROJECT – MANUAL SIGNAL SIMULATION TEST REPORT**  
**ARLINGTON TRANSPORTATION ADVISORY COMMITTEE**  
**January 13, 2016**

**EXECUTIVE SUMMARY**

The Arlington Transportation Advisory Committee (TAC) presented the results of the Lake Street Corridor Transportation Analysis Report (December 2014) to the Board of Selectmen (BoS) on February 5, 2015. The study was completed to identify potential improvements to safety and vehicle delay along the Lake Street corridor. The TAC report recommended the installation of a new traffic/pedestrian/bicycle signal at the intersection of Lake Street and the Minuteman Bikeway to improve operations and safety.

The BoS were cautiously supportive of the TAC recommendations, and voted to have the TAC conduct a field test simulating a traffic signal with police officer control at the Lake Street/Bikeway intersection. In response to this request, the TAC collected transportation data in the study area for approximately two weeks between Thursday, June 4 and Friday, June 19, 2015 both with and without police officer control simulating a signal.

The following summarizes the results of the study:

- Lake Street experiences up to 1,200 vehicles during the weekday PM peak hour (4:45-5:45). Almost 400 users on the Bikeway cross Lake Street during the PM peak hour (average of more than six persons crossing every minute).
- Traffic volume on northbound Lake Street at Brooks Avenue during the PM peak hour was 10 to 15% higher with police officer control. Higher traffic volume flow rates were observed for shorter time periods within the overall peak period.
- Bikeway users crossing Lake Street with police officer control during the weekday PM peak period (4:30-6:30) experienced stopped delay between 0 and 40 seconds, with an average delay between 15 and 20 seconds.
- Vehicle travel times on Lake Street between Route 2 and Mass Avenue during the weekday PM peak period were about 4 minutes faster on average with police officer control.
- The vehicle queue lengths on northbound Lake Street during the weekday PM peak period were similar for both the current condition (without police control) and for the simulated traffic signal condition (with police control). However, with police control the vehicles progressed in platoons versus stop-and-go operation with the current unsignalized condition.
- There were 14 crashes at the Bikeway crossing of Lake Street reported between January 1, 2014 and December 31, 2015. Two of the crashes involved pedestrians, five crashes resulted in



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personal injury and seven crashes involved property damage only. The most common type of crash at the Bikeway was rear end collisions.

A new traffic/pedestrian/bicycle signal on Lake Street at the Bikeway would provide a modest improvement in traffic delay and vehicle travel time during weekday peak hours. During off-peak and weekend periods the travel benefits to traffic would be less noticeable. The signal would provide a more orderly, predictable crossing for both Bikeway and Lake Street users.

The TAC recommends the BoS consider pursuing a new signal at Lake Street and the Bikeway crossing. Due to the complexity and issues involved in constructing a new signal at this location, the TAC recommends forming a design review committee. The goal of the design review committee would be to evaluate issues and identify constraints, design details, types and hours of operations, and costs. The committee's results would be used to develop and advance design plans. It is envisioned that, at a minimum, the committee would include members from the TAC, DPW, APD, ABAC, EALS, Walk Arlington, and a traffic engineering consultant.

The data collection effort completed for this study was the largest ever conducted by the TAC. The data collection program was a collaborative effort between TAC, BoS, Town Manager, APD and volunteers consisting of current and former TAC members, ABAC and EALS members and citizens (too many to name). We would like to thank all those who participated in this study.

## **INTRODUCTION**

The Arlington Transportation Advisory Committee (TAC) prepared the Lake Street Corridor Transportation Analysis Report, December 2014 and presented the results at the February 5, 2015 Board of Selectmen (BoS) meeting. Based on the findings of the report, the TAC recommended the installation of a new traffic/pedestrian/bicycle signal at the intersection of Lake Street and the Minuteman Bikeway to improve operations and safety. The signal would be coordinated with the adjacent signal at Lake Street and Brooks Avenue. Other minor items were also recommended to improve operations and safety at the Bikeway crossing.

The BoS were cautiously supportive of the recommendations, and voted to have the TAC conduct a field test simulating a traffic signal with police officer control at the Lake Street/Bikeway intersection. The purpose of the signal simulation test is to estimate the impact of a proposed traffic signal at the intersection of Lake Street and the Minuteman Bikeway on traffic operations along Lake Street and bicycle and pedestrian flow on the Bikeway. In the winter and spring of 2015 TAC coordinated with the Town Manager and Police Department to develop a data collection program.

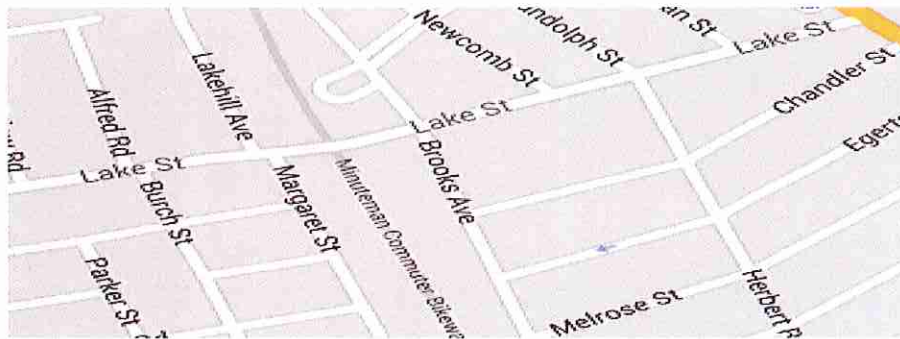
This memorandum presents the results of the signal simulation test.

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**STUDY APPROACH**

Transportation data were collected in the study area for approximately two weeks between Thursday, June 4 and Friday, June 19, 2015. For the first week, transportation data were collected for existing conditions without police officer control. These results represent existing baseline conditions and were used to compare with the results collected with police officer control at Lake Street and the Bikeway. On Monday through Thursday of the second week, two police officers controlled the Lake Street/Bikeway intersection in coordination with the Brooks Avenue signal between 4:00 and 7:00 PM to simulate the proposed signal at the Bikeway.

Because Route 2 and Mass Avenue in Arlington are generally referred to as east-west roadways, Lake Street was designated as a north-south roadway and Brooks Avenue an east-west roadway for the purpose of this study.



The following transportation data were collected in the Lake Street study area:

- Automatic traffic recorder (ATR) counts were performed on Brooks Avenue east and west of Lake Street and on Lake Street at Cabot Road. Traffic volume was collected by direction for a 16-day period between June 4 and June 19. Traffic volume was recorded for 24 hours each day in 15-minute increments. The Arlington Police Department used a combination of ATR machines and radar recorders to measure traffic volume.
- Manual traffic turning movement counts were recorded at the intersection of Lake Street with Brooks Avenue. Traffic volume and vehicle classification was recorded between 4:30 and 6:30 PM on two Tuesdays (June 9 and 16) and two Thursdays (June 11 and 18). Two volunteers conducted the turning movement counts each survey day, a total of 8.
- Manual volume and classification (pedestrians, bicycles, strollers, etc.) counts of Bikeway users crossing Lake Street were also conducted between 4:30 and 6:30 PM on the same two Tuesdays and Thursdays when the traffic counts described above were conducted. For the second week (June 16 and 18), Bikeway user delay was also measured when police officers stopped the



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Bikeway approaches to allow Lake Street traffic to proceed through the intersection (simulating a green signal indication). There was little or no delay observed for Bikeway users crossing Lake Street during the first week (June 9 and 11) without police officer control. Two additional volunteers conducted the Bikeway counts and measurements each survey day.

- Vehicle travel time runs along Lake Street were recorded in the northbound direction beginning on the Route 2 eastbound overpass over Lake Street and ending at Mass Avenue (approximately 1.2 miles). Travel time runs were conducted between 4:30 and 6:30 PM on June 9, 11, 16 and 18. The number of travel time runs conducted each day varied depending on vehicle congestion and queuing on Lake Street. Travel time runs were performed using a “floating car” technique where the survey vehicle travels at the prevailing traffic speed. Vehicle queue lengths on Lake Street northbound approaching the Bikeway and Mass Avenue were also observed. Two additional volunteers in one vehicle recorded travel times and vehicle queues each survey day.
- Observations of operating transportation conditions along Lake Street and at the intersections with the Bikeway and Brooks Avenue were made by TAC members and traffic engineer Jason Sobel, who was contracted by TAC for consulting services for this study.

On Monday through Thursday June 15-18 between 4:00 and 7:00 PM, two Arlington police officers manually controlled the intersection of Lake Street/Bikeway to simulate conditions of a traffic signal coordinated with the existing signal at the Lake Street/Brooks Avenue intersection. The officers stopped Lake Street traffic at the Bikeway when the Brooks signal had a red indication for Lake Street traffic and allowed traffic to proceed when Lake Street traffic had a green light at the Brooks signal. The timings at the Brooks Avenue signal (40 seconds green time for Lake Street and 25 seconds green time for Brooks Avenue) were approximately replicated by the officers at the Bikeway. Bikeway users crossing Lake Street were stopped (for up to approximately 40 seconds) when traffic was allowed to proceed through the intersection. Pedestrian signal phases occurred regularly at the Lake Street/Brooks Avenue intersection resulting in additional “green” time for Bikeway users to cross Lake Street.

## **ANALYSIS RESULTS**

The traffic volumes, travel times, delay, and queue lengths are summarized below.

### **Lake Street Traffic Volumes**

Table 1 summarizes the PM peak hour (approximately 4:45-5:45) traffic volumes on Lake Street south of Brooks Avenue. The northbound Lake Street peak hour volume at Brooks Avenue was approximately 11 percent greater on average with police officer control than without (609 vs. 546). However, traffic volume throughput was even higher on northbound Lake Street on June 18<sup>th</sup> starting at 5:00 PM when police officers allocated additional “green” time to Lake Street vehicles when there were no Bikeway users waiting to cross Lake Street (similar to coordinated signal operation). This resulted in a 15 percent increase in northbound Lake Street traffic volumes (629) compared to no police officer control. The peak 15-minute northbound Lake Street flow rate from 5:00-5:15 PM on June 18 was 209 vehicles with officer

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control. This rate is approximately 30 percent greater than the highest 15-minute flow rate (160 vehicles on June 9) without police officer control. Based on this analysis, it appears that coordinated computerized traffic signal control will result in higher northbound traffic volume throughput.

**Table 1**  
**Lake Street Traffic Volume Summary**  
**PM Peak Hour (4:45-5:45)**

Count Date	Day	Police Control	NB	SB	Total
			Towards Mass Ave	Towards Rt. 2	
6/9/2015	Tuesday	NO	543	555	1098
6/11/2015	Thursday	NO	549	561	1110
<b>Average</b>			<b>546</b>	<b>558</b>	<b>1104</b>
6/16/2015	Tuesday	YES	588	514	1102
6/18/2015	Thursday	YES	629	553	1182
<b>Average</b>			<b>609</b>	<b>534</b>	<b>1143</b>

**Brooks Avenue Traffic Volumes**

One concern expressed about a possible impact of the proposed signal at the Bikeway was a potential increase in traffic on Brooks Avenue. The concern was that increased throughput on Lake Street at the Bikeway would result in longer queues and increased delay on Lake Street at Mass Avenue. Drivers headed to Mass Avenue eastbound might seek to avoid the longer queues by turning right onto Brooks Avenue eastbound from Lake Street to find a quicker, alternative route to reach Mass Avenue headed toward Cambridge.

The study included recording traffic volumes on Brooks Avenue, east and west of Lake Street, to determine if there were any significant changes in traffic volumes during police officer control at the Bikeway. Table 2 shows average PM peak period (4:00 – 7:00) traffic volumes on Brooks Avenue by direction with and without police officer control. Eastbound traffic on Brooks Avenue east of Lake Street experienced a small increase of 8 vehicles with police officer control over the three hour period analyzed. Westbound traffic showed a slightly larger increase of 12 vehicles (6 percent increase with police officer control). West of Lake Street, westbound traffic increased by an average of 9 vehicles per hour. By percentage, the biggest impact on Brooks Avenue was 6 percent, which is considerably less than the 11 percent (peak hour) impact on Lake Street flow (described above), which indicates that the impact on Brooks Avenue traffic was commensurate with the overall increase of flow in the Lake Street corridor (at worst) and there was no evidence that more drivers were diverting onto Brooks Avenue to avoid queues on Lake Street approaching Mass Ave.



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**Table 2**  
**Brooks Avenue Average Traffic Volume Comparison**  
**PM Peak Period (4:00-7:00)**

Police Officer Control	East of Lake Street			West of Lake Street		
	Eastbound	Westbound	Total	Eastbound	Westbound	Total
No*	466	204	670	387	260	647
Yes**	<u>474</u>	<u>216</u>	<u>690</u>	<u>347</u>	<u>287</u>	<u>634</u>
Difference	+8	+12	+20	-40	+27	-13

\* 6/8 - 6/11/15

\*\* 6/15 – 6/18/15

**Bikeway Volumes and Delay Crossing Lake Street**

Table 3 summarizes the volume of bikeway users crossing Lake Street on Tuesday, June 9; Thursday, June 11 without police officer control; and Tuesday, June 16; and Thursday, June 18, 2015 between 4:30 and 6:30 PM with police officer control.

The results show an average of 754 Bikeway user crossings (536 to Arlington Center and 218 towards Alewife) on the days without police officer control. This represents an average of over six Bikeway users crossing Lake Street every minute between 4:30 and 6:30 PM. Bikeway users experienced little or no delay crossing Lake Street without police officer control as motorists typically stop to yield the right-of-way to Bikeway users (regardless of travel mode).

The table shows a total of 503 Bikeway crossings on June 16 (374 to Arlington Center and 129 to Alewife Station) with police officer control. It is important to note that it rained on June 16, and that the weather forecast was for heavy rain. This appeared to reduce the number of Bikeway users for this day. Weather was clear on June 18 and there were 771 crossings (533 to Arlington Center and 238 towards Alewife) with police officer control. This represents over six Bikeway crossings per minute, or about one every 10 seconds.

The minimum delay for Bikeway users crossing Lake Street with police officer control was 0 seconds, when they arrived during a “red” signal indication for Lake Street traffic. The maximum delay was 40 seconds, when bikeway users arrived at beginning of a “green” signal indication for Lake Street traffic. The average delay for all Bikeway crossings with police officer control was approximately 18 seconds. The results show that on a typical clear weather weekday over 700 Bikeway users crossed Lake Street during the two-hour PM peak period both without and with police officer control.

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**Table 3**  
**Lake Street Bikeway Crossing Volumes**  
**PM Peak Period (4:30-6:30)**  
**June 2015**

Count Date	Day	Police Control	To Alewife	To Arlington Center	Total	Average Bikeway Delay (secs)	Notes
6/9/2015	Tuesday	NO	216	517	733	0	
6/11/2015	Thursday	NO	220	554	774	0	
<b>Average</b>			<b>218</b>	<b>536</b>	<b>754</b>	<b>0</b>	
6/16/2015	Tuesday	YES	129*	374*	503*	19	*Rain
6/18/2015	Thursday	YES	238	533	771	18	
<b>Average</b>			<b>184</b>	<b>454</b>	<b>637</b>	<b>18</b>	



**Bikeway Users Crossing Lake Street with Police Officer Control, June 2015**

**Lake Street Travel Times and Queue Lengths**

Table 4 compares the vehicle travel time results recorded on Lake Street northbound without police officer control on Tuesday, June 9 and Thursday, June 11, 2015 with travel times with police officer control present on Tuesday, June 16 and Thursday, June 18, 2015 between 4:30 and 6:30 PM.



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The results show that without police officer control, the time for a vehicle to travel from Route 2 to Mass Ave on Lake Street during the afternoon peak period ranged between 10 and 24+ minutes, with an average travel time over 16½ minutes (16:43). With police officer control, travel times ranged between 8 and 20 minutes with an average travel time of approximately 12 ½ minutes. The results show that travel times were about 4 minutes faster on average with police officer control.

Northbound vehicle queues on Lake Street were recorded during the travel time surveys in the afternoon peak period. The northbound vehicle queue on Lake Street typically extended from the Bikeway to under Route 2 and onto the Route 2 eastbound off-ramp with and with police officer control. However, the progression of northbound traffic flow on Lake Street was different without and with police officer control. Without police control, vehicles progressed incrementally northbound toward Mass Avenue. With police control, vehicles progressed in platoons as the simulated signal at the bikeway alternated between “green” and “red” phases. Vehicles traveling in platoons generally provide more predictability to motorists.

**Table 4**  
**Lake Street Vehicle Travel Time Runs**  
**PM Peak Period (4:30-6:30)**  
**June 2015**

Date	Day	Police Control	# Runs	Travel Time (min:sec)*		
				Shortest	Longest	Average of total runs
6/9/2015	Tuesday	No	4	14:14	24:42	19:24
6/11/2015	Thursday	No	5	10:16	19:20	14:02
<b>Average</b>			<b>4.5</b>	<b>12:15</b>	<b>22:01</b>	<b>16:43</b>
6/16/2015	Tuesday	Yes	7	8:03	14:36	12:05
6/18/2015	Thursday	Yes	6	9:00	20:00	12:50
<b>Average</b>			<b>6.5</b>	<b>8:32</b>	<b>17:18</b>	<b>12:28</b>
<b>Difference^</b>				<b>-3:43</b>	<b>-4:43</b>	<b>-4:15</b>

\* Travel time from Route 2 EB over Lake Street onto Mass Ave, about 1.2 miles

^ Days with police officer control minus days without police officer control

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**Crash Data**

Crash data for Lake Street between January 1, 2014 and December 31, 2015 were analyzed for this report. During that period, the Arlington Police Department responded to a total of 82 crashes on Lake Street. The vast majority of these crashes were at the intersection of Lake Street and Mass Ave.

Fourteen of the reported crashes on Lake Street occurred at the Bikeway crossing. Two of the crashes at the Bikeway involved pedestrians. There were no crashes at the Bikeway involving a bicyclist. Five crashes resulted in personal injury while seven crashes involved property damage only. It appears that the most common crash occurring at the Bikeway involved cars stopping for either cyclists or pedestrians crossing Lake Street and getting rear ended.

**Observations**

- With police officer control at the Bikeway crossing, the vehicle queue on northbound Lake Street traveled in large platoons, similar to what one would expect with a traffic signal versus stop-and-go traffic flow associated with the current unsignalized crossing.
- For some simulated “signal” cycles, southbound vehicles on Lake Street queued back through the Brooks Avenue intersection and onto the Brooks Avenue westbound approach (i.e., westbound left-turning cars from Brooks Avenue had nowhere to go). The queue dissipated once the police officers began allowing Lake Street southbound traffic to proceed at the Bikeway when there was an exclusive pedestrian signal at Brooks Avenue.
- Police officers could not fully replicate the operation of a coordinated computerized signal system. A traffic signal system would operate more efficiently by:
  - Allocating additional “green time” to Lake Street traffic when there is a pedestrian phase at Brooks Avenue and when there are no users waiting to cross Lake Street at the Bikeway; and
  - Minimizing the off-set time between the Bikeway and Brooks Avenue. The measured time it took northbound Lake Street vehicles to reach Brooks Avenue was approximately 14 seconds. A signal would give a green indication to northbound Lake Street vehicles at the Bikeway prior to the green indication for Lake Street at Brooks Avenue. This would result in less lost green time between the signals (approximately 6 seconds).
- Northbound and southbound vehicles on Lake Street making left turns into side streets (Lakehill Avenue and Margaret Street) often blocked through traffic on Lake Street.



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- Northbound motorists on Lake Street were observed making a left turn onto Lakehill Avenue to avoid delays (by traveling on Hamilton Road and Linwood Street to travel westbound on Mass Avenue.
- The northbound Lake Street queue at Mass Ave did not extend back Brooks Avenue.
- Many Bikeway users stopped at Lake Street with police officer control verbally indicated support for the installation of a signal.

### CONCLUSIONS

As requested by the Arlington Board of Selectmen, the Arlington Transportation Advisory Committee (TAC) conducted an evaluation of the Lake Street corridor to measure the potential impact of a new traffic/pedestrian/bicycle signal at the Bikeway crossing on operations and safety. New transportation data were collected in the study corridor between Thursday, June 4 and Friday, June 19, 2015. Arlington Police officers simulated a traffic/pedestrian/bicycle signal at Lake Street and the Bikeway crossing between Monday, June 15, and Thursday June 19, 2015 between 4:00 and 7:00 PM. Traffic, pedestrian and bikeway volumes and delay for the weekday PM peak period were compared for the current condition (without police control) to the simulated traffic signal condition (with police control). The study findings include the following:

- During the weekday PM peak hour (4:45-5:45), Lake Street experiences between 1,100 and 1,200 vehicles per hour.
- Almost 400 users on the Bikeway cross Lake Street during the PM peak hour on a weekday, an average of more than six persons crossing every minute.
- Traffic volume on northbound Lake Street at Brooks Avenue during the PM peak period (4:30-5:30) was 10 to 15% higher with police officer control. Higher traffic volume flow rates were observed for short periods.
- Bikeway users crossing Lake Street with police officer control during the weekday PM peak period experienced stopped delay between 0 and 40 seconds, with an average delay between 15 and 20 seconds per crossing.
- Vehicle travel times on Lake Street between Route 2 and Mass Avenue during the weekday PM peak period were about 4 minutes faster on average with police officer control.
- The vehicle queue lengths on northbound Lake Street during the weekday PM peak period were similar for both the current condition (without police control) and for the simulated traffic signal

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condition (with police control). However, with police control the vehicles progressed in platoons versus stop-and-go operation with the current unsignalized condition.

- There were 14 crashes at the Bikeway crossing of Lake Street reported between January 1, 2014 and December 31, 2015. Two of the crashes involved pedestrians, five crashes resulted in personal injury and seven crashes involved property damage only. The most common type of crash at the Bikeway was rear end collisions.
- A new traffic/pedestrian/bicycle signal on Lake Street at the Bikeway would provide a modest improvement in traffic delay and vehicle travel time during weekday peak hours. During off-peak and weekend periods the travel benefits to traffic would be less noticeable. Bikeway users would experience a signal controlled crossing of Lake Street with average delays of up to 20 seconds.
- The signal would provide a more orderly, predictable crossing for both Bikeway and Lake Street users.