

ROAD SAFETY AUDIT

Crescent Street Intersection Improvement Project

City of Brockton

December 30, 2015

Prepared For:
MassDOT



On Behalf Of:
City of Brockton Massachusetts



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Background

On behalf of the City of Brockton and in conjunction with the Massachusetts Department of Transportation (MassDOT) Highway Division Safety Section and representatives from other federal, state and local agencies, CDM Smith conducted a Road Safety Audit (RSA) for four intersections as part of the Crescent Street Intersection Improvement Project in the City of Brockton. The Federal Highway Administration (FHWA) defines an RSA as “the formal safety performance examination of an existing or future road or intersection by an independent, multidisciplinary team.” An RSA is required to be performed during the design process for any MassDOT project that includes a high crash location. The goal of the RSA is to identify safety issues and provide potential enhancements to improve safety for all roadway users. Additionally, the potential enhancements are categorized by timeframe and cost which allows responsible agencies to determine when to make proposed implementations.

CDM Smith conducted the RSA on Wednesday, September 23, 2015. The pre and post audit portions of the RSA were held at the Old Colony Planning Council’s (OCPC) office located at 70 School Street, Brockton, Massachusetts 02301. Members of the interdisciplinary audit team discussed safety issues, conducted a site visit and identified possible safety improvements that could be made to improve the infrastructure and operating conditions of the four (4) subject intersections. The audit team, ranging from emergency responders to transportation planners and engineers, was comprised of members of the local, regional and state agencies. The representatives in attendance, and their affiliations, are provided in Table 1.

Project Data

Audit team members received a meeting packet prior to the RSA, which included a meeting agenda (Appendix A), study area details, detailed crash data, and traffic volume information. The crash data details and collision diagrams along with graphical representations of the crash data are provided in Appendix C. The traffic volume information is provided in Appendix D. The audit members were asked to review the packet and visit the RSA study area prior to the meeting. Project background, general field conditions, crash data and traffic volumes were presented by CDM Smith at the beginning of the RSA, followed by a field visit to the subject intersections. The audit team finished the meeting by identifying appropriate countermeasures for the safety issues discussed.

The crash data and collision diagrams were based on crashes that were reported by the Brockton Police Department and occurred from January 2010- December 2012. According to the data, approximately 61 crashes were reported at the four intersections during the three year period. Of the four intersections, Crescent Street at Lyman Street has the highest crash rate. It is ranked 196th on MassDOT’s list of top 200 crash locations in the state, according to the MassDOT Top 200 Intersection Cluster 2010-2012.

Intersection-specific crash data may be found at the beginning of each intersection’s section in the body of the report as well as in Appendix C.

Table 1: Participating Audit Team Members

Audit Team Member	Agency/Affiliation
Nick Giaquinto	Mayor's Office
Howard Newton	City of Brockton, Engineering
Robert DiBari	Brockton Police Department
Lt. Don Mills	Brockton Police Department
Deputy Chief Kevin Galligan	Brockton Fire Department
Tobias Cowens	Brockton Public Schools
Promise Otaluka	FHWA
John Mastera	MassDOT Highway Safety Management
Rich Olivera	MassDOT District 5 Projects
Sandra Serpa	MassDOT District 5 Projects
Pat Ciaramella	Old Colony Planning Council (OCPC)
Shawn Bailey	OCPC
Paul Chenard	OCPC
Ray Guarino	OCPC
Charles Kilmer	OCPC
Bill McNulty	OCPC
Jimmy Pereira	OCPC
Daniel Murphy	CDM Smith
Paul Carter	CDM Smith
Shana Gare	CDM Smith
Michael Pezzullo	CDM Smith
Zachary Hellyar	CDM Smith

Project Location and Description

Crescent Street is functionally classified as an urban principal arterial and is a State Numbered Route (27) under the jurisdiction of the City of Brockton. Crescent Street is a primary east/west route that has regional importance for access to downtown Brockton. Summer Street is functionally classified as an urban collector whereas Lyman Street is classified as an urban minor arterial. The intersections at Summer Street and Lyman Street are on either side of City Fire Station #4. The driveway to Plouffe Academy Middle School is located on Crescent Street just north of the intersection with Summer Street (see Figure 1). Plymouth Street is functionally classified as an urban minor arterial. The intersection at Plymouth Street is on the western portion of Crescent Street and serves as the primary access for Plouffe Academy Middle School busses and other activities. Grove Street is functionally classified as an urban minor arterial. The intersection of Summer Street at Lyman and Grove Streets is also within the scope of this project. The municipal bridge “B25005-42V-MUN” located south of the Lyman Street, Summer Street and Grove Street intersection is included in this project as well. The speed limit within the project area is a speed limit of 30MPH “prima fascia” not a posted regulatory speed limit (based on a Speed Regulation for a specific section of street), with the exception of the 20 MPH school zone speed limit west of Summer Street during appropriate hours. The existing pavement, sidewalks, and traffic medians in the project area are in poor condition. Further, the existing signal phases as well as their visibility is a major concern at these locations. Lastly, wheelchair ramps and pedestrian pushbuttons at street crossings are non-existent or are not ADA compliant. Images of all the aforementioned locations may be found in figures 1-5 below.

Crescent Street at Plymouth Street

The intersection of Crescent Street and Plymouth Street is a three-way un-signalized intersection. The Plymouth Street southbound approach is under stop control while Crescent Street is uncontrolled. The Crescent Street eastbound approach consists of one shared left-turn/through lane and one through-only lane. The Crescent Street westbound approach consists of one through-only lane and a shared through/right-turn lane. The Plymouth Street southbound approach consists of a shared left-turn/right-turn lane and an 8-foot parking lane along both sides (tapering down to a 1-foot shoulder at the intersection). There are 1-foot painted shoulders and 5-foot sidewalks on both sides of the road on all approaches, except as noted on the Plymouth Street southbound approach. There are no existing wheelchair ramps at the intersection.

Crescent Street at Summer Street

The intersection of Crescent Street and Summer Street is a three-way signalized intersection. The Crescent Street eastbound approach consists of two through lanes, one exclusive, uncontrolled right-turn lane, and a painted 8-foot shoulder on both sides (tapering down to 1-foot at the intersection). There are “no parking” signs adjacent to the intersection. The Crescent Street westbound approach consists of two through lanes. The Summer Street northbound approach consists of two (2) exclusive left-turn lanes and one uncontrolled right-turn lane. There are 1-foot painted shoulders and 5-foot sidewalks on both sides of the road on all approaches, except as noted on the Crescent Street eastbound approach.

Crescent Street at Lyman Street

The intersection of Crescent Street and Lyman Street is a four-way signalized intersection. The Crescent Street eastbound approach consists of one exclusive left-turn lane and one shared through/right-turn lane. The Crescent Street westbound approach consists of a shared left-turn/through lane, and one shared through/right-turn lane. The Lyman Street northbound approach consists of a shared left-turn/through lane and one exclusive right-turn lane. The Lyman Street southbound approach consists of a shared left-turn/through lane and one exclusive right-turn lane. There are 1-foot painted shoulders and 5-foot sidewalks on both sides of the road on all approaches.

Lyman/Grove Street at Summer Street

The intersection of Lyman/Grove Street and Summer Street is a four-way signalized intersection. The Grove Street eastbound approach consists of a shared left-turn/through lane and one exclusive right-turn lane. The Lyman Street westbound approach consists of one exclusive left-turn lane and one shared through/right-turn lane. The Summer Street northbound approach consists of one exclusive left-turn lane, one through lane, and one exclusive, uncontrolled right-turn lane. The Summer Street southbound approach consists of one exclusive left-turn lane, one through lane, and one exclusive right-turn lane. There are 1-foot painted shoulders and 5-foot sidewalks on both sides of the road on all approaches.



Figure 1: Locus Map (S=traffic signal. The traffic signal at Plymouth St is proposed)

Audit Observations and Potential Safety Enhancements

Crescent Street (Route 27) at Lyman Street

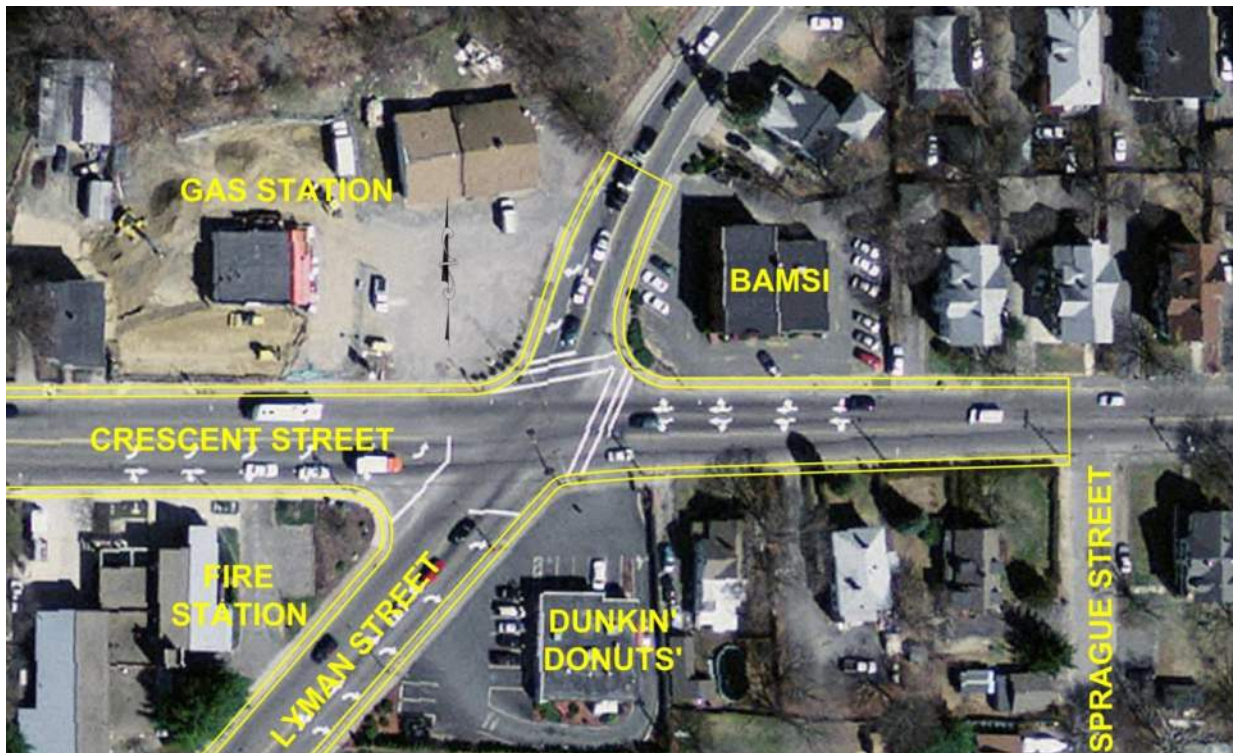


Figure 2: Crescent Street at Lyman Street

Crash Details and Overview:

The intersection of Crescent Street at Lyman Street had reported 30 crashes during the study period. The majority were angle crashes (57 percent – 17 crashes). The remaining crashes included six single rear-end collisions, four single vehicle crashes and three sideswipe collisions. The most common causes of crashes was angle collisions involving Crescent Street Eastbound vehicles and Lyman Street Northbound vehicles. The majority of crashes occurred during daylight with clear dry conditions. The intersection has a crash rate of 1.26 crashes per million entering vehicles from 2010-2012¹.

¹ In its recently prepared DRAFT list of the Top 100 High Crash Intersections in Old Colony Region 2011-2013, OCPC ranked the Crescent Street/Lyman Street intersection at #15, with 15 non-fatal injury crashes and 21 non-injury crashes over that three year period.

The MassDOT District 5 average for crashes at signalized intersections is 0.77 crashes per million entering vehicles. More detailed crash data is located in Appendix C

Safety Issue #1: Speed

Observations:

Representatives from the Old Colony Planning Council stated that speed is a big problem along the Crescent Street corridor. The “prima fascia” speed limit is 30MPH but there are no speed limit signs on Crescent Street within the project limits. Vehicles were observed speeding through the all-red clearance interval phase of the intersection creating near miss crashes. The Brockton Police Department also stated they receive a lot of near miss calls that are not accounted for in the crash data.

Potential enhancements:

1. Consider establishing a regulatory speed limit location within the project limits on Crescent Street and adding posted speed limit signs to Crescent Street in both directions.
2. Increase general police enforcement of the speed limit or provide a more targeted speed limit enforcement approach during the times when vehicles are observed speeding.

Safety Issue #2: Sidewalks

Observations:

The existing sidewalks in the eastern corners of the intersection are narrow. The locations of the mast arms and utility poles at this location obstruct pedestrian walking movements.

Potential enhancements:

1. Make sure that any replacement traffic signal mast arms and posts are sited to minimize obstruction impacts on the sidewalk.

Safety Issue #3: Crosswalks & Pedestrian Ramps

Observations:

Crosswalks at this intersection are long and placed at skewed angles. Although there are no painted crosswalks on the Crescent Street eastbound approach or the Lyman Street northbound approach, pedestrians still cross at these locations if there is a gap in traffic. There is a reported crash of a pedestrian being struck trying to cross at the Lyman Street northbound approach (please refer to Appendix C). Wheelchair ramps are not provided at the crossing locations and the wheelchair ramps that are provided do not comply with ADA requirements.

Potential enhancements:

1. Provide two (2) more painted crosswalks; one on the Crescent Street eastbound approach and one on the Lyman Street northbound approach.
2. Provide ADA-compliant wheelchair ramps at all corners of the intersection.

Safety Issue #4: Pedestrian Signals

Observations:

Pedestrian signals are not provided. Pedestrians currently cross concurrently with traffic. The pedestrian push buttons are currently located on outdated single poles.

Potential enhancements:

1. Add new audible pedestrian signals with countdown heads for all pedestrian crossings within the intersection at standard locations.
2. Incorporate an exclusive dedicated signal phase for pedestrians. The Fire Department specifically requested that an exclusive pedestrian phase be provided at this intersection.
3. Combine Accessible Pedestrian Signal (APS) push buttons and posts with the new mast arms.

Safety Issue #5: Bicycle Accommodations

Observations:

There are no bicycle accommodations at this intersection. During the RSA there were no bicyclists observed at this intersection; however, there does not appear to be a safe location for bicyclists to cross through the intersection.

Potential enhancements:

1. To the extent practicable, provide a bike lane in the shoulders along each approach of the intersection. This may also help to reduce the speed of the cars as well.
2. Consider a painted “bike box” behind the stop line on the Lyman Street southbound approach if 5’ bike lanes are not achievable.

Safety Issue #6: Pavement Markings

Observations:

The Crescent Street EB left lane is a left turn only lane. No pavement markings are present in advance of the intersection that identify that a left turn lane is coming up even though there are pavement markings right at the intersection approach. An old and outdated “Left Lane Must Turn Left” sign is present at the intersection. Vehicles accustomed to the intersection are aware of the left turn lane. However, vehicles not accustomed with the intersection often wait and try to merge into the right lane to cross through the intersection. This creates a queue of cars behind them and may contribute to crashes at this intersection. This movement also creates congestion in front of the Fire Station emergency response bays and appears to have resulted in many crashes as shown on the crash diagram for the intersection. Five (5) crashes have occurred in connection with this problem. Refer to Appendix C for more detailed crash data.



Figure 3: Looking East on Crescent Street

Potential enhancements:

1. Provide advanced lane usage pavement markings in both Crescent Street EB lanes from Summer Street to Lyman Street. Add an array of the Left Turn symbol and the “ONLY” legend.

Safety Issue #7: Signs

Observations:

There are no existing MUTCD-compliant lane designation signs on the approaches to this intersection. Vehicles often do not position themselves in the proper lanes for their desired path. As a result, they often wait in the intersection to make the left turn well into the all-red clearance interval phase. The existing street name signs are small, difficult to see and non-conforming to MUTCD. A RSA participant suggested adding “Right Turn on Red After Stop” signs at the intersection.

Potential enhancements:

1. Provide advanced lane designation signs for each approach to the intersection including the Crescent Street EB lanes indicating a left turn only lane and a thru/right lane
2. Replace existing street name signs with larger MUTCD compliant street name signs.

Safety Issue #8: Red Light Running

Observations:

The all red clearance interval phase of the existing signalized intersection is only 1 second long. It appears that vehicles waiting to make a left turn from Crescent Street eastbound to Lyman Street northbound may find themselves in the middle of the intersection when the next green phase on Lyman Street has started. Approximately twelve (12) of the vehicle crashes may have been caused by Crescent Street eastbound vehicles running the red light. Refer to Appendix C for more detailed crash data.



Figure 4: Vehicle running a red light

Potential enhancements:

1. Installation of a white strobe light in the red traffic signal indication was suggested by a member of the RSA team, however a representative from MassDOT stated that its use is not approved by FHWA, MUTCD or MassDOT.
2. Evaluate the existing traffic signal timing and extend the duration of the all red clearance interval signal phase.
3. Re-evaluate the traffic signal timing at this intersection to more safely accommodate all turning movements.

Safety Issue #9: Signal Phase

Observations:

The Crescent Street eastbound left turn lane doesn't have a green arrow signal head and drivers who are unfamiliar with the intersection don't seem to recognize that it has a "lead" protected left turn phase.

Potential enhancements:

1. Re-evaluate signal phasing.
2. Evaluate if the existing green ball signal head can be replaced with a doghouse style signal head to provide green arrow indications during the lead phase.
2. Replace old existing traffic signals with new fully activated traffic signals mounted on mast arms with signalized pedestrian crossings.

Safety Issue #10: Signal visibility

Observations:

Several crash reports suggested that vehicles may be unable to tell whether the light was red or green, as both claimed to have the green light. It was observed that it was difficult to quickly and clearly see whether the light was red or green.

Potential enhancements:

1. Evaluate the feasibility of adding reflectorized back plates to the signal heads including determining if the existing traffic signal structure can handle the additional wind forces due to the addition of the back plates.
2. Upgrade to LED signal heads.

Safety Issue #11: Lane alignment

Observations:

The RSA team noticed that the Lyman Street southbound lane south of the intersection is striped as a single lane but appears to be wide enough for two lanes. This seems to cause confusion for some vehicles that approach the intersection from the north. The Lyman Street southbound approach is not lined up with the northbound approach. The southbound approach is offset and at a different skew angle than the northbound approach. This creates a situation where the southbound through movements can end up facing the northbound left and through movements. One of the RSA team members commented that on the Crescent Street westbound approach, they had observed that the cars are sometimes queued in three lines; right turn, through and left turns, even though this approach is only striped for two lanes.

Potential enhancements:

1. Evaluate lane configuration to accommodate all turning movements in the safest manner possible.
2. Provide skip lane pavement markings for the Lyman Street southbound through movement across Crescent Street.

Safety Issue #12: Obstructions

Observations:

As stated in Safety Issue #6, vehicles that are unfamiliar with the intersection traveling east on Crescent Street block the Fire Station emergency response bays. There is a sign that states not to block the Fire Station driveway, but the sign is mostly ignored.



Figure 5: Vehicles obstructing the Fire Station emergency egress

Potential enhancements:

1. Provide emergency signal phase preemption, using Opticom technology, with secondary transit priority for all of the project intersections. The preemption will clear the intersections, giving the emergency vehicles the right of way.
2. Install a manual push button for an emergency traffic signal that is normally black flashes yellow, but turns red upon push button activation by the Fire Department and also clears the Crescent/Summer Street intersection for left turning fire trucks. Install a stop line for the Fire Station on the eastbound approach to the west of the Fire Station driveway with a “Stop Here On Red” sign.

Safety Issue #13: Intersection Geometry

Observations:

The intersection is skewed. A member of the RSA team noted that firefighters assigned to the Fire Station reported that the location of the stop line makes a right turn very difficult when turning from Crescent Street eastbound to Lyman Street southbound. It was also noted by a RSA team member that there are a lot of trucks that pass through this intersection and some of the corner radii do not accommodate them. As a result, the Brockton Police and Fire Departments stated that the traffic signal posts at the south east corner of the intersection are constantly being hit. A member of the RSA team noted that the corner radii on the southeast corner is very large and results in a clear amount of untraveled area in this part of the intersection.

Potential enhancements:

1. Evaluate whether it would be possible to re-align any portion of the intersection geometry.
2. Consider installing a channeling island for the right turn lane and evaluate whether it would be possible to increase the corner radii to better accommodate vehicles with a large turning radius.

Safety Issue #14: Access Control

Observations:

There are two existing driveway curb cuts that may create unsafe vehicle movements in the middle of the intersection.

The newly constructed Cumberland Farms is located on the northwest corner of the intersection. The Cumberland Farms has a two-way driveway curb cut on the Crescent Street western approach and a second two-way driveway curb cut on the Lyman Street northern approach. It also has a one-way-in driveway curb cut located on Crescent Street right at the northwest corner of the intersection. This third driveway allows cars to enter the Cumberland Farms from the middle of the intersection. This third driveway curb cut creates a potential safety hazard, with conflicting vehicles and pedestrians

A Dunkin Donuts is located on the southeast corner of the intersection. The Dunkin Donuts has a two-way driveway curb cut on the Crescent Street eastern approach and a second two-way driveway curb cut on the Lyman Street southern approach. It also has a third driveway curb cut located immediately south of the intersection corner radii on Lyman Street.

There have been two crashes that appear to have occurred at this third Dunkin Donuts' driveway curb cut. Although we are not aware of any crashes that have been attributed to the third Cumberland Farms driveway, vehicles were observed driving through the middle of the intersection to enter Cumberland Farms through their third driveway curb cut. Refer to Appendix C for more detailed crash data.

Potential enhancements:

1. Close the one-way-in Cumberland Farms driveway curb cut that forms the third driveway.
2. Close the Dunkin Donuts third driveway curb cut located on Lyman Street immediately south of the intersection curb radius.



Figure 6: Access at Cumberland Farms



Figure 7: Access at Dunkin Donuts

Crescent Street (Route 27) at Summer Street

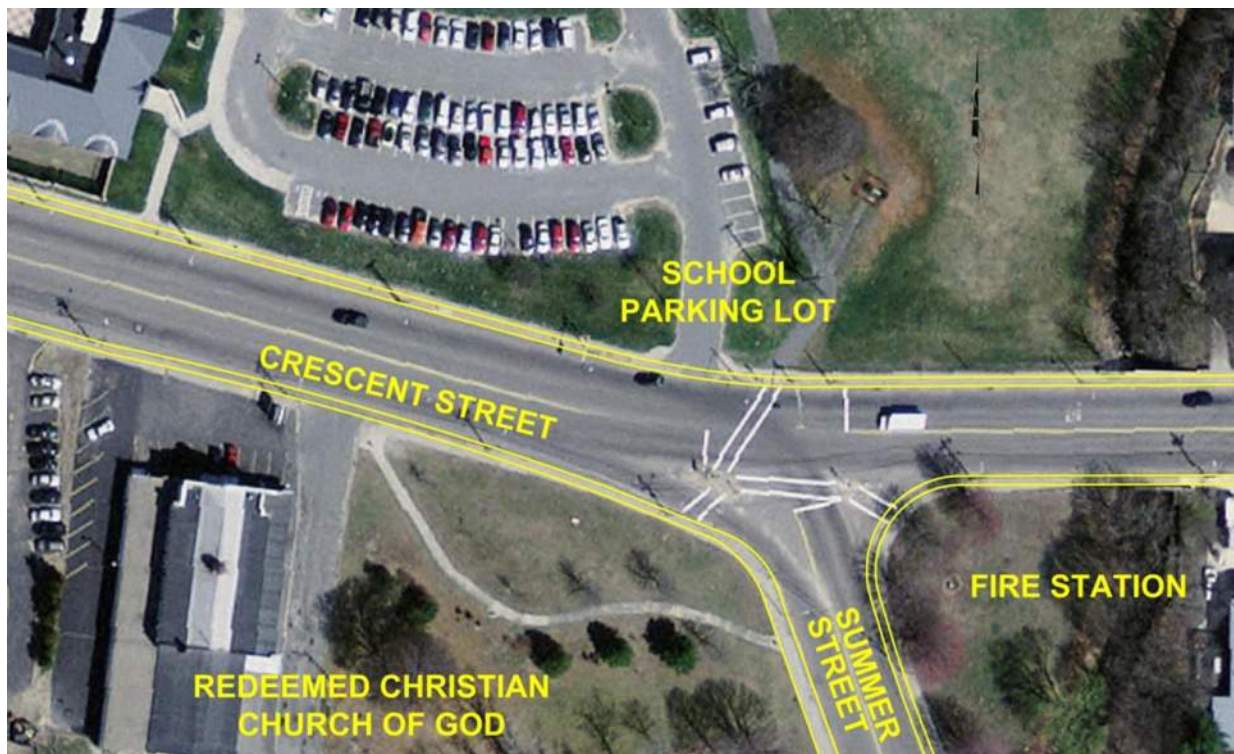


Figure 8: Crescent Street at Summer Street Intersection

Crash Details and Overview:

The intersection of Crescent Street at Summer Street reported 10 crashes during the study period. The majority were angle crashes (50 percent – 5 crashes). The remaining crashes included four single vehicle crashes and one rear-end collision. The common cause of four (4) of the crashes appears to be vehicles making unsafe turning movements into the Plouffe Academy Middle School parking lot. The majority of crashes occurred during daylight with clear dry conditions. The intersection has a crash rate of 0.52 crashes per million entering vehicles from 2010-2012. The MassDOT District 5 average for crashes at signalized intersections is 0.77 crashes per million entering vehicles. Additional detailed crash data is located in Appendix C.

Safety Issue #1: Speed

Observations:

A member of the RSA team observed that drivers didn't seem to slow down much as they approach the right turn slip lane from Crescent Street eastbound to Summer Street. A member of the RSA team observed that some cars seemed to be speeding from the Plymouth Street intersection to beat the red light at Summer Street. There were two (2) crashes at this location due to out of control vehicles, where speed may have been a

factor. There were also two (2) angle crashes at this location where vehicles on Crescent Street hit vehicles making a left turn from Summer Street to go westbound.

Potential enhancements:

1. Re-align or eliminate the Crescent Street right turn slip lane to Summer Street to force vehicles to make a slower more deliberate turning movement.
2. Update “School Zone” signage.
3. Implement regular police enforcement of speed limit

Safety Issue #2: Crosswalks & Pedestrian Ramps

Observations:

Some members of the RSA team noted that the pedestrian islands in this location seemed to be inadequate in terms of size. The traffic islands appear to be serving more for lane channelizing than for pedestrian refuge. Crosswalks in this area did not appear to be placed in logical locations and seemed excessively long. The traffic islands also lacked wheelchair accommodations.

Potential enhancements:

1. Make sure any re-constructed islands provide adequate pedestrian refuge.
2. Upgrade existing pedestrian ramps in compliance with ADA requirements.
3. Provide new pedestrian signals with countdown heads and audible crossing phases at crosswalk locations.
4. Update crosswalk locations to reduce travel distance, if possible.

Safety Issue #3: Bicycle Accommodations

Observations:

There are currently no bicycle accommodations at this intersection.

Potential enhancements:

1. Add bike lanes along both sides of Crescent and Summer Streets with special attention to conflict zones between bicycles and vehicles at Plouffe Academy Middle School driveway.

Safety Issue #4: Pavement Markings

Observations:

Vehicles traveling north on Summer Street turning west on Crescent Street were observed crossing into the other lane while traveling through the intersection.

Potential Enhancements:

1. Consider adding “skip lines” in the intersection to channelize the dual left turning movements.

Safety Issue #5: Signs

Observations:

The existing overhead flashing school zone signs did not appear to be flashing during school operations. A representative from the school department stated that he has not seen them flashing and believes them to be non-functioning. There was discussion of the missing yield/stop controls on particularly on the eastbound right turn slip lane to Summer Street but also on the northbound right turn lane to Crescent Street.

Potential enhancements:

1. Repair or replace existing flashing school zone signs
2. Add yield signs to right turn lanes. Consider including stop control of the right turn lanes for pedestrians as part of the replacement and upgrading of the existing traffic signal.

Safety Issue #6: Signal Visibility

Observations:

An existing fire alarm communications cable is located on a utility pole that was observed to be blocking the Crescent Street westbound signal head. There is also a sign mounted on the pole that states “No Left Turn”. However, a firetruck was observed taking a left turn on this approach during the field visit. It was discussed during the audit that the purpose of maintaining the accepting lane for the left turns was for emergency vehicle access.

Potential enhancements:

1. Remove the existing utility pole and reroute the fire alarm communications cable underground from the adjacent manhole to utility pole #13 on Crescent Street.
2. Replace old existing traffic signals with new fully activated traffic signals mounted on mast arms with signalized pedestrian crossings.

Safety Issue #7: Lane Usage

Observations:

Left turn movements on Crescent Street westbound to enter the Church and Day Care Center located on the south side of Crescent Street, just west of the intersection, create potentially unsafe conditions for vehicles. Vehicles often stop traffic in the left lane and wait to make the turn, creating a queue into the intersection.

Potential enhancements:

1. Add left turn lane pavement markings to provide a center left turn lane to serve the Church and Day Care Center. Extend a painted or raised median to the Plymouth Street intersection from the Church and Day Care Center left turn lane and also use it to shield a left turn lane at Plymouth Street.



Figure 9: Looking South at the Church

Safety Issue #8: Sight Distance:

Observations:

The vegetation is overgrown on the south side of Crescent Street to the east of the intersection. It significantly impedes the Fire Stations sight distance when exiting the emergency vehicle bays.

Potential enhancements:

1. Clear trees and brush in area immediately behind the sidewalk and guardrail.



Figure 10: Vegetation to the East inhibiting Fire station egress sight distance

Safety Issue #9: Intersection Geometry



Figure 11: Looking North at Plouffe Academy Driveway

Observations:

The Plouffe Academy Middle School parking lot entrance is not currently aligned with the intersection. Vehicles utilizing the parking lot traveling eastbound on Crescent Street have to stop traffic and wait to make the left turn. Vehicles leaving the Plouffe Academy Middle School parking lot heading east on Crescent Street have to wait for gaps in traffic and make a quick left turn to drive down Crescent Street. There were two (2) reported crashes at this location that appear to have been the result of vehicles entering or exiting the driveway. The representative of the Brockton Schools stated that the parking area and driveway is now being used as the school bus drop-off and pick-up area for the school.

Review of the turning movement volumes indicate there are rarely any right turns from Summer Street to go eastbound on Crescent Street. The intersection is currently signed as no left turn allowed. However a fire truck was observed making the left turn movement. The Fire Department representative suggested that left turns be permitted from Crescent Street westbound to Summer Street.

Potential enhancements:

1. Re-align the Plouffe Academy Middle School parking lot driveway with the intersection and include the school driveway into a new fully activated traffic signal.
2. Evaluate the impact of eliminating the no left turn restriction from Crescent Street westbound to Summer Street. If the left turn restriction is to remain, than a short term solution would be to change the signal indications for westbound Crescent Street to be green thru arrows from green balls for clarity of allowable movements.



Figure 12: Looking South down Summer Street

3. Re-align the Crescent Street right turn slip lane to Summer Street to force vehicles to make a slower more deliberate turning movement.
4. If the left turn restriction is to remain, than a short term solution would be to change the signal indications for westbound Crescent Street to be green thru arrows from green balls for clarity of allowable movements.
5. Eliminate the right turn slip lane from Summer Street north to Crescent Street eastbound.



Figure 13: Looking East on Crescent Street Right Turn Lane

Crescent Street (Route 27) at Plymouth Street

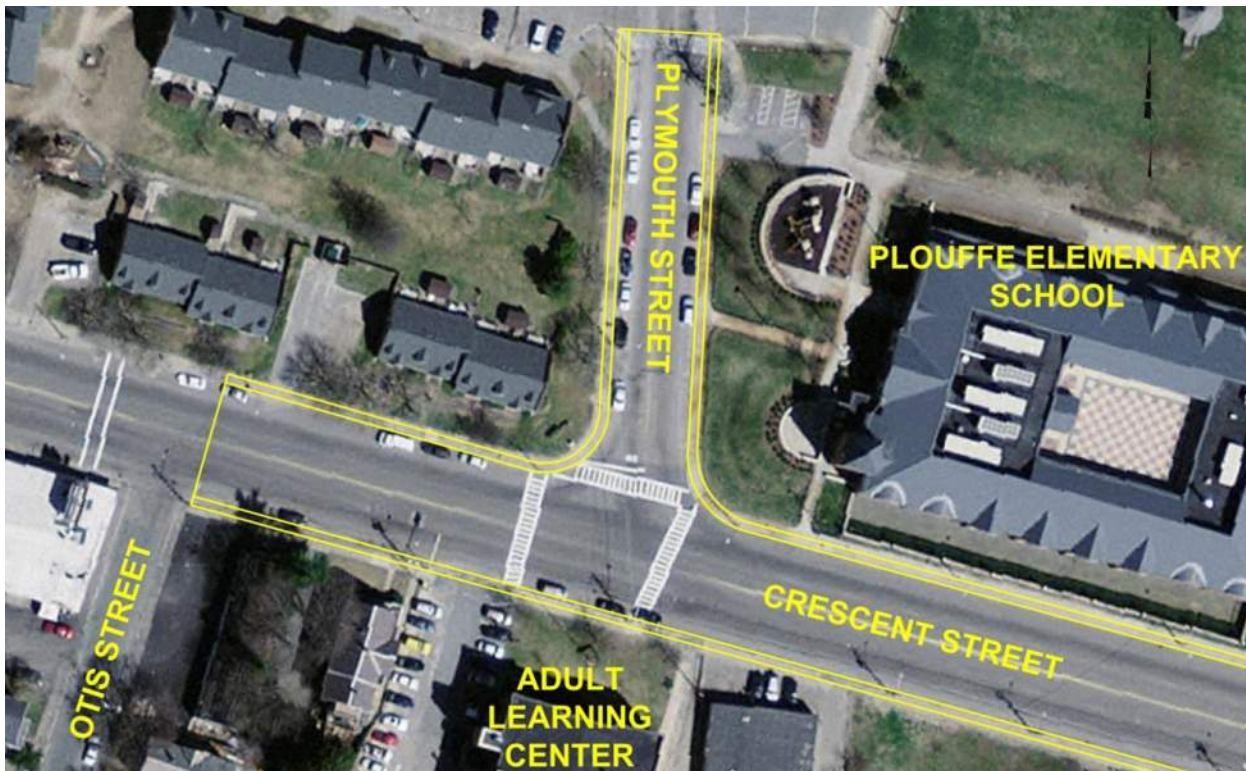


Figure 14: Crescent Street at Plymouth Street Intersection

Crash Details and Overview:

The intersection of Crescent Street at Plymouth Street reported 10 crashes during the study period. The majority were angle crashes (50 percent – 5 crashes). The remaining crashes included three single vehicle crashes and two sideswipe collisions. The common cause of crashes was vehicles making unsafe turning movements. The majority of crashes occurred during daylight with clear, dry conditions. The intersection has a crash rate of 0.43 crashes per million entering vehicles from 2010-2012. The MassDOT District 5 average for crashes at un-signalized intersections is 0.58 crashes per million entering vehicles. More detailed crash data is located in Appendix C.

Safety Issue #1: Speed

Observations:

Vehicles traveling along Crescent Street in both travel directions have sufficient sight distance and often speed as a result. Drivers are able to see the crosswalks, but not necessarily the pedestrians waiting to cross the wide street. Plouffe Academy Middle School employs crossing guards to help the young students cross the street before and after school hours. Vehicles making a right turn from Crescent Street westbound onto Plymouth Street were observed speeding around the corner, some vehicle's tires could be heard "squealing."



Figure 15: Looking North at Plymouth Street

Potential enhancements:

1. Consider restriping the pavement markings to narrow the shoulders and travel lanes on Crescent Street, install a center left turn lane, and a center median where there are no driveways requiring a left turn.
2. Consider implementing a road diet for the section of Crescent Street from Plymouth Street to Summer Street eliminating the four (4) lane cross section and replacing it with a three (3) lane section with one (1) thru lane in each direction and a center left turn lane.
3. Consider installing curb extensions (bump outs) to both slow traffic and make the presence of pedestrians with the intent to cross more visible.
4. Implement Complete Streets treatments on Crescent Street, particularly from the Plymouth Street intersection to the Summer Street intersection, on Lyman Street and on Summer Street.
5. Consider implementing Traffic Calming measures such as bump outs on Crescent Street, particularly from the Plymouth Street intersection to the Summer Street intersection.

Safety Issue #2: Crosswalks & Pedestrian Ramps

Observations:

Each approach to the intersection has a painted crosswalk but no wheelchair ramps. The crossing distance is also unreasonably long on Crescent (65 feet) and causes problems for pedestrians. Any pedestrian trying to cross has to navigate across four lanes of traffic on a heavily traveled road. Some pedestrians were observed waiting on the double yellow center line for cars to pass. A crash involving a pedestrian (student) crossing Plymouth Street hit by a vehicle turning left from Crescent Street eastbound was reported at this intersection. It was also noted that very often there are students that are walking to or from school prior to when the crossing guards are in place causing safety concerns.



Figure 16: Looking West on Crescent Street (Plouffe School)

Potential enhancements:

1. Consider installing “Yield to Pedestrian” flexible stanchions as a short term safety improvement measure.
2. Consider installing solar powered flashing pedestrian signage as a short term measure.
3. Restripe the existing pavement markings to narrow the shoulders and travel lanes on Crescent Street, install a left turn lane and median where there is no left turn lane to provide some pedestrian refuge in the middle of the street.
4. Install a fully activated traffic signal with an exclusive pedestrian phase.
5. Consider using high visibility different colored paint material (such as yellow) and/or patterns (such as hatch marks) for the crosswalks.
6. Consider installing curb extensions on Plymouth Street to enhance the pedestrian crossing and to bring the stop sign closer to the traveled way.

Safety Issue #3: Bicycle Accommodations

Observations:

There are no bicycle accommodations at this intersection. The existing shoulders and the sidewalks on Crescent Street and Plymouth Street are relatively wide.

Potential enhancements:

1. Restripe the existing pavement markings to provide a bike lane on both sides of Crescent Street.

2. Consider alternatives for accommodating bicycles on Plymouth Street in combination with the existing parking.
3. Consider eliminating parking on one or both sides of Crescent Street to provide room for buffered bike lanes.
4. Implement and enforce parking restrictions on Plymouth Street near the intersection.

Safety Issue #4: Signs

Observations:

There are no signs indicating pedestrians will be crossing the street at the intersection of Crescent Street with Plymouth Street. In addition, there are no posted speed limit signs. There is a mast arm mounted school zone sign on Crescent Street with flashing beacons, however the lights were not flashing during school hours. On Plymouth Street, the “Stop” sign is placed 10 feet away from the Stop line. There is a No-Parking / Stop sign combination on Plymouth Street, which is not MUTCD compliant.

Potential enhancements:

1. Repair or replace existing flashing beacon school zone mast arm signs.
2. Install School Zone speed limit signs on the Crescent Street and Plymouth Street approaches.
3. Move the Plymouth Street stop sign further south to align with the painted Stop line.
4. Install pedestrian crossing signs.

Safety Issue #5: Congestion

Observations:

There is a constant unimpeded traffic flow along Crescent Street, making it difficult for cars to enter or exit from Plymouth Street and for pedestrians to cross the road. This situation causes congestion on Plymouth Street during pickup and drop off times. There is not enough room for the right turning vehicles exiting Plymouth Street to get by the left turning vehicles that are blocking the single lane. A RSA participant suggested that perhaps a roundabout should be investigated as an alternative to a new traffic signal. It was noted that a roundabout would probably not be appropriate at this location.

Potential enhancements:

1. Evaluate installing a fully actuated traffic control signal at this intersection with an exclusive pedestrian phase.
2. Implement and enforce parking restrictions near the intersection to improve sight distance for cars exiting Plymouth Street.

Safety Issue #6: Lighting

Observations:

The lighting along the Crescent Street and Plymouth Street corridors may be inadequate and may present dangerous situations at night for pedestrians.

Potential enhancements:

1. Consider adding more overhead lights on the existing utility poles.
2. Replace existing overhead roadway lighting with LED lights along Crescent and Plymouth Streets.

Safety Issue #7: Sight distance

Observations:

Pedestrians and vehicles on Plymouth Street have little to no sight distance on Crescent Street in both directions. On both sides of the intersection there are fill slopes, fences and parked cars that obstruct sight distance. Pedestrians have to walk into the shoulder at times to get a better view of the oncoming traffic. Vehicles trying to turn onto Crescent Street from Plymouth Street have to pull forward into the roadway to get a clear view.



Figure 17: Looking West on Crescent Street

Potential enhancements:

1. Consider implementing a road diet for the section of Crescent Street from Plymouth Street to Summer Street eliminating the four (4) lane cross section and replacing it with a three (3) lane section with one (1) thru lane in each direction and a center left turn lane.
2. Eliminate on-street parking immediately adjacent to the intersection.

Safety Issue #8: Intersection Geometry

Observations:

The Adult Learning Center driveway is located adjacent to the southwest side of the Plymouth Street intersection. The placement of the driveway makes it difficult for exiting vehicles wanting to go westbound on Crescent Street or northbound on Plymouth Street. These vehicles have to wait for gaps in both the eastbound and westbound traffic before making the exiting movement. Vehicles trying to enter the Adult Learning Center from Crescent westbound have to



Figure 18: Looking South at Adult Learning Center Driveway

wait for gaps in the eastbound traffic before turning into the parking lot. There have been two (2) reported crashes at the Adult Learning Center driveway.

Potential enhancements:

1. If a new traffic signal is installed than relocate the driveway to include the Adult Learning Center driveway as part of the intersection new traffic signal operation.
2. Restripe the Adult Learning Center parking lot so that the driveway is on the east side of the parking area and the parking is moved to the west side of the parking area. This would bring the Adult Learning Center driveway closer to forming a 4-way intersection with Plymouth Street.

Safety Issue #9: On-Street Parking

Observations:

Vehicles have a tendency to park on both sides of Crescent Street to drop off / pick up students during school hours. This creates problems in the morning and evening rush hour traffic with unsupervised children crossing Crescent Street at numerous mid-block locations. On-street parking on the north side of Crescent Street impacts the sight distance of vehicles on Plymouth Street looking to turn on to Crescent Street.

Potential enhancements:

1. Provide a fully dedicated 5 foot wide bike lane that will also discourage vehicles from parking on Crescent Street because there will not be adequate space for them to pull over.
2. Remove the currently allowed on-street parking on Crescent Street and place No Parking signs at appropriate locations. Work with Brockton Police department for initial enforcement of no parking for school drop off or pick up.
3. Work with the Plouffe Academy Middle School to add signing and distribute flyers directing parents to the Plymouth Street parent drop-off and pick-up lot.

Summer Street at Lyman Street and Grove Street



Figure 19: Summer Street at Lyman & Grove Street Intersection

Crash Details and Overview:

The intersection of Summer Street at Lyman and Grove Streets reported 11 crashes during the study period. The majority were angle crashes (64 percent – 7 crashes). The remaining crashes included two rear-end collisions, one single vehicle crash and one sideswipe collision. The majority of crashes occurred during daylight with clear dry conditions. The intersection has a crash rate of 0.43 crashes per million entering vehicles from 2010-2012. The MassDOT District 5 average for crashes at signalized intersections is 0.77 crashes per million entering vehicles. More detailed crash data is located in Appendix C.

Safety Issue #1: Crosswalks & Pedestrian Ramps

Observations:

Crosswalks at this intersection appear to be placed in appropriate locations but no wheelchair ramps are provided. There are three raised pedestrian islands at this intersection also with no wheelchair ramps. A RSA participant noted that there is only one crosswalk located on the separate right turn lane from Summer Street northbound to Lyman Street eastbound. The one crosswalk is located near the end of the separate right

turn lane adjacent to Lyman Street. However there is no cross walk at the beginning of the separate right turn lane along Summer Street. The existing cross-walk does not have appropriate pedestrian signage.

Potential enhancements:

1. Construct ADA compliant wheelchair ramps at all crosswalk locations and pedestrian islands.
2. Install pedestrian crossing signage at the existing cross walk on the separate right turn lane from Summer Street northbound to Lyman Street eastbound.
3. Add a second crosswalk on the separate right turn lane from Summer Street northbound to Lyman Street eastbound near the Summer Street end of the turn lane.

Safety Issue #2: Pedestrian Signals

Observations:

Pedestrian signals are present at this location but the signal heads are very small and difficult to see.

Potential enhancements:

1. Replace the existing pedestrian signals with new countdown audible pedestrian signals...
2. Integrate pedestrian buttons with the mast arms to reduce the number of pedestrian traffic signal posts.

Safety Issue #3: Bicycle Accommodations

Observations:

There are no existing bicycle accommodations at this intersection. During the RSA a bicyclist was observed riding through the intersection perpendicular to the traffic flow. There is one (1) reported bicycle crash at this location.

Potential Enhancements:

1. Add a 5 foot wide bike lane in the shoulders for each approach to the intersection.
2. Consider “bike boxes” to encourage bike ridership along Summer Street.

Safety Issue #4: Pavement Markings

Observations:

There are two through lanes on Summer Street on the west side of the intersection; however there is only one receiving lane on the east side of the intersection. Further east on the Summer Street at the next intersection the pavement markings show an exclusive left turn lane and a through lane.



Figure 20: Vehicles queuing on Summer Street

Potential enhancements:

1. Restripe Summer Street eastbound to provide two (2) receiving lanes and a formal merge area east of the intersection.

Safety Issue #5: Signs

Observations:

There are no lane designation signs at this intersection. Vehicles not familiar with the intersection appear to have trouble positioning themselves in the proper lanes. This results in vehicle congestion and traffic trying to navigate back onto their desired path. There are no object marker signs on the post mounted signal located in the small island on the Summer Street southbound approach. It was noted that this traffic signal post has been struck in the past.

Potential enhancements:

1. Provide advanced lane designation signs on each approach to the intersection.
2. Provide an object marker sign on the existing traffic signal post.

Safety Issue #6: Signal Phasing

Observations:

One RSA participant mentioned that the existing vehicle loop detectors in the pavement on the Lyman Street southbound approach are no longer functioning. As a result, the Lyman Street southbound signal phase appears to be running on max green time. Vehicles on the other intersection approaches were observed waiting for the green light while Lyman Street southbound was clear of vehicles but still had the green light.

Potential enhancements:

1. Replace the broken loop detectors and reset the signal phasing at this intersection.

Safety Issue #7: Signal visibility

Observations:

Overhead signals are only provided for two of the four intersection approaches. The rest of the signals are post mounted traffic signals. These signals are not easy to identify. There are also no back plates on the signals making them difficult to read. The Fire Department representative at the RSA stated that pedestrian signal post has been struck many times and requested that no traffic signal post be placed on the median island on the Summer Street approach to the intersection.

Potential enhancements:

1. Add additional mast arms with overhead signals to the intersection.
2. Add reflectorized back plates and signal visors to the signal heads.
4. Replace old existing traffic signals with new fully activated traffic signals mounted on mast arms. Avoid placing any traffic signal posts on the Summer Street median island.

Safety Issue #8: Intersection geometry

Observations:

The audit team observed that the Grove Street right turn lane has only enough room for two or three cars. Vehicles traveling over the bridge must abruptly turn right to make it into the right turn lane.

Potential Enhancements:

1. Consider widening the bridge to extend the length of the right turn lane on the Grove Street northbound approach.



Figure 21: Looking West at Grove Street

Table 2: Potential Safety Enhancement Summary

Safety Issue	Potential Safety Enhancement	Safety Payoff	Time Frame	Cost	Responsible Agency
Crescent Street at Lyman Street					
Speed	Consider adding Regulatory Speed Zones and Signs	Medium	Short-Term	Low	City of Brockton
	Increase police enforcement of the speed limit	Medium	Short-Term	Low	City of Brockton
Crosswalks & Pedestrian Ramps	Add wheelchair ramps at all locations	High	Long-Term	Medium	MassDOT Project
	Add crosswalks on the south and west legs of the intersection	High	Long-Term	Low	MassDOT Project
Pedestrian Signals	Add pedestrian signals for all pedestrian crossings	High	Long-Term	Medium	MassDOT Project
	Add exclusive dedicated pedestrian phase	High	Long-Term	Low	MassDOT Project
	Integrate pedestrian signal buttons with mast arms	Low	Long-Term	Medium	MassDOT Project
Bicycle Accommodation	Add bicycle lanes and consider adding bike boxes	Medium	Long-Term	Low	MassDOT Project
Pavement Markings	Add turning movement markings	High	Short-Term	Low	City of Brockton
Signs	Add lane designation signs	Medium	Short-Term	Low	City of Brockton
Red Light Running	Extend all-red clearance interval phase	High	Short-Term	Low	City of Brockton
Signal Phasing	Reconfigure signal phases	High	Long-Term	Low	MassDOT Project
	Replace existing traffic signals	High	Long-Term	High	MassDOT Project
Signal Visibility	Provide traffic signal head back plates	Medium	Long-Term	Medium	MassDOT Project
Lane Alignment	Provide “skip” lines for Lyman Street through movement	Low	Long-Term	Low	MassDOT Project
Obstructions	Install push button manually operated Fire Station traffic signal on mast arm	Medium	Long-Term	High	MassDOT Project
	Provide all traffic signals with Opticom with secondary transit priority	High	Long-Term	Medium	MassDOT Project
	Minimize pedestrian signal poles	Low	Long-Term	Medium	MassDOT Project
Intersection Geometry	Consider adding a right turn channelizing island	Medium	Long-Term	Medium	MassDOT Project

Safety Issue	Potential Safety Enhancement	Safety Payoff	Time Frame	Cost	Responsible Agency
Access Controls	Remove Cumberland Farms easterly one-way-in curb cut on Crescent Street	High	Long -Term	Medium	MassDOT Project
	Remove Duncan Donuts northerly curb cut on Lyman Street	High	Long Term	Medium	MassDOT Project
Crescent Street at Summer Street					
Speed	Realign or eliminate the separated right turn slip lane	Medium	Long-Term	Medium	MassDOT Project
	Update School Zone signage	Medium	Long-Term	Medium	MassDOT Project
	Increase police enforcement of the speed limit	Medium	Short-Term	Low	City of Brockton
Crosswalks & Pedestrian Ramps	Add wheelchair ramps at all cross-walks	High	Long-Term	Medium	MassDOT Project
	Add new pedestrian crossing signals	High	Long-Term	Medium	MassDOT Project
Bicycle Accommodation	Add bicycle lanes	Medium	Long-Term	Low	MassDOT Project
Pavement Markings	Consider adding "skip" lines for the Crescent double left movement	Medium	Short-Term	Low	City of Brockton
Signs	Repair or replace existing School Zone flashing beacon	Medium	Long-Term	Medium	MassDOT Project
	Add Speed Limit signs	Medium	Short-Term	Low	City of Brockton
Signal Visibility	Replace existing traffic signals	High	Long-Term	High	MassDOT Project
	Remove or relocate existing utility pole with fire alarm cable	Medium	Long-Term	Medium	MassDOT Project
Lane Usage	Provide a center left turn lane for Church and Day Care Center	Medium	Long-Term	Medium	MassDOT Project
Sight Distance	Clear brush from area behind sidewalk	Low	Short-Term	Low	City of Brockton
Intersection Geometry	Realign Plouffe School parking lot driveway entrance	High	Long-Term	High	MassDOT Project
	Remove Summer Street right turn lane	Low	Long-Term	Medium	MassDOT Project

Safety Issue	Potential Safety Enhancement	Safety Payoff	Time Frame	Cost	Responsible Agency
Crescent Street at Plymouth Street					
Speed	Narrow shoulders and travel lanes to make room for a center left turn lane	High	Long-Term	Medium	MassDOT Project
	Consider implementing a “road diet” from 4 lanes to 3 lanes from Plymouth Street to Summer Street	Medium	Long-Term	Low	MassDOT Project
	Consider installing curb extensions or bump-outs	Medium	Long-Term	Medium	MassDOT Project
Crosswalks and Pedestrian Ramps	Provide high visibility colored or hatched crosswalk	Low	Short-Term	Medium	City of Brockton
	Install “Yield to Pedestrians” flexible stanchions	Medium	Short-Term	Low	City of Brockton
	Install solar powered flashing pedestrian crossing signs	Medium	Short-Term	Medium	City of Brockton
Bicycle Accommodations	Add bicycle Lanes	Medium	Long-Term	Low	MassDOT Project
	Consider eliminating parking on one or both sides of the street	Medium	Short-Term	Low	City of Brockton
	Consider implementing parking restrictions on Plymouth Street near the intersection	Medium	Short-Term	Low	City of Brockton
Signs	Add pedestrian crossing signs	High	Short-Term	Low	City of Brockton
	Repair or replace existing School Zone flashing beacon	Medium	Long-Term	Medium	MassDOT Project
	Consider establishing a Regulatory Speed Zone and adding Speed Limit signs	High	Short-Term	Low	City of Brockton
	Move Plymouth Street Stop sign	Medium	Short-Term	Low	City of Brockton
Congestion	Install new traffic signal	High	Long-Term	High	MassDOT Project
	Implement and enforce parking restrictions near the intersection	Medium	Short-Term	Low	City of Brockton
Lighting	Install LED lights on street lights	Medium	Short-Term	Medium	City of Brockton
	Consider adding more street lights on existing utility poles	Medium	Short-Term	Medium	City of Brockton
Sight distance	Eliminate parking adjacent to intersection	Medium	Short-Term	Low	City of Brockton
Intersection Geometry	Reconstruct intersection to include the Adult Learning Center driveway into a new signalized intersection by moving the driveway entrance east	Medium	Long-Term	Medium	MassDOT Project
On-Street Parking	Install bicycle lanes and remove parking	Medium	Long-Term	Medium	MassDOT Project
	Remove parking and add No-Parking signs	High	Short-Term	Low	City of Brockton

Safety Issue	Potential Safety Enhancement	Safety Payoff	Time Frame	Cost	Responsible Agency
Summer Street at Lyman & Grove Street					
Crosswalks and Pedestrian Ramps	Add a second crosswalk on the right turn lane from Summer Street to Lyman Street	Low	Short-Term	Low	City of Brockton
	Install ADA compliant wheelchair ramps	Medium	Long-Term	Medium	MassDOT Project
	Add pedestrian crossing signs on the existing crosswalk on the right turn lane from Summer Street to Lyman Street	Low	Short-Term	Low	City of Brockton
Pedestrian Signals	Install new countdown audible pedestrian signals	High	Long-Term	Medium	MassDOT Project
	Integrate pedestrian push buttons in new traffic signal mast arms	Low	Long-Term	Low	MassDOT Project
Bicycle Accommodation	Add bicycle lanes and consider adding bike boxes	Medium	Long-Term	Low	MassDOT Project
Pavement Markings	Stripe two lanes on Summer east of intersection	Medium	Short-Term	Low	City of Brockton
Signs	Add lane designation signs	Medium	Short-Term	Low	City of Brockton
	Add object marker sign on traffic signal pole	Low	Short-Term	Low	City of Brockton
Signal phasing	Replace traffic signal loops	Medium	Mid-Term	Medium	City of Brockton
Signal visibility	Replace existing traffic signals	High	Long-Term	High	MassDOT Project
	Install back plates on traffic signal heads	Medium	Short-Term	Low	MassDOT Project
Intersection Geometry	Consider widening bridge as part of Bridge Replacement to provide a longer right turn lane	Medium	Long-Term	High	MassDOT Project

Appendix A. RSA Meeting Agenda

Road Safety Audit Agenda

**Crescent Street (Route 27), Lyman Street
and Summer Street Intersection Improvement Project
9/23/2015
9:00 AM to 12:30 PM
Meeting Location: Old Colony Planning Council
Meeting Address: 70 School Street, Brockton, MA**

Type of meeting: Road Safety Audit

Attendees: MassDOT, City Officials, Emergency Responders

Agenda

Welcome and Introductions	9:00 AM
Review of Site Specific Material	9:15 AM
<ul style="list-style-type: none">• Crash data• Traffic volumes• Proposed/existing conditions	
Visit the Site	10:00 AM
<ul style="list-style-type: none">• Drive to site• Group discussion of areas of improvement	
Post Visit Discussion/Completion of RSA	11:30 AM
<ul style="list-style-type: none">• Discuss observations and findings• Discuss proposed improvements	
Adjourn for the day/Closing Remarks	12:30 PM

Additional Information

- Before attending the RSA, participants are encouraged to drive through the intersection and complete/consider elements on the RSA prompt list with a focus on safety.
- All participants will be actively involved in the process throughout. Participants are encouraged to come with thoughts and ideas, but are reminded that the synergy that develops and respect for others' opinions are key elements to the success of the overall RSA process.
- After the RSA meeting, participants will be asked to comment and respond to the document materials to assure it is reflective of the RSA completed by the multidisciplinary team.
- Attachments:
 - Crash diagrams and charts
 - Turning movement counts
 - Safety review prompt list

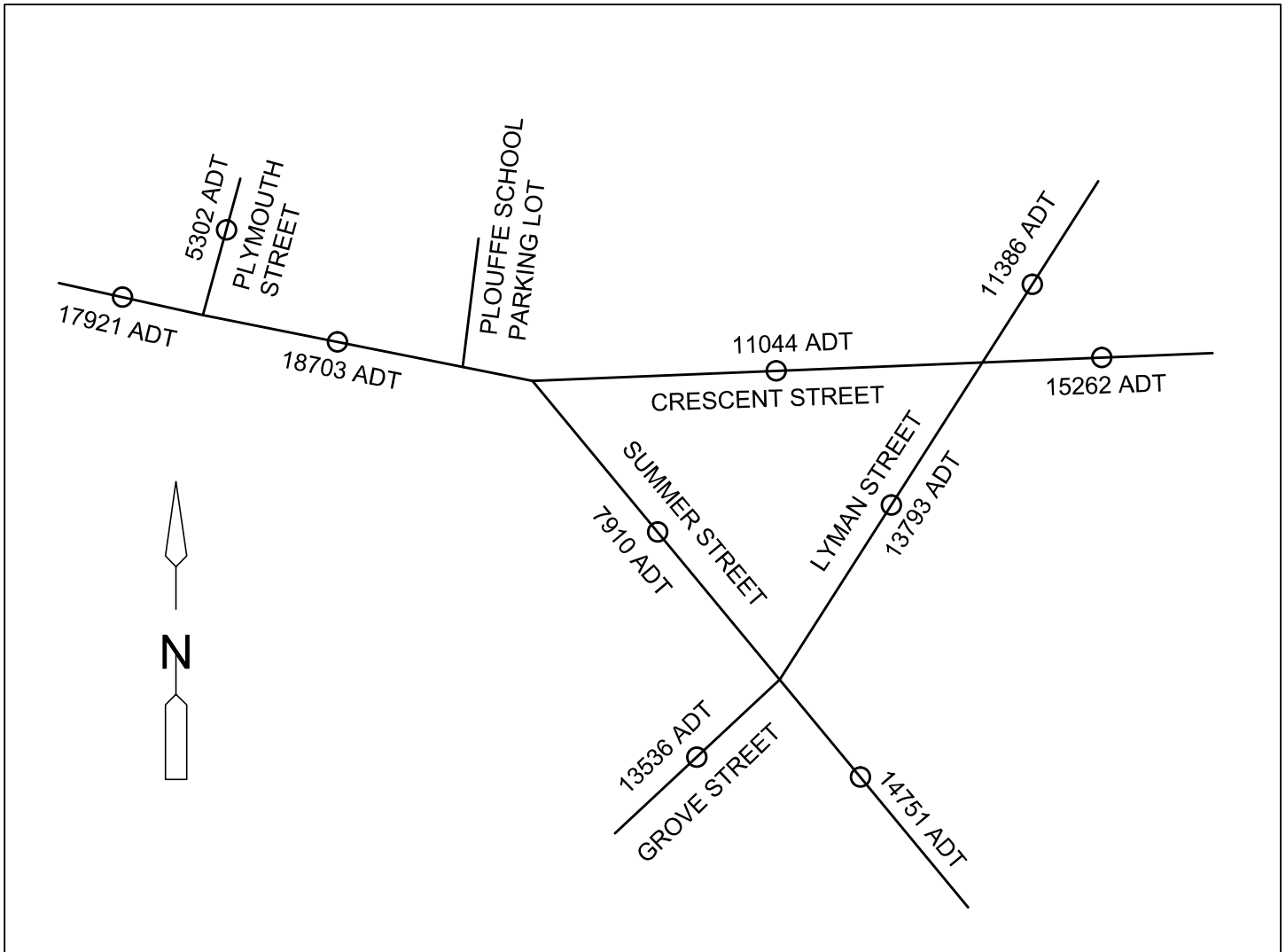
Appendix B. RSA Audit Team Contact List

Participating Audit Team Members

Date: September 23, 2015 Location:

Audit Team Members	Agency/Affiliation	Email Address
Nick Giaquinto	Mayor's Office	ngiaquinto@cob.ma.us
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Lt. Don Mills	Brockton Police Department	dmills@brocktonpolice.com
Deputy Chief Kevin Galligan	Brockton Fire Department	kmgalligan@cobma.us
Tobias Cowens	Brockton Public Schools	tobias.cowens@bpsma.org
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Michael Pezzullo	CDM Smith	pezzullom@cdmsmith.com
Zachary Hellyar	CDM Smith	hellyarz@cdmsmith.com

Appendix C. Detailed Crash Data and Traffic Volume Information



Street	Location	Average Daily Traffic (ADT)	PHV		PHF		K-Factor	
			AM	PM	AM	PM	AM	PM
Summer St.	South of Crescent St.	7910	578	620	0.861	0.903	0.073	0.078
	South of Lyman St.	14751	1053	1113	0.889	0.967	0.071	0.075
Grove St.	West of Summer St.	13536	913	1049	0.978	0.937	0.067	0.077
Plymouth St.	North of Crescent St.	5302	433	436	0.725	0.908	0.082	0.082
Lyman St.	South of Crescent St.	13793	905	871	0.953	0.966	0.066	0.063
	North of Crescent St.	11386	777	817	0.966	0.972	0.068	0.072
Crescent St.	West of Plymouth St.	17921	1173	1389	0.952	0.937	0.065	0.078
	East of Summer St.	11044	746	786	0.891	0.931	0.068	0.071
	East of Lyman St.	15262	1029	1168	0.916	0.915	0.067	0.077
	West of Summer St.	18703	1227	1454	0.926	0.932	0.066	0.078



75 State Street, Suite 701
 Boston, MA 02109
 Tel: (617) 452-6000

CITY OF BROCKTON

CRESCENT STREET (ROUTE 27), LYMAN STREET
 AND SUMMER STREET INTERSECTION IMPROVEMENT PROJECT

AVERAGE DAILY TRAFFIC (ADT)
 COLLECTED ON 10-8-14

FIGURE 2 - 2015 AUTOMATIC TRAFFIC RECORDER COUNTS

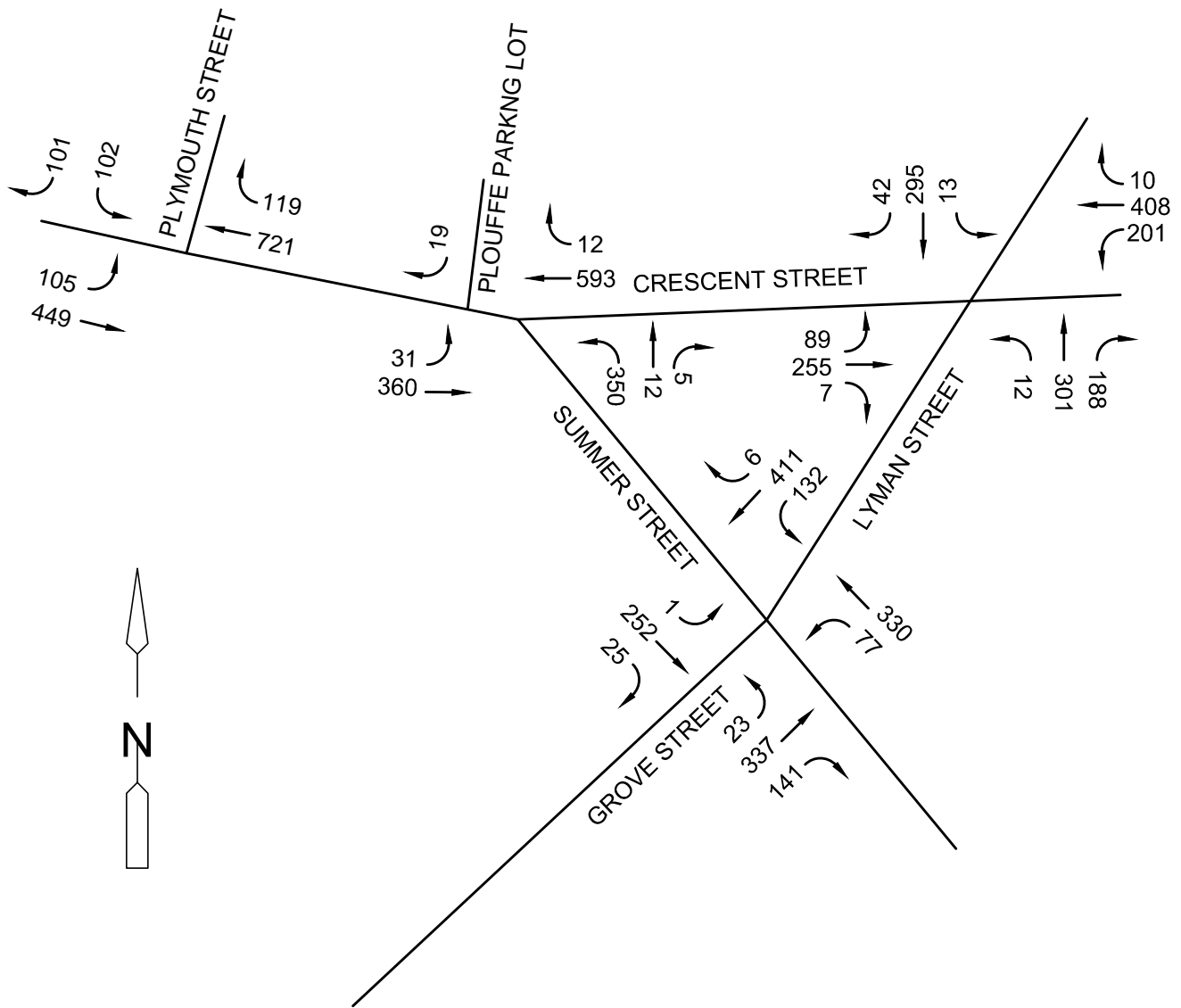


FIGURE 3A - 2015 EXISTING AM PEAK HOUR TURNING MOVEMENT COUNTS
 BROCKTON MA
 7:30AM TO 8:30AM



75 State Street, Suite 701
 Boston, MA 02109
 Tel: (617) 452-6000

CITY OF BROCKTON

CRESCENT STREET (ROUTE 27), LYMAN STREET
 AND SUMMER STREET INTERSECTION IMPROVEMENT PROJECT

TURNING MOVEMENT COUNTS
 COLLECTED ON 10-8-14 & 10-9-14

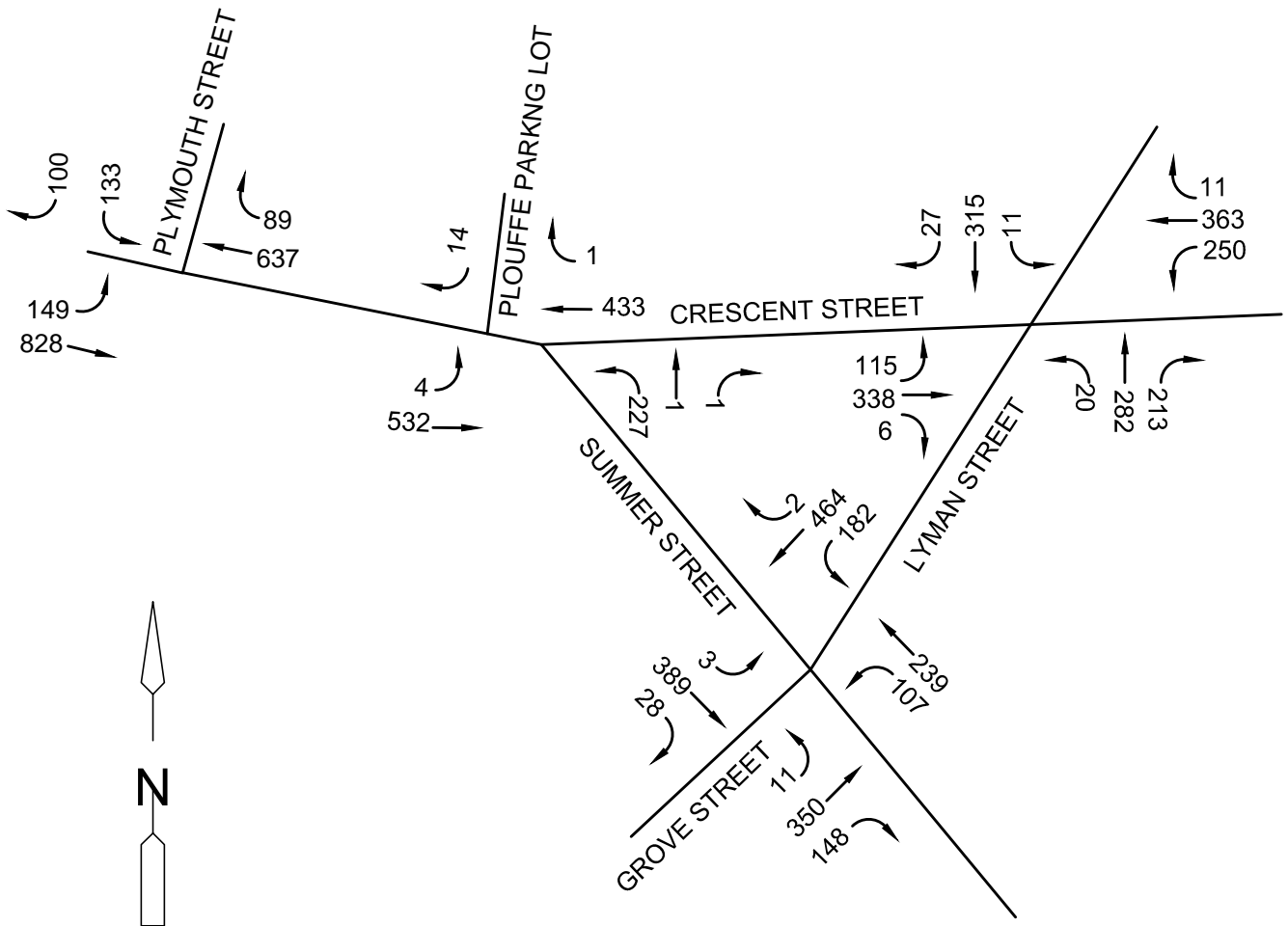


FIGURE 3B - 2015 EXISTING PM PEAK HOUR TURNING MOVEMENT COUNTS
 BROCKTON MA
 3:45PM TO 4:45PM



75 State Street, Suite 701
 Boston, MA 02109
 Tel: (617) 452-6000

CITY OF BROCKTON

CRESCENT STREET (ROUTE 27), LYMAN STREET
 AND SUMMER STREET INTERSECTION IMPROVEMENT PROJECT

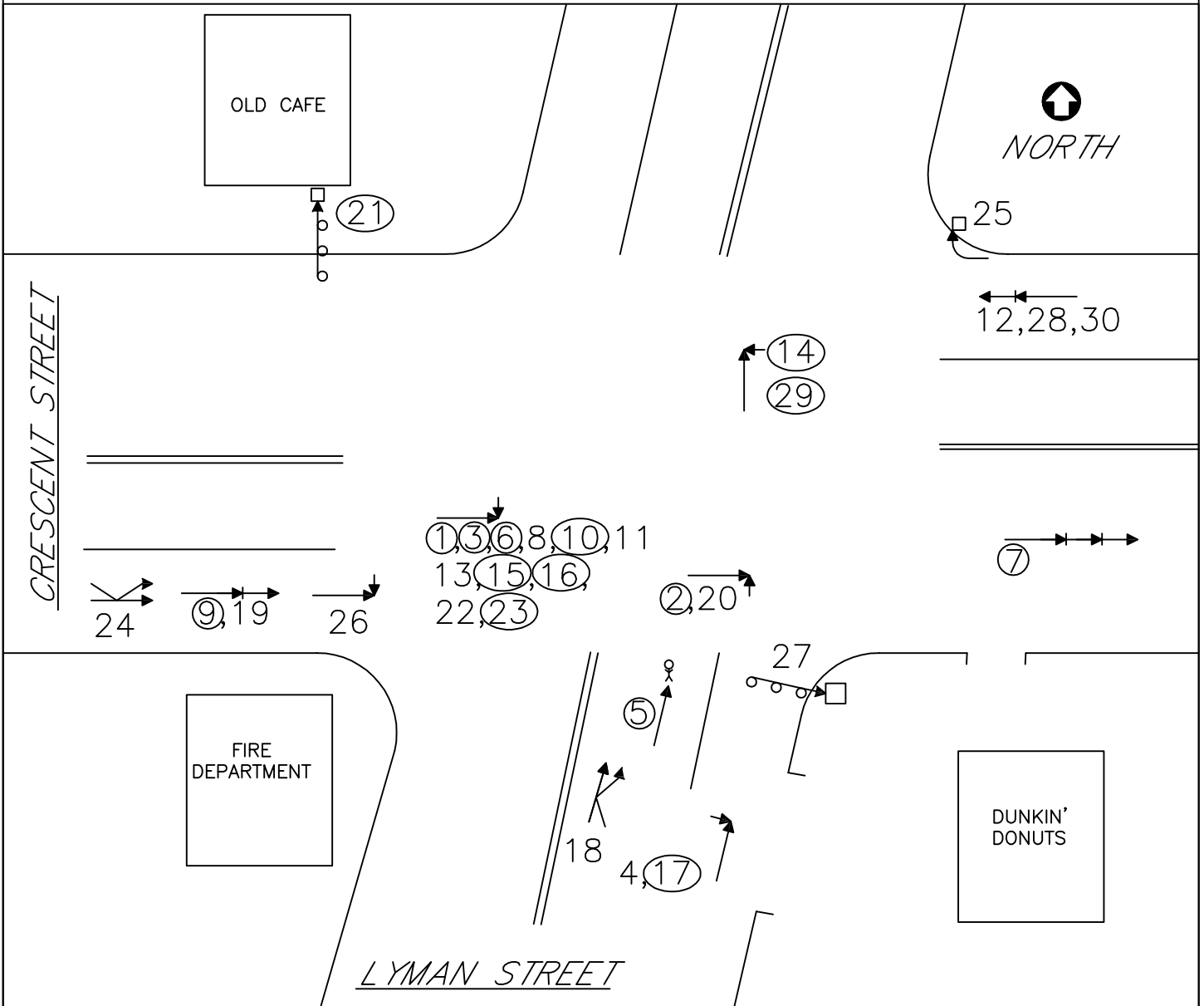
TURNING MOVEMENT COUNTS
 COLLECTED ON 10-8-14



COLLISION DIAGRAM

CRESCENT STREET (ROUTE 27)

CITY/TOWN:	<u>BROCKTON</u>
REGION:	<u>OCPC</u>
ROADWAY NAMES:	<u>CRESCENT STREET AND LYMAN STREET</u>
TIME PERIOD ANALYZED:	<u>JANUARY 2010 – DECEMBER 2012</u>
SOURCE OF CRASH DATA:	<u>BROCKTON POLICE DEPARTMENT</u>
DATE PREPARED:	<u>AUGUST 2015</u>
PREPARED BY:	<u>CDM SMITH</u>

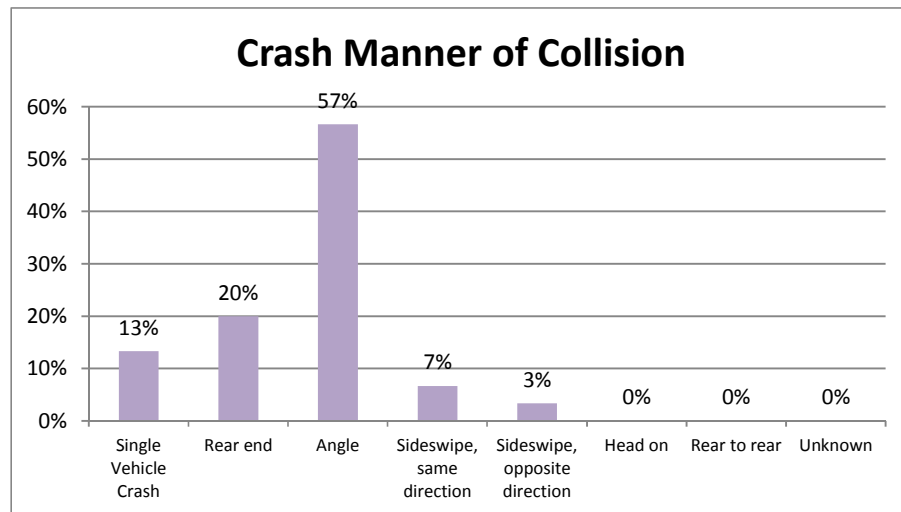
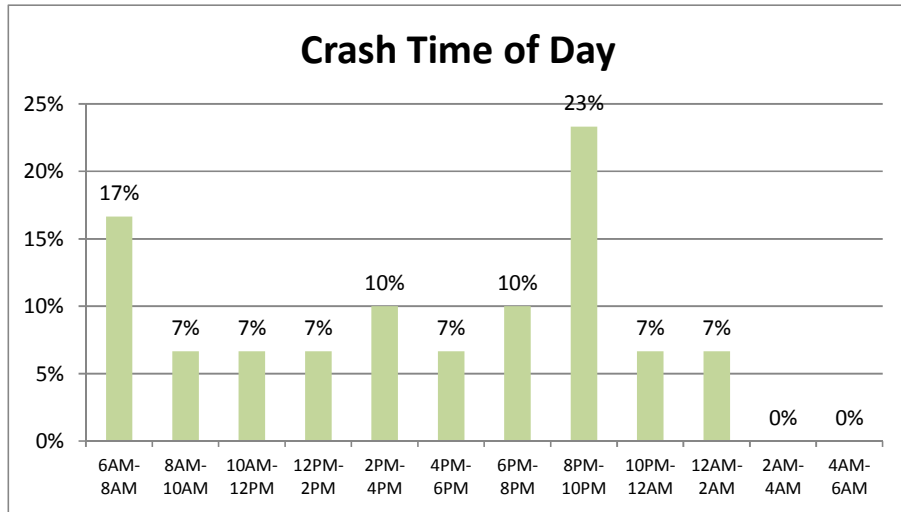
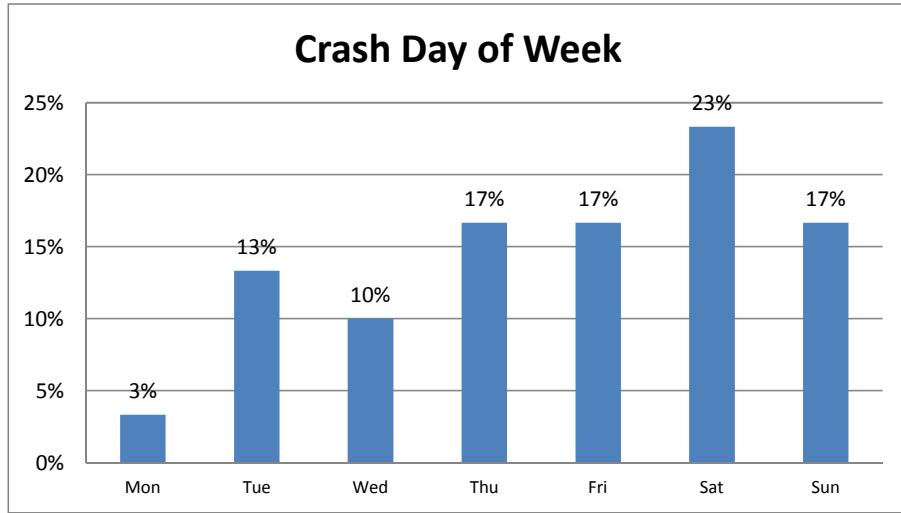


SYMBOLS	TYPES OF CRASH	SEVERITY
Moving Vehicle Backing Vehicle Non-Involved Vehicle Pedestrian Parked Vehicle Fixed Object Bicycle Animal Turning Vehicle	Head On Angle Rear End Sideswipe, opposite direction Sideswipe, same direction Out of Control	Injury Accident Fatal Accident

Collision Data Summary Table - Crescent Street at Lyman Street

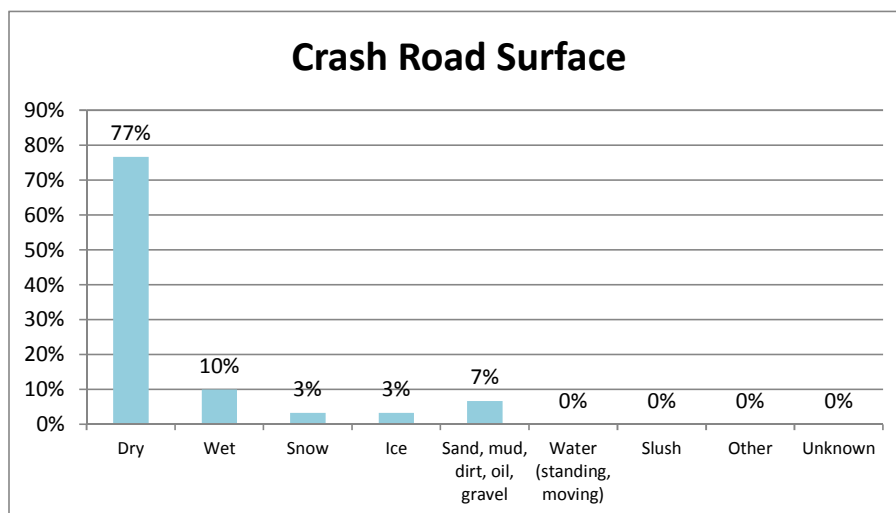
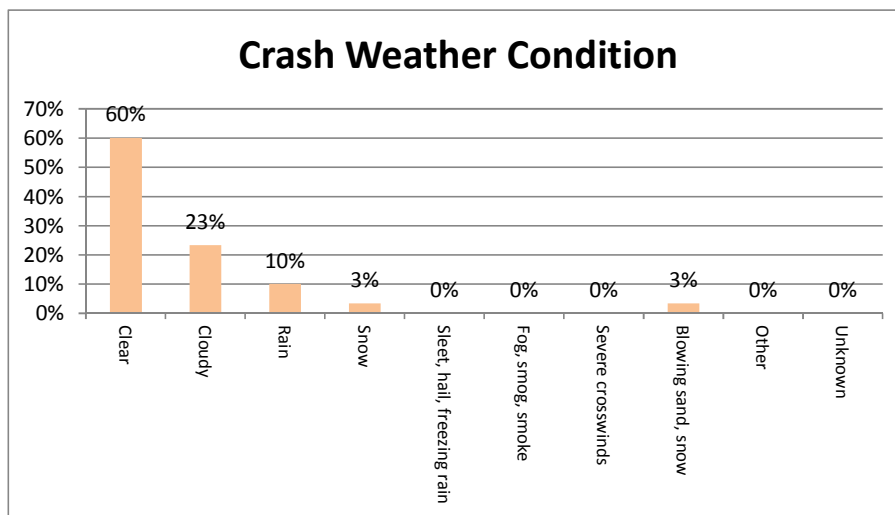
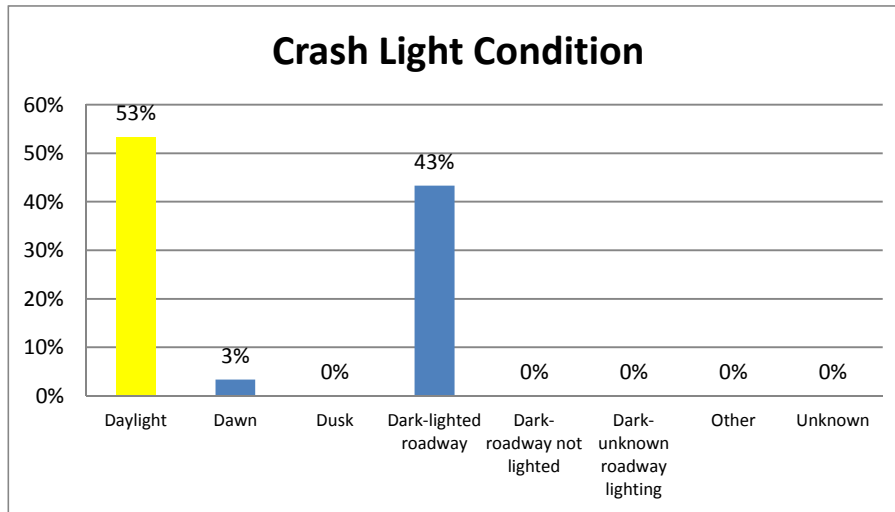
Diagram Ref. #	Crash Date	Crash Day	Time of Day	Manner of Collision	Light Conditions	Weather Conditions	Road Surface	Driver Contributing Code	Injury Status	Citation	Comments
1	1/3/10	Sun	12:23 AM	angle	dark-lighted roadway	blowing sand, snow	snow	Disregarded traffic signs, signals, road markings	non-incapacitating injury	Yes	V2 (EB) cited for failing to stop at red light
2	1/9/10	Sat	7:43 PM	angle	dark-lighted roadway	clear	sand, mud, dirt, oil, gravel	Disregarded traffic signs, signals, road markings	non-incapacitating injury	Yes	V2 (EB) cited for failing to stop at red light
3	3/4/10	Thu	9:53 PM	angle	dark-lighted roadway	snow	wet	Disregarded traffic signs, signals, road markings	possible	Yes	V2 (SB) cited for failure to stop at yellow light when reasonable
4	3/10/10	Wed	7:11 AM	angle	daylight	clear	dry	Failed to yield right of way	no injury	Yes	V1 cited for cutting off V2 when turning into Dunkin Donuts
5	5/1/10	Sat	10:18 AM	single vehicle crash	daylight	clear	dry	No Improper Driving	non-incapacitating injury	No	Pedestrian injured
6	5/27/10	Thu	10:58 PM	angle	dark-lighted roadway	rain	dry	Unknown	non-incapacitating injury	No	Both drivers stated they had green light
7	7/6/10	Tue	3:49 PM	rear end	daylight	clear	dry	No Improper Driving	possible	Yes	V3 rear ended V2, who rear ended V1. V1 and V3 cited
8	7/9/10	Fri	9:48 PM	angle	dark-lighted roadway	clear	dry	Disregarded traffic signs, signals, road markings	no injury	No	V1 (EB) cited for disregarding a traffic signal
9	8/3/10	Tue	3:21 PM	rear end	daylight	cloudy	dry	Followed too closely	non-incapacitating injury	Yes	V1 rear ended V2
10	8/14/10	Sat	6:53 AM	angle	daylight	clear	dry	Disregarded traffic signs, signals, road markings	non-incapacitating injury	Yes	V1 (SB) cited for disregarding a traffic signal
11	12/28/10	Tue	2:28 PM	angle	daylight	clear	sand, mud, dirt, oil, gravel	No Improper Driving	no injury	No	-
12	1/15/11	Sat	11:10 AM	rear end	daylight	clear	ice	Inattention	no injury	Yes	V1 cited for operating a M/V not licensed and for failure to yield
13	3/25/11	Fri	9:02 PM	angle	dark-lighted roadway	clear	dry	No Improper Driving	no injury	Yes	V2 (EB) cited for operating license suspended
14	5/22/11	Sun	8:17 AM	angle	daylight	cloudy	dry	Failed to yield right of way	possible	Yes	V1 (NB) cited for failure to grant right of way at intersection
15	5/30/11	Mon	9:54 PM	angle	dark-lighted roadway	clear	dry	Disregarded traffic signs, signals, road markings	possible	Yes	V1 (SB) cited for failure to stop at red light
16	6/14/11	Tue	8:57 PM	angle	dark-lighted roadway	cloudy	dry	Other Improper Action	non-incapacitating injury	Yes	V1 (SB) cited for failure to stop at red light
17	6/17/11	Fri	6:03 PM	angle	daylight	cloudy	dry	Failed to yield right of way	non-incapacitating injury	Yes	V2 cited for cutting off V1 (motorcycle) when turning into Dunkin Donuts
18	9/14/11	Wed	7:42 AM	sideswipe, same direction	daylight	clear	dry	Failure to keep in proper lane or running off road	no injury	Yes	V1 cited for failure to stay in marked lane
19	9/15/11	Thu	1:23 PM	rear end	daylight	cloudy	dry	Failure to keep in proper lane or running off road	no injury	Yes	V1 cited for failure to stay in marked lane
20	11/5/11	Sat	5:04 PM	angle	daylight	clear	dry	Failed to yield right of way	no injury	No	-
21	1/7/12	Sat	12:38 AM	single vehicle crash	dark-lighted roadway	clear	dry	Operating vehicle in erratic, reckless, careless, negligent or aggressive manner	non-incapacitating injury	Yes	The operator (NB) sped through intersection. Appeared intoxicated.
22	1/8/12	Sun	11:02 PM	angle	dark-lighted roadway	clear	dry	No Improper Driving	no injury	No	Both drivers stated they had green light
23	1/14/12	Sat	6:32 AM	angle	dawn	clear	dry	Failed to yield right of way	non-incapacitating injury	Yes	V1 (SB) cited for failure to stay in marked lane
24	2/9/12	Thu	1:00 PM	sideswipe, same direction	daylight	clear	dry	Failure to keep in proper lane or running off road	no injury	Yes	V2 cited for failure to stay in marked lane
25	5/9/12	Wed	9:21 AM	single vehicle crash	daylight	rain	wet	Over-correcting/Over-steering	no injury	No	Operator (WB turning NB) hit the traffic light pole, causing it to fall
26	6/3/12	Sun	8:29 PM	sideswipe, opposite direction	dark-lighted roadway	cloudy	dry	Distracted	unknown	Yes	V1 (SB turning WB) cited for failure to stay in marked lane
27	8/5/12	Sun	4:37 PM	single vehicle crash	daylight	cloudy	dry	Over-correcting/Over-steering	no injury	No	Operator (EB) hit the pedestrian signal
28	9/13/12	Thu	7:50 AM	rear end	daylight	clear	dry	No Improper Driving	no injury	No	-
29	9/28/12	Fri	8:32 PM	angle	dark-lighted roadway	rain	wet	Disregarded traffic signs, signals, road markings	possible	No	Both drivers stated they had green light
30	11/16/12	Fri	7:47 PM	rear end	dark-lighted roadway	clear	dry	Inattention	no injury	No	V2 was distracted looking for dropped cell phone

Crash Data Summary Tables and Charts
Crescent Street at Lyman Street



Crash Data Summary Tables and Charts

Crescent Street at Lyman Street

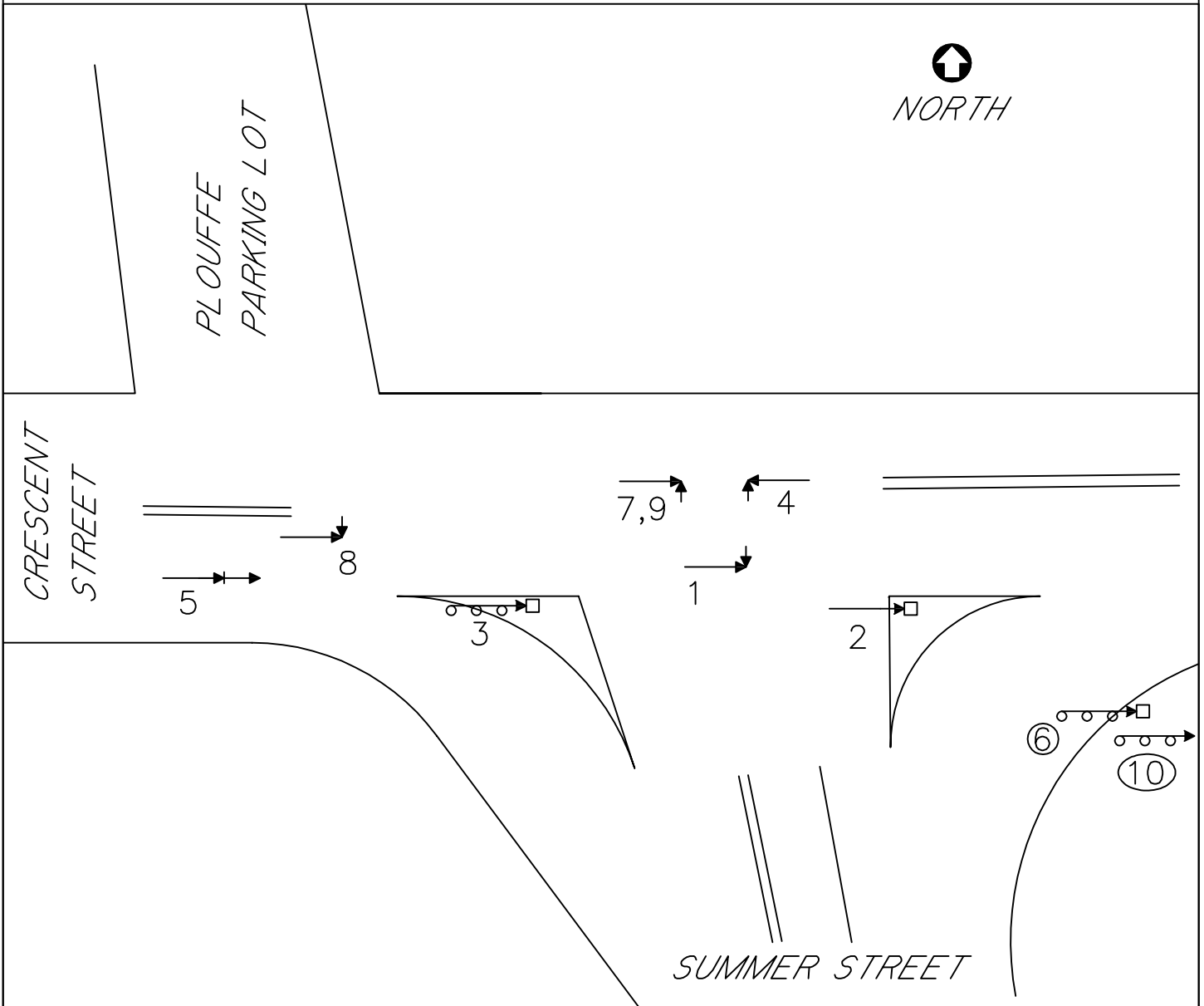




COLLISION DIAGRAM

CRESCENT STREET (ROUTE 27)

CITY/TOWN:	<u>BROCKTON</u>
REGION:	<u>OCPC</u>
ROADWAY NAMES:	<u>CRESCENT STREET AND SUMMER STREET</u>
TIME PERIOD ANALYZED:	<u>JANUARY 2010 – DECEMBER 2012</u>
SOURCE OF CRASH DATA:	<u>BROCKTON POLICE DEPARTMENT</u>
DATE PREPARED:	<u>AUGUST 2015</u>
PREPARED BY:	<u>CDM SMITH</u>



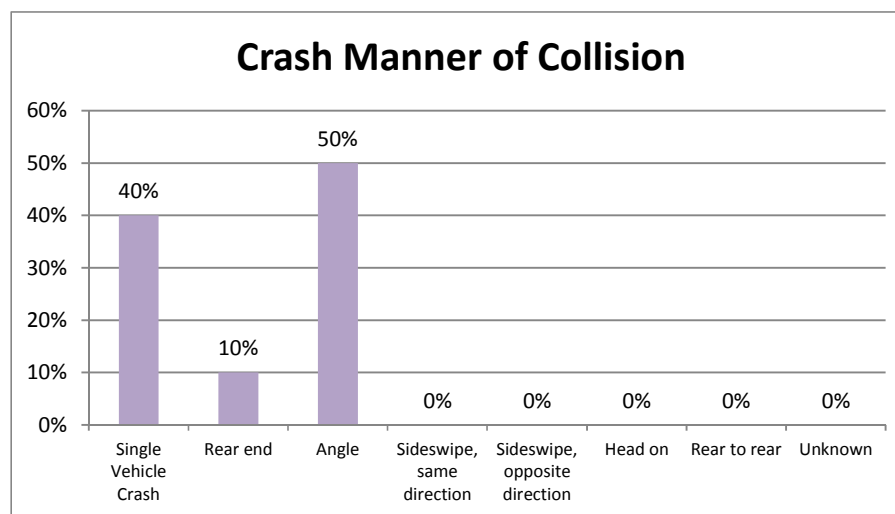
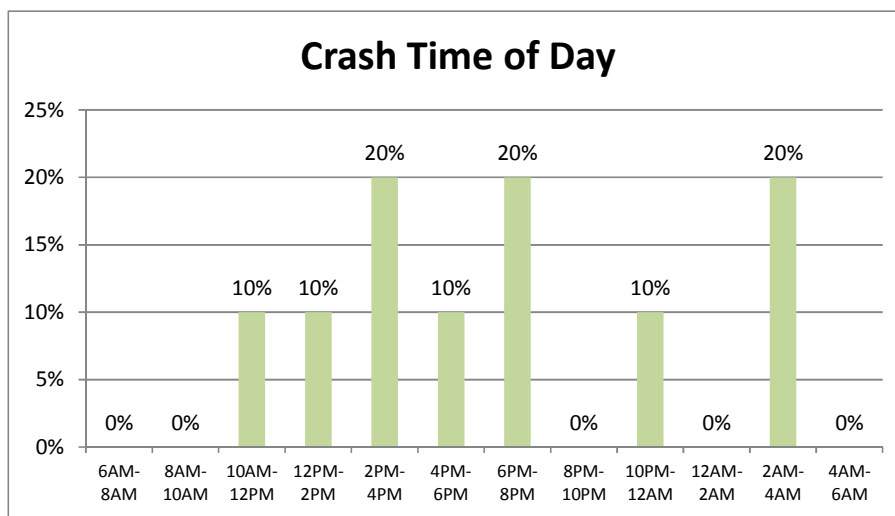
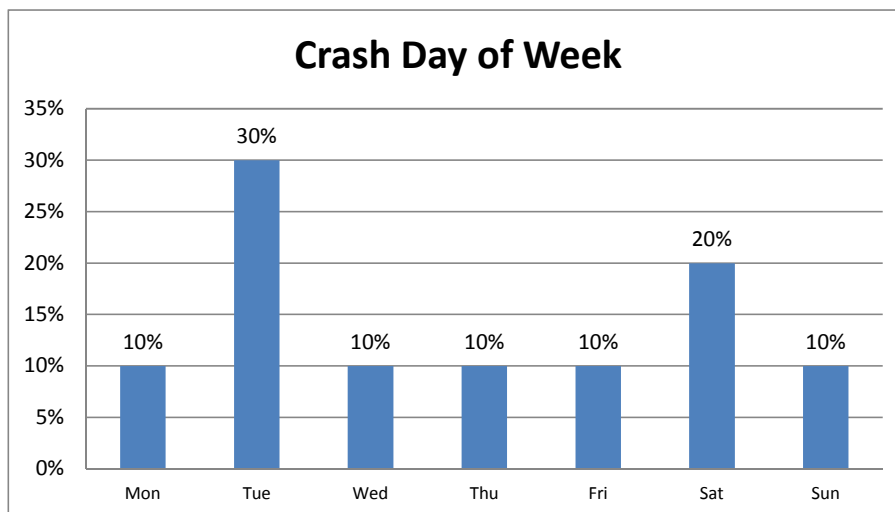
SYMBOLS	TYPES OF CRASH	SEVERITY	
Moving Vehicle Backing Vehicle Non-Involved Vehicle Pedestrian Parked Vehicle Fixed Object Bicycle Animal	Head On Angle Rear End Sideswipe, opposite direction Sideswipe, same direction Out of Control	Injury Accident Fatal Accident	

Collision Data Summary Table - Crescent Street at Summer Street

Diagram Ref. #	Crash Date	Crash Day	Time of Day	Manner of Collision	Light Conditions	Weather Conditions	Road Surface	Driver Contributing Code	Injury Status	Citation	Comments
1	3/2/10	Tue	7:21 PM	angle	dark-lighted roadway	clear	dry	Failed to yield right of way	no injury	Yes	V2 (WB turning SB) cited for failure to yield right of way
2	3/17/10	Wed	11:47 AM	single vehicle crash	daylight	rain	dry	Inattention	no injury	No	Operator hit traffic control lights
3	3/27/10	Sat	2:22 AM	single vehicle crash	dark-lighted roadway	cloudy	dry	Swerving or avoiding due to wind, slippery surface, vehicle, object, non-motorist in roadway, etc...	no injury	Yes	Operator cited for driving while intoxicated
4	1/28/11	Fri	2:53 PM	angle	daylight	clear	dry	Failed to yield right of way	no injury	Yes	V2 (NB) cited for failure to stop at red light and failure to stop after collision
5	2/22/11	Tue	5:50 PM	rear end	dark-lighted roadway	clear	dry	Followed too closely	no injury	Yes	V1 cited for following too closely
6	2/27/11	Sun	2:38 AM	single vehicle crash	dark-lighted roadway	snow	wet	Inattention	possible	No	Operator lost control and initially hit a snowbank on the west side of Summer St
7	3/21/11	Mon	12:58 PM	angle	daylight	snow	snow	Unknown	no injury	No	Both drivers stated they had green light
8	9/13/11	Tue	2:19 PM	angle	daylight	clear	dry	Failed to yield right of way	no injury	Yes	V1 (SB out of Plouffe) cited for failure to yield right of way
9	3/3/12	Sat	10:12 PM	angle	dark-lighted roadway	clear	dry	Unknown	no injury	No	Both drivers stated they had green light
10	7/19/12	Thu	6:13 PM	single vehicle crash	daylight	clear	dry	Unknown	incapacitating injury	Yes	Operator (EB) lost control and ended up in Salisbury Brook. Cited for failure to stay in marked lane.

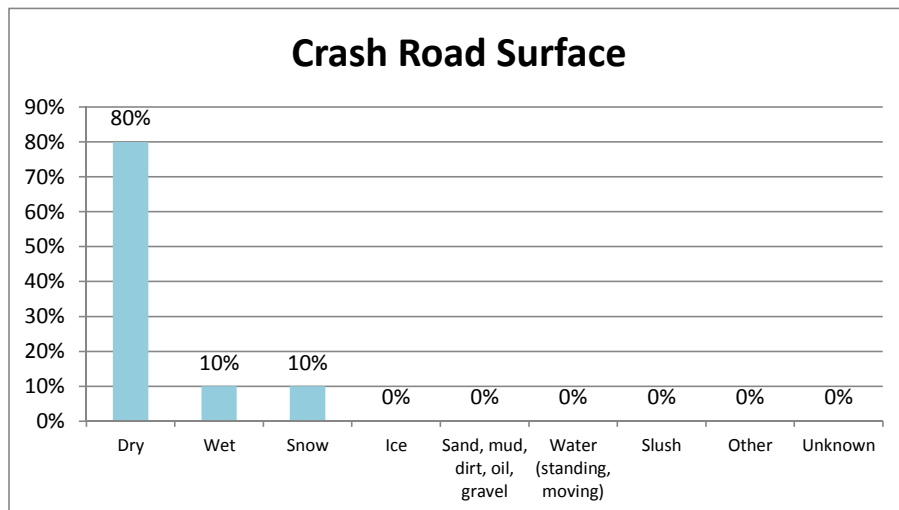
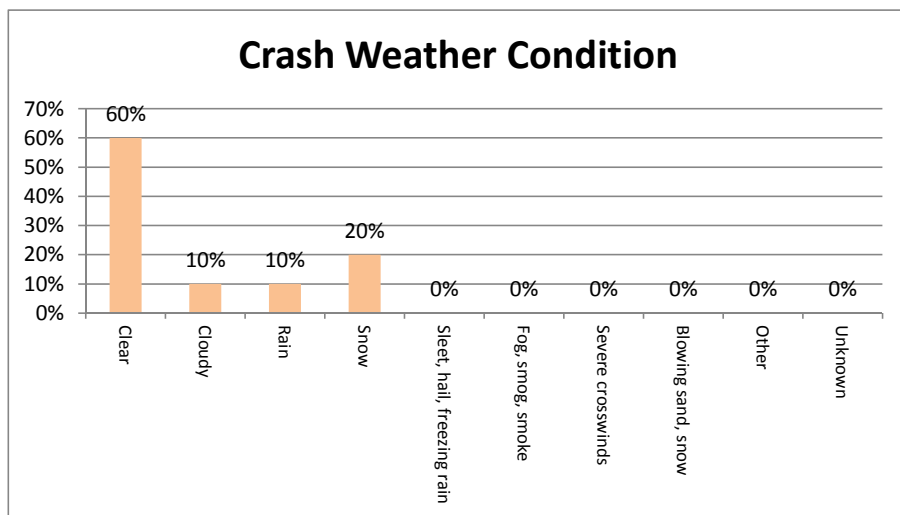
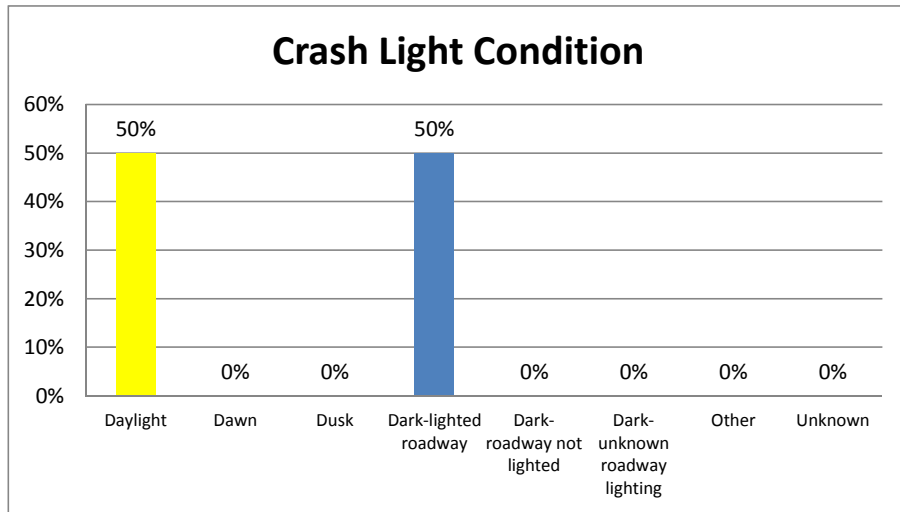
Crash Data Summary Tables and Charts

Crescent Street at Summer Street



Crash Data Summary Tables and Charts

Crescent Street at Summer Street

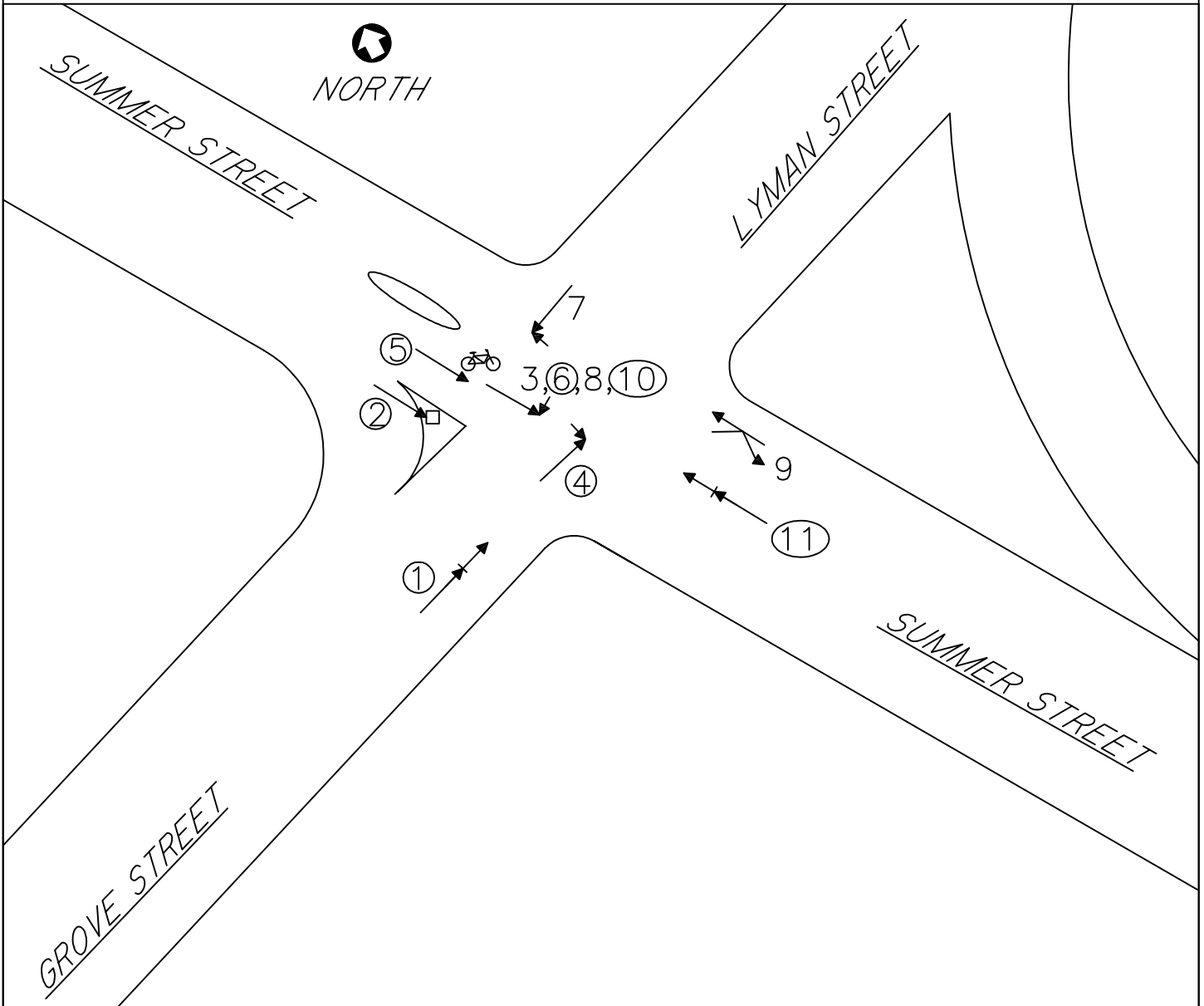




COLLISION DIAGRAM

CRESCENT STREET (ROUTE 27)

CITY/TOWN:	<u>BROCKTON</u>
REGION:	<u>OCPC</u>
ROADWAY NAMES:	<u>SUMMER STREET AND LYMAN/GROVE STREET</u>
TIME PERIOD ANALYZED:	<u>JANUARY 2010 – DECEMBER 2012</u>
SOURCE OF CRASH DATA:	<u>BROCKTON POLICE DEPARTMENT</u>
DATE PREPARED:	<u>AUGUST 2015</u>
PREPARED BY:	<u>CDM SMITH</u>

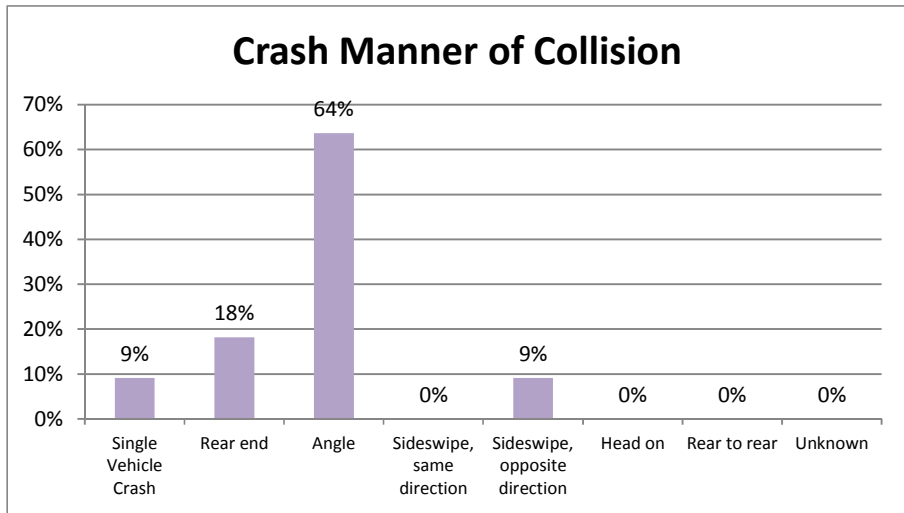
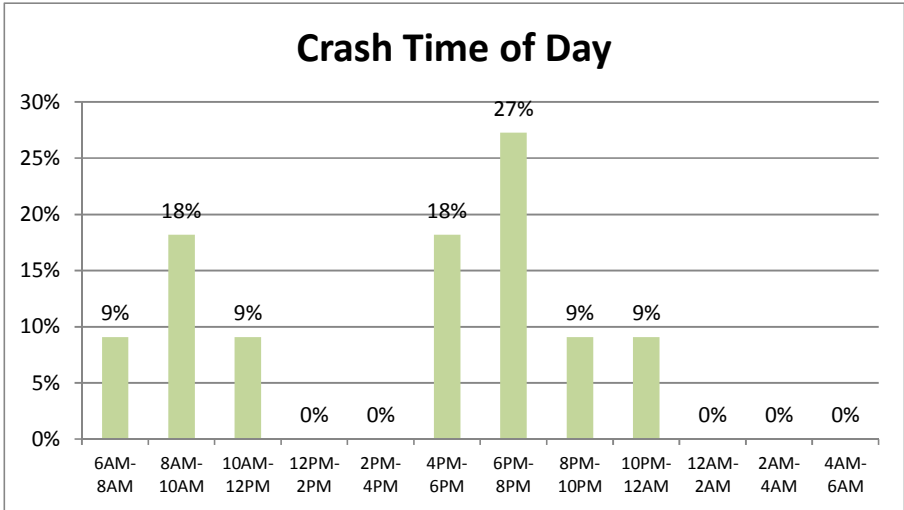
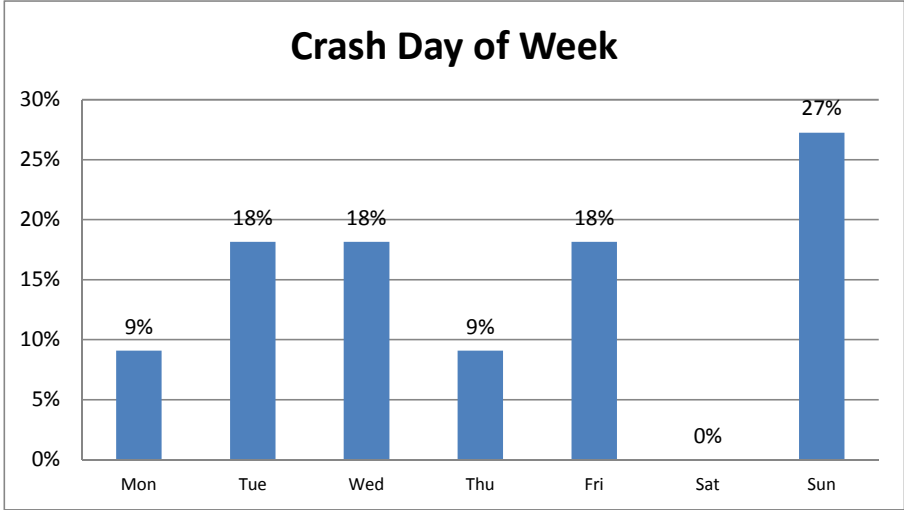


SYMBOLS	TYPES OF CRASH	SEVERITY
Moving Vehicle Backing Vehicle Non-Involved Vehicle Pedestrian Parked Vehicle Fixed Object Bicycle Animal	Head On Angle Rear End Sideswipe, opposite direction Sideswipe, same direction Out of Control	Injury Accident Fatal Accident

Collision Data Summary Table - Summer Street at Lyman/Grove Street

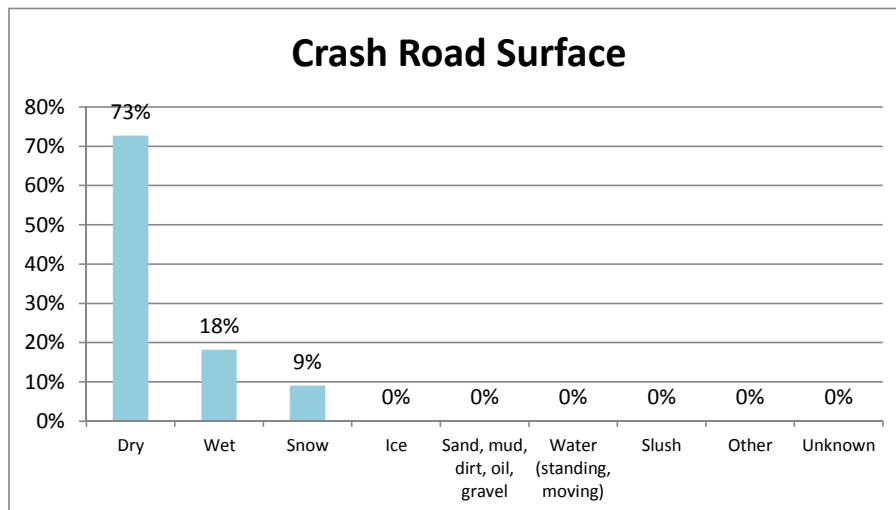
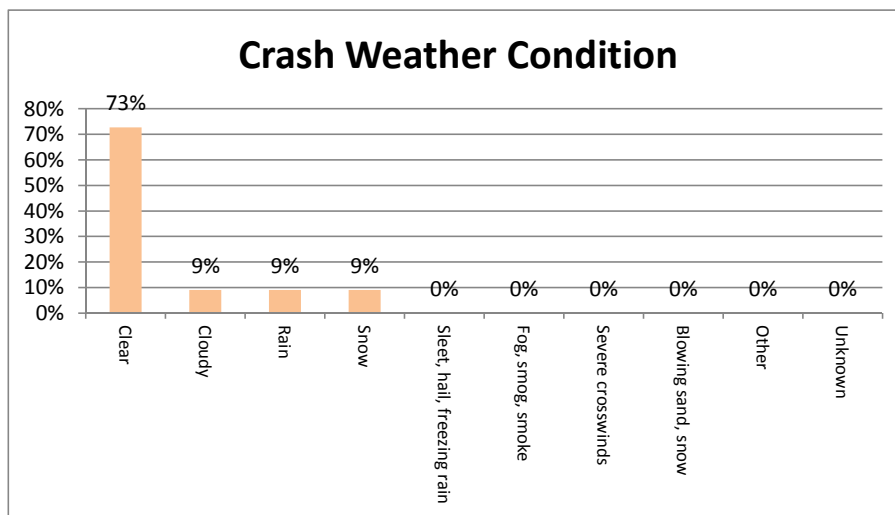
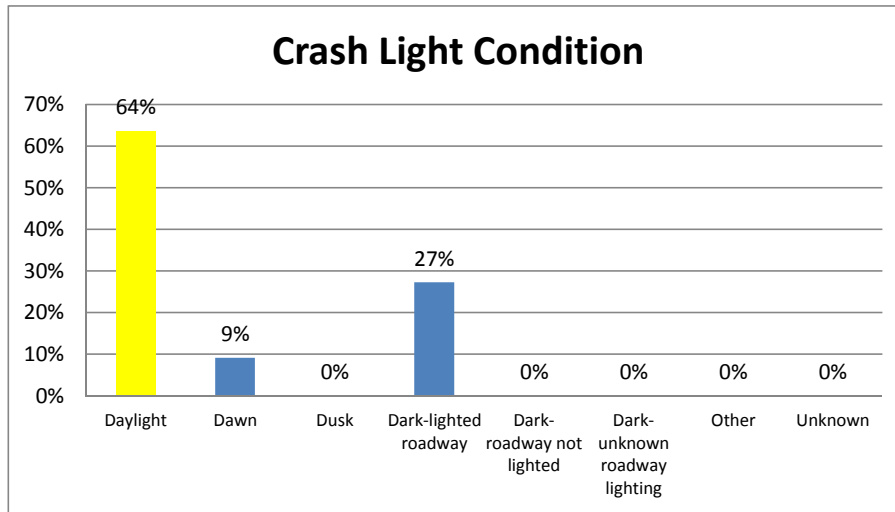
Diagram Ref. #	Crash Date	Crash Day	Time of Day	Manner of Collision	Light Conditions	Weather Conditions	Road Surface	Driver Contributing Code	Injury Status	Citation	Comments
1	1/5/10	Tue	10:50 AM	rear end	daylight	clear	wet	Inattention	possible	No	-
2	8/17/10	Tue	8:15 AM	single vehicle crash	daylight	cloudy	dry	Distracted	possible	No	-
3	9/19/10	Sun	9:29 PM	angle	daylight	clear	dry	Unknown	no injury	No	Both drivers stated they had green light
4	7/8/11	Fri	6:55 PM	angle	daylight	rain	wet	Failed to yield right of way	non-incapacitating injury	Yes	V2 (SB turning WB) cited for failure to yield right of way
5	8/22/11	Mon	4:36 PM	angle	daylight	clear	dry	No Improper Driving	possible	No	Bicyclist was attempting to cross the road
6	10/6/11	Thu	9:29 AM	angle	daylight	clear	dry	Failed to yield right of way	non-incapacitating injury	No	V2 (NB turning WB) turned left into V1
7	10/26/11	Wed	4:28 PM	angle	daylight	clear	dry	Unknown	no injury	No	Both drivers stated they had green light
8	1/13/12	Fri	6:24 PM	angle	dark-lighted roadway	clear	dry	Failed to yield right of way	no injury	Yes	turned left into V2.
9	2/29/12	Wed	6:49 PM	sideswipe, opposite direction	dark-lighted roadway	snow	snow	Failure to keep in proper lane or running off road	no injury	Yes	V1 (WB turning SB) cited for failure to stay in marked lane
10	3/18/12	Sun	11:20 PM	angle	dark-lighted roadway	clear	dry	Failed to yield right of way	possible	Yes	V1 (NB turning WB) cited for failure to yield right of way
11	11/18/12	Sun	6:00 AM	rear end	dawn	clear	dry	Failed to yield right of way	possible	Yes	V2 cited for failure to stop

Crash Data Summary Tables and Charts
 Summer Street at Lyman/Grove Street



Crash Data Summary Tables and Charts

Summer Street at Lyman/Grove Street

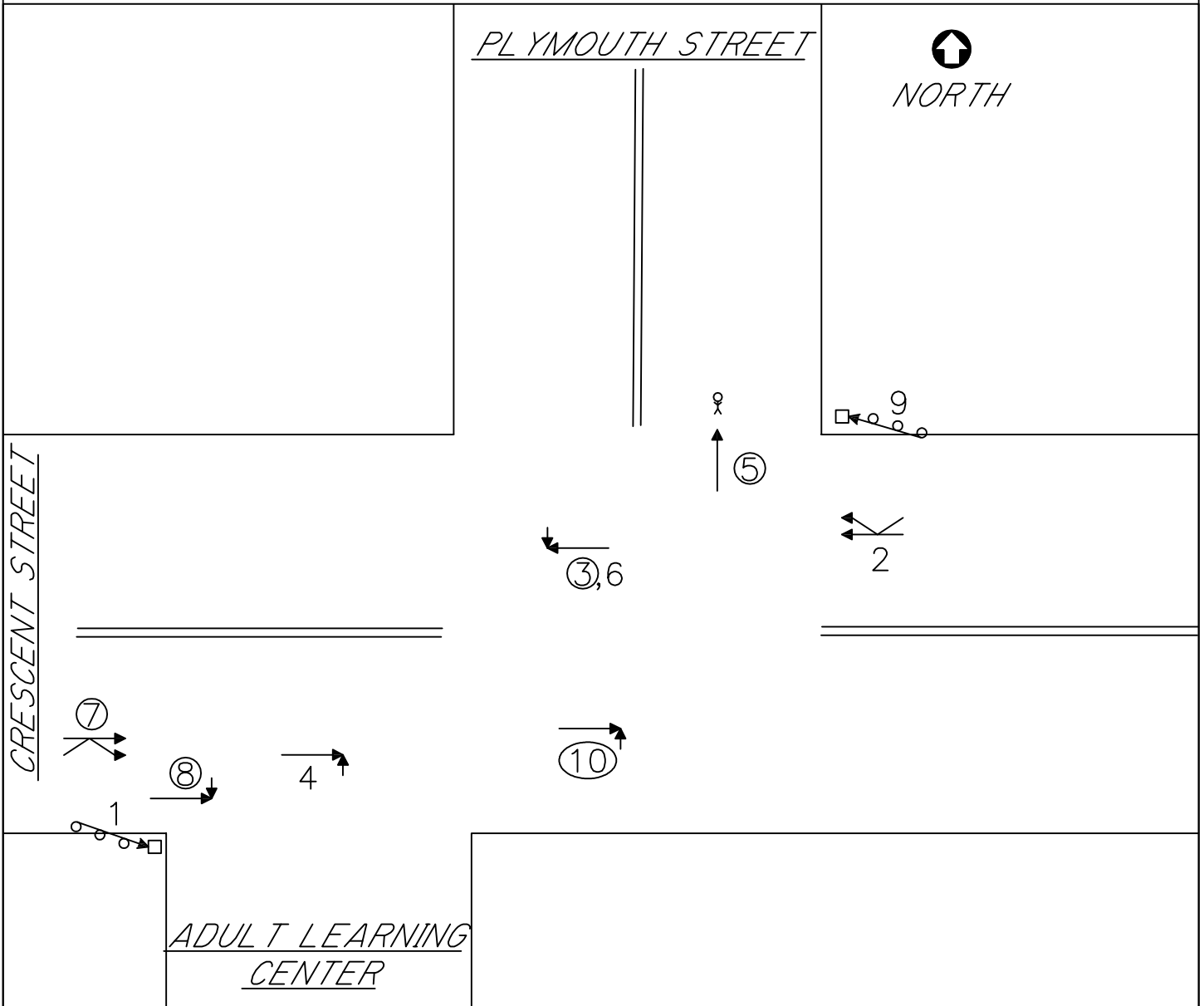




COLLISION DIAGRAM

CRESCENT STREET (ROUTE 27)

CITY/TOWN: BROCKTON
 REGION: OCPC
 ROADWAY NAMES: CRESCENT STREET AND PLYMOUTH STREET
 TIME PERIOD ANALYZED: JANUARY 2010 – DECEMBER 2012
 SOURCE OF CRASH DATA: BROCKTON POLICE DEPARTMENT
 DATE PREPARED: AUGUST 2015
 PREPARED BY: CDM SMITH



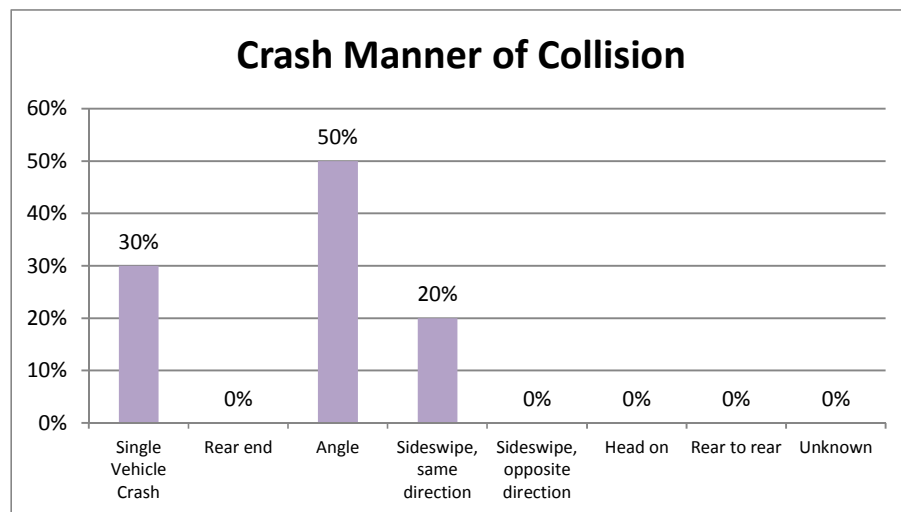
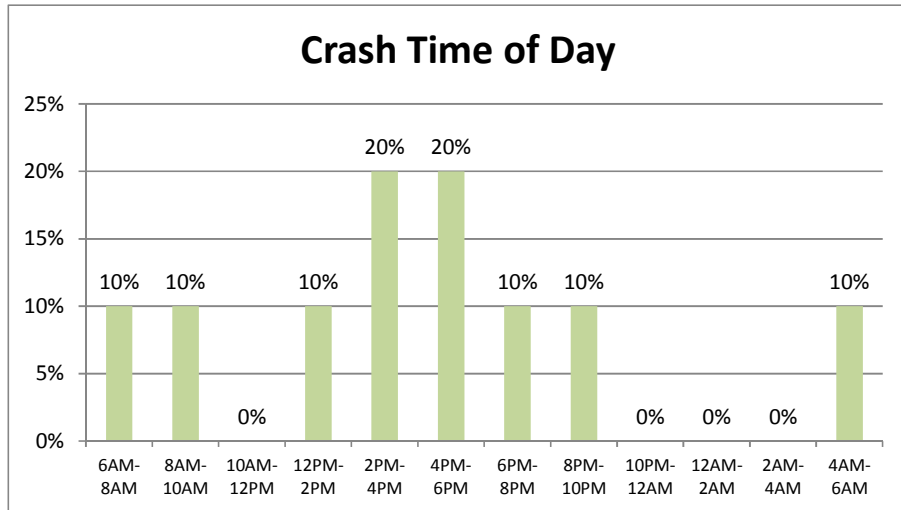
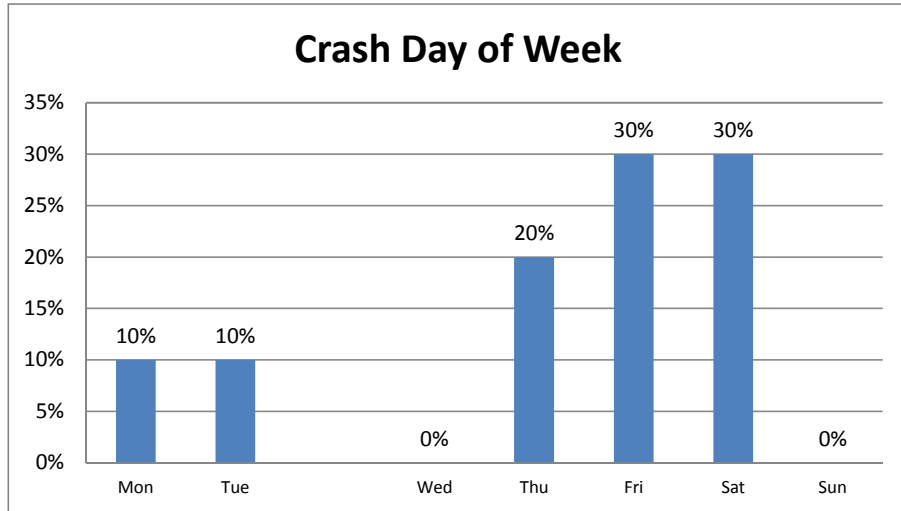
SYMBOLS	TYPES OF CRASH	SEVERITY
Moving Vehicle Backing Vehicle Non-Involved Vehicle Pedestrian Parked Vehicle Fixed Object Bicycle Animal	Head On Angle Rear End Sideswipe, opposite direction Sideswipe, same direction Out of Control	Injury Accident Fatal Accident

Collision Data Summary Table - Crescent Street at Plymouth Street

Diagram Ref. #	Crash Date	Crash Day	Time of Day	Manner of Collision	Light Conditions	Weather Conditions	Road Surface	Driver Contributing Code	Injury Status	Citation	Comments
1	1/2/10	Sat	4:23 PM	single vehicle crash	daylight	blowing sand, snow	snow	No Improper Driving	no injury	No	Operator lost control and hit pole
2	2/13/10	Sat	2:37 PM	sideswipe, same direction	daylight	clear	dry	Swerving or avoiding due to wind, slippery surface, vehicle, object, non-motorist in roadway, etc...	no injury	No	-
3	4/9/10	Fri	12:55 PM	angle	daylight	rain	wet	Failed to yield right of way	non-incapacitating injury	Yes	V2 cited for failure to yield right of way
4	4/12/10	Mon	2:49 PM	angle	daylight	clear	dry	Failed to yield right of way	no injury	Yes	V2 (exiting parking lot turning EB) hit V1 (EB). V2 cited for failure to yield right of way.
5	4/30/10	Fri	7:11 AM	single vehicle crash	daylight	clear	dry	No Improper Driving	non-incapacitating injury	No	Operator traveling EB and turning NB. Pedestrian injured.
6	6/29/10	Tue	5:14 PM	angle	daylight	clear	dry	Made improper turn	incapacitating injury	No	V1 (SB turning EB) collided with V2 (WB)
7	10/2/10	Sat	8:23 PM	sideswipe, same direction	dark-lighted roadway	clear	dry	Disregarded traffic signs, signals, road markings	possible	Yes	V1 cited for failure to stay in marked lane. V2 cited for operation of unregistered vehicle.
8	5/5/11	Thu	6:32 PM	angle	daylight	clear	dry	Failed to yield right of way	possible	Yes	V2 was traveling EB and turning SB. V1 cited for low-speed on state highway and operating a vehicle without a valid license.
9	4/20/12	Fri	5:57 AM	single vehicle crash	daylight	clear	dry	Failure to keep in proper lane or running off road	no injury	No	Operator hit a traffic sign and fire hydrant
10	11/29/12	Thu	9:07 AM	angle	daylight	clear	dry	Failed to yield right of way	possible	Yes	V2 (EB turning NB) cut off V1 and was cited

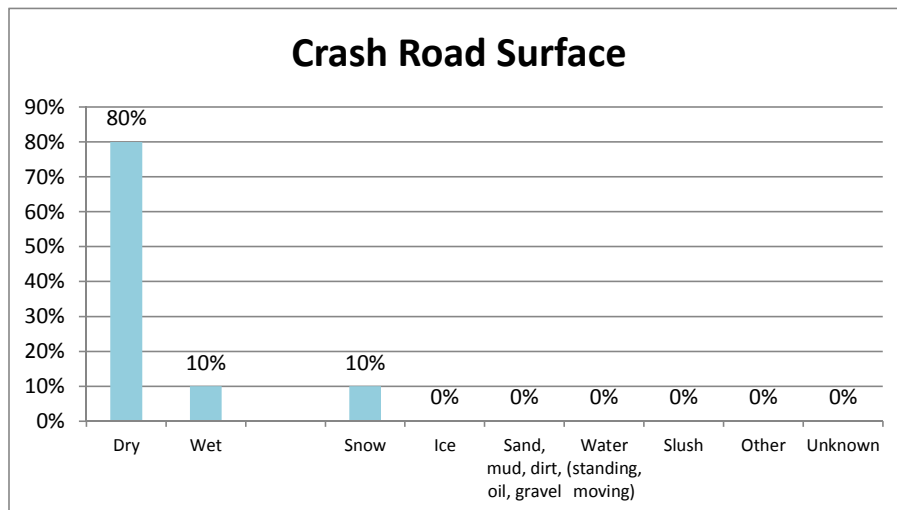
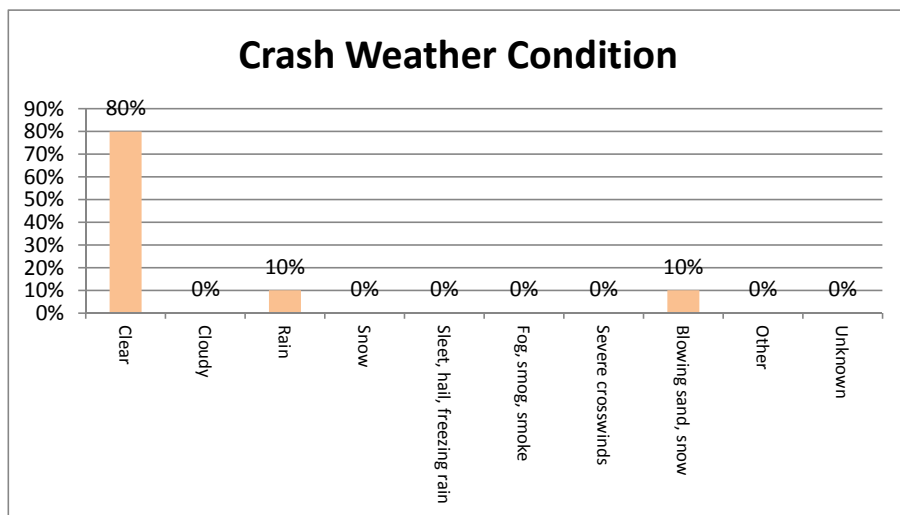
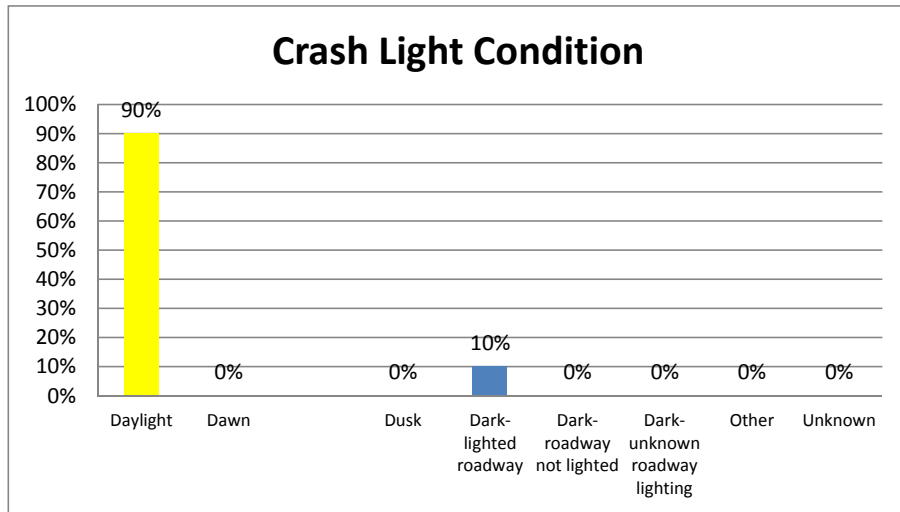
Crash Data Summary Tables and Charts

Crescent Street at Plymouth Street



Crash Data Summary Tables and Charts

Crescent Street at Plymouth Street



Appendix D. Road Safety Audit References

Road Safety Audit References

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