FUNCTIONAL DESIGN REPORT

Reconstruction and Related Work
On Derby Street
From Pond Park Road to Cushing Street

Hingham, Massachusetts

Project File No. 607309

Prepared for:

Town of Hingham
210 Central Street
Hingham, MA 02043

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September 2013

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Introduction

This Functional Design Report is prepared for proposed roadway improvements on Derby Street in the Town of Hingham. The purpose of this functional design report is to document the proposed project locus, the existing conditions of the roadway within the project area, and support design decisions for improving traffic flow while enhancing safety for all roadway users. A safety review of the corridor has been performed based on available accident data. Existing traffic volume data is presented in this report along with supporting documentation utilized to adjust current traffic volume data to produce future design year traffic volumes. The traffic volume data has been reviewed in accordance with the current version of the Manual on Uniform Traffic Control Devices (MUTCD) to determine if any of the key intersections along the project corridor meet traffic signal warrants. Capacity analyses were performed for morning, afternoon, and Saturday peak hours for the major intersections along the corridor. The capacity analyses considered the existing traffic conditions as well as design year conditions with and without improvements. These project evaluations were utilized to document the design decisions and recommendations for proposed improvements and traffic controls during construction.

A. Existing Conditions

The intent of this section of the report is to document the existing features and current conditions surrounding the proposed project. Following is a detailed description of the project locus, existing deficiencies and issues found along the corridor.

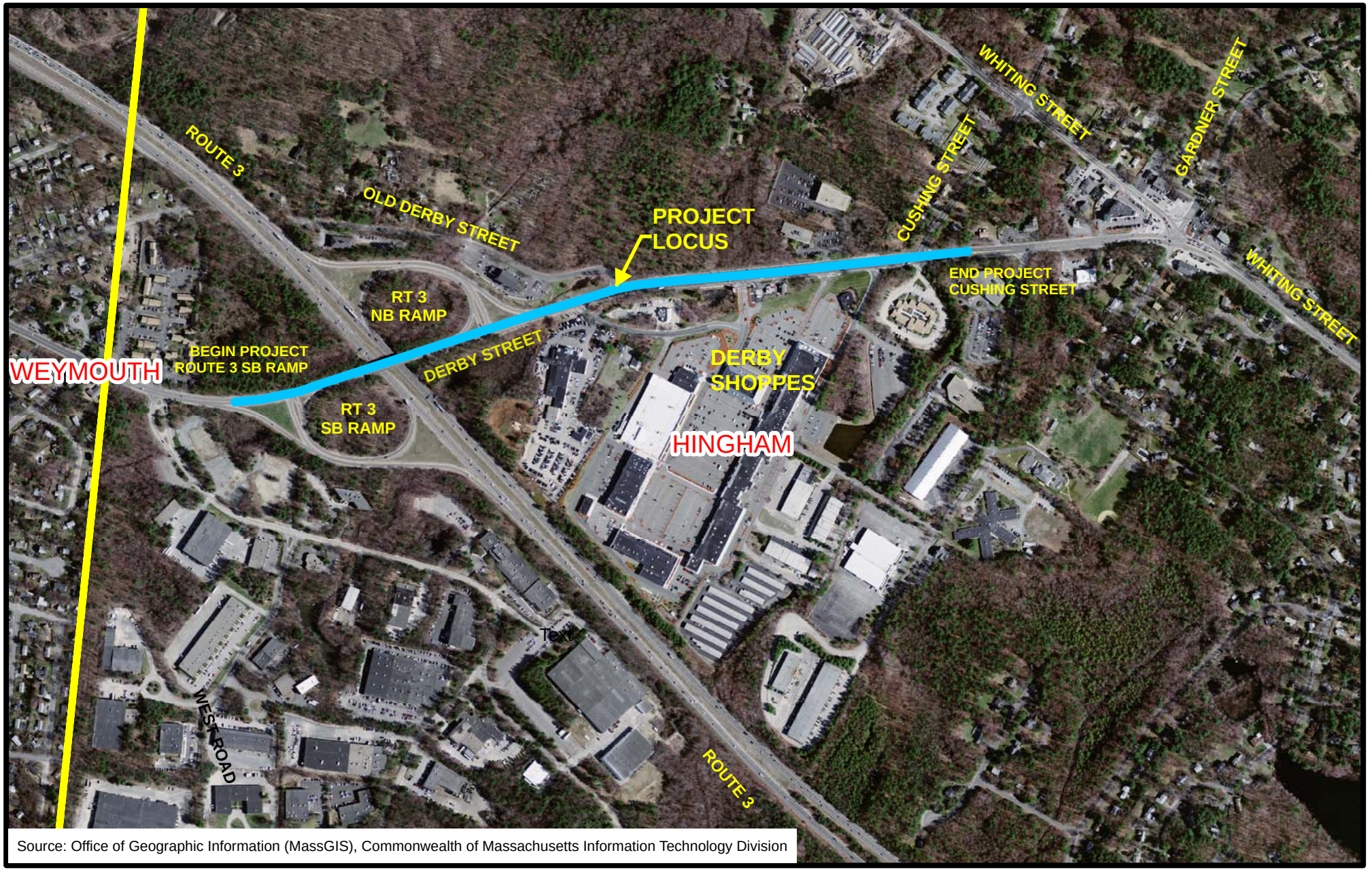
1. Study Area

The Derby Street Reconstruction and Related Work Project in Hingham, MA is a 0.8 mile corridor improvement project. Intersection improvements, sidewalk construction, pavement rehabilitation, and widening for bicycle accommodation are proposed on Derby Street from Pond Park Road to Cushing Street. The project limits are graphically depicted in Figure 1. Derby Street is functionally classified as urban minor arterial, providing access to Route 3 and Route 53 in Hingham as well as the Town of Weymouth. Derby Street has a posted speed limit of 40 miles per hour (mph). The primary land use along the south side of the corridor is commercial businesses. The major commercial land use is the Derby Shoppes Plaza, with large grocery and big box retail stores in addition to smaller restaurants and businesses located on the premises. Along the north side of the roadway there are stand-alone businesses and a single family house. There is undeveloped, wooded land adjacent to the Route 3 ramps and along the north side of Derby Street, opposite Derby Shoppes.

At the westerly limit of work, this project will meet the recently completed Derby Street intersection improvements at Pond Park Road. Here, Derby Street begins as a three lane roadway with one lane in the westbound direction and two lanes in the eastbound direction that merge into one lane approaching the intersection with the Route 3 southbound ramps. A striped gore area associated with the widening of Derby Street for the westbound left turn lane at Pond Park Road separates the eastbound and westbound traffic. There is a sidewalk located along the northerly side of the roadway that terminates at the Old Derby Street Intersection.

Exit 15 of Route 3 is a partial cloverleaf interchange with the southbound exit located west of Route 3 intersecting Derby Street from the south and the northbound exit located east of Route 3 intersecting Derby Street from the north. Each exit arrangement allows “YIELD” controlled movements for right turn exits and entrances to Route 3. At Derby Street, left turns from the Route 3 off-ramps operate under “STOP” control. Currently there are no left turn lanes on Derby Street at either on-ramp to Route 3 to provide queue storage. Between Old Derby Street and the southbound ramps, the paved roadway surface is approximately 45 feet wide.

At the Old Derby Street intersection, there is a crosswalk connecting the end of the sidewalk on the north side of Derby Street to the beginning of the sidewalk on the south side. Here, Derby Street increases widens to four lanes with two in each direction and a center gore striping separating the directional travel lanes approaching the Derby Shoppes main entrance. At the Derby Shoppes main entrance, there is a signalized intersection with a westbound left turn lane into the shops main drive. East of this intersection, the center turn lane becomes a



TOWN OF HINGHAM, MA

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Figure 1. Locus Map

two-way left turn lane providing access to businesses on the north and the secondary entrance to Derby Shoppes on the south. Continuing on Derby Street toward the Cushing Street intersection the center two-way left turn lane becomes an eastbound left turn lane onto Cushing Street. At the Cushing Street intersection there is a crosswalk linking the sidewalk on the south side of Derby Street to a sidewalk along the east side of Cushing Street. The sidewalk on the south side of Derby Street continues toward the Gardner Street/Whiting Street intersection beyond the project limits. Here, the westbound lane on Derby Street has a left turn lane into a business parking lot.

The existing layout and geometry of Derby Street within the project limits fluctuates through the intersections described previously. Derby Street begins as a 56-foot wide, three lane roadway prior to the Route 3 southbound ramps that narrows to a two lane, 44-foot wide roadway with 8-foot wide shoulders. A 15-foot westbound lane provides limited room for vehicles to maneuver around the left turn queue onto the ramp. Along the north side of the roadway, there is a 5.5 foot wide asphalt sidewalk continuing from Pond Park Road with guardrail behind beginning at the ramp entrance. Derby Street maintains a 44-foot paved width over the Route 3 overpass with 14 foot lanes, 8-foot shoulders, and a 5.5-foot wide concrete sidewalk. At the northbound ramps intersection, Derby Street has the same layout as the southbound ramps with a wider 15' eastbound lane which allows vehicles to maneuver around the left turn queue. Guardrail is located on both sides of the roadway extending from the Route 3 overpass through the northbound ramps intersection, ending prior to Old Derby Street. The 5.5-foot wide sidewalk along the north side continues through the ramp intersection ending at Old Derby Street. East of the northbound ramps, Derby Street expands to a 50-foot wide, four lane roadway with 12-foot eastbound lanes, 11-foot westbound lanes, and 2-foot shoulders. At Old Derby Street, a 5.5-foot wide asphalt sidewalk begins on the south side and continues through the eastern project limit. Heading east, Derby Street expands to a 65-foot wide roadway with four 12-foot travel lanes, an 11-foot gore striping separating eastbound and westbound traffic with 3-foot shoulders. Guardrail is located on both sides of the road, with the south side guardrail ending at the Derby Shoppes Main Entrance and north side guardrail ending at 101 Derby Street. Derby Street continues east with a 65-foot width to Cushing Street. There is a 12-foot wide westbound left turn lane into the Derby Shoppes Main Entrance. Approximately 150 feet east of Derby Shoppes Main Entrance, the left turn lane becomes a center turn lane for both directions. For this stretch of Derby Street there is a 3.5-foot wide shoulder along the north side and a 1.5' shoulder along the south side. Vertical granite curbing is located throughout the entire length of Derby Street between the project limits.

The existing pavement surface on Derby Street is in fair condition. Delamination and alligator cracking are the primary deficiencies exhibited on Derby Street with most instances being of low or medium severity. There are a limited amount of potholes present on Derby Street, with low to medium severity with a maximum depth of 3 inches. Minor amounts of transverse and longitudinal cracking as well as utility patches were identified on Derby Street, primarily with low severity. The pavement core samples indicate that Derby Street has an average pavement thickness of 7.5 inches. A pavement joint from prior construction on Derby Street is located at the south leg of Old Derby Street.

There are no residential driveways located within the project limits. There are five large driveways for commercial businesses and two driveways used as an entrance and exit for a Sunoco gas station. The commercial driveways are used continuously during the day, with the Derby Shoppes entrances generating the highest volumes. The driveway layouts appear to be in good condition and accommodate allowed movements. Currently there is no parking on Derby Street since it is a State Highway; however, there are also no signs prohibiting parking along the road. On street parking would significantly impede travel. There are no bus routes or public transit on Derby Street.

2. Existing Conditions

The primary deficiencies on Derby Street involve traffic and capacity issues as well as bicycle and pedestrian accommodation deficiencies. A lack of turn storage located that the Route 3 exit ramps is a problem area for the existing design. At both exit ramps, left turning vehicles onto Derby Street experience lengthy delays and vehicle queues. This likely increases the amount of accidents at the location because drivers will accept shorter gaps in traffic in order to enter Derby Street. The lack of left turn lanes onto the ramps is also a problem. Operators must navigate around stopped vehicles waiting to take a left onto either ramp. At each location a queue forms at peak hours and other times because the wait time for the high volume of traffic in the opposite direction on Derby Street is substantial.

Roadway features west of the pavement joint at Old Derby Street show signs of deterioration. Existing signs and pavement markings west of this location are faded, no longer reflective, and need to be replaced. Guardrail located at the ramps is non-complaint with current standards. There is a large amount of build up at guardrail locations rendering some entirely useless. Most roadway features east of the pavement joint are in acceptable condition due to the more recent construction associated with the redevelopment of the Derby Shoppes.

There are two primary concerns along the corridor with regards to pedestrian and bicycle accommodations. A mid-block crosswalk located between the southerly and northerly legs of Old Derby Street links the end of the sidewalk on the north side of Derby Street to the beginning of the sidewalk on the south side. This crosswalk is not under signal control and requires pedestrians to cross four lanes of traffic. This location also lacks proper signage. The second area of concern is the width of shoulders for bicycle accommodations along the roadway. Existing shoulders are only 1.5 feet to 3 feet wide in many locations, requiring bicyclists to share the roadway with motorists travelling at higher speeds.

Alignment

The existing 3,900 foot roadway segment of Derby Street has a relatively straight alignment with two (2) tangents connected by one (1) horizontal curve, with an additional horizontal curve at the westerly end of the project. The two 1,500 foot curve radii within the project limits; are located west of the southbound exit ramp and at the Old Derby Street intersection.

The existing vertical alignment of the roadway is characterized by a high point located at the Route 3 Overpass with existing grades of approximately 3.0% heading into and out of the

high point. The low point within the project limits is located just west of the northerly leg of Old Derby Street. East of Old Derby Street, the project corridor is very flat with an approximate 0.50% gradient.

Sight distances along the crest and sag curves were examined for conformance with the AASHTO guidelines. It was found that all of the existing vertical curves along Derby Street meet sight distance requirements for the design speed.

Travel Speeds

A review of the traffic data indicates average travel speeds are consistently about 38 mph with speeds slightly higher west of Derby Shoppes. The 40mph design speed chosen closely matches the posted speed limit and 85th% speeds observed within the project limits.

Drainage

Stormwater runoff along the roadway is collected by multiple closed drainage systems consisting of catch basins and manholes. The bridge over Route 3 is a high point within the project limits and acts as a divide. Stormwater runoff to the west of Route 3 is collected by a series of catch basins that discharge into wetlands along the southerly side of Derby Street at Pond Park Road and wetlands adjacent to the Route 3 southbound off-ramp. On the eastern side of the bridge, a series of catch basins outlet to wetlands adjacent to Derby Street and the northbound ramps at various points. Between Old Derby Street and the Derby Shoppes Main Entrance, a 12-inch diameter trunk line conveys stormwater runoff to an outlet point on the northerly side of Derby Street at Old Derby Street. East of the Derby Shoppes Main Entrance, stormwater runoff is conveyed from Recreation Park Drive through a trunk line increasing in size from 12 inches to 24 inches at the outlet point at a wetland opposite the Derby Street Main Entrance. Most of the existing drainage structures appear to be fairly well maintained and have been utilized in the proposed design.

Utilities

In addition to the drainage systems, several other utilities exist along the roadway. These include underground water, telephone, and gas, and overhead electrical lines running between utility poles. Utility poles are located on both sides of Derby Street at the Route 3 northbound ramps. The utility poles then run along Old Derby Street to the Derby Shoppes. Utility poles are then located on both sides of Derby Street from the Derby Shoppes side entrance to Cushing Street.

Sight Distance

Sight distances at the intersections within the project limits were analyzed to determine what, if any, improvements were necessary. The adequacy of available sight distance is a function of the speed at which vehicles are approaching. In order to determine the adequacy of available sight distance, the vehicle speeds on Derby Street were reviewed. 72-hour speed

counts conducted at various locations along Derby Street were used to determine a design speed of 40 mph along Derby Street, which is consistent with the posted speed limit.

Two separate sight distance criteria were considered in evaluating the sight distance available at each side street location. Vehicles entering Derby Street from the intersecting side streets require sufficient intersection sight distance to safely access Derby Street. The recommended intersection sight distances determined from AASHTO *Case B1 – Left Turn from Stop* and *Case C2 – Left or Right Turn at Yield-Controlled Intersections* present the distance required for a vehicle entering the main road to safely access or cross the adjacent roadway without interrupting the flow of traffic on the through street. Accordingly, at a minimum, vehicles travelling on Derby Street must have sufficient sight distance to come to a complete stop to avoid a collision with an entering vehicle. CHA conducted a sight distance inspection in the field and reviewed the existing profile of Derby Street to determine the available stopping and intersection sight distances. The stopping sight distances presented in Table 1 below reflect adjustments for approach grades. The available sight distance at each intersection was determined in the field from procedures described in Chapter 3 of the MassDOT *Project Development and Design Guide* (PDDG) and is tabulated in Table 1, below.

Table 1 – Intersection Sight Distance

Street Name	Min. Required Sight Distance Onto Derby Street[1]	Recommended Sight Distance Onto Derby Street[2]	Existing Sight Distance Available		Obstruction
			Right	Left	
Southbound Ramp Left Turn	289' LT 315' RT	445'	500'+	500'+	Rt: None Lt: None
Southbound Ramp Right Turn	289' LT	475'	N/A*	500'+	Rt: None Lt: None
Northbound Ramp Left Turn	289' LT 315' RT	445'	500'+	500'+	Rt: None Lt: None
Northbound Ramp Right Turn	289' LT	475'	N/A*	500'+	Rt: None Lt: None
Old Derby (South Leg)	305'	445'	N/A*	394'	Rt: None Lt: Overgrown shrubs
Old Derby (North Leg)	305'	445'	500'+	500'+	Rt: None Lt: None
Cushing Street	305'	445'	500'+	500'+	Rt: None Lt: None

* N/A – Left turn movement not permitted at these locations

The available intersection sight distance found at all 5 intersections within the project limits exceed the minimum required intersection sight distance and nearly all exceed the

[1] American Association of State Highway and Transportation Officials, *A Policy on Geometric Design of Highways and Streets*, AASHTO, 2011, Page 3-14.
[2] Ibid, Page 9-36 to 9-49.

recommended intersection sight distance. Currently, only the southerly leg of Old Derby Street does not meet the recommended intersection sight distance. Widening of Derby Street to provide adequate capacity at a signalized intersection should result in a cleared line of sight to obtain the recommended sight distance at this location.

B. Traffic Volumes

In order to determine base traffic volume conditions, automatic traffic recorder counts (ATRs) and manual turning movement counts (TMCs) were performed. The traffic analyses performed included the determination of the ADT, an evaluation of travel speed, and the classification of vehicles. The traffic counts were performed by Transportation Data Corporation in June 2012.

3. Traffic Count Data

a. ATR Counts

ATR counts were conducted at representative points along the project corridor during a 48 hour period. The locations are as follows: Derby Street, west of Pond Park Road; Southbound On and Off Ramps; Derby Street, on the bridge overpass; Northbound On and Off Ramps; Derby Street, east of Old Derby Street; Derby Street, east of Cushing Street. The ATR counts located on Derby Street also recorded vehicle classification and travel speeds. Copies of the ATR traffic counts are included in the Appendix.

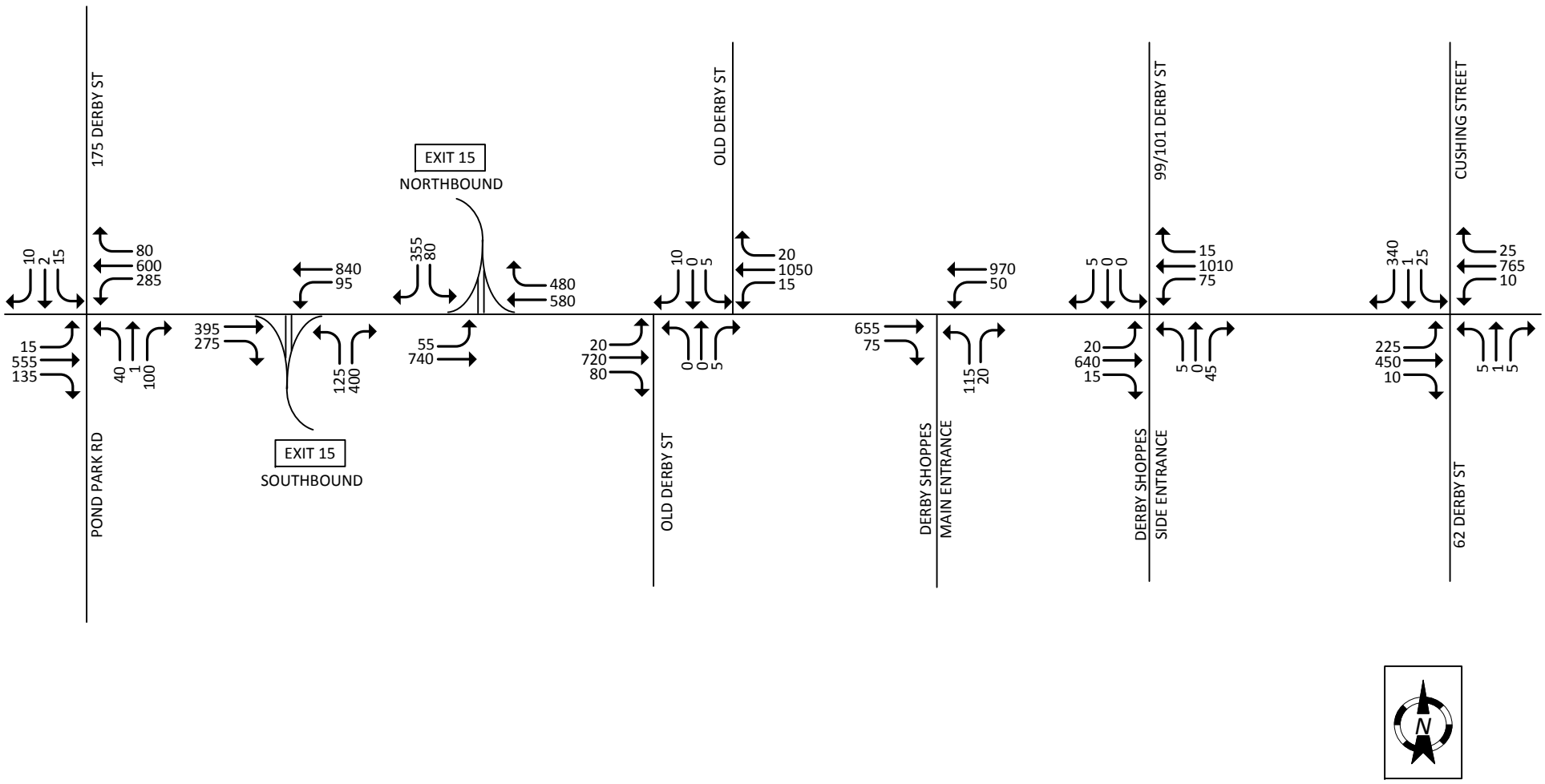
Average Daily Traffic was computed from the traffic counts at the specified locations. A summary of ADT's is presented in Table 2. The average daily traffic volumes have been adjusted for seasonal variations as discussed below. The percentage of trucks was determined to be between 1% and 1.5%.

Table 2 –Adjusted Traffic Count Data

Location	*2012 Weekday ADT*	*2012 Saturday ADT*
Derby Street – West of Pond Park Road:	18,800 vpd	15,200 vpd
Route 3 Southbound On Ramp	7,400 vpd	6,100 vpd
Route 3 Southbound Off Ramp	9,900 vpd	8,600 vpd
Derby Street – Bridge over Route 3	27,100 vpd	22,200 vpd
Route 3 Northbound Off Ramp	11,000 vpd	9,400 vpd
Route 3 Northbound On Ramp	5,100 vpd	4,500 vpd
Derby Street – East of Old Derby Street:	27,900 vpd	24,400 vpd
Derby Street – East of Cushing Street	18,900 vpd	16,300 vpd

b. TMC Data

Manual turning movement counts were performed during the weekday morning peak period (7:00 to 9:00 am), the weekday evening peak period (4:00 to 6:00 pm) and Saturday peak hour period (12:00 to 1:00 pm) at the intersections of Derby Street at Pond Park Road; Derby Street at the Exit 15 Interchange, both Northbound and Southbound ramps; Derby Street at Old Derby Street; Derby Street at the Derby Shoppes Main Entrance and Side Entrance; Derby Street at Cushing Street. Copies of the turning movement counts are provided in the Appendix. Figures 2, 3 and 4 present the 2012 existing weekday morning and evening peak hour traffic volume conditions, respectively. Figure 4 depicts the Saturday peak hour traffic volumes.



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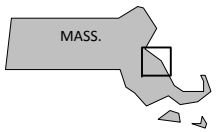
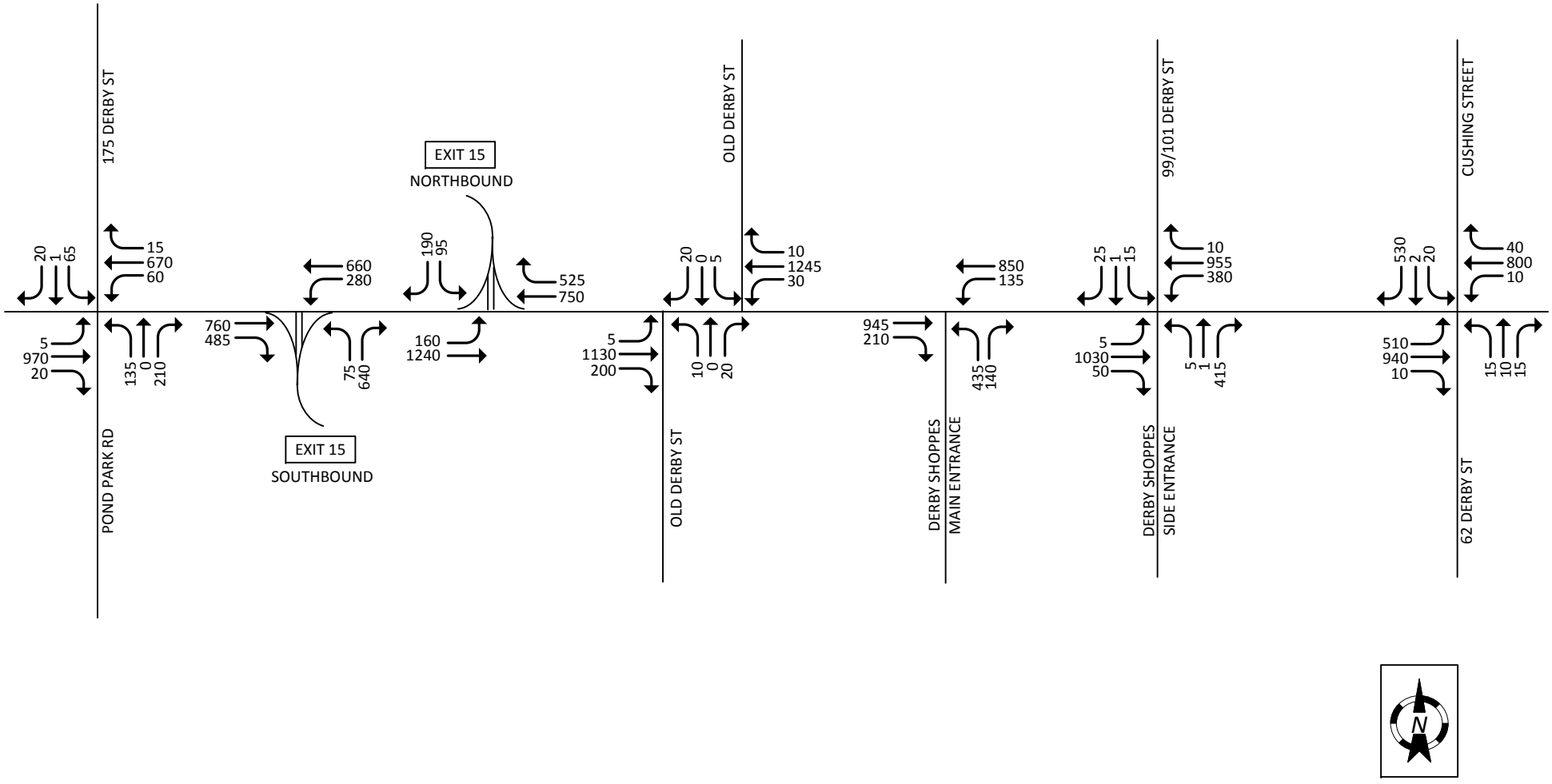


2012 Existing Conditions
AM Peak Hour Traffic Volumes
8:00 – 9:00 AM

Reconstruction and Related Work on Derby Street
Hingham, Massachusetts

Figure **2**



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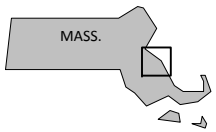
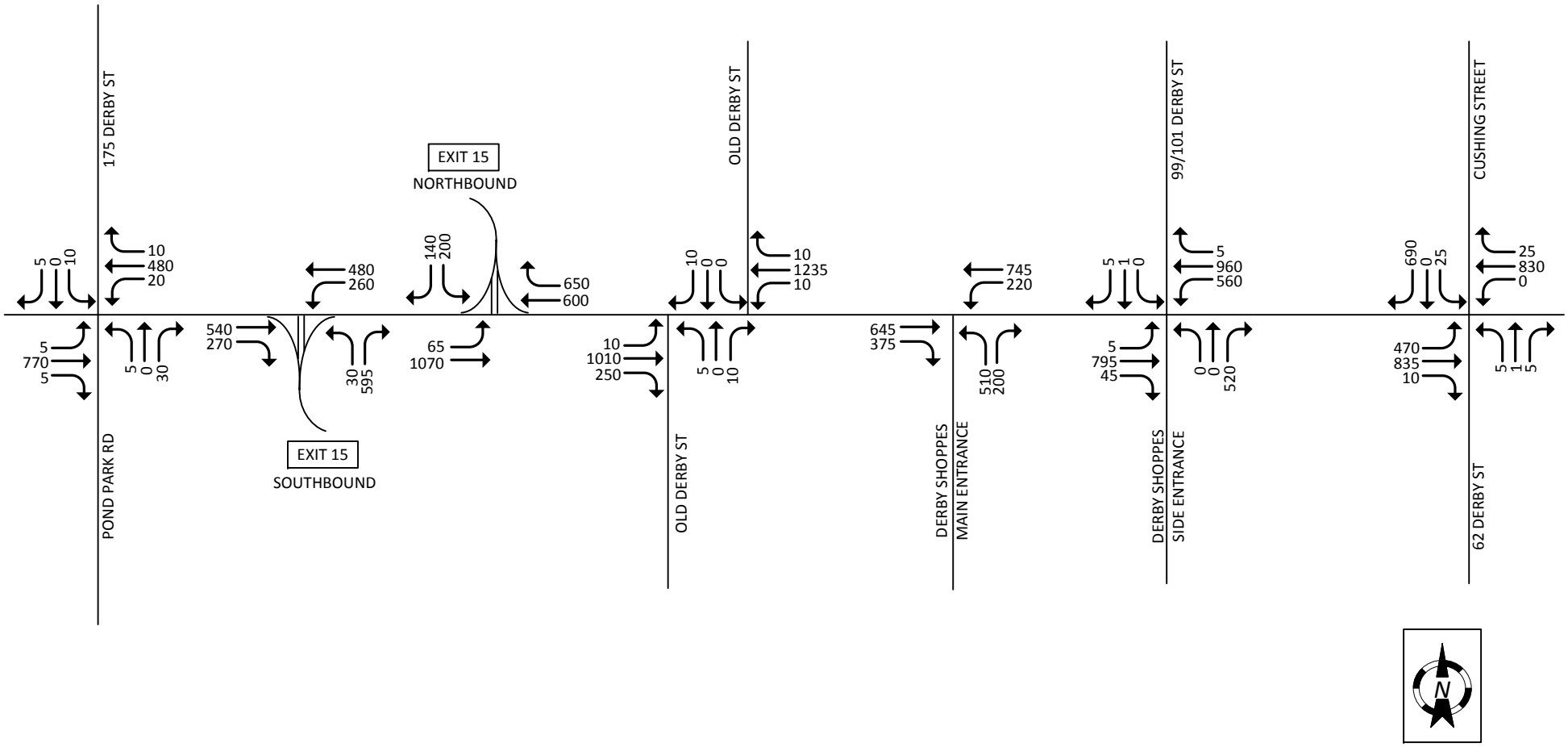


2012 Existing Conditions
PM Peak Hour Traffic Volumes
4:45 – 5:45 PM

Reconstruction and Related Work on Derby Street
Hingham, Massachusetts

Figure **3**



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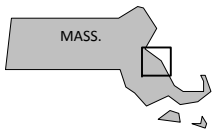


2012 Existing Conditions
Saturday Peak Hour Traffic Volumes
12:00 – 1:00 PM

Reconstruction and Related Work on Derby Street
Hingham, Massachusetts

Figure **4**

4. Base Year Traffic Volumes

Traffic volume data collected during a single period may be influenced by a number of factors, including weather, time of year, construction detours, traffic delays, etc. In order to accurately assess traffic counts conducted during a specific period, record traffic data near the project area must be considered to predict annual average daily traffic conditions. One such factor that must be considered is seasonal variations to determine whether the traffic count data must be adjusted up or down to reflect average conditions.

Seasonal Factors

Based on a review of the monthly average daily traffic at nearby MassDOT continuous count stations, the average daily traffic in the month of June is slightly higher than the average annual daily traffic. At continuous count station #7318 located on Route 3 between exits 14 and 15 in Hingham, the average daily traffic volumes for the month of June were 2.3% above the average annual daily traffic volumes in 2008. Since the traffic counts were collected during a month that is only slightly above the annual average in the area, a seasonal adjustment factor was not used for the counts.

5. Future Year Traffic Volumes

For the purposes of design, it is necessary to project present day traffic volume data to a future design year. It is common practice to project traffic volumes 20 years into the future for the construction of roadways and 10 years for the review of intersection operations since intersection operations may be more significantly impacted by changes in future traffic patterns. To project traffic volumes to a future design year it is necessary to consider factors that may result in increased traffic, such as population growth and proposed development.

c. Annual Background Growth Rate

In order to estimate the expected annual background growth of traffic within the study area, historic traffic volume data was reviewed. Massachusetts Department of Transportation (MassDOT) permanent count stations and locations with counts over multiple years were reviewed. Count locations reviewed included:

Route 3A in Hingham (west of North Street)
Route 3A in Scituate (south of Cornet Stetson Road)
Route 3 in Hingham
Route 3 in Norwell

All of the locations with the exception of Route 3A in Scituate have shown a negative growth rate in recent years. The Route 3A location had a 1% increase in growth. Recent traffic studies performed for projects on Derby Street have estimated a 1% annual growth rate. Based on the data available a 1.0% growth rate was chosen as the most appropriate for this project. The 1.0% annual growth

rate was applied to the existing conditions traffic volumes compounded annually to project the 2017 No-Build Conditions traffic volumes.

d. Other Specific Development

CHA Companies contacted the Town of Hingham Office of Community Development and Engineering Department to determine if there are any proposed developments in the vicinity of Derby Street that would affect the current traffic volumes along Derby Street between Pond Park Road and Cushing Street.

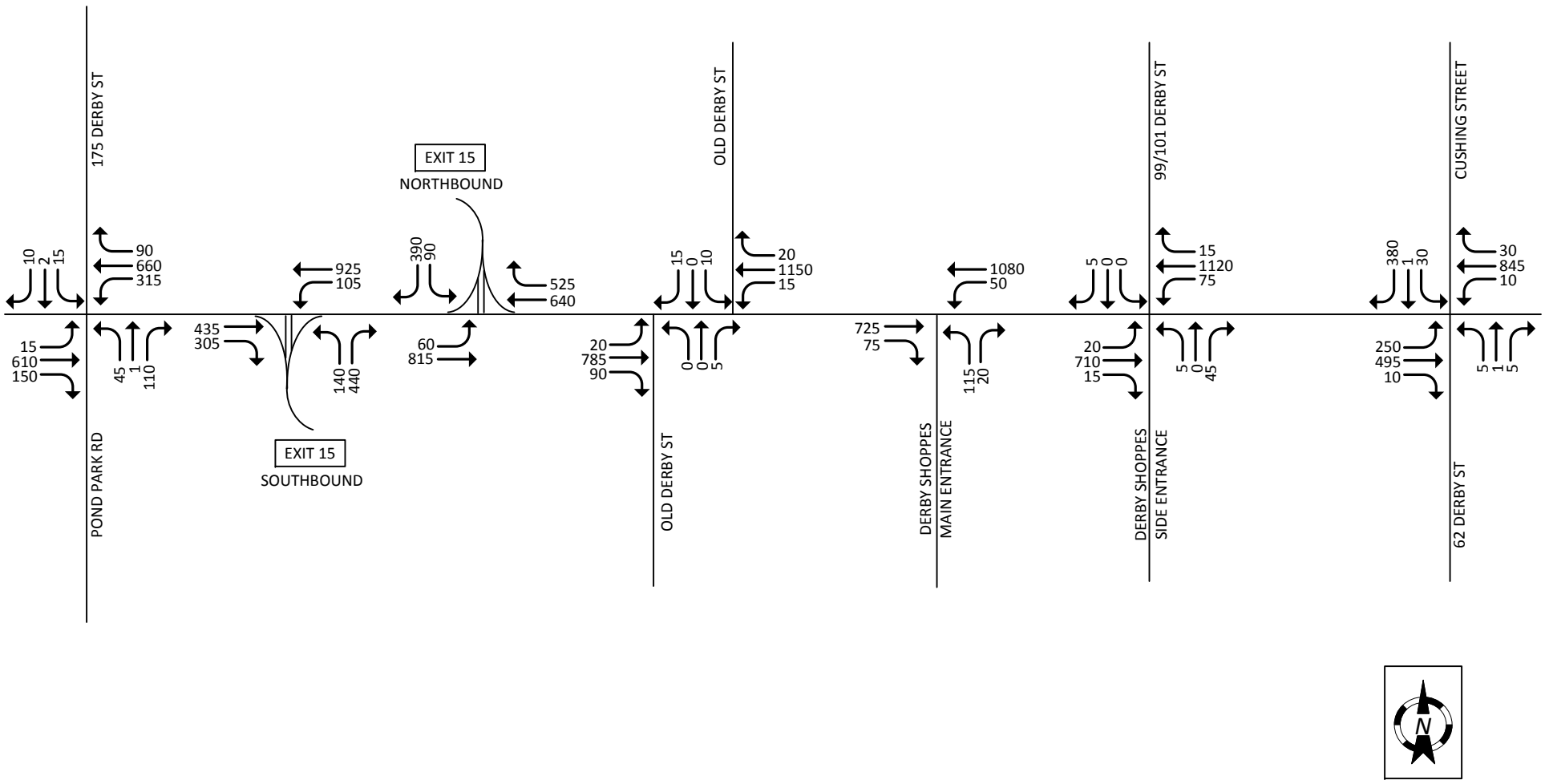
A proposed Auto Dealership at 141 Derby Street was identified as a potential project. The project involves a new 38,000 s.f. auto dealership. Traffic for this planned development was included in the background growth for the projected future volumes on Derby Street.

The South Shore Chamber of Commerce and the Town of Hingham have both indicated that there is a significant amount of developable land in the vicinity of Derby Street. Although there are currently no known specific plans, redevelopment in the South Shore Industrial Park or development of land on the north side of Derby Street near Old Derby Street is possible in the future. If and when future developments proceed, they will be required to perform traffic analyses to determine their impact on the Derby Street corridor and the need for further transportation infrastructure.

Table 3 depicts the projected 2032 ADT volumes at various locations along the corridor. Figures 5, 6 and 7 depict the projected 2022 Peak Hour traffic volumes.

Table 3 –2032 Projected Traffic Volumes

Location	***2032 ADT***
Derby Street – West of Pond Park Road:	23,000 vpd
Route 3 Southbound On Ramp:	9,000 vpd
Route 3 Southbound Off Ramp:	12,100 vpd
Derby Street – Bridge over Route 3	33,100 vpd
Route 3 Northbound Off Ramp:	13,400 vpd
Route 3 Northbound On Ramp:	6,200 vpd
Derby Street – East of Old Derby Street:	34,000 vpd
Derby Street – East of Cushing Street	23,100 vpd



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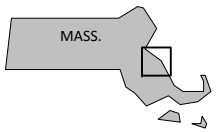
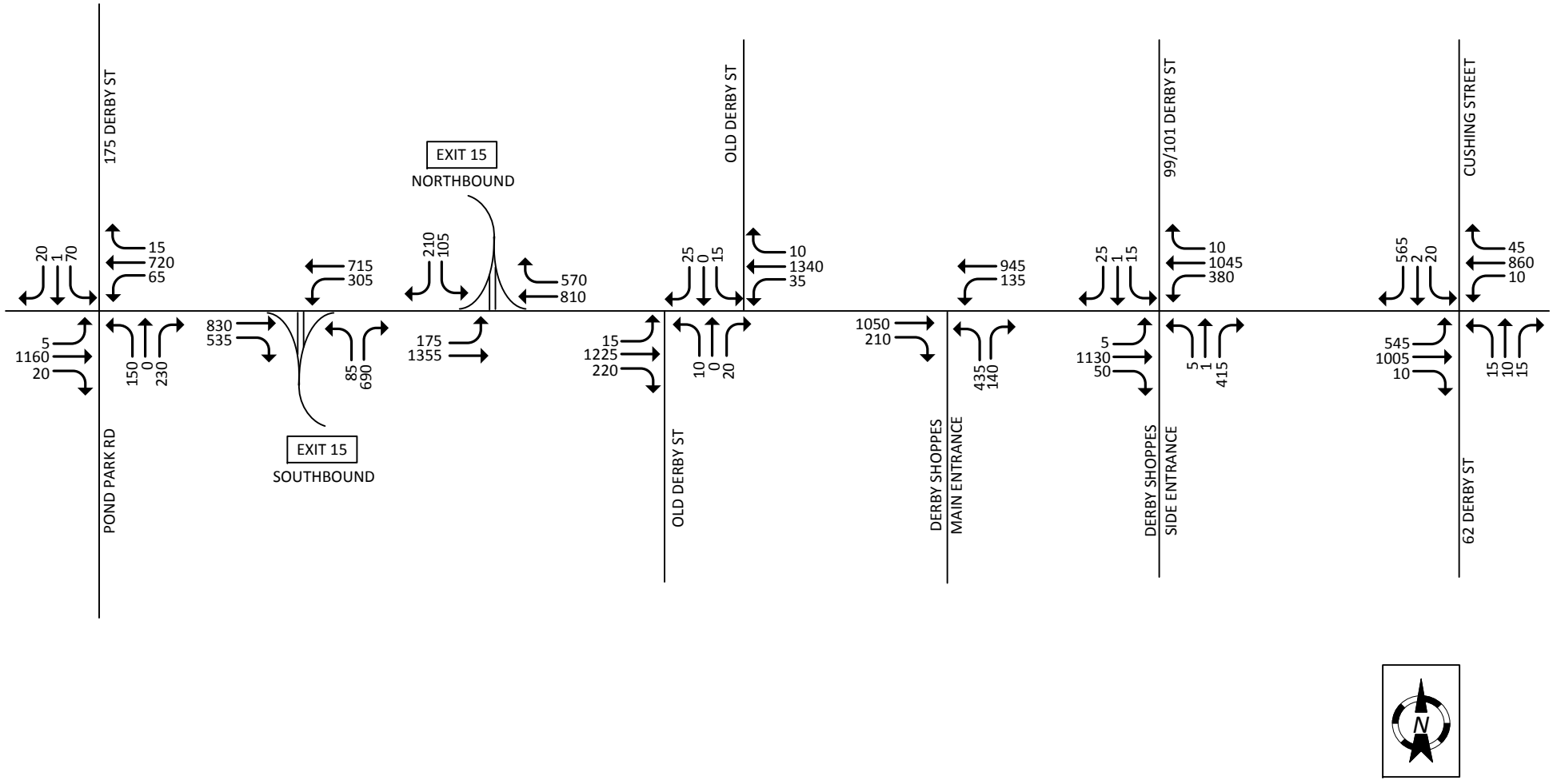


2022 Future Conditions
AM Peak Hour Traffic Volumes
8:00 – 9:00 AM

Reconstruction and Related Work on Derby Street
Hingham, Massachusetts

Figure 5



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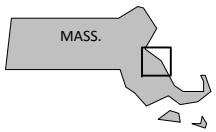
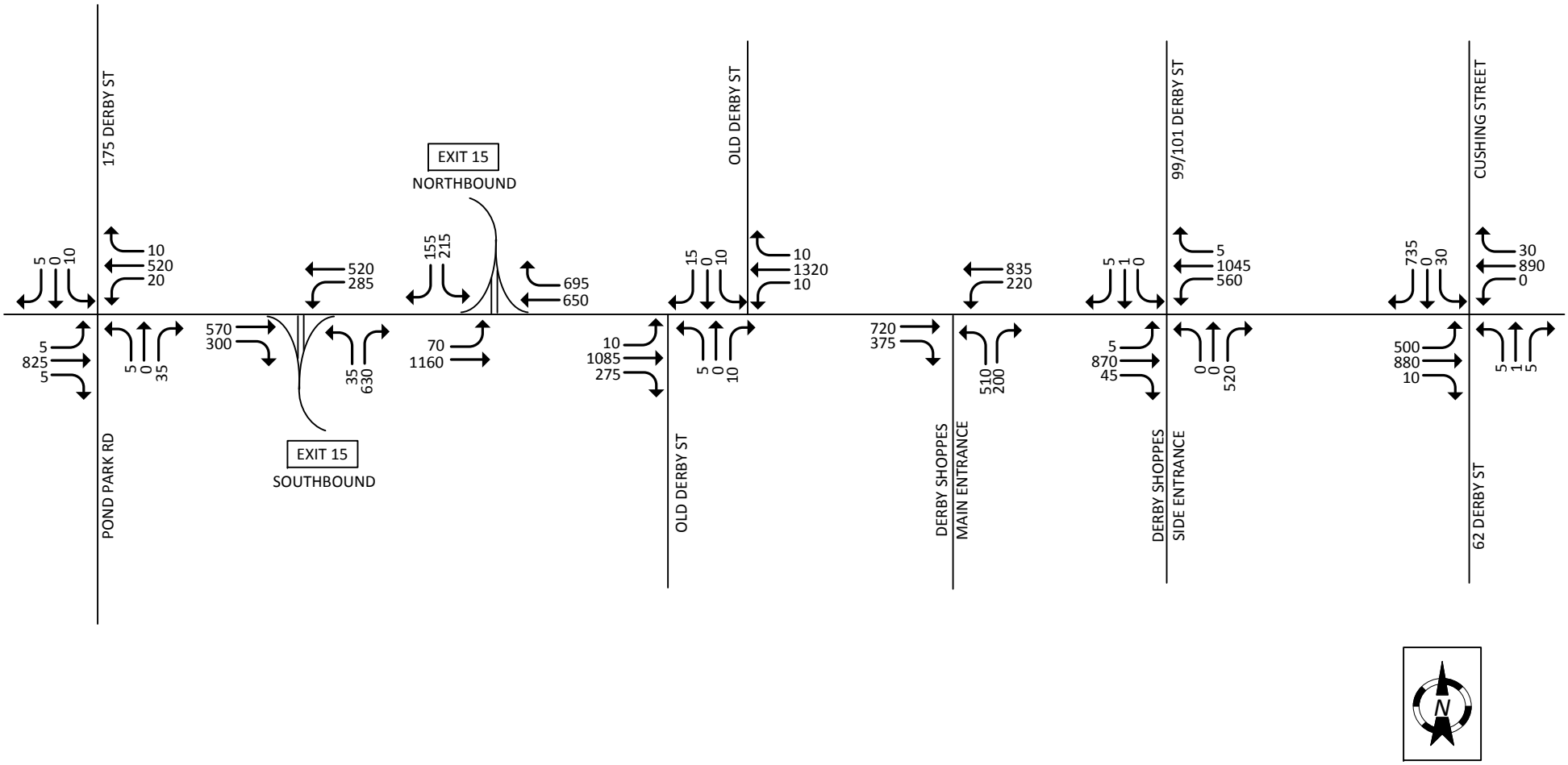


2022 Future Conditions
PM Peak Hour Traffic Volumes
4:45 – 5:45 PM

Reconstruction and Related Work on Derby Street
Hingham, Massachusetts

Figure **6**



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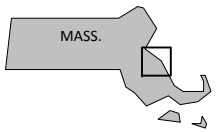


2022 Future Conditions
Saturday Peak Hour Traffic Volumes
12:00 – 1:00 PM

Reconstruction and Related Work on Derby Street
Hingham, Massachusetts

Figure 7

C. Safety Analysis

1. Crash Analysis

Accident data from 2007 to 2010 for the project roadways was compiled from MassDOT's accident records for the Town of Hingham and from the Hingham Police Department. Table 4 shows a summary of these accidents.

Table 4 – Accident Summary 2007-2010

	Rte. 3 Ramp NB	Rte. 3 Ramp SB	Rte. 3 Bridge Overpass/Ramp Unknown	Old Derby St	Derby Shoppes (Sunoco)	Derby Shoppes (Bertuccis)	Cushing Street
Year							
2007	5	2	8	5	9	0	6
2008	6	2	9	6	5	2	2
2009	4	3	3	4	10	2	5
2010	10	4	4	1	8	4	3
2011	0	0	0	0	0	0	0
Total	25	11	24	16	32	8	16
Type							
Angle	13	2	13	8	8	3	2
Head-on	0	1	1	0	1	1	0
Rear-end	10	6	9	2	18	3	12
Sideswipe	1	1	0	5	2	1	1
Single Vehicle Crash	1	1	0	1	3	0	1
Pedestrian	0	0	0	0	0	0	0
Unknown	0	0	1	0	0	0	0
Total	*25*	*11*	*24*	*15*	*32*	*4*	*13*
Severity							
Property Damage	19	8	19	14	22	5	15
Personal Injury	6	3	5	2	10	3	1
Fatality	0	0	0	0	0	0	0
Hit & Run	0	0	0	0	0	0	0
Unknown	0	0	0	0	0	0	0
Lighting							
Daylight	20	9	15	12	25	5	5
Dusk	0	1	1	0	0	0	3
Dark – Lighted Road	2	0	5	4	7	1	8
Dark – Unlit Road	2	1	2	0	0	0	0
Dawn	0	0	1	0	0	0	0
Unknown	1	0	0	0	0	2	0
Conditions							
Dry	21	7	14	14	26	6	12
Wet	4	4	9	2	6	1	4
Ice/snow	0	0	1	0	0	0	0
Slush	0	0	0	0	0	0	0
Unknown	0	0	0	0	0	1	0
Time of Day							
7:00 – 9:00 AM	4	2	0	1	1	0	2
4:00 – 6:00 PM	5	1	5	1	15	2	6
Remainder of day	16	8	19	14	16	2	8

During the 4-year study period, one hundred and thirty-two (132) incidents were reported along Derby Street within the project limits. Approximately forty-nine (49) accidents during

this time period were angular and another sixty (60) were read-end accidents, comprising of most of the accidents along the roadway. Approximately eighty percent of the accidents (102 total) were property damage only, while personal injuries were reported in the other thirty (30) accidents. An overwhelming majority of incidents reported dry roadway conditions or occurred during daylight hours. Incidents were spread out along the project, with the most occurring at the Derby Shoppes Main Entrance and at the Route 3 Interchange (most accidents were unknown of which ramp it occurred on).

2. Crash Rate Worksheets

Crash rate worksheets have been prepared for the intersections of Derby Street and Route 3 southbound ramp, Derby Street and Route 3 northbound ramp, Derby Street and Derby Shoppes main entrance, and Derby Street and Cushing Street.

The intersection of Derby Street and the southbound ramps is a three-way unsignalized "T" intersection with STOP control on the ramp approach. Based on traffic counts collected in June 2012 and a total of 11 accidents reported at the intersection from 2007 to 2010, a crash rate of 0.18 crashes per million entering vehicles (MEV) was calculated for the intersection.

The intersection of Derby Street and the northbound ramps is a three-way unsignalized "T" intersection with STOP control on the ramp approach. Based on traffic counts collected in June 2012 and a total of 25 accidents reported at the intersection from 2007 to 2010, a crash rate of 0.40 crashes per million entering vehicles (MEV) was calculated for the intersection.

The intersection of Derby Street and Old Derby Street is two three-way unsignalized "T" intersections with STOP control on the separate Old Derby Street approaches. Based on traffic counts collected in June 2012 and a total of 16 accidents reported at the intersection from 2007 to 2010, a crash rate of 0.29 crashes per million entering vehicles (MEV) was calculated for the intersection.

The intersection of Derby Street and Cushing Street is a three-way signalized "T" intersection. Based on traffic counts collected in June 2012 and a total of 16 accidents reported at the intersection from 2007 to 2010, a crash rate of 0.26 crashes per million entering vehicles (MEV) was calculated for the intersection.

The average crash rate for unsignalized intersections located in District 5 is 0.58, and the Statewide average is 0.60. The average crash rate for signalized intersections located in District 5 is 0.77, and the Statewide average is 0.80. This information indicates that there is a low collision rate at all intersections along Derby Street in comparison to District and Statewide signalized and unsignalized intersections.

A segment crash rate worksheet has been prepared for the length of the Derby Street project. Based on an average daily traffic volume compiled on Derby Street within the project limits, a crash rate of 4.05 crashes per million vehicle miles traveled (MVMT) was calculated. The average segment crash rate is 3.68 for urban minor arterials and 1.95 for urban areas statewide. This calculation indicates that this section of Derby Street is above the average segment crash rate for urban minor arterials and roadways statewide.

3. Collision Diagrams

Four locations indicated an average of more than three (3) crashes per year during the study period: Derby Street at the Route 3 Northbound Ramp; Derby Street at Old Derby Street; Derby Street at Derby Shoppes Main Entrance; Derby Street at Cushing Street. Collision diagrams were prepared for all locations as well as the intersection of Derby Street and the Route 3 Southbound Ramp. No collision diagram was produced for the Bridge overpass/Route 3 due to the unknown location of the accidents. Back-up data including the raw accident data is included in the appendix.

During the 4-year study period, the intersection of Derby Street at the Route 3 Southbound Ramp experienced twelve (11) accidents including six (6) rear end collisions, four (4) of which involved vehicles traveling westbound on Derby. The collision diagram for this intersection is shown as Figure 8.

During this same period, the intersection of Derby Street at the Route 3 Northbound Ramp experienced twenty-five (25) accidents as shown in Figure 9. Nine (12) of the accidents were identified as angular collisions. Eleven (11) of the angular collisions occurred with vehicles traveling in the eastbound direction primarily with the other vehicles heading in the south and west directions. There were also nine (9) rear-end collisions at this intersection evenly spread in all directions.

From 2007-2010 the intersection of Derby Street at Old Derby Street experienced sixteen (16) accidents as shown in Figure 10. Six (6) of the accidents were identified as angular collisions, five (5) were identified as sideswipes and three (3) were identified as rear-ends. The other two collisions were single vehicle collisions with the drive losing control.

The intersection of Derby Street and Derby Shoppes experienced the most accidents within the 4-year study period. There were thirty-two accidents located at this intersection as shown in Figure 11. Eighteen (18) of those accidents were identified as rear end collisions. There was an even split between the angular collisions as five (5) were in the westbound direction, six (6) were in the eastbound direction and seven (7) were in the northbound direction at the entrance. There were also eight (8) angular collisions with half of those being described as east-west collisions.

The last intersection which warranted a collision diagram during the 4-year study period is the intersection of Derby Street and Cushing Street. There were sixteen (16) accidents at this location shown in Figure 12. Ten (10) of those accidents were rear end collisions with five (5) occurring in the eastbound direction. Three (3) others were angular collisions, with one in each direction.

4. Collision Mapping

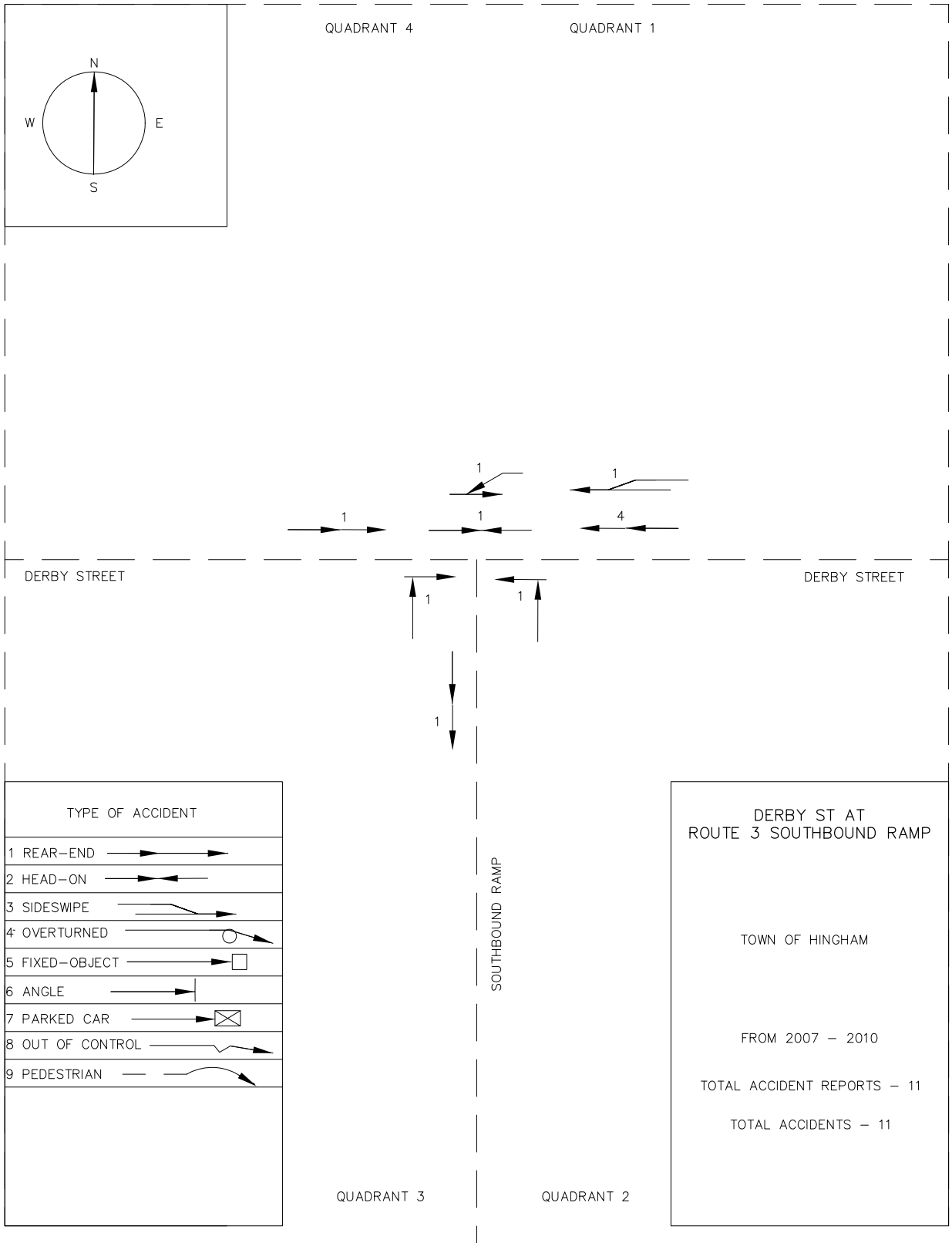
A collision map has been prepared illustrating the number and location of the crashes. As shown in Figure 13, locations with the most accidents are at the Route 3 Northbound ramp and Derby Shoppes. The high percentage of angular collisions along the corridor is expected

in a dense urban area with only STOP controls at the intersecting side streets. The high percentage of rear-end collisions along the corridor could be due to the lack of left-turn lanes and existing signalized intersections.

5. Safety Review

Derby Street in Hingham is a frequently traveled roadway with lots of activity within the project limits due to the nature of the land use. Due to this, safety for all modes of transportation is of the upmost importance. Using the Safety Review Prompt List included in Appendix B current safety issues were noted. Presently on Derby Street the shoulder width of 1.5'-3' is inadequate for bicycle accommodations east of the Route 3 northbound exit ramps. Proposed shoulder widths are a minimum of 5' wide to accommodate bicycles. Existing sidewalks on Derby Street are non-contiguous. The north side sidewalk ends at the north leg of Old Derby Street. A crosswalk located at the south leg of Old Derby Street creates a mid-block crosswalk for pedestrians to access the south side sidewalk.

Accident occurrences on Derby Street are shown to be high in the segment Crash Rate Worksheet outlined in section 3. The lack of left turn lanes at the Route 3 exit ramps contributes to the large amount of rear end accidents along Derby Street. The high volume of traffic on Derby Street results in long wait time for vehicles under Stop control exiting the ramps and encourages drivers to shorter gaps in traffic than recommended.



101 Accord Park Drive
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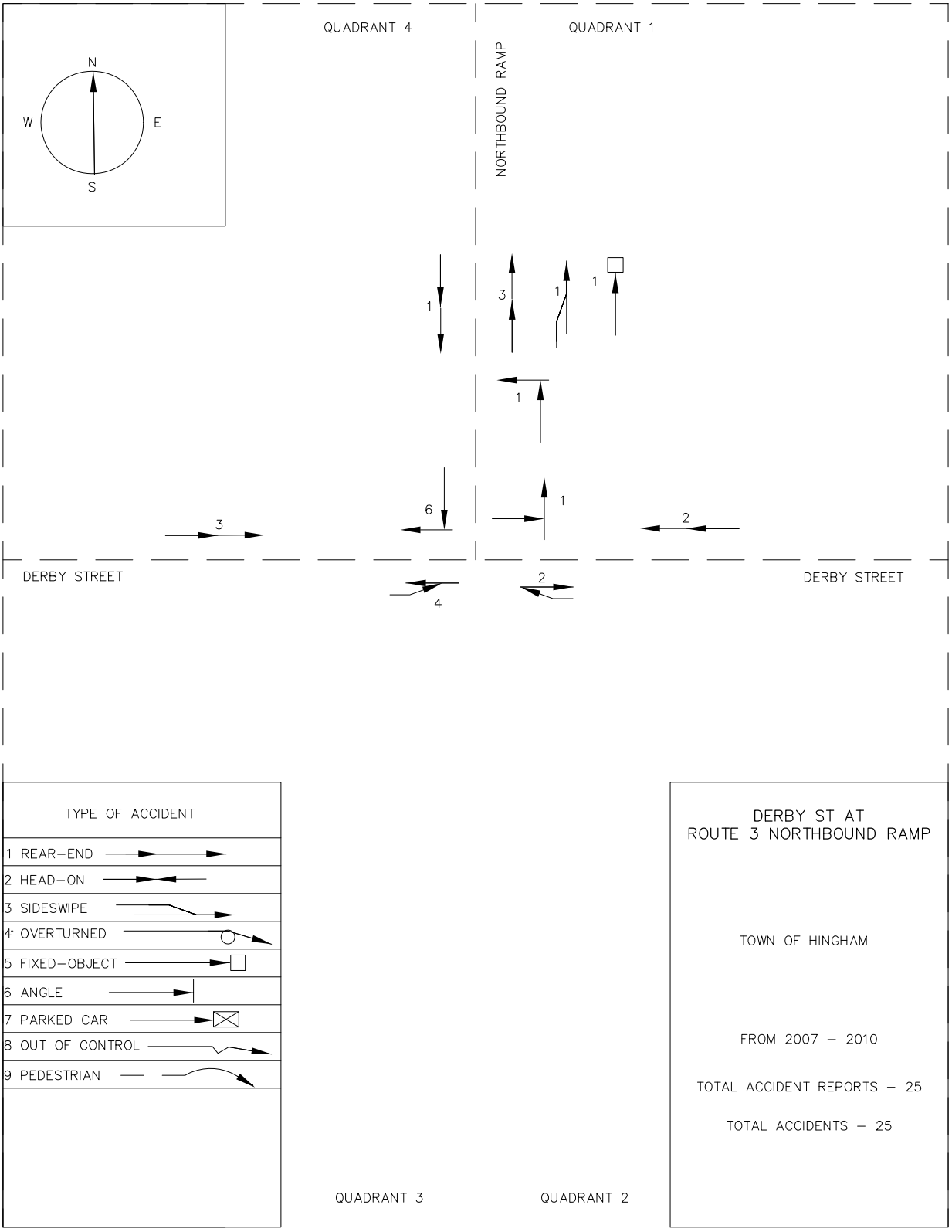
TITLE:

COLLISION DIAGRAM
DERBY ST AT
ROUTE 3 SOUTH RAMP

DATE: JUNE 2013

FIGURE 8



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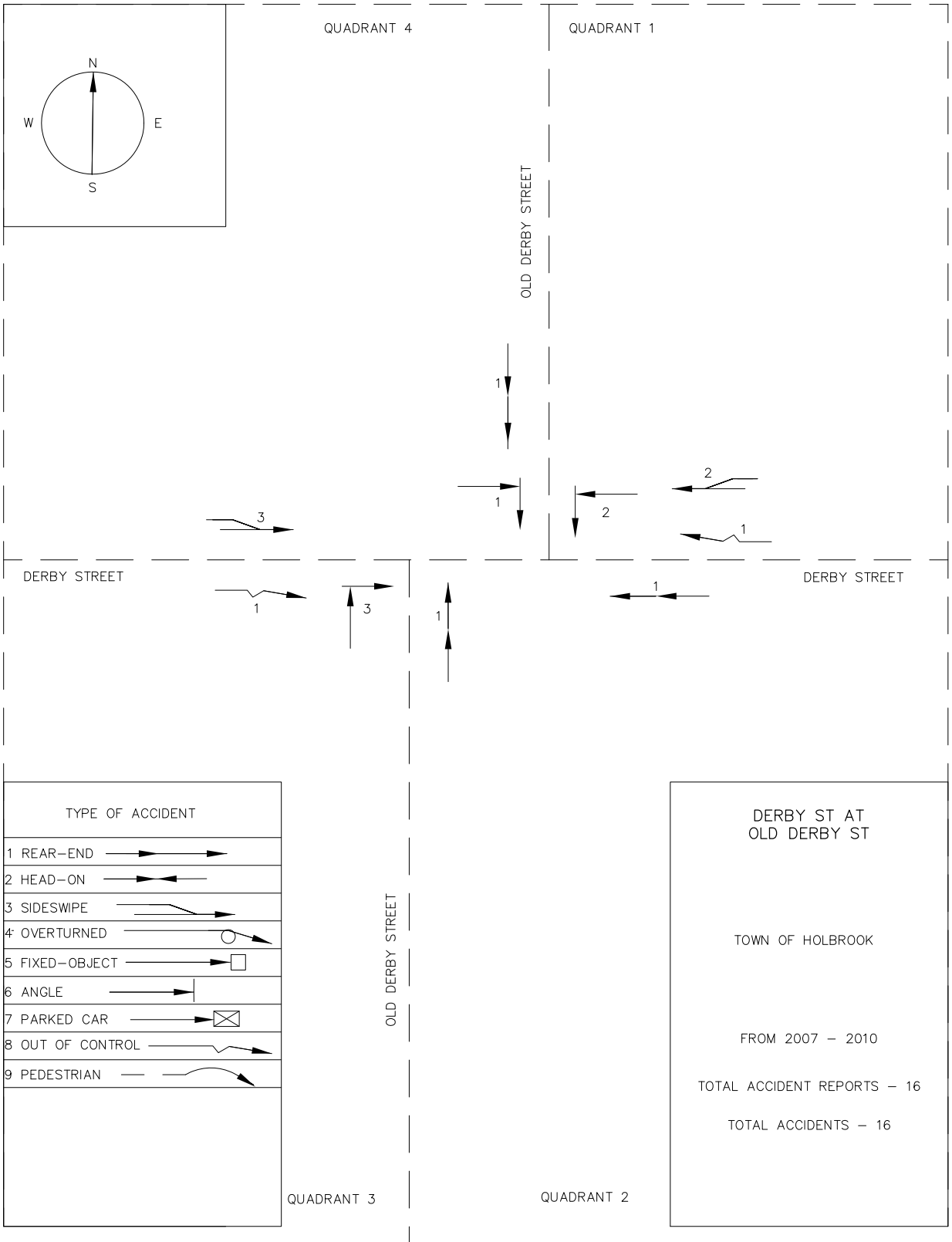
TITLE:

COLLISION DIAGRAM
DERBY ST AT
ROUTE 3 NORTH RAMP

DATE: JUNE 2013

FIGURE 9



101 Accord Park Drive
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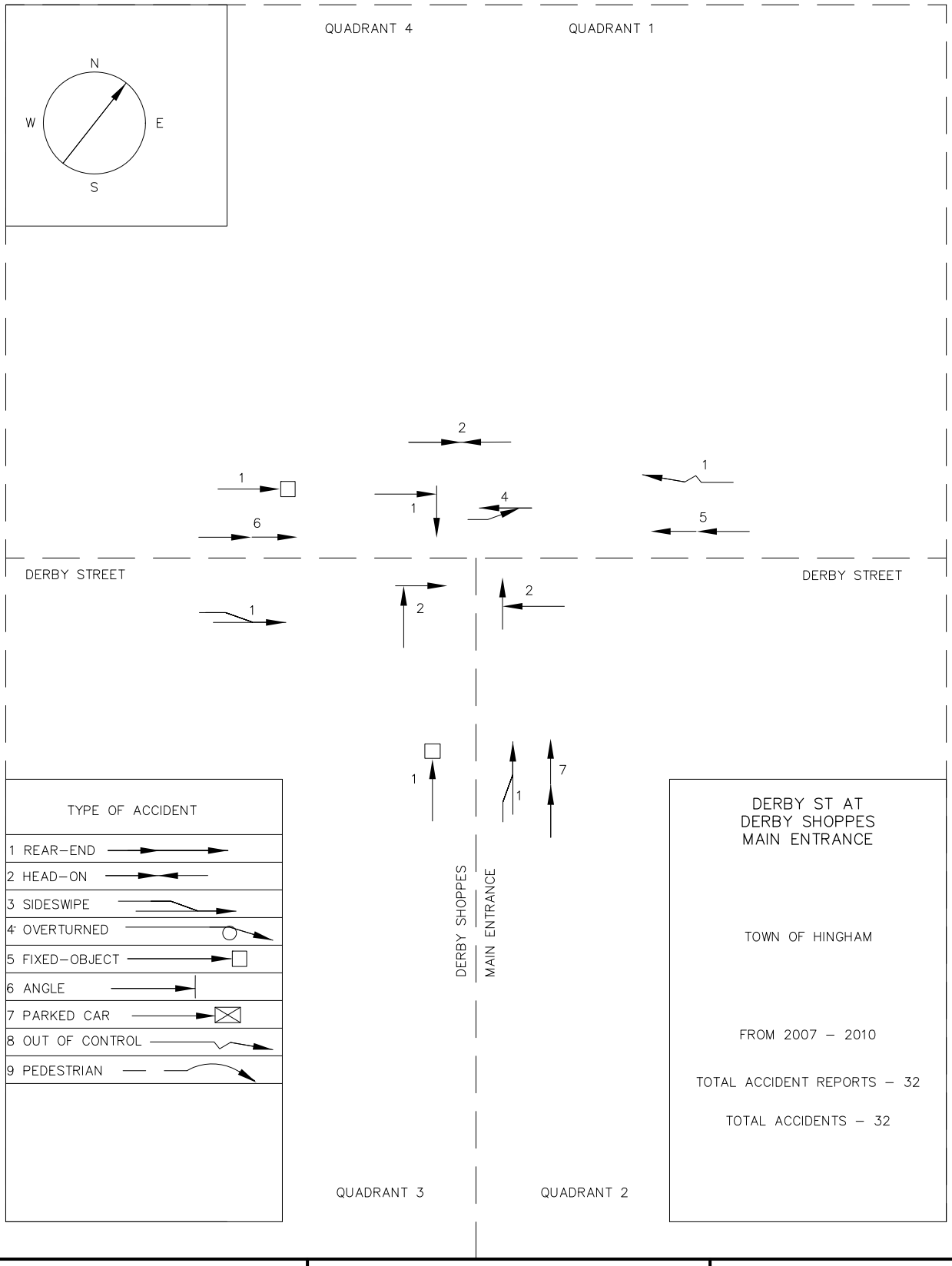
TITLE:

COLLISION DIAGRAM
DERBY ST AT
OLD DERBY ST

DATE: JUNE 2013

FIGURE 10



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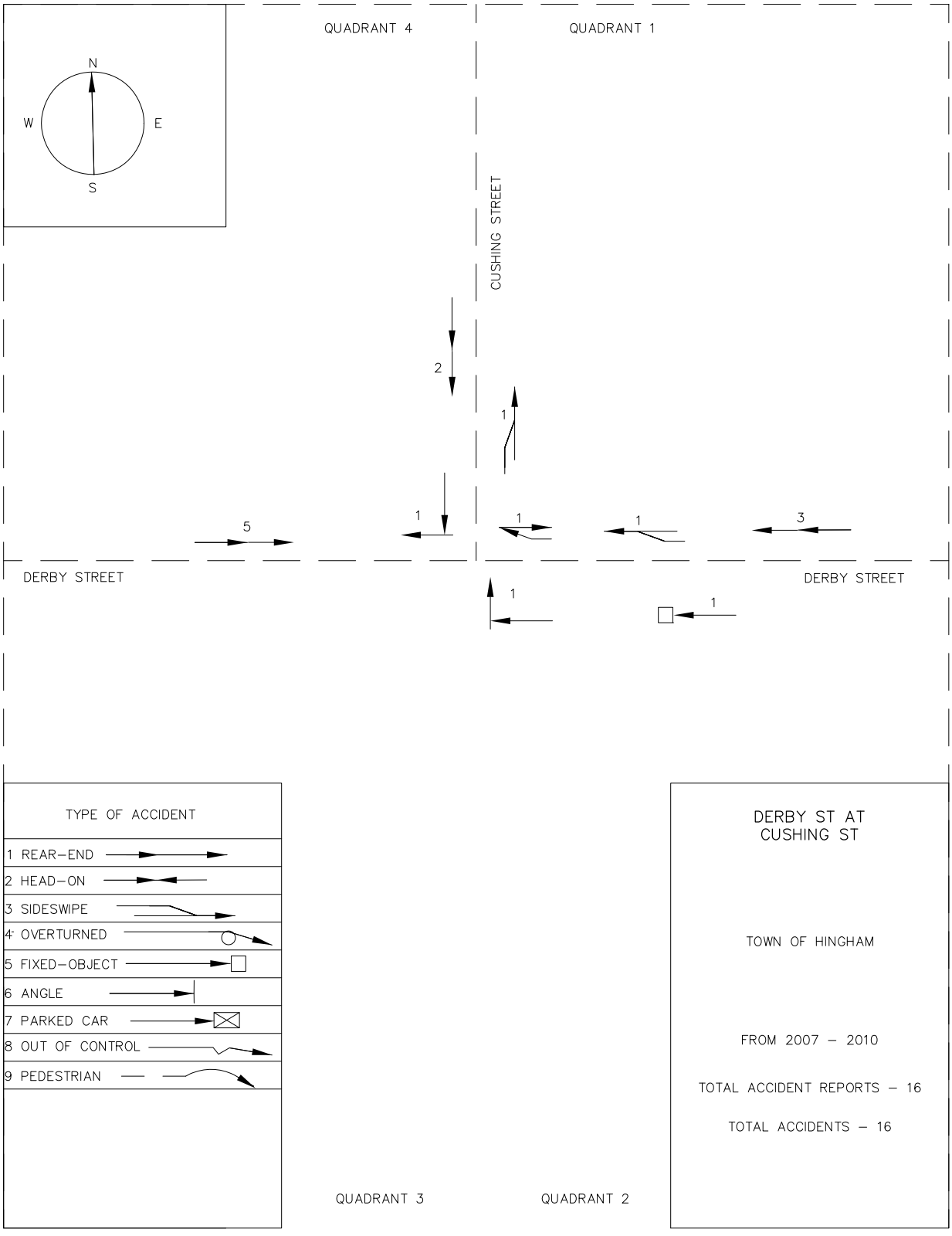
TITLE:

COLLISION DIAGRAM
DERBY ST AT
DERBY SHOPPES

DATE: JUNE 2013

FIGURE 11



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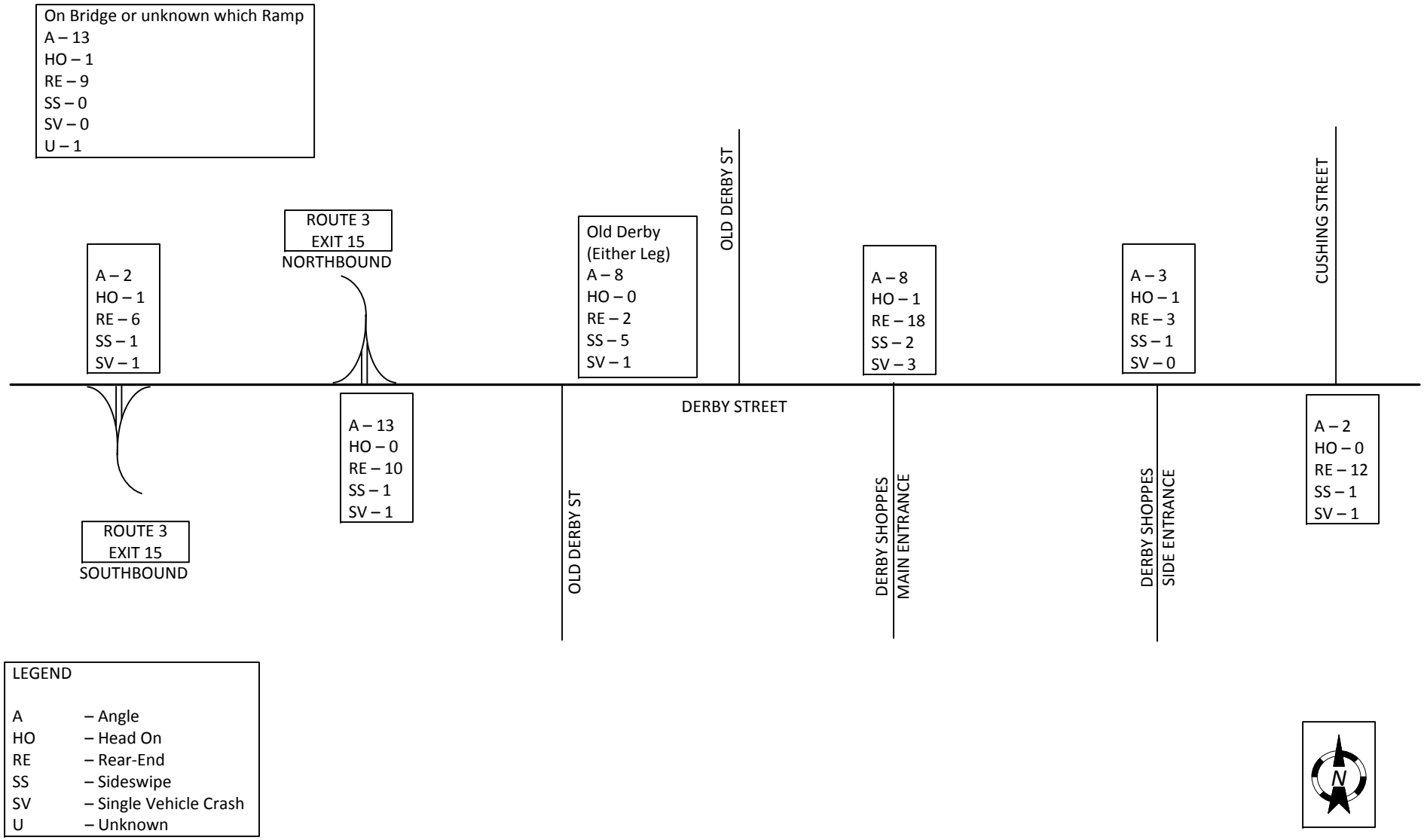
TITLE:

COLLISION DIAGRAM
DERBY ST AT
CUSHING ST

DATE: JUNE 2013

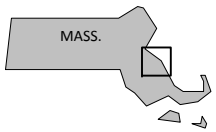
FIGURE 12



Not to Scale

CHA design/construction solutions

Project #:607309
Hingham, Massachusetts



Reconstruction and Related Work on Derby Street
Collision Map

Figure **13**

D. MUTCD Signal Warrants

A study of traffic conditions, pedestrian characteristics, and physical characteristics of intersections within the project limits is required to determine whether installation of traffic control signals are justified at any particular locations. Based on the roadway network and observed traffic and field conditions, two intersections within the project limits were considered for installation of traffic control signals: Derby Street at Route 3 Northbound Ramps and Derby Street at Route 3 Southbound Ramps.

1. Traffic Data

One of the primary considerations for the installation of traffic control signals is the volume of traffic processed by an intersection during peak periods. The first three signal warrants pertain to vehicular volume. As described in Section C.1.b of this report and illustrated in Figures 2, 3 & 4, manual turning movement counts were performed during the weekday morning peak period (7:00 to 9:00 am), the weekday evening peak period (4:00 to 6:00 pm) and Saturday mid-day (11:00 am to 1:00 pm) at the two subject intersections. ATR's conducted on Derby Street and the Route 3 Ramps were used to identify the peak periods. This traffic count data for the major street and minor street approaches is needed for the assessment of the Traffic Control Signal Warrants.

The traffic volumes collected during the peak 8-hour periods are tabulated below. The volumes depicted for the Route 3 ramp approaches include only the left turn traffic and do not include the vehicles that are proceeding right from the ramps as these vehicles would not be under signal control under the proposed signalized condition. Copies of the traffic count data are provided in the Appendix.

Table 5 –Traffic Data

Period	*Derby Street at Route 3 Southbound Ramps*		
	Derby Street EB	***Derby Street WB***	***Ramp NB***
7:00-8:00 AM	251	714	96
8:00-9:00 AM	339	877	122
9:00-10:00 AM	429	636	151
10:00-11:00 AM	468	626	106
11:00-12:00 PM	564	697	99
12:00-1:00 PM	510	743	99
1:00-2:00 PM	477	848	104
2:00-3:00 PM	408	868	110
3:00-4:00 PM	572	782	117
4:00-5:00 PM	663	824	83
5:00-6:00 PM	574	762	75
6:00-7:00 PM	434	664	66
Period	***Derby Street at Route 3 Northbound Ramps***		
	Derby Street EB	***Derby Street WB***	***Ramp SB***
7:00-8:00 AM	617	379	72
8:00-9:00 AM	722	529	89
9:00-10:00 AM	837	410	127
10:00-11:00 AM	904	426	136
11:00-12:00 PM	1082	484	112
12:00-1:00 PM	1166	494	62
1:00-2:00 PM	1086	634	94
2:00-3:00 PM	1015	621	100
3:00-4:00 PM	1171	572	91
4:00-5:00 PM	1226	573	92
5:00-6:00 PM	1243	545	84
6:00-7:00 PM	1181	478	99

2. Warrant Analysis

Chapter of 4C of the 2009 MUTCD was reviewed in conjunction with the prevailing geometric and speed conditions to determine if signal installation should be considered at each of the two ramp intersection. There are nine individual warrants that need to be considered to justify the installation of a traffic control signal. Meeting the requirements of one or more warrants alone does not mean that signals are required at a given location. It is understood that MassDOT prefers that the data satisfies Warrant 1: Eight Hour Vehicular Volume to justify signal installation. Table 6 below summarizes the findings for each of the traffic control signal warrants for the two intersections. A complete warrant summary for each location is included in the Appendix.

Table 6 – Traffic Signal Control Warrant Summary

Warrant	***Derby Street at Route 3 Southbound Ramps*** Warrant Satisfied	***Derby Street at Route 3 Northbound Ramps*** Warrant Satisfied
Warrant 1: Eight-Hour Vehicular Volume	Yes	Yes
Warrant 2: Four-Hour Vehicular Volume	Yes	Yes
Warrant 3: Peak Hour	No	Yes
Warrant 4: Pedestrian Volume	No	No
Warrant 5: School Crossing	No	No
Warrant 6: Coordinated Signal System	Yes	Yes
Warrant 7: Crash Experience	No	Yes
Warrant 8: Roadway Network	No	No
Warrant 9: Intersection Near a Grade Crossing	No	No

Under existing conditions, both intersections meet Warrant 1: Eight-Hour Vehicular Volume, Warrant 2: Four-Hour Vehicular Volume, and Warrant 6: Coordinated Signal System. The intersection of Derby Street at Route 3 Northbound Ramps also meets Warrant 3: Peak Hour, and Warrant 7: Crash Experience. In accordance with MassDOT standard practice stated in the *Massachusetts Amendments to the 2009 MUTCD*, the Department expects that Warrant 1 be satisfied for the consideration of a traffic signal. As both intersections meet Warrant 1, as well as several others, installation of traffic signals at these locations is an appropriate design alternative.

E. Operational Analysis

1. Capacity Analysis

Intersection capacity analyses were conducted for each of the intersections within the project limits as described above to determine the traffic operations and vehicle delays found at each approach. Three scenarios were reviewed at each location: Base year traffic volumes with existing geometry and controls (Existing), Future year traffic volumes with existing geometry (No-Build) and Future year traffic volumes with proposed geometry and controls (Build). The analysis and assumptions are described below.

Traffic analyses were conducted for the existing unsignalized and signalized intersections using the peak hour factor and heavy vehicle percentages based on an approach-by-approach basis determined from the turning movement counts. The analyses indicate that under current conditions, several of the minor leg approaches of the unsignalized intersections currently operate at LOS "F" during the peak hours. Synchro is unable to compute the volume to capacity ratio, delay, or 95th percentile queue lengths at some locations due to the excessive volume of traffic on the minor street approaches operating under STOP control. Intersection traffic volumes were projected 10 years into the future and analyzed to establish a design year base condition for the intersection. Capacity analysis worksheets are included in Appendix D.

2012 Existing Analysis

The results of the base year (2012) analyses including the approach level of service (LOS); volume-to-capacity ratio (v/c), and vehicle delay are presented in Table 7 below.

The results of the existing conditions capacity analysis indicate that the intersections of the Route 3 Northbound and Southbound Ramps at Derby Street experience long delays and queues for vehicles exiting the ramps to turn left onto Derby Street in each of the peak hour periods. The level of service for these left turn movements is LOS "F" in each of the peak hours. This is due to the combination of high exiting volumes from the ramp and high through volumes on Derby Street. Vehicles exiting the ramps turning right onto Derby Street are under yield control and experience shorter delays as they are yielding to only one direction as opposed to the left turns which must stop and wait for gaps in both directions.

The Old Derby Street intersections both operate well in the weekday morning peak period with minor delays. The level of service for the south leg of Old Derby Street operates at LOS "F" during the weekday evening due to the high through volumes on Derby Street. The queues on both Old Derby Street legs are relatively minor due to the low volume of exiting vehicles. There is little delay for vehicles turning left onto either leg of Old Derby Street as these movements operate at LOS "A" in each of the peak hour periods.

From Table 7 it is evident that the signalized intersection of Derby Shoppes at Derby Street is currently operating at acceptable level of service during the weekday morning (LOS "A"),

Table 7 – Level of Service Summary – 2012 Existing Conditions

Location/Movement	Weekday Morning Peak Hour			Weekday Evening Peak Hour			Weekend Midday Peak Hour		
	Delay (spv)[a]	LOS[b]	V/C Ratio	Delay (spv)	LOS	V/C Ratio	Delay (spv)	LOS	V/C Ratio
Derby St. @ Pond Park Road									
Derby St. EB	13.6	B	0.57	21.4	C	0.77	7.2	A	0.38
Derby St. WB – L	5.2	A	0.46	7.3	A	0.24	2.5	A	0.03
Derby St. WB – T	5.6	A	0.48	12.8	B	0.66	3.4	A	0.32
Pond Park Road NB – TL	24.3	C	0.17	40.7	D	0.72	20.6	C	0.04
Pond Park Road NB – R	11.8	B	0.22	17.7	B	0.50	13.3	B	0.16
175 Derby SB – TL	24.0	C	0.09	29.7	C	0.42	20.6	C	0.05
175 Derby SB – R	23.8	C	0.06	21.9	C	0.08	20.6	C	0.03
All Movements	*9.9*	*A*		*20.1*	*C*		*6.6*	*A*	
Derby St. @ Route 3 Southbound Ramps									
Derby St. WB – TL	2.3	A	0.09	12.8	B	0.46	6.1	A	0.27
Southbound Ramp NB – L	>100	F	1.24	>100	F	8.52	95.7	F	0.46
Southbound Ramp NB – R	21.3	C	0.68	>100	F	2.14	>100	F	1.16
Derby St. @ Route 3 Northbound Ramps									
Derby St. EB – TL	1.7	A	0.07	10.8	B	0.23	2.2	A	0.07
Northbound Ramp SB – L	95.5	F	0.75	>100	F	4.98	>100	F	2.83
Northbound Ramp SB – R	40.2	E	0.83	27.0	D	0.57	15.4	C	0.30
Derby St. @ Old Derby Street (South Leg)									
Derby St. WB – L	0.7	A	0.02	2.0	A	0.07	0.6	A	0.02
Old Derby St. NB	11.4	B	0.01	62.5	F	0.35	34.5	D	0.12
Derby St. @ Old Derby Street (North)									
Derby St. EB – L	1.3	A	0.03	0.3	A	0.01	0.6	A	0.02
Old Derby St. SB	21.7	C	0.07	27.2	D	0.14	12.2	B	0.02
Derby St. @ Derby Shoppes Main Entrance									
Derby St. EB – TR	9.7	A	0.35	18.6	B	0.68	24.7	C	0.74
Derby St. WB – L	42.0	D	0.34	47.5	D	0.69	46.2	D	0.76
Derby St. WB – T	4.0	A	0.49	9.4	A	0.38	9.3	A	0.35
Derby Shoppes NB- LR	37.4	D	0.49	64.8	E	0.97	42.7	D	0.88
All Movements	*10.1*	*B*		*26.6*	*C*		*26.9*	*C*	
Derby St. @ Cushing Street									
Derby St. EB – L	53.9	D	0.70	46.2	D	0.85	70.9	E	1.00
Derby St. EB – TR	4.9	A	0.20	6.1	A	0.38	7.7	A	0.34
Derby St. WB – L	41.2	D	0.10	40.7	D	0.09	0	A	-
Derby St. WB – TR	18.8	B	0.50	32.1	C	0.77	27.0	C	0.70
62 Derby St. - NB	23.6	C	0.13	29.3	C	0.28	23.8	C	0.08
Cushing St. SB - TL	36.0	D	0.16	38.9	D	0.16	34.4	C	0.12
Cushing St. SB - R	20.4	C	0.61	22.2	C	0.74	38.5	D	0.92
All Movements	*20.3*	*C*		*24.5*	*C*		*31.3*	*C*	

weekday evening (LOS"C") and Saturday mid-day (LOS"C") peak hour periods. The minor leg Derby Shoppes approach experiences the longest delays in each period.

From Table 7 it is evident that the signalized intersection of Cushing Street at Derby Street Street is currently operating at acceptable level of service during the weekday morning (LOS "B"), weekday evening (LOS"C") and Saturday mid-day (LOS"C") peak hour periods.

Although outside the limit of work for physical improvements, the intersection of Derby Street and Pond Park Road was included in the Synchro analysis of the corridor due to its proximity to the other project intersections. The intersection is currently operating at acceptable level of service during the weekday morning (LOS "A"), weekday evening (LOS"C") and Saturday mid-day (LOS"A") peak hour periods.

2022 No-Build Analysis

Future year traffic volumes with existing geometry (No-Build) condition results are summarized in Table 8. The results are similar to the Existing Conditions with some reductions in Level of Service predicted as a result of the projected traffic growth. The existing signalized intersections are expected to continue to operate at an acceptable level of service, while the unsignalized locations at the Route 3 ramps and Old Derby Street are expected to see an increase in delays with continued poor level of service.

2022 Build Analysis

Since the existing conditions at the two Route 3 ramp intersections meet multiple traffic signal warrants and the existing traffic volumes satisfy Warrant 1 - Eight-Hour Vehicular Volume as presented in Section E., traffic signal controls were considered at each of the ramp locations. Traffic analyses were performed to evaluate the traffic operations under the 2022 design year traffic volume conditions during each of the peak hours under proposed conditions. Due to the spacing of the intersections, analyses were performed assuming that each of the traffic signals would be part of a closed loop coordinated system. Proposed geometry and lane configuration for each intersection is described in Section G. Table 9 summarizes the results of these traffic analyses. The analysis worksheets are included in Appendix F.

As shown in Table 9, the proposed traffic signals at the Route 3 Northbound and Southbound Ramps will both operate at acceptable level of service (overall LOS A or LOS B in each peak hour period) under future design year conditions. Each of the proposed signalized ramp intersections will have additional capacity to accommodate future traffic increases should development occur in the future.

Conditions at the other intersections within the study area are expected to remain similar to existing conditions. Each of the signalized intersections will operate at LOS "C" or better during peak periods under 2022 Build conditions.

Table 8 – Level of Service Summary – 2022 No-Build Conditions

Location/Movement	Weekday Morning Peak Hour			Weekday Evening Peak Hour			Weekend Midday Peak Hour		
	Delay (spv)[a]	LOS[b]	V/C Ratio	Delay (spv)	LOS	V/C Ratio	Delay (spv)	LOS	V/C Ratio
Derby St. @ Pond Park Road									
Derby St. EB	15.1	B	0.62	31.6	C	0.92	8.4	A	0.47
Derby St. WB – L	6.5	A	0.50	7.6	A	0.26	2.4	A	0.04
Derby St. WB – T	5.7	A	0.52	13.9	B	0.70	3.4	A	0.34
Pond Park Road NB – TL	27.4	C	0.21	48.9	D	0.81	21.6	C	0.04
Pond Park Road NB – R	12.8	B	0.23	18.6	B	0.54	15.2	B	0.21
175 Derby SB – TL	26.7	C	0.11	33.2	C	0.50	21.7	C	0.06
175 Derby SB – R	26.5	C	0.07	22.1	C	0.08	21.6	C	0.03
All Movements	*10.8*	*B*		*26.0*	*C*		*7.4*	*A*	
Derby St. @ Route 3 Southbound Ramps									
Derby St. WB – TL	2.3	A	0.10	19.2	C	0.57	6.8	A	0.31
Southbound Ramp NB – L	>100	F	1.92	>100	F	24.95	>100	F	0.75
Southbound Ramp NB – R	27.1	D	0.77	>100	F	2.70	>100	F	1.27
Derby St. @ Route 3 Northbound Ramps									
Derby St. EB – TL	2.0	A	0.08	11.4	B	0.26	2.9	A	0.08
Northbound Ramp SB – L	>100	F	1.07	>100	F	8.07	>100	F	3.84
Northbound Ramp SB – R	73.9	F	1.00	36.3	E	0.69	17.0	C	0.36
Derby St. @ Old Derby Street (South Leg)									
Derby St. WB – L	0.7	A	0.02	2.7	A	0.09	0.7	A	0.02
Old Derby St. NB	11.9	B	0.01	97.9	F	0.47	41.7	E	0.14
Derby St. @ Old Derby Street (North)									
Derby St. EB – L	1.9	A	0.06	1.0	A	0.03	0.7	A	0.02
Old Derby St. SB	30.8	D	0.16	75.5	F	0.47	48.5	E	0.25
Derby St. @ Derby Shoppes Main Entrance									
Derby St. EB – TR	10.0	B	0.39	20.2	C	0.74	28.0	C	0.80
Derby St. WB – L	41.4	D	0.34	45.9	D	0.69	44.9	D	0.76
Derby St. WB – T	4.7	A	0.45	10.3	B	0.43	10.1	B	0.40
Derby Shoppes NB- LR	37.4	D	0.49	64.8	E	0.97	42.7	D	0.88
All Movements	*10.2*	*B*		*26.7*	*C*		*27.7*	*C*	
Derby St. @ Cushing Street									
Derby St. EB – L	55.1	E	0.73	48.5	D	0.88	87.1	F	1.06
Derby St. EB – TR	5.0	A	0.22	6.9	A	0.40	8.4	A	0.36
Derby St. WB – L	41.2	D	0.10	40.7	D	0.09	0	A	-
Derby St. WB – TR	20.5	C	0.57	37.2	D	0.85	28.6	C	0.75
62 Derby St. - NB	23.6	C	0.13	29.3	C	0.28	23.8	C	0.08
Cushing St. SB - TL	36.8	D	0.19	38.9	D	0.16	34.8	C	0.15
Cushing St. SB - R	23.2	C	0.67	23.5	C	0.78	51.1	D	0.98
All Movements	*21.8*	*C*		*27.0*	*C*		*37.5*	*D*	

Table 9 – Level of Service Summary – 2022 Build Conditions

Location/Movement	Weekday Morning Peak Hour			Weekday Evening Peak Hour			Weekend Midday Peak Hour		
	Delay (spv)[a]	LOS[b]	V/C Ratio	Delay (spv)	LOS	V/C Ratio	Delay (spv)	LOS	V/C Ratio
Derby St. @ Pond Park Road									
Derby St. EB	15.2	B	0.50	15.5	B	0.58	4.3	A	0.36
Derby St. WB – L	4.1	A	0.47	5.8	A	0.33	1.6	A	0.04
Derby St. WB – T	3.2	A	0.52	4.4	A	0.63	2.2	A	0.32
Pond Park Road NB – TL	52.3	D	0.47	78.7	E	0.93	42.0	D	0.12
Pond Park Road NB – R	20.0	C	0.24	39.1	D	0.75	42.6	D	0.47
175 Derby SB – TL	42.3	D	0.23	59.6	E	0.70	42.8	D	0.16
175 Derby SB – R	38.8	D	0.11	30.4	C	0.09	41.6	D	0.10
All Movements	*11.0*	*B*		*22.2*	*C*		*6.7*	*A*	
Derby St. @ Route 3 Southbound Ramps									
Derby St. EB – T	19.1	B	0.26	16.8	B	0.85	6.8	A	0.43
Derby St. WB – L	5.2	A	0.18	38.2	D	0.84	10.6	B	0.55
Derby St. WB – T	10.1	B	0.72	3.0	A	0.53	4.5	A	0.35
Southbound Ramp NB – L	45.2	D	0.60	45.8	D	0.51	42.3	D	0.25
Southbound Ramp NB – R	0.5	A	0.31	1.0	A	0.47	0.8	A	0.41
All Movements	*12.3*	*B*		*13.2*	*B*		*5.7*	*A*	
Derby St. @ Route 3 Northbound Ramps									
Derby St. EB – L	45.1	D	0.40	47.0	D	0.64	43.7	D	0.42
Derby St. EB – T	1.9	A	0.31	2.3	A	0.55	4.6	A	0.45
Derby St. WB – T	7.2	A	0.58	9.9	A	0.79	10.6	B	0.63
Northbound Ramp SB – L	40.8	D	0.32	41.0	D	0.36	41.1	D	0.53
Northbound Ramp SB – R	0.4	A	0.27	0.2	A	0.15	10.9	B	0.48
All Movements	*6.6*	*A*		*9.1*	*A*		*11.3*	*B*	
Derby St. @ Old Derby Street (South Leg)									
Derby St. WB – L	0.7	A	0.02	2.5	A	0.08	0.7	A	0.02
Old Derby St. NB	10.9	B	0.01	27.3	D	0.17	22.6	C	0.07
Derby St. @ Old Derby Street (North)									
Derby St. EB – L	1.3	A	0.04	12.9	B	0.03	12.4	B	0.02
Old Derby St. SB	28.6	D	0.15	28.1	D	0.22	31.2	D	0.17
Derby St. @ Derby Shoppes Main Entrance									
Derby St. EB – TR	17.2	B	0.39	12.2	B	0.74	31.1	C	0.81
Derby St. WB – L	41.4	D	0.34	46.4	D	0.73	35.5	D	0.72
Derby St. WB – T	4.7	A	0.45	8.4	A	0.46	5.5	A	0.40
Derby Shoppes NB- LR	37.4	D	0.49	46.3	D	0.97	42.7	D	0.88
All Movements	*12.8*	*B*		*19.1*	*B*		*26.7*	*C*	
Derby St. @ Cushing Street									
Derby St. EB – L	57.6	E	0.73	48.1	D	0.88	51.9	D	0.89
Derby St. EB – TR	2.9	A	0.22	2.6	A	0.39	7.1	A	0.35
Derby St. WB – L	41.2	D	0.10	45.6	D	0.14	0	A	-
Derby St. WB – TR	20.5	C	0.57	34.7	C	0.83	33.5	C	0.82
62 Derby St. - NB	23.6	C	0.13	30.8	C	0.30	25.3	C	0.10
Cushing St. SB - TL	36.8	D	0.19	40.1	D	0.17	37.2	D	0.17
Cushing St. SB - R	23.2	C	0.67	25.0	C	0.79	39.2	D	0.93
All Movements	*21.7*	*C*		*25.1*	*C*		*30.4*	*C*	

2. Systems Analysis

A Systems Analysis has been performed for the Derby Street corridor using Synchro software. Coordination of the signalized intersections along Derby Street from Pond Park Road to Cushing Street is planned. Signals would be interconnected by either hard wire or spread spectrum radio. A network analysis was performed using Synchro software to determine optimal timings and phasings for each intersection. The master controller was placed at the Cushing Street intersection, which is the location of the existing master for the two coordinated intersection of Cushing Street and Derby Shoppes. The 2022 Build Conditions level of service, delay and queue results included in this section are all based on a coordinated system along Derby Street.

3. Queue Length Analysis

A review of projected peak hour queues has been performed for the Existing Conditions, No-Build conditions and proposed Build conditions, which includes signalization at the Route 3 Northbound and Southbound Ramps. Queue lengths were calculated for each intersection using Synchro software and included coordinated systems for existing or proposed interconnected locations. Tables 10 to 12 summarize the 50^{th} and 95^{th} percentile queues in each peak hour for all approaches at the project intersections.

The results of the Existing conditions and No-Build conditions queue analyses indicate extensive queues at the Route 3 off-ramps during the weekday evening peak hour periods. The analysis indicates 95^{th} percentile queue lengths in excess of 1000 feet on each ramp. The 95^{th} percentile queues are significantly reduced under Build conditions with the installation of traffic signals at the ramps. Build conditions queue lengths on the Route 3 Ramps are less than 150 feet in each of the peak hour periods under proposed conditions.

Table 10 – Queue Summary – Existing Conditions

Location/Movement	Weekday Morning Peak Hour		Weekday Evening Peak Hour		Weekend Peak Hour	
	50% Queue (feet)	95% Queue (feet)	50% Queue (feet)	95% Queue (feet)	50% Queue (feet)	95% Queue (feet)
Derby St. @ Pond Park Road						
Derby St. EB – TLR	43	144	205	277	43	144
Derby St. WB – L	29	52	10	22	1	6
Derby St. WB – T	108	180	185	295	0	117
Pond Park Road NB – TL	14	42	87	99	2	7
Pond Park Road NB – R	21	53	102	104	15	17
175 Pond Park Road SB – TL	14	42	36	56	3	12
175 Pond Park Road SB – R	3	12	10	22	2	8
Derby St. @ Route 3 Southbound Ramps						
Derby St. WB – TL	-	7	-	60	-	28
Southbound Ramp NB – L	-	228	-	Err	-	46
Southbound Ramp NB – R	-	132	-	1311	-	547
Derby St. @ Route 3 Northbound Ramps						
Derby St. EB – TL	-	5	-	22	-	6
Northbound Ramp SB – L	-	105	-	Err	-	525
Northbound Ramp SB – R	-	202	-	85	-	31
Derby St. @ Old Derby Street (South Leg)						
Derby St. WB – L	-	2	-	6	-	2
Old Derby St. NB	-	1	-	34	-	10
Derby St. @ Old Derby Street (North Leg)						
Derby St. EB – L	-	3	-	1	-	2
Old Derby St. SB	-	6	-	12	-	2
Derby St. @ Derby Shoppes Main Entrance						
Derby St. EB – TR	106	170	257	332	237	324
Derby St. WB – L	33	62	83	121	128	171
Derby St. WB – T	57	127	145	202	96	137
Derby Shoppes NB- LR	46	59	166	275	194	285
Derby St. @ Cushing Street						
Derby St. EB – L	143	218	304	407	278	465
Derby St. EB – TR	37	59	73	177	105	163
Derby St. WB – L	6	21	6	22	-	-
Derby St. WB – TR	164	241	259	336	235	305
62 Derby St. - NB	8	8	18	40	6	13
Cushing St. SB - TL	16	38	14	36	13	37
Cushing St. SB - R	145	186	241	324	358	609

Table 11 –Queue Summary – No-Build Conditions

Location/Movement	Weekday Morning Peak Hour		Weekday Evening Peak Hour		Weekend Peak Hour	
	50% Queue (feet)	95% Queue (feet)	50% Queue (feet)	95% Queue (feet)	50% Queue (feet)	95% Queue (feet)
Derby St. @ Pond Park Road						
Derby St. EB – TLR	127	181	273	410	47	156
Derby St. WB – L	34	83	10	23	1	6
Derby St. WB – T	130	212	209	335	0	128
Pond Park Road NB – TL	18	49	99	110	3	8
Pond Park Road NB – R	26	63	114	114	19	21
175 Pond Park Road SB – TL	9	22	40	60	4	13
175 Pond Park Road SB – R	5	15	10	22	2	8
Derby St. @ Route 3 Southbound Ramps						
Derby St. WB – TL	-	9	-	89	-	33
Southbound Ramp NB – L	-	340	-	Err	-	76
Southbound Ramp NB – R	-	180	-	1620	-	674
Derby St. @ Route 3 Northbound Ramps						
Derby St. EB – TL	-	6	-	26	-	6
Northbound Ramp SB – L	-	162	-	Err	-	Err
Northbound Ramp SB – R	-	315	-	121	-	40
Derby St. @ Old Derby Street (South Leg)						
Derby St. WB – L	-	2	-	7	-	2
Old Derby St. NB	-	1	-	48	-	12
Derby St. @ Old Derby Street (North Leg)						
Derby St. EB – L	-	5	-	3	-	2
Old Derby St. SB	-	14	-	51	-	23
Derby St. @ Derby Shoppes Main Entrance						
Derby St. EB – TR	120	190	296	380	275	402
Derby St. WB – L	33	56	83	111	129	158
Derby St. WB – T	63	169	186	226	116	157
Derby Shoppes NB- LR	46	59	166	275	194	285
Derby St. @ Cushing Street						
Derby St. EB – L	160	239	331	459	329	491
Derby St. EB – TR	41	63	94	203	125	181
Derby St. WB – L	6	21	6	22	-	-
Derby St. WB – TR	197	273	293	403	260	336
62 Derby St. - NB	8	8	18	40	6	13
Cushing St. SB - TL	19	44	14	36	16	42
Cushing St. SB - R	176	228	262	364	411	678

Table 12 – Queue Summary – Build Conditions

Location/Movement	Weekday Morning Peak Hour		Weekday Evening Peak Hour		Weekend Peak Hour	
	50% Queue (feet)	95% Queue (feet)	50% Queue (feet)	95% Queue (feet)	50% Queue (feet)	95% Queue (feet)
Derby St. @ Pond Park Road						
Derby St. EB – TLR	155	214	257	325	98	120
Derby St. WB – L	22	21	4	6	1	4
Derby St. WB – T	132	85	80	94	48	96
Pond Park Road NB – TL	30	63	136	142	8	11
Pond Park Road NB – R	49	81	188	177	48	36
175 Pond Park Road SB – TL	14	28	56	80	11	19
175 Pond Park Road SB – R	8	20	14	28	6	12
Derby St. @ Route 3 Southbound Ramps						
Derby St. EB – T	135	188	330	336	34	155
Derby St. EB – R	54	126	-	-	-	-
Derby St. WB – L	14	41	82	163	51	128
Derby St. WB – T	168	349	33	51	87	152
Southbound Ramp NB – L	84	138	51	95	20	49
Southbound Ramp NB – R	0	0	0	0	0	0
Derby St. @ Route 3 Northbound Ramps						
Derby St. EB – L	37	77	96	134	41	85
Derby St. EB – T	30	44	51	67	103	140
Derby St. WB – TR	211	141	95	176	201	249
Northbound Ramp SB – L	27	51	32	57	63	96
Northbound Ramp SB – R	0	0	0	0	0	54
Derby St. @ Old Derby Street (South Leg)						
Derby St. WB – L	-	2	-	7	-	2
Old Derby St. NB	-	1	-	15	-	6
Derby St. @ Old Derby Street (North Leg)						
Derby St. EB – L	-	3	-	3	-	2
Old Derby St. SB	-	13	-	20	-	14
Derby St. @ Derby Shoppes Main Entrance						
Derby St. EB – TR	181	278	176	223	297	377
Derby St. WB – L	33	56	72	101	127	138
Derby St. WB – T	63	169	178	261	87	95
Derby Shoppes NB- LR	46	59	159	244	194	285
Derby St. @ Cushing Street						
Derby St. EB – L	160	238	255	441	296	423
Derby St. EB – TR	21	38	45	73	115	157
Derby St. WB – L	6	21	6	23	-	-
Derby St. WB – TR	197	273	288	390	276	356
62 Derby St. - NB	8	8	19	40	6	13
Cushing St. SB - TL	19	44	14	37	16	44
Cushing St. SB - R	176	228	269	373	385	651

F. Proposed Design

1. Modified Geometry

The proposed roadway closely follows the existing alignment to minimize the amount of work required to the existing infrastructure. Box Widening is proposed throughout the project to create a sufficient roadway cross section.

Proposed Pavement Improvement Program

The existing pavement thickness on Derby Street is adequate and most of the pavement deficiencies between Pond Park Road and Cushing Street are surficial. Therefore, the primary proposed pavement rehabilitation program for this section is a 1.75" mill and overlay.

The proposed pavement structure for the box widening has been designed to meet MassDOT's minimum pavement section for arterial roadways including: 1.75 inches SUPERPAVE surface course over 1.75 inches SUPERPAVE intermediate course over 3.5 inches SUPERPAVE base course. The proposed sub-base consists of 4 inches of dense graded crushed stone over 8 inches of type B gravel borrow. Where box widening is less than 4 feet wide, the SUPERPAVE base course and subbase will be replaced with a high early strength cement concrete base course.

Proposed Cross Section

The proposed cross section for Derby Street changes throughout the project. The project begins at the Route 3 southbound ramps with a 57-foot cross section consisting of two 11-foot eastbound lanes and one 11-foot westbound lane. In the westbound direction, an 11-foot left turn lane entering the southbound ramp is proposed. Proposed shoulders are to be 8 feet wide along the ramp and 5 feet wide on the north side of the road. The 5.5-foot wide sidewalk along the north side of the road is proposed to be reconstructed to connect the northbound ramps and the previously reconstructed sidewalk from Pond Park Road. The pavement width narrows to meet the approximate 44-foot wide width over the bridge. No structural improvements or widening is currently being proposed on the bridge over Route 3. At the northbound ramps, Derby Street widens to become a 68-foot wide, 5-lane roadway including two 11-foot lanes in each direction and one eastbound left turn lane onto the ramp. A 12-foot wide shoulder is proposed along the northbound ramp and a 5-foot shoulder along the south side of the roadway. The 5.5-foot wide sidewalk continues along the north side of Derby Street across the northbound ramps. Derby Street continues as a four lane roadway with a gore stripe median separating opposing traffic to Old Derby Street where an 11-foot wide left turn lane is proposed in the eastbound direction. The sidewalk on the north side of Derby Street will be extended to Cushing Street to eliminate the need for the existing crosswalk at Old Derby Street. A new crosswalk is proposed at the Derby Shoppes signal to create a signalized pedestrian crossing and provide pedestrian access to existing and future businesses on the north side of Derby Street. The project will continue through Derby Shoppes to Cushing Street maintaining a 66-foot wide cross section with minor widening on

the north side of Derby Street to provide a 12-foot wide center turn lane and 5-foot shoulders for improved bicycle accommodation.

Intersection Improvements

The Derby Street Reconstruction Project is primarily an intersection improvements project. There are two intersections that will have major improvements to their layout; Derby Street at the Route 3 Southbound ramps and Derby Street at the Route 3 Northbound ramps. At each location a traffic signal will be implemented and a left turn lane will be added to enter the on ramp. A second through lane will be added in the eastbound direction at the southbound ramp. At the northbound ramps, the westbound through lane will be increased from one to two lanes and the ramp will be widened to accommodate two left turn lanes on to Derby Street eastbound. .

Minor improvements are also proposed as part of this project at the intersection of Derby Street at Old Derby Street, Derby Street at Derby Shoppes, and Derby Street at Cushing Street. At Old Derby Street a dedicated left turn lane is proposed in the eastbound direction entering the north leg of Old Derby Street to move vehicles attempting to turn left onto Old Derby Street out of the flow of traffic. At both Derby Shoppes and Cushing Street pedestrian crossing signals will be added to accommodate the newly constructed sidewalk on the north side of Derby Street.

All signalized intersections including Derby Street at Pond Park Road will be coordinated to optimize the flow of traffic along the corridor.

2. Bicycle and Pedestrian Accommodation

The proposed improvements include reconstructing the existing sidewalks along the north side of Derby Street and extending the sidewalk along the northerly side of Derby Street from Old Derby Street to Cushing Street. At this time, the project intends to retain the existing sidewalk along the south side of Derby Street to the extent possible to minimize construction costs. Wheelchair ramps, compliant with MassDOT and ADA/AAB standards will be installed at each side street and proposed crosswalk location. These proposed improvements will provide continuous accessible pedestrian accommodations on the north side of Derby Street within the project limits.

A solid white edge line is proposed to define the outer edge of the travel lanes and delineate a minimum 5-foot wide zone for bicycle travel. These wider shoulders will provide a dedicated space for bicycles to travel in along the corridor without impeding traffic flow. Bicycle detection and corresponding signage will be provided at new signal installations and upgraded as required at existing signals.

3. Proposed Traffic Control Modifications

One of the main objectives of this project is to improve the traffic control measures on Derby Street to increase capacity and improve safety along the corridor. Two traffic signals are

proposed on Derby Street: one located at the Route 3 southbound ramp; and one at the Route 3 northbound ramp. The new traffic signals will be coordinated with the existing signals to create an interconnected signal system from Pond Park Road to Cushing Street. Left turn lanes will be implemented at each new traffic signal and at Old Derby Street to improve traffic flow through the corridor by removing left turning vehicles from the through lanes.

4. Safety Enhancements

Two new traffic signals are proposed on Derby Street to increase the intersection capacity at the Route 3 ramps and improve the safety of these intersections by reducing turning vehicle conflicts. Additional safety improvements including: emergency vehicle pre-emption with confirmation strobes, bicycle detection, protected turn phases, and signalized pedestrian crossing phases will be implemented at each signal. Shoulders will be increased to a minimum width of 5 feet throughout the project for bicycle accommodations. Sidewalks will be constructed at a width of 5.5 feet to accommodate pedestrians.
Existing traffic signs that are in poor condition, or that are not warranted, will be removed or replaced as needed. New signs conforming to the provisions of the MUTCD and MassDOT will be installed. These signs will be consistent with the proposed roadway design.

Thermoplastic pavement markings are proposed to delineate the traveled ways and shoulders. Stop lines will be added at intersections. The yellow centerline will be painted to appropriately designate no passing zones and the center two-way left turn lane. Reflectorized slotted pavement markings are proposed along the yellow centerlines and white lane lines to improve the visibility of the travel lanes during dimly lit periods.

5. Work By Others

There are overhead telephone, electrical and cable lines running between utility poles along the length of the project. Water, gas, and drainage lines are located underground at various locations within the project limits. Various utility castings are proposed to be adjusted during the work. One utility pole is proposed to be relocated where the existing pole location conflicts with the widening for the right turns onto the Route 3 northbound ramp. Approximately 6 new utility poles will be required to extend the existing electrical services to the two ramp locations to provide electricity to the proposed signal locations. The work required to relocate utility poles and adjust gas, electric, and telephone castings is proposed to be done by the respective utility purveyors.

G. Traffic Management

1. Construction Management Outline

The proposed construction of this project includes: modification/installation of drainage structures and piping; replacement of deteriorated or affected headwalls; installation/ relocation of utility poles; box widening along Derby Street; relocation/replacement of guardrails; installation of traffic control signals, equipment, and conduit; pavement milling; curb installation; sidewalk construction/reconstruction; paving; and installation of signage and pavement markings. The most significant widening will occur at the Route 3 northbound ramps. At this location, Derby Street is proposed to be widened more than 10 feet on each side of the roadway and the interior lanes on the ramp will be realigned and widened to provide two left turn lanes coming off of Route 3 northbound. Due in part to the inadequate bicycle and pedestrian accommodations along the corridor and the nature of surrounding land uses, this section of Derby Street currently experiences few pedestrians and bicyclists. It is a goal of this project to significantly upgrade these accommodations and maintain the current level of accommodations to the extent practical during construction.

West of Route 3 at the southbound ramps, box cut widening is proposed on both sides of Derby Street. Currently, two lanes of traffic operate on a 44-foot wide paved width with one 12-foot or wider travel lane in each direction. Due to the traffic volumes along this section of the project, it is proposed to conduct the proposed widening on one side of the roadway at a time and maintain the two lane traffic flow using a closed shoulder and a two-lane shift. The wide pavement width should provide a sufficient 5-foot width to divert the limited number of pedestrians around the work zone while the sidewalk is being reconstructed. Equipment will need to be removed from the roadway during non-working hours and temporary ramps provided to furnish a temporary accessible route for pedestrians along the shoulder for the intermediate length of the construction duration. Using a two-lane shift, the work could be performed during normal working hours between 7:00 AM and 3:30 PM.

On the bridge over Route 3, the proposed construction is limited to pavement milling and resurfacing. Two 13.5-foot travel lanes with one lane in each direction are provided over the bridge within an approximate 44-foot paved width. This work will have limited impacts to bicyclists and pedestrians. Signage will be installed in accordance with the MUTCD to indicating that “GROOVED PAVEMENT” will be encountered ahead. A two-lane shift will be proposed for work on the bridge to maintain the two-lane traffic flow over the bridge. Using a two-lane shift, the work could be performed during normal working hours between 7:00 AM and 3:30 PM.

East of Route 3, the existing 44-foot wide paved width extends to Old Derby Street with a 12.5-foot plus travel lane in each direction. Derby Street is proposed to be widened on both sides to provide a five lane cross section at the Derby Street northbound ramps. Due to the traffic volumes along this section of the project, it is proposed to conduct the proposed widening on one side of the roadway at a time and maintain the two lane traffic flow using a closed shoulder and a two-lane shift. The wide pavement width should provide a sufficient 5-foot width to divert the limited number of pedestrians around the work zone while the

sidewalk is being reconstructed. Equipment will need to be removed from the roadway during non-working hours and temporary ramps provided to furnish a temporary accessible route for pedestrians along the shoulder for the intermediate length of the construction duration. Using a two-lane shift, the work could be performed during normal working hours between 7:00 AM and 3:30 PM.

East of Old Derby Street, Derby Street widens to approximately 65 feet including two 12-foot travel lanes in each direction and a two-way left turn lane in front of Derby Shoppes. In this section, most of the box widening will be limited to the north side of Derby Street. Pedestrian access will be improved during construction where a police detail on-site could assist the rare pedestrian to cross the street at Old Derby Street to the existing sidewalk. It is proposed that one lane in the westbound direction be closed while the box widening and sidewalk construction on the north side of Derby Street are conducted. Equipment will need to be removed from the roadway during non-working hours. During pavement milling and paving operations, Derby Street could be reduced to one lane of traffic in each direction during normal working hours between 7:00 AM and 3:30 PM.

At top of the northbound ramps, a significant amount of realignment is proposed to the interior ramps for left turns onto the Route 3 northbound on-ramp and left turns from the Route 3 northbound off-ramp. Work on this portion of the project will have little impact to pedestrians and bicyclists since these modes of travel are prohibited on the ramps. For this work, it may be possible to conduct a good portion of the realignment during normal working hours by first constructing the northbound on-ramp in its new location, re-routing the left turns onto the new on-ramp location, then constructing the proposed realignment for the off-ramp left turn lane. Final paving of the ramps will likely require a detour and night time work to minimize impacts to motorists and area businesses. A closure of the northbound ramps would require motorists to access Route 3 northbound by taking a detour onto Route 3 southbound to Exit 14-Route 228 and accessing Route 3 northbound from Hingham Street. The total length of the detour is approximately 4 miles.

a. Traffic Count Data

ATR counts were conducted at representative points along the project corridor during a 48 hour period. The locations are as follows: Derby Street, west of Pond Park Road; Southbound On and Off Ramps; Derby Street, on the bridge overpass; Northbound On and Off Ramps; Derby Street, east of Old Derby Street; Derby Street, east of Cushing Street. The ATR counts located on Derby Street also recorded vehicle classification and travel speeds. Copies of the ATR traffic counts are included in the Appendix.

Average Daily Traffic was computed from the traffic counts at the specified locations. A summary of ADT's is presented in Table 3. Hourly traffic volumes at the northbound and southbound ramps between 7:00 AM and 7:00 PM are presented in Table 8 – Traffic Data.

b. Capacity Analysis

Based on the existing and proposed width of Derby Street, the expected traffic volumes, and reconstruction techniques, it is anticipated that the majority of the work on this project could be completed through the use of a two-lane shift or a single lane closure. The available traffic counts indicate that the two-way traffic volumes on Derby Street are generally less than 2,000 vehicles per hour. Based on this information and the studies presented in Figure Gen-1 of the *Standard Details and Drawings for the Development of Temporary Traffic Control Plans*, two lanes of traffic would need to be maintained during work periods. Table 13 below illustrates the traffic volumes in each location with the proposed work zone configuration and capacity.

Table 13 –Work Zone Traffic Data

Period	*Derby Street at Route 3 Southbound Ramps*		
	Derby Street EB	***Derby Street WB***	***Combined Total Volume***
7:00-8:00 AM	251	714	965
8:00-9:00 AM	339	877	1,216
9:00-10:00 AM	429	636	1,065
10:00-11:00 AM	468	626	1,094
11:00-12:00 PM	564	697	1,261
12:00-1:00 PM	510	743	1,253
1:00-2:00 PM	477	848	1,325
2:00-3:00 PM	408	868	1,276
3:00-4:00 PM	572	782	1,354

Number of Lanes		Average Capacity	
Normal (Existing)	Open to traffic	VPHPL	VPH
2 (1 Each Dir.)	2 (1 Each Direction)	1,900	3,800

Period	*Derby Street at Route 3 Northbound Ramps*		
	Derby Street EB	***Derby Street WB***	***Combined Total Volume***
7:00-8:00 AM	617	379	996
8:00-9:00 AM	722	529	1,251
9:00-10:00 AM	837	410	1,247
10:00-11:00 AM	904	426	1,330
11:00-12:00 PM	1,082	484	1,566
12:00-1:00 PM	1,166	494	1,660
1:00-2:00 PM	1,086	634	1,720
2:00-3:00 PM	1,015	621	1,636
3:00-4:00 PM	1,171	572	1,743

Number of Lanes		Average Capacity	
Normal (Existing)	Open to traffic	VPHPL	VPH
2 (1 Each Dir.)	2 (1 Each Direction)	1,900	3,800

Period	*Derby Street at Derby Shoppes*		
	Derby Street EB	***Derby Street WB***	***Combined Total Volume***
7:00-8:00 AM	589	857	1,446
8:00-9:00 AM	707	886	1,593
9:00-10:00 AM	731	908	1,639
10:00-11:00 AM	738	916	1,654
11:00-12:00 PM	824	956	1,780
12:00-1:00 PM	929	1,058	1,987
1:00-2:00 PM	824	967	1,791
2:00-3:00 PM	760	1,084	1,844
3:00-4:00 PM	847	990	1,837

Number of Lanes		Average Capacity	
Normal (Existing)	Open to traffic	VPHPL	VPH
4 (2 Each Dir.)	2 (1 Each Direction)	1,340	2,680