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# *DRAFT MEMORANDUM*

**DATE** **February 22, 2012**

**TO** **City of Newton**

**FROM** **Steven Andrews and Chen-Yuan Wang, MPO Staff**

**RE** **FFY 2011 Safety and Operations Analyses at Selected Boston Region MPO Intersections: Crafts Street at Albemarle Road and at North Street in Newton**

## INTRODUCTION

Staff selected the intersection of Crafts Street at Albemarle Road for study because of the large number of responses and comments received about this intersection through the Boston Region MPO's Intersections Survey. Meanwhile, Crafts Street at Albemarle Road's traffic conditions and pedestrian movements are highly correlated to those of the adjacent intersection of Crafts Street at North Street, which is why MPO staff studied the two intersections together.

This memorandum summarizes safety and operations analyses and proposes improvement strategies for the intersections of Crafts Street at Albemarle Road and Crafts Street at North Street. It contains the following sections:

- Intersection Layout and Traffic Control
- Issues and Concerns
- Crash Data Analysis
- Existing Conditions Analysis
- Preliminary Analysis of Traffic Signal Warrants for the Intersection of Crafts Street at Albemarle Road
- Analysis of Improvement Alternatives
- Improvement Recommendations and Discussion

The memorandum also includes a collection of technical appendices that contain methods and data applied in the study and detailed reports of the intersection capacity analyses.

## INTERSECTION LAYOUT AND TRAFFIC CONTROL

These two intersections are located in the northern part of Newton near the Charles River. Crafts Street, running in the east-west direction, is a two-lane roadway classified as a minor urban arterial. It serves mainly the city's northern neighborhoods and carries a large portion of crosstown traffic. It connects with Waltham Street to the west and Washington Street to the east. Waltham Street leads to the downtown area of Waltham, and Washington Street connects to the Massachusetts Turnpike at Newton Corner.

North Street, running in the north-south direction, is also a two-lane minor urban arterial. It starts at the Crafts Street intersection as North Street, and it passes through Newton for about half a mile as North Street and then continues north with different street names, until it finally connects with Route 20 (Main Street) in Waltham. Albemarle Road, also running in the north-south direction, is a two-lane urban collector (which is considered a more minor roadway than an arterial) divided by Cheesecake Brook. It follows the brook north to the Charles River, where it connects to the Charles River Bike Path. To the south, it intersects with Watertown Street and terminates in a residential neighborhood. Figure 1 shows the locations of the intersections, the adjacent roadways, and the surrounding area.

Figure 2 shows the layout of the two intersections and recently collected peak-hour counts for vehicles, bicycles, and pedestrians. At the intersection of Crafts Street at Albemarle Road, the northbound approach has a shared through and left-turn lane and a short right-turn bay. The southbound approach is wide and an ad hoc right-turn queue forms, when necessary. Both the eastbound and westbound approaches (Craft Street) have a lane shared by all movements. There is a short left-turn bay in the middle of the intersection (storing about two cars) for traffic heading to Albemarle Road southbound from Crafts Street westbound. Both of the Albemarle Road approaches are stop-controlled; Crafts Street operates freely through the intersection.

There are crosswalks across Albemarle Road and one across Crafts Street, allowing pedestrians to cross the busy roadway at the eastern side of the intersection. There is no crosswalk crossing Crafts Street on the western side of the intersection. There are sidewalks on both sides of Crafts Street, and sidewalks on the right side of all of the Albemarle Road approach legs, except Albemarle Road southbound south of the intersection. Left turns from Crafts Street eastbound to Albemarle Road northbound are prohibited. In addition, heavy vehicles are prohibited from traveling southbound on Albemarle Road.

The intersection of Craft Street at North Street is a “T” intersection, with North Street intersecting with Crafts Street at about 60 degrees. The southbound approach is primarily a single lane shared by all movements, but occasionally vehicles form an additional queue on the approach for right turns. The eastbound approach of Crafts Street has two lanes: a left-turn exclusive lane (storing about five to six cars) and a through lane. The westbound approach has a short right-turn exclusive lane (storing about four cars) to North Street and a through lane. There are sidewalks and crosswalks on all of the approach legs at the intersection of Crafts Street at North Street.

The traffic signal at Crafts Street at North Street is semi-actuated and operates with three traffic phases and one exclusive pedestrian phase: southbound North Street, all movements (left turns protected) with an overlapping eastbound right turn; eastbound Crafts Street, all movements (left turns protected); eastbound/westbound Crafts Street, all movements (left turns permitted); and an actuated, exclusive pedestrian phase. The southbound phase is actuated. Field measurements indicate that the southbound phase receives a maximum of 30 seconds, including 25 seconds of green time, 3 seconds of yellow, and 2 seconds of all-red time. The leading eastbound phase is 11 seconds long, including 8 seconds of green time and 3 seconds of yellow time. The eastbound/westbound phase receives 37 seconds, including 31 seconds of green time, 4 seconds of yellow time, and 2 seconds of all-red time. The exclusive pedestrian phase receives 7 seconds of “walk” time, 23 seconds of “don’t walk” time, and 5 seconds of all-red time. Right turns on red are not permitted at any of the approaches. The signal heads, while pole-mounted, are clearly


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**FIGURE 1**
**Intersection Locations and Surrounding Areas**
**Crafts Street at Albemarle Road and North Street, Newton**

*Safety and Operations Analyses at Selected Intersections*

visible from all approaches. The signal lenses appear to be of sufficient size, and at least two signal heads face each approach.

MBTA bus Route 556 has two stops on the south side of Crafts Street eastbound (inbound), and two stops on the north side of Crafts Street (outbound.) The stop on the south side of Crafts Street at North Street is in the middle of the intersection. When a bus stops here, vehicles have to maneuver around the bus or queue behind it, as would be the case for any bus stop, but for a bus stop in an intersection, it is more likely that vehicles try to pass the bus. Buses operate with 30-minute headways during the peak and 60-minute headways during the off-peak. Due to the infrequent bus service, they are probably not interfering with operations at either intersection. The bus stop on the north side at North Street, on the other hand, is occupying the entire right turn lane before the intersection. It appears that it can be consolidated with the adjacent stop just about 300 feet downstream.

A draft of a bicycle plan presented to the City of Newton Transportation Advisory Committee's April 6, 2011, meeting shows some potential bicycle routes that could be planned for the area. The draft bicycle plan indicates that Crafts Street between California Street and Newton's boundary with Waltham could serve as a location for a dedicated bicycle lane (see Appendix A). Watertown Street could receive treatments encouraging bicyclists and motorists to share the road. Albemarle Road connects to the Charles River Bike Path, a popular recreational and commuter multiple-use path, on the eastern side of its northern end. Installing dedicated bicycle lanes on Albemarle Road is mentioned in the 2009 Cheesecake Brook Greenway Master Plan Report, but is not mentioned in the draft bicycle plan.

The land use in the vicinity of the intersection is mainly residential. There are also many athletic facilities and schools in the area. Albemarle Field is immediately adjacent to both intersections. One entrance to the park is just to the east of North Street, one is located near the bus stop in the middle of the intersection of Albemarle at North Street, and one is on Albemarle Road at the intersection with Crafts Street. Three schools are located south of Crafts Street in the area. Their start and release times and enrollments are as follows:

- F.A. Day Middle School, 8:05–2:35 (on Tuesday dismissal is at 1:50), 750 students
- Horace Mann Elem. School, 8:20–3:00 (on Tuesday dismissal is at 12:30), 370 students
- The Fessenden School: 7:55–2:30 (times are approximate), 480 students

According to the schedule, the peak pedestrian crossing hours at the two intersections are presumed to be 7:30 to 8:30 in the morning and 2:30 to 3:30 in the afternoon. During field visits in mid-June and mid-September, a crossing guard was present at each intersection during school opening and closing periods.

**ISSUES AND CONCERNS**

According to crash data and comments received from the MPO's Intersection Survey, of the two intersections, Crafts Street at Albemarle Road is more of a concern. A review of recent crash data from 2006 to 2008 indicates a high number of crashes occurring at the intersection, with a crash rate much higher than other unsignalized intersections in MassDOT Highway Division District 6.

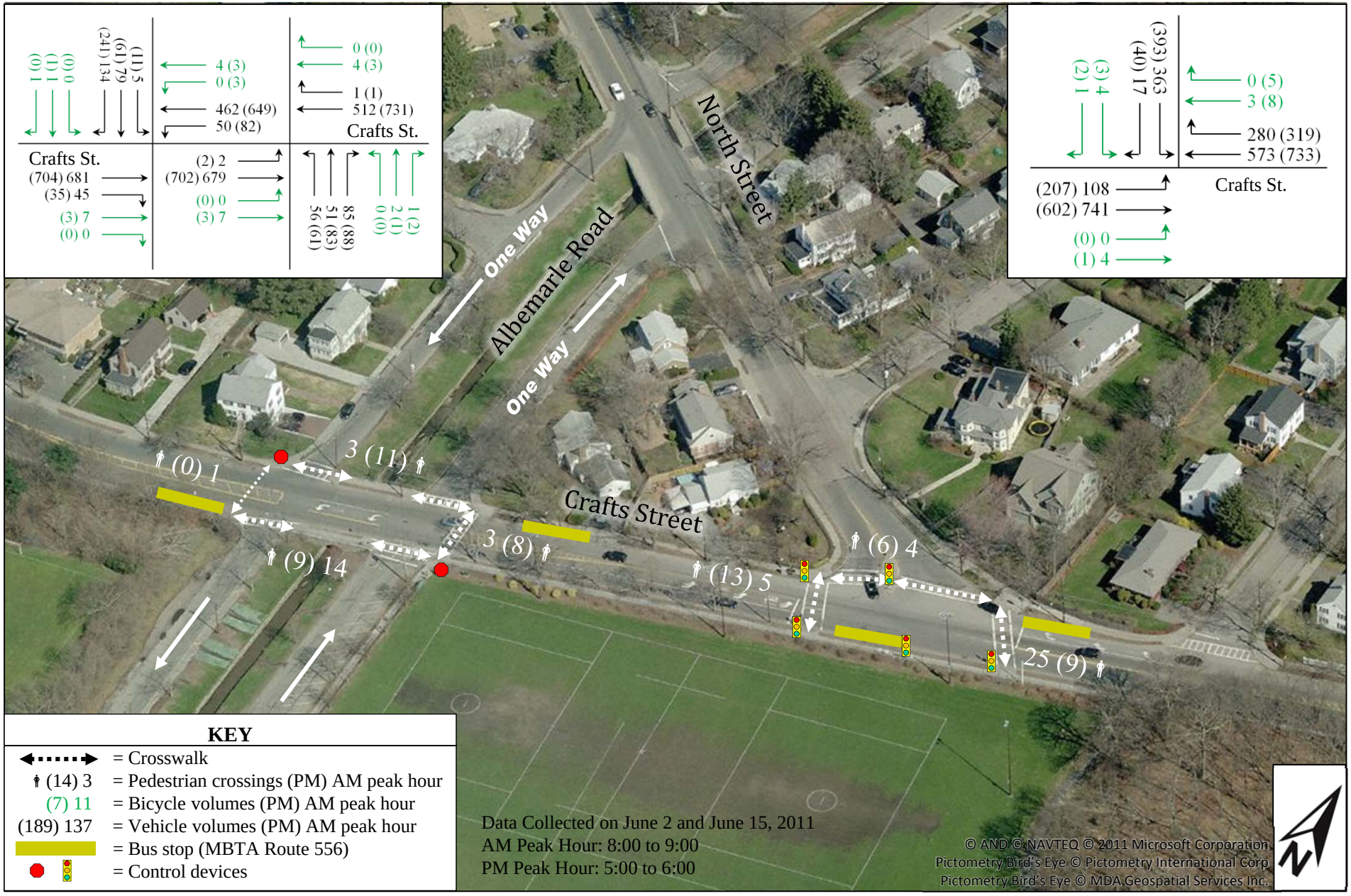


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**FIGURE 2**
**Intersections Layout and Transportation Data**
**Crafts Street at Albemarle Road and North Street, Newton**

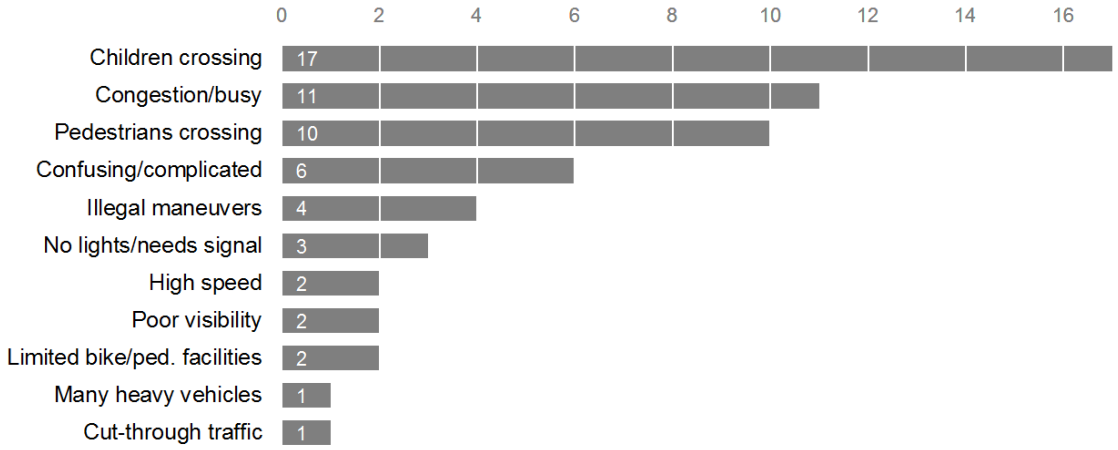
*Safety and Operations Analyses at Selected Intersections*

Pedestrian crossings are also a major issue at the intersection. There are plenty of attractions for pedestrians in the area south of Crafts Street, including three schools, recreational fields, a swimming pool (Gath Pool), and a linear park used by walkers and joggers. Pedestrians from the north must cross Crafts Street to get to the park and recreational facilities. They can cross at the intersection with North Street or walk several hundred feet west to the signalized intersection at Albemarle Road and cross Crafts Street there. The only crosswalk crossing Crafts Street at Albemarle Road is just west of the left-turn lane of Craft Street westbound leading to the signalized intersection at North Street. Drivers often pay more attention to whether there is space to get into that left-turn lane than to whether there are pedestrians crossing the roadway. The length of the crosswalk – the distance pedestrians must walk to cross Crafts Street – is nearly 50 feet.

At the intersection of Crafts Street at North Street, the crosswalks across Crafts Street are about 45 feet long. The crosswalk across North Street is even longer – a distance of over 100 feet – but it has a pedestrian refuge in the middle. While not explicitly part of this study, the intersection of North Street at Albemarle Road does not have clearly marked crosswalks.

In the fall of 2010, the Boston Region Metropolitan Planning Organization (MPO) conducted a survey of the region's intersections to identify priorities for safety and mobility improvements. The online survey offered the public the opportunity to comment on the intersections in their communities. The intersection of Crafts Street at Albemarle Road was one of the locations in the survey that received a high number of responses. In total, staff received comments from 23 Newton residents about this location (see Appendix B). Staff received only one comment about Crafts Street at North Street, which is not about that intersection itself but rather references its proximity to the intersection at Albemarle Road. Since one person could comment on multiple issues, the comments by the 24 residents were further divided into 59 comments and placed into 11 categories. Figure 3 shows the number of comments in the 11 categories.

**FIGURE 3**
**Number of Comments in 11 Categories from the Boston Region MPO Intersection Survey: Crafts Street at Albemarle Road and Crafts Street at North Street**




Staff separated the comments about children crossing from comments about pedestrians in general because many people specifically mentioned children or the nearby school. The other

two issues that residents have concerns about are the traffic congestion at the intersections and the confusing design of the intersections. Several people also mentioned that drivers make illegal maneuvers. Two respondents mentioned speed as an issue. Currently, the posted speed limit at the sections of Crafts Street adjacent to the two intersections is 30 miles per hour (mph). Field observations indicate that vehicles on Craft Street frequently travel at higher speeds than the speed limit, sometimes at 40 mph or more. This occurs most often in the section between Waltham Street and Albemarle Road.

The peak-hour traffic congestion on Crafts Street eastbound at Albemarle Road is mostly due to the spillbacks of traffic queuing from the intersection at North Street. Field observations indicate that at times queues even extend from North Street westward past Fessenden Lane and near Morrill Street (see Figure 4). During the morning and afternoon peak hours, eastbound traffic queues frequently block the intersection at Albemarle Road and affect its operation. It is especially difficult for the drivers on the northbound approach, as their sight line to Crafts Street is obstructed and traffic gaps are usually not available. There is a traffic regulatory sign – "Do Not Block Intersection" – located on Crafts Street eastbound before Albemarle Road (see Figure 5). However, it appears to have minimal effect; the intersection is frequently blocked.

**FIGURE 4**
**Traffic Queue on Crafts Street Eastbound during AM Peak Period:**
**Crafts Street at North Street**

This picture was taken on Crafts Street at North Street looking west toward Albemarle Road.

**FIGURE 5**
**Multiple Signs at the Intersection:**
**Crafts Street Eastbound at Albemarle Road during the AM Peak Period**

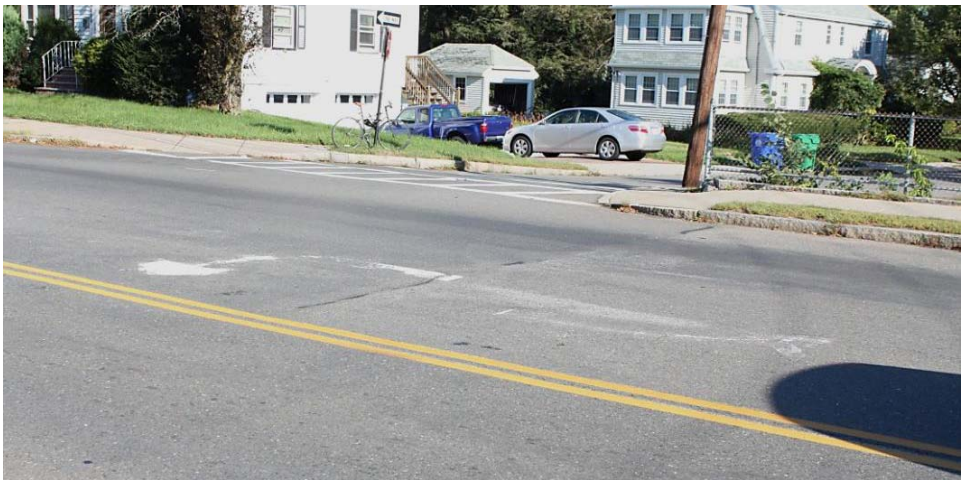

On Crafts Street eastbound, vehicles occasionally form a second lane in order to better utilize the exclusive left-turn lane to North Street. These vehicles frequently encroach on the opposite left-turn lane on Crafts Street and creates potential conflicts. Vehicles turning left from Albemarle Road northbound to Crafts Street westbound cannot, nor would they expect to, see the hidden additional vehicle queue on Crafts Street eastbound in the middle of the intersection.

Since Albemarle Road is split by a creek with one-way operation on each side of the creek, and is under stop control, having appropriate signage at the intersection can be challenging. There are "Stop" signs and "Do Not Enter" signs on Albemarle Road. Meanwhile, there are multiple signs on Crafts Street near the intersection, including a "School Advance Crossing" warning sign (MUTCD S1-1), a "Do Not Block Intersection" sign, "One-way Street" signs, a "No Left Turn" sign, street name signs, and an MBTA bus stop sign (see Figure 5).[1] These multiple signs create a confusing environment for drivers, cyclists, and pedestrians. On the other hand, all of the signs appear to be necessary for the existing operations at the intersection.

At the intersection of Crafts Street at Albemarle Road, the westbound left-turn lane on Crafts Street was converted recently from an eastbound left-turn lane. Old pavement markings are still somewhat visible, and the two sets of arrows are on top of each other. Although there is a "No left turn" sign on a light pole at the northeast corner of the intersection, some drivers may mistake the lane as a two-way left-turn lane. As Figure 6 shows, the westbound left-turn lane on Crafts Street in the middle of the intersection has two sets of left turn arrows.

[1] *The Manual on Uniform Traffic Control Devices (MUTCD)*, defines the standards used to install traffic control devices on roads open to the public. MUTCD includes guidance on how and where to install traffic signs, road markings, signalized intersections, and other types of traffic control devices.

**FIGURE 6**
**Residue from Old Pavement Markings on Crafts Street Westbound:**
**Crafts Street at Albemarle Road**



In summary, the issues and concerns related to the two intersections on Crafts Street are:

- There are a high number of crashes and a high crash rate at the intersection of Crafts Street at Albemarle Road.
- There are a high number of pedestrians, notably children walking to school, using the two intersections. Although there are school crossing guards to help children during school hours, there are no pedestrian signals for crossing Crafts Street at Albemarle Road during other time periods.
- Traffic congestion eastbound during the AM and PM peak periods causes backups from North Street past Albemarle Road. The backups frequently block the intersection at Albemarle Road and affect its operations.
- There are multiple signs at the intersection of Crafts Street at Albemarle Road, causing confusion for drivers.
- People occasionally make illegal maneuvers. Some of these are likely unintentional due to the complicated nature of the intersections.
- Vehicles travel at speeds higher than the posted speed limit on Crafts Street.
- Old left-turn pavement markings on Crafts Street at Albemarle Road are still somewhat visible.
- There are no clear connections from Albemarle Road to the bicycle trail near Charles River.

## CRASH DATA ANALYSIS

Based on the 2006 to 2008 MassDOT Registry of Motor Vehicles Division crash data, Table 1 shows that, on average, about nine crashes occurred at Albemarle Road and Crafts Street each year. Almost 30% of the crashes resulted in personal injuries and about 70% of the total crashes involved property damage only. None of the crashes caused a fatality. The crash types consist of about 73% angle collisions, 12% sideswipe collisions, 8% rear-end collisions, and 4% single-vehicle collisions. There were no head-on crashes. One crash involved a pedestrian, but no crashes involved bicyclists. About 42% of the total crashes occurred during peak periods. About

27% of the total crashes happened when the roadway pavement was wet or icy. Only 8% of the crashes occurred in dark conditions (dawn, dusk, and nighttime).

Crash rates are another effective metric for examining the relative safety of a particular location.[2] Based on the 2006 to2008 crash data and the recently collected traffic volume data, the crash rate for the intersection of Crafts Street at Albemarle Road is 1.06 crashes per million entering vehicles (see Appendix C for the calculation). This crash rate is nearly double the average rate for unsignalized intersections in MassDOT Highway Division District 6, reported by MassDOT to be 0.57 crashes per million entering vehicles.[3]

**TABLE 1**
**Summary of MassDOT Crash Data (2006–08):**
**Crafts Street at Albemarle Road, Newton**

| Statistics Period | | 2006 | 2007 | 2008 | 3-Year | Annual |
|---|---|---|---|---|---|---|
| **Total Number of Crashes** | | 14 | 7 | 5 | 26 | 9 |
| **Severity** | Property Damage Only | 9 | 6 | 4 | 19 | 6 |
| | Personal Injury | 5 | 1 | 1 | 7 | 2 |
| | Fatality | 0 | 0 | 0 | 0 | 0 |
| | Not Reported | 0 | 0 | 0 | 0 | 0 |
| **Collision Type** | Angle | 7 | 7 | 5 | 19 | 6 |
| | Rear-end | 2 | 0 | 0 | 2 | 1 |
| | Sideswipe | 3 | 0 | 0 | 3 | 1 |
| | Head-on | 0 | 0 | 0 | 0 | 0 |
| | Single Vehicle | 1 | 0 | 0 | 1 | 0 |
| | Not Reported/Unknown | 1 | 0 | 0 | 1 | 0 |
| **Involved pedestrian(s)** | | 1 | 0 | 0 | 1 | 0 |
| **Involved cyclist(s)** | | 0 | 0 | 0 | 0 | 0 |
| **Occurred during weekday peak periods*** | | 7 | 1 | 3 | 11 | 4 |
| **Wet or icy pavement conditions** | | 4 | 3 | 0 | 7 | 2 |
| **Dark/lighted conditions** | | 0 | 1 | 1 | 2 | 1 |

* Peak periods are defined as 7:00–10:00 AM and 3:30–6:30 PM.

Staff also collected crash reports from the Newton Police Department (NPD) for the 14 reported crashes that occurred during the period 2008 to 2010: 4 in 2008, 6 in 2009, and 4 in 2010. From the reports, staff constructed a collision diagram for the intersection (see Appendix D). The prevailing type of collision in the three-year period (about 40% of the total crashes) is the angle collision caused by a vehicle traveling eastbound on Crafts Street and a vehicle traveling southbound on Albemarle Road. As was already mentioned, the speed limit on the section of Crafts Street west of the intersection, at Albemarle Road, is 30 mph, but vehicles frequently travel at 40 mph or more in this section. Coming from Waltham Street, the section is downhill and curved. Drivers do not see the intersection until they are near Fessenden Lane. In addition,

[2] Crash rates are estimated based on crash frequency (crashes per year) and vehicle exposure (traffic volumes or miles traveled). Crash rates are expressed as "crashes per million entering vehicles" for intersection locations and as "crashes per million miles traveled" for roadway segments.

[3] The average crash rates estimated by the MassDOT Highway Division are based upon a database that contains intersection crash rates submitted to MassDOT as part of the review process for an Environmental Impact Report or Functional Design Report. The most recent average crash rates, which are updated on a nearly annual basis, are based on all entries in the database, not just those entries made within the past year. The average crash rate for District 6 was calculated on July 7, 2011.

the vegetation on both sides of Crafts Street in this section limits drivers' sight distance to each other from Crafts Street eastbound and the northbound and southbound Albemarle Road approaches.

The collision diagram also shows 10 angle collisions (about 75% of the total crashes), every one of which was caused by a vehicle from Albemarle Road and a vehicle traveling on Crafts Street. A high traffic volume and congestion on Crafts Street during peak periods compel drivers turning off Albemarle Road to choose smaller, and therefore riskier, gaps.

Based on the MassDOT crash data, Table 2 shows that the intersection of Crafts Street at North Street had an average of three crashes each year from 2006 to 2008, a third of the number of crashes that occurred at the Albemarle Road intersection. Most of the crashes (78%) involved property damage only. The crash types consist of 44% angle crashes, 33% rear-end collisions, 11% sideswipes, and 11% head-on collisions. There were no single-vehicle crashes. There was one crash, in 2008, where a bicyclist was involved. The crash rate at the intersection is 0.32 crashes per million entering vehicles, which is about half the average crash rate of District 6 signalized intersections (see Appendix C). The crash rate at Crafts Street at North Street is much lower than the crash rate at Crafts Street at Albemarle Road.

The crash reports from the NPD for 2008 to 2010 for the intersection of Crafts Street at North Street indicate that seven crashes were reported at the intersection (see Appendix D for the collision diagram). The total number of crashes is about the same as the data obtained from MassDOT's database, but the prevailing type of collision (nearly 50% of the total crashes) is the rear-end collision. Two of the three rear-end collisions occurred on the westbound approach of Crafts Street and one on the eastbound approach. The collision diagram also shows two crashes between the westbound through traffic and the eastbound left-turning traffic. These crashes are not unusual for a signalized intersection, especially for one that is frequently congested during peak periods.

**TABLE 2**
**Summary of MassDOT Crash Data (2006–08):**
**Crafts Street at North Street, Newton**

| Statistics Period | | 2006 | 2007 | 2008 | 3-Year | Annual |
|---|---|---|---|---|---|---|
| **Total Number of Crashes** | | 2 | 3 | 4 | 9 | 3 |
| **Severity** | Property Damage Only | 1 | 3 | 3 | 7 | 2 |
| | Personal Injury | 1 | 0 | 1 | 2 | 1 |
| | Fatality | 0 | 0 | 0 | 0 | 0 |
| | Not Reported | 0 | 0 | 0 | 0 | 0 |
| **Collision Type** | Angle | 0 | 1 | 3 | 4 | 1 |
| | Rear-end | 2 | 1 | 0 | 3 | 1 |
| | Sideswipe | 0 | 1 | 0 | 1 | 0 |
| | Head-on | 0 | 0 | 1 | 1 | 0 |
| | Single Vehicle | 0 | 0 | 0 | 0 | 0 |
| | Not Reported/Unknown | 0 | 0 | 0 | 0 | 0 |
| **Involved pedestrian(s)** | | 0 | 0 | 0 | 0 | 0 |
| **Involved cyclist(s)** | | 0 | 0 | 1 | 1 | 0 |
| **Occurred during weekday peak periods*** | | 0 | 1 | 3 | 4 | 1 |
| **Wet or icy pavement conditions** | | 1 | 2 | 2 | 5 | 2 |
| **Dark/lighted conditions** | | 0 | 1 | 1 | 2 | 1 |

* Peak periods are defined as 7:00–10:00 AM and 3:30–6:30 PM.

## EXISTING CONDITIONS ANALYSIS

Staff collected turning-movement counts at the intersections on June 2 and 15t, 2011. The data were recorded in 15-minute intervals for the peak traffic periods in the morning, from 7:00 to 9:00 AM, and in the evening, from 4:00 to 6:00 PM.

The collected data indicate that the area's traffic is very busy during both peak periods. The peak traffic hour in the morning was from 8:00 to 9:00, and in the evening, it was from 5:00 to 6:00. Table 3 shows that the intersection of Crafts Street at North Street carried about 2,100 vehicles and with about 35 pedestrian crossings in the morning peak hour, and about 2,300 vehicles with about 30 pedestrian crossings during the evening peak hour. Table 4 shows that the intersection of Crafts Street at Albemarle Road carried about 1,650 vehicles with about 20 pedestrian crossings in the morning peak hour, and about 2,000 vehicles with about 30 pedestrian crossings in the evening peak hour.

Due to the proximity to the intersections of three schools, the pedestrian activities peaked somewhat earlier in the morning than the vehicular activities – from 7:30 to 8:30. During this hour, the intersection of Crafts Street at North Street had over 50 pedestrian crossings and the intersection of Crafts Street at Albemarle Road had nearly 50 pedestrian crossings. Presumably, about the same number of pedestrian crossings and same patterns would occur during the schools' releasing hour, roughly from 2:30 to 3:30.

The two intersections each carried a total of about 10 to 15 bicyclists in each of the AM and PM peak traffic hours. There were more bicyclists (about 15 to 20 bicycles) going through each intersection in the morning hour from 7:00 to 8:00 than at any other hour during the peak periods. Figure 2 shows the vehicle and bicycle turning movements and the pedestrian crossings at the two intersections in the AM and PM peak traffic hours.

**TABLE 3**
**AM and PM Peak-Hour Traffic Volumes and Pedestrian Crossings:**
**Crafts Street at North Street**

| Street name | | North Street | | Crafts Street | | | | Total |
|---|---|---|---|---|---|---|---|---|
| Direction | | Southbound | | Eastbound | | Westbound | | |
| Turning movement | | LT | RT | LT | TH | TH | RT | |
| AM peak hour | Turning volume | 363 | 17 | 108 | 741 | 573 | 280 | |
| | Mvmt. percentage | 96% | 4% | 13% | 87% | 67% | 23% | 2,082 |
| | Approach volume | 380 | | 849 | | 853 | | |
| | Ped. crossings | 4 | | 5 | | 25 | | 34 |
| PM peak hour | Turning volume | 393 | 40 | 207 | 602 | 733 | 319 | |
| | Mvmt. percentage | 91% | 9% | 26% | 74% | 70% | 30% | 2,294 |
| | Approach volume | 433 | | 809 | | 1,052 | | |
| | Ped. crossings | 6 | | 13 | | 9 | | 28 |

**TABLE 4**
**AM and PM Peak-Hour Traffic Volumes and Pedestrian Crossings:**
**Crafts Street at Albemarle Road**

| Street name | | Albemarle Road | | | | | | Crafts Street | | | | | | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Direction | | Northbound | | | Southbound | | | Eastbound | | | Westbound | | | |
| Turning movement | | LT | TH | RT | LT | TH | RT | LT | TH | RT | LT | TH | RT | |
| AM peak hour | Turning volume | 56 | 51 | 85 | 5 | 79 | 134 | 2 | 681 | 45 | 50 | 462 | 1 | |
| | Mvmt. percentage | 29% | 27% | 44% | 2% | 36% | 61% | 0% | 94% | 6% | 10% | 90% | 0% | 1,651 |
| | Approach volume | 192 | | | 218 | | | 728 | | | 513 | | | |
| | Ped. crossings | 14 | | | 3 | | | 1 | | | 3 | | | 21 |
| PM peak hour | Turning volume | 61 | 83 | 88 | 11 | 61 | 241 | 2 | 704 | 35 | 82 | 649 | 1 | |
| | Mvmt. percentage | 26% | 36% | 38% | 4% | 19% | 77% | 0% | 95% | 5% | 11% | 89% | 0% | 2,018 |
| | Approach volume | 232 | | | 313 | | | 741 | | | 732 | | | |
| | Ped. crossings | 9 | | | 11 | | | 0 | | | 8 | | | 28 |

Note: Eastbound left-turns are prohibited.
There is not a marked crosswalk across the eastbound Crafts Street approach.

Based on the turning-movement counts and the signal timings measured at the site, staff analyzed the intersection capacity using an intersection capacity analysis program, Synchro.[4] Crafts Street at North Street was modeled as a semi-actuated signalized intersection. Table 5 shows that all of the movements on Crafts Street encounter some delays during peak periods, especially the westbound through movement. Synchro analysis indicates that the intersection operates at an overall level of service (LOS) E in the AM peak hour with an average delay of just over a minute per vehicle, and at LOS F in the PM peak hour with an average delay of nearly one and a half minutes per vehicle. The volume on the westbound approach surpasses its capacity in both peak hours, and the volume on the eastbound approach is slightly over its capacity in the

[4] Synchro Version 7 is developed and distributed by Trafficware Ltd. The software can perform capacity analysis and traffic simulation (when combined with SimTraffic) for an individual intersection or a series of intersections.

AM peak hour. The traffic queues observed on both approaches of Crafts Street support these analyses. See Appendix E for the Synchro reports of the analyses for the existing conditions.

Crafts Street at Albemarle Road was modeled as two closely spaced stop-control intersections. The existing right-turn bay was included in the Synchro simulation. While there is not a formal southbound right-turn bay, a small southbound right-turn bay was also added to model the flared area vehicles could use to form two queues. Table 6 summarizes the analysis results. It shows that the northbound and southbound movements endure significant delays due to the heavy traffic on Crafts Street. The Crafts Street approaches seem to be serving vehicles well, with no major delays. The estimation, however, does not include delays on the eastbound approach caused by the queues from the intersection at North Street.

**TABLE 5**
**Intersection Capacity Analysis, Existing Conditions:**
**Crafts Street at North Street, Newton**

| Street name | | North Street | Crafts Street | | | | Overall |
|---|---|---|---|---|---|---|---|
| Direction | | Southbound | Eastbound | | Westbound | | |
| Turning movement | | LT/RT | LT | TH | TH | RT | |
| AM peak hour | LOS | E | C | E | F | A | E |
| | Delay (sec/veh) | 55.5 | 30.6 | 67.8 | 94.8 | 9.3 | 63.1 |
| PM peak hour | LOS | D | E | C | F | A | F |
| | Delay (sec/veh) | 47.2 | 63.3 | 31.2 | 178.4 | 7.8 | 82.0 |

**TABLE 6**
**Intersection Capacity Analysis, Existing Conditions:**
**Crafts Street at Albemarle Road, Newton**

| Street name | | Western Intersection | | | | Eastern Intersection | | |
|---|---|---|---|---|---|---|---|---|
| Direction | | SB | EB | WB | | NB | EB | WB |
| Turning movement | | LT/TH/RT | TH/RT | LT | TH | LT/TH/RT | LT/TH | TH/RT |
| AM peak hour | LOS | F | A | A | A | F | A | A |
| | Delay | 135 | 0.0 | 9.5 | 0.0 | >180 | 0.1 | 0.0 |
| PM peak hour | LOS | F | A | A | A | F | A | A |
| | Delay | >180 | 0.0 | 10 | 0.0 | >180 | 0.1 | 0.0 |

In addition, staff analyzed the regional traffic patterns in the area. Both Crafts Street and North Street are major crosstown arterials that carry high volumes of vehicles. The two intersections being analyzed – Crafts Street at North Street and Crafts Street at Albemarle Street – and the intersection of North Street at Albemarle Road form a triangle and are interconnected. To analyze the traffic patterns, MPO staff requested 24-hour traffic counts from MassDOT. Automatic Traffic Recorders (ATRs) were placed on the roadways adjacent to the three intersections for three consecutive weekdays in late May of 2011 (see Appendix F for the summary of daily and hourly traffic volumes from the ATR counts).

The data indicate that Crafts Street carries about 9,000 to 12,000 vehicles and North Street carries about 4,500 to 8,500 vehicles in each direction per weekday (see Figure F-1 in Appendix

F for the directional weekday traffic volumes on these streets). Except for the southbound section of Albemarle Road from North Street to Crafts Street, which carries about 3,500 vehicles per weekday, Albemarle Road carries fewer than 2,000 vehicles in each of the one-way directions on both sides of Crafts Street. About 7,500 vehicles per day arrive via North Street from the north. About 60% of these vehicles continue southward to the intersection at Crafts Street, where most of them make left-turns. About 40% of them turn right onto southbound Albemarle Road and reach the intersection at Crafts Street, where most of them make right turns.

Analysis of the peak-hour traffic volumes on these streets indicates a similar traffic pattern (see Figure F-2 in appendix F). Essentially, the southbound section of Albemarle Road serves as a connector for traffic from North Street southbound to Crafts Street westbound. This traffic pattern actually helps alleviate the pressure on the intersection of Crafts Street at North Street, which carries heavy traffic from all approaches. Except for this pattern, no traffic patterns are especially notable.

## PRELIMINARY ANALYSIS OF TRAFFIC SIGNAL WARRANTS FOR THE INTERSECTION OF CRAFTS STREET AT ALBEMARLE ROAD

According to the MUTCD, an engineering study of traffic conditions, pedestrian characteristics, and physical characteristics of a location should be performed to determine whether installation of a traffic control signal is justified at that location.[5] The investigation should include applicable factors contained in the following traffic signal warrants and other factors related to existing operations and safety at the study location:

| | |
|---|---|
| Warrant 1 | Eight-Hour Vehicular Volume Warrant |
| Warrant 2 | Four-Hour Vehicular Volume Warrant |
| Warrant 3 | Peak-Hour Warrant |
| Warrant 4 | Pedestrian Volume Warrant |
| Warrant 5 | School Crossing Warrant |
| Warrant 6 | Coordinated Signal System Warrant |
| Warrant 7 | Crash Experience Warrant |
| Warrant 8 | Roadway Network Warrant |
| Warrant 9 | Intersection Near a Grade Crossing |

A traffic control signal should not be installed unless one or more of the conditions represented in these warrants are present. Moreover, the satisfaction of a warrant or warrants in itself does not justify signal installation unless an engineering study indicates that the installation will improve the overall safety and/or operation of the intersection.

In this study, staff performed a preliminary analysis of the applicable traffic signal warrants at the intersection of Crafts Street at Albemarle Road. The applicable factors for this intersection are contained in Warrants 1, 2, 5, and 7. Warrant 3 is intended for unusual cases, such as office complexes, manufacturing plants, industrial complexes, or high-occupancy-vehicle facilities that attract or discharge large numbers of vehicles over a short time. Pedestrian volume is not high at this intersection, but the intersection is close to several schools. The intersection is not near a

[5] Federal Highway Administration, U.S. Department of Transportation, *The Manual on Uniform Traffic Control Devices (MUTCD), Chapter 4C. Traffic Control Signal Needs,* 2009 Edition, December 2009.

grade crossing, and installing a signal at this intersection is not crucial for maintaining proper vehicle grouping (platooning). Therefore, Warrants 3, 4, 6, 8, and 9 were not tested.

Because the school crossing guard directed most children to cross at Crafts Street's intersection with North Street, fewer than 20 schoolchildren crossed Crafts Street at Albemarle Road during the hour with the highest number of pedestrian crossings. Warrant 5, school crossings, is thus not satisfied.

The examination of Warrants 1, 2, and 7 was based on hourly volumes of an average day, which were derived from the recent MassDOT ATR counts (see Appendix F). Analysis indicates that the intersection meets the conditions required by Warrant 1 (Eight-Hour Vehicular Volume Warrant) and Warrant 2 (Four-Hour Vehicular Volume Warrant). Warrant 7 is not satisfied, as the traffic conditions meet the required criteria but the NPD data indicate that the number of crashes is less than five in 2010. Appendix G presents the analysis of the required hourly volumes for the three warrants.

MPO staff have determined that this intersection qualifies for the installation of a traffic signal, as its traffic conditions meet the requirements of Warrants 1 and 2. To justify the traffic signal installation, MassDOT usually prefers that Warrant 1, eight-hour vehicle volume, is met.

## ANALYSIS OF IMPROVEMENT ALTERNATIVES

To improve operations and safety for all users at the two intersections on Crafts Street, staff examined improvement alternatives related mainly to signal operation strategies. Because of the adjacent residential land use and the limited availability of right-of-way, staff did not develop any alternatives that included major geometric modifications. Among the alternatives examined, three are considered feasible. They are (from the least to the most expensive improvement option):

**Alternative 1** Retime the signal at North Street; maintain the existing operations at Albemarle Road.

**Alternative 2** Upgrade the signal at North Street; maintain the existing operations at Albemarle Road.

**Alternative 3** Upgrade the signal at North Street; install a traffic signal at Albemarle Road; coordinate the two traffic signals.

All of the alternatives would maintain or install on-call exclusive pedestrian phases in the existing or new traffic signals (using a pedestrian actuation button). The North Street pedestrian signal phase would remain the same (35 seconds) and the new signal at the Albemarle Road intersection would include an exclusive pedestrian phase of 30 seconds. In addition, all the alternatives would include a minor geometric modification on the northbound approach of Albemarle Road. The approach has a high proportion of right turns. Lengthening the existing right-turn lane from 25 feet to about 75 feet would increase the capacity of the approach significantly. The extension would require removing two existing on-street angle parking spaces.

Alternative 1 would simply retime the traffic signal at the North Street intersection and maintain the existing two-way stop operations at the Albemarle Road intersection. Based on the recent turning-movement counts, Synchro optimization tests indicate that the intersection would improve from LOS E to LOS D in the AM peak hour, and in the PM peak hour from LOS F to

LOS E, with a reduction of overall delay about 10 to 15 seconds per vehicle (see Table 7). The tested model maintained the existing cycle length and pedestrian phase time but reallocated two seconds of green time in the AM peak hour and four in the PM peak hour from the southbound (North Street) phase to the eastbound/westbound phase. See Appendix H for the Synchro reports of the timing settings and analysis results.

Alternative 2 would upgrade the traffic signal at the North Street intersection to a fully actuated signal. It would require installing vehicle and bicycle detectors on both approaches of Crafts Street and upgrading the existing signal controllers. As Table 7 shows, the alternative would further improve the intersection operations by reducing overall delay by about 3 to 6 seconds per vehicle over Alternative 1. Since the signal system would be actuated, both approaches of Crafts Street would operate more efficiently, and the eastbound left-turn signal could gap out at its minimum green time or be skipped.[6] The tested model contained a cycle length of 115 seconds, including one pedestrian and three traffic phases, in the AM peak period, and a cycle length of 120 seconds in the PM peak period. See Appendix I for the Synchro reports of the timing settings and analysis results.

Under Alternatives 1 and 2, the Albemarle Road approaches would maintain the existing stop-control traffic operation. Although there would be no major operational improvements expected, the intersection's operations and safety would be improved to a certain degree by the installation and modification of traffic control devices. These measures include installing additional crosswalk walk signage at the crosswalk, enlarging and doubling the number of "Stop" signs, and relocating traffic signs on the eastbound approaches. These are low-cost improvements and can be implemented in the short term. See the next section for further discussions of the recommended measures.

Alternative 3 is the most costly, and the most effective, improvement option. It would significantly improve the safety and operations at the Albemarle Road intersection. The alternative would upgrade the North Street intersection to a fully actuated traffic signal, install a fully actuated traffic signal at the Albemarle Road intersection, and coordinate the two traffic signals as a closed-loop system. The traffic signal would prevent blockage of the intersection during peak hours and provide intervals of sufficient time for vehicles from Albemarle Road to pass through the intersection in a more orderly and safe manner and endure less delay during peak hours.[7] Moreover, it would provide exclusive pedestrian signal phases to stop traffic at all approaches for pedestrians to cross Crafts Street.

Tables 8 and 9 show that Alternative 3 would improve the Albemarle Road approaches from the undesirable LOS F to the acceptable LOS C, D, and E in both the AM and PM peak hours, with a significant reduction of delays, from several minutes to about a half a minute or a minute per vehicle. Meanwhile, it would maintain traffic operations at the desirable LOS A, B, and C on all the Crafts Street approaches.

Unlike existing operations, the signal installation at Albemarle Road would create interruptions of traffic flow on Crafts Street. Coordination would synchronize the two intersections' traffic

[6] A traffic signal is said to have "gapped out" when an actuated phase terminates before its maximum allotted green time is reached because there is a gap in traffic.

[7] Installing a traffic signal would potentially reduce delays on the Albemarle Road approaches during other, non-peak hours, as the traffic is usually heavy during most of the daylight hours.

signals and would smooth traffic flow on Crafts Street. As Table 8 shows, all of the alternatives would maintain intersection operations at the acceptable LOS D and E in the AM and PM peak hours. The model designated the North Street intersection as the master intersection in coordinating the eastbound/westbound approaches of the two intersections. The North Street intersection would operate with phasing and timing settings similar to those in Alternative 2.

**TABLE 7**
**Intersection Capacity Analyses of Improvement Alternatives:**
**Crafts Street at North Street, Newton**

| Street name | | Crafts Street | | | | North Street | | Overall | |
|---|---|---|---|---|---|---|---|---|---|
| Direction | | Eastbound | | Westbound | | Southbound | | | |
| Measurement | | LOS | Delay | LOS | Delay | LOS | Delay | LOS | Delay |
| AM peak hour | Existing | E | 63.1 | E | 66.7 | E | 55.5 | E | 63.1 |
| | Alternative 1 | E | 53.2 | D | 48.5 | E | 66.6 | D | 53.8 |
| | Alternative 2 | D | 49.8 | C | 34.5 | E | 71.3 | D | 47.6 |
| | Alternative 3 | C | 34.6 | C | 30.0 | F | 92.6 | D | 43.6 |
| PM peak hour | Existing | D | 39.4 | F | 126.7 | D | 47.2 | F | 82.0 |
| | Alternative 1 | D | 35.4 | F | 83.2 | E | 72.6 | E | 64.8 |
| | Alternative 2 | D | 36.3 | E | 73.1 | E | 79.0 | E | 61.5 |
| | Alternative 3 | E | 66.2 | E | 64.8 | F | 92.2 | E | 70.4 |

**TABLE 8**
**Intersection Capacity Analyses of Improvement Alternatives:**
**Eastern Intersection, Crafts Street at Albemarle Road, Newton**

| Street name | | Crafts Street | | | | Albemarle Road | | Overall | |
|---|---|---|---|---|---|---|---|---|---|
| Direction | | Eastbound | | Westbound | | Northbound | | | |
| Measurement | | LOS | Delay | LOS | Delay | LOS | Delay | LOS | Delay |
| AM peak hour | Existing<br>Alt. 1/2 | A | 0.1 | A | 0.0 | F | >180 | NA | NA |
| | Alternative 3 | A | 4.8 | A | 5.1 | E | 72.4 | B | 15.7 |
| PM peak hour | Existing<br>Alt. 1/2 | A | 0.1 | A | 0.0 | F | >180 | NA | NA |
| | Alternative 3 | A | 2.7 | B | 12.2 | E | 65.4 | B | 15.8 |

**TABLE 9**
**Intersection Capacity Analyses of Improvement Alternatives:**
**Western Intersection, Crafts Street at Albemarle Road, Newton**

| Street name | | Crafts Street | | | | Albemarle Road | | Overall | |
|---|---|---|---|---|---|---|---|---|---|
| Direction | | Eastbound | | Westbound | | Southbound | | | |
| Measurement | | LOS | Delay | LOS | Delay | LOS | Delay | LOS | Delay |
| AM peak hour | Existing | A | 0.0 | A | 0.9 | F | 135 | NA | NA |
| | Alt. 1/2 | | | | | | | | |
| | Alternative 3 | C | 26.1 | A | 1.5 | D | 47.4 | C | 21.0 |
| PM peak hour | Existing | A | 0.0 | A | 1.1 | F | >180 | NA | NA |
| | Alt. 1/2 | | | | | | | | |
| | Alternative 3 | C | 29.0 | A | 4.0 | C | 33.4 | B | 18.6 |

The Albemarle Road intersection would operate with a split phase on Albemarle Road approaches so that traffic would not get stuck in the middle of the intersection. See Appendix J for the Synchro reports of the timing settings and analysis results.

## IMPROVEMENT RECCOMENDATIONS AND DISCUSSION

The two intersections on Crafts Street carried heavy traffic and the intersection of Crafts Street at Albemarle Road had a high number of crashes in recent years. To improve the operations and safety for all users at the two intersections, staff collected traffic and crash data, performed intersection capacity and safety analyses, and developed improvement alternatives. Three alternatives selected for consideration are:

**Alternative 1** Retime the signal at North Street; maintain the existing operations at Albemarle Road.

**Alternative 2** Upgrade the signal at North Street; maintain the existing operations at Albemarle Road.

**Alternative 3** Upgrade the signal at North Street; install a traffic signal at Albemarle Road; coordinate the two traffic signals.

Alternatives 1 and 2 basically aim at improving the signal operations at the North Street intersection and maintain the operations at the Albemarle Road intersection with signage and pavement marking improvements. These measures would improve the operations at the Albemarle Road intersection to a certain degree but not significantly. Alternative 3 proposes to install a traffic signal at the Albemarle Road intersection with exclusive pedestrian signal phases and coordinate the two traffic signals on Crafts Street. It would significantly improve the safety and operations at the intersection.

In the short term, staff recommends Alternative 1 with the following improvements at the Albemarle Road intersection:

- Double the number of (left and right) and enlarge the "Stop" signs on the both approaches of Albemarle Road.[8]
- Double the number of and enlarge the "Do Not Enter" signs on the both approaches of Albemarle Road.
- Install "Pedestrian Crossing" warning sign (MUTCD W11-2) on both approaches of Crafts Street about 100 feet ahead of the intersection. [9,10]
- Install a pedestrian crossing warning sign (W11-2) with downward sloping arrow plaque (W16-7P) at both ends of the existing crosswalk on Crafts Street to indicate the crossing location and to supplement to the advance placement of the pedestrian crossing warning sign.
- Clear the vegetation on the northwest corner of Crafts Street at Albemarle Road; this vegetation limits the distance at which drivers on the eastbound and southbound can see each other.
- Install a series of "Slow" pavement markings, as discussed in Section 3B.20 of the MUTCD, on the Crafts Street eastbound approach to slow down traffic on the approach.[11]
- Increase the length of the northbound right-turn lane on Albemarle Road.
- Increase the size of "Do Not Block Intersection" on the eastbound approach of Crafts Street.[12]
- Increase the size of "No Left Turn" (MUTCD R3-2) sign on the eastbound approach.
- Set back the "One Way" street arrow signs to at least 50 feet from the intersection so that they will not crowd with the multiple traffic signs at the intersection.[13]
- Obliterate the old left-turn arrows in turning lane on Crafts Street.
- Maintain clear pavement markings in the intersection vicinity, especially the crosswalks at the intersection.

At the North Street intersection, staff recommends that the city maintain clearly marked crosswalks. Lastly, staff recommends keeping the existing school guards at the two intersections during the school opening and releasing hours. At this preliminary planning stage, the total cost of these short-term improvements is roughly estimated as about $15,000 to $20,000.

In the long term, staff recommends Alternative 3 with the following features and improvements:

---

[8] Currently there is a 24-by-24-inch stop sign on each of the two approaches of Albemarle Road. Since the approaches are wide and traffic usually forms two lanes during peak hours, doubling the number of stop signs would increase drivers' awareness of the stop operation. In addition, the size of the stop sign should be increased to 36-inch-by-36-inch.

[9] *The Manual on Uniform Traffic Control Devices (MUTCD)* defines the standards used by road managers nationwide to install and maintain traffic control devices on all public streets, highways, bikeways, and private roads open to public traffic. The manual is published by the Federal Highway Administration (FHWA).

[10] Currently there is a pedestrian crossing warning sign on the eastbound approach. However, it is not noticeable as it is attached to a light pole away from the edge of the road and is obstructed by nearby trees (see the hidden yellow sign on the far right in Figure 5 on page 7). It should be relocated closer to the edge of the road and about 50 feet west of its current location.

[11] At least three "Slow" pavement markings should be placed sequentially on the approach within about 250 to 500 feet from the intersection.

[12] The existing sign's size is too small and is obstructed by foliage. It should be doubled in size and located away from the nearby trees.

[13] The one-way street signs are confusing to drivers, as the multiple signs at the intersection crowd them. Especially important is that drivers from the eastbound approach are likely to be confused by the multiple "arrow" signs facing the approach pointing in different directions (see Figure 5 on page 7). Enlarging and doubling the number of "Do Not Enter" signs should be sufficient to deter drivers entering the wrong way.

- Install countdown and audible pedestrian signals at the two intersections.
- Install ADA (Americans with Disabilities Act)-compliant curb ramps with tactile paving at the two intersections.
- Install overhead signal heads that are clearly visible from all approaches at the two intersections.
- Add emergency vehicle preemption to the coordinated signal system.
- Consider removing or relocating the MBTA bus stop at the North Street intersection.[14]
- Integrate the design of bicycle lanes (dedicated or shared) in the functional design of the two intersections.
- Consider designating the entire section of Albemarle Road between Watertown Street and Charles River as a bicycle route.

As Crafts Street is designated as a bicycle route in the City's draft bicycle transportation plan, dedicated or shared bicycle lanes should be considered at the function design stage of improving the two intersections. At moment, it appears that the section between Fessenden Street and Albemarle Road has limited space for the shared lane option, as it has to accommodate turning lanes to North Street. However, bicycle lanes or five-foot wide shoulders could potentially be added to both sides of the section of Crafts Street west of Albemarle Road.[15] The addition will also narrow the existing wide traffic lanes and could help reduce vehicle speeds.

In addition, staff recommends designating Albemarle Road as a bicycle route in the City's bicycle transportation plan. Albemarle Road is a major connection for the City to the popular Charles River Bike Path. Albemarle Road also connects the proposed Crafts Street and Watertown Street bike routes. A previous study, Cheesecake Brook Greenway Master Plan (December 2009), proposed the installation of bicycle lanes adjacent to the creek on both approaches of Albemarle Road between Watertown Street and Crafts Street. The bicycle lanes could probably continue north of Crafts Street until the Charles River Bike Path, but they would probably have to change to share-the-road lanes north of Crafts Street. A transition between the bicycle lane at the intersection of North Street and sharrows can be attained by installing bicycle boxes on Albemarle Road at the intersection. Bicycle facility improvements should be considered at the functional design stage of the two intersections.

At this preliminary planning stage, the total cost of these long-term improvements is roughly estimated as about $1,000,000 to $1,250,000. Both streets and the intersections are under the jurisdiction of the City of Newton. The city can seek funding support from the state by working closely with MassDOT Highway District 6 through the project implementation process. See Appendix K for more information on the project implementation process.

SPA/CW/spa/cw

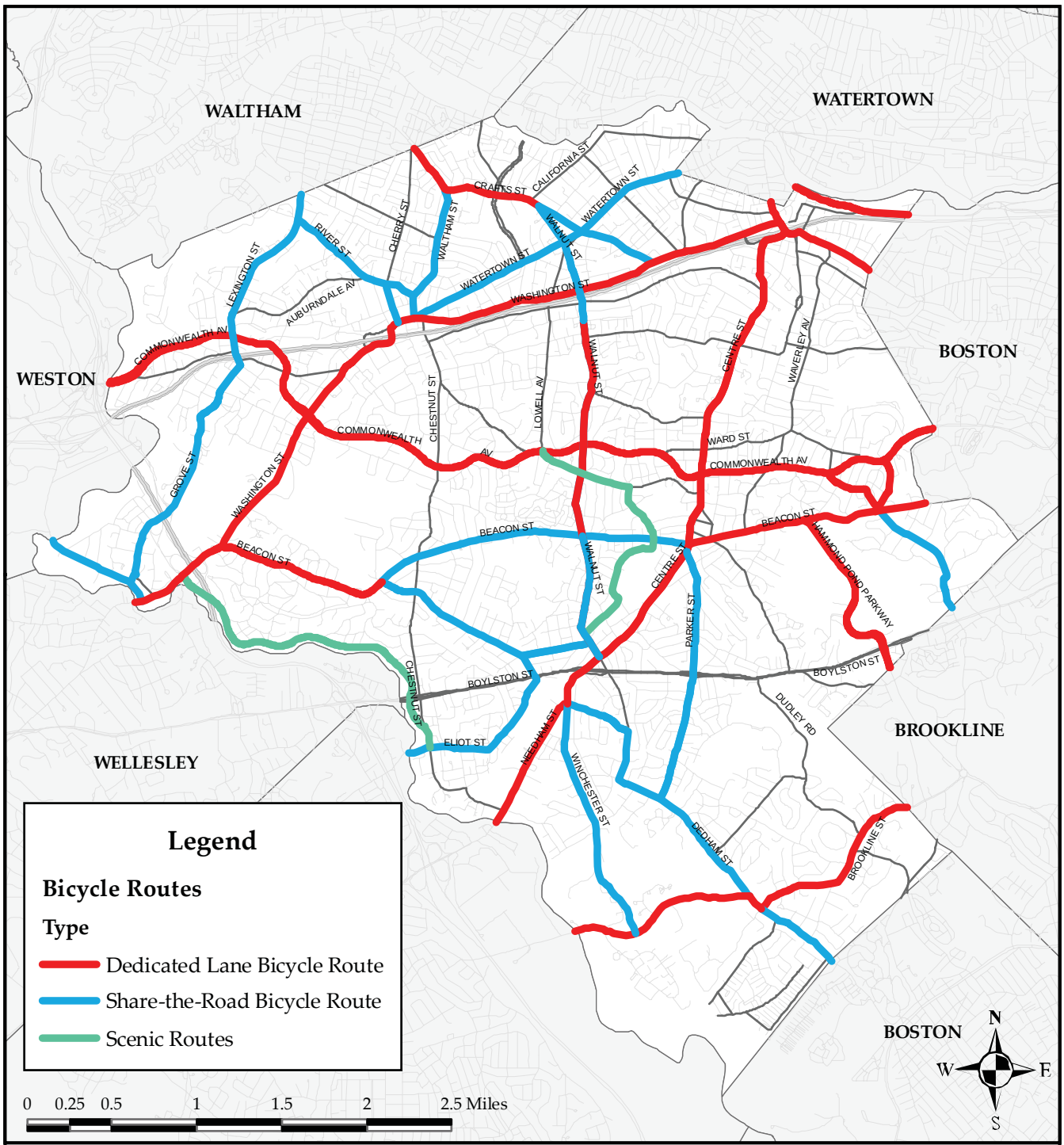
[14] This bus stop is located on the westbound right-turn lane at of the intersection. It sometimes causes traffic to back up during the peak periods. There is another bus stop about 300 feet father west, on westbound Crafts Street, before Albemarle Road. If the city decides to remove the stop in the right-turn lane, the other bus stop on westbound Crafts Street could remain in its current location or it could be moved closer to North Street. Another option is to relocate the bus stop from the right-turn lane to about 50 feet east of Fessenden Street.

[15] The MassDOT Roadway Inventory File indicates that the section of Crafts Street between Fessenden Street and Waltham Street has a right-of-way of 60 feet and a surface width of 40 feet.

# APPENDIX A

**City of Newton Transportation Advisory Committee's**
**Bicycle Routes Map**

**(from Their Draft Bicycle Transportation Plan, February 2, 2011)**




# Bicycle Routes (Transportation Advisory Committee)
# City of Newton, Massachusetts

SOURCE: City of Newton GIS

CITY OF NEWTON, MASSACHUSETTS
Mayor - Setti D. Warren
GIS Administrator - Douglas Greenfield

MAP DATE: January 13, 2011

# APPENDIX B

**Responses to the Boston Region MPO's Survey**
**on the Intersection of Crafts Street at Albemarle Road, Newton**

**Fall 2010**

# Newton Intersection Survey

## Albemarle Road/Crafts Street

**Responses:** 25

**Note:** 23 out of 25 respondents wrote a comment.

**Comments:**

“Crafts and Linwood and Crafts and Albemarle are both extremely dangerous because drivers fly down the roads. The light needs attention---never seem to work and there are lots of kids on one side of Crafts that need to get to school/pool/fields on the other side--thank you for your attention!”

“It is awful and needs to be addressed. There are so many near misses, illegal turns, added to the fact that the children are crossing to get to schools and fields. The crossing guard looks scared to step into the road!”

“It is a very difficult and dangerous intersection to get through, especially in times of high traffic.”

“Of the group listed above, this one has much confusion for drivers and pedestrians. There is a high traffic volume and public resources that pedestrians must cross Crafts Street to access.”

“It can be quite dangerous to cross here unless you are at the light, which is not the most convenient place to cross. Commuters, school kids for both Day and Horace Mann, and families walking to the Gath Pool all use this intersection. Having a safe crossing at California and Crafts would make a lot of sense.”

“I live 1/10 mile from it. Crafts St is very busy and crossing it on Albemarle or turning onto Crafts St. from Albemarle can be risky and take several minutes. In addition, there is a lot of foot traffic from FA Day, Horace Mann School, Fessenden School, and the recreation facilities on Albemarle.”

“This street is very heavily traveled and people often turn onto Crafts only to turn around to the other side of Albemarle. It is very dangerous.”

“This is a very busy interaction during morning and afternoon rush hours. Many children who go to Horace Man Elementary school and Day Middle school need to go through this intersection on foot or in cars. There are no traffic lights.”

“A lot of kids cross it to get to Day Middle School, Horace Mann Elementary School, the Gath Pool, sports activities at Albemarle playing fields, and the summer camps at those locations. In addition, cars from school and camp pick-ups and sports events pull out from Albemarle onto Crafts and are blinded by the line of cars backed up on Crafts from the North St. light. Many cars

speed down the hill past the Scandinavian home and Fessenden School (east on Crafts). Often they try to make a left lane as they go through the intersection with Albemarle in anticipation of a left turn at the light at North St. Cars pulling out of Albemarle Rd. onto Crafts can't see them coming. It's a recipe for disaster."

"This intersection is very dangerous as there is a confluence of factors:

1) Three school zones (two public one private)
2) A heavily used recreation area and pool with many children and adults
3) Heavy cut-through traffic from Waltham to the Pike
4) Heavy repair vehicle traffic from the NSTAR facility on Calvary Street in Waltham
5) Heavy pedestrian and bike traffic heading to the Charles River Pathway at the end of Albemarle Road

Newton has funded planning for a pedestrian/bike path following Cheesecake Brook to the Charles River Pathway at the end of Albemarle. However, there are no funds to implement the plan. If as a state we are going to encourage more biking and walking, safe pedestrian ways to bike trails like the Charles River Pathway are essential. With the poor crossing at Albemarle and Crafts, a major bikeway is cut off by a dangerous intersection from a heavily populated section of Newton."

"The traffic is heavy on Crafts and the light at the corner with North St causes traffic to back up. The visibility is bad with the fence there due to Cheesecake Brook and you must pull further onto Crafts than is safe to see."

"Complicated intersection. Difficult when school is in session -- kids crossing the road, traffic backs up from light."

"It is a major intersection around 3 schools. Every weekday, cars block the intersection so that cars that are on Albemarle looking to cross over Crafts to go to/from the schools & fields have to cross 1/2 of the road to await a "kind" driver who will let them in to cross the other 1/2. I have waited 5 minutes before to cross the street in one action! There are never police there to monitor the gridlock & most of the time, drivers are on cell phones & don't think twice about blocking the intersection. A light that works at school hours & rush hours might be useful."

"I see accidents there all the time. It's also hard for me to cross the street to get to the Charles River pathway where I go to ride my bike."

"I use it every day. Lots of kids use it to go to Horace Mann or Day or the fields and the pool."

"From the intersection of Albemarle/Crafts, California/Crafts, Walnut/Crafts and Linwood/Crafts and Linwood/Walnut are all problematic. The light at Albemarle causes the traffic to back up all the way to Linwood making it hard to turn onto Crafts from any side street. People take risks as a result. I will not try and make a left from California onto Crafts because it is too hazardous. I avoid it by using Linwood. Because of the Day Middle School and the size of both Walnut and Crafts feeding into Crafts and Albemarle, the traffic is very heavy. Whatever is done, all of these intersections need to be dealt with together."

“Lived on/around Albemarle Road for 37 years (went to grade school at Horace Mann, Day Jr. High, NNHS while living on Albemarle Road and later bought a house two streets away). I take my two kids to Horace Mann in the morning and pick them up every day having to negotiate a way to cross through Washington Street to get out of the jam. Cars are always racing through trying to hit the lights (which makes this a very scary place for kids to cross to get to school or even the park during the day. There was a minor improvement with not allowing someone to take a left down Albemarle Road, but what makes it so complicated is that you have cars coming and going in multiple directions, which makes this headache for everyone involved. A new and safe system needs to be implemented that keep in mind that these dangerous intersections have two big schools in its perimeter.”

“Extremely poor visibility on either side of Albemarle turning on to Crafts. Need to edge out into traffic in order for you to see cars coming. Moreover, since it's metro Boston, no one -- I mean NO ONE -- will ever stop and let you go unless you edge out. The solution? A traffic light.”

“At peak times and despite the recent changes made to the traffic flow, it is a hazard to pedestrians (children walking to school especially) and difficult to figure out the wrong way intersections if you are not familiar with the area. Many times cars are in the wrong turning lanes making illegal turns.”

“Vehicular accidents are routine here. Vehicle/pedestrian incidents have been infrequent, but the high concentration of schoolchildren and recreational users mean such accidents will necessarily be very serious. The city has taken small steps to improve safety over the years, but the head of DPW has been adamant in his refusal to implement a plan for improved pedestrian and recreational access. This plan was paid for with CPA funding, developed by DPW, and promptly forgotten. In a meeting with the head of DPW earlier this year, it was clear that he was completely unfamiliar with his department's plan, and had no interest in hearing community concerns, and was unwilling to use ANY resources to improve safety in the area.”

“There are three schools off Albemarle, which causes serious safety and traffic issues at the intersection.”

“I live nearby and the backups here in the morning are horrible. Then there is the fact that it's near multiple schools, PLUS it's a main route to the MDC biking trail. This should be a safe place for kids to cross, but it's not.”

“Despite all the effort to make improvements by limiting options and reducing lanes this is one of the worst intersection around, mostly because of rude driver behavior. When drivers are courteous, things go okay but this is a rarity. I use this intersection every day, throw in a soccer game at Albemarle or school release time and you have mayhem. It would mean more driving for me but I see forced turns and prohibition of crossing traffic as only way short of a traffic light.”

# APPENDIX C

**Calculation of Crash Rate for Both Intersections:**

**Crafts Street at Albemarle Road, Newton**
**and**
**Crafts Street at North Street, Newton**

**June 2, 2011**

# INTERSECTION CRASH RATE WORKSHEET

CITY/TOWN : Newton COUNT DATE : 06/02/11

DISTRICT : 6 UNSIGNALIZED : X SIGNALIZED :

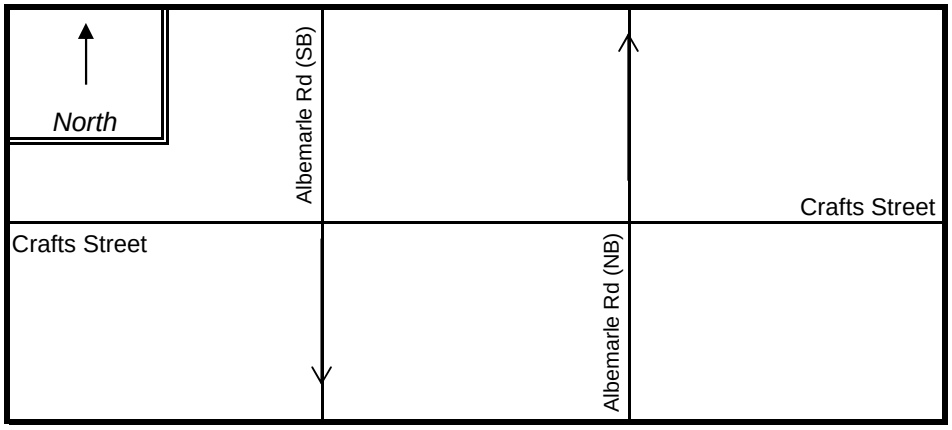
**~ INTERSECTION DATA ~**

MAJOR STREET : Crafts Street

MINOR STREET(S) : Albemarle Road (SB): One-way to Watertown Street

Albemarle Road (NB): One-way to North Street

**INTERSECTION DIAGRAM (Label Approaches)**




**PEAK HOUR VOLUMES**

| APPROACH : | 1 | 2 | 3 | 4 | 5 | Total Peak Hourly Approach Volume |
|---|---|---|---|---|---|---|
| DIRECTION : | EB | WB | NB | SB | | |
| PEAK HOURLY VOLUMES (AM/**PM**) : | 732 | 739 | 232 | 313 | | **2,016** |

" K " FACTOR : **0.090** INTERSECTION ADT ( **V** ) = TOTAL DAILY APPROACH VOLUME : **22,400**

TOTAL # OF CRASHES : 26 # OF YEARS : 3 AVERAGE # OF CRASHES PER YEAR ( **A** ) : **8.67**

**CRASH RATE CALCULATION :** **1.060** RATE = $\frac{(A * 1{,}000{,}000)}{(V * 365)}$

Comments : MassDOT District 6 Average Rate = 0.57 (July 7, 2011)

Project Title & Date: Safety and Operations Analyses at Selected Intersections

# INTERSECTION CRASH RATE WORKSHEET

CITY/TOWN : Newton | COUNT DATE : 06/02/11

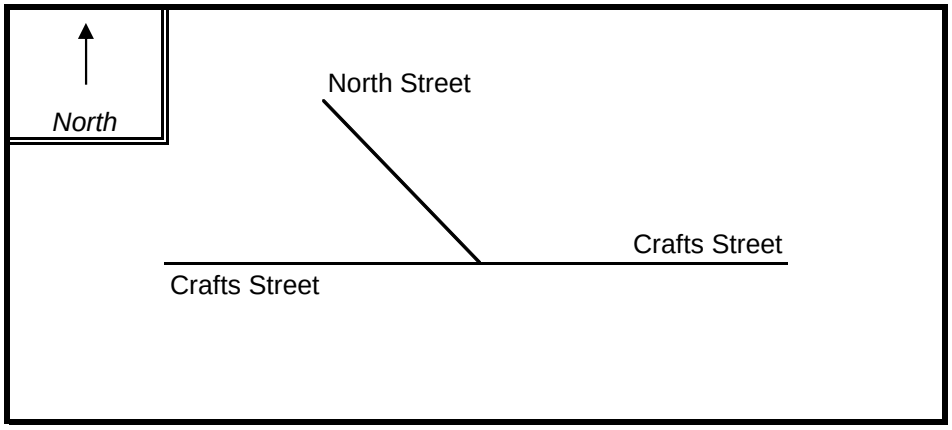
DISTRICT : 6 | UNSIGNALIZED : | SIGNALIZED : X

**~ INTERSECTION DATA ~**

MAJOR STREET : Crafts Street

MINOR STREET(S) : North Street

**INTERSECTION DIAGRAM (Label Approaches)**




**PEAK HOUR VOLUMES**

| APPROACH : | 1 | 2 | 3 | 4 | 5 | Total Peak Hourly Approach Volume |
|---|---|---|---|---|---|---|
| DIRECTION : | EB | WB | SB | | | |
| PEAK HOURLY VOLUMES (AM/**PM**) : | 809 | 1,052 | 433 | | | **2,294** |

" K " FACTOR : **0.090**

INTERSECTION ADT ( **V** ) = TOTAL DAILY APPROACH VOLUME : **25,489**

TOTAL # OF CRASHES : 9

# OF YEARS : 3

AVERAGE # OF CRASHES PER YEAR ( **A** ) : **3.00**

**CRASH RATE CALCULATION :** **0.322**

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

Comments : MassDOT District 6 Average Rate = 0.77 (July 7, 2011)

Project Title & Date: Safety and Operations Analyses at Selected Intersections

# APPENDIX D

**Collision Diagrams for Both Intersections:**

**Crafts Street at Albemarle Road, Newton**
**and**
**Crafts Street at North Street, Newton**

**November 30, 2011**

# COLLISION DIAGRAM

CITY/TOWN : NEWTON

DATE PREPARED: 11/30/11

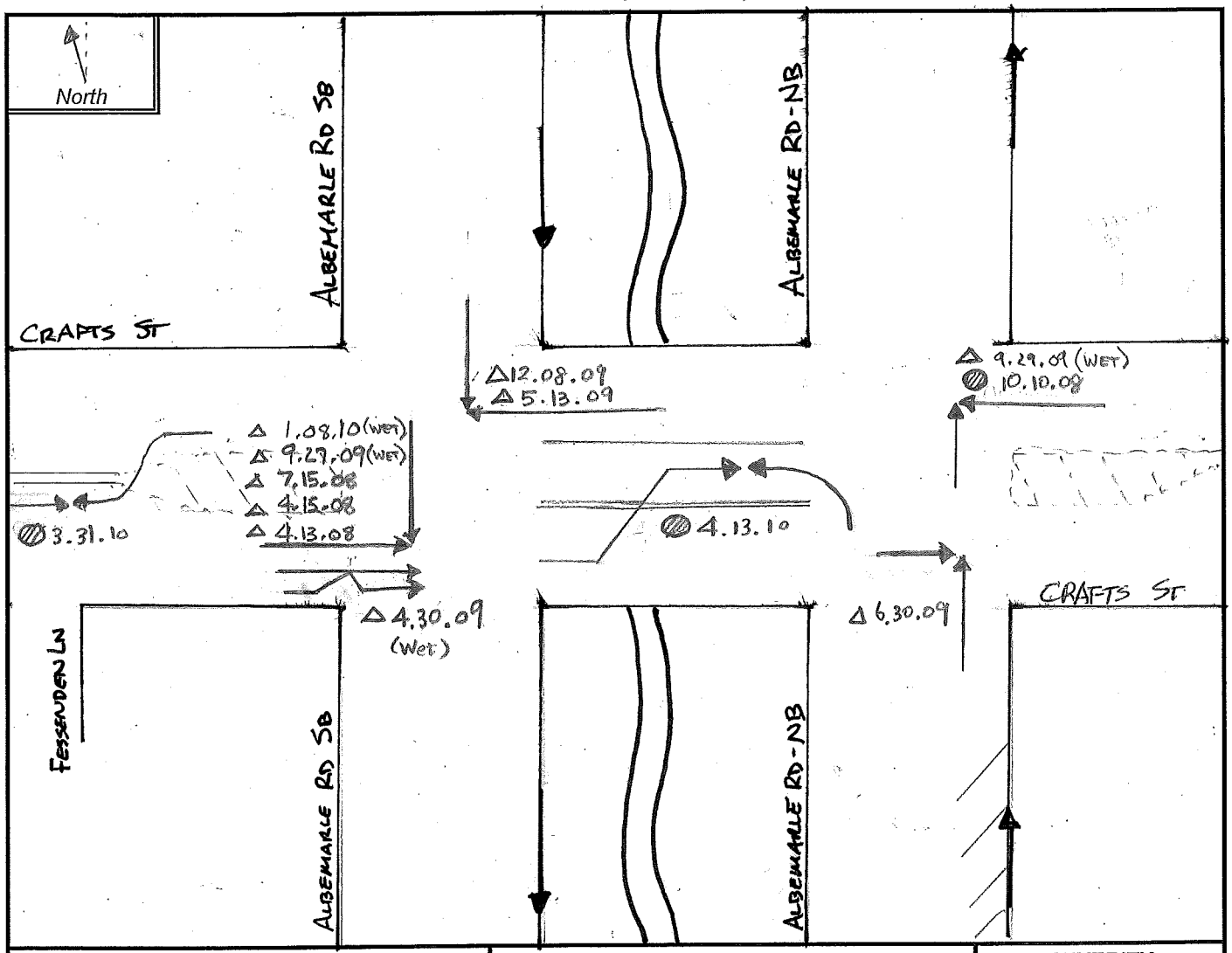
REGION: 6

PREPARED BY: STEVEN ANDREWS (CTPS)

ROADWAY NAMES: CRAFTS ST (MAJOR) AT ALBEMARLE RD (MINOR)

TIME PERIOD ANALYZED: 2008 - 2010

SOURCE OF CRASH REPORTS: NEWTON POLICE DEPT.

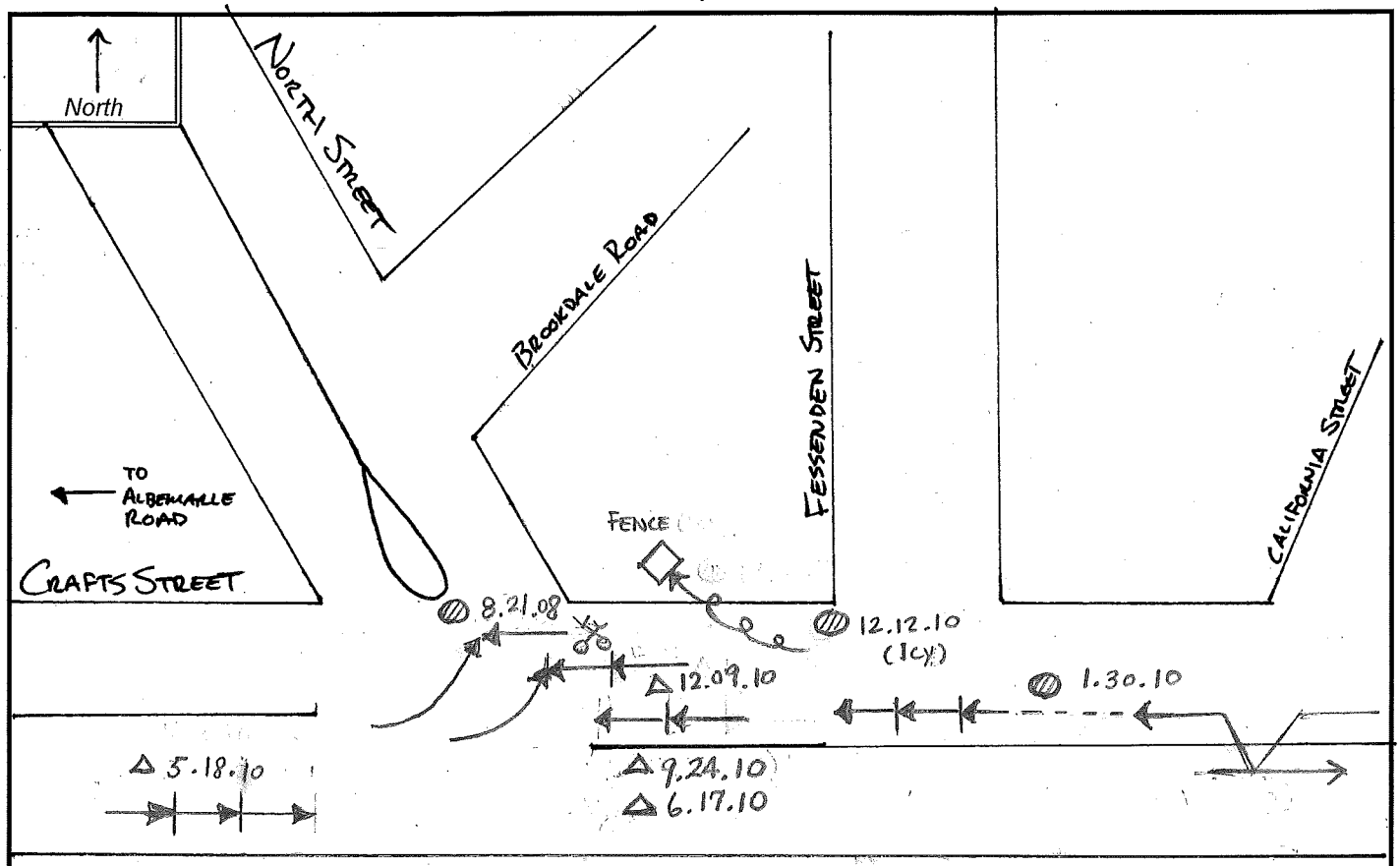



| SYMBOLS | TYPES OF CRASH | SEVERITY |
|---|---|---|
| Moving Vehicle | Head On | Property Damage Only |
| Backing Vehicle | Angle | |
| Non-Involved Vehicle | | Injury Accident |
| Pedestrian | Turning Move | |
| Parked Vehicle | Rear End | Fatal Accident |
| Fixed Object | Sideswipe | DATE |
| Bicycle | Out of Control | Month. Day. Year |
| Animal | | |

massDOT
Massachusetts Department of Transportation
Highway Division

# COLLISION DIAGRAM

CITY/TOWN : NEWTON
DATE PREPARED: 12/1/11
REGION: 6
PREPARED BY: STEVEN ANDREWS GPS
ROADWAY NAMES: CRAFTS STREET AT NORTH STREET
TIME PERIOD ANALYZED: 2008 – 10
SOURCE OF CRASH REPORTS: NEWTON POLICE DEPT




| SYMBOLS | | TYPES OF CRASH | | SEVERITY |
|---|---|---|---|---|
| → | Moving Vehicle | → ← | Head On | △ Property Damage Only |
| →→→ | Backing Vehicle | → ↘ ← | Angle | ◍ Injury Accident |
| - - - - → | Non-Involved Vehicle | ↓ ← | Turning Move | |
| → 🚶 | Pedestrian | → → | Rear End | ● Fatal Accident |
| → ▭ | Parked Vehicle | → ⟍ ⟋ → | Sideswipe | DATE |
| → □ | Fixed Object | ~ → | Out of Control | Month . Day . Year |
| → 🚲 | Bicycle | | | |
| → 🐾 | Animal | | | |

# APPENDIX E

**Existing Conditions**

**AM/PM Peak-Hour Intersection Capacity Analysis for Both Intersections:**

**Crafts Street at North Street, Newton (Signalized)**
**and**
**Crafts Street at Albemarle Road, Newton (Stop-Controlled)**

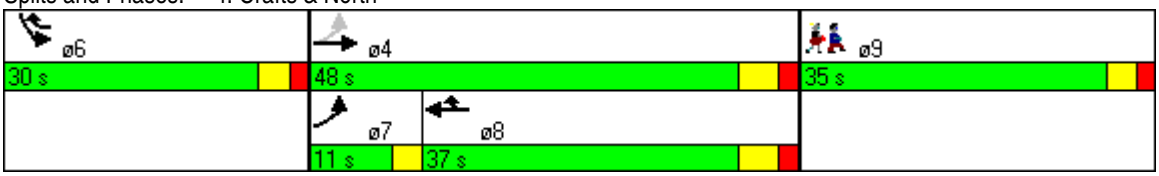
| Lane Group | EBL | EBT | WBT | WBR | SBL | ø9 |
|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | |
| Volume (vph) | 108 | 741 | 573 | 280 | 363 | |
| Lane Group Flow (vph) | 115 | 788 | 610 | 298 | 418 | |
| Turn Type | pm+pt | | | pt+ov | | |
| Protected Phases | 7 | 4 | 8 | 6 8 | 6 | 9 |
| Permitted Phases | 4 | | | | | |
| Detector Phase | 7 | 4 | 8 | 6 8 | 6 | |
| Switch Phase | | | | | | |
| Minimum Initial (s) | 4.0 | 8.0 | 8.0 | | 8.0 | 4.0 |
| Minimum Split (s) | 11.0 | 14.0 | 14.0 | | 14.0 | 35.0 |
| Total Split (s) | 11.0 | 48.0 | 37.0 | 67.0 | 30.0 | 35.0 |
| Total Split (%) | 9.7% | 42.5% | 32.7% | 59.3% | 26.5% | 31% |
| Yellow Time (s) | 3.0 | 4.0 | 4.0 | | 3.0 | 3.0 |
| All-Red Time (s) | 0.0 | 2.0 | 2.0 | | 2.0 | 2.0 |
| Lost Time Adjust (s) | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | |
| Total Lost Time (s) | 3.0 | 6.0 | 6.0 | 5.0 | 5.0 | |
| Lead/Lag | Lead | | Lag | | | |
| Lead-Lag Optimize? | | | | | | |
| Recall Mode | Max | Max | Max | | None | None |
| Act Effct Green (s) | 46.5 | 43.4 | 32.1 | 61.3 | 25.7 | |
| Actuated g/C Ratio | 0.47 | 0.44 | 0.32 | 0.62 | 0.26 | |
| v/c Ratio | 0.54 | 1.01 | 1.07 | 0.32 | 0.85 | |
| Control Delay | 30.6 | 67.8 | 94.8 | 9.3 | 55.5 | |
| Queue Delay | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | |
| Total Delay | 30.6 | 67.8 | 94.8 | 9.3 | 55.5 | |
| LOS | C | E | F | A | E | |
| Approach Delay | | 63.1 | 66.7 | | 55.5 | |
| Approach LOS | | E | E | | E | |
| Queue Length 50th (ft) | 53 | ~696 | ~560 | 88 | 305 | |
| Queue Length 95th (ft) | #108 | #932 | #780 | 134 | #510 | |
| Internal Link Dist (ft) | | 282 | 1100 | | 528 | |
| Turn Bay Length (ft) | 110 | | | | | |
| Base Capacity (vph) | 212 | 777 | 568 | 948 | 496 | |
| Starvation Cap Reductn | 0 | 0 | 0 | 0 | 0 | |
| Spillback Cap Reductn | 0 | 0 | 0 | 0 | 0 | |
| Storage Cap Reductn | 0 | 0 | 0 | 0 | 0 | |
| Reduced v/c Ratio | 0.54 | 1.01 | 1.07 | 0.31 | 0.84 | |

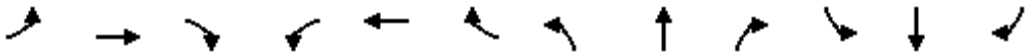
| Intersection Summary | |
|---|---|
| Cycle Length: 113 | |
| Actuated Cycle Length: 98.9 | |
| Natural Cycle: 130 | |
| Control Type: Semi Act-Uncoord | |
| Maximum v/c Ratio: 1.07 | |
| Intersection Signal Delay: 63.1 | Intersection LOS: E |
| Intersection Capacity Utilization 69.8% | ICU Level of Service C |
| Analysis Period (min) 15 | |

~ Volume exceeds capacity, queue is theoretically infinite.
Queue shown is maximum after two cycles.

# 95th percentile volume exceeds capacity, queue may be longer.
Queue shown is maximum after two cycles.

Splits and Phases: 4: Crafts & North

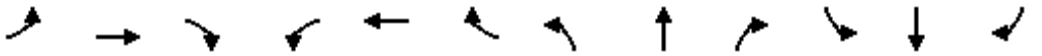




| Movement | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Volume (veh/h) | 2 | 679 | 0 | 0 | 512 | 1 | 56 | 51 | 85 | 0 | 0 | 0 |
| Sign Control | | Free | | | Free | | | Stop | | | Stop | |
| Grade | | 0% | | | 0% | | | 0% | | | 0% | |
| Peak Hour Factor | 0.94 | 0.94 | 0.94 | 0.94 | 0.94 | 0.94 | 0.80 | 0.80 | 0.80 | 0.92 | 0.92 | 0.92 |
| Hourly flow rate (vph) | 2 | 722 | 0 | 0 | 545 | 1 | 70 | 64 | 106 | 0 | 0 | 0 |
| Pedestrians | | 1 | | | 1 | | | 14 | | | 3 | |
| Lane Width (ft) | | 16.0 | | | 16.0 | | | 12.0 | | | 0.0 | |
| Walking Speed (ft/s) | | 4.0 | | | 4.0 | | | 4.0 | | | 4.0 | |
| Percent Blockage | | 0 | | | 0 | | | 1 | | | 0 | |
| Right turn flare (veh) | | | | | | | | | 1 | | | |
| Median type | | None | | | None | | | | | | | |
| Median storage veh) | | | | | | | | | | | | |
| Upstream signal (ft) | | | | | 362 | | | | | | | |
| pX, platoon unblocked | 0.70 | | | | | | 0.70 | 0.70 | | 0.70 | 0.70 | 0.70 |
| vC, conflicting volume | 549 | | | 736 | | | 1287 | 1289 | 737 | 1361 | 1289 | 549 |
| vC1, stage 1 conf vol | | | | | | | | | | | | |
| vC2, stage 2 conf vol | | | | | | | | | | | | |
| vCu, unblocked vol | 132 | | | 736 | | | 1194 | 1197 | 737 | 1300 | 1196 | 133 |
| tC, single (s) | 4.1 | | | 4.1 | | | 7.1 | 6.5 | 6.3 | 7.1 | 6.5 | 6.2 |
| tC, 2 stage (s) | | | | | | | | | | | | |
| tF (s) | 2.2 | | | 2.2 | | | 3.5 | 4.0 | 3.4 | 3.5 | 4.0 | 3.3 |
| p0 queue free % | 100 | | | 100 | | | 36 | 50 | 74 | 100 | 100 | 100 |
| cM capacity (veh/h) | 1019 | | | 868 | | | 110 | 127 | 405 | 43 | 129 | 640 |

| Direction, Lane # | EB 1 | WB 1 | NB 1 |
|---|---|---|---|
| Volume Total | 724 | 546 | 240 |
| Volume Left | 2 | 0 | 70 |
| Volume Right | 0 | 1 | 106 |
| cSH | 1019 | 1700 | 177 |
| Volume to Capacity | 0.00 | 0.32 | 1.36 |
| Queue Length 95th (ft) | 0 | 0 | 356 |
| Control Delay (s) | 0.1 | 0.0 | 243.5 |
| Lane LOS | A | | F |
| Approach Delay (s) | 0.1 | 0.0 | 243.5 |
| Approach LOS | | | F |

| Intersection Summary | | | |
|---|---|---|---|
| Average Delay | 38.7 | | |
| Intersection Capacity Utilization | 56.5% | ICU Level of Service | B |
| Analysis Period (min) | 15 | | |



| Movement | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Volume (veh/h) | 0 | 681 | 45 | 50 | 462 | 0 | 0 | 0 | 0 | 5 | 79 | 134 |
| Sign Control | | Free | | | Free | | | Stop | | | Stop | |
| Grade | | 0% | | | 0% | | | 0% | | | 0% | |
| Peak Hour Factor | 0.94 | 0.94 | 0.94 | 0.94 | 0.94 | 0.94 | 0.92 | 0.92 | 0.92 | 0.86 | 0.86 | 0.86 |
| Hourly flow rate (vph) | 0 | 724 | 48 | 53 | 491 | 0 | 0 | 0 | 0 | 6 | 92 | 156 |
| Pedestrians | | | | | | | | | | | | |
| Lane Width (ft) | | | | | | | | | | | | |
| Walking Speed (ft/s) | | | | | | | | | | | | |
| Percent Blockage | | | | | | | | | | | | |
| Right turn flare (veh) | | | | | | | | | | | | 1 |
| Median type | | None | | | None | | | | | | | |
| Median storage veh) | | | | | | | | | | | | |
| Upstream signal (ft) | | | | | 451 | | | | | | | |
| pX, platoon unblocked | 0.73 | | | | | | 0.73 | 0.73 | | 0.73 | 0.73 | 0.73 |
| vC, conflicting volume | 491 | | | 772 | | | 1470 | 1346 | 748 | 1346 | 1370 | 491 |
| vC1, stage 1 conf vol | | | | | | | | | | | | |
| vC2, stage 2 conf vol | | | | | | | | | | | | |
| vCu, unblocked vol | 113 | | | 772 | | | 1459 | 1289 | 748 | 1289 | 1322 | 113 |
| tC, single (s) | 4.1 | | | 4.1 | | | 7.1 | 6.5 | 6.2 | 7.1 | 6.5 | 6.3 |
| tC, 2 stage (s) | | | | | | | | | | | | |
| tF (s) | 2.2 | | | 2.2 | | | 3.5 | 4.0 | 3.3 | 3.5 | 4.0 | 3.4 |
| p0 queue free % | 100 | | | 94 | | | 100 | 100 | 100 | 94 | 14 | 77 |
| cM capacity (veh/h) | 1083 | | | 852 | | | 15 | 113 | 415 | 98 | 106 | 664 |

| Direction, Lane # | EB 1 | WB 1 | WB 2 | SB 1 |
|---|---|---|---|---|
| Volume Total | 772 | 53 | 491 | 253 |
| Volume Left | 0 | 53 | 0 | 6 |
| Volume Right | 48 | 0 | 0 | 156 |
| cSH | 1700 | 852 | 1700 | 230 |
| Volume to Capacity | 0.45 | 0.06 | 0.29 | 1.10 |
| Queue Length 95th (ft) | 0 | 5 | 0 | 283 |
| Control Delay (s) | 0.0 | 9.5 | 0.0 | 134.9 |
| Lane LOS | | A | | F |
| Approach Delay (s) | 0.0 | 0.9 | | 134.9 |
| Approach LOS | | | | F |

| Intersection Summary | | | |
|---|---|---|---|
| Average Delay | 22.1 | | |
| Intersection Capacity Utilization | 52.7% | ICU Level of Service | A |
| Analysis Period (min) | 15 | | |

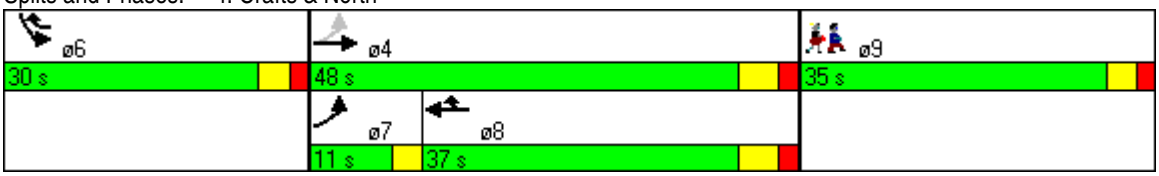
| Lane Group | EBL | EBT | WBT | WBR | SBL | ø9 |
|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | |
| Volume (vph) | 207 | 602 | 733 | 319 | 393 | |
| Lane Group Flow (vph) | 218 | 634 | 814 | 354 | 456 | |
| Turn Type | pm+pt | | | pt+ov | | |
| Protected Phases | 7 | 4 | 8 | 6 8 | 6 | 9 |
| Permitted Phases | 4 | | | | | |
| Detector Phase | 7 | 4 | 8 | 6 8 | 6 | |
| Switch Phase | | | | | | |
| Minimum Initial (s) | 4.0 | 8.0 | 8.0 | | 8.0 | 4.0 |
| Minimum Split (s) | 11.0 | 14.0 | 14.0 | | 14.0 | 35.0 |
| Total Split (s) | 11.0 | 48.0 | 37.0 | 67.0 | 30.0 | 35.0 |
| Total Split (%) | 9.7% | 42.5% | 32.7% | 59.3% | 26.5% | 31% |
| Yellow Time (s) | 3.0 | 4.0 | 4.0 | | 3.0 | 3.0 |
| All-Red Time (s) | 0.0 | 2.0 | 2.0 | | 2.0 | 2.0 |
| Lost Time Adjust (s) | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | |
| Total Lost Time (s) | 3.0 | 6.0 | 6.0 | 5.0 | 5.0 | |
| Lead/Lag | Lead | | Lag | | | |
| Lead-Lag Optimize? | | | | | | |
| Recall Mode | Max | Max | Max | | None | None |
| Act Effct Green (s) | 46.5 | 43.4 | 32.0 | 62.4 | 25.8 | |
| Actuated g/C Ratio | 0.51 | 0.47 | 0.35 | 0.68 | 0.28 | |
| v/c Ratio | 0.91 | 0.75 | 1.31 | 0.33 | 0.81 | |
| Control Delay | 63.3 | 31.2 | 178.4 | 7.8 | 47.2 | |
| Queue Delay | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | |
| Total Delay | 63.3 | 31.2 | 178.4 | 7.8 | 47.2 | |
| LOS | E | C | F | A | D | |
| Approach Delay | | 39.4 | 126.7 | | 47.2 | |
| Approach LOS | | D | F | | D | |
| Queue Length 50th (ft) | 51 | 205 | ~472 | 32 | 193 | |
| Queue Length 95th (ft) | #293 | #680 | #1100 | 162 | #557 | |
| Internal Link Dist (ft) | | 282 | 1100 | | 528 | |
| Turn Bay Length (ft) | 110 | | | | | |
| Base Capacity (vph) | 239 | 843 | 622 | 1064 | 561 | |
| Starvation Cap Reductn | 0 | 0 | 0 | 0 | 0 | |
| Spillback Cap Reductn | 0 | 0 | 0 | 0 | 0 | |
| Storage Cap Reductn | 0 | 0 | 0 | 0 | 0 | |
| Reduced v/c Ratio | 0.91 | 0.75 | 1.31 | 0.33 | 0.81 | |

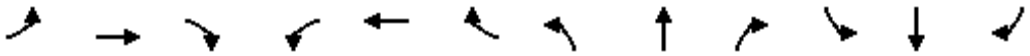
## Intersection Summary

Cycle Length: 113
Actuated Cycle Length: 92
Natural Cycle: 150
Control Type: Semi Act-Uncoord
Maximum v/c Ratio: 1.31
Intersection Signal Delay: 82.0 Intersection LOS: F
Intersection Capacity Utilization 86.9% ICU Level of Service E
Analysis Period (min) 15
~ Volume exceeds capacity, queue is theoretically infinite.
Queue shown is maximum after two cycles.

# 95th percentile volume exceeds capacity, queue may be longer.
Queue shown is maximum after two cycles.

Splits and Phases: 4: Crafts & North

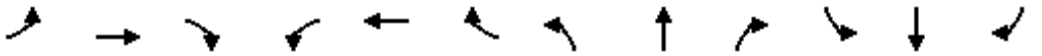




| Movement | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Volume (veh/h) | 2 | 702 | 0 | 0 | 731 | 1 | 61 | 83 | 88 | 0 | 0 | 0 |
| Sign Control | | Free | | | Free | | | Stop | | | Stop | |
| Grade | | 0% | | | 0% | | | 0% | | | 0% | |
| Peak Hour Factor | 0.94 | 0.94 | 0.94 | 0.92 | 0.92 | 0.92 | 0.87 | 0.87 | 0.87 | 0.92 | 0.92 | 0.92 |
| Hourly flow rate (vph) | 2 | 747 | 0 | 0 | 795 | 1 | 70 | 95 | 101 | 0 | 0 | 0 |
| Pedestrians | | 1 | | | 8 | | | 9 | | | 11 | |
| Lane Width (ft) | | 16.0 | | | 16.0 | | | 12.0 | | | 0.0 | |
| Walking Speed (ft/s) | | 4.0 | | | 4.0 | | | 4.0 | | | 4.0 | |
| Percent Blockage | | 0 | | | 1 | | | 1 | | | 0 | |
| Right turn flare (veh) | | | | | | | | | 1 | | | |
| Median type | | None | | | None | | | | | | | |
| Median storage veh) | | | | | | | | | | | | |
| Upstream signal (ft) | | | | | 362 | | | | | | | |
| pX, platoon unblocked | 0.67 | | | | | | 0.67 | 0.67 | | 0.67 | 0.67 | 0.67 |
| vC, conflicting volume | 807 | | | 756 | | | 1556 | 1567 | 764 | 1663 | 1566 | 807 |
| vC1, stage 1 conf vol | | | | | | | | | | | | |
| vC2, stage 2 conf vol | | | | | | | | | | | | |
| vCu, unblocked vol | 466 | | | 756 | | | 1584 | 1599 | 764 | 1744 | 1599 | 467 |
| tC, single (s) | 4.1 | | | 4.1 | | | 7.1 | 6.5 | 6.2 | 7.1 | 6.5 | 6.2 |
| tC, 2 stage (s) | | | | | | | | | | | | |
| tF (s) | 2.2 | | | 2.2 | | | 3.5 | 4.0 | 3.3 | 3.5 | 4.0 | 3.3 |
| p0 queue free % | 100 | | | 100 | | | 0 | 0 | 75 | 0 | 100 | 100 |
| cM capacity (veh/h) | 742 | | | 857 | | | 58 | 71 | 400 | 0 | 71 | 402 |

| Direction, Lane # | EB 1 | WB 1 | NB 1 |
|---|---|---|---|
| Volume Total | 749 | 796 | 267 |
| Volume Left | 2 | 0 | 70 |
| Volume Right | 0 | 1 | 101 |
| cSH | 742 | 1700 | 95 |
| Volume to Capacity | 0.00 | 0.47 | 2.80 |
| Queue Length 95th (ft) | 0 | 0 | 635 |
| Control Delay (s) | 0.1 | 0.0 | 909.4 |
| Lane LOS | A | | F |
| Approach Delay (s) | 0.1 | 0.0 | 909.4 |
| Approach LOS | | | F |

| Intersection Summary | | | |
|---|---|---|---|
| Average Delay | 133.9 | | |
| Intersection Capacity Utilization | 59.6% | ICU Level of Service | B |
| Analysis Period (min) | 15 | | |



| Movement | EBL | EBT | EBR | WBL | WBT | WBR | NBL | NBT | NBR | SBL | SBT | SBR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | | | | | | | |
| Volume (veh/h) | 0 | 704 | 35 | 82 | 649 | 0 | 0 | 0 | 0 | 11 | 61 | 241 |
| Sign Control | | Free | | | Free | | | Stop | | | Stop | |
| Grade | | 0% | | | 0% | | | 0% | | | 0% | |
| Peak Hour Factor | 0.94 | 0.94 | 0.94 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.92 | 0.90 | 0.90 | 0.90 |
| Hourly flow rate (vph) | 0 | 749 | 37 | 89 | 705 | 0 | 0 | 0 | 0 | 12 | 68 | 268 |
| Pedestrians | | 1 | | | 8 | | | 9 | | | 11 | |
| Lane Width (ft) | | 14.0 | | | 14.0 | | | 0.0 | | | 12.0 | |
| Walking Speed (ft/s) | | 4.0 | | | 4.0 | | | 4.0 | | | 4.0 | |
| Percent Blockage | | 0 | | | 1 | | | 0 | | | 1 | |
| Right turn flare (veh) | | | | | | | | | | | | 1 |
| Median type | | None | | | None | | | | | | | |
| Median storage veh) | | | | | | | | | | | | |
| Upstream signal (ft) | | | | | 451 | | | | | | | |
| pX, platoon unblocked | 0.67 | | | | | | 0.67 | 0.67 | | 0.67 | 0.67 | 0.67 |
| vC, conflicting volume | 716 | | | 795 | | | 1829 | 1671 | 785 | 1670 | 1690 | 717 |
| vC1, stage 1 conf vol | | | | | | | | | | | | |
| vC2, stage 2 conf vol | | | | | | | | | | | | |
| vCu, unblocked vol | 335 | | | 795 | | | 1989 | 1755 | 785 | 1753 | 1782 | 336 |
| tC, single (s) | 4.1 | | | 4.1 | | | 7.1 | 6.5 | 6.2 | 7.1 | 6.5 | 6.2 |
| tC, 2 stage (s) | | | | | | | | | | | | |
| tF (s) | 2.2 | | | 2.2 | | | 3.5 | 4.0 | 3.3 | 3.5 | 4.0 | 3.3 |
| p0 queue free % | 100 | | | 89 | | | 0 | 100 | 100 | 70 | 0 | 43 |
| cM capacity (veh/h) | 823 | | | 831 | | | 0 | 51 | 393 | 41 | 49 | 471 |

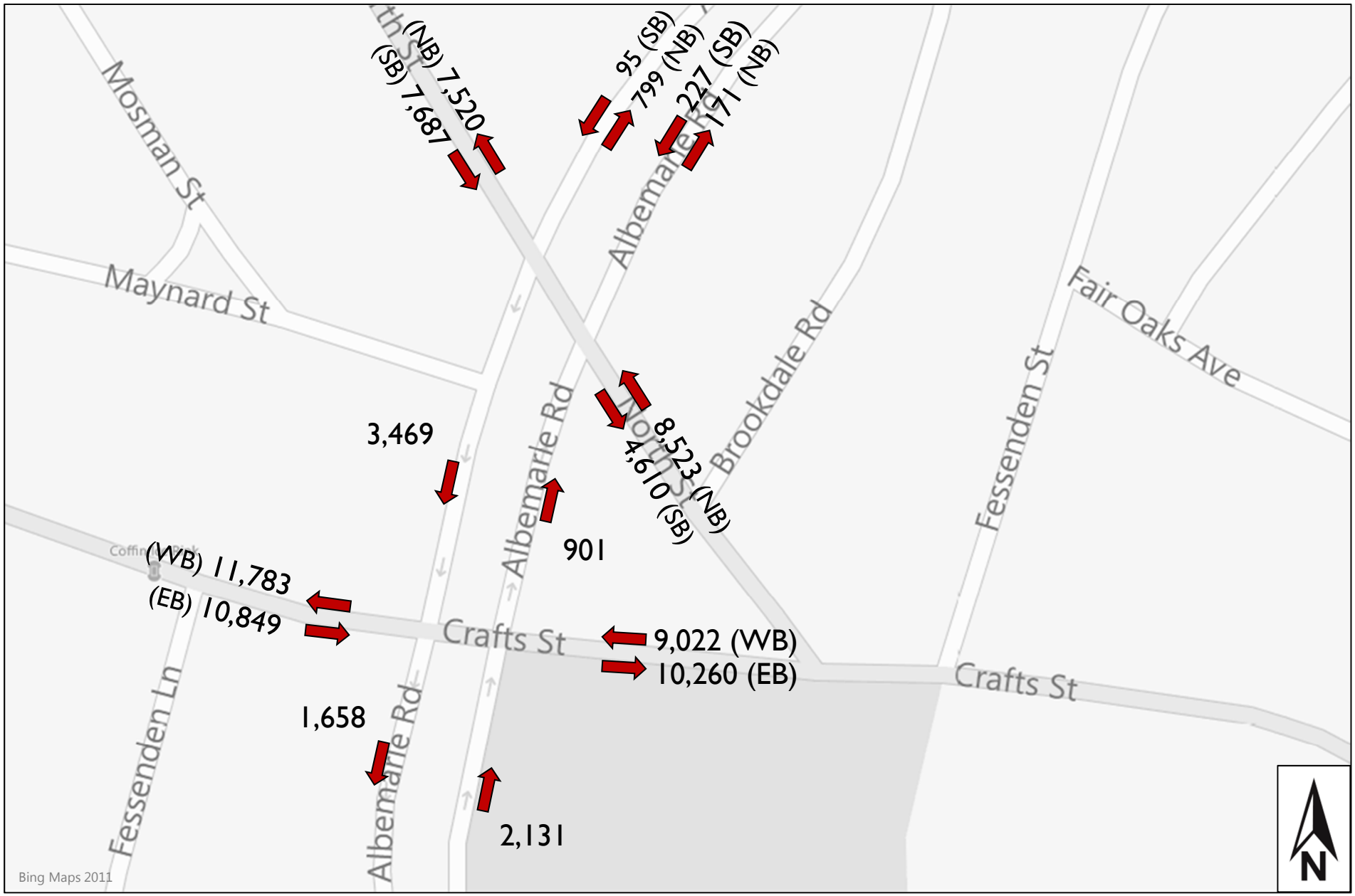
| Direction, Lane # | EB 1 | WB 1 | WB 2 | SB 1 |
|---|---|---|---|---|
| Volume Total | 786 | 89 | 705 | 348 |
| Volume Left | 0 | 89 | 0 | 12 |
| Volume Right | 37 | 0 | 0 | 268 |
| cSH | 1700 | 831 | 1700 | 159 |
| Volume to Capacity | 0.46 | 0.11 | 0.41 | 2.18 |
| Queue Length 95th (ft) | 0 | 9 | 0 | 704 |
| Control Delay (s) | 0.0 | 9.9 | 0.0 | 598.5 |
| Lane LOS | | A | | F |
| Approach Delay (s) | 0.0 | 1.1 | | 598.5 |
| Approach LOS | | | | F |

| Intersection Summary | | | |
|---|---|---|---|
| Average Delay | 108.4 | | |
| Intersection Capacity Utilization | 57.9% | ICU Level of Service | B |
| Analysis Period (min) | 15 | | |

# APPENDIX F

**Average Daily Traffic (ADT) and Average AM/PM Peak-Hour Traffic of the Study Area Roadways**

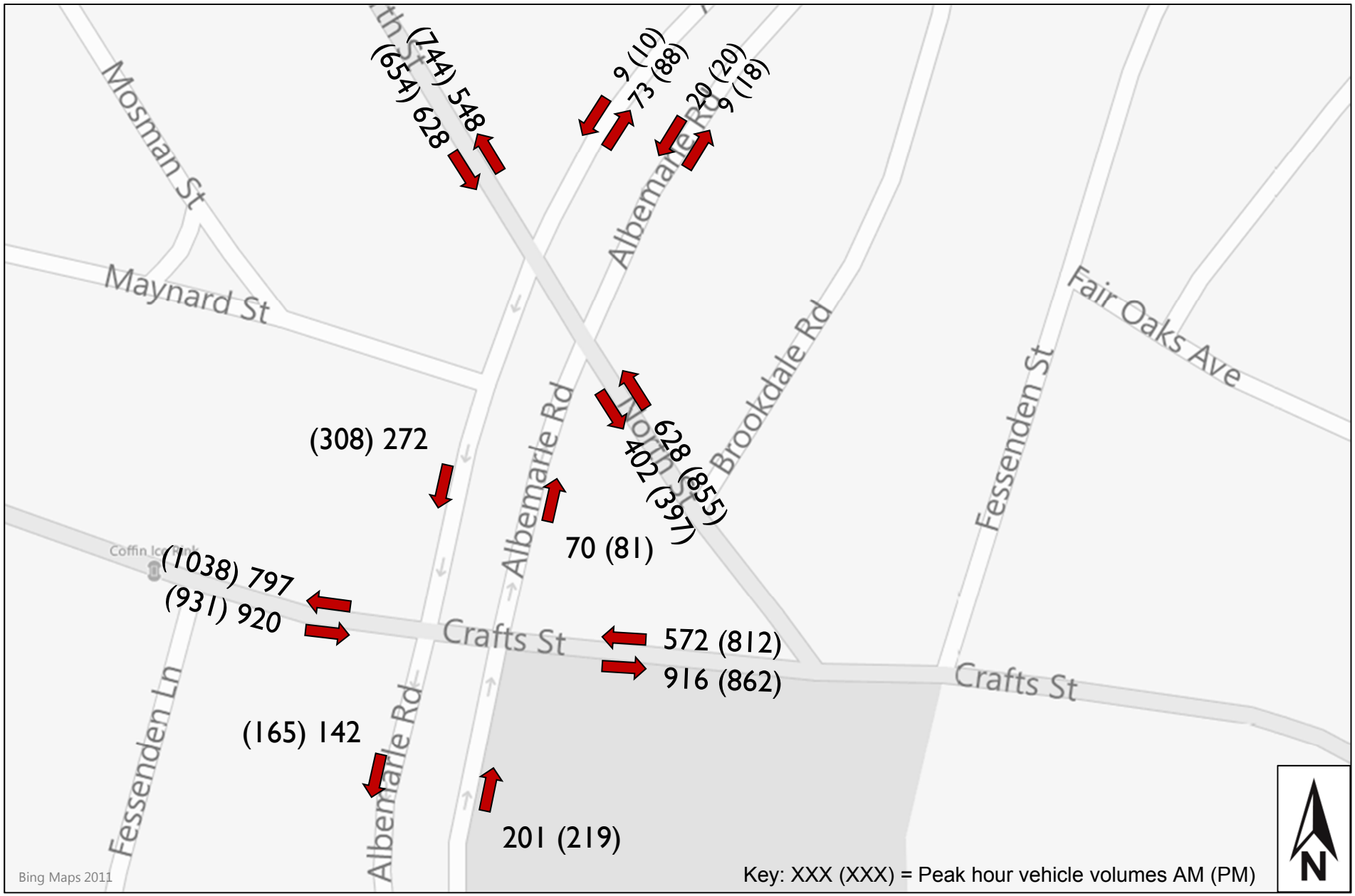
**May 23–26, 2011**




BOSTON REGION MPO

**FIGURE F-1**
**Average Daily Traffic (ADT) of the Study Area Roadways**
**May 23–26, 2011**

*Safety and Operations Analyses at Selected Intersections*




BOSTON REGION MPO

**FIGURE F-2**
**Average AM/PM Peak-Hour Traffic of the Study Area Roadways**
**May 23–26, 2011**

*Safety and Operations Analyses at Selected Intersections*

Mass Highway Department
WEEKLY SUMMARY FOR LANE 1
Starting: 5/23/2011



STA. 1 NB

Site Reference: 110280000605
Site ID: 000000000101
Location: ALBEMARLE RD. SOUTH OF CRAFTS ST.
Direction: NORTH

File: 101.prn
City: NEWTON
County: VOL N.B.

| TIME | MON 23 | TUE 24 | WED 25 | THU 26 | FRI | WKDAY AVG | SAT | SUN | WEEK AVG | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|
| 01:00 | | 8 | 6 | 4 | | 6 | | | 6 | 18 |
| 02:00 | | 3 | 5 | 1 | | 3 | | | 3 | 9 |
| 03:00 | | 0 | 3 | 4 | | 2 | | | 2 | 7 |
| 04:00 | | 0 | 0 | 0 | | 0 | | | 0 | 0 |
| 05:00 | | 4 | 4 | 5 | | 4 | | | 4 | 13 |
| 06:00 | | 9 | 14 | 13 | | 12 | | | 12 | 36 |
| 07:00 | | 29 | 26 | 35 | | 30 | | | 30 | 90 |
| 08:00 | | 125 | 123 | 122 | | 123 | | | 123 | 370 |
| 09:00 | | 185 | 204 | 216 | | 201 | | | 201 | 605 |
| 10:00 | | 94 | 105 | 108 | | 102 | | | 102 | 307 |
| 11:00 | 82 | 89 | 85 | 86 | | 85 | | | 85 | 342 |
| 12:00 | 81 | 100 | 127 | | | 102 | | | 102 | 308 |
| 13:00 | 97 | 163 | 110 | | | 123 | | | 123 | 370 |
| 14:00 | 95 | 120 | 119 | | | 111 | | | 111 | 334 |
| 15:00 | 123 | 152 | 128 | | | 134 | | | 134 | 403 |
| 16:00 | 216 | 154 | 230 | | | 200 | | | 200 | 600 |
| 17:00 | 169 | 166 | 213 | | | 182 | | | 182 | 548 |
| 18:00 | 227 | 201 | 230 | | | 219 | | | 219 | 658 |
| 19:00 | 189 | 170 | 196 | | | 185 | | | 185 | 555 |
| 20:00 | 107 | 148 | 131 | | | 128 | | | 128 | 386 |
| 21:00 | 65 | 103 | 87 | | | 85 | | | 85 | 255 |
| 22:00 | 44 | 51 | 84 | | | 59 | | | 59 | 179 |
| 23:00 | 20 | 20 | 20 | | | 20 | | | 20 | 60 |
| 24:00 | 14 | 13 | 18 | | | 15 | | | 15 | 45 |
| TOTALS | 1529 | 2107 | 2268 | 594 | 0 | 2131 | 0 | 0 | 2131 | 6498 |
| % AVG WKDY | 71.7 | 98.8 | 106.4 | 27.8 | | | | | | |
| % AVG WEEK | 71.7 | 98.8 | 106.4 | 27.8 | | | | | | |
| AM Times | 11:00 | 09:00 | 09:00 | 09:00 | | 09:00 | | | 09:00 | |
| AM Peaks | 82 | 185 | 204 | 216 | | 201 | | | 201 | |
| PM Times | 18:00 | 18:00 | 16:00 | | | 18:00 | | | 18:00 | |
| PM Peaks | 227 | 201 | 230 | | | 219 | | | 219 | |

46

NB 2131
SB 1658
COMB AWD 3789

FAC .91 (.99)
COMB ADT 3,400

Mass Highway Department
WEEKLY SUMMARY FOR LANE 1
Starting: 5/23/2011



STA. 1 SB

Site Reference: 110280000400
Site ID: 000000000102
Location: ALBEMARLE RD. SOUTH OF CRAFTS ST.
Direction: SOUTH

File: 102.prn
City: NEWTON
County: VOL S.B.

| TIME | MON 23 | TUE 24 | WED 25 | THU 26 | FRI | WKDAY AVG | SAT | SUN | WEEK AVG | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|
| 01:00 | | 5 | 7 | 3 | | 5 | | | 5 | 15 |
| 02:00 | | 2 | 1 | 4 | | 2 | | | 2 | 7 |
| 03:00 | | 2 | 3 | 3 | | 2 | | | 2 | 8 |
| 04:00 | | 1 | 0 | 1 | | 0 | | | 0 | 2 |
| 05:00 | | 1 | 2 | 1 | | 1 | | | 1 | 4 |
| 06:00 | | 6 | 11 | 10 | | 9 | | | 9 | 27 |
| 07:00 | | 37 | 41 | 44 | | 40 | | | 40 | 122 |
| 08:00 | | 107 | 130 | 120 | | 119 | | | 119 | 357 |
| 09:00 | | 137 | 149 | 142 | | 142 | | | 142 | 428 |
| 10:00 | | 86 | 70 | 61 | | 72 | | | 72 | 217 |
| 11:00 | | 67 | 81 | 82 | | 76 | | | 76 | 230 |
| 12:00 | 71 | 74 | 85 | | | 76 | | | 76 | 230 |
| 13:00 | 74 | 132 | 88 | | | 98 | | | 98 | 294 |
| 14:00 | 105 | 123 | 76 | | | 101 | | | 101 | 304 |
| 15:00 | 144 | 109 | 133 | | | 128 | | | 128 | 386 |
| 16:00 | 120 | 111 | 174 | | | 135 | | | 135 | 405 |
| 17:00 | 112 | 123 | 145 | | | 126 | | | 126 | 380 |
| 18:00 | 176 | 170 | 151 | | | 165 | | | 165 | 497 |
| 19:00 | 126 | 138 | 128 | | | 130 | | | 130 | 392 |
| 20:00 | 69 | 72 | 124 | | | 88 | | | 88 | 265 |
| 21:00 | 64 | 78 | 62 | | | 68 | | | 68 | 204 |
| 22:00 | 27 | 44 | 49 | | | 40 | | | 40 | 120 |
| 23:00 | 20 | 28 | 24 | | | 24 | | | 24 | 72 |
| 24:00 | 14 | 10 | 11 | | | 11 | | | 11 | 35 |
| TOTALS | 1122 | 1663 | 1745 | 471 | 0 | 1658 | 0 | 0 | 1658 | 5001 |
| % AVG WKDY | 67.6 | 100.3 | 105.2 | 28.4 | | | | | | |
| % AVG WEEK | 67.6 | 100.3 | 105.2 | 28.4 | | | | | | |
| AM Times | 12:00 | 09:00 | 09:00 | 09:00 | | 09:00 | | | 09:00 | |
| AM Peaks | 71 | 137 | 149 | 142 | | 142 | | | 142 | |
| PM Times | 18:00 | 18:00 | 16:00 | | | 18:00 | | | 18:00 | |
| PM Peaks | 176 | 170 | 174 | | | 165 | | | 165 | |

Mass Highway Department
WEEKLY SUMMARY FOR LANE 1
Starting: 5/23/2011



STA. 2 NB

Site Reference: 110280000613
Site ID: 000000000201
Location: ALBEMARLE RD. NORTH OF CRAFTS ST.
Direction: NORTH

File: 201.prn
City: NEWTON
County: VOL N.B.

| TIME | MON 23 | TUE 24 | WED 25 | THU 26 | FRI | WKDAY AVG | SAT | SUN | WEEK AVG | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|
| 01:00 | | 3 | 3 | 3 | | 3 | | | 3 | 9 |
| 02:00 | | 1 | 4 | 2 | | 2 | | | 2 | 7 |
| 03:00 | | 0 | 2 | 5 | | 2 | | | 2 | 7 |
| 04:00 | | 1 | 1 | 1 | | 1 | | | 1 | 3 |
| 05:00 | | 5 | 4 | 4 | | 4 | | | 4 | 13 |
| 06:00 | | 12 | 17 | 18 | | 15 | | | 15 | 47 |
| 07:00 | | 25 | 26 | 17 | | 22 | | | 22 | 68 |
| 08:00 | | 35 | 32 | 37 | | 34 | | | 34 | 104 |
| 09:00 | | 67 | 65 | 79 | | 70 | | | 70 | 211 |
| 10:00 | | 57 | 58 | 61 | | 58 | | | 58 | 176 |
| 11:00 | 58 | 45 | 42 | | | 48 | | | 48 | 145 |
| 12:00 | 59 | 50 | 70 | | | 59 | | | 59 | 179 |
| 13:00 | 53 | 64 | 57 | | | 58 | | | 58 | 174 |
| 14:00 | 61 | 45 | 68 | | | 58 | | | 58 | 174 |
| 15:00 | 55 | 61 | 52 | | | 56 | | | 56 | 168 |
| 16:00 | 65 | 60 | 67 | | | 64 | | | 64 | 192 |
| 17:00 | 75 | 70 | 79 | | | 74 | | | 74 | 224 |
| 18:00 | 79 | 78 | 86 | | | 81 | | | 81 | 243 |
| 19:00 | 67 | 69 | 71 | | | 69 | | | 69 | 207 |
| 20:00 | 50 | 44 | 40 | | | 44 | | | 44 | 134 |
| 21:00 | 27 | 36 | 36 | | | 33 | | | 33 | 99 |
| 22:00 | 17 | 27 | 31 | | | 25 | | | 25 | 75 |
| 23:00 | 14 | 12 | 11 | | | 12 | | | 12 | 37 |
| 24:00 | 10 | 9 | 10 | | | 9 | | | 9 | 29 |
| TOTALS | 690 | 876 | 932 | 227 | 0 | 901 | 0 | 0 | 901 | 2725 |
| % AVG WKDY | 76.5 | 97.2 | 103.4 | 25.1 | | | | | | |
| % AVG WEEK | 76.5 | 97.2 | 103.4 | 25.1 | | | | | | |
| AM Times | 12:00 | 09:00 | 12:00 | 09:00 | | 09:00 | | | 09:00 | |
| AM Peaks | 59 | 67 | 70 | 79 | | 70 | | | 70 | |
| PM Times | 18:00 | 18:00 | 18:00 | | | 18:00 | | | 18:00 | |
| PM Peaks | 79 | 78 | 86 | | | 81 | | | 81 | |

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NB 901
SB 3469
COMB AWD 4370
FAC .91 (.99)
COMB ADT 3,900

Mass Highway Department
WEEKLY SUMMARY FOR LANE 1 Page: 1
Starting: 5/23/2011

STA. 2 SB

Site Reference: 110280000402 File: 202.prn
Site ID: 000000000202 City: NEWTON
Location: ALBEMARLE RD. NORTH OF CRAFTS ST. County: VOL S.B.
Direction: SOUTH

| TIME | MON 23 | TUE 24 | WED 25 | THU 26 | FRI | WKDAY AVG | SAT | SUN | WEEK AVG | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|
| 01:00 | | 9 | 6 | 11 | | 8 | | | 8 | 26 |
| 02:00 | | 13 | 3 | 12 | | 9 | | | 9 | 28 |
| 03:00 | | 7 | 5 | 7 | | 6 | | | 6 | 19 |
| 04:00 | | 4 | 2 | 7 | | 4 | | | 4 | 13 |
| 05:00 | | 9 | 9 | 7 | | 8 | | | 8 | 25 |
| 06:00 | | 35 | 47 | 41 | | 41 | | | 41 | 123 |
| 07:00 | | 106 | 144 | 150 | | 133 | | | 133 | 400 |
| 08:00 | | 275 | 265 | 266 | | 268 | | | 268 | 806 |
| 09:00 | | 277 | 278 | 262 | | 272 | | | 272 | 817 |
| 10:00 | | 191 | 187 | 152 | | 176 | | | 176 | 530 |
| 11:00 | | 160 | 189 | | | 174 | | | 174 | 349 |
| 12:00 | 156 | 163 | 220 | | | 179 | | | 179 | 539 |
| 13:00 | 181 | 231 | 190 | | | 200 | | | 200 | 602 |
| 14:00 | 216 | 197 | 195 | | | 202 | | | 202 | 608 |
| 15:00 | 267 | 229 | 234 | | | 243 | | | 243 | 730 |
| 16:00 | 251 | 266 | 253 | | | 256 | | | 256 | 770 |
| 17:00 | 265 | 289 | 320 | | | 291 | | | 291 | 874 |
| 18:00 | 272 | 319 | 333 | | | 308 | | | 308 | 924 |
| 19:00 | 227 | 229 | 228 | | | 228 | | | 228 | 684 |
| 20:00 | 179 | 156 | 193 | | | 176 | | | 176 | 528 |
| 21:00 | 97 | 119 | 145 | | | 120 | | | 120 | 361 |
| 22:00 | 68 | 108 | 94 | | | 90 | | | 90 | 270 |
| 23:00 | 45 | 53 | 54 | | | 50 | | | 50 | 152 |
| 24:00 | 25 | 19 | 39 | | | 27 | | | 27 | 83 |
| TOTALS | 2249 | 3464 | 3633 | 915 | 0 | 3469 | 0 | 0 | 3469 | 10261 |
| % AVG WKDY | 64.8 | 99.8 | 104.7 | 26.3 | | | | | | |
| % AVG WEEK | 64.8 | 99.8 | 104.7 | 26.3 | | | | | | |
| AM Times | 12:00 | 09:00 | 09:00 | 08:00 | | 09:00 | | | 09:00 | |
| AM Peaks | 156 | 277 | 278 | 266 | | 272 | | | 272 | |
| PM Times | 18:00 | 18:00 | 18:00 | | | 18:00 | | | 18:00 | |
| PM Peaks | 272 | 319 | 333 | | | 308 | | | 308 | |

Mass Highway Department
WEEKLY SUMMARY FOR LANE 1 Page: 1
Starting: 5/23/2011

STA. 3 NB - NORTH SIDE

Site Reference: 110280000856 File: 30102-NB.prn
Site ID: 010000030102 City: NEWTON
Location: ALBEMARLE RD. NORTH OF NORTH ST. County: DIR VOL N&S NO. SIDE
Direction: NORTH

| TIME | MON 23 | TUE 24 | WED 25 | THU 26 | FRI | WKDAY AVG | SAT | SUN | WEEK AVG | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|
| 01:00 | | 1 | 2 | 1 | | 1 | | | 1 | 4 |
| 02:00 | | 3 | 0 | 2 | | 1 | | | 1 | 5 |
| 03:00 | | 1 | 1 | 1 | | 1 | | | 1 | 3 |
| 04:00 | | 0 | 0 | 0 | | 0 | | | 0 | 0 |
| 05:00 | | 2 | 2 | 0 | | 1 | | | 1 | 4 |
| 06:00 | | 4 | 4 | 11 | | 6 | | | 6 | 19 |
| 07:00 | | 16 | 16 | 16 | | 16 | | | 16 | 48 |
| 08:00 | | 44 | 48 | 50 | | 47 | | | 47 | 142 |
| 09:00 | | 71 | 76 | 73 | | 73 | | | 73 | 220 |
| 10:00 | | 38 | 43 | 29 | | 36 | | | 36 | 110 |
| 11:00 | | 29 | 33 | | | 31 | | | 31 | 62 |
| 12:00 | 37 | 45 | 54 | | | 45 | | | 45 | 136 |
| 13:00 | 31 | 43 | 43 | | | 39 | | | 39 | 117 |
| 14:00 | 41 | 44 | 34 | | | 39 | | | 39 | 119 |
| 15:00 | 58 | 59 | 47 | | | 54 | | | 54 | 164 |
| 16:00 | 58 | 62 | 48 | | | 56 | | | 56 | 168 |
| 17:00 | 53 | 59 | 72 | | | 61 | | | 61 | 184 |
| 18:00 | 92 | 87 | 87 | | | 88 | | | 88 | 266 |
| 19:00 | 73 | 85 | 85 | | | 81 | | | 81 | 243 |
| 20:00 | 40 | 55 | 63 | | | 52 | | | 52 | 158 |
| 21:00 | 34 | 44 | 25 | | | 34 | | | 34 | 103 |
| 22:00 | 15 | 24 | 22 | | | 20 | | | 20 | 61 |
| 23:00 | 10 | 13 | 18 | | | 13 | | | 13 | 41 |
| 24:00 | 3 | 3 | 8 | | | 4 | | | 4 | 14 |
| TOTALS | 545 | 832 | 831 | 183 | 0 | 799 | 0 | 0 | 799 | 2391 |
| % AVG WKDY | 68.2 | 104.1 | 104 | 22.9 | | | | | | |
| % AVG WEEK | 68.2 | 104.1 | 104 | 22.9 | | | | | | |
| AM Times | 12:00 | 09:00 | 09:00 | 09:00 | | 09:00 | | | 09:00 | |
| AM Peaks | 37 | 71 | 76 | 73 | | 73 | | | 73 | |
| PM Times | 18:00 | 18:00 | 18:00 | | | 18:00 | | | 18:00 | |
| PM Peaks | 92 | 87 | 87 | | | 88 | | | 88 | |

U6

NB 799
SB 95
COMB AWD 894
FAC .91(.99)
COMB ADT 800

Mass Highway Department
WEEKLY SUMMARY FOR LANE 2
Starting: 5/23/2011



STA. 3 SB - NORTH SIDE

Site Reference: 110280000856
Site ID: 010000030102
Location: ALBEMARLE RD. NORTH OF NORTH ST.
Direction: SOUTH

File: 30102-NB.prn
City: NEWTON
County: DIR VOL N&S NO. SIDE

| TIME | MON 23 | TUE 24 | WED 25 | THU 26 | FRI | WKDAY AVG | SAT | SUN | WEEK AVG | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|
| 01:00 | | 0 | 0 | 1 | | 0 | | | 0 | 1 |
| 02:00 | | 0 | 0 | 1 | | 0 | | | 0 | 1 |
| 03:00 | | 0 | 1 | 0 | | 0 | | | 0 | 1 |
| 04:00 | | 0 | 0 | 1 | | 0 | | | 0 | 1 |
| 05:00 | | 0 | 0 | 2 | | 0 | | | 0 | 2 |
| 06:00 | | 1 | 0 | 0 | | 0 | | | 0 | 1 |
| 07:00 | | 3 | 2 | 3 | | 2 | | | 2 | 8 |
| 08:00 | | 5 | 2 | 6 | | 4 | | | 4 | 13 |
| 09:00 | | 11 | 8 | 9 | | 9 | | | 9 | 28 |
| 10:00 | | 9 | 1 | 7 | | 5 | | | 5 | 17 |
| 11:00 | | 6 | 6 | | | 6 | | | 6 | 12 |
| 12:00 | 1 | 10 | 3 | | | 4 | | | 4 | 14 |
| 13:00 | 7 | 8 | 4 | | | 6 | | | 6 | 19 |
| 14:00 | 4 | 6 | 8 | | | 6 | | | 6 | 18 |
| 15:00 | 7 | 3 | 4 | | | 4 | | | 4 | 14 |
| 16:00 | 3 | 3 | 3 | | | 3 | | | 3 | 9 |
| 17:00 | 10 | 11 | 9 | | | 10 | | | 10 | 30 |
| 18:00 | 7 | 11 | 14 | | | 10 | | | 10 | 32 |
| 19:00 | 6 | 13 | 13 | | | 10 | | | 10 | 32 |
| 20:00 | 3 | 9 | 10 | | | 7 | | | 7 | 22 |
| 21:00 | 6 | 3 | 3 | | | 4 | | | 4 | 12 |
| 22:00 | 1 | 2 | 6 | | | 3 | | | 3 | 9 |
| 23:00 | 2 | 3 | 3 | | | 2 | | | 2 | 8 |
| 24:00 | 0 | 0 | 2 | | | 0 | | | 0 | 2 |
| TOTALS | 57 | 117 | 102 | 30 | 0 | 95 | 0 | 0 | 95 | 306 |
| % AVG WKDY | 60 | 123.1 | 107.3 | 31.5 | | | | | | |
| % AVG WEEK | 60 | 123.1 | 107.3 | 31.5 | | | | | | |
| AM Times | 12:00 | 09:00 | 09:00 | 09:00 | | 09:00 | | | 09:00 | |
| AM Peaks | 1 | 11 | 8 | 9 | | 9 | | | 9 | |
| PM Times | 17:00 | 19:00 | 18:00 | | | 17:00 | | | 17:00 | |
| PM Peaks | 10 | 13 | 14 | | | 10 | | | 10 | |

Mass Highway Department
WEEKLY SUMMARY FOR LANE 1 Page: 1
Starting: 5/23/2011

STA. 3 NB - SOUTH SIDE

Site Reference: 110280000750
Site ID: 020000030102
Location: ALBEMARLE RD. NORTH OF NORTH ST.
Direction: NORTH

File: 30102-SB.prn
City: NEWTON
County: DIR VOL N&S SO. SIDE

| TIME | MON 23 | TUE 24 | WED 25 | THU 26 | FRI | WKDAY AVG | SAT | SUN | WEEK AVG | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|
| 01:00 | | 2 | 0 | 1 | | 1 | | | 1 | 3 |
| 02:00 | | 1 | 0 | 0 | | 0 | | | 0 | 1 |
| 03:00 | | 0 | 1 | 0 | | 0 | | | 0 | 1 |
| 04:00 | | 0 | 0 | 0 | | 0 | | | 0 | 0 |
| 05:00 | | 1 | 1 | 0 | | 0 | | | 0 | 2 |
| 06:00 | | 1 | 1 | 3 | | 1 | | | 1 | 5 |
| 07:00 | | 6 | 4 | 4 | | 4 | | | 4 | 14 |
| 08:00 | | 5 | 10 | 7 | | 7 | | | 7 | 22 |
| 09:00 | | 6 | 9 | 12 | | 9 | | | 9 | 27 |
| 10:00 | | 11 | 10 | 7 | | 9 | | | 9 | 28 |
| 11:00 | | 8 | 5 | | | 6 | | | 6 | 13 |
| 12:00 | 6 | 7 | 8 | | | 7 | | | 7 | 21 |
| 13:00 | 10 | 15 | 11 | | | 12 | | | 12 | 36 |
| 14:00 | 13 | 17 | 14 | | | 14 | | | 14 | 44 |
| 15:00 | 10 | 15 | 13 | | | 12 | | | 12 | 38 |
| 16:00 | 12 | 15 | 23 | | | 16 | | | 16 | 50 |
| 17:00 | 17 | 17 | 20 | | | 18 | | | 18 | 54 |
| 18:00 | 15 | 6 | 14 | | | 11 | | | 11 | 35 |
| 19:00 | 7 | 8 | 20 | | | 11 | | | 11 | 35 |
| 20:00 | 14 | 9 | 12 | | | 11 | | | 11 | 35 |
| 21:00 | 9 | 11 | 8 | | | 9 | | | 9 | 28 |
| 22:00 | 5 | 11 | 4 | | | 6 | | | 6 | 20 |
| 23:00 | 4 | 4 | 5 | | | 4 | | | 4 | 13 |
| 24:00 | 0 | 5 | 5 | | | 3 | | | 3 | 10 |
| TOTALS | 122 | 181 | 198 | 34 | 0 | 171 | 0 | 0 | 171 | 535 |
| % AVG WKDY | 71.3 | 105.8 | 115.7 | 19.8 | | | | | | |
| % AVG WEEK | 71.3 | 105.8 | 115.7 | 19.8 | | | | | | |
| AM Times | 12:00 | 10:00 | 08:00 | 09:00 | | 09:00 | | | 09:00 | |
| AM Peaks | 6 | 11 | 10 | 12 | | 9 | | | 9 | |
| PM Times | 17:00 | 14:00 | 16:00 | | | 17:00 | | | 17:00 | |
| PM Peaks | 17 | 17 | 23 | | | 18 | | | 18 | |

NB 171
SB 227
COMB AWD 398
FAC .91 (.99)
COMB ADT 360

Mass Highway Department
WEEKLY SUMMARY FOR LANE 2
Starting: 5/23/2011



STA. 3 SB - SOUTH SIDE

Site Reference: 110280000750
Site ID: 020000030102
Location: ALBEMARLE RD. NORTH OF NORTH ST.
Direction: SOUTH

File: 30102-SB.prn
City: NEWTON
County: DIR VOL N&S SO. SIDE

| TIME | MON 23 | TUE 24 | WED 25 | THU 26 | FRI | WKDAY AVG | SAT | SUN | WEEK AVG | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|
| 01:00 | | 0 | 1 | 4 | | 1 | | | 1 | 5 |
| 02:00 | | 0 | 0 | 0 | | 0 | | | 0 | 0 |
| 03:00 | | 0 | 1 | 1 | | 0 | | | 0 | 2 |
| 04:00 | | 0 | 0 | 0 | | 0 | | | 0 | 0 |
| 05:00 | | 0 | 0 | 1 | | 0 | | | 0 | 1 |
| 06:00 | | 6 | 6 | 4 | | 5 | | | 5 | 16 |
| 07:00 | | 7 | 12 | 13 | | 10 | | | 10 | 32 |
| 08:00 | | 16 | 16 | 15 | | 15 | | | 15 | 47 |
| 09:00 | | 18 | 18 | 25 | | 20 | | | 20 | 61 |
| 10:00 | | 11 | 17 | 8 | | 12 | | | 12 | 36 |
| 11:00 | | 18 | 13 | | | 15 | | | 15 | 31 |
| 12:00 | 13 | 16 | 14 | | | 14 | | | 14 | 43 |
| 13:00 | 11 | 16 | 14 | | | 13 | | | 13 | 41 |
| 14:00 | 16 | 27 | 17 | | | 20 | | | 20 | 60 |
| 15:00 | 13 | 16 | 17 | | | 15 | | | 15 | 46 |
| 16:00 | 10 | 15 | 17 | | | 14 | | | 14 | 42 |
| 17:00 | 9 | 10 | 12 | | | 10 | | | 10 | 31 |
| 18:00 | 20 | 15 | 23 | | | 19 | | | 19 | 58 |
| 19:00 | 12 | 14 | 16 | | | 14 | | | 14 | 42 |
| 20:00 | 9 | 15 | 22 | | | 15 | | | 15 | 46 |
| 21:00 | 2 | 6 | 13 | | | 7 | | | 7 | 21 |
| 22:00 | 1 | 3 | 5 | | | 3 | | | 3 | 9 |
| 23:00 | 2 | 6 | 3 | | | 3 | | | 3 | 11 |
| 24:00 | 2 | 1 | 3 | | | 2 | | | 2 | 6 |
| TOTALS | 120 | 236 | 260 | 71 | 0 | 227 | 0 | 0 | 227 | 687 |
| % AVG WKDY | 52.8 | 103.9 | 114.5 | 31.2 | | | | | | |
| % AVG WEEK | 52.8 | 103.9 | 114.5 | 31.2 | | | | | | |
| AM Times | 12:00 | 09:00 | 09:00 | 09:00 | | 09:00 | | | 09:00 | |
| AM Peaks | 13 | 18 | 18 | 25 | | 20 | | | 20 | |
| PM Times | 18:00 | 14:00 | 18:00 | | | 14:00 | | | 14:00 | |
| PM Peaks | 20 | 27 | 23 | | | 20 | | | 20 | |

Mass Highway Department
WEEKLY SUMMARY FOR LANE 1 Page: 1
Starting: 5/23/2011

STA. 4 EB

Site Reference: 110280000596 File: 40304.prn
Site ID: 000000040304 City: NEWTON
Location: CRAFTS ST. EAST OF ALBEMARLE RD. County: DIR VOL E&W
Direction: EAST

| TIME | MON 23 | TUE 24 | WED 25 | THU 26 | FRI | WKDAY AVG | SAT | SUN | WEEK AVG | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|
| 01:00 | | 44 | 33 | 46 | | 41 | | | 41 | 123 |
| 02:00 | | 20 | 26 | 22 | | 22 | | | 22 | 68 |
| 03:00 | | 13 | 11 | 22 | | 15 | | | 15 | 46 |
| 04:00 | | 13 | 17 | 14 | | 14 | | | 14 | 44 |
| 05:00 | | 48 | 50 | 35 | | 44 | | | 44 | 133 |
| 06:00 | | 119 | 128 | 134 | | 127 | | | 127 | 381 |
| 07:00 | | 440 | 431 | 407 | | 426 | | | 426 | 1278 |
| 08:00 | | 903 | 773 | 820 | | 832 | | | 832 | 2496 |
| 09:00 | | 906 | 933 | 909 | | 916 | | | 916 | 2748 |
| 10:00 | | 637 | 654 | 626 | | 639 | | | 639 | 1917 |
| 11:00 | 510 | 511 | 500 | | | 507 | | | 507 | 1521 |
| 12:00 | 455 | 515 | 529 | | | 499 | | | 499 | 1499 |
| 13:00 | 554 | 626 | 551 | | | 577 | | | 577 | 1731 |
| 14:00 | 522 | 611 | 565 | | | 566 | | | 566 | 1698 |
| 15:00 | 574 | 607 | 561 | | | 580 | | | 580 | 1742 |
| 16:00 | 740 | 665 | 796 | | | 733 | | | 733 | 2201 |
| 17:00 | 744 | 705 | 745 | | | 731 | | | 731 | 2194 |
| 18:00 | 827 | 840 | 921 | | | 862 | | | 862 | 2588 |
| 19:00 | 683 | 690 | 778 | | | 717 | | | 717 | 2151 |
| 20:00 | 498 | 542 | 555 | | | 531 | | | 531 | 1595 |
| 21:00 | 295 | 407 | 357 | | | 353 | | | 353 | 1059 |
| 22:00 | 225 | 277 | 327 | | | 276 | | | 276 | 829 |
| 23:00 | 135 | 168 | 183 | | | 162 | | | 162 | 486 |
| 24:00 | 81 | 75 | 114 | | | 90 | | | 90 | 270 |
| TOTALS | 6843 | 10382 | 10538 | 3035 | 0 | 10260 | 0 | 0 | 10260 | 30798 |
| % AVG WKDY | 66.6 | 101.1 | 102.7 | 29.5 | | | | | | |
| % AVG WEEK | 66.6 | 101.1 | 102.7 | 29.5 | | | | | | |
| AM Times | 11:00 | 09:00 | 09:00 | 09:00 | | 09:00 | | | 09:00 | |
| AM Peaks | 510 | 906 | 933 | 909 | | 916 | | | 916 | |
| PM Times | 18:00 | 18:00 | 18:00 | | | 18:00 | | | 18:00 | |
| PM Peaks | 827 | 840 | 921 | | | 862 | | | 862 | |

US

EB 10260
WB 9022
COMB AWD 19282
FAC .91 (.98)
COMB ADT 17,200

STA. 4 WB

Site Reference: 110280000596
Site ID: 000000040304
Location: CRAFTS ST. EAST OF ALBEMARLE RD.
Direction: WEST

File: 40304.prn
City: NEWTON
County: DIR VOL E&W

| TIME | MON 23 | TUE 24 | WED 25 | THU 26 | FRI | WKDAY AVG | SAT | SUN | WEEK AVG | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|
| 01:00 | | 78 | 66 | 80 | | 74 | | | 74 | 224 |
| 02:00 | | 33 | 27 | 28 | | 29 | | | 29 | 88 |
| 03:00 | | 20 | 12 | 25 | | 19 | | | 19 | 57 |
| 04:00 | | 19 | 19 | 18 | | 18 | | | 18 | 56 |
| 05:00 | | 37 | 33 | 31 | | 33 | | | 33 | 101 |
| 06:00 | | 95 | 109 | 91 | | 98 | | | 98 | 295 |
| 07:00 | | 272 | 290 | 282 | | 281 | | | 281 | 844 |
| 08:00 | | 524 | 579 | 549 | | 550 | | | 550 | 1652 |
| 09:00 | | 586 | 568 | 564 | | 572 | | | 572 | 1718 |
| 10:00 | | 449 | 448 | 472 | | 456 | | | 456 | 1369 |
| 11:00 | 388 | 407 | 414 | | | 403 | | | 403 | 1209 |
| 12:00 | 417 | 511 | 450 | | | 459 | | | 459 | 1378 |
| 13:00 | 471 | 526 | 486 | | | 494 | | | 494 | 1483 |
| 14:00 | 458 | 476 | 533 | | | 489 | | | 489 | 1467 |
| 15:00 | 510 | 581 | 529 | | | 540 | | | 540 | 1620 |
| 16:00 | 629 | 655 | 671 | | | 651 | | | 651 | 1955 |
| 17:00 | 748 | 735 | 728 | | | 737 | | | 737 | 2211 |
| 18:00 | 795 | 848 | 794 | | | 812 | | | 812 | 2437 |
| 19:00 | 667 | 733 | 735 | | | 711 | | | 711 | 2135 |
| 20:00 | 469 | 535 | 605 | | | 536 | | | 536 | 1609 |
| 21:00 | 376 | 378 | 396 | | | 383 | | | 383 | 1150 |
| 22:00 | 283 | 331 | 343 | | | 319 | | | 319 | 957 |
| 23:00 | 196 | 212 | 216 | | | 208 | | | 208 | 624 |
| 24:00 | 137 | 147 | 166 | | | 150 | | | 150 | 450 |
| TOTALS | 6544 | 9188 | 9217 | 2140 | 0 | 9022 | 0 | 0 | 9022 | 27089 |
| % AVG WKDY | 72.5 | 101.8 | 102.1 | 23.7 | | | | | | |
| % AVG WEEK | 72.5 | 101.8 | 102.1 | 23.7 | | | | | | |
| AM Times | 12:00 | 09:00 | 08:00 | 09:00 | | 09:00 | | | 09:00 | |
| AM Peaks | 417 | 586 | 579 | 564 | | 572 | | | 572 | |
| PM Times | 18:00 | 18:00 | 18:00 | | | 18:00 | | | 18:00 | |
| PM Peaks | 795 | 848 | 794 | | | 812 | | | 812 | |

Mass Highway Department
WEEKLY SUMMARY FOR LANE 1 Page: 1
Starting: 5/23/2011

STA. 5 EB

Site Reference: 110280000614
Site ID: 000000050304
Location: CRAFTS ST. WEST OF ALBEMARLE RD.
Direction: EAST

File: 50304.prn
City: NEWTON
County: DIR VOL E&W

| TIME | MON 23 | TUE 24 | WED 25 | THU 26 | FRI | WKDAY AVG | SAT | SUN | WEEK AVG | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|
| 01:00 | | 46 | 63 | 67 | | 58 | | | 58 | 176 |
| 02:00 | | 17 | 40 | 34 | | 30 | | | 30 | 91 |
| 03:00 | | 14 | 17 | 30 | | 20 | | | 20 | 61 |
| 04:00 | | 13 | 21 | 18 | | 17 | | | 17 | 52 |
| 05:00 | | 45 | 57 | 35 | | 45 | | | 45 | 137 |
| 06:00 | | 112 | 147 | 146 | | 135 | | | 135 | 405 |
| 07:00 | | 394 | 461 | 424 | | 426 | | | 426 | 1279 |
| 08:00 | | 774 | 886 | 888 | | 849 | | | 849 | 2548 |
| 09:00 | | 766 | 1016 | 979 | | 920 | | | 920 | 2761 |
| 10:00 | | 562 | 718 | 684 | | 654 | | | 654 | 1964 |
| 11:00 | | 461 | 565 | | | 513 | | | 513 | 1026 |
| 12:00 | 419 | 468 | 591 | | | 492 | | | 492 | 1478 |
| 13:00 | 479 | 541 | 636 | | | 552 | | | 552 | 1656 |
| 14:00 | 468 | 593 | 681 | | | 580 | | | 580 | 1742 |
| 15:00 | 533 | 612 | 679 | | | 608 | | | 608 | 1824 |
| 16:00 | 628 | 730 | 915 | | | 757 | | | 757 | 2273 |
| 17:00 | 644 | 822 | 1045 | | | 837 | | | 837 | 2511 |
| 18:00 | 715 | 980 | 1099 | | | 931 | | | 931 | 2794 |
| 19:00 | 589 | 835 | 916 | | | 780 | | | 780 | 2340 |
| 20:00 | 435 | 653 | 689 | | | 592 | | | 592 | 1777 |
| 21:00 | 260 | 467 | 459 | | | 395 | | | 395 | 1186 |
| 22:00 | 209 | 386 | 410 | | | 335 | | | 335 | 1005 |
| 23:00 | 144 | 236 | 240 | | | 206 | | | 206 | 620 |
| 24:00 | 80 | 112 | 161 | | | 117 | | | 117 | 353 |
| TOTALS | 5603 | 10639 | 12512 | 3305 | 0 | 10849 | 0 | 0 | 10849 | 32059 |
| % AVG WKDY | 51.6 | 98 | 115.3 | 30.4 | | | | | | |
| % AVG WEEK | 51.6 | 98 | 115.3 | 30.4 | | | | | | |
| AM Times | 12:00 | 08:00 | 09:00 | 09:00 | | 09:00 | | | 09:00 | |
| AM Peaks | 419 | 774 | 1016 | 979 | | 920 | | | 920 | |
| PM Times | 18:00 | 18:00 | 18:00 | | | 18:00 | | | 18:00 | |
| PM Peaks | 715 | 980 | 1099 | | | 931 | | | 931 | |

U5

EB 10849
WB 11783
COMB AWD 22632
FAC .91 (.98)
COMB ADT 20,200

STA. 5 WB

Site Reference: 110280000614
Site ID: 000000050304
Location: CRAFTS ST. WEST OF ALBEMARLE RD.
Direction: WEST

File: 50304.prn
City: NEWTON
County: DIR VOL E&W

| TIME | MON 23 | TUE 24 | WED 25 | THU 26 | FRI | WKDAY AVG | SAT | SUN | WEEK AVG | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|
| 01:00 | | 93 | 79 | 100 | | 90 | | | 90 | 272 |
| 02:00 | | 51 | 30 | 41 | | 40 | | | 40 | 122 |
| 03:00 | | 27 | 17 | 37 | | 27 | | | 27 | 81 |
| 04:00 | | 22 | 24 | 28 | | 24 | | | 24 | 74 |
| 05:00 | | 51 | 50 | 45 | | 48 | | | 48 | 146 |
| 06:00 | | 119 | 154 | 118 | | 130 | | | 130 | 391 |
| 07:00 | | 333 | 412 | 460 | | 401 | | | 401 | 1205 |
| 08:00 | | 723 | 805 | 848 | | 792 | | | 792 | 2376 |
| 09:00 | | 768 | 796 | 829 | | 797 | | | 797 | 2393 |
| 10:00 | | 573 | 560 | 628 | | 587 | | | 587 | 1761 |
| 11:00 | | 521 | 522 | | | 521 | | | 521 | 1043 |
| 12:00 | 522 | 612 | 586 | | | 573 | | | 573 | 1720 |
| 13:00 | 594 | 655 | 586 | | | 611 | | | 611 | 1835 |
| 14:00 | 604 | 601 | 638 | | | 614 | | | 614 | 1843 |
| 15:00 | 685 | 749 | 658 | | | 697 | | | 697 | 2092 |
| 16:00 | 834 | 862 | 809 | | | 835 | | | 835 | 2505 |
| 17:00 | 943 | 986 | 1006 | | | 978 | | | 978 | 2935 |
| 18:00 | 973 | 1069 | 1073 | | | 1038 | | | 1038 | 3115 |
| 19:00 | 876 | 898 | 1006 | | | 926 | | | 926 | 2780 |
| 20:00 | 605 | 655 | 821 | | | 693 | | | 693 | 2081 |
| 21:00 | 422 | 470 | 571 | | | 487 | | | 487 | 1463 |
| 22:00 | 348 | 416 | 465 | | | 409 | | | 409 | 1229 |
| 23:00 | 256 | 260 | 297 | | | 271 | | | 271 | 813 |
| 24:00 | 166 | 185 | 232 | | | 194 | | | 194 | 583 |
| TOTALS | 7828 | 11699 | 12197 | 3134 | 0 | 11783 | 0 | 0 | 11783 | 34858 |
| % AVG WKDY | 66.4 | 99.2 | 103.5 | 26.5 | | | | | | |
| % AVG WEEK | 66.4 | 99.2 | 103.5 | 26.5 | | | | | | |
| AM Times | 12:00 | 09:00 | 08:00 | 08:00 | | 09:00 | | | 09:00 | |
| AM Peaks | 522 | 768 | 805 | 848 | | 797 | | | 797 | |
| PM Times | 18:00 | 18:00 | 18:00 | | | 18:00 | | | 18:00 | |
| PM Peaks | 973 | 1069 | 1073 | | | 1038 | | | 1038 | |

Mass Highway Department
WEEKLY SUMMARY FOR LANE 1 Page: 1
Starting: 5/23/2011

STA. 6 EB

Site Reference: 110280000754
Site ID: 000000060304
Location: NORTH ST. WEST OF ALBEMARLE RD.
Direction: EAST

File: 60304.prn
City: NEWTON
County: DIR VOL E&W

| TIME | MON 23 | TUE 24 | WED 25 | THU 26 | FRI | WKDAY AVG | SAT | SUN | WEEK AVG | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|
| 01:00 | | 25 | 19 | 24 | | 22 | | | 22 | 68 |
| 02:00 | | 17 | 18 | 31 | | 22 | | | 22 | 66 |
| 03:00 | | 15 | 9 | 8 | | 10 | | | 10 | 32 |
| 04:00 | | 11 | 6 | 14 | | 10 | | | 10 | 31 |
| 05:00 | | 32 | 25 | 27 | | 28 | | | 28 | 84 |
| 06:00 | | 80 | 90 | 86 | | 85 | | | 85 | 256 |
| 07:00 | | 270 | 325 | 293 | | 296 | | | 296 | 888 |
| 08:00 | | 589 | 583 | 594 | | 588 | | | 588 | 1766 |
| 09:00 | | 620 | 652 | 613 | | 628 | | | 628 | 1885 |
| 10:00 | | 468 | 414 | 419 | | 433 | | | 433 | 1301 |
| 11:00 | | 366 | 382 | | | 374 | | | 374 | 748 |
| 12:00 | 406 | 394 | 421 | | | 407 | | | 407 | 1221 |
| 13:00 | 454 | 466 | 423 | | | 447 | | | 447 | 1343 |
| 14:00 | 470 | 429 | 423 | | | 440 | | | 440 | 1322 |
| 15:00 | 563 | 504 | 476 | | | 514 | | | 514 | 1543 |
| 16:00 | 523 | 579 | 512 | | | 538 | | | 538 | 1614 |
| 17:00 | 620 | 617 | 606 | | | 614 | | | 614 | 1843 |
| 18:00 | 622 | 648 | 694 | | | 654 | | | 654 | 1964 |
| 19:00 | 527 | 538 | 533 | | | 532 | | | 532 | 1598 |
| 20:00 | 366 | 373 | 416 | | | 385 | | | 385 | 1155 |
| 21:00 | 245 | 293 | 291 | | | 276 | | | 276 | 829 |
| 22:00 | 185 | 222 | 208 | | | 205 | | | 205 | 615 |
| 23:00 | 106 | 109 | 133 | | | 116 | | | 116 | 348 |
| 24:00 | 59 | 45 | 85 | | | 63 | | | 63 | 189 |
| TOTALS | 5146 | 7710 | 7744 | 2109 | 0 | 7687 | 0 | 0 | 7687 | 22709 |
| % AVG WKDY | 66.9 | 100.2 | 100.7 | 27.4 | | | | | | |
| % AVG WEEK | 66.9 | 100.2 | 100.7 | 27.4 | | | | | | |
| AM Times | 12:00 | 09:00 | 09:00 | 09:00 | | 09:00 | | | 09:00 | |
| AM Peaks | 406 | 620 | 652 | 613 | | 628 | | | 628 | |
| PM Times | 18:00 | 18:00 | 18:00 | | | 18:00 | | | 18:00 | |
| PM Peaks | 622 | 648 | 694 | | | 654 | | | 654 | |

45

EB 7687
WB 7520
COMB AWD 15207
FAC .91 (.99)
COMB ADT 13,700

Mass Highway Department
WEEKLY SUMMARY FOR LANE 2 Page: 2
Starting: 5/23/2011

STA. 6 WB

Site Reference: 110280000754 File: 60304.prn
Site ID: 000000060304 City: NEWTON
Location: NORTH ST. WEST OF ALBEMARLE RD. County: DIR VOL E&W
Direction: WEST

| TIME | MON 23 | TUE 24 | WED 25 | THU 26 | FRI | WKDAY AVG | SAT | SUN | WEEK AVG | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|
| 01:00 | | 31 | 34 | 40 | | 35 | | | 35 | 105 |
| 02:00 | | 11 | 13 | 21 | | 15 | | | 15 | 45 |
| 03:00 | | 8 | 9 | 16 | | 11 | | | 11 | 33 |
| 04:00 | | 7 | 11 | 20 | | 12 | | | 12 | 38 |
| 05:00 | | 30 | 17 | 27 | | 24 | | | 24 | 74 |
| 06:00 | | 76 | 91 | 83 | | 83 | | | 83 | 250 |
| 07:00 | | 210 | 196 | 172 | | 192 | | | 192 | 578 |
| 08:00 | | 374 | 334 | 316 | | 341 | | | 341 | 1024 |
| 09:00 | | 529 | 598 | 517 | | 548 | | | 548 | 1644 |
| 10:00 | | 414 | 453 | 431 | | 432 | | | 432 | 1298 |
| 11:00 | | 371 | 396 | | | 383 | | | 383 | 767 |
| 12:00 | 334 | 432 | 493 | | | 419 | | | 419 | 1259 |
| 13:00 | 405 | 434 | 470 | | | 436 | | | 436 | 1309 |
| 14:00 | 420 | 475 | 492 | | | 462 | | | 462 | 1387 |
| 15:00 | 461 | 538 | 477 | | | 492 | | | 492 | 1476 |
| 16:00 | 536 | 612 | 632 | | | 593 | | | 593 | 1780 |
| 17:00 | 582 | 651 | 668 | | | 633 | | | 633 | 1901 |
| 18:00 | 717 | 837 | 680 | | | 744 | | | 744 | 2234 |
| 19:00 | 533 | 684 | 640 | | | 619 | | | 619 | 1857 |
| 20:00 | 365 | 428 | 458 | | | 417 | | | 417 | 1251 |
| 21:00 | 217 | 296 | 287 | | | 266 | | | 266 | 800 |
| 22:00 | 154 | 223 | 220 | | | 199 | | | 199 | 597 |
| 23:00 | 86 | 102 | 124 | | | 104 | | | 104 | 312 |
| 24:00 | 72 | 45 | 65 | | | 60 | | | 60 | 182 |
| TOTALS | 4882 | 7818 | 7858 | 1643 | 0 | 7520 | 0 | 0 | 7520 | 22201 |
| % AVG WKDY | 64.9 | 103.9 | 104.4 | 21.8 | | | | | | |
| % AVG WEEK | 64.9 | 103.9 | 104.4 | 21.8 | | | | | | |
| AM Times | 12:00 | 09:00 | 09:00 | 09:00 | | 09:00 | | | 09:00 | |
| AM Peaks | 334 | 529 | 598 | 517 | | 548 | | | 548 | |
| PM Times | 18:00 | 18:00 | 18:00 | | | 18:00 | | | 18:00 | |
| PM Peaks | 717 | 837 | 680 | | | 744 | | | 744 | |

Mass Highway Department
WEEKLY SUMMARY FOR LANE 1
Starting: 5/23/2011



STA. 7EB

Site Reference: 110280000859
Site ID: 000000070304
Location: NORTH ST. EAST OF ALBEMARLE RD.
Direction: EAST

File: 70304.prn
City: NEWTON
County: DIR VOL E&W

| TIME | MON 23 | TUE 24 | WED 25 | THU 26 | FRI | WKDAY AVG | SAT | SUN | WEEK AVG | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|
| 01:00 | | 14 | 15 | 12 | | 13 | | | 13 | 41 |
| 02:00 | | 6 | 14 | 18 | | 12 | | | 12 | 38 |
| 03:00 | | 9 | 4 | 3 | | 5 | | | 5 | 16 |
| 04:00 | | 7 | 5 | 8 | | 6 | | | 6 | 20 |
| 05:00 | | 23 | 16 | 18 | | 19 | | | 19 | 57 |
| 06:00 | | 51 | 52 | 43 | | 48 | | | 48 | 146 |
| 07:00 | | 180 | 201 | 168 | | 183 | | | 183 | 549 |
| 08:00 | | 367 | 365 | 357 | | 363 | | | 363 | 1089 |
| 09:00 | | 401 | 421 | 385 | | 402 | | | 402 | 1207 |
| 10:00 | | 283 | 276 | 288 | | 282 | | | 282 | 847 |
| 11:00 | 239 | 233 | 227 | | | 233 | | | 233 | 699 |
| 12:00 | 233 | 261 | 227 | | | 240 | | | 240 | 721 |
| 13:00 | 278 | 264 | 259 | | | 267 | | | 267 | 801 |
| 14:00 | 281 | 267 | 253 | | | 267 | | | 267 | 801 |
| 15:00 | 293 | 312 | 284 | | | 296 | | | 296 | 889 |
| 16:00 | 270 | 346 | 283 | | | 299 | | | 299 | 899 |
| 17:00 | 359 | 361 | 330 | | | 350 | | | 350 | 1050 |
| 18:00 | 369 | 409 | 415 | | | 397 | | | 397 | 1193 |
| 19:00 | 299 | 334 | 330 | | | 321 | | | 321 | 963 |
| 20:00 | 209 | 222 | 256 | | | 229 | | | 229 | 687 |
| 21:00 | 144 | 172 | 153 | | | 156 | | | 156 | 469 |
| 22:00 | 112 | 119 | 119 | | | 116 | | | 116 | 350 |
| 23:00 | 64 | 60 | 78 | | | 67 | | | 67 | 202 |
| 24:00 | 42 | 30 | 46 | | | 39 | | | 39 | 118 |
| TOTALS | 3192 | 4731 | 4629 | 1300 | 0 | 4610 | 0 | 0 | 4610 | 13852 |
| % AVG WKDY | 69.2 | 102.6 | 100.4 | 28.1 | | | | | | |
| % AVG WEEK | 69.2 | 102.6 | 100.4 | 28.1 | | | | | | |
| AM Times | 11:00 | 09:00 | 09:00 | 09:00 | | 09:00 | | | 09:00 | |
| AM Peaks | 239 | 401 | 421 | 385 | | 402 | | | 402 | |
| PM Times | 18:00 | 18:00 | 18:00 | | | 18:00 | | | 18:00 | |
| PM Peaks | 369 | 409 | 415 | | | 397 | | | 397 | |

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EB 4610
WB 8557
COMB AWD 13167
FAC .91(.98)
COMB ADT 11,700

Mass Highway Department
WEEKLY SUMMARY FOR LANE 2
Starting: 5/23/2011



STA. 7 WB

Site Reference: 110280000859
Site ID: 000000070304
Location: NORTH ST. EAST OF ALBEMARLE RD.
Direction: WEST

File: 70304.prn
City: NEWTON
County: DIR VOL E&W

| TIME | MON 23 | TUE 24 | WED 25 | THU 26 | FRI | WKDAY AVG | SAT | SUN | WEEK AVG | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|
| 01:00 | | 36 | 39 | 42 | | 39 | | | 39 | 117 |
| 02:00 | | 15 | 10 | 25 | | 16 | | | 16 | 50 |
| 03:00 | | 14 | 8 | 14 | | 12 | | | 12 | 36 |
| 04:00 | | 4 | 12 | 20 | | 12 | | | 12 | 36 |
| 05:00 | | 33 | 18 | 27 | | 26 | | | 26 | 78 |
| 06:00 | | 89 | 92 | 94 | | 91 | | | 91 | 275 |
| 07:00 | | 230 | 200 | 216 | | 215 | | | 215 | 646 |
| 08:00 | | 469 | 390 | 423 | | 427 | | | 427 | 1282 |
| 09:00 | | 596 | 654 | 636 | | 628 | | | 628 | 1886 |
| 10:00 | | 479 | 500 | 474 | | 484 | | | 484 | 1453 |
| 11:00 | 455 | 436 | 438 | | | 443 | | | 443 | 1329 |
| 12:00 | 393 | 450 | 495 | | | 446 | | | 446 | 1338 |
| 13:00 | 524 | 502 | 483 | | | 503 | | | 503 | 1509 |
| 14:00 | 487 | 532 | 532 | | | 517 | | | 517 | 1551 |
| 15:00 | 468 | 579 | 517 | | | 521 | | | 521 | 1564 |
| 16:00 | 609 | 674 | 736 | | | 673 | | | 673 | 2019 |
| 17:00 | 713 | 719 | 760 | | | 730 | | | 730 | 2192 |
| 18:00 | 866 | 927 | 773 | | | 855 | | | 855 | 2566 |
| 19:00 | 607 | 743 | 699 | | | 683 | | | 683 | 2049 |
| 20:00 | 440 | 485 | 515 | | | 480 | | | 480 | 1440 |
| 21:00 | 279 | 336 | 343 | | | 319 | | | 319 | 958 |
| 22:00 | 190 | 283 | 262 | | | 245 | | | 245 | 735 |
| 23:00 | 103 | 103 | 152 | | | 119 | | | 119 | 358 |
| 24:00 | 82 | 56 | 81 | | | 73 | | | 73 | 219 |
| TOTALS | 6216 | 8790 | 8709 | 1971 | 0 | 8557 | 0 | 0 | 8557 | 25686 |
| % AVG WKDY | 72.6 | 102.7 | 101.7 | 23 | | | | | | |
| % AVG WEEK | 72.6 | 102.7 | 101.7 | 23 | | | | | | |
| AM Times | 11:00 | 09:00 | 09:00 | 09:00 | | 09:00 | | | 09:00 | |
| AM Peaks | 455 | 596 | 654 | 636 | | 628 | | | 628 | |
| PM Times | 18:00 | 18:00 | 18:00 | | | 18:00 | | | 18:00 | |
| PM Peaks | 866 | 927 | 773 | | | 855 | | | 855 | |

# APPENDIX G

**Preliminary Traffic Signal Warrants Analysis:**
**Crafts Street at Albemarle Road, Newton**

## Summary of Hourly Volumes and Warrant Fulfillment
## Crafts Street at Albemarle Road, Newton

| Hourly Period Starting | Crafts Street (main street) | | Albemarle Road (minor street) | | Sum of main street | Higher of minor street | Volumes above the minimum requirement | | |
|---|---|---|---|---|---|---|---|---|---|
| | EB | WB | SB | NB | | | Warrant 1 | Warrant 2 | Warrant 7 |
| **6:00** | 127 | 130 | 12 | 41 | 257 | 41 | | | |
| **7:00** | 426 | 401 | 30 | 133 | 827 | 133 | | | X |
| **8:00** | 832 | 792 | 123 | 268 | 1,624 | 268 | X | X | X |
| **9:00** | 916 | 797 | 201 | 272 | 1,713 | 272 | X | X | X |
| **10:00** | 639 | 587 | 102 | 176 | 1,226 | 176 | X | X | X |
| **11:00** | 507 | 521 | 85 | 174 | 1,028 | 174 | X | X | X |
| **12:00** | 499 | 573 | 102 | 179 | 1,072 | 179 | X | X | X |
| **13:00** | 577 | 611 | 123 | 200 | 1,188 | 200 | X | X | X |
| **14:00** | 566 | 614 | 111 | 202 | 1,180 | 202 | X | X | X |
| **15:00** | 580 | 697 | 134 | 243 | 1,277 | 243 | X | X | X |
| **16:00** | 733 | 835 | 200 | 256 | 1,568 | 256 | X | X | X |
| **17:00** | 731 | 978 | 182 | 291 | 1,709 | 291 | X | X | X |
| **18:00** | 862 | 1,038 | 219 | 308 | 1,900 | 308 | X | X | X |
| **19:00** | 717 | 926 | 185 | 228 | 1,643 | 228 | X | X | X |

Note: **Warrant 1 is fulfilled.** It requires that the traffic conditions (observed vehicular volumes higher than the specified minimum volumes) exist for each of any 8 hours of an average day. Condition A was applied in this case.
**Warrant 2 is fulfilled.** It requires that the traffic conditions (minimum volumes specified differently from Warrant 1) exist for each of any 4 hours of an average day.
**Warrant 7** (crash experience) requires that the traffic conditions (vehicular volumes higher than 80 percent of the volumes specified in Warrant 1 Condition A), in addition to the requirement of five or more correctable crashes in a recent 12-month period.

# APPENDIX H

**Alternative 1: Retime the Signal at North Street**

**AM/PM Peak-Hour Intersection Capacity Analysis:**
**Crafts Street at North Street, Newton**

| Lane Group | EBL | EBT | WBT | WBR | SBL | ø9 |
|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | |
| Volume (vph) | 108 | 741 | 573 | 280 | 363 | |
| Lane Group Flow (vph) | 115 | 788 | 610 | 298 | 418 | |
| Turn Type | pm+pt | | | pt+ov | | |
| Protected Phases | 7 | 4 | 8 | 6 8 | 6 | 9 |
| Permitted Phases | 4 | | | | | |
| Detector Phase | 7 | 4 | 8 | 6 8 | 6 | |
| Switch Phase | | | | | | |
| Minimum Initial (s) | 4.0 | 8.0 | 8.0 | | 8.0 | 4.0 |
| Minimum Split (s) | 10.0 | 14.0 | 14.0 | | 14.0 | 35.0 |
| Total Split (s) | 10.0 | 50.0 | 40.0 | 68.0 | 28.0 | 35.0 |
| Total Split (%) | 8.8% | 44.2% | 35.4% | 60.2% | 24.8% | 31% |
| Yellow Time (s) | 3.0 | 4.0 | 4.0 | | 3.0 | 3.0 |
| All-Red Time (s) | 0.0 | 2.0 | 2.0 | | 2.0 | 2.0 |
| Lost Time Adjust (s) | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | |
| Total Lost Time (s) | 3.0 | 6.0 | 6.0 | 5.0 | 5.0 | |
| Lead/Lag | Lead | | Lag | | | |
| Lead-Lag Optimize? | | | | | | |
| Recall Mode | Max | Max | Max | | None | None |
| Act Effct Green (s) | 48.6 | 45.5 | 35.1 | 62.5 | 23.8 | |
| Actuated g/C Ratio | 0.49 | 0.46 | 0.35 | 0.63 | 0.24 | |
| v/c Ratio | 0.59 | 0.97 | 0.98 | 0.31 | 0.92 | |
| Control Delay | 33.4 | 56.0 | 67.7 | 9.1 | 66.6 | |
| Queue Delay | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | |
| Total Delay | 33.4 | 56.0 | 67.7 | 9.1 | 66.6 | |
| LOS | C | E | E | A | E | |
| Approach Delay | | 53.2 | 48.5 | | 66.6 | |
| Approach LOS | | D | D | | E | |
| Queue Length 50th (ft) | 52 | ~672 | ~525 | 88 | ~340 | |
| Queue Length 95th (ft) | #121 | #908 | #744 | 134 | #536 | |
| Internal Link Dist (ft) | | 282 | 1100 | | 528 | |
| Turn Bay Length (ft) | 110 | | | | | |
| Base Capacity (vph) | 194 | 813 | 622 | 962 | 456 | |
| Starvation Cap Reductn | 0 | 0 | 0 | 0 | 0 | |
| Spillback Cap Reductn | 0 | 0 | 0 | 0 | 0 | |
| Storage Cap Reductn | 0 | 0 | 0 | 0 | 0 | |
| Reduced v/c Ratio | 0.59 | 0.97 | 0.98 | 0.31 | 0.92 | |

## Intersection Summary

Cycle Length: 113
Actuated Cycle Length: 99
Natural Cycle: 130
Control Type: Semi Act-Uncoord
Maximum v/c Ratio: 0.98
Intersection Signal Delay: 53.8 Intersection LOS: D
Intersection Capacity Utilization 69.8% ICU Level of Service C
Analysis Period (min) 15

~ Volume exceeds capacity, queue is theoretically infinite.
Queue shown is maximum after two cycles.

# 95th percentile volume exceeds capacity, queue may be longer.
Queue shown is maximum after two cycles.

Splits and Phases: 4: Crafts & North

| Lane Group | EBL | EBT | WBT | WBR | SBL | ø9 |
|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | |
| Volume (vph) | 207 | 602 | 733 | 319 | 393 | |
| Lane Group Flow (vph) | 218 | 634 | 814 | 354 | 456 | |
| Turn Type | pm+pt | | | pt+ov | | |
| Protected Phases | 7 | 4 | 8 | 6 8 | 6 | 9 |
| Permitted Phases | 4 | | | | | |
| Detector Phase | 7 | 4 | 8 | 6 8 | 6 | |
| Switch Phase | | | | | | |
| Minimum Initial (s) | 4.0 | 8.0 | 8.0 | | 8.0 | 4.0 |
| Minimum Split (s) | 11.0 | 14.0 | 14.0 | | 14.0 | 35.0 |
| Total Split (s) | 11.0 | 52.0 | 41.0 | 67.0 | 26.0 | 35.0 |
| Total Split (%) | 9.7% | 46.0% | 36.3% | 59.3% | 23.0% | 31% |
| Yellow Time (s) | 3.0 | 4.0 | 4.0 | | 3.0 | 3.0 |
| All-Red Time (s) | 0.0 | 2.0 | 2.0 | | 2.0 | 2.0 |
| Lost Time Adjust (s) | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | |
| Total Lost Time (s) | 3.0 | 6.0 | 6.0 | 5.0 | 5.0 | |
| Lead/Lag | Lead | | Lag | | | |
| Lead-Lag Optimize? | | | | | | |
| Recall Mode | Max | Max | Max | | None | None |
| Act Effct Green (s) | 50.6 | 47.5 | 36.2 | 62.4 | 21.7 | |
| Actuated g/C Ratio | 0.55 | 0.52 | 0.39 | 0.68 | 0.24 | |
| v/c Ratio | 0.92 | 0.69 | 1.16 | 0.33 | 0.97 | |
| Control Delay | 62.8 | 26.0 | 116.0 | 7.8 | 72.6 | |
| Queue Delay | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | |
| Total Delay | 62.8 | 26.0 | 116.0 | 7.8 | 72.6 | |
| LOS | E | C | F | A | E | |
| Approach Delay | | 35.4 | 83.2 | | 72.6 | |
| Approach LOS | | D | F | | E | |
| Queue Length 50th (ft) | 51 | 178 | ~396 | 32 | 210 | |
| Queue Length 95th (ft) | #294 | #632 | #1052 | 162 | #611 | |
| Internal Link Dist (ft) | | 282 | 1100 | | 528 | |
| Turn Bay Length (ft) | 110 | | | | | |
| Base Capacity (vph) | 238 | 923 | 702 | 1064 | 471 | |
| Starvation Cap Reductn | 0 | 0 | 0 | 0 | 0 | |
| Spillback Cap Reductn | 0 | 0 | 0 | 0 | 0 | |
| Storage Cap Reductn | 0 | 0 | 0 | 0 | 0 | |
| Reduced v/c Ratio | 0.92 | 0.69 | 1.16 | 0.33 | 0.97 | |

| Intersection Summary | |
|---|---|
| Cycle Length: 113 | |
| Actuated Cycle Length: 92 | |
| Natural Cycle: 150 | |
| Control Type: Semi Act-Uncoord | |
| Maximum v/c Ratio: 1.16 | |
| Intersection Signal Delay: 64.8 | Intersection LOS: E |
| Intersection Capacity Utilization 86.9% | ICU Level of Service E |
| Analysis Period (min) 15 | |

~ Volume exceeds capacity, queue is theoretically infinite.
Queue shown is maximum after two cycles.

# 95th percentile volume exceeds capacity, queue may be longer.
Queue shown is maximum after two cycles.

Splits and Phases: 4: Crafts & North

# APPENDIX I

## Alternative 2: Upgrade the Signal at North Street

## AM/PM Peak-Hour Intersection Capacity Analysis: Crafts Street at North Street, Newton

| Lane Group | EBL | EBT | WBT | WBR | SBL | ø9 |
|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | |
| Volume (vph) | 108 | 741 | 573 | 280 | 363 | |
| Lane Group Flow (vph) | 115 | 788 | 610 | 298 | 418 | |
| Turn Type | pm+pt | | | pm+ov | | |
| Protected Phases | 7 | 4 | 8 | 6 | 6 | 9 |
| Permitted Phases | 4 | | | 8 | | |
| Detector Phase | 7 | 4 | 8 | 6 | 6 | |
| Switch Phase | | | | | | |
| Minimum Initial (s) | 2.0 | 8.0 | 8.0 | 8.0 | 8.0 | 4.0 |
| Minimum Split (s) | 6.0 | 14.0 | 14.0 | 14.0 | 14.0 | 35.0 |
| Total Split (s) | 7.0 | 52.0 | 45.0 | 28.0 | 28.0 | 35.0 |
| Total Split (%) | 6.1% | 45.2% | 39.1% | 24.3% | 24.3% | 30% |
| Yellow Time (s) | 3.0 | 4.0 | 4.0 | 3.0 | 3.0 | 3.0 |
| All-Red Time (s) | 0.0 | 2.0 | 2.0 | 2.0 | 2.0 | 2.0 |
| Lost Time Adjust (s) | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | |
| Total Lost Time (s) | 3.0 | 6.0 | 6.0 | 5.0 | 5.0 | |
| Lead/Lag | Lead | | Lag | | | |
| Lead-Lag Optimize? | Yes | | Yes | | | |
| Recall Mode | Max | Max | Max | None | None | None |
| Act Effct Green (s) | 50.6 | 47.5 | 40.2 | 65.0 | 23.7 | |
| Actuated g/C Ratio | 0.50 | 0.47 | 0.40 | 0.64 | 0.23 | |
| v/c Ratio | 0.64 | 0.95 | 0.87 | 0.31 | 0.94 | |
| Control Delay | 39.7 | 51.3 | 47.2 | 8.5 | 71.2 | |
| Queue Delay | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | |
| Total Delay | 39.7 | 51.3 | 47.2 | 8.5 | 71.2 | |
| LOS | D | D | D | A | E | |
| Approach Delay | | 49.8 | 34.5 | | 71.3 | |
| Approach LOS | | D | C | | E | |
| Queue Length 50th (ft) | 52 | ~670 | ~483 | 88 | ~352 | |
| Queue Length 95th (ft) | #124 | #906 | #703 | 133 | #548 | |
| Internal Link Dist (ft) | | 282 | 1100 | | 528 | |
| Turn Bay Length (ft) | 110 | | | | | |
| Base Capacity (vph) | 179 | 832 | 698 | 966 | 446 | |
| Starvation Cap Reductn | 0 | 0 | 0 | 0 | 0 | |
| Spillback Cap Reductn | 0 | 0 | 0 | 0 | 0 | |
| Storage Cap Reductn | 0 | 0 | 0 | 0 | 0 | |
| Reduced v/c Ratio | 0.64 | 0.95 | 0.87 | 0.31 | 0.94 | |

## Intersection Summary

Cycle Length: 115
Actuated Cycle Length: 101
Natural Cycle: 130
Control Type: Actuated-Uncoordinated
Maximum v/c Ratio: 0.95
Intersection Signal Delay: 47.6 Intersection LOS: D
Intersection Capacity Utilization 69.8% ICU Level of Service C
Analysis Period (min) 15

~ Volume exceeds capacity, queue is theoretically infinite.
Queue shown is maximum after two cycles.

# 95th percentile volume exceeds capacity, queue may be longer.
Queue shown is maximum after two cycles.

Splits and Phases: 8: Crafts & North

| Lane Group | EBL | EBT | WBT | WBR | SBL | ø9 |
|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | |
| Volume (vph) | 207 | 602 | 733 | 319 | 393 | |
| Lane Group Flow (vph) | 218 | 634 | 814 | 354 | 456 | |
| Turn Type | pm+pt | | | pm+ov | | |
| Protected Phases | 7 | 4 | 8 | 6 | 6 | 9 |
| Permitted Phases | 4 | | | 8 | | |
| Detector Phase | 7 | 4 | 8 | 6 | 6 | |
| Switch Phase | | | | | | |
| Minimum Initial (s) | 2.0 | 8.0 | 8.0 | 8.0 | 8.0 | 4.0 |
| Minimum Split (s) | 6.0 | 14.0 | 14.0 | 14.0 | 14.0 | 35.0 |
| Total Split (s) | 11.0 | 54.0 | 43.0 | 26.0 | 26.0 | 35.0 |
| Total Split (%) | 9.6% | 47.0% | 37.4% | 22.6% | 22.6% | 30% |
| Yellow Time (s) | 3.0 | 4.0 | 4.0 | 3.0 | 3.0 | 3.0 |
| All-Red Time (s) | 0.0 | 2.0 | 2.0 | 2.0 | 2.0 | 2.0 |
| Lost Time Adjust (s) | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | |
| Total Lost Time (s) | 3.0 | 6.0 | 6.0 | 5.0 | 5.0 | |
| Lead/Lag | Lead | | Lag | | | |
| Lead-Lag Optimize? | Yes | | Yes | | | |
| Recall Mode | Max | Max | Max | None | None | None |
| Act Effct Green (s) | 52.6 | 49.5 | 38.2 | 60.9 | 21.7 | |
| Actuated g/C Ratio | 0.56 | 0.53 | 0.41 | 0.65 | 0.23 | |
| v/c Ratio | 0.94 | 0.67 | 1.12 | 0.35 | 0.99 | |
| Control Delay | 68.4 | 25.3 | 101.4 | 7.9 | 79.0 | |
| Queue Delay | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | |
| Total Delay | 68.4 | 25.3 | 101.4 | 7.9 | 79.0 | |
| LOS | E | C | F | A | E | |
| Approach Delay | | 36.3 | 73.1 | | 79.0 | |
| Approach LOS | | D | E | | E | |
| Queue Length 50th (ft) | 55 | 178 | 385 | 32 | 218 | |
| Queue Length 95th (ft) | #302 | #627 | #1051 | 160 | #626 | |
| Internal Link Dist (ft) | | 282 | 1100 | | 528 | |
| Turn Bay Length (ft) | 110 | | | | | |
| Base Capacity (vph) | 233 | 941 | 726 | 999 | 460 | |
| Starvation Cap Reductn | 0 | 0 | 0 | 0 | 0 | |
| Spillback Cap Reductn | 0 | 0 | 0 | 0 | 0 | |
| Storage Cap Reductn | 0 | 0 | 0 | 0 | 0 | |
| Reduced v/c Ratio | 0.94 | 0.67 | 1.12 | 0.35 | 0.99 | |

## Intersection Summary

Cycle Length: 115
Actuated Cycle Length: 94
Natural Cycle: 150
Control Type: Actuated-Uncoordinated
Maximum v/c Ratio: 1.12
Intersection Signal Delay: 61.5 Intersection LOS: E
Intersection Capacity Utilization 86.9% ICU Level of Service E
Analysis Period (min) 15
# 95th percentile volume exceeds capacity, queue may be longer.
Queue shown is maximum after two cycles.

Splits and Phases: 4: Crafts & North

# APPENDIX J

**Alternative 3: Install a Traffic Signal at Albemarle Road and Coordinate It with the Upgraded Signal at North Street**

**AM/PM Peak-Hour Intersection Capacity Analysis:**

**Crafts Street at North Street, Newton**
**and**
**Crafts Street at Albemarle Road, Newton**

| Lane Group | EBL | EBT | WBT | WBR | SBL | ø9 |
|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | |
| Volume (vph) | 108 | 741 | 573 | 280 | 363 | |
| Lane Group Flow (vph) | 115 | 788 | 610 | 298 | 418 | |
| Turn Type | pm+pt | | | pt+ov | | |
| Protected Phases | 7 | 4 | 8 | 6 8 | 6 | 9 |
| Permitted Phases | 4 | | | | | |
| Detector Phase | 7 | 4 | 8 | 6 8 | 6 | |
| Switch Phase | | | | | | |
| Minimum Initial (s) | 5.0 | 4.0 | 4.0 | | 4.0 | 4.0 |
| Minimum Split (s) | 8.0 | 20.0 | 20.0 | | 20.0 | 35.0 |
| Total Split (s) | 8.0 | 50.0 | 42.0 | 72.0 | 30.0 | 35.0 |
| Total Split (%) | 7.0% | 43.5% | 36.5% | 62.6% | 26.1% | 30% |
| Yellow Time (s) | 3.0 | 3.0 | 3.0 | | 3.0 | 3.0 |
| All-Red Time (s) | 0.0 | 2.0 | 2.0 | | 2.0 | 2.0 |
| Lost Time Adjust (s) | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | |
| Total Lost Time (s) | 3.0 | 5.0 | 5.0 | 5.0 | 5.0 | |
| Lead/Lag | Lead | | Lag | | | |
| Lead-Lag Optimize? | | | Yes | | | |
| Recall Mode | None | C-Max | C-Max | | None | None |
| Act Effct Green (s) | 61.0 | 59.0 | 51.0 | 78.0 | 25.0 | |
| Actuated g/C Ratio | 0.53 | 0.51 | 0.44 | 0.68 | 0.22 | |
| v/c Ratio | 0.55 | 0.87 | 0.79 | 0.29 | 1.01 | |
| Control Delay | 26.9 | 35.2 | 40.6 | 8.2 | 92.6 | |
| Queue Delay | 0.0 | 0.6 | 0.0 | 0.0 | 0.0 | |
| Total Delay | 26.9 | 35.8 | 40.6 | 8.2 | 92.6 | |
| LOS | C | D | D | A | F | |
| Approach Delay | | 34.6 | 30.0 | | 92.6 | |
| Approach LOS | | C | C | | F | |
| Queue Length 50th (ft) | 46 | ~685 | ~506 | 88 | ~318 | |
| Queue Length 95th (ft) | m#76 | #900 | #727 | 133 | #522 | |
| Internal Link Dist (ft) | | 282 | 1100 | | 528 | |
| Turn Bay Length (ft) | 110 | | | | | |
| Base Capacity (vph) | 211 | 908 | 777 | 1034 | 413 | |
| Starvation Cap Reductn | 0 | 17 | 0 | 0 | 0 | |
| Spillback Cap Reductn | 0 | 0 | 0 | 0 | 0 | |
| Storage Cap Reductn | 0 | 0 | 0 | 0 | 0 | |
| Reduced v/c Ratio | 0.55 | 0.88 | 0.79 | 0.29 | 1.01 | |

## Intersection Summary

Cycle Length: 115
Actuated Cycle Length: 115
Offset: 0 (0%), Referenced to phase 4:EBTL and 8:WBT, Start of Green, Master Intersection
Natural Cycle: 125
Control Type: Actuated-Coordinated
Maximum v/c Ratio: 1.01
Intersection Signal Delay: 43.6 Intersection LOS: D
Intersection Capacity Utilization 69.0% ICU Level of Service C
Analysis Period (min) 15
~ Volume exceeds capacity, queue is theoretically infinite.

Queue shown is maximum after two cycles.

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

Queue shown is maximum after two cycles.

m Volume for 95th percentile queue is metered by upstream signal.

Splits and Phases: 4: Crafts & North

| Lane Group | EBT | WBT | NBT | NBR | ø4 | ø11 |
|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | |
| Volume (vph) | 679 | 512 | 51 | 85 | | |
| Lane Group Flow (vph) | 722 | 546 | 134 | 106 | | |
| Turn Type | | | | Prot | | |
| Protected Phases | 4 10 | 10 | 2 | 2 | 4 | 11 |
| Permitted Phases | | | | | | |
| Detector Phase | 4 10 | 10 | 2 | 2 | | |
| Switch Phase | | | | | | |
| Minimum Initial (s) | | 4.0 | 4.0 | 4.0 | 4.0 | 4.0 |
| Minimum Split (s) | | 20.0 | 10.0 | 10.0 | 10.0 | 30.0 |
| Total Split (s) | 67.0 | 52.0 | 18.0 | 18.0 | 15.0 | 30.0 |
| Total Split (%) | 58.3% | 45.2% | 15.7% | 15.7% | 13% | 26% |
| Yellow Time (s) | | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 |
| All-Red Time (s) | | 2.0 | 2.0 | 2.0 | 2.0 | 2.0 |
| Lost Time Adjust (s) | 0.0 | 0.0 | 0.0 | 0.0 | | |
| Total Lost Time (s) | 5.0 | 5.0 | 5.0 | 5.0 | | |
| Lead/Lag | | | | | | |
| Lead-Lag Optimize? | | | | | | |
| Recall Mode | | C-Max | None | None | None | None |
| Act Effct Green (s) | 80.8 | 65.8 | 12.2 | 12.2 | | |
| Actuated g/C Ratio | 0.70 | 0.57 | 0.11 | 0.11 | | |
| v/c Ratio | 0.50 | 0.47 | 0.71 | 0.66 | | |
| Control Delay | 3.7 | 3.8 | 69.7 | 69.5 | | |
| Queue Delay | 1.1 | 1.3 | 0.0 | 6.3 | | |
| Total Delay | 4.8 | 5.1 | 69.7 | 75.8 | | |
| LOS | A | A | E | E | | |
| Approach Delay | 4.8 | 5.1 | 72.4 | | | |
| Approach LOS | A | A | E | | | |
| Queue Length 50th (ft) | 11 | 14 | 97 | 76 | | |
| Queue Length 95th (ft) | 54 | m36 | 144 | 120 | | |
| Internal Link Dist (ft) | 9 | 282 | 317 | | | |
| Turn Bay Length (ft) | | | | 50 | | |
| Base Capacity (vph) | 1442 | 1164 | 203 | 171 | | |
| Starvation Cap Reductn | 0 | 397 | 0 | 0 | | |
| Spillback Cap Reductn | 451 | 0 | 0 | 32 | | |
| Storage Cap Reductn | 0 | 0 | 0 | 0 | | |
| Reduced v/c Ratio | 0.73 | 0.71 | 0.66 | 0.76 | | |

## Intersection Summary

Cycle Length: 115
Actuated Cycle Length: 115
Offset: 112 (97%), Referenced to phase 10:EBWB, Start of Green
Natural Cycle: 90
Control Type: Actuated-Coordinated
Maximum v/c Ratio: 0.71
Intersection Signal Delay: 15.7 Intersection LOS: B
Intersection Capacity Utilization 94.1% ICU Level of Service F
Analysis Period (min) 15
m Volume for 95th percentile queue is metered by upstream signal.

Splits and Phases: 8: Crafts & Albemarle

| Lane Group | EBT | WBL | WBT | SBT | SBR | ø11 |
|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | |
| Volume (vph) | 681 | 50 | 462 | 79 | 134 | |
| Lane Group Flow (vph) | 772 | 53 | 491 | 98 | 156 | |
| Turn Type | | D.P+P | | | Prot | |
| Protected Phases | 10 | 2 | 2 10 | 4 | 4 | 11 |
| Permitted Phases | | 10 | | | | |
| Detector Phase | 10 | 2 | 2 10 | 4 | 4 | |
| Switch Phase | | | | | | |
| Minimum Initial (s) | 4.0 | 4.0 | | 4.0 | 4.0 | 4.0 |
| Minimum Split (s) | 20.0 | 10.0 | | 10.0 | 10.0 | 30.0 |
| Total Split (s) | 52.0 | 18.0 | 70.0 | 15.0 | 15.0 | 30.0 |
| Total Split (%) | 45.2% | 15.7% | 60.9% | 13.0% | 13.0% | 26% |
| Yellow Time (s) | 3.0 | 3.0 | | 3.0 | 3.0 | 3.0 |
| All-Red Time (s) | 2.0 | 2.0 | | 2.0 | 2.0 | 2.0 |
| Lost Time Adjust (s) | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | |
| Total Lost Time (s) | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | |
| Lead/Lag | | | | | | |
| Lead-Lag Optimize? | | | | | | |
| Recall Mode | C-Max | None | | None | None | None |
| Act Effct Green (s) | 65.8 | 78.0 | 81.0 | 10.0 | 10.0 | |
| Actuated g/C Ratio | 0.57 | 0.68 | 0.70 | 0.09 | 0.09 | |
| v/c Ratio | 0.69 | 0.14 | 0.34 | 0.61 | 0.69 | |
| Control Delay | 26.0 | 1.9 | 1.5 | 67.6 | 34.7 | |
| Queue Delay | 0.1 | 0.0 | 0.0 | 0.0 | 0.0 | |
| Total Delay | 26.1 | 1.9 | 1.5 | 67.6 | 34.7 | |
| LOS | C | A | A | E | C | |
| Approach Delay | 26.1 | | 1.5 | 47.4 | | |
| Approach LOS | C | | A | D | | |
| Queue Length 50th (ft) | 284 | 0 | 1 | 71 | 33 | |
| Queue Length 95th (ft) | #811 | m4 | 22 | #125 | #107 | |
| Internal Link Dist (ft) | 637 | | 9 | 245 | | |
| Turn Bay Length (ft) | | | | | 25 | |
| Base Capacity (vph) | 1118 | 389 | 1459 | 160 | 225 | |
| Starvation Cap Reductn | 0 | 0 | 0 | 0 | 0 | |
| Spillback Cap Reductn | 22 | 0 | 0 | 0 | 0 | |
| Storage Cap Reductn | 0 | 0 | 0 | 0 | 0 | |
| Reduced v/c Ratio | 0.70 | 0.14 | 0.34 | 0.61 | 0.69 | |

## Intersection Summary

Cycle Length: 115
Actuated Cycle Length: 115
Offset: 112 (97%), Referenced to phase 10:EBWB, Start of Green
Natural Cycle: 90
Control Type: Actuated-Coordinated
Maximum v/c Ratio: 0.71
Intersection Signal Delay: 21.0 Intersection LOS: C
Intersection Capacity Utilization 94.1% ICU Level of Service F
Analysis Period (min) 15
# 95th percentile volume exceeds capacity, queue may be longer.

Queue shown is maximum after two cycles.

m Volume for 95th percentile queue is metered by upstream signal.

Splits and Phases: 5: Crafts & Albemarle

| Lane Group | EBL | EBT | WBT | WBR | SBL | ø9 |
|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | |
| Volume (vph) | 207 | 602 | 733 | 319 | 393 | |
| Lane Group Flow (vph) | 218 | 634 | 797 | 347 | 456 | |
| Turn Type | pm+pt | | | pt+ov | | |
| Protected Phases | 7 | 4 | 8 | 6 8 | 6 | 9 |
| Permitted Phases | 4 | | | | | |
| Detector Phase | 7 | 4 | 8 | 6 8 | 6 | |
| Switch Phase | | | | | | |
| Minimum Initial (s) | 5.0 | 8.0 | 8.0 | | 8.0 | 4.0 |
| Minimum Split (s) | 10.0 | 14.0 | 14.0 | | 14.0 | 35.0 |
| Total Split (s) | 11.0 | 53.0 | 42.0 | 74.0 | 32.0 | 35.0 |
| Total Split (%) | 9.2% | 44.2% | 35.0% | 61.7% | 26.7% | 29% |
| Yellow Time (s) | 3.0 | 4.0 | 4.0 | | 3.0 | 3.0 |
| All-Red Time (s) | 0.0 | 2.0 | 2.0 | | 2.0 | 2.0 |
| Lost Time Adjust (s) | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | |
| Total Lost Time (s) | 3.0 | 6.0 | 6.0 | 5.0 | 5.0 | |
| Lead/Lag | Lead | | Lag | | | |
| Lead-Lag Optimize? | | | | | | |
| Recall Mode | Min | C-Max | C-Max | | None | None |
| Act Effct Green (s) | 64.0 | 61.0 | 50.0 | 80.0 | 27.0 | |
| Actuated g/C Ratio | 0.53 | 0.51 | 0.42 | 0.67 | 0.22 | |
| v/c Ratio | 1.22 | 0.70 | 1.07 | 0.33 | 1.01 | |
| Control Delay | 170.2 | 30.1 | 89.2 | 8.7 | 92.2 | |
| Queue Delay | 0.0 | 0.3 | 0.0 | 0.0 | 0.0 | |
| Total Delay | 170.2 | 30.4 | 89.2 | 8.7 | 92.2 | |
| LOS | F | C | F | A | F | |
| Approach Delay | | 66.2 | 64.8 | | 92.2 | |
| Approach LOS | | E | E | | F | |
| Queue Length 50th (ft) | ~185 | 284 | ~853 | 105 | ~363 | |
| Queue Length 95th (ft) | #346 | #670 | #1093 | 156 | #577 | |
| Internal Link Dist (ft) | | 282 | 1100 | | 528 | |
| Turn Bay Length (ft) | 110 | | | | | |
| Base Capacity (vph) | 179 | 908 | 744 | 1045 | 450 | |
| Starvation Cap Reductn | 0 | 43 | 0 | 0 | 0 | |
| Spillback Cap Reductn | 0 | 0 | 0 | 0 | 0 | |
| Storage Cap Reductn | 0 | 0 | 0 | 0 | 0 | |
| Reduced v/c Ratio | 1.22 | 0.73 | 1.07 | 0.33 | 1.01 | |

## Intersection Summary

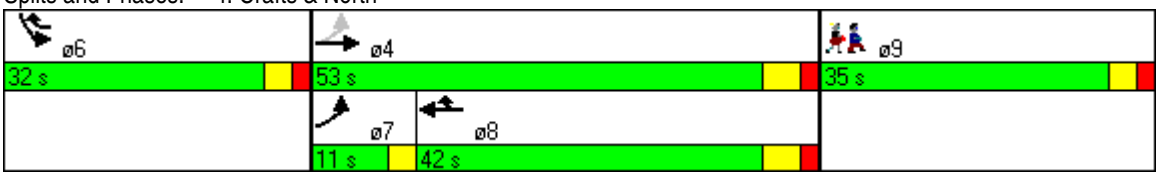
Cycle Length: 120
Actuated Cycle Length: 120
Offset: 0 (0%), Referenced to phase 4:EBTL and 8:WBT, Start of Green, Master Intersection
Natural Cycle: 150
Control Type: Actuated-Coordinated
Maximum v/c Ratio: 1.22
Intersection Signal Delay: 70.4 Intersection LOS: E
Intersection Capacity Utilization 86.9% ICU Level of Service E
Analysis Period (min) 15
~ Volume exceeds capacity, queue is theoretically infinite.

Queue shown is maximum after two cycles.

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

Queue shown is maximum after two cycles.

Splits and Phases: 4: Crafts & North



| Lane Group | EBT | WBT | NBT | NBR | ø4 | ø11 |
|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | |
| Volume (vph) | 702 | 731 | 83 | 88 | | |
| Lane Group Flow (vph) | 747 | 796 | 165 | 91 | | |
| Turn Type | | | | Prot | | |
| Protected Phases | 4 10 | 10 | 2 | 2 | 4 | 11 |
| Permitted Phases | | | | | | |
| Detector Phase | 4 10 | 10 | 2 | 2 | | |
| Switch Phase | | | | | | |
| Minimum Initial (s) | | 4.0 | 4.0 | 4.0 | 4.0 | 4.0 |
| Minimum Split (s) | | 20.0 | 20.0 | 20.0 | 10.0 | 30.0 |
| Total Split (s) | 70.0 | 58.0 | 20.0 | 20.0 | 12.0 | 30.0 |
| Total Split (%) | 58.3% | 48.3% | 16.7% | 16.7% | 10% | 25% |
| Yellow Time (s) | | 3.5 | 3.5 | 3.5 | 3.5 | 3.0 |
| All-Red Time (s) | | 0.5 | 0.5 | 0.5 | 0.5 | 2.0 |
| Lost Time Adjust (s) | 0.0 | 0.0 | 0.0 | 0.0 | | |
| Total Lost Time (s) | 4.0 | 4.0 | 4.0 | 4.0 | | |
| Lead/Lag | | | | | | |
| Lead-Lag Optimize? | | | | | | |
| Recall Mode | | C-Max | None | None | None | None |
| Act Effct Green (s) | 79.0 | 67.0 | 15.0 | 15.0 | | |
| Actuated g/C Ratio | 0.66 | 0.56 | 0.12 | 0.12 | | |
| v/c Ratio | 0.54 | 0.70 | 0.72 | 0.45 | | |
| Control Delay | 2.2 | 9.0 | 68.2 | 55.9 | | |
| Queue Delay | 0.5 | 3.1 | 0.0 | 4.4 | | |
| Total Delay | 2.7 | 12.2 | 68.2 | 60.3 | | |
| LOS | A | B | E | E | | |
| Approach Delay | 2.7 | 12.2 | 65.4 | | | |
| Approach LOS | A | B | E | | | |
| Queue Length 50th (ft) | 10 | 121 | 123 | 66 | | |
| Queue Length 95th (ft) | 27 | m80 | 192 | 120 | | |
| Internal Link Dist (ft) | 9 | 282 | 317 | | | |
| Turn Bay Length (ft) | | | | 50 | | |
| Base Capacity (vph) | 1377 | 1136 | 245 | 215 | | |
| Starvation Cap Reductn | 0 | 236 | 0 | 0 | | |
| Spillback Cap Reductn | 260 | 0 | 0 | 71 | | |
| Storage Cap Reductn | 0 | 0 | 0 | 0 | | |
| Reduced v/c Ratio | 0.67 | 0.88 | 0.67 | 0.63 | | |

## Intersection Summary

Cycle Length: 120
Actuated Cycle Length: 120
Offset: 0 (0%), Referenced to phase 10:EBWB, Start of Green
Natural Cycle: 100
Control Type: Actuated-Coordinated
Maximum v/c Ratio: 0.75
Intersection Signal Delay: 15.8 Intersection LOS: B
Intersection Capacity Utilization 111.7% ICU Level of Service H
Analysis Period (min) 15
m Volume for 95th percentile queue is metered by upstream signal.

Splits and Phases: 8: Crafts & Albemarle

| Lane Group | EBT | WBL | WBT | SBT | SBR | ø11 |
|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | |
| Volume (vph) | 704 | 82 | 649 | 61 | 241 | |
| Lane Group Flow (vph) | 786 | 89 | 705 | 80 | 268 | |
| Turn Type | | D.P+P | | | Prot | |
| Protected Phases | 10 | 2 | 2 10 | 4 | 4 | 11 |
| Permitted Phases | | 10 | | | | |
| Detector Phase | 10 | 2 | 2 10 | 4 | 4 | |
| Switch Phase | | | | | | |
| Minimum Initial (s) | 4.0 | 4.0 | | 4.0 | 4.0 | 4.0 |
| Minimum Split (s) | 20.0 | 20.0 | | 10.0 | 10.0 | 30.0 |
| Total Split (s) | 58.0 | 20.0 | 78.0 | 12.0 | 12.0 | 30.0 |
| Total Split (%) | 48.3% | 16.7% | 65.0% | 10.0% | 10.0% | 25% |
| Yellow Time (s) | 3.5 | 3.5 | | 3.5 | 3.5 | 3.0 |
| All-Red Time (s) | 0.5 | 0.5 | | 0.5 | 0.5 | 2.0 |
| Lost Time Adjust (s) | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | |
| Total Lost Time (s) | 4.0 | 4.0 | 4.0 | 4.0 | 4.0 | |
| Lead/Lag | | | | | | |
| Lead-Lag Optimize? | | | | | | |
| Recall Mode | C-Max | None | | None | None | None |
| Act Effct Green (s) | 67.0 | 82.0 | 83.6 | 8.0 | 8.0 | |
| Actuated g/C Ratio | 0.56 | 0.68 | 0.70 | 0.07 | 0.07 | |
| v/c Ratio | 0.73 | 0.23 | 0.48 | 0.63 | 0.75 | |
| Control Delay | 29.0 | 4.0 | 1.5 | 77.2 | 20.3 | |
| Queue Delay | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | |
| Total Delay | 29.0 | 4.0 | 1.5 | 77.2 | 20.3 | |
| LOS | C | A | A | E | C | |
| Approach Delay | 29.0 | | 1.8 | 33.4 | | |
| Approach LOS | C | | A | C | | |
| Queue Length 50th (ft) | 551 | 1 | 8 | 61 | 0 | |
| Queue Length 95th (ft) | #804 | m4 | 24 | #132 | #107 | |
| Internal Link Dist (ft) | 637 | | 9 | 245 | | |
| Turn Bay Length (ft) | | | | | 100 | |
| Base Capacity (vph) | 1083 | 394 | 1474 | 126 | 357 | |
| Starvation Cap Reductn | 0 | 0 | 0 | 0 | 0 | |
| Spillback Cap Reductn | 1 | 0 | 0 | 0 | 0 | |
| Storage Cap Reductn | 0 | 0 | 0 | 0 | 0 | |
| Reduced v/c Ratio | 0.73 | 0.23 | 0.48 | 0.63 | 0.75 | |

## Intersection Summary

Cycle Length: 120
Actuated Cycle Length: 120
Offset: 0 (0%), Referenced to phase 10:EBWB, Start of Green
Natural Cycle: 100
Control Type: Actuated-Coordinated
Maximum v/c Ratio: 0.75
Intersection Signal Delay: 18.6 Intersection LOS: B
Intersection Capacity Utilization 111.7% ICU Level of Service H
Analysis Period (min) 15
# 95th percentile volume exceeds capacity, queue may be longer.

Queue shown is maximum after two cycles.

m Volume for 95th percentile queue is metered by upstream signal.

Splits and Phases: 5: Crafts & Albemarle

# APPENDIX K

## MassDOT Project Implementation Process

## MassDOT Project Implementation Process

The following description of the implementation process is based on Chapter 2 of the MassDOT Highway Division's *Project Development and Design Guide (2005)*. The text below borrows heavily from that document.

### 1 NEEDS IDENTIFICATION

For each of the locations at which an improvement is to be implemented, the MassDOT Highway Division leads an effort to define the problem, establishes project goals and objectives, and defines the scope of the planning needed for implementation. To that end, it has to complete a Project Need Form (PNF), which states in general terms the deficiencies or needs related to the transportation facility or location. The PNF documents the problems and explains why corrective action is needed. For this study, the information defining the need for the project will be drawn primarily, perhaps exclusively, from the present report. Also, at this point in the process, the MassDOT Highway Division meets with potential participants, such as the Boston Region Metropolitan Planning Organization (MPO) and community members, to allow for an informal review of the project.

The PNF is reviewed by the MassDOT Highway Division district office whose jurisdiction includes the location of the proposed project. The MassDOT Highway Division also sends the PNF to the MPO, for informational purposes. The outcome of this step determines whether the project requires further planning, whether it is already well supported by prior planning studies, and, therefore, whether it is ready to move forward into the design phase, or whether it should be dismissed from further consideration.

### 2 PLANNING

This phase will likely not be required for the implementation of the improvements proposed in this planning study, as this planning report should constitute the outcome of this step. However, in general, the purpose of this implementation step is for the project proponent to identify issues, impacts, and approvals that may need to be obtained, so that the subsequent design and permitting processes are understood.

The level of planning needed will vary widely, based on the complexity of the project. Typical tasks include: define the existing context, confirm project need, establish goals and objectives, initiate public outreach, define the project, collect data, develop and analyze alternatives, make recommendations, and provide documentation. Likely outcomes include consensus on the project definition to enable it to move forward into environmental documentation (if needed) and design, or a recommendation to delay the project or dismiss it from further consideration.

### 3 PROJECT INITIATION

At this point in the process, the proponent, the MassDOT Highway Division, fills out, for each improvement, a Project Initiation Form (PIF), which is reviewed by its Project Review Committee (PRC) and the MPO. The PRC is composed of the Chief Engineer, each District Highway Director, and representatives of the Project Management, Environmental, Planning, Right-of-Way, Traffic,

and Bridge departments, and the Capital Expenditure Program Office (CEPO). The PIF documents the project type and description, summarizes the project planning process, identifies likely funding and project management responsibility, and defines a plan for interagency and public participation. First the PRC reviews and evaluates the proposed project based on MassDOT's statewide priorities and criteria. If the result is positive, the MassDOT Highway Division moves the project forward to the design phase, and to programming review by the MPO. The PRC may provide a Project Management Plan to define roles and responsibilities for subsequent steps. The MPO review includes project evaluation based on the MPO's regional priorities and criteria. The MPO may assign a project evaluation criteria score, a Transportation Improvement Program (TIP) year, a tentative project category, and a tentative funding category.

4 ENVIRONMENTAL, DESIGN, AND RIGHT-OF-WAY PROCESS

This step has four distinct but closely integrated elements: public outreach, environmental documentation and permitting (if required), design, and right-of-way acquisition (if required). The outcome of this step is a fully designed and permitted project ready for construction. However, a project does not have to be fully designed in order for the MPO to program it in the TIP.

5 PROGRAMMING

Programming, which typically begins during the design phase, can actually occur at any time during the process, from planning to design. In this step, which is distinct from project initiation, where the MPO receives preliminary information on the proposed project, the proponent requests that the MPO place the project in the region's TIP. The MPO considers the project in terms of regional needs, evaluation criteria, and compliance with the Long-Range Transportation Plan and decides whether to place it in the draft TIP for public review and then in the final TIP.

6 PROCUREMENT

Following project design and programming, the MassDOT Highway Division publishes a request for proposals. It then reviews the bids and awards the contract to the qualified bidder with the lowest bid.

7 CONSTRUCTION

After a construction contract is awarded, the MassDOT Highway Division and the contractor develop a public participation plan and a management plan for the construction process.

8 PROJECT ASSESSMENT

The purpose of this step is to receive constituents' comments on the project development process and the project's design elements. The MassDOT Highway Division can apply what is learned in this process to future projects.