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MEMORANDUM

DATE April 19, 2012
TO Boston Region Metropolitan Planning Organization
FROM Mark Abbott
RE Arterial Traffic Signal Improvements and Coordination Study:
Lexington/Bedford

BACKGROUND

This study was recommended by the Boston Region MPO's Congestion Management Process and was funded by the MPO in the federal fiscal year (FFY) 2010 Unified Planning Work Program.

Traffic signal coordination or synchronization promotes efficient traffic flow along an arterial roadway. Typically, arterial flow quality and efficiency is dictated by the level of service at traffic signals and the degree of coordination between them. Generally traffic flow can be improved by coordination when the signals are located within one-quarter of a mile of each other. Where traffic signals are coordinated, traffic moves in platoons along the road and, at certain speeds, can proceed through intersections without braking or stopping. In coordination, side street traffic and pedestrians must be considered, so that their needs for service through the coordinated intersections are met. A side benefit of coordination is enhanced safety through more efficient management and operation of the arterial signal systems.

The study's overall purpose was to evaluate three or four groups of arterial signalized intersections, consisting of two to three intersections each, throughout the region and to develop recommendations for improvements. The improvements were focused primarily on traffic signal coordination aimed at improving traffic flow and safety along the arterials. As part of the traffic signal coordination strategy, staff also considered geometric improvements and traffic signal design changes at the selected locations.

The process for selecting the groups of intersections for this study began with identifying traffic signals at intersections that are a quarter mile or less apart and that were included in the "Conceptual" or the "Pre-TIP" project category in the FFYs 2009–11 Transportation Improvement Program (TIP). Each location's crash history was also examined. In addition, staff asked MassDOT's Highway Division District 4 to suggest locations that they thought would be appropriate. A table showing the resultant universe of potential signal coordination locations is provided as Appendix A; correspondence with the District 4 traffic engineer is

provided as Appendix B. The locations were then examined to verify from a technical standpoint that signal coordination could potentially be implemented at them.

The final four groups of intersections selected by staff and District 4 through this process were then discussed with the MassDOT District 4 traffic engineer and the towns where the intersections are located. The final four signal groupings selected for this study were:

- *Braintree*
Washington Street at Common Street/President Road; at Route 3 southbound off-ramp; and at Independence Avenue/Church Street
- *Lexington/Bedford*
Route 4/225 (Great Road) at Hartwell Avenue; at Shawsheen Road; and at Great Road Shopping Center
- *Randolph*
Route 28 (as North Main Street) at Warren Street; at Memorial Parkway; and (as South Main Street) at North and Union streets
- *Weymouth*
Route 53 at Mutton Lane and at Pleasant Street

This memorandum provides information, analysis, and recommendations for the intersections located in Lexington and Bedford. Separate memoranda are provided for each of the signal groupings.

OVERVIEW OF THE STUDY AREA

The three Route 4/225 (Great Road) intersections chosen in Lexington and Bedford (listed above) are shown in Figure 1. These intersections are currently signalized and located along 0.90 miles (4,750 feet) of the roadway. Hartwell Avenue and Shawsheen Road are 3,450 feet apart; Shawsheen Road and Great Road Shopping Center are 1,300 feet apart.

Route 4/225 is a main commuter route for people accessing I-95, Hanscom Field (Hanscom Air Force Base), and several office buildings, primarily along Hartwell Avenue. On-street parking is not permitted along either side of Route 4/225 in the study area.

Route 4/225 between Hartwell Avenue and Shawsheen Road has residential housing located on the eastern side of the roadway. Access is provided by several minor unsignalized streets. The Westview Cemetery is located on the western side. A sidewalk is present on the eastern side.

The general land use north of Shawsheen Road through the Great Road Shopping Center intersection is commercial along both sides, with several small stores and businesses. Sidewalks are present along both sides of Route 4/225 in this small commercial area.



FIGURE 1
Study Area Intersections



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Route 4/225 north of Hartwell Avenue is classified as an urban minor arterial. Shawsheen Road is an urban minor arterial as well. South of Hartwell Avenue, Route 4/225 is an urban principal arterial. Hartwell Avenue is also classified as an urban principal arterial.

Route 4/225 is under the jurisdiction of MassDOT Highway Division throughout the study area. Shawsheen Road and Hartwell Avenue are under local jurisdiction.

OBJECTIVES OF THE STUDY

The objectives for the locations in Lexington and Bedford were to verify if signal coordination would, in fact, improve traffic operations and to identify other possible improvements that would reduce delays and enhance safety. Coordination at these intersections could ease congestion along Route 4/225, although it may not significantly improve access to Hanscom Field, the businesses along Hartwell Avenue, or I-95.

EXISTING CONDITIONS

Note: Traffic volume data and crash analyses are provided in separate sections that follow.

Route 4/225 at Hartwell Avenue (Lexington)

Layout

This is a four-way intersection, with Route 4/225 (Great Road) running north/south. The southbound Route 4/225 approach to the intersection consists of two general-purpose lanes, with an exclusive right-turn lane that is separated by a traffic island. The approach widens to two lanes approximately 500 feet north of the intersection. There are two departure lanes in the southbound direction.

The northbound Route 4/225 approach to the intersection consist of two general-purpose lanes, with two departure lanes which narrow to one lane approximately 430 feet north of the intersection. The right lane on this approach splits approximately 400 feet south of the intersection to provide for left turns onto Hartwell Avenue and U-turns made on the jug handle westbound approach to the intersection. This jug handle widens from one lane (as it splits from the northbound approach) to two lanes approximately 300 feet from the intersection.

The Hartwell Avenue eastbound approach to the intersection is striped as a wide single lane. Immediately at the intersection the lane splits for the left and right turns onto Route 4/225, northbound and southbound respectively. These turning movements are separated by a small traffic island.

No crosswalks are present at this intersection. A sidewalk is provided along Route 4/225 north and south on the eastern side of the roadway; however, no crosswalk or pedestrian signal equipment is provided at the intersection.

Land Use

The lane use adjacent to the intersection varies. The southeast quadrant of the intersection contains a Boston Sports Club, whose driveway is located approximately 450 feet south of the intersection. This driveway is located where the northbound split occurs for the jug handle. The northeast quadrant is residential, with single-family homes. The nearest driveway is located approximately 200 feet north of the intersection. In the northwest quadrant of the intersection is the Westview Cemetery. The Children's Hospital and Beth Israel Deaconess Health Center is located southwest of the intersection. The hospital has access both from Route 4/225 and Hartwell Avenue, while the health center only has access from Route 4/225.

There are numerous office buildings, as well as access to Hanscom Field, along Hartwell Avenue.

Signal System

The intersection has a fully actuated signal system, with loop detectors provided on all approaches. It is designed as a three-phase signal operation. There is no pedestrian phase provided in the signal phasing. The northbound and southbound Route 4/225 movements are concurrent through movements. The Hartwell Avenue approach has a lead protected phase, followed by a permitted phase, to accommodate the left-turning movements at the intersection. The permitted phase also allows for all movements on the jug handle approach to proceed through the intersection. The Hartwell Avenue right turns to the south are under yield sign control. The cycle length of the intersection is 128 seconds.

The signal heads are all post-mounted. All signal heads are standard three-section, 12-inch heads except for the signal head located opposite the Hartwell Avenue approach to the intersection, which has a five-section head (dog house) to accommodate the protected/permitted left-turn movement.

Observations of Operation

Observations of the intersection indicate that during both peak hours traffic at the intersection is heavy and operations suffer. Queuing occurs along Route 4/225 (its location depending on the peak hour) and for the Hartwell Avenue left turns.

Route 4/225 at Shawsheen Road/Pine Street (Bedford)

Layout

This is a four-way intersection, with Route 4/225 running north and south, Shawsheen Road the westbound approach, and Pine Street the eastbound approach. The northbound approach has two lanes, with the right lane designated as a right-turn-only lane. This right-turn lane is approximately 300 feet in length and occurs when Route 4/225 widens from a single lane to two lanes. The southbound Route 4/225 approach is a single lane from which all movements are provided with a single departure lane. The Shawsheen Road westbound movement has a single

lane that widens to allow right turns to bypass the left-turn queue; left turns are the primary movement at the intersection. The eastbound Pine Street approach to the intersection is also a single lane.

Sidewalks are present along the east side of Route 4/225 from south of Hartwell Avenue through this intersection and continuing north past the Great Road Shopping Center intersection. A narrow sidewalk begins on the west side of Route 4/225 north of the shopping center, continues south to this intersection, and then follows Pine Street, terminating at the intersection of Pine Street and Yankee Division Road approximately 130 feet south of this intersection. Crosswalks are provided across the Shawsheen Road approach and across the southbound Route 4/225 approach.

Land Use

The land use at this intersection varies, as it does at the Hartwell Avenue intersection. On the southeast corner is the Shawsheen Cemetery, and the southwest corner contains a single-family residence. The northeast corner contains a Shell gas station, which has curb cuts onto Route 4/225 and Shawsheen Road. A shopping plaza sits on the northwest corner of the intersection; it has an entrance located only 30 feet from the Route 4/225 southbound stop line. Additional access/egress is provided from Pine Street.

Signal System

This is a four-way signalized intersection with the majority of signal heads located upon two mast arms. The mast arm located on the southeast corner of the intersection contains three-section signal heads for the Route 4/225 northbound and Pine Street approaches. The mast arm located in the northwest corner contains three-section signal heads for the Route 4/225 southbound and Shawsheen Road approaches. A single four-section signal head is also located on this mast arm for left-turning vehicles from Pine Street. A single post-mounted three-section signal head is also located on the northwest corner approximately 10 feet north of the mast arm location. This signal head provides a secondary signal indication for the Shawsheen Road approach. Actuated pedestrian signal heads are located on the southeast, northeast, and northwest corners of the intersection.

The intersection operates under a fully actuated signal system, with loop detectors provided on all the approaches. It has a simple three-phase operation, with an actuated pedestrian phase. The Route 4/225 northbound and southbound movements operate concurrently. The Pine Street approach to the intersection has a short (five-second) advance phase upon actuation; otherwise, both Shawsheen Road and Pine Street will operate concurrently upon a Shawsheen Road activation.

Observations of Operation

Peak-hour field observations of this intersection indicated that the Shawsheen Road approach has a high number of left-turning vehicles during the AM peak hour and that the AM peak hour is the busier of the two peak hours.

Route 4/225 at Great Road Shopping Center (Bedford)

Layout

This is a four-legged intersection, with Route 4/225 being the eastbound and westbound movement after rounding a curve approximately 400 feet from the intersection. The northbound approach to the intersection is the entrance/exit to the Great Road Shopping Center. The southbound approach is the entrance/exit to Bedford's DPW building.

The westbound Route 4/225 approach consists of one left-turn lane that is approximately 100 feet in length and one general-purpose lane. Route 4/225 widens from one lane to accommodate the left lane. There is a single departure lane, which is 20 feet in width. This lane tapers to 16 feet in width approximately 300 feet from the intersection.

The eastbound approach also widens from one lane to two lanes approximately 100 feet prior to the intersection. The additional lane on this approach is a right-turn-only lane which provides access to the shopping center. The departure lane is 20 feet in width and narrows to 12 feet in width approximately 100 feet from the intersection.

The northbound approach (the exit from the shopping center) has two lanes, exclusive left- and right-turn lanes. These lanes are separated from the entrance by a four-foot landscaped, raised median which is 100 feet in length.

Sidewalks are present along both sides of Route 4/225. One crosswalk is provided across the entrance/exit of the shopping center and another across the eastbound approach of Route 4/225.

Land Use

The land use adjacent to the intersection is commercial except for the DPW building. The portion of Route 4/225 around the intersection has a variety of commercial activities, with the shopping center being the main attraction in the area.

Signal System

This is a four-way signalized intersection, with the signal heads for Route 4/225 and the shopping center primarily located upon two mast arms. The mast arm located on the southeastern corner of the intersection has two three-section signal heads for the eastbound approach. The other mast arm is located on the northeast corner of the intersection. This mast arm provides one three-section signal head for the general-purpose lane and one five-section head for the left-turn lane. An additional three-section head is provided for the shopping center approach.

Three post-mounted three-section signal heads are also provided at the intersection. One is located adjacent to the mast arm on the northeast corner and provides signal indications for the shopping center (along with the mast-arm signal head already mentioned). Another is located on the landscaped median island at the shopping center for the DPW approach. An additional signal indication for the DPW is located on the southwest corner of the intersection.

Pedestrian signal heads and push buttons are provided on the northwest, southwest, and southeast corners of the intersection. These pedestrian signal heads provide indications for all pedestrian movements within the crosswalks.

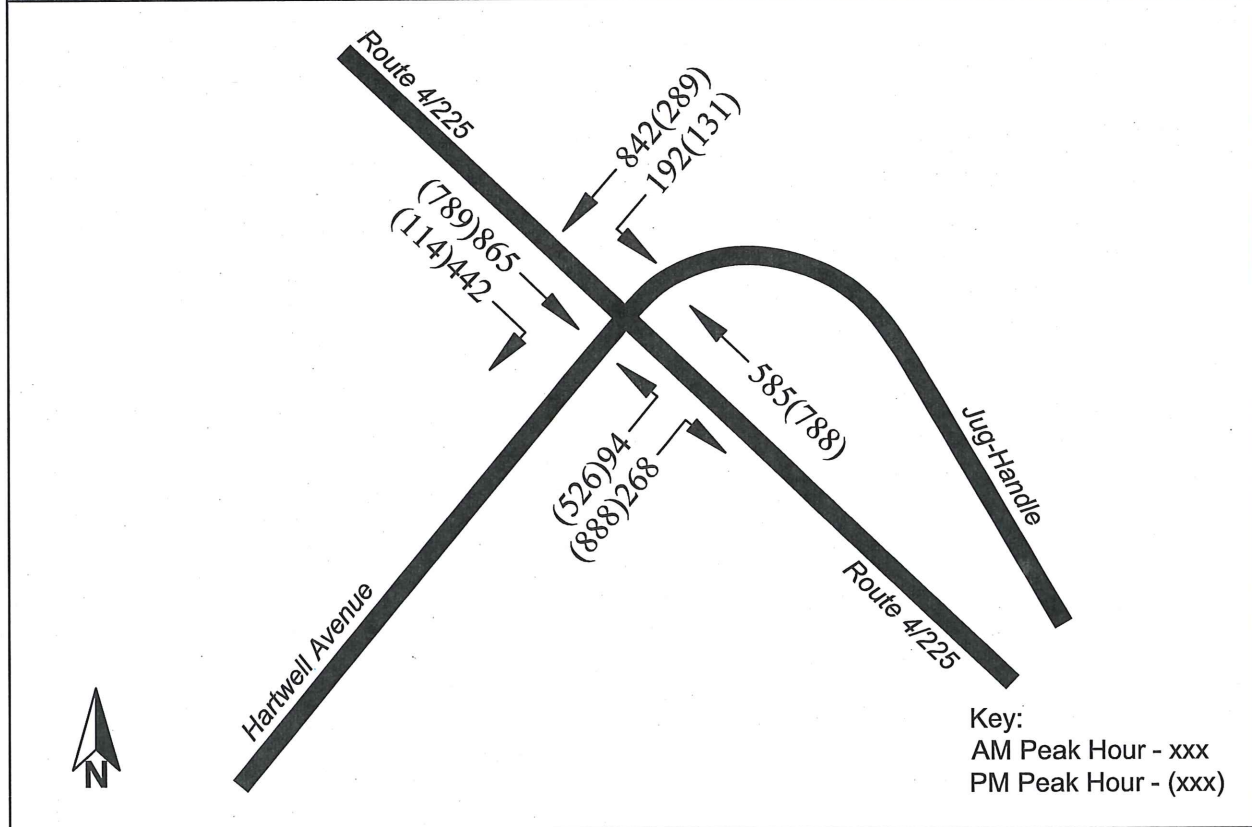
The signal system present at the intersection has three traffic phases and an exclusive pedestrian phase. The system is a fully actuated signal with detectors present on all approaches. The first phase allows both the eastbound and westbound approaches to advance. The westbound left-turns are permitted during this phase. The second phase is a lagging protected left-turn phase upon actuation. The third phase allows the shopping center and DPW movements to proceed. The exclusive pedestrian phase is provided upon actuation.

Observations of Operation

The AM peak hour is primarily commuter traffic along Route 4/225. The shopping center is not a major contributor to traffic during this time. However, during the PM peak hour, the shopping center is a major contributor of traffic. The DPW during both peak hours only has an occasional exiting vehicle.

TRAFFIC VOLUMES

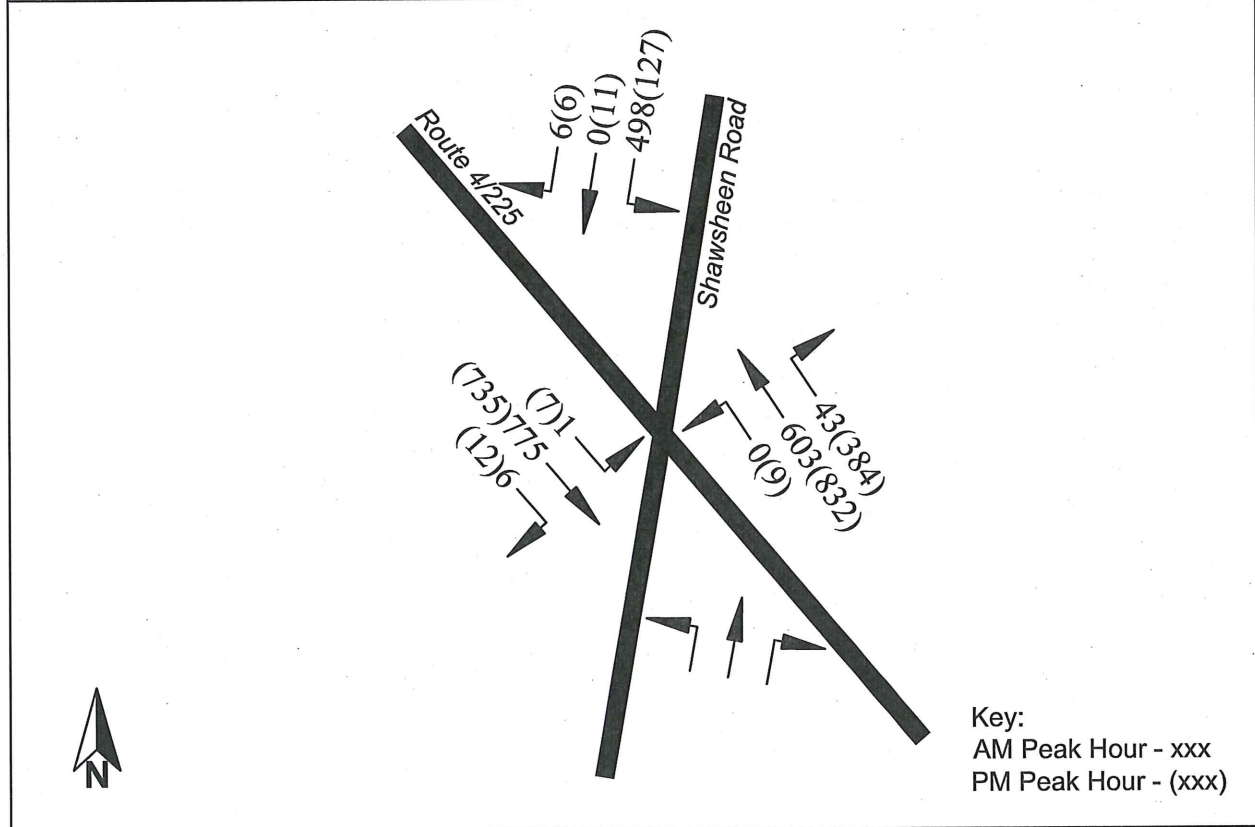
MPO staff collected traffic volumes for the intersections by conducting manual turning-movement counts on June 16, 2009. Traffic volumes for the Hartwell Avenue intersection are shown in Figure 2, for the Shawsheen Road/Pine Street intersection in Figure 3, and for the Great Road Shopping Center intersection in Figure 4. Additional count data are in Appendix C.



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FIGURE 2
 Route 4/225 at Hartwell Avenue:
 Traffic Volumes

Arterial Traffic Signal
 Improvements and
 Coordination:
 Lexington/Bedford



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FIGURE 3
 Route 4/225 at Shawsheen Rd./
 Pine St.: Traffic Volumes

*Arterial Traffic Signal
 Improvements and
 Coordination:
 Lexington/Bedford*

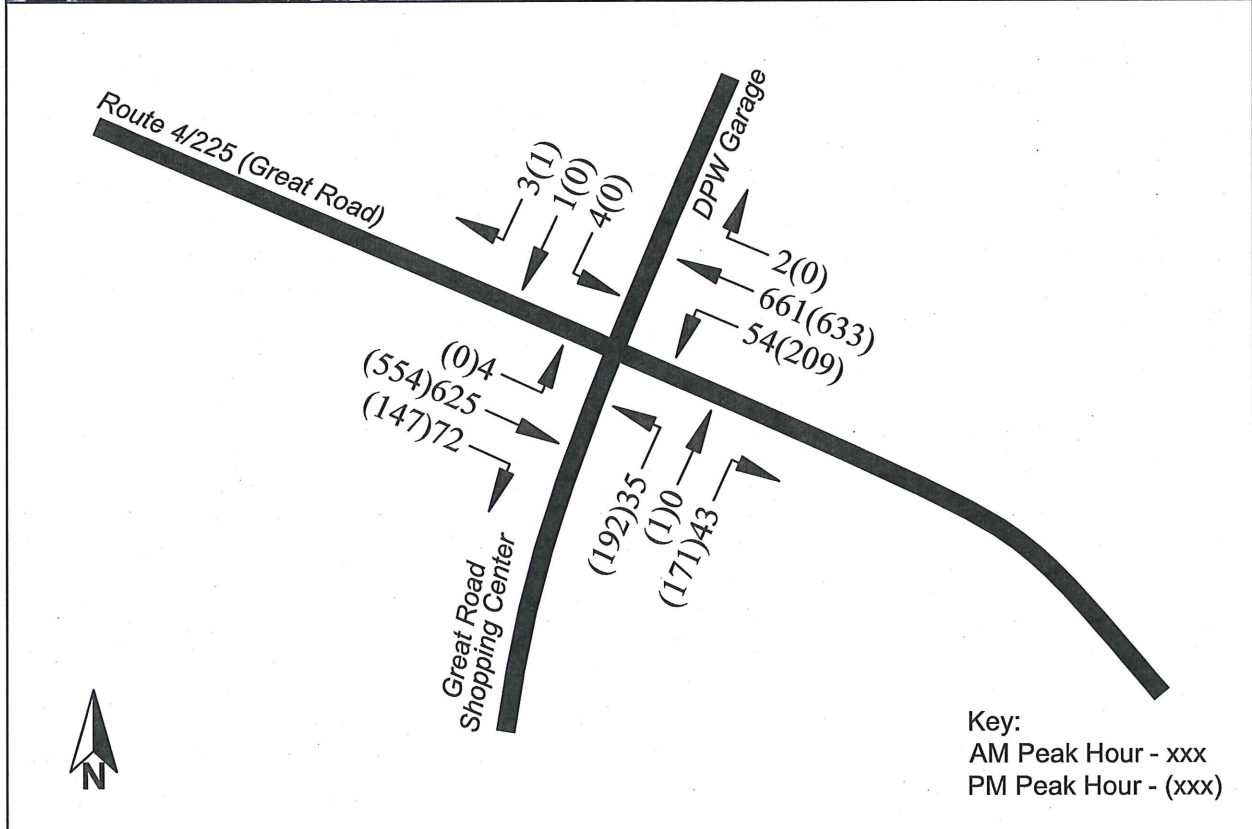


FIGURE 4
 Route 4/225 at Great Road
 Shopping Center: Traffic Volumes

CRASH ANALYSIS

Staff gathered the most recent three years of crash data for the three intersections that were available from Registry of Motor Vehicle records. Tables 1, 2, and 3 provide the crash data for the Hartwell Avenue, Shawsheen Road/Pine Street, and Great Road Shopping Center intersections, respectively.

The Hartwell Avenue intersection had 36 crashes over the three-year period, averaging 12 crashes a year. The majority of the crashes resulted in property damage only, and most were the angle or rear-end type. Angle and rear-end crashes are typical at signalized intersections. No pedestrian or bicyclist was involved in any of the crashes. It should be noted that the Minuteman Bikeway is located approximately one-half mile from the intersection along Hartwell Avenue. The crash rate, calculated using MassDOT's Intersection Crash Rate Worksheet (see Appendix D), was 0.84. This is above the MassDOT Highway District 4 average of 0.78 for signalized intersections.

TABLE 1
Route 4/225 (Great Road) at Hartwell Avenue:
Summary of RMV Crash Data (2005–2007)

		Year	2005	2006	2007	2005–2007	
						Total	Average
Total Number of Crashes			5	11	20	36	12
Crash Severity	Property Damage Only		3	7	15	25	8
	Personal Injury		1	3	4	8	3
	Fatality		0	0	0	0	0
	Not Reported		1	1	1	3	1
Collision Type	Angle		2	3	7	12	4
	Rear-end		2	5	12	19	6
	Sideswipe		1	2	1	4	1
	Head-on		0	0	0	0	0
	Single Vehicle		0	0	0	0	0
	Not Reported		0	1	0	1	0
Roadway Conditions	Wet or icy pavement		2	1	7	10	3
	Dark/lighted		2	1	6	9	3
Weather Conditions	Clear		3	9	12	24	8
	Cloudy		0	1	2	3	3
	Rain		2	1	4	7	2
	Snow		0	0	2	2	1
Crashes during weekday peak periods¹			2	6	4	12	4
Crashes involving pedestrian(s)			0	0	0	0	0
Crashes involving bicyclist(s)			0	0	0	0	0

1. Peak periods are from 7:00 to 9:00 AM and 4:00 to 6:00 PM.

The Shawsheen Road/Pine Street intersection had 10 crashes over the three-year period, averaging just over 3 crashes a year. The majority of the crashes resulted in property damage only. Four of the crashes were rear-end; with angle, sideswipe, and single-vehicle crashes each numbering 2 over the three years. No pedestrian or bicyclist was involved in any of the crashes. The crash rate for the intersection, calculated using MassDOT's Intersection Crash Rate Worksheet, was 0.38. This is below the MassDOT Highway District 4 average of 0.78 for signalized intersections.

TABLE 2
Route 4/225 (Great Road) at Shawsheen Road/Pine Street:
Summary of RMV Crash Data (2005–2007)

		Year	2005	2006	2007	2005–2007	
						Total	Average
Total Number of Crashes			5	1	4	10	3
Crash Severity	Property Damage Only		5	1	2	8	2
	Personal Injury		0	0	2	2	1
	Fatality		0	0	0	0	0
	Not Reported		0	0	0	0	0
Collision Type	Angle		2	0	0	2	1
	Rear-end		1	1	2	4	1
	Sideswipe		1	0	1	2	1
	Head-on		0	0	0	0	0
	Single Vehicle		1	0	1	2	1
	Not Reported		0	0	0	0	0
Roadway Conditions	Wet or icy pavement		1	0	1	2	1
	Dark/lighted		2	0	0	2	1
Weather Conditions	Clear		5	1	2	8	2
	Cloudy		0	0	1	1	0
	Rain		0	0	1	1	0
	Snow		0	0	0	0	0
Crashes during weekday peak periods¹			1	0	1	2	1
Crashes involving pedestrian(s)			0	0	0	0	0
Crashes involving bicyclist(s)			0	0	0	0	0

1. Peak periods are from 7:00 to 9:00 AM and 4:00 to 6:00 PM.

The Great Road Shopping Center intersection has a three-year total of 6 crashes, with a majority resulting in property damage only. There was no predominant collision type; however, angle and sideswipe collisions accounted for 4 of the 6 crashes. The crash rate for this intersection is 0.26, below the District 4 average of 0.78 for signalized intersections.

TABLE 3
Route 4/225 (Great Road) at Great Road Shopping Center:
Summary of RMV Crash Data (2005–2007)

		Year	2005	2006	2007	2005–2007	
						Total	Average
Total Number of Crashes			1	3	2	6	2
Crash Severity	Property Damage Only		1	2	2	5	2
	Personal Injury		0	1	0	1	0
	Fatality		0	0	0	0	0
	Not Reported		0	0	0	0	0
Collision Type	Angle		0	1	1	2	1
	Rear-end		1	1	0	2	1
	Sideswipe		0	0	1	1	0
	Head-on		0	0	0	0	0
	Single Vehicle		0	1	0	1	0
	Not Reported		0	0	0	0	0
Roadway Conditions	Wet or icy pavement		1	1	0	2	1
	Dark/lighted		0	1	0	1	0
Weather Conditions	Clear		0	1	2	3	1
	Cloudy		0	1	0	1	0
	Rain		1	1	0	2	1
	Snow		0	0	0	0	0
Crashes during weekday peak periods¹			0	1	1	2	1
Crashes involving pedestrian(s)			0	0	0	0	0
Crashes involving bicyclist(s)			0	0	0	0	0

1. Peak periods are from 7:00 to 9:00 AM and 4:00 to 6:00 PM.

DEVELOPMENT OF ALTERNATIVES

Staff examined various traffic signal designs and lane-use alternatives in conjunction with examining coordination between the three intersections. The software Synchro 7¹ was the analysis tool staff used to examine coordination and other strategies. Data from the Synchro capacity analysis are in Appendix E.

Staff analyzed existing conditions and two alternatives:

- **Existing Geometry and Signal Design** — In this base-case scenario, signal timings and lane configurations at the three intersections are those existing currently in the field (see existing-conditions description above). Staff used the analysis results from this scenario as a basis for comparing the alternatives.
- **Alternative 1: Existing Geometry with Optimized Timings²** — In this option, staff optimized the signal timings at the isolated intersections without altering existing geometry or lane configurations.
- **Alternative 2: Existing Geometry with Coordinated Timings** — In the development of this alternative, staff first examined a coordinated signal plan for all three intersections while maintaining the existing geometry and lane configurations. During the analysis it was determined that inclusion of the Hartwell Avenue intersection in the coordination plan did not work effectively. The distance between Hartwell Avenue and the Shawsheen Road intersection is greater than the quarter mile recommended distance between intersections, and the jug handle approach volumes are high. In addition, the Shawsheen Road approach to that intersection has a large volume of traffic which creates essentially two traffic platoons (Route 4/225 southbound through and Shawsheen left turns) which need to be coordinated. Therefore in this alternative only the shopping center and Shawsheen Road intersections were coordinated.

¹ Synchro by Traffware, Version 7.

² Optimized timings: Signal timings are optimized to minimize delays associated with critical movements.

TRAFFIC OPERATIONS ANALYSIS

The traffic operations analysis for the intersections was conducted using Synchro 7.³ Tables 4 and 5 show the results of the analyses for the AM and PM peak hours, respectively. Included in the analysis are estimates of energy measures of effectiveness, which provide information on energy savings and vehicle emissions. These are shown in Tables 6 and 7. Complete data from the Synchro capacity analysis are in Appendix E.

Existing Geometry and Signal Design

The existing-conditions analysis indicates that the Hartwell Avenue and Great Road Shopping Center intersections are each operating at an acceptable level of service (LOS) in both peak hours under existing conditions: LOS D (AM) and C (PM) at Hartwell Avenue and LOS B (AM) and C (PM) at Great Road Shopping Center. The Route 4/225 at Shawsheen Road/Pine Street intersection operates poorly in both peak hours. The existing LOS in both the AM and PM peak hours is F, with both Route 4/225 approaches experiencing high delays and queues. This intersection contains high approach volumes not only on Route 4/225, the main arterial, but on the Shawsheen Road approach as well due to the tendency of commuters to use this as an alternative route from Route 3 to Hartwell Avenue and I-95.

Alternative 1: Existing Geometry with Optimized Timings

The optimized timings at the Hartwell Avenue and Great Road Shopping Center intersections resulted in moderately improved LOS and delays. However the Shawsheen Road intersection improved dramatically in both peak hours. The overall LOS at this intersection improved to D in the AM peak and B in the PM peak. This improvement was due to the reduced delays on the Route 4/225 approaches, which contain the majority of traffic at the intersection. The Shawsheen Road approach had added delays due to this improvement; however this approach still operated at an acceptable LOS in both peak hours.

Alternative 2: Existing Geometry with Coordinated Timings

In the development of this alternative, staff initially examined a coordinated signal system between the three intersections, as mentioned in the alternative description, but the Hartwell Avenue intersection was not included in the coordinated system due to its distance from the Shawsheen Road intersection and its high jug handle volumes. However, the signals are retimed at the Hartwell Avenue intersection under this alternative, and also at the Shawsheen Road and Great Road Shopping Center intersections.

The coordination between the Shawsheen Road and Great Road Shopping Center intersections did provide some measure of improvement for the Route 4/225 approaches to the intersections in both peak hours. While the overall LOS at both intersections did not change significantly, queuing on Route 4/225 was reduced. An example of this reduction is during the AM peak hour on the Route 4/225 northbound approach to the Shawsheen Road intersection, where the queue was reduced from 809 feet to 669 feet, a reduction of approximately six vehicles. The benefit in

³ Synchro by Trafficware, Version 7.

terms of progression or bandwidth⁴ of vehicles traveling in both directions in the AM peak hour was 81 seconds southbound/eastbound (eastbound is towards I-95) and 47 seconds northbound/westbound. In the PM peak, the bandwidth was 49 seconds southbound/eastbound and 66 seconds northbound/westbound.

CONCLUSIONS AND RECOMMENDATIONS

Alternative 2 is recommended for implementation. The analysis of the Shawsheen Road and Great Road Shopping Center intersections found that the intersections would benefit from a coordinated signal plan (along with optimized signal timings) in both peak hours to reduce delays and queuing on Route 4/225. The analysis of the Hartwell Avenue intersection showed that it could benefit from signal retiming, but that, due to its distance from the Shawsheen Road intersection and to volumes at the intersection, it should not be included in the coordination plan with the Shawsheen Road or Great Road Shopping Center intersection.

However, based upon the crash data for the Hartwell Avenue intersection, which include an annual average of 12 crashes occurring over the three-year period, a crash rate of 0.84 (district average is 0.78), and a high number of rear-end and angle crashes, a safety improvement should be made there. The recommended safety improvement, based upon the types of crashes which are predominantly occurring, is signal head and mounting replacement. The signal heads should not be post mounted but rather mounted on mast arms to give drivers a clearer view of the signal indications, as is recommended in such cases in the Manual of Uniform Traffic Control Devices.

The Alternative 2 improvements would be simple to implement and are cost-effective. They require no land takings and can be accomplished with the existing signal equipment, provided a communication system is present between the two intersections or could be installed. They also provide air quality benefits to the intersections and the corridor in the study area.

⁴ Bandwidth: The amount of green time available for vehicles to travel through intersections in a coordinated signal system.

TABLE 4
AM Peak Hour
Level-of-Service Summary

Intersection/Approach	Existing Conditions				Alternative 1				Alternative 2			
	LOS	Delay ¹	V/C ²	Q ³	LOS	Delay	V/C	Q	LOS	Delay	V/C	Q
Route 4/225 at Hartwell Avenue												
Route 4/225 – NB	C	25.5	0.44	269	B	19.1	0.42	171	B	19.1	0.42	171
Route 4/225 – SB	E	64.1	1.02	857	D	41.9	0.96	541	D	41.9	0.96	541
Hartwell Ave. – EB	D	36.4	0.72	124	B	15.5	0.85	140	B	15.5	0.85	140
Jug handle – WB	C	23.8	0.73	394	C	23.5	0.79	361	C	23.5	0.79	361
Overall	D	38.2	0.86	-	C	29.0	0.91	-	C	29.0	0.91	-
Route 4/225 at Shawsheen Rd./Pine St.												
Route 4/225 – NB	E	69.0	1.01	711	C	34.6	0.79	809	D	43.5	0.91	669
Route 4/225 – SB	F	186.9	0.50	1,030	D	48.7	0.93	584	D	36.7	0.78	986
Pine St. – EB	D	35.8	0.11	46	E	57.0	0.22	64	E	67.8	0.25	64
Shawsheen Rd. – WB	C	32.8	0.77	735	D	54.9	0.89	794	E	57.6	0.88	934
Overall	F	103.9	1.01	-	D	45.7	0.91	-	D	45.3	0.89	-
Route 4/225 at Great Road Shopping Center												
Shopping Center – NB	D	52.1	0.42	62	C	31.8	0.52	0	E	70.2	0.51	0
DPW – SB	D	50.9	0.11	15	C	29.9	0.16	13	E	68.2	0.13	19
Route 4/225 – EB	B	10.7	0.53	568	A	8.7	0.58	481	A	5.9	0.45	463
Route 4/225 - WB	A	5.2	0.49	465	A	5.4	0.54	409	A	5.3	0.46	338
Overall	B	10.7	0.78	-	A	8.6	0.54	-	A	39.6	0.46	-

1. Delay measured in seconds.
2. V/C = volume/capacity ratio.
3. 95% queue, measured in feet.

TABLE 5
PM Peak Hour
Level-of-Service Summary

Intersection/Approach	Existing Conditions				Alternative 1				Alternative 2			
	LOS	Delay ¹	V/C ²	Q ³	LOS	Delay	V/C	Q	LOS	Delay	V/C	Q
Route 4/225 at Hartwell Avenue												
Route 4/225 – NB	D	38.6	0.69	393	C	32.3	0.85	278	C	32.3	0.85	278
Route 4/225 – SB	D	41.7	0.77	445	D	42.1	0.94	326	D	42.1	0.94	326
Hartwell Ave. – EB	E	79.7	1.05	710	B	19.0	0.98	422	B	19.0	0.98	422
Jughandle – WB	B	15.9	0.57	143	A	8.6	0.41	78	A	8.6	0.41	78
Overall	C	33.2	0.94	-	C	26.4	0.97	-	C	26.4	0.97	-
Route 4/225 at Shawsheen Rd./Pine St.												
Route 4/225 – NB	F	123.8	1.27	1,067	B	12.6	0.76	771	B	25.0	0.81	815
Route 4/225 – SB	F	438.5	1.88	1,133	B	12.4	0.67	560	C	16.1	0.73	316
Pine St. – EB	B	36.2	0.14	58	E	57.1	0.51	87	D	44.6	0.15	86
Shawsheen Rd. – WB	D	18.1	0.21	140	D	43.0	0.63	202	D	41.7	0.37	209
Overall	F	221.3	0.95	-	B	15.8	0.73	-	C	23.6	0.67	-
Route 4/225 at Great Road Shopping Center												
Shopping Center – NB	E	65.3	0.92	285	D	36.4	0.82	260	E	65.4	0.84	278
DPW – SB	D	41.0	0.00	0	C	24.2	0.00	0	D	49.1	0.00	0
Route 4/225 – EB	B	11.1	0.52	489	B	11.9	0.59	453	B	18.4	0.54	613
Route 4/225 – WB	B	16.8	0.56	537	B	18.1	0.69	518	A	7.9	0.40	221
Overall	C	23.3	0.60	-	B	39.3	0.67	-	C	22.5	0.58	-

1. Delay measured in seconds.
2. V/C = volume/capacity ratio.
3. 95% queue, measured in feet.

TABLE 6
AM Peak Hour
Energy Measures of Effectiveness

Intersection/MOEs	Existing	Alt. 1	Alt. 2
Route 4/225 at Hartwell			
Fuel Consumed (gal)	83	77	77
Fuel Economy (mpg)	12.9	13.9	13.9
CO Emissions (kg)	5.77	5.38	5.38
NOx Emissions (kg)	1.12	1.05	1.05
VOC Emissions (kg)	1.34	1.25	1.25
Route 4/225 at Shawsheen			
Fuel Consumed (gal)	71	54	12
Fuel Economy (mpg)	8.6	11.4	11.0
CO Emissions (kg)	4.95	3.74	0.85
NOx Emissions (kg)	0.96	0.73	0.17
VOC Emissions (kg)	1.15	0.87	0.20
Route 4/225 at Shopping Center			
Fuel Consumed (gal)	16	17	50
Fuel Economy (mpg)	15.0	14.3	6.2
CO Emissions (kg)	1.13	1.18	3.47
NOx Emissions (kg)	0.22	0.23	0.68
VOC Emissions (kg)	0.26	0.27	0.80
Route 4/225 Arterial			
Fuel Consumed (gal)	146	116	62
Fuel Economy (mpg)	12.10	14.7	15.8
CO Emissions (kg)	10.23	8.10	4.32
NOx Emissions (kg)	1.99	1.58	0.84
VOC Emissions (kg)	2.37	1.88	1.00

TABLE 7
PM Peak Hour
Energy Measures of Effectiveness

Intersection/MOEs	Existing	Alt. 1	Alt. 2
Route 4/225 at Hartwell			
Fuel Consumed (gal)	72	68	68
Fuel Economy (mpg)	12.3	13.0	13.0
CO Emissions (kg)	5.05	4.76	4.76
NOx Emissions (kg)	0.98	0.93	0.93
VOC Emissions (kg)	1.17	1.10	1.10
Route 4/225 at Shawsheen			
Fuel Consumed (gal)	134	52	57
Fuel Economy (mpg)	7.1	18.1	17.7
CO Emissions (kg)	9.40	3.66	3.99
NOx Emissions (kg)	1.83	0.71	0.78
VOC Emissions (kg)	2.18	0.85	0.92
Route 4/225 at Shopping Center			
Fuel Consumed (gal)	24	24	29
Fuel Economy (mpg)	10.8	10.8	14.2
CO Emissions (kg)	1.69	1.67	2.01
NOx Emissions (kg)	0.33	0.33	0.39
VOC Emissions (kg)	0.39	0.39	0.47
Route 4/225 Arterial			
Fuel Consumed (gal)	200	118	77
Fuel Economy (mpg)	9.2	15.7	17.9
CO Emissions (kg)	13.98	8.22	5.36
NOx Emissions (kg)	2.72	1.60	1.04
VOC Emissions (kg)	3.24	1.90	1.24

Appendix A

Universe of Potential Signal Coordination Locations

Universe of Intersection Locations

Town/City	Location	2005-2007	
		# Crashes	EPDO*
Burlington	Route 3A @ Francis Wyman Rd. (Route 62)	3	3
Burlington	Route 3A @ Wilmington Rd. (Route 62)	3	15
Danvers	Conant St @ Poplar St.	2	6
Danvers	Conant St @ Elliott St	6	18
Hingham	Route 3A @ Kilby St	1	5
Hingham	Route 3 A @ Summer St	1	5
Bedford	Route 4/225 @ Great Road Shopping Center	6	10
Bedford	Route 4/225 @ Shawsheen Rd	10	18
Lexington	Route 4/225 @ Hartwell Ave.	36	68
Maynard	Acton St @ Main St and Summer St	5	5
Maynard	Acton St @ Powder Mill Rd	7	15
Randolph	Route 28 @ Warren St	44	76
Randolph	Route 28 @ Memorial Ave	19	35
Randolph	Route 28 @ N. Main St	43	67
Weymouth	Route 53 @ Pleasant St	96	64
Weymouth	Route 53 @ Mutton Lane	28	40
Braintree	Washington St @ Common St	12	36
Braintree	Washington St @ Ramp E	22	62
Braintree	Washington St @ Independence Ave	14	26
Peabody	Route 114 @ Cross St	6	10
Peabody	Route 114 @ North Shore Mall	7	7
Peabody	Route 114 @ Loris St	6	18

***EPDO - Equivalent Property Damage Only**

EPDO = 10*Fatal Crashes + 5*Injury Crashes + 1*Other Crashes (Property Damage Only or Not Reported)

Appendix B
Correspondence

Mark Abbott

From: Raphael, Connie (MHD) [Connie.Raphael@state.ma.us]
Sent: Monday, June 08, 2009 11:55 AM
To: Mark Abbott
Cc: Kulen, Raj (MHD)
Subject: RE: District 4 Arterial Intersections

Sorry for the delay in getting back to you. Our traffic engineers were out of the office most of last week.

We agree with the Route 4/225 at Shawsheen Road and Home Goods plaza. The intersection at Hartwell Road is fairly far away and our concern there is back up toward Route 128. So if you include Hartwell be sure to check the queuing.

The Weymouth locations are another good choice.

Our traffic section has two other suggestions.

Braintree - Washington Street at Ramp E; Washington Street at Presidential/Common Street; and Washington Street at Church/Independence and Ramp F

Peabody - Route 114 at Cross; Route 114 at North Shore Mall; and Route 114 at Loris

Connie

-----Original Message-----

From: Mark Abbott [mailto:mabbott@ctps.org]
Sent: Monday, June 08, 2009 11:01 AM
To: 'Raphael, Connie (MHD)'
Subject: RE: District 4 Arterial Intersections

Connie,

Have you heard anything from Mike concerning any possible locations.

Two locations we've come up with are Route 4 in Lexington at Shawsheen Road and at the signal at the Home Goods shopping plaza. Also possibly including Brooksby Road (unsignalized) and Hartwell Avenue. The other location is in Weymouth on Route 53 at Pleasant Street and at Mutton Lane signalized intersections. The Pleasant Street intersection is #70 on the MassHighway crash list.

What are your thoughts on these two locations.

Thanks,

Mark

-----Original Message-----

From: Raphael, Connie (MHD) [mailto:Connie.Raphael@state.ma.us]
Sent: Monday, June 01, 2009 3:33 PM
To: Mark Abbott
Subject: RE: District 4 Arterial Intersections

Hi Mark,

I referred the study material to Mike Karas, Manager of Traffic Operations. I will get back to you with any suggestions.

Connie

-----Original Message-----

From: Mark Abbott [mailto:mabbott@ctps.org]

Sent: Monday, June 01, 2009 3:25 PM
To: Raphael, Connie (MHD)
Subject: District 4 Arterial Intersections

Connie,

We (CTPS) has a study to look at signal improvements and coordination at several locations. I've attached the scope of work that was approved for this study, so you can have a better understanding of the study.

Efi and I are wondering if you have any possible suggestions of intersections which we could include in this study. Please let me know.

Thanks,

Mark S. Abbott, P.E.
Central Transportation Planning Staff
10 Park Plaza, Suite 2150
Boston, MA. 02116
email: mabbott@ctps.org
phone: 617-973-7095
fax: 617-973-8855

Appendix C
Turning Movement Counts

CTPS
 ARTERIAL INTERSECTIONS
 Lexington/Bedford
Route 4 at Home Goods Shopping

File Name : RO80DB~1
 Site Code : 02031001
 Start Date : 02/03/2010
 Page No : 1

Groups Printed- Cars and Trucks

Start Time	Route 4 Northbound Northbound				Route 4 Southbound Southbound				Home Goods Plaza Eastbound Eastbound				DPW Westbound Westbound				Int. Total
	Left	Thru	Right	Peds	Left	Thru	Right	Peds	Left	Thru	Right	Peds	Left	Thru	Right	Peds	
Factor	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	
07:00 AM	8	126	0	0	0	172	14	0	4	1	5	0	0	0	3	0	333
07:15 AM	9	154	1	0	0	185	10	0	4	0	10	0	2	0	3	0	378
07:30 AM	12	142	0	0	3	196	12	0	9	0	8	0	0	0	1	0	383
07:45 AM	8	177	1	1	1	155	15	0	7	0	6	1	2	0	0	0	374
Total	37	599	2	1	4	708	51	0	24	1	29	1	4	0	7	0	1468
08:00 AM	14	135	1	0	0	157	24	0	11	0	11	0	1	0	1	0	355
08:15 AM	16	171	0	1	2	158	19	0	7	0	14	0	1	1	1	1	392
08:30 AM	16	178	0	0	1	155	14	0	10	0	12	0	0	0	1	0	387
08:45 AM	18	159	1	0	0	143	17	0	11	0	9	0	1	0	0	1	360
Total	64	643	2	1	3	613	74	0	39	0	46	0	3	1	3	2	1494
Grand Total	101	1242	4	2	7	1321	125	0	63	1	75	1	7	1	10	2	2962
Apprch %	7.5	92.1	0.3	0.1	0.5	90.9	8.6	0.0	45.0	0.7	53.6	0.7	35.0	5.0	50.0	10.0	
Total %	3.4	41.9	0.1	0.1	0.2	44.6	4.2	0.0	2.1	0.0	2.5	0.0	0.2	0.0	0.3	0.1	

CTPS
 ARTERIAL INTERSECTIONS
 Lexington/Bedford
Route 4 at Home Goods Shopping

File Name : RO80DB~1
 Site Code : 02031001
 Start Date : 02/03/2010
 Page No : 2

Start Time	Route 4 Northbound Northbound					Route 4 Southbound Southbound					Home Goods Plaza Eastbound Eastbound					DPW Westbound Westbound					Int. Total
	Left	Thru	Right	Peds	App. Total	Left	Thru	Right	Peds	App. Total	Left	Thru	Right	Peds	App. Total	Left	Thru	Right	Peds	App. Total	
Peak Hour From 07:00 AM to 08:45 AM - Peak 1 of 1																					
Intersection	07:45 AM																				
Volume	54	661	2	2	719	4	625	72	0	701	35	0	43	1	79	4	1	3	1	9	1508
Percent	7.5	91.9	0.3	0.3		0.6	89.2	10.3	0.0		44.3	0.0	54.4	1.3		44.4	11.1	33.3	11.1		
08:15																					
Volume	16	171	0	1	188	2	158	19	0	179	7	0	14	0	21	1	1	1	1	4	392
Peak Factor																					
High Int.	08:30 AM					08:00 AM					08:00 AM					08:15 AM					0.962
Volume	16	178	0	0	194	0	157	24	0	181	11	0	11	0	22	1	1	1	1	4	
Peak Factor	0.927										0.968										0.563

CTPS
 ARTERIAL INTERSECTIONS
 Lexington/Bedford
Route 4 at Home Goods Shopping

File Name : RO80DB~1
 Site Code : 02031001
 Start Date : 02/03/2010
 Page No : 1

Groups Printed- Trucks

Start Time	Route 4 Northbound Northbound				Route 4 Southbound Southbound				Home Goods Plaza Eastbound Eastbound				DPW Westbound Westbound				Int. Total	
	Left	Thru	Right	Peds	Left	Thru	Right	Peds	Left	Thru	Right	Peds	Left	Thru	Right	Peds		
Factor	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0		
07:00 AM	0	7	0	0	0	8	0	0	0	0	0	0	0	0	0	0	0	15
07:15 AM	1	8	0	0	0	8	0	0	0	0	0	0	0	0	1	0	0	18
07:30 AM	1	7	0	0	1	7	0	0	0	0	0	0	0	0	0	0	0	16
07:45 AM	0	2	0	0	0	5	0	0	0	0	0	0	1	0	0	0	0	8
Total	2	24	0	0	1	28	0	0	0	0	0	0	1	0	1	0	0	57
08:00 AM	1	4	0	0	0	4	1	0	0	0	1	0	0	0	0	0	0	11
08:15 AM	0	13	0	0	0	6	1	0	0	0	1	0	0	0	0	0	0	21
08:30 AM	1	8	0	0	3	9	0	0	1	0	0	0	0	0	1	0	0	23
08:45 AM	0	9	0	0	0	9	0	0	0	0	0	0	0	0	1	0	0	19
Total	2	34	0	0	3	28	2	0	1	0	2	0	0	0	2	0	0	74
Grand Total	4	58	0	0	4	56	2	0	1	0	2	0	1	0	3	0	0	131
Apprch %	6.5	93.5	0.0	0.0	6.5	90.3	3.2	0.0	33.3	0.0	66.7	0.0	25.0	0.0	75.0	0.0	0.0	
Total %	3.1	44.3	0.0	0.0	3.1	42.7	1.5	0.0	0.8	0.0	1.5	0.0	0.8	0.0	2.3	0.0	0.0	

CTPS
 ARTERIAL INTERSECTIONS
 Lexington/Bedford
Route 4 at Home Goods Shopping

File Name : RO80DB~1
 Site Code : 02031001
 Start Date : 02/03/2010
 Page No : 2

Start Time	Route 4 Northbound Northbound					Route 4 Southbound Southbound					Home Goods Plaza Eastbound Eastbound					DPW Westbound Westbound					Int. Total
	Left	Thru	Right	Peds	App. Total	Left	Thru	Right	Peds	App. Total	Left	Thru	Right	Peds	App. Total	Left	Thru	Right	Peds	App. Total	
Peak Hour From 07:00 AM to 08:45 AM - Peak 1 of 1																					
Intersection	08:00 AM																				
Volume	2	34	0	0	36	3	28	2	0	33	1	0	2	0	3	0	0	2	0	2	74
Percent	5.6	94.4	0.0	0.0		9.1	84.8	6.1	0.0		33.3	0.0	66.7	0.0		0.0	0.0	100.0	0.0		
08:30																					
Volume	1	8	0	0	9	3	9	0	0	12	1	0	0	0	1	0	0	1	0	1	23
Peak Factor																					0.804
High Int.	08:15 AM					08:30 AM					08:00 AM					08:30 AM					
Volume	0	13	0	0	13	3	9	0	0	12	0	0	1	0	1	0	0	1	0	1	
Peak Factor	0.692										0.688					0.750					0.500

CTPS
 ARTERIAL INTERSECTIONS
 Lexington/Bedford
Route 4 at Home Goods Shopping

File Name : RO80DB~1
 Site Code : 02031001
 Start Date : 02/03/2010
 Page No : 1

Groups Printed- Bikes

Start Time	Route 4 Northbound Northbound				Route 4 Southbound Southbound				Home Goods Plaza Eastbound Eastbound				DPW Westbound Westbound				Int. Total	
	Left	Thru	Right	Peds	Left	Thru	Right	Peds	Left	Thru	Right	Peds	Left	Thru	Right	Peds		
Factor	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0		
07:00 AM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
07:15 AM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
07:30 AM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
07:45 AM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
08:00 AM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
08:15 AM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
08:30 AM	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	1
08:45 AM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	1
Grand Total	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	1
Apprch %	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	100.0	0.0	0.0	0.0	0.0	0.0	
Total %	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	100.0	0.0	0.0	0.0	0.0	0.0	

CTPS
ARTERIAL INTERSECTIONS
 Lexington-Bedford
Route 4 at Shawsheen Road

Counter: DB 400
 Counted By: John Farley
 Weather:
 Other:

File Name : route4 at shawsheen rd - am
 Site Code : 06160301
 Start Date : 06/16/2009
 Page No : 1

Groups Printed- Cars - Trucks

Start Time	Route 4 (Great Road) Northbound					Route 4 (Great Road) Southbound					Pine Street Eastbound					Shawsheen Road Westbound					Int. Total
	Left	Thru	Right	Peds	App. Total	Left	Thru	Right	Peds	App. Total	Left	Thru	Right	Peds	App. Total	Left	Thru	Right	Peds	App. Total	
Factor	1.0	1.0	1.0	1.0		1.0	1.0	1.0	1.0		1.0	1.0	1.0	1.0		1.0	1.0	1.0	1.0		
07:00 AM	0	134	12	1	147	0	195	2	1	198	4	0	5	1	10	138	0	1	0	139	494
07:15 AM	0	153	4	1	158	1	185	1	0	187	7	0	4	1	12	138	0	0	0	138	495
07:30 AM	0	147	12	0	159	0	192	0	0	192	4	1	5	0	10	109	0	4	0	113	474
07:45 AM	0	169	15	0	184	0	203	3	0	206	6	1	6	0	13	113	0	1	0	114	517
Total	0	603	43	2	648	1	775	6	1	783	21	2	20	2	45	498	0	6	0	504	1980
08:00 AM	2	151	27	0	180	1	168	2	0	171	10	6	1	0	17	114	2	0	0	116	484
08:15 AM	0	157	25	0	182	0	194	1	0	195	2	1	2	0	5	112	1	2	1	116	498
08:30 AM	1	138	23	1	163	0	172	0	0	172	9	1	4	0	14	103	4	5	0	112	461
08:45 AM	1	150	24	0	175	0	169	1	0	170	8	1	7	0	16	135	0	1	0	136	497
Total	4	596	99	1	700	1	703	4	0	708	29	9	14	0	52	464	7	8	1	480	1940
Grand Total	4	1199	142	3	1348	2	1478	10	1	1491	50	11	34	2	97	962	7	14	1	984	3920
Apprch %	0.3	88.9	10.5	0.2		0.1	99.1	0.7	0.1		51.5	11.3	35.1	2.1		97.8	0.7	1.4	0.1		
Total %	0.1	30.6	3.6	0.1	34.4	0.1	37.7	0.3	0.0	38.0	1.3	0.3	0.9	0.1	2.5	24.5	0.2	0.4	0.0	25.1	

CTPS
 ARTERIAL INTERSECTIONS
 Lexington-Bedford
 Route 4 at Shawsheen Road

File Name : route4 at shawsheen rd - am
 Site Code : 06160301
 Start Date : 06/16/2009
 Page No : 2

Start Time	Route 4 (Great Road) Northbound					Route 4 (Great Road) Southbound					Pine Street Eastbound					Shawsheen Road Westbound					Int. Total	
	Left	Thru	Right	Peds	App. Total	Left	Thru	Right	Peds	App. Total	Left	Thru	Right	Peds	App. Total	Left	Thru	Right	Peds	App. Total		
Peak Hour From 07:00 AM to 08:45 AM - Peak 1 of 1																						
Intersection	07:00 AM																					
Volume	0	603	43	2	648	1	775	6	1	783	21	2	20	2	45	498	0	6	0	504	1980	
Percent	0.0	93.1	6.6	0.3		0.1	99.0	0.8	0.1		46.7	4.4	44.4	4.4		98.8	0.0	1.2	0.0			
07:45 Volume	0	169	15	0	184	0	203	3	0	206	6	1	6	0	13	113	0	1	0	114	517	
Peak Factor																						
High Int.	07:45 AM																					
Volume	0	169	15	0	184	0	203	3	0	206	6	1	6	0	13	138	0	1	0	139	0.957	
Peak Factor	0.880					0.950					0.865					0.906						

CTPS
ARTERIAL INTERSECTIONS
 Lexington-Bedford
Route 4 at Shawsheen Road

File Name : route4 at shawsheen rd - am
 Site Code : 06160301
 Start Date : 06/16/2009
 Page No : 1

Groups Printed- Trucks

Start Time	Route 4 (Great Road) Northbound					Route 4 (Great Road) Southbound					Pine Street Eastbound					Shawsheen Road Westbound					Int. Total	
	Left	Thru	Right	Peds	App. Total	Left	Thru	Right	Peds	App. Total	Left	Thru	Right	Peds	App. Total	Left	Thru	Right	Peds	App. Total		
Factor	1.0	1.0	1.0	1.0		1.0	1.0	1.0	1.0		1.0	1.0	1.0	1.0		1.0	1.0	1.0	1.0			
07:00 AM	0	7	0	0	7	0	7	1	0	8	0	0	0	0	0	4	0	0	0	0	4	19
07:15 AM	0	6	1	0	7	0	5	0	0	5	0	0	0	0	0	3	0	0	0	0	3	15
07:30 AM	0	10	1	0	11	0	7	0	0	7	0	0	0	0	0	0	0	0	0	0	0	18
07:45 AM	0	11	0	0	11	0	3	0	0	3	0	0	0	0	0	3	0	0	0	0	3	17
Total	0	34	2	0	36	0	22	1	0	23	0	0	0	0	0	10	0	0	0	0	10	69
08:00 AM	1	10	2	0	13	1	6	0	0	7	1	0	0	0	1	2	0	0	0	0	2	23
08:15 AM	0	4	0	0	4	0	8	0	0	8	0	0	0	0	0	3	0	0	0	0	3	15
08:30 AM	1	3	3	0	7	0	10	0	0	10	1	0	0	0	1	2	0	0	0	0	2	20
08:45 AM	0	6	0	0	6	0	7	1	0	8	0	0	0	0	0	2	0	0	0	0	2	16
Total	2	23	5	0	30	1	31	1	0	33	2	0	0	0	2	9	0	0	0	0	9	74
Grand Total	2	57	7	0	66	1	53	2	0	56	2	0	0	0	2	19	0	0	0	0	19	143
Apprch %	3.0	86.4	10.6	0.0		1.8	94.6	3.6	0.0		100.0	0.0	0.0	0.0		100.0	0.0	0.0	0.0			
Total %	1.4	39.9	4.9	0.0	46.2	0.7	37.1	1.4	0.0	39.2	1.4	0.0	0.0	0.0	1.4	13.3	0.0	0.0	0.0		13.3	

CTPS
 ARTERIAL INTERSECTIONS

CTPS
ARTERIAL INTERSECTIONS
Lexington-Bedford
Route 4 at Shawsheen Road

File Name : route4 at shawsheen rd - am
 Site Code : 06160301
 Start Date : 06/16/2009
 Page No : 2

Start Time	Route 4 (Great Road) Northbound					Route 4 (Great Road) Southbound					Pine Street Eastbound					Shawsheen Road Westbound					Int. Total
	Left	Thru	Right	Peds	App. Total	Left	Thru	Right	Peds	App. Total	Left	Thru	Right	Peds	App. Total	Left	Thru	Right	Peds	App. Total	
Peak Hour From 07:00 AM to 08:45 AM - Peak 1 of 1																					
Intersection	07:45 AM																				
Volume	2	28	5	0	35	1	27	0	0	28	2	0	0	0	2	10	0	0	0	10	75
Percent	5.7	80.0	14.3	0.0		3.6	96.4	0.0	0.0		100.0	0.0	0.0	0.0		100.0	0.0	0.0	0.0		
08:00 Volume	1	10	2	0	13	1	6	0	0	7	1	0	0	0	1	2	0	0	0	2	23
Peak Factor																					0.815
High Int.	08:00 AM					08:30 AM					08:00 AM					07:45 AM					
Volume	1	10	2	0	13	0	10	0	0	10	1	0	0	0	1	3	0	0	0	3	
Peak Factor	0.673										0.700					0.500					0.833

CTPS
 ARTERIAL INTERSECTIONS
 Lexington-Bedford
 Route 4 at Shawsheen Road

CTPS
ARTERIAL INTERSECTIONS
Lexington-Bedford
Route 4 at Shawsheen Road

File Name : route4 at shawsheen rd - am
 Site Code : 06160301
 Start Date : 06/16/2009
 Page No : 1

Groups Printed- Bikes

Start Time	Route 4 (Great Road) Northbound					Route 4 (Great Road) Southbound					Pine Street Eastbound					Shawsheen Road Westbound					Int. Total
	Left	Thru	Right	Peds	App. Total	Left	Thru	Right	Peds	App. Total	Left	Thru	Right	Peds	App. Total	Left	Thru	Right	Peds	App. Total	
Factor	1.0	1.0	1.0	1.0		1.0	1.0	1.0	1.0		1.0	1.0	1.0	1.0		1.0	1.0	1.0	1.0		
07:00 AM	0	0	2	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2
07:15 AM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
07:30 AM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	1
07:45 AM	0	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
Total	0	0	3	0	3	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1	4
08:00 AM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
08:15 AM	0	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
08:30 AM	0	0	0	0	0	0	1	0	0	1	0	1	0	0	1	0	0	0	0	0	2
08:45 AM	0	0	0	0	0	0	1	0	0	1	0	0	0	0	0	0	0	0	0	0	1
Total	0	0	1	0	1	0	2	0	0	2	0	1	0	0	1	0	0	0	0	0	4
Grand Total	0	0	4	0	4	0	2	0	0	2	0	1	0	0	1	0	1	0	0	1	8
Apprch %	0.0	0.0	100.0	0.0		0.0	100.0	0.0	0.0		0.0	100.0	0.0	0.0		0.0	100.0	0.0	0.0		
Total %	0.0	0.0	50.0	0.0	50.0	0.0	25.0	0.0	0.0	25.0	0.0	12.5	0.0	0.0	12.5	0.0	12.5	0.0	0.0	12.5	

CTPS
ARTERIAL INTERSECTIONS
Bedford
Route 4 at Hartwell Avenue

File Name : Route4 at Hartwell Ave - AM
 Site Code : 06160201
 Start Date : 06/16/2009
 Page No : 1

Counter:
 Counted By: Francesca Moroney
 Weather:
 Other:

Groups Printed- Cars - Trucks

Start Time	Route 4 (Bedford Street) Northbound					Route 4 (Bedford Street) Southbound					Hartwell Avenue Eastbound					Jug-Handle Westbound					Int. Total
	Left	Thru	Right	Peds	App. Total	Left	Thru	Right	Peds	App. Total	Left	Thru	Right	Peds	App. Total	Left	Thru	Right	Peds	App. Total	
Factor	1.0	1.0	1.0	1.0		1.0	1.0	1.0	1.0		1.0	1.0	1.0	1.0		1.0	1.0	1.0	1.0		
07:00 AM	0	121	0	1	122	0	232	123	3	358	16	0	51	0	67	32	219	0	4	255	802
07:15 AM	0	147	0	0	147	0	232	119	0	351	9	0	54	0	63	42	197	0	0	239	800
07:30 AM	0	141	2	4	147	0	218	110	0	328	13	0	61	3	77	47	171	1	0	219	771
07:45 AM	0	155	0	0	155	0	229	81	0	310	29	0	70	0	99	54	226	2	0	282	846
Total	0	564	2	5	571	0	911	433	3	1347	67	0	236	3	306	175	813	3	4	995	3219
08:00 AM	0	148	0	3	151	0	226	129	1	356	19	0	58	0	77	47	211	0	1	259	843
08:15 AM	0	142	0	0	142	0	197	104	0	301	25	0	86	0	111	47	205	2	0	254	808
08:30 AM	0	140	0	0	140	0	213	128	0	341	21	0	54	0	75	44	200	1	0	245	801
08:45 AM	0	126	0	0	126	0	164	137	0	301	24	1	52	0	77	56	239	1	0	296	800
Total	0	556	0	3	559	0	800	498	1	1299	89	1	250	0	340	194	855	4	1	1054	3252
Grand Total	0	1120	2	8	1130	0	1711	931	4	2646	156	1	486	3	646	369	1668	7	5	2049	6471
Apprch %	0.0	99.1	0.2	0.7		0.0	64.7	35.2	0.2		24.1	0.2	75.2	0.5		18.0	81.4	0.3	0.2		
Total %	0.0	17.3	0.0	0.1	17.5	0.0	26.4	14.4	0.1	40.9	2.4	0.0	7.5	0.0	10.0	5.7	25.8	0.1	0.1	31.7	

CTPS
 ARTERIAL INTERSECTIONS
 Bedford
 Route 4 at Hartwell Avenue

File Name : Route4 at Hartwell Ave - AM
 Site Code : 06160201
 Start Date : 06/16/2009
 Page No : 2

Start Time	Route 4 (Bedford Street) Northbound					Route 4 (Bedford Street) Southbound					Hartwell Avenue Eastbound					Jug-Handle Westbound					Int. Total					
	Left	Thru	Right	Peds	App. Total	Left	Thru	Right	Peds	App. Total	Left	Thru	Right	Peds	App. Total	Left	Thru	Right	Peds	App. Total						
Peak Hour From 07:00 AM to 08:45 AM - Peak 1 of 1																										
Intersection 07:45 AM																										
Volume	0	585	0	3	588	0	865	442	1	1308	94	0	268	0	362	192	842	5	1	1040	3298					
Percent	0.0	99.5	0.0	0.5		0.0	66.1	33.8	0.1		26.0	0.0	74.0	0.0		18.5	81.0	0.5	0.1							
07:45 Volume	0	155	0	0	155	0	229	81	0	310	29	0	70	0	99	54	226	2	0	282	846					
Peak Factor																										
High Int. 07:45 AM						08:00 AM						08:15 AM						07:45 AM						0.975		
Volume	0	155	0	0	155	0	226	129	1	356	25	0	86	0	111	54	226	2	0	282						
Peak Factor	0.948										0.919					0.815					0.922					

CTPS
ARTERIAL INTERSECTIONS
Bedford
Route 4 at Hartwell Avenue

File Name : Route4 at Hartwell Ave - AM
 Site Code : 06160201
 Start Date : 06/16/2009
 Page No : 1

Groups Printed- Trucks

Start Time	Route 4 (Bedford Street) Northbound					Route 4 (Bedford Street) Southbound					Hartwell Avenue Eastbound					Jug-Handle Westbound					Int. Total	
	Left	Thru	Right	Peds	App. Total	Left	Thru	Right	Peds	App. Total	Left	Thru	Right	Peds	App. Total	Left	Thru	Right	Peds	App. Total		
Factor	1.0	1.0	1.0	1.0		1.0	1.0	1.0	1.0		1.0	1.0	1.0	1.0		1.0	1.0	1.0	1.0			
07:00 AM	0	6	0	0	6	0	9	0	0	9	0	0	5	0	5	0	3	0	0	0	3	23
07:15 AM	0	3	0	0	3	0	4	1	0	5	1	0	5	0	6	2	7	0	0	0	9	23
07:30 AM	0	12	0	0	12	0	5	2	0	7	1	0	7	0	8	0	5	1	0	0	6	33
07:45 AM	0	9	0	0	9	0	7	2	0	9	3	0	5	0	8	2	5	0	0	0	7	33
Total	0	30	0	0	30	0	25	5	0	30	5	0	22	0	27	4	20	1	0	0	25	112
08:00 AM	0	11	0	0	11	0	12	1	0	13	1	0	8	0	9	0	6	0	0	0	6	39
08:15 AM	0	5	0	0	5	0	9	2	0	11	0	0	8	0	8	0	4	0	0	0	4	28
08:30 AM	0	5	0	0	5	0	8	2	0	10	1	0	6	0	7	2	2	0	0	0	4	26
08:45 AM	0	5	0	0	5	0	7	1	0	8	1	0	4	0	5	1	5	0	0	0	6	24
Total	0	26	0	0	26	0	36	6	0	42	3	0	26	0	29	3	17	0	0	0	20	117
Grand Total	0	56	0	0	56	0	61	11	0	72	8	0	48	0	56	7	37	1	0	0	45	229
Apprch %	0.0	100.0	0.0	0.0		0.0	84.7	15.3	0.0		14.3	0.0	85.7	0.0		15.6	82.2	2.2	0.0			
Total %	0.0	24.5	0.0	0.0	24.5	0.0	26.6	4.8	0.0	31.4	3.5	0.0	21.0	0.0	24.5	3.1	16.2	0.4	0.0		19.7	

CTPS
 ARTERIAL INTERSECTIONS
 Bedford
 Route 4 at Hartwell Avenue

File Name : Route4 at Hartwell Ave - AM
 Site Code : 06160201
 Start Date : 06/16/2009
 Page No : 2

Start Time	Route 4 (Bedford Street) Northbound					Route 4 (Bedford Street) Southbound					Hartwell Avenue Eastbound					Jug-Handle Westbound					Int. Total		
	Left	Thru	Right	Peds	App. Total	Left	Thru	Right	Peds	App. Total	Left	Thru	Right	Peds	App. Total	Left	Thru	Right	Peds	App. Total			
Peak Hour From 07:00 AM to 08:45 AM - Peak 1 of 1																							
Intersection: 07:30 AM																							
Volume	0	37	0	0	37	0	33	7	0	40	5	0	28	0	33	2	20	1	0	23	133		
Percent	0.0	100.0	0.0	0.0		0.0	82.5	17.5	0.0		15.2	0.0	84.8	0.0		8.7	87.0	4.3	0.0				
08:00 Volume	0	11	0	0	11	0	12	1	0	13	1	0	8	0	9	0	6	0	0	6	39		
Peak Factor																							
High Int. 07:30 AM																							
Volume	0	12	0	0	12	08:00 AM	0	12	1	0	13	08:00 AM	1	0	8	0	9	07:45 AM	2	5	0	0	7
Peak Factor	0.771										0.769					0.917					0.821		

CTPS
ARTERIAL INTERSECTIONS
 Lexington/Bedford
Route 4 at Home Goods Shopping

File Name : ROC94E~1
 Site Code : 02031002
 Start Date : 02/03/2010
 Page No : 1

Groups Printed- Cars and Trucks

Start Time	Route 4 Northbound Northbound				Route 4 Southbound Southbound				Home Goods Plaza Eastbound Eastbound				DPW Westbound Westbound				Int. Total
	Left	Thru	Right	Peds	Left	Thru	Right	Peds	Left	Thru	Right	Peds	Left	Thru	Right	Peds	
Factor	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	
04:00 PM	47	116	0	2	0	141	41	1	45	0	52	0	1	1	1	1	449
04:15 PM	40	164	0	2	0	151	43	0	48	0	49	1	1	0	0	0	499
04:30 PM	43	124	0	0	0	141	31	1	40	0	43	1	0	0	0	1	425
04:45 PM	60	153	0	0	0	152	37	0	57	0	38	0	0	0	1	1	499
Total	190	557	0	4	0	585	152	2	190	0	182	2	2	1	2	3	1872
05:00 PM	45	156	0	1	0	143	36	0	49	0	35	1	0	0	0	0	466
05:15 PM	54	149	0	0	0	141	44	1	42	0	49	0	0	0	0	0	480
05:30 PM	50	175	0	1	0	118	30	0	44	1	49	1	0	0	0	0	469
05:45 PM	44	161	0	0	0	137	32	0	42	0	36	0	0	0	0	1	453
Total	193	641	0	2	0	539	142	1	177	1	169	2	0	0	0	1	1868
Grand Total	383	1198	0	6	0	1124	294	3	367	1	351	4	2	1	2	4	3740
Apprch %	24.1	75.5	0.0	0.4	0.0	79.1	20.7	0.2	50.8	0.1	48.5	0.6	22.2	11.1	22.2	44.4	
Total %	10.2	32.0	0.0	0.2	0.0	30.1	7.9	0.1	9.8	0.0	9.4	0.1	0.1	0.0	0.1	0.1	

CTPS
 ARTERIAL INTERSECTIONS
 Lexington/Bedford
Route 4 at Home Goods Shopping

File Name : ROC94E~1
 Site Code : 02031002
 Start Date : 02/03/2010
 Page No : 2

Start Time	Route 4 Northbound Northbound					Route 4 Southbound Southbound					Home Goods Plaza Eastbound Eastbound					DPW Westbound Westbound					Int. Total	
	Left	Thru	Right	Peds	App. Total	Left	Thru	Right	Peds	App. Total	Left	Thru	Right	Peds	App. Total	Left	Thru	Right	Peds	App. Total		
Peak Hour From 04:00 PM to 05:45 PM - Peak 1 of 1																						
Intersection	04:45 PM																					
Volume	209	633	0	2	844	0	554	147	1	702	192	1	171	2	366	0	0	1	1	2	1914	
Percent	24.8	75.0	0.0	0.2		0.0	78.9	20.9	0.1		52.5	0.3	46.7	0.5		0.0	0.0	50.0	50.0			
04:45 Volume	60	153	0	0	213	0	152	37	0	189	57	0	38	0	95	0	0	1	1	2	499	
Peak Factor																						0.959
High Int.	05:30 PM					04:45 PM					04:45 PM					04:45 PM						
Volume	50	175	0	1	226	0	152	37	0	189	57	0	38	0	95	0	0	1	1	2		
Peak Factor	0.934										0.929					0.963					0.250	

CTPS
 ARTERIAL INTERSECTIONS
 Lexington/Bedford
Route 4 at Home Goods Shopping

File Name : ROC94E~1
 Site Code : 02031002
 Start Date : 02/03/2010
 Page No : 1

Groups Printed- Trucks

Start Time	Route 4 Northbound Northbound				Route 4 Southbound Southbound				Home Goods Plaza Eastbound Eastbound				DPW Westbound Westbound				Int. Total
	Left	Thru	Right	Peds	Left	Thru	Right	Peds	Left	Thru	Right	Peds	Left	Thru	Right	Peds	
Factor	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	
04:00 PM	0	5	0	0	0	2	1	0	1	0	1	0	0	0	0	0	10
04:15 PM	0	4	0	0	0	1	0	0	0	0	0	0	0	0	0	0	5
04:30 PM	0	5	0	0	0	4	0	0	0	0	0	0	0	0	0	0	9
04:45 PM	0	3	0	0	0	1	0	0	0	0	0	0	0	0	0	0	4
Total	0	17	0	0	0	8	1	0	1	0	1	0	0	0	0	0	28
05:00 PM	0	2	0	0	0	3	0	0	0	0	0	0	0	0	0	0	5
05:15 PM	0	2	0	0	0	2	1	0	0	0	0	0	0	0	0	0	5
05:30 PM	0	1	0	0	0	4	0	0	1	0	0	0	0	0	0	0	6
05:45 PM	0	1	0	0	0	1	0	0	0	0	0	0	0	0	0	0	2
Total	0	6	0	0	0	10	1	0	1	0	0	0	0	0	0	0	18
Grand Total	0	23	0	0	0	18	2	0	2	0	1	0	0	0	0	0	46
Apprch %	0.0	100.0	0.0	0.0	0.0	90.0	10.0	0.0	66.7	0.0	33.3	0.0	0.0	0.0	0.0	0.0	
Total %	0.0	50.0	0.0	0.0	0.0	39.1	4.3	0.0	4.3	0.0	2.2	0.0	0.0	0.0	0.0	0.0	

CTPS
ARTERIAL INTERSECTIONS
 Lexington/Bedford
Route 4 at Home Goods Shopping

File Name : ROC94E~1
 Site Code : 02031002
 Start Date : 02/03/2010
 Page No : 2

Start Time	Route 4 Northbound Northbound					Route 4 Southbound Southbound					Home Goods Plaza Eastbound Eastbound					DPW Westbound Westbound					Int. Total
	Left	Thru	Right	Peds	App. Total	Left	Thru	Right	Peds	App. Total	Left	Thru	Right	Peds	App. Total	Left	Thru	Right	Peds	App. Total	
Peak Hour From 04:00 PM to 05:45 PM - Peak 1 of 1																					
Intersection	04:00 PM																				
Volume	0	17	0	0	17	0	8	1	0	9	1	0	1	0	2	0	0	0	0	0	28
Percent	0.0	100.0	0.0	0.0		0.0	88.9	11.1	0.0		50.0	0.0	50.0	0.0		0.0	0.0	0.0	0.0		
04:00 Volume	0	5	0	0	5	0	2	1	0	3	1	0	1	0	2	0	0	0	0	0	10
Peak Factor																					0.700
High Int.	04:00 PM					04:30 PM					04:00 PM					3:45:00 PM					
Volume	0	5	0	0	5	0	4	0	0	4	1	0	1	0	2						
Peak Factor	0.850										0.563					0.250					

CTPS
 ARTERIAL INTERSECTIONS
 Lexington/Bedford
Route 4 at Home Goods Shopping

File Name : ROC94E~1
 Site Code : 02031002
 Start Date : 02/03/2010
 Page No : 2

Start Time	Route 4 Northbound Northbound					Route 4 Southbound Southbound					Home Goods Plaza Eastbound Eastbound					DPW Westbound Westbound					Int. Total
	Left	Thru	Right	Peds	App. Total	Left	Thru	Right	Peds	App. Total	Left	Thru	Right	Peds	App. Total	Left	Thru	Right	Peds	App. Total	
Peak Hour From 04:00 PM to 05:45 PM - Peak 1 of 1																					
Intersection	04:00 PM																				
Volume	1	0	0	0	1	0	0	1	0	1	0	0	0	0	0	0	0	0	0	0	2
Percent	100.0	0.0	0.0	0.0		0.0	0.0	100.0	0.0		0.0	0.0	0.0	0.0		0.0	0.0	0.0	0.0		
04:15																					
Volume	1	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
Peak Factor																					
High Int.	04:15 PM					04:00 PM					3:45:00 PM					3:45:00 PM					0.500
Volume	1	0	0	0	1	0	0	1	0	1	0	0	0	0	1	0	0	0	0	0	
Peak Factor	0.250										0.250										

CTPS
ARTERIAL INTERSECTIONS
Lexington-Bedford
Route 4 at Shawsheen Road

Counter: DB400
 Counted By: John Farley
 Weather:
 Other:

File Name : ROUTE4 at Shawsheen Rd - PM
 Site Code : 06160302
 Start Date : 06/16/2009
 Page No : 1

Groups Printed- Cars - Trucks

Start Time	Route 4 (Great Road) Northbound					Route 4 (Great Road) Southbound					Pine Street Eastbound					Shawsheen Road Westbound					Int. Total
	Left	Thru	Right	Peds	App. Total	Left	Thru	Right	Peds	App. Total	Left	Thru	Right	Peds	App. Total	Left	Thru	Right	Peds	App. Total	
Factor	1.0	1.0	1.0	1.0		1.0	1.0	1.0	1.0		1.0	1.0	1.0	1.0		1.0	1.0	1.0	1.0		
04:00 PM	0	178	99	2	279	0	203	4	0	207	7	2	7	0	16	31	6	4	0	41	543
04:15 PM	4	189	90	0	283	3	187	2	1	193	6	0	2	0	8	31	2	2	0	35	519
04:30 PM	1	195	96	1	293	0	197	2	0	199	4	4	8	0	16	32	2	2	0	36	544
04:45 PM	2	214	114	0	330	2	192	4	0	198	5	1	2	0	8	30	3	1	0	34	570
Total	7	776	399	3	1185	5	779	12	1	797	22	7	19	0	48	124	13	9	0	146	2176
05:00 PM	3	215	83	1	302	1	168	2	0	171	6	5	5	0	16	31	3	1	0	35	524
05:15 PM	3	208	91	1	303	4	178	4	0	186	9	1	4	0	14	34	3	2	0	39	542
05:30 PM	2	205	86	0	293	0	155	4	1	160	2	1	7	0	10	35	4	1	0	40	503
05:45 PM	4	174	78	1	257	0	152	4	0	156	6	0	3	0	9	32	3	2	0	37	459
Total	12	802	338	3	1155	5	653	14	1	673	23	7	19	0	49	132	13	6	0	151	2028
Grand Total	19	1578	737	6	2340	10	1432	26	2	1470	45	14	38	0	97	256	26	15	0	297	4204
Apprch %	0.8	67.4	31.5	0.3		0.7	97.4	1.8	0.1		46.4	14.4	39.2	0.0		86.2	8.8	5.1	0.0		
Total %	0.5	37.5	17.5	0.1	55.7	0.2	34.1	0.6	0.0	35.0	1.1	0.3	0.9	0.0	2.3	6.1	0.6	0.4	0.0	7.1	

CTPS
 06/16/2009
 06:00 PM

CTPS
ARTERIAL INTERSECTIONS
 Lexington-Bedford
Route 4 at Shawsheen Road

File Name : ROUTE4 at Shawsheen Rd - PM
 Site Code : 06160302
 Start Date : 06/16/2009
 Page No : 2

Start Time	Route 4 (Great Road) Northbound					Route 4 (Great Road) Southbound					Pine Street Eastbound					Shawsheen Road Westbound					Int. Total
	Left	Thru	Right	Peds	App. Total	Left	Thru	Right	Peds	App. Total	Left	Thru	Right	Peds	App. Total	Left	Thru	Right	Peds	App. Total	
Peak Hour From 04:00 PM to 05:45 PM - Peak 1 of 1																					
Intersection	04:30 PM																				
Volume	9	832	384	3	1228	7	735	12	0	754	24	11	19	0	54	127	11	6	0	144	2180
Percent	0.7	67.8	31.3	0.2		0.9	97.5	1.6	0.0		44.4	20.4	35.2	0.0		88.2	7.6	4.2	0.0		
04:45 Volume	2	214	114	0	330	2	192	4	0	198	5	1	2	0	8	30	3	1	0	34	570
Peak Factor																					0.956
High Int.	04:45 PM					04:30 PM					04:30 PM					05:15 PM					
Volume	2	214	114	0	330	0	197	2	0	199	4	4	8	0	16	34	3	2	0	39	
Peak Factor	0.930										0.947					0.844					0.923

CTPS
ARTERIAL INTERSECTIONS
 Lexington-Bedford
Route 4 at Shawsheen Road

File Name : ROUTE4 at Shawsheen Rd - PM
 Site Code : 06160302
 Start Date : 06/16/2009
 Page No : 1

Groups Printed- Trucks

Start Time	Route 4 (Great Road) Northbound					Route 4 (Great Road) Southbound					Pine Street Eastbound					Shawsheen Road Westbound					Int. Total	
	Left	Thru	Right	Peds	App. Total	Left	Thru	Right	Peds	App. Total	Left	Thru	Right	Peds	App. Total	Left	Thru	Right	Peds	App. Total		
Factor	1.0	1.0	1.0	1.0		1.0	1.0	1.0	1.0		1.0	1.0	1.0	1.0		1.0	1.0	1.0	1.0			
04:00 PM	0	1	0	0	1	0	4	0	0	4	0	0	0	0	0	0	0	0	0	0	0	5
04:15 PM	0	2	1	0	3	0	3	0	0	3	0	0	0	0	0	0	0	0	0	0	0	6
04:30 PM	0	5	1	0	6	0	3	0	0	3	0	0	0	0	0	0	0	0	0	0	0	9
04:45 PM	0	2	1	0	3	0	8	0	0	8	0	0	0	0	0	0	0	0	0	0	0	11
Total	0	10	3	0	13	0	18	0	0	18	0	0	0	0	0	0	0	0	0	0	0	31
05:00 PM	0	0	0	0	0	0	3	0	0	3	0	0	0	0	0	1	0	0	0	0	1	4
05:15 PM	0	4	1	0	5	0	2	0	0	2	0	0	0	0	0	0	0	0	0	0	0	7
05:30 PM	0	1	0	0	1	0	4	0	0	4	0	0	0	0	0	1	0	0	0	0	1	6
05:45 PM	0	3	1	0	4	0	2	0	0	2	0	0	0	0	0	0	0	0	0	0	0	6
Total	0	8	2	0	10	0	11	0	0	11	0	0	0	0	0	2	0	0	0	0	2	23
Grand Total	0	18	5	0	23	0	29	0	0	29	0	0	0	0	0	2	0	0	0	0	2	54
Apprch %	0.0	78.3	21.7	0.0		0.0	100.0	0.0	0.0		0.0	0.0	0.0	0.0		100.0	0.0	0.0	0.0			
Total %	0.0	33.3	9.3	0.0	42.6	0.0	53.7	0.0	0.0	53.7	0.0	0.0	0.0	0.0	0.0	3.7	0.0	0.0	0.0		3.7	

CTPS
ARTERIAL INTERSECTIONS
 Lexington-Bedford
Route 4 at Shawsheen Road

File Name : ROUTE4 at Shawsheen Rd - PM
 Site Code : 06160302
 Start Date : 06/16/2009
 Page No : 2

Start Time	Route 4 (Great Road) Northbound					Route 4 (Great Road) Southbound					Pine Street Eastbound					Shawsheen Road Westbound					Int. Total
	Left	Thru	Right	Peds	App. Total	Left	Thru	Right	Peds	App. Total	Left	Thru	Right	Peds	App. Total	Left	Thru	Right	Peds	App. Total	
Peak Hour From 04:00 PM to 05:45 PM - Peak 1 of 1																					
Intersection	04:00 PM																				
Volume	0	10	3	0	13	0	18	0	0	18	0	0	0	0	0	0	0	0	0	0	31
Percent	0.0	76.9	23.1	0.0		0.0	100.0	0.0	0.0		0.0	0.0	0.0	0.0		0.0	0.0	0.0	0.0		
04:45 Volume	0	2	1	0	3	0	8	0	0	8	0	0	0	0	0	0	0	0	0	0	11
Peak Factor																					0.705
High Int.	04:30 PM					04:45 PM					3:45:00 PM					3:45:00 PM					
Volume	0	5	1	0	6	0	8	0	0	8											
Peak Factor	0.542										0.563										

CTPS
 06/16/2009

CTPS
ARTERIAL INTERSECTIONS
Lexington-Bedford
Route 4 at Shawsheen Road

File Name : ROUTE4 at Shawsheen Rd - PM
 Site Code : 06160302
 Start Date : 06/16/2009
 Page No : 1

Groups Printed- Bikes

Start Time	Route 4 (Great Road) Northbound					Route 4 (Great Road) Southbound					Pine Street Eastbound					Shawsheen Road Westbound					Int. Total	
	Left	Thru	Right	Peds	App. Total	Left	Thru	Right	Peds	App. Total	Left	Thru	Right	Peds	App. Total	Left	Thru	Right	Peds	App. Total		
Factor	1.0	1.0	1.0	1.0		1.0	1.0	1.0	1.0		1.0	1.0	1.0	1.0		1.0	1.0	1.0	1.0			
04:00 PM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
04:15 PM	0	0	0	0	0	0	2	0	0	2	0	0	0	0	0	0	1	0	0	0	1	3
04:30 PM	0	2	0	0	2	0	2	0	0	2	0	0	0	0	0	0	0	0	0	0	0	4
04:45 PM	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1	0	0	0	0	0	0	1
Total	0	2	0	0	2	0	4	0	0	4	0	1	0	0	1	0	1	0	0	0	1	8
05:00 PM	0	1	0	0	1	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	2	3
05:15 PM	0	0	0	0	0	0	1	0	0	1	0	0	0	0	0	0	1	0	0	0	1	2
05:30 PM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0	3	3
05:45 PM	0	0	1	0	1	0	1	0	0	1	0	0	0	0	0	2	0	0	0	0	2	4
Total	0	1	1	0	2	0	2	0	0	2	0	0	0	0	0	3	5	0	0	0	8	12
Grand Total	0	3	1	0	4	0	6	0	0	6	0	1	0	0	1	3	6	0	0	0	9	20
Apprch %	0.0	75.0	25.0	0.0		0.0	100.0	0.0	0.0		0.0	100.0	0.0	0.0		33.3	66.7	0.0	0.0			
Total %	0.0	15.0	5.0	0.0	20.0	0.0	30.0	0.0	0.0	30.0	0.0	5.0	0.0	0.0	5.0	15.0	30.0	0.0	0.0		45.0	

**CTPS
ARTERIAL INTERSECTIONS
Bedford
Route 4 at Hartwell Avenue**

Counter:
Counted By: Francesca Moroney
Weather:
Other:

File Name : Route4 at Hartwell Ave - PM
Site Code : 06160102
Start Date : 06/16/2009
Page No : 1

Groups Printed- Cars - Trucks

Start Time	Route 4 (Bedford Street) Northbound					Route 4 (Bedford Street) Southbound					Hartwell Avenue Eastbound					Jug-Handle Westbound					Int. Total
	Left	Thru	Right	Peds	App. Total	Left	Thru	Right	Peds	App. Total	Left	Thru	Right	Peds	App. Total	Left	Thru	Right	Peds	App. Total	
Factor	1.0	1.0	1.0	1.0		1.0	1.0	1.0	1.0		1.0	1.0	1.0	1.0		1.0	1.0	1.0	1.0		
04:00 PM	1	155	0	0	156	0	220	28	0	248	150	0	211	0	361	24	48	0	0	72	837
04:15 PM	0	183	0	0	183	0	193	27	0	220	143	0	195	0	338	31	57	0	1	89	830
04:30 PM	0	209	0	0	209	0	205	34	1	240	127	0	203	3	333	30	54	1	1	86	868
04:45 PM	0	185	0	0	185	0	200	22	3	225	148	0	212	1	361	31	100	2	1	134	905
Total	1	732	0	0	733	0	818	111	4	933	568	0	821	4	1393	116	259	3	3	381	3440
05:00 PM	0	179	0	0	179	0	173	29	1	203	130	0	235	1	366	43	61	0	1	105	853
05:15 PM	0	215	0	0	215	0	211	29	0	240	121	0	238	0	359	27	74	2	1	104	918
05:30 PM	1	178	0	0	179	0	170	31	0	201	119	0	229	1	349	31	65	1	0	97	826
05:45 PM	1	178	1	1	181	0	141	26	2	169	109	0	228	2	339	33	91	1	1	126	815
Total	2	750	1	1	754	0	695	115	3	813	479	0	930	4	1413	134	291	4	3	432	3412
Grand Total	3	1482	1	1	1487	0	1513	226	7	1746	1047	0	1751	8	2806	250	550	7	6	813	6852
Apprch %	0.2	99.7	0.1	0.1		0.0	86.7	12.9	0.4		37.3	0.0	62.4	0.3		30.8	67.7	0.9	0.7		
Total %	0.0	21.6	0.0	0.0	21.7	0.0	22.1	3.3	0.1	25.5	15.3	0.0	25.6	0.1	41.0	3.6	8.0	0.1	0.1	11.9	

CTPS
 ARTERIAL INTERSECTIONS
 Bedford
 Route 4 at Hartwell Avenue

File Name : Route4 at Hartwell Ave - PM
 Site Code : 06160102
 Start Date : 06/16/2009
 Page No : 2

Start Time	Route 4 (Bedford Street) Northbound					Route 4 (Bedford Street) Southbound					Hartwell Avenue Eastbound					Jug-Handle Westbound					Int. Total				
	Left	Thru	Right	Peds	App. Total	Left	Thru	Right	Peds	App. Total	Left	Thru	Right	Peds	App. Total	Left	Thru	Right	Peds	App. Total					
Peak Hour From 04:00 PM to 05:45 PM - Peak 1 of 1																									
Intersection 04:30 PM																									
Volume	0	788	0	0	788	0	789	114	5	908	526	0	888	5	1419	131	289	5	4	429	3544				
Percent	0.0	100.0	0.0	0.0		0.0	86.9	12.6	0.6		37.1	0.0	62.6	0.4		30.5	67.4	1.2	0.9						
05:15 Volume	0	215	0	0	215	0	211	29	0	240	121	0	238	0	359	27	74	2	1	104	918				
Peak Factor																									
High Int. 05:15 PM						04:30 PM						05:00 PM						04:45 PM							
Volume	0	215	0	0	215	0	205	34	1	240	130	0	235	1	366	31	100	2	1	134					
Peak Factor	0.916										0.946					0.969					0.800				

CTPS
 ARTERIAL INTERSECTIONS
 Bedford
Route 4 at Hartwell Avenue

File Name : Route4 at Hartwell Ave - PM
 Site Code : 06160102
 Start Date : 06/16/2009
 Page No : 1

Groups Printed- Trucks

Start Time	Route 4 (Bedford Street) Northbound					Route 4 (Bedford Street) Southbound					Hartwell Avenue Eastbound					Jug-Handle Westbound					Int. Total
	Left	Thru	Right	Peds	App. Total	Left	Thru	Right	Peds	App. Total	Left	Thru	Right	Peds	App. Total	Left	Thru	Right	Peds	App. Total	
Factor	1.0	1.0	1.0	1.0		1.0	1.0	1.0	1.0		1.0	1.0	1.0	1.0		1.0	1.0	1.0	1.0		
04:00 PM	0	0	0	0	0	0	2	1	0	3	0	0	2	0	2	0	1	0	0	1	6
04:15 PM	0	3	0	0	3	0	1	0	0	1	1	0	3	0	4	0	4	0	0	4	12
04:30 PM	0	6	0	0	6	0	3	0	0	3	1	0	6	0	7	0	2	0	0	2	18
04:45 PM	0	2	0	0	2	0	7	0	0	7	0	0	6	0	6	0	1	0	0	1	16
Total	0	11	0	0	11	0	13	1	0	14	2	0	17	0	19	0	8	0	0	8	52
05:00 PM	0	0	0	0	0	0	3	1	0	4	0	0	0	0	0	0	0	0	0	0	4
05:15 PM	0	8	0	0	8	0	2	0	0	2	0	0	0	0	0	0	1	0	0	1	11
05:30 PM	1	2	0	0	3	0	3	0	0	3	0	0	2	0	2	0	1	0	0	1	9
05:45 PM	0	1	0	0	1	0	1	0	0	1	1	0	0	0	1	0	0	0	0	0	3
Total	1	11	0	0	12	0	9	1	0	10	1	0	2	0	3	0	2	0	0	2	27
Grand Total	1	22	0	0	23	0	22	2	0	24	3	0	19	0	22	0	10	0	0	10	79
Apprch %	4.3	95.7	0.0	0.0		0.0	91.7	8.3	0.0		13.6	0.0	86.4	0.0		0.0	100.0	0.0	0.0		
Total %	1.3	27.8	0.0	0.0	29.1	0.0	27.8	2.5	0.0	30.4	3.8	0.0	24.1	0.0	27.8	0.0	12.7	0.0	0.0	12.7	

CTPS
 ARTERIAL INTERSECTIONS
 Bedford
 Route 4 at Hartwell Avenue

File Name : Route4 at Hartwell Ave - PM
 Site Code : 06160102
 Start Date : 06/16/2009
 Page No : 2

Start Time	Route 4 (Bedford Street) Northbound					Route 4 (Bedford Street) Southbound					Hartwell Avenue Eastbound					Jug-Handle Westbound					Int. Total			
	Left	Thru	Right	Peds	App. Total	Left	Thru	Right	Peds	App. Total	Left	Thru	Right	Peds	App. Total	Left	Thru	Right	Peds	App. Total				
Peak Hour From 04:00 PM to 05:45 PM - Peak 1 of 1																								
Intersection	04:00 PM																							
Volume	0	11	0	0	11	0	13	1	0	14	2	0	17	0	19	0	8	0	0	8	52			
Percent	0.0	100.0	0.0	0.0		0.0	92.9	7.1	0.0		10.5	0.0	89.5	0.0		0.0	100.0	0.0	0.0					
04:30 Volume	0	6	0	0	6	0	3	0	0	3	1	0	6	0	7	0	2	0	0	2	18			
Peak Factor																					0.722			
High Int.	04:30 PM																							
Volume	0	6	0	0	6	04:45 PM	0	7	0	0	7	04:30 PM	1	0	6	0	7	04:15 PM	0	4	0	0	4	
Peak Factor	0.458					0.500					0.679					0.500								

CTPS
 ARTERIAL INTERSECTIONS
 Bedford
 Route 4 at Hartwell Avenue

File Name : Route4 at Hartwell Ave - PM
 Site Code : 06160102
 Start Date : 06/16/2009
 Page No : 1

Groups Printed- Bikes

Start Time	Route 4 (Bedford Street) Northbound					Route 4 (Bedford Street) Southbound					Hartwell Avenue Eastbound					Jug-Handle Westbound					Int. Total
	Left	Thru	Right	Peds	App. Total	Left	Thru	Right	Peds	App. Total	Left	Thru	Right	Peds	App. Total	Left	Thru	Right	Peds	App. Total	
Factor	1.0	1.0	1.0	1.0		1.0	1.0	1.0	1.0		1.0	1.0	1.0	1.0		1.0	1.0	1.0	1.0		
04:00 PM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
04:15 PM	0	0	0	0	0	0	2	0	0	2	0	0	0	0	0	0	0	0	0	0	0
04:30 PM	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1	0	0	0	0	0	0
04:45 PM	0	1	0	0	1	0	2	1	0	3	0	0	0	0	0	0	0	0	0	0	0
Total	0	1	0	0	1	0	4	1	0	5	0	1	0	0	1	0	0	0	0	0	0
05:00 PM	0	0	0	0	0	0	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0
05:15 PM	0	1	0	0	1	0	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0
05:30 PM	0	0	0	0	0	0	0	1	0	1	1	0	1	0	2	0	0	0	0	0	0
05:45 PM	0	1	0	0	1	0	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0
Total	0	2	0	0	2	0	1	3	0	4	1	0	1	0	2	0	0	0	0	0	0
Grand Total	0	3	0	0	3	0	5	4	0	9	1	1	1	0	3	0	0	0	0	0	15
Apprch %	0.0	100.0	0.0	0.0		0.0	55.6	44.4	0.0		33.3	33.3	33.3	0.0		0.0	0.0	0.0	0.0		
Total %	0.0	20.0	0.0	0.0	20.0	0.0	33.3	26.7	0.0	60.0	6.7	6.7	6.7	0.0	20.0	0.0	0.0	0.0	0.0	0.0	

CTPS
 ARTERIAL INTERSECTIONS
 Bedford
Route 4 at Hartwell Avenue

File Name : Route4 at Hartwell Ave - PM
 Site Code : 06160102
 Start Date : 06/16/2009
 Page No : 2

Start Time	Route 4 (Bedford Street) Northbound					Route 4 (Bedford Street) Southbound					Hartwell Avenue Eastbound					Jug-Handle Westbound					Int. Total
	Left	Thru	Right	Peds	App. Total	Left	Thru	Right	Peds	App. Total	Left	Thru	Right	Peds	App. Total	Left	Thru	Right	Peds	App. Total	
Peak Hour From 04:00 PM to 05:45 PM - Peak 1 of 1																					
Intersection 04:45 PM																					
Volume	0	2	0	0	2	0	3	3	0	6	1	0	1	0	2	0	0	0	0	0	10
Percent	0.0	100.0	0.0	0.0		0.0	50.0	50.0	0.0		50.0	0.0	50.0	0.0		0.0	0.0	0.0	0.0		
04:45 Volume	0	1	0	0	1	0	2	1	0	3	0	0	0	0	0	0	0	0	0	0	4
Peak Factor																					
High Int. 04:45 PM						04:45 PM					05:30 PM					3:45:00 PM					
Volume	0	1	0	0	1	0	2	1	0	3	1	0	1	0	2						
Peak Factor	0.500					0.500					0.250										0.625

Appendix D

MassDOT Intersection Crash Rate Worksheets

INTERSECTION CRASH RATE WORKSHEET

CITY/TOWN : Lexington COUNT DATE : 6/16/2009

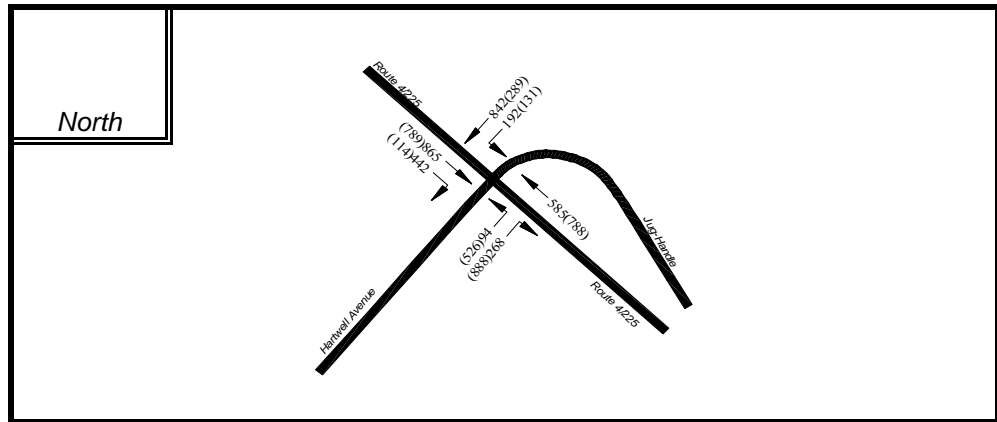
DISTRICT : 4 UNSIGNALIZED : SIGNALIZED :

~ INTERSECTION DATA ~

MAJOR STREET : Route 4/225 (Bedford Street)

MINOR STREET(S) : Hartwell Avenue

**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)	788	903	1,414	420	3,525	

" K " FACTOR :

0.090	INTERSECTION ADT (V) = TOTAL DAILY APPROACH VOLUME :	39,167
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TOTAL # OF CRASHES :

36	# OF YEARS :	3	AVERAGE # OF CRASHES PER YEAR (A) :	12.00
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CRASH RATE CALCULATION :

0.84

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

Comments : District 4 Average = 0.78

Project Title & Date: Arterial Intersections

INTERSECTION CRASH RATE WORKSHEET

CITY/TOWN : Bedford COUNTY : DA DATE : 6/17/2009

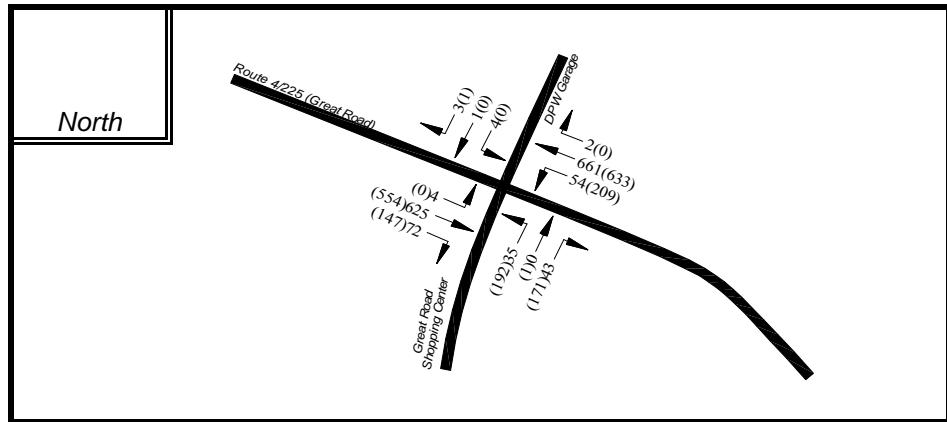
DISTRICT : 4 UNSIGNALIZED : SIGNALIZED :

~ INTERSECTION DATA ~

MAJOR STREET : Route 4/225 (Great Road)

MINOR STREET(S) : Great Road Shopping Center

**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)	842	701	364	1		1,908

"K" FACTOR :

0.090

INTERSECTION ADT (V) = TOTAL DAILY APPROACH VOLUME :

21,200

TOTAL # OF CRASHES :

6

OF YEARS :

3

AVERAGE # OF CRASHES PER YEAR (A) :

2.00

CRASH RATE CALCULATION :

0.26

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

Comments : District 4 Average = 0.78

Project Title & Date: Arterial Intersections