CAPE COD COMMISSION

Route 6 Hydroplaning Crash Analysis and Alternatives Development

Bourne, Sandwich, Barnstable, Yarmouth, Dennis, Harwich, Brewster and Orleans

October 2013

COUNTY OF BARNSTABLE • MASSACHUSETTS •

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INTRODUCTION

The focus of this study is to identify sources of wet weather related crashes on Route 6, and to recommend improvements. Based on initial crash analysis, the segment of roadway between the Sagamore Bridge and the Orleans Rotary was selected for analysis. The following study looks at wet-weather related crash data on this segment of Route 6, drainage problems along the roadway, the current state of practice for stormwater management solutions and then examines preferred solutions for specific roadway segments. Because of the sensitivity of the Cape's drinking water and coastal resources to nutrient and pollutant loading, stormwater solutions recommended in this report include alternatives which address nutrient attenuation and improve water quality.

Hydroplaning occurs when a thin layer of water develops between vehicle tires and the road surface, resulting in loss of contact between the two. As the layer of water builds up it exerts a force which can lift the tire off the pavement causing what is also referred to as "full dynamic drag" (Hayes et al., 1983). As hydroplaning occurs tires slide over the pavement surface causing skidding, loss of control and potential collisions.

Hydrodynamic drag differs from hydroplaning as it refers to the force applied by water to a tire pushing through the water as opposed to the tire lifting from the road surface. Hydrodynamic drag causes vehicles to be "pulled" from side to side in the water and usually occurs at slower speeds.

Hydroplaning and Hydrodynamic drag are dynamic events dependent on many factors including pavement condition, roadway geometries, tire inflation and condition, driving speed and extent of ponding from stormwater runoff on the road surface.

Stormwater runoff is caused by precipitation from rain and snowmelt events which flow over land or impervious surfaces and is unable to percolate into the ground. In natural systems, precipitation may be directly infiltrated subsurface, stored in natural depressions, and reintroduced to the atmosphere through evapotranspiration. Development alters this native state and replaces it with impervious cover including heavily landscaped areas (such as lawns and playgrounds), roads, sidewalks, paved driveways and roofs. The increase in impervious cover that accompanies development results in two main issues: 1) greater volume and peak flows of runoff resulting in increased ponding and hydroplaning potential and 2) the transportation of contaminants into groundwater.

In natural ecosystems runoff is infiltrated into groundwater and discharged to freshwater streams, ponds, lakes, rivers and marine estuaries. Flooding is less significant in these natural systems because they are able to absorb greater volumes of stormwater, passing it from the surface to the groundwater. In urbanized areas these natural systems are replaced with dense impervious cover reducing the amount of infiltration that can occur. Even on Cape Cod, an area with a naturally high infiltration rate, flooding can occur in areas affected by urbanization causing damage to infrastructure and making roadways unsafe for travel.

Common pollutants found in stormwater runoff include oil; grease and metals from vehicular traffic; salts and other deicing agents used to maintain safe roadway operation under winter weather conditions; pesticides and fertilizers from landscaping activities; sediments from various activities; altered water temperatures and litter including cigarette butts, paper wrappers and plastic bottles. When conveyed by stormwater runoff these pollutants impair waterways, degrade natural habitat, pollute ground water, increase flooding, cause erosion of streambeds or siltation of waterways, and decrease the amount of water recharged to aquifers. Transported by stormwater runoff, pollutants, including nitrogen, find their way into the ground and surface waters throughout the Cape. These waters, along with their increased pollutant loads, ultimately discharge to coastal embayments.

Due to the Cape's unique geology the presence of increased nitrogen loading from development has a particularly significant effect on the nitrogen-limited coastal embayments of Cape Cod. Nitrogen limited ecosystems are ecosystems that have adapted under low nitrogen conditions. When an excess of nitrogen is introduced to an embayment, changes in the natural ecology will occur. A common result from excess nitrogen loading is the increase of fast growing species (i.e. algae), which often outcompete other life forms resulting in the loss of species diversity and community richness. This is referred to as the process of eutrophication. In some severe cases eutrophication creates anoxic environments resulting in fish kills and aesthetically unpleasant conditions. The nitrogen load that changes a healthy system to a eutrophic condition is defined as a critical threshold, which under the federal Clean Water Act is referred to as a Total Maximum Daily Load (TMDL). Communities are required to restore impaired surface water bodies where the TMDL is known.

BACKGROUND

Cape Cod is a sand and gravel remnant of the last continental deglaciation that occurred from 15,000 to 20,000 years ago. This deglaciation created a series of broad gently sloping outwash plains that are truncated by long linear moraine deposits found along the present day Route 6 Mid-Cape Highway and Route 28 MacArthur Boulevard. Cape Cod's only source of drinking water, the Sole Source Aquifer, is highly susceptible to contamination with the quality of the aquifer directly affecting our freshwater ponds, marine embayments and drinking water supplies. What makes the Cape a unique area for stormwater management is the combination of highly porous native soils left by the retreating glaciers and the often shallow groundwater levels which are especially prevalent in our coastal communities. Stormwater Best Management Practices (BMPs), rely heavily on infiltration to improve the quality and reduce the quantity of runoff. While these well drained soils readily infiltrate runoff, providing excellent volume reduction of stormwater, rapid infiltration allows contaminated runoff access to the groundwater, and through the natural movement of groundwater towards nutrient-sensitive water bodies, with little or no water quality treatment. Where most efforts to manage stormwater focus on moving the volume of water off roadways, in nitrogen sensitive areas, stormwater management also requires addressing the quality of the stormwater that infiltrates to the Cape's groundwater (drinking water) resources and the Cape's coastal estuaries. Wellhead Protection Areas (shown in Figure 1) are the areas of land that receive precipitation to recharge drinking water pumping wells. These areas are a mapped resource area in the 2009 Cape Cod Commission Regional Policy Plan and have specific regulations in place to protect the Capes drinking water supply.

Cape Cod is currently engaged as a region in examining water-quality management through an update to the Environmental Protection Agency (EPA) Section 208 Water Quality Management Plan. Many of the Cape's coastal water bodies have impaired water quality. The Massachusetts Estuaries Project (MEP) has calculated the Total Maximum Daily Loads (TMDLs) for most of these impaired water bodies; as illustrated in Figure 1, much of the Route 6 study area lies within a watershed which contributes to an impaired water body where the TMDL has been established. The sections of Route 6 examined in this report fall within 7 major nitrogen sensitive watersheds where water quality improvements must be made. Noting additionally that the April 2011 Order of Entry of Judgment in the civil case 06-11295-WGY requires documentation that MassDOT is making progress toward implementing its Stormwater Management Plan, this report makes recommendations that advance both Barnstable County's and MassDOT's interests in improving stormwater quality management.

Figure 1 depicts the study area for this report including locations where Route 6 intersects nitrogen sensitive watersheds and Wellhead Protection Areas (WHPA) as defined in the 2009 Cape Cod Commission Regional Policy Plan. Nitrogen sensitive watersheds have been determined by the Massachusetts Estuaries Project (MEP) and values provided in Figure 1 reflect those put forth by the MEP analysis. Watersheds shown in blue do not currently have an established nitrogen loading rate. Green watersheds do not require a reduction in nitrogen from wastewater sources while watersheds shown in yellow, orange and red require reductions in nitrogen from wastewater sources of <50%, 51-75%, and >75%, respectively.

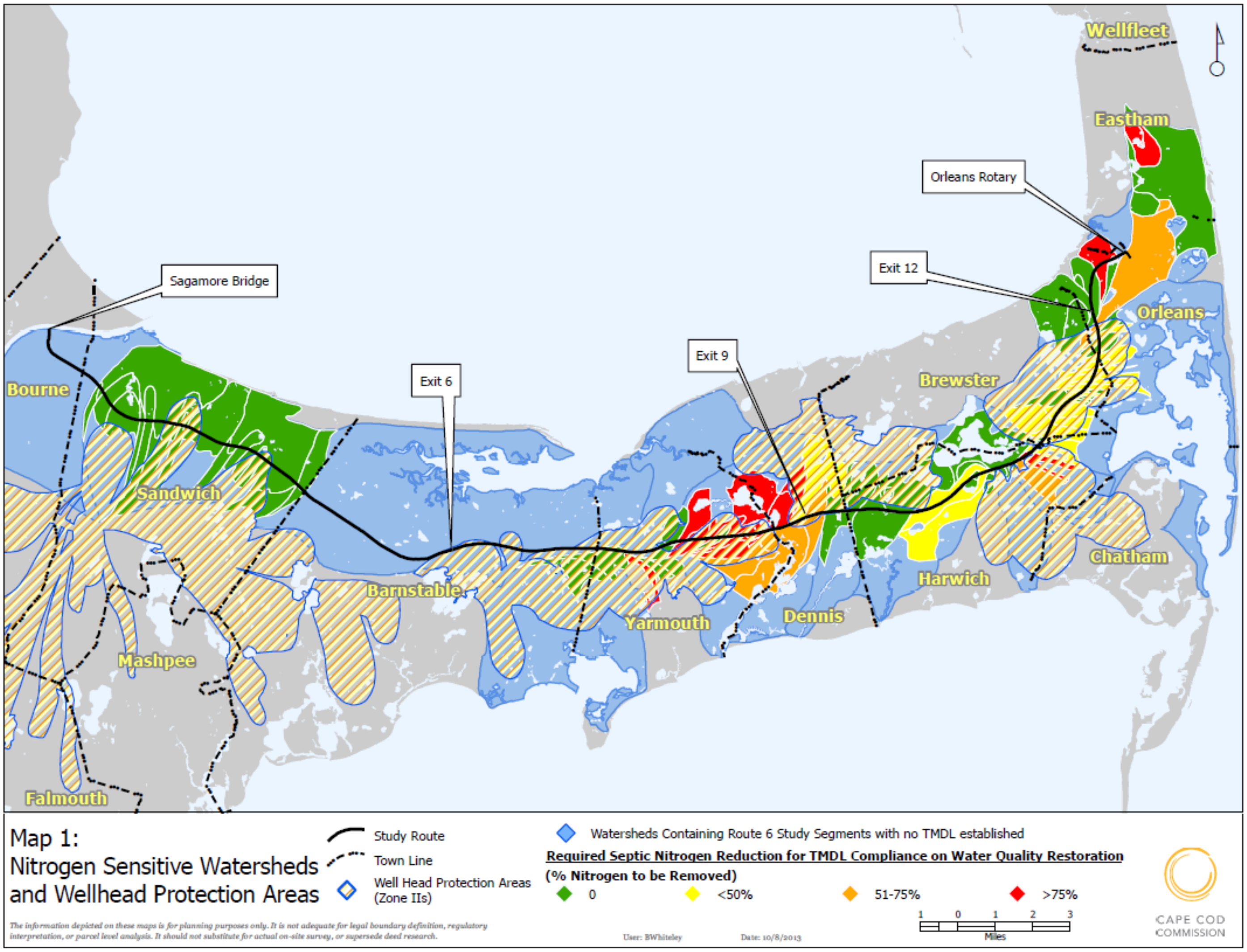


FIGURE 1: NITROGEN SENSITIVE WATERSHEDS AND WELLHEAD PROTECTION AREAS

Characterization of Route 6 Existing Conditions

The current configuration of the Mid-Cape Highway from the Sagamore Bridge to the Orleans Rotary was constructed over a 20 year time period starting in 1950. The road segment from the bridge to Exit 6 (Hyannis) was constructed in 1950 and expanded to four lanes in 1954. Additional segments from Exit 6 to the Orleans Rotary were constructed during the period between 1955 and 1971 (CCC, 2013). Improvements have been made at select sections of the roadway, such as resurfacing every 15 – 20 years, new exit ramp configurations, addition of rest areas, stormwater improvements, etc., since that time, but the basic configuration of the roadway, including cuts and fills, slopes, road profile and geometry, were designed and constructed based on engineering and design criteria from 60 years ago.

According to MassDOT, approximately 20 years ago concerns over water quality impacts to environmentally sensitive areas led to the construction of retention ponds in the divided median between Exits 3 and 4 in Sandwich, and just west of Old Bass River Road in Dennis. Drainage discharges were diverted into these swales to improve water quality treatment. To date these facilities are reportedly working properly with little maintenance. More recently, in response to hydroplaning concerns on Route 6, MassDOT made additional stormwater improvements in 2007. In the vicinity of Exit 5 (Route 149), Mass DOT installed additional drainage infiltration structures, waterways, berms and other treatments. In the vicinity of Exit 9 (Route 134, Dennis), MassDOT performed additional milling and resurfacing, and installed waterways. In 2008, at the request of the Orleans Conservation Commission, MassDOT constructed individual leaching type structures on the soft shoulder of Route 6 adjacent to Cedar Pond in Orleans in order to improve water quality treatment before it discharges to the pond. These facilities are maintained by MassDOT Highway Division maintenance crews and contractors, on an as needed basis.

With the exception of these recent improvements, stormwater systems incorporated into the original Route 6 roadway design do not reflect current best management practices; additionally, they may not reflect consideration for current and anticipated stormwater design flows.

Segments of the existing roadway do not always drain adequately during storm events. Depending on storm conditions, portions of the roadway may flood with significant sheet flow over the surface, pond in low areas, and/or retain large volumes of water at the road edge-of-pavement. Most of Route 6 does not have a paved shoulder; instead, the edge of pavement is typically finished with a low paved curb, which has the effect of collecting and channelizing stormwater. Sheet flow off of the roadway, or traditional country drainage, is inhibited by the presence of this paved curb, and/or grading at the roadside that slopes up from the roadway rather than down.

EXISTING CONDITIONS

The Route 6 corridor changes in character from the Sagamore Bridge to the Orleans Rotary. Different segments of the roadway need to be examined separately, as key elements vary, including right-of-way (ROW) width, roadway cross section, posted road speeds, etc. For the purposes of this hydroplaning study, Route 6 was broken into four different analysis segments: Sagamore Bridge to Exit 6, Exit 6 to Exit 9, Exit 9 to Exit 12, and Exit 12 to Orleans Rotary. These analysis segments, in conjunction with elevation above sea level, are depicted in Figure 2 below and summarized in Table 1.

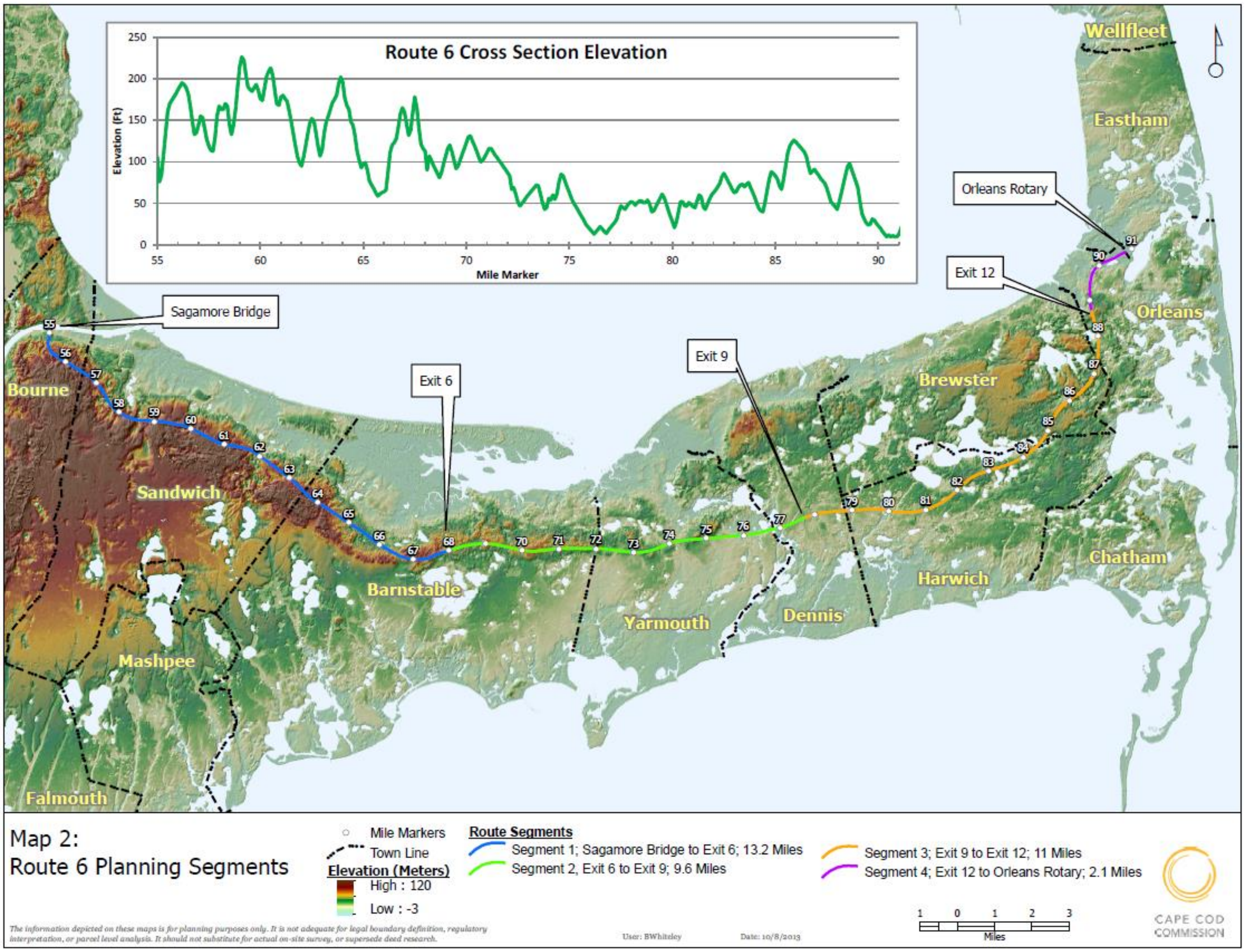


FIGURE 2: ROUTE 6 HYDROPLANING STUDY ANALYSIS SEGMENTS

SAGAMORE BRIDGE TO EXIT 6

This section of Route 6, shown in Figure 7, was originally constructed as a two-lane roadway in 1950, and was later expanded to four lanes in 1954. The state-owned ROW is approximately 200 ft. wide from the Bridge to Exit 2, where it widens to 400 – 500 ft. This section of roadway has a paved surface that is only inches wider than the marked travel lanes; the pavement edge is finished with a paved berm. The shoulder is graded, perhaps hardened in places, with occasional guard rails that narrow the graded shoulder. The central median is mostly natural, with occasional graded areas. Grading in the median was not designed for stormwater management. The median along this stretch of the roadway from the bridge to Exit 2 is approximately 30 ft. wide; traveling eastwards from Exit 2 it widens to 45 – 60 ft. The roadway contains catch basins located within the paved surface; there appears to be little additional formal stormwater management facilities. The posted speed limit is 55 mph.

EXIT 6 TO EXIT 9

This section of Route 6, shown in Figure 8, was originally constructed as a two-lane roadway in 1955, and was later expanded to four lanes in 1967 and 1971. The state-owned ROW is approximately 400 - 500 ft. wide from Exit 6 to Exit 9. The eastbound section of this roadway has an approximately 12 ft. wide paved shoulder on the right hand side of the roadway; there is no shoulder on the left. Neither side of the road has paved berms in this section of roadway. The shoulder is graded, perhaps hardened in places, with occasional guard rails that narrow the graded shoulder. The central median is mostly natural, with occasional graded areas. The median along this stretch of the roadway from Exit 6 is approximately 70 ft. wide. This section of roadway appears to have country drainage, with both the right and left edges of pavement are graded to drain away from the road surface. Partway between Exits 6 and 7 eastbound remnants of granite curbing appear on the right hand side of the edge of pavement. Paved outflow channels on either side of the pavement are located frequently between Exits 6 and 7 in addition to the occasional storm drain. From Exit 7 eastwards the edge of pavement is finished with a paved berm, more storm drains are installed at the edge of pavement, and few if any paved outflows occur. The posted speed limit is 55 mph.

EXIT 9 TO EXIT 12

This two-lane section of roadway, shown in Figure 9, was constructed from 1956 to 1958. The state-owned ROW is approximately 300 ft. wide. This section of Route 6 does not have paved shoulders, and the graded shoulder typically slopes up from the road edge, including in road sections where the surrounding terrain is lower than the paved road. The road edge has paved berms in places. The two lanes are divided by a continuous raised paved berm. Storm drains are located frequently along the paved edge of the road. The posted speed limit is 50 mph.

EXIT 12 TO ORLEANS ROTARY

This two-lane section of roadway, shown in Figure 9, was constructed in 1959. The state-owned ROW varies, but typically is approximately 200 ft. wide. This section of Route 6 does not have paved shoulders, and the graded shoulder typically slopes up from the road edge, including in road sections where the surrounding terrain is lower than the paved road. The road edge has paved berms in places. The two lanes are divided by a continuous raised paved berm. Storm drains are located frequently along the paved edge of the road. The posted speed limit is 50 mph.

TABLE 1: ROUTE 6 SEGMENT OVERVIEW

Section	# lanes	ROW width	Date Constructed	Shoulders	Pavement Edge	Median	Stormwater
Bridge to Exit 6	4, divided	200 – 500 ft	1950, 1954	Hardened and graded	Paved berm	30 – 60 ft graded in places, natural	Catch basins
Exit 6 to Exit 9	4, divided	400 – 500 ft	1955, 1967, 1971	12 ft paved to Exit 7, hardened and graded	None, granite, or paved berm	70 ft, graded in places, natural	Outflow channels, catch basins, country drainage
Exit 9 to Exit 12	2, undivided	300 ft	1956, 1958	Hardened and graded	Paved berm	Paved berm	Catch basins
Exit 12 to Orleans Rotary	2, undivided	200 ft	1959	Hardened and graded	Paved berm	Paved berm	Catch basins

Task 1 – Route 6 Crash Analyses

MassDOT Registry of Motor Vehicle crash records for crashes occurring on Route 6 between the Sagamore Bridge and the Orleans Rotary during the five-year period from 2006 through 2010 were analyzed as part of this study. A number of indicators where used to identify crashes potentially related to hydroplaning. The most reliable field on the crash report for identifying potential hydroplaning crashes is the “road surface” field where police officers are asked to report the condition of the roadway surface at the time of the crash. Where the road surface condition was reported as “water (standing, moving)” the crash was almost certainly related to hydroplaning. Where the road surface condition was reported as “wet” there is a potential that the crash was related to hydroplaning. Considering the crashes occurring under both “water (standing, moving)” and “wet” road conditions, 147 crashes were identified as “wet weather crashes” that were potentially related to hydroplaning.

These wet weather crashes were further broken down to identify the crashes that were most likely related to hydroplaning and to identify segments of road where these crashes were occurring. Of the 147 wet weather crashes, 99 occurred in the vicinity of the on and off ramps. Considering the merging and diverging conflicts at these locations that are particularly problematic given the substandard geometries at the ramps, these crashes were excluded from further analysis. While it is likely that some of these crashes were related to hydroplaning, in order to focus on identifying locations specifically related to hydroplaning the more detailed analysis was focused on the remaining 48 crashes not related to on and off ramp impacts.

The most common crash type among the 48 crashes not occurring near ramps was a single vehicle run-off-the road crash that resulted in a collision with a tree, guardrail, embankment, or other roadside feature. Key characteristics of these crashes are shown in Figure 3. Of great concern is the high number of injury crashes among this set of crashes.

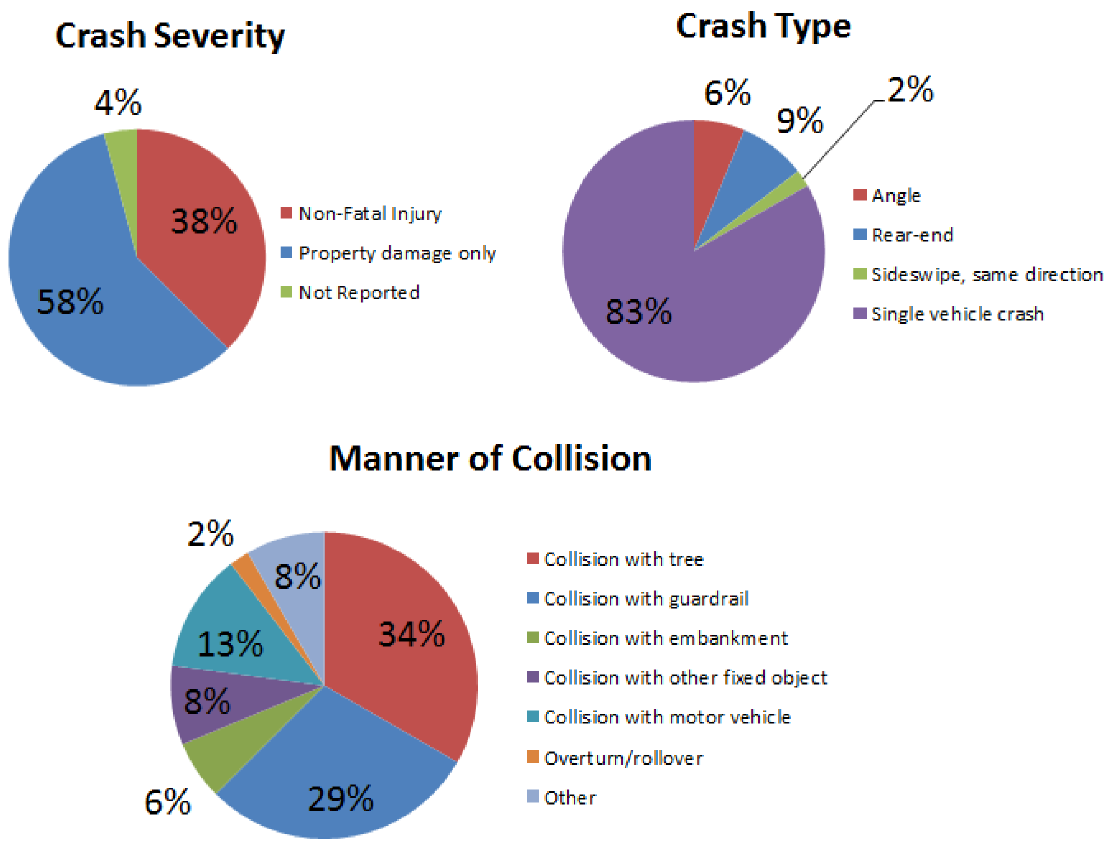
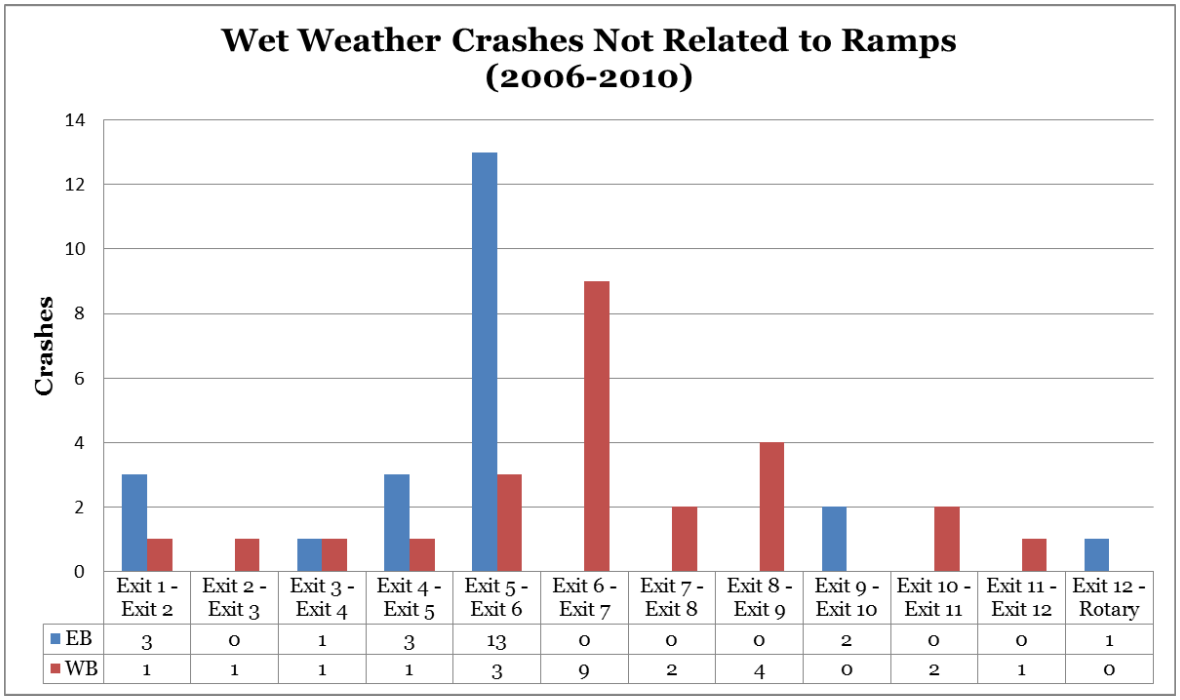


FIGURE 3: ANALYSIS OF WET WEATHER CRASHES UNRELATED TO RAMP TRAFFIC

Looking at the locations of the wet weather crashes not related to on or off ramps a number of high crash segments are clearly identifiable. As shown in Figure 4, the segment of Route 6 eastbound between Exits 5 and 6 has the highest number of crashes with 13 crashes, and the eastbound segment of Route 6 between Exits 6 and 7 being the next highest with nine crashes. It should be noted that the lack of crashes on a segment does not necessarily suggest there is not a hydroplaning problem on the segment of Route 6. Factors such as design elements of the specific roadway could result in drivers being able to recover from hydroplaning incidents without ever being involved in a crash.



	Exit 1 - Exit 2	Exit 2 - Exit 3	Exit 3 - Exit 4	Exit 4 - Exit 5	Exit 5 - Exit 6	Exit 6 - Exit 7	Exit 7 - Exit 8	Exit 8 - Exit 9	Exit 9 - Exit 10	Exit 10 - Exit 11	Exit 11 - Exit 12	Exit 12 - Rotary
EB	3	0	1	3	13	0	0	0	2	0	0	1
WB	1	1	1	1	3	9	2	4	0	2	1	0

FIGURE 4: LOCATION OF WET WEATHER CRASHES UNRELATED TO RAMP TRAFFIC

To further investigate locations where hydroplaning may be resulting in unsafe locations, a field investigation of ponding conditions during rain events was conducted during the summer of 2013. The intent of this "puddle inventory" was to identify locations where there may or may not be a documented crash history, where ponding is resulting in conditions that could result in hydroplaning incidents. A complete description of puddle inventory methodology is provided in Appendix B of this report. The degree to which ponding is present in the roadway is a function of both the duration and the depth of rain that falls in a specific period of time, also referred to as intensity. The puddle inventory covered rain events varying in both duration and intensity. Overall, the puddle inventory was developed during rain events that resulted in 0.6 to 2.8 inches over a 24 hr. period of storm event. Figure 5 and Figure 6 present a summary of results for the puddle inventory considering the eastbound and westbound direction of Route 6 between each exit.

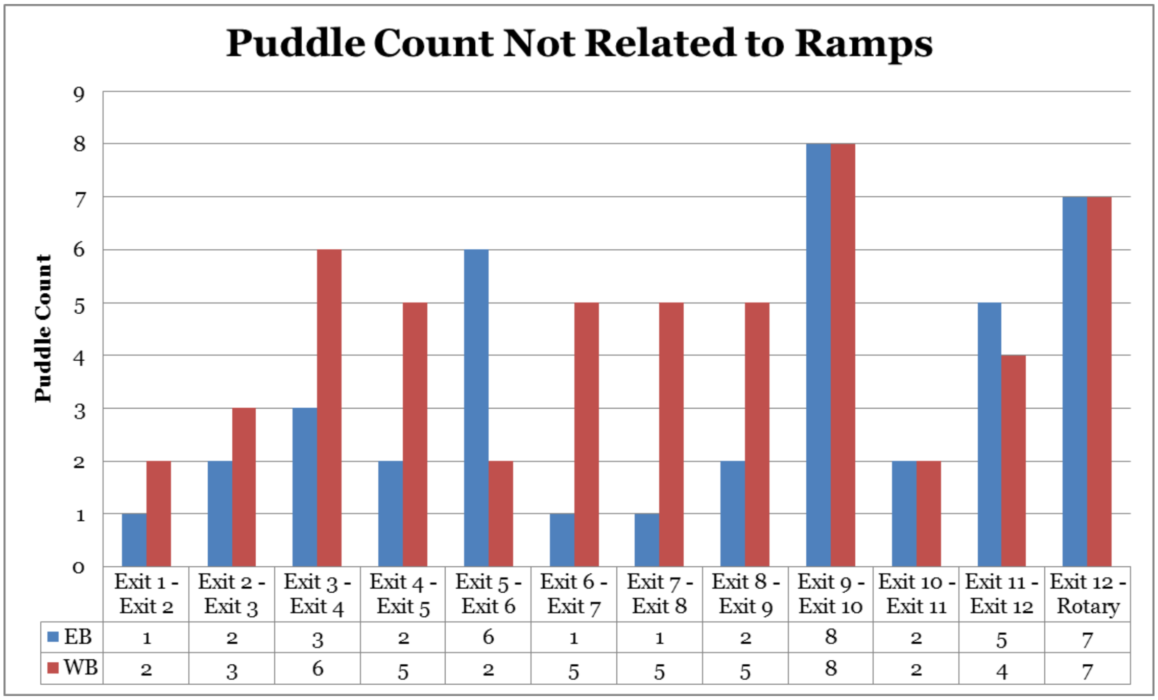


FIGURE 5: PUDDLE COUNT DURING RESEARCH STUDY PERIOD (JUNE – AUGUST, 2013)

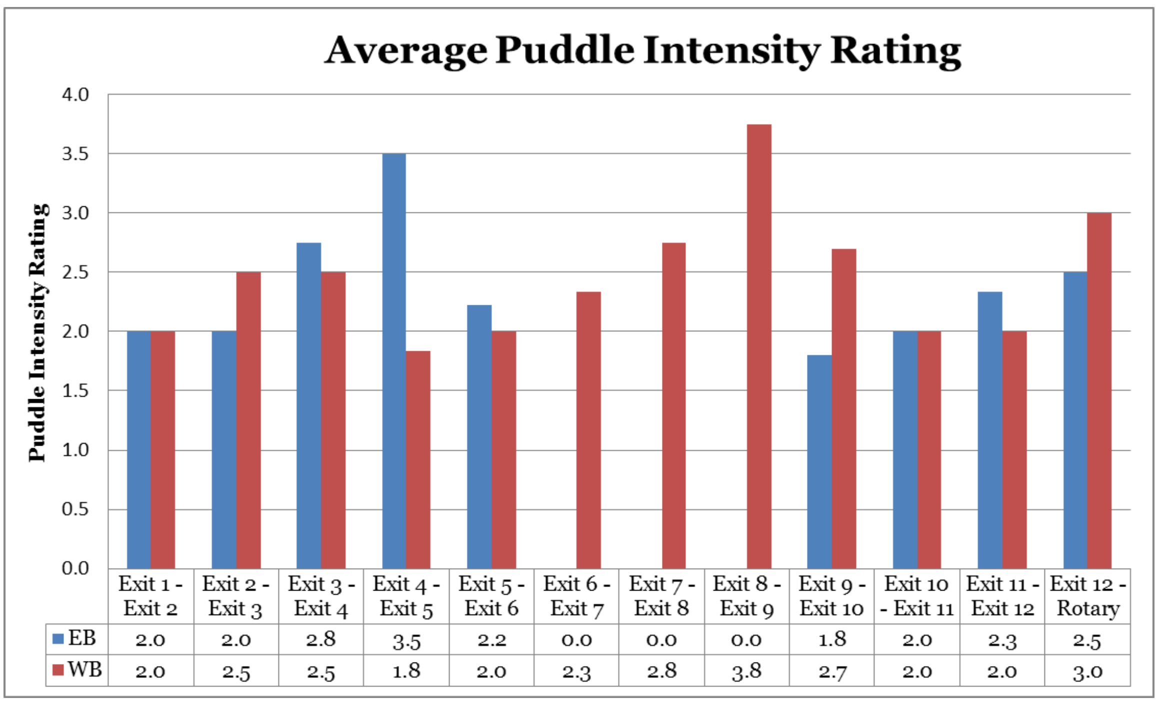


FIGURE 6: AVERAGED PUDDLE INTENSITY RATINGS DURING RESEARCH STUDY PERIOD (JUNE – AUGUST, 2013)

The data collected through the crash analysis and the puddle inventory, as well as the results of research on the nitrogen sensitivity (Figure 1) of the impacted water sheds, is depicted on the maps on the following pages.

Overall, the greatest number of wet weather crashes occurred between Exits 5 and 7 with the eastbound lanes between Exits 5 and 6 and the westbound lanes between Exits 6 and 7 containing the majority of the crashes. While puddle counts are higher in Segments 3 and 4, crash data shows that the risks of wet weather accidents are relatively low. As discussed in the Characterization of Route 6 Existing Conditions section and summarized in Table 1, Segments 3 and 4 are 2 lane undivided roadways. These sections have lower posted speed limits and tend to have reduced driving speeds during periods of higher traffic volume. As shown in Figure 10 the largest puddle, covering both driving lanes, occurs between Exits 10 and 11 westbound indicating increased severity of puddles for Segment 3. These factors, along with other differences in roadway design, may account for reduced speeds and minimized crash risk as compared to the faster four-lane divided Segments 1 and 2.

Figures 7 – 9 depict a summation of crashes per mile long stretch of roadway (both east and west bound) and roadway puddles locations and ratings. Puddle ratings, discussed in Appendix B, determine the severity of the puddle with respect to puddle location and width across the roadway and any noticeable effect on traffic.

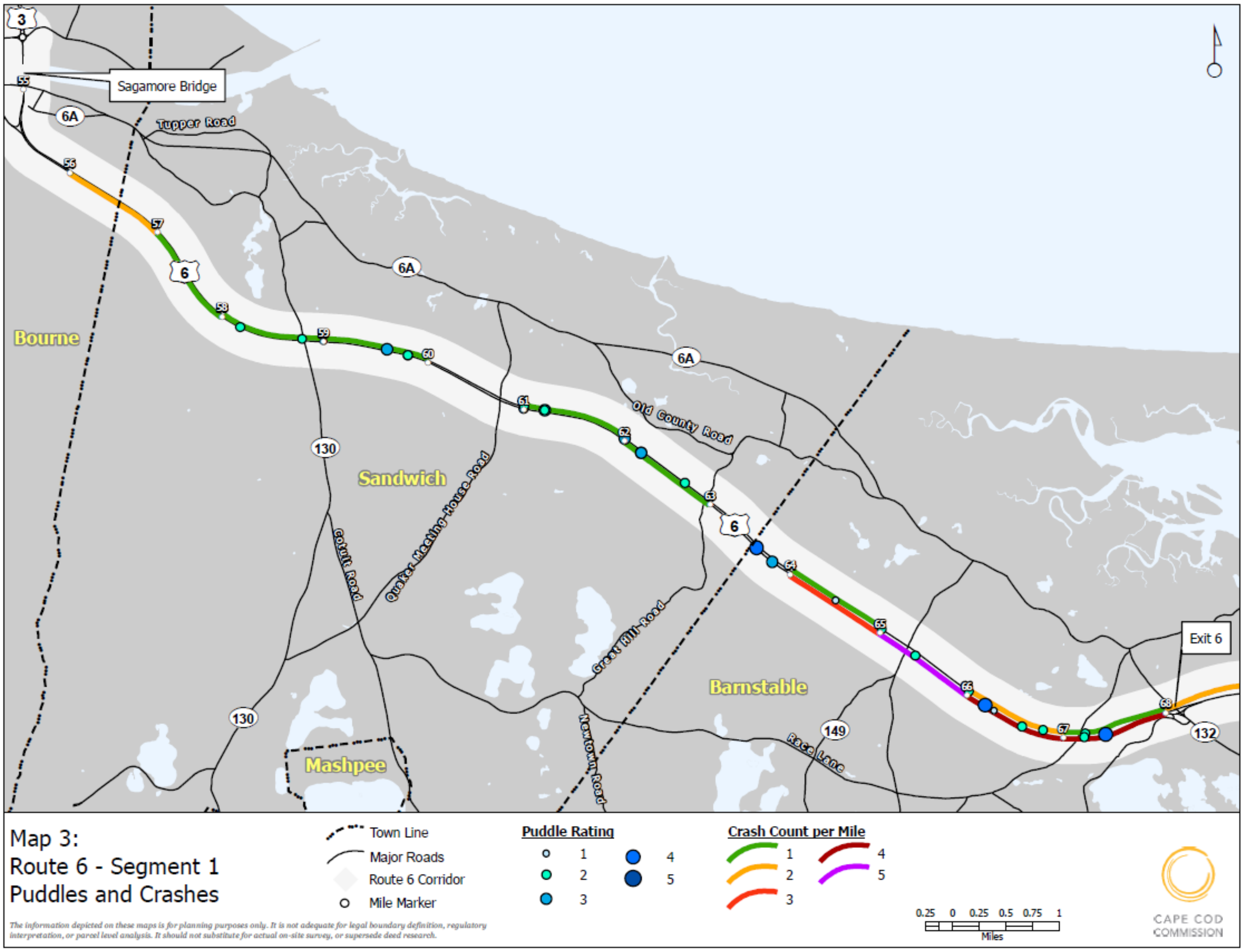


FIGURE 7: ROUTE 6 - SEGMENT 1: CRASH AND PUDDLE ANALYSIS

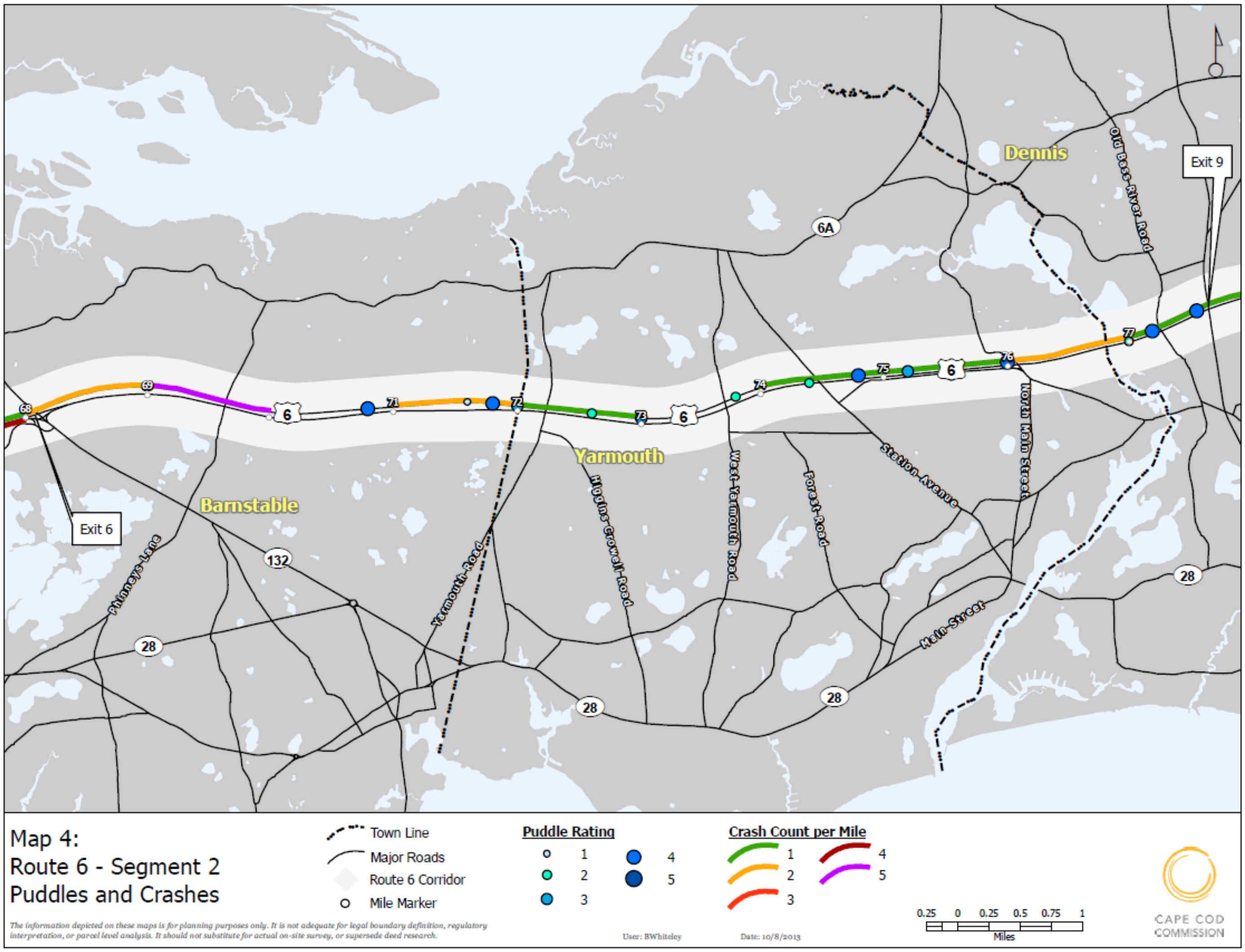


FIGURE 8: ROUTE 6 - SEGMENT 2: CRASH AND PUDDLE ANALYSIS

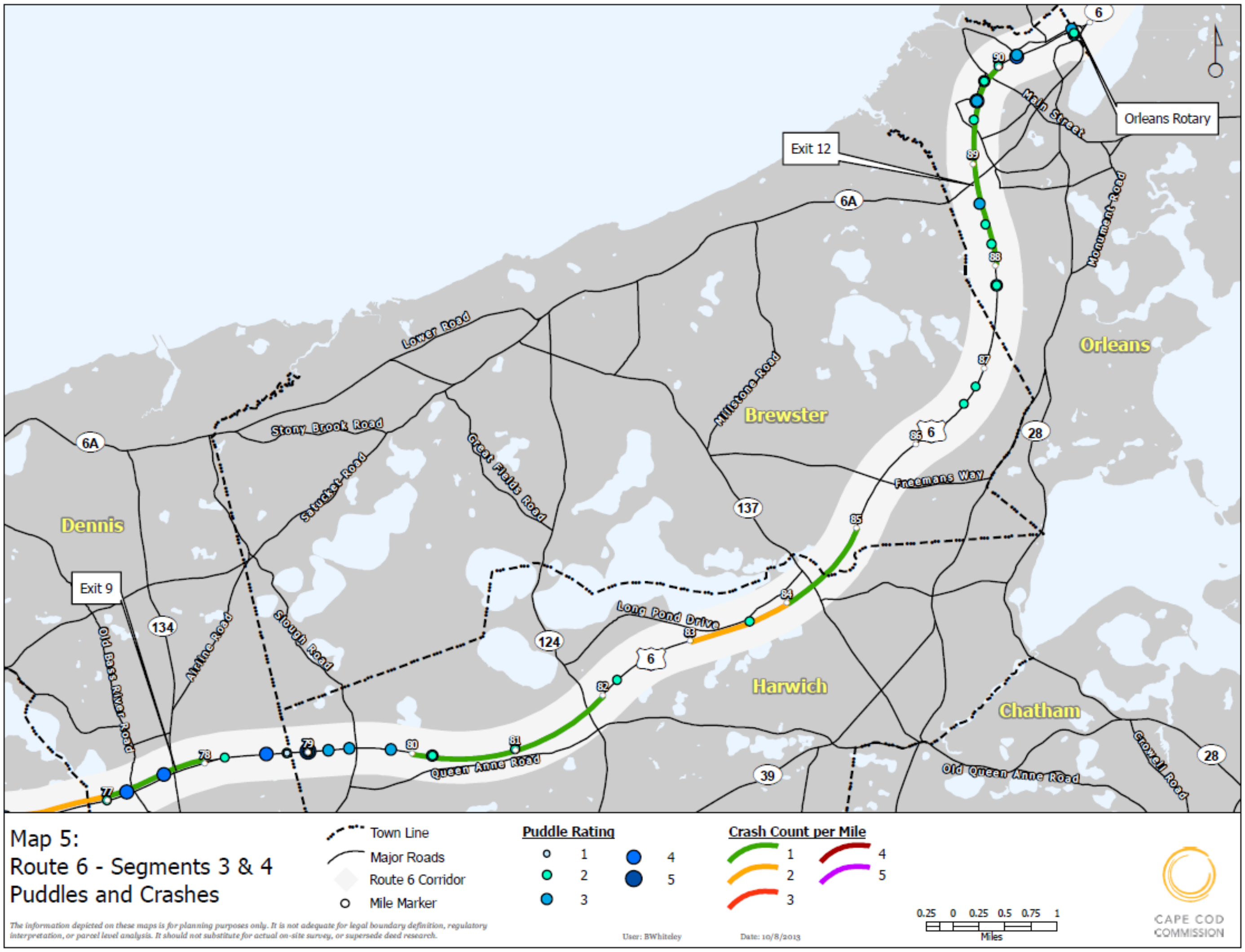


FIGURE 9: ROUTE 6 - SEGMENT 3-4: CRASH AND PUDDLE ANALYSIS

Task 2 – Stormwater Management - State of the Practice Review

Urban stormwater management has evolved over time from the early combined wastewater/stormwater and flood control systems, to a waterways protection tool, and most recently into systems which are designed to closely mimic the natural hydrology of an area to protect water quality and minimize flooding. This evolution has taken place over generations with both stormwater science and expanded regulation contributing to current stormwater practices.

The current state of practice for stormwater management exists in three categories of treatment technologies; conventional, manufactured or proprietary and Low Impact Development (LID). Conventional Treatment strategies have been used for decades within the field of stormwater management and consist primarily of onsite conveyance and storage technologies. Conventional conveyance may include piping networks and stone, bermed or vegetated swales, while conventional storage technologies include retention/detention ponds and catch basins. Manufactured systems consist of a wide variety of technologies including but not limited to catch basin inserts, sub-surface storage, hydrodynamic separators and systems promoting sedimentation and filtration. Manufactured treatment systems often are designed for LID approaches such as tree box filters, infiltration systems and porous pavers. LID is a method for development and re-development that mimics natural systems to facilitate the management of stormwater runoff. LID utilizes a range of strategy options including land conservation, recognition of natural resources buffers, minimizing effective impervious cover and utilizing appropriate structural best management practices. Proper use and integration of these approaches create functional and appealing site drainage systems that treat stormwater as a resource rather than a waste product. Structural LID best management practices include gravel wetlands, bioretention systems (also known as rain gardens), tree filters, sand filters and porous pavements. Applied on a broad scale, LID can maintain or restore a watershed's hydrologic and ecological functions.

Progress in the field of stormwater management has been facilitated by federal regulations stemming from the seminal 1972 amendments to the Federal Water Pollution Control Act known as the Clean Water Act (CWA). In general, the CWA prohibits discharge of pollutants to navigable waters from a point source unless authorized through the National Pollution Discharge Elimination System (NPDES). Stemming from the CWA the Water Quality Act (WQA) of 1987 created the framework for current regulations. These regulations were put forth in two increments (Phase I and Phase II) and were written to include an expanded scope of stormwater discharge permits previously exempted in the CWA. Expanded uses include industrial stormwater and municipal separate storm sewer systems (MS4's) serving a population over 100,000.

Based off of the 1987 WQA, the Environmental Protection Agency (EPA) initiated Phase I of the National Stormwater Permit Program. Phase I required NPDES permits for industrial stormwater, the above mentioned MS4 communities and construction sites greater than 5 acres (EPA, 2000). Between the initiation of Phase I and Phase II of the 1987 WQA the EPA issued a strategy where municipalities were required to address combined sewer overflow (CSO) systems, a form of stormwater/wastewater management in existence since the early to mid-nineteenth century. Phase II became effective in 2003 and further broadened the scope for controls on stormwater to include MS4 communities serving a population less than 100,000, construction sites of 1 acre or more and large property owners (EPA, 2000). In addition, Phase II considers MassDOT to be an operator of MS4's and, as such, MassDOT must meet all requirements for MS4's as defined under the Phase II rule.

Recent storm records and predictions for storm activity in the coming years suggest that roadways in Massachusetts should be designed to accommodate higher intensity storm events (MCCAR, 2011). The Massachusetts Climate Change Adaptation Report also cites evidence that by 2050 annual precipitation in Massachusetts may increase by 8%, with a winter increase of 16% (accompanied by a decrease in snow days and an increase in winter rain precipitation). These climate predictions suggest that future planning for stormwater management should consider increased volumes of water on Massachusetts roadways.

Task 3 – Alternatives Development

ALTERNATIVE 1: EXPANDED SHOULDER

Road Shoulders help convey design runoff from the driving lanes. Roadways with relatively high traffic volumes and speeds lacking proper shoulder width to convey runoff may increase the risk of hydroplaning. Where feasible, creating or expanding a paved shoulder along Route 6 may provide the dual function of facilitating stormwater conveyance off the roadway surface and providing a safe breakdown area for motorists. Shoulders must be properly sloped to drain away from pavement.

Expanded shoulders are not recommended throughout the study area. Sections of Route 6 pass through areas of significant topography; creating or expanding shoulders will require extensive clearing and grading in these areas, resulting in a significant change in the wooded character of the roadway. New grading along the roadway edge may also open up views to development now abutting the ROW, and reducing the noise and visual buffer to this development. Changes to the Route 6 buffer could potentially affect residences along the entire study corridor. There are discrete segments where changes to the roadway buffer within the ROW could have less significant visual and noise impacts; these segments are where currently undeveloped lands abut the ROW, including some municipal and state protected open space lands.

In addition to improving runoff conveyance the shoulder would improve overall safety by providing a safer pull-off area for disabled vehicles or vehicle yielding right of way to an emergency vehicle. Additionally the shoulder would provide a greater recovery zone for vehicles avoiding an obstacle in the roadway or recovering from a loss of vehicular control.

ALTERNATIVE 2: REMOVE CURBING AND BERMING

Curbing is primarily used at the outside edge of pavement to contain surface runoff within the roadway and away from adjacent properties. Secondary and tertiary benefits of curbing include the prevention of slope erosion and roadside delineation.

In many instances, preventing runoff from exiting the road surface is an important goal when large quantities of runoff have the potential to affect adjacent property owners and protected natural resources. Curbing and berming may be unnecessary in areas where there are sufficient median and adjacent rights of way to capture roadway runoff. Where there is sufficient land area to capture roadway runoff excess curbing and berming may be an unnecessary preventative measure and counterproductive when attempting to minimize the potential for hydroplaning. Intermittent or complete removal of curbing and berms in applicable areas will reduce runoff build up and minimize drainage path lengths (discussed in Alternative 4).

When combined with a properly designed cross slope (Alternative 7) the complete removal of curbing and berms will promote country drainage and have minimal risk for slope erosion. Where curbing and berming must remain, drainage pathways may still be minimized by frequent curb cuts. Curb cuts capturing runoff from large drainage areas and long drainage path lengths must account for the increased energy and velocity of runoff to prevent erosion. This may be accomplished through a variety of stormwater controls including energy dissipaters such as vegetated filter strips, riprap aprons and riprap outlet basins. Curb cuts capturing runoff within nitrogen sensitive watersheds may utilize specific stormwater Best Management Practices (BMP's) addressing nutrient reduction. These systems (discussed in Alternative 9) may be placed down gradient of energy dissipaters to accept a more controlled flow.

ALTERNATIVE 3: SUBSTITUTE WATER QUALITY SWALES FOR CURB AND BERMING APPROACH

Where sufficient space is available, water quality swales may be used as a method of conveyance and treatment for stormwater flows. As a substitute for curbing and berming, roadside water quality swales paired with country drainage provide increased water quality benefits, mimic the natural landscape, are highly compatible with LID design, have minimal impact on wildlife and reduce driving hazards by keeping stormwater flows off of the roadway surface. As with expanded shoulders, decisions to site water quality swales within the roadway buffer should reflect consideration for environmental resources and abutting residences that may be adversely affected by reductions in the vegetated buffer to Route 6.

ALTERNATIVE 4: MINIMIZE DRAINAGE PATH LENGTHS

Long downhill grades where water is channelized through raised shoulders or berms increases stormwater velocity and quantity until release points are reached, such as a curb cut or a curve transition where flow turns to sheet flow across the roadway. As drainage path lengths increase, the effects of channelization are compounded. By minimizing drainage path lengths through frequent curb cuts, velocity and overall runoff volume with associated ponding are minimized. Catch basins, while a useful management tool for overall runoff reduction, should not be relied upon to minimize drainage path lengths. Due to improper placement, clogging and infrequent maintenance, catch basins are often unable to capture design volumes on busy roadways.

ALTERNATIVE 5: CONSIDER USING GREATER DESIGN FLOOD FREQUENCY

As discussed in the 2011 Massachusetts Climate Change Adaptation Report (MCCAR, 2011) addressing the resiliency and adaptability of infrastructure in the face of global climate change is of paramount concern. A 2010 study from the University of New Hampshire (Spierre and Wake) discussing trends in precipitation in the Northeastern United States indicates "that the occurrences of extreme precipitation events, and the intensity of rainfall, are increasing." The study shows that annual precipitation has increased since the late 1940's with the largest increases occurring in recent years. Researchers with the University of Massachusetts Boston Environmental, Earth and Ocean Science Department analyzed trends in precipitation from 1954 to 2008. Findings in the study strongly suggest the need for updating of design storm estimates in Maine, New Hampshire and Massachusetts (Douglas and Fairbank, 2011).

The table below is an excerpt from Chapter 8 of the Mass Highway Design Manual, 2006 Edition and shows the recommended design flood frequencies for drainage systems by highway functional class. With trends showing an increase in event intensity and frequency, consideration should be taken to use greater design flood frequency values in areas of increased hydroplaning risk.

TABLE 2: EXHIBIT 8-2 FROM CHAPTER 8 OF THE MASS HIGHWAY DESIGN MANUAL

Exhibit 8-2
Recommended Design Flood Frequency[1]

		Type of Installation		
Highway Functional Class	**Urban/Rural**	**Cross Culverts**	**Storm Drain System[2]**	**Open Channels[3]**
Interstate/Freeway/Expressway	Both	50-yr	10-yr[4]	50-yr
Arterial	Urban	50-yr	10-yr[4]	50-yr
	Rural	50-yr	10-yr[4]	50-yr
Collectors/Local	Urban	25-yr[5]	5-yr	25-yr[5]
	Rural	10 or 25-yr	2 or 5-yr	10 or 25-yr

1. The values in the table are typical ranges. The selected value for a project is based on an assessment of the likely damage of a given flow and the costs of the drainage facility.
2. This includes pavement drainage design.
3. This includes any culverts which pass under intersecting roads, driveways, or median crossings.
4. Use a 50-yr frequency at underpasses or depressed sections where ponded water can only be removed through the storm drain system.
5. The selected frequency depends on the anticipated watershed development and potential property damage.

Source: HEC #1, March, 1969. Design of Highway Pavements, pp. 12-5 to 12-6. Note: HEC #12 — Revised, March, 1984.

Note: 100-year requirements must be checked if the proposed highway is in an established regulatory floodway or floodplain, or resource area is defined by the April, 1983 revisions to Ch. 131 MGL, Section 40. See Section 10.1.2.

ALTERNATIVE 6: PROPER MAINTENANCE OF ROADWAY AND STORMWATER CONTROLS

Proper roadway maintenance will minimize ponding potential within wheel ruts and damaged pavement sections. When partnered with scheduled upkeep of stormwater management controls (ie. catch basins and curb cuts), regular maintenance of the road surface will reduce the risk of hydroplaning and hydrodynamic drag.

ALTERNATIVE 7: PROVIDE ADEQUATE PAVEMENT CROSS SLOPE

Providing adequate cross slope on a roadway surface is one of the most effective ways to manage runoff. Selection of an appropriate cross slope for a roadway considers many factors including the design speed and weather patterns of the regions and must appropriately transition between and along the vertical and horizontal curvature of the roadway. Redesigning the roadway to improve drainage by adjusting the roadway cross slope would be very expensive and result in a significant disruption to vehicular travel. Such an approach would only be considered if a segment of roadway was already slated for reconstruction or if the existing cross slope was so poor that none of the other potential improvement alternatives would be effective.

ALTERNATIVE 8: UTILIZE ALTERNATE PAVEMENT SURFACE TEXTURES

For hydroplaning to occur the amount of fluid encountered by a tire must exceed the combined drainage capacity of the tire tread and pavement texture (Browne and Whicker, 1983). By applying a more permeable top pavement course water can drain more quickly and reduce the potential for hydroplaning. As stated in the Mass Highway Design Manual, 2006 Edition, "permeable surface friction courses such as Open Graded Friction Course (OGFC) permit water to drain from the driving surface below the tire-pavement interface. This reduces hydroplaning, tire spray and tire noise while improving skid resistance and visibility." As the design manual goes on to note "several types of OGFC have been placed on Interstate and limited access highways in Massachusetts."

One reason that OGFC has not been more widely used is that there have historically been durability issues with OGFC; however, more recently, mix improvements, particularly a polymer modified version (OGFC-P) has shown improved durability. If application of OGFC-P can be worked into the normally scheduled re-paving schedule of the roadway the cost of this alternative approach can be minimal.

ALTERNATIVE 9: STORMWATER CONTROLS ADDRESSING NUTRIENT REDUCTION

Effective nutrient reduction is achieved within stormwater control systems that encourage effective nutrient retention both through nutrient uptake within the root zones and through a biologically mediated conversion process. Systems vary with some providing solely uptake and nitrification within aerobic environments while certain technologies promote denitrification within anaerobic environments. A variety of stormwater controls addressing nutrient management include but are not limited to bio retention systems, gravel wetlands, and retention and detention ponds.

Bioretention is a method of treating stormwater where runoff infiltrates through vegetated systems followed by a sandy engineered soil mix encouraging sedimentation and nutrient reduction. Bioretention systems can easily be incorporated into the landscape to mimic and maintain many natural hydrologic functions. The predominance of sandy soils in Cape Cod will allow bioretention systems to be designed as infiltration systems further increasing the level of treatment possible. Properly designed bioretention systems have been shown to achieve 40% nitrogen removal on a yearly basis (UNHSC, 2012).

ALTERNATIVE 10: EDUCATION AND OUTREACH

Proper driver education and roadside signage will facilitate safe driving techniques in dangerous situations. In areas of high risk, as shown in Figure 4, wet weather hazard signs could encourage motorists to reduce speeds and heighten driver awareness. In addition, roadside warnings on the dangers of driving with balding or improperly inflated tires may educate motorists during a wet weather event.

Preferred Alternatives

SEGMENT SUMMATION: SAGAMORE BRIDGE TO ORLEANS ROTARY

CLIMATE AWARENESS: With trends showing an increase in event intensity and frequency (Alternative 5), consideration should be taken to use greater design flood frequency values in areas of increased hydroplaning risk. As the potential effects put forth in Alternative 5 will have a broad effect on not just Cape Cod but all of New England, it is considered a preferred alternative for each segment of this study.

EDUCATION AND OUTREACH: Heightened awareness of wet weather travel hazards affect each study Segment and should be utilized in a wide variety of ways wherever possible. As such, Alternative 10 is considered a preferred alternative for each segment of this study.

ROADWAY IMPROVEMENTS AND MAINTENANCE: Alternatives 6, 7 and 8, discussing roadway improvements and proper maintenance, can be used in conjunction with the primary recommendations from each section to further reduce hydroplaning and hydrodynamic drag risk.

A summary of the preferred alternatives for each study segment is provided in Table 7 at the end of this section.

SEGMENT 1: SAGAMORE BRIDGE TO EXIT 6

The main issue of concern for Segment 1 is the high number of wet weather related crashes. As discussed in the Route 6 Crash Analysis section, Segment 1 has the highest number of crashes within the study area, and that the crashes are clustered between exits 5 and 6 in the eastbound travel lane.

ROADWAY IMPROVEMENTS: Improper stormwater controls and lack of maintenance contribute to inadequate stormwater management. Due to the high number of crashes between Exits 5-6 eastbound, the primary goal is to eliminate stormwater runoff from the road surface through removal of curbing and berming (Alternative 2). In the absence of removal of curbing/berming, minimizing stormwater drainage path lengths (Alternative 4) with curb cuts in lieu of or in addition to catch basins would facilitate reduction in stormwater. As mentioned in the discussion of Alternatives above, expanded shoulders in areas of high crash risk would facilitate movement of stormwater off the roadway, and greatly improve safety.

STORMWATER BMP'S: While Segment 1 lacks mapped nitrogen sensitive watersheds, Route 6 intersects several Wellhead Protection Areas (WHPA) between exits 2 and 4 (Figure 1). As such, this area is not of paramount concern for nitrogen management and Alternative 9 is not recommended for this segment. However, WHPAs are particularly sensitive to the release of hazardous materials and petroleum products from potential releases occurring on Route 6. As such, implementing stormwater management improvements should be prioritized for these sensitive sections contributing to our drinking water supply.

ENVIRONMENTAL IMPACT: The primary recommendations for the Segment 1 area include Alternative 2: Remove Curbing, Alternative 4: Minimize Path Lengths, and Alternative 1: Expand Road Shoulder. Alternatives 2 and 4 will have a very minor footprint of disturbance as they involve alterations within the existing road surface area. Consequently, these alternatives will have little adverse impact on the environment. Alternative 1, Expand Road Shoulder, is a recommended alternative for this segment, but only in areas where additional roadside clearing and grading can be minimized and/or will not adversely affect the existing environment. Careful consideration of appropriate areas to expand the shoulder will minimize impacts to the environment and neighboring residences. Considerations for siting shoulder expansions should include: nearby wetlands, water bodies, rare species habitat, extremes in topography, and vegetated buffers to residences.

TABLE 3: SEGMENT 1 SUMMARY DATA

Segment 1	Crashes		Puddles	
	EB	WB	EB	WB
Exit 1 - Exit 2	3	1	1	2
Exit 2 - Exit 3	0	1	2	3
Exit 3 - Exit 4	1	1	3	6
Exit 4 - Exit 5	3	1	2	5
Exit 5 - Exit 6	13	3	6	2

SEGMENT 2 – EXIT 6 TO EXIT 9

The main issue for Segment 2 is primarily within the westbound travel lane. While the eastbound lane has a low number of puddles and no recorded crashes, the westbound travel lane has puddles and crashes, and should be the primary focus of improvements in this segment.

ROADWAY IMPROVEMENTS: A primary recommendation is facilitating country drainage through removal of curbing and berming (Alternative 2). In the absence of removal of curbing/berming, minimizing stormwater path lengths with curb cuts in lieu of or in addition to catch basins would facilitate reduction in stormwater (Alternative 4). As mentioned in the discussion of Alternatives above, creating or expanding paved shoulders in areas of high crash risk, or taking advantage of areas where the road shoulder is already cleared to create a paved shoulder, could facilitate movement of stormwater off the roadway and greatly improve safety (e.g. on the north side of the westbound travel lane between Exits 7 and 6). Segment 2, with the second highest number of crashes in this study, should utilize an expanded shoulder (Alternative 1) where possible to address safety concerns. As discussed in the Environmental Impacts section from Segment 1, Alternative 1 should only be implemented where expanded shoulders will not adversely affect the environment and neighboring residences.

Special drainage considerations should be taken in areas of low elevation (Figure 2). In areas with a high groundwater table many methods of infiltration may not be appropriate and an increased level of effort should be placed on improving water quality areas which quickly access groundwater.

STORMWATER BMP'S: Nearly the entire length of Segment 2 contributes to Wellhead Protection Areas (Figure 1) in addition to portions of Segment 2 contributing to the Bass River watershed, a nitrogen sensitive area requiring stringent reductions in nitrogen loading. Where nitrogen sensitive watersheds and Wellhead Protection Areas overlap, special consideration should be taken to address nitrogen reduction. Furthermore, reducing the potential for the potential release of hazardous materials within WHPAs is an important consideration for prioritizing remedial roadway improvements.

The Bass River Watershed Segment 2 of Route 6 travels through Hamblin Brook Gauge, Mill Pond, Mill Stream, North Yarmouth Wells, Follins Pond, Dinah's Pond, Kelley's Bay, Northwest Dennis wells and Bass River Mid watersheds. The majority of these contributing watersheds lie between Exits 7 and 9 with multiple watersheds requiring a 100% reduction in the septic contribution of nitrogen to meet nitrogen loading thresholds. In these sensitive watersheds stormwater controls as mentioned in Alternative 9 should be utilized to the maximum extent practicable. While nutrient reduction should be addressed on both east and westbound travel lanes special consideration should be given to the eastbound lane as water quantity control is not of as great a concern. Investing in water quality management within this Segment of Route 6 is strongly recommended, and will help address local, regional, and state responsibilities for nutrient management within these sensitive watersheds.

ENVIRONMENTAL IMPACTS: The primary recommendations for the Segment 2 area include Alternative 9: Nutrient Management, Alternative 2: Remove Curbing, Alternative 4: Minimize Path Lengths, and Alternative 1: Expand Road Shoulder. Alternatives 2 and 4 will have a very minor footprint of disturbance as they involve alterations within the existing road surface area. Consequently, these alternatives will have little adverse impact on the environment. Alternative 1: Expand Road Shoulder is a recommended alternative for this segment, but only in areas where additional roadside clearing and grading can be minimized and/or will not adversely affect the existing environment. Careful consideration of appropriate areas to expand the shoulder will minimize impacts to the environment and neighboring residences. Considerations for siting shoulder expansions should include: nearby wetlands, water bodies, rare species habitat, extremes in topography, and vegetated buffers to residences.

Alternative 9: Stormwater BMPs is strongly recommended for stormwater improvements within this segment, as mentioned above, because of the BMPs' ability to remove nutrients. Consequently application of this alternative will have positive effects on the environment. However, placement of these BMPs should also reflect careful consideration of ancillary impacts on resources found along this segment of Route 6, including wetlands, water bodies, rare species habitat, extremes in topography, and vegetated buffers to residences. Much of Segment 2 includes wider median areas, and fewer areas where buffers to residences are a concern; therefore there may be more opportunities for creation of stormwater BMPs.

TABLE 4: SEGMENT 2 SUMMARY DATA

Segment 2	Crashes		Puddles	
	EB	WB	EB	WB
Exit 6 - Exit 7	0	9	1	5
Exit 7 - Exit 8	0	2	1	5
Exit 8 - Exit 9	0	4	2	5
Exit 9 - Exit 10	2	0	8	8

SEGMENT 3 – EXIT 9 TO 12

The main issue for this Segment is to address locations of severe ponding. As noted by field technicians the largest puddle in the entire study area spans the roadway between exits 10 and 11. Crash data shows that fewer crashes occur in this segment of the roadway, yet puddle and anecdotal data shows the highest quantity and intensity of puddles of any segment along Route 6. The design and character of this segment of the roadway changes significantly from previous segments, requiring a reduction in normal travel speeds due to the two lane road layout and absence of a vegetated median. Travelers familiar with the roadway may naturally reduce their speeds in poor travel conditions due to awareness of the potentially hazardous conditions.

ROADWAY IMPROVEMENTS: In areas with adequate Rights of Way and suitable topography, removal of curbing (Alternative 2) facilitating runoff to a receiving water quality conveyance swale (Alternative 3) will take advantage of country drainage and decrease risk of hydroplaning. Certain locations with extreme puddle formations (Figure 10) should be prioritized for consideration.

FIGURE 10: EAST OF EXIT 9 IN WESTBOUND LANE. PUDDLE COVERING ENTIRE DRIVING LANE.

STORMWATER BMP'S: The majority of Segment 3 is not located within high nitrogen removal watersheds. However, the entire stretch between exit 11 and 12 contributes to Wellhead Protection Areas (Figure 1) and a portion of Segment 3 west of exit 11 contributes to the Pleasant Bay watershed through the Lower Muddy Creek sub-watershed. As shown on Figure 1 Lower Muddy Creek requires a 100% reduction in the septic contribution of nitrogen. It is suggested that Alternative 9 be considered for the above mentioned sections of Segment 3.

ENVIRONMENTAL IMPACTS: The primary recommendations for the Segment 3 area include Alternative 2: Remove Curbing, and Alternative 3: Create Drainage Swales. Alternative 2 will have a very minor footprint of disturbance as it involves alterations within the existing road surface area. Consequently, this alternative will have little adverse impact on the environment. Alternative 3: Create Drainage Swales is a recommended alternative for this segment, but only in areas where additional roadside clearing and grading can be minimized and/or will not adversely affect the existing environment. Careful consideration of appropriate areas to create swales will minimize impacts to the environment and neighboring residences. Considerations for siting swales should include: nearby wetlands, water bodies, rare species habitat, extremes in topography, and vegetated buffers to residences.

Alternative 9: Stormwater BMPs is strongly recommended for stormwater improvements within the portion of this segment west of Exit 11 located within the Pleasant Bay watershed, as mentioned above, because of the BMPs' ability to remove nutrients. Consequently application of this alternative will have positive effects on the environment. However, placement of these BMPs should also reflect careful consideration of ancillary impacts on resources found along this segment of Route 6, including wetlands, water bodies, rare species habitat, extremes in topography, and vegetated buffers to residences.

TABLE 5: SEGMENT 3 SUMMARY DATA

Segment 3	Crashes		Puddles	
	EB	WB	EB	WB
Exit 10 - Exit 11	0	2	2	2
Exit 11 - Exit 12	0	1	5	4

SEGMENT 4 – EXIT 12 TO ROTARY

The main issue affecting this Segment is the quantity of puddles within the driving lane. This Segment has the second highest number of puddles from the Bridge to the Rotary and is the shortest segment in this study. It is hypothesized that the minimal number of wet weather crashes in this Segment is due to the reduced speeds from roadway layout, approach and exit from the Orleans Rotary and the high amount of puddles apparent on the roadway.

ROADWAY IMPROVEMENTS: For much of this Segment of Route 6 both east and westbound lanes are a high point with gently sloping shoulders to either side of the roadway. Removal of curb and berming (Alternative 2) will take advantage of the existing grade to enhance Rotary and Route 6 related drainage and ponding issues. In addition, the central area bounded by the traffic circle could be utilized as a stormwater retention area if curbing is removed and proper grading performed to allow access of stormwater into the interior of the circle.

STORMWATER BMP'S: West of the Rotary portions of Segment 4 contribute to Rock Harbor, an MEP identified watershed requiring a 79% reduction in septic nitrogen load. The entirety of the Rotary contributes to the Town Cove watershed requiring a 75% reduction in septic nitrogen load. Taking into account the adjacency of the Rotary to Town Cove and contributing surface waters to Rock Harbor, it is suggested that Alternative 9 be considered in these sections of Segment 4 to address nutrient reduction. As the number of crashes associated with the Rotary are relatively low and the number of puddles being some of the greatest in the provided crash study it is further suggested that stormwater improvements utilizing infiltration and storage capabilities be integrated to the Rotary hydroplaning improvements.

ENVIRONMENTAL IMPACTS: The primary recommendations for the Segment 4 area include Alternative 2: Remove Curbing, and Alternative 3: Create Drainage Swales. Alternative 2 will have a very minor footprint of disturbance as it involves alterations within the existing road surface area. Consequently, this alternative will have little adverse impact on the environment. As Segment 4 has limited ability to expand Alternative 3 is a recommended alternative where sections of the roadway have sufficient shoulder and buffer to adjacent properties. Considerations for siting swales should include: nearby wetlands, water bodies (i.e. Cedar Pond), rare species habitat, extremes in topography, and vegetated buffers to residences.

Alternative 9: Stormwater BMPs is strongly recommended for stormwater improvements within the portion of this segment, as mentioned above, because of the BMPs' ability to remove nutrients. Consequently application of this alternative will have positive effects on the environment. However, placement of these BMPs should also reflect careful consideration of ancillary impacts on resources found along this segment of Route 6, including wetlands, water bodies, rare species habitat, extremes in topography, and vegetated buffers to residences.

TABLE 6: SEGMENT 4 SUMMARY DATA

Segment 4	Crashes		Puddles	
	EB	WB	EB	WB
Exit 12 - Rotary	1	0	7	7

TABLE 7: PREFERRED ALTERNATIVES SUMMARY

	Alternative 1	Alternative 2	Alternative 3	Alternative 4	Alternative 5	Alternative 6	Alternative 7	Alternative 8	Alternative 9	Alternative 10
Segment 1	×	×		×	×	×	×	×		×
Segment 2	×	×		×	×	×	×	×	×	×
Segment 3		×	×		×	×	×	×	×	×
Segment 4		×	×		×	×	×	×	×	×

Conclusion

Review of available data shows that under wet weather conditions predominant safety concerns occur between exits 5 and 7 with 52% of the study's total crashes. Segments 3 and 4 have widespread drainage issues and the most severe puddle covering both driving lanes between exits 10 and 11 westbound. Segment 2 traverses sub-watersheds requiring a 100% reduction in septic nitrogen within the Bass River Watershed. Preferred alternatives address the specific needs for each segment and provide suggestions to improve roadway surface and function, stormwater techniques to facilitate rapid removal of roadway runoff and methods to reduce the nitrogen contribution from Route 6 to the Bass River Watershed.

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APPENDIX A: SELECTION OF RAW CRASH DATA

Crash Number	Crash Date	Crash Time	City/Town	Locality	Crash Severity	Vehicle Travel Directions	Road Surface	Ambient Light	Weather Condition	Roadway	Distance And Direction From Exit Number	Exit Number	Milemarker	Traffic Way	Speed Limit	X	Y	Road Segment ID
2220253	5/20/2007	2:30 AM	BOURNE	BOURNE	Property damage only (none injured)	V1:E	Wet	Dark - roadway not lighted	Rain	Rte 6 E				Two-way, divided, positive median	55	280949.301	834687.072	63778
2220277	5/20/2007	2:30 AM	BOURNE	BOURNE	Not Reported/Unknown	V1:E	Wet	Dark - roadway not lighted	Rain	Rte 6		1		Two-way, divided, positive median	55	280957.041	834682.359	63778
2671337	12/13/2010	1:27 AM	SANDWICH	SANDWICH	Non-fatal injury	V1:E	Wet	Dark - roadway not lighted	Rain	Rte 6 E			57.8	Two-way, divided, positive median	55	282177.44	833294.34	335555
2114441	6/24/2006	12:00 AM	SANDWICH	SANDWICH	Property damage only (none injured)	V1:W	Wet	Dark - roadway not lighted	Cloudy/Clear	Rte 6 W	150 feet W of		58.2	Two-way, divided, positive median	55	283364.633	832634.792	337069
2198087	12/26/2006	2:10 AM	SANDWICH	SANDWICH	Property damage only (none injured)	V1:W	Wet	Dark - roadway not lighted	Cloudy/Cloudy	Rte 6 W	500 feet W of	2		Two-way, divided, unprotected median	65	283611.657	832614.9	337082
2076178	5/14/2006	6:30 AM	SANDWICH	SANDWICH	Property damage only (none injured)	V1:E	Wet	Daylight	Rain	Rte 6 E		2		Two-way, divided, positive median	0	283678.893	832593.99	335533
2225093	11/9/2006	1:00 AM	SANDWICH	SANDWICH	Non-fatal injury	V1:E	Wet	Dark - unknown roadway	Rain	Rte 6		2		Two-way, divided, positive median	0	283678.893	832593.99	335533
2235941	8/10/2007	3:00 PM	SANDWICH	SANDWICH	Property damage only (none injured)	V1:E / V2:E	Wet	Not reported	Rain	Rte 6 E		2		Two-way, divided, positive median	55	283678.893	832593.99	335533
2258601	10/11/2006	11:15 AM	SANDWICH	SANDWICH	Not Reported/Unknown	V1:E	Wet	Not reported	Rain	Rte 6		2		Two-way, divided, positive median	0	283678.893	832593.99	335533
2261723	11/16/2007	3:30 AM	SANDWICH	SANDWICH	Property damage only (none injured)	V1:E	Wet	Dark - roadway not lighted	Rain	Rte 6 E		2		Two-way, divided, positive median	55	283678.893	832593.99	335533
2314365	11/27/2007	1:05 AM	SANDWICH	SANDWICH	Property damage only (none injured)	V1:E	Wet	Dark - roadway not lighted	Rain	Rte 6 E		2		Two-way, divided, unprotected median	55	283678.912	832593.989	335533
2381277	12/2/2007	8:51 PM	SANDWICH	SANDWICH	Property damage only (none injured)	V1:W / V2:W	Wet	Dark - unknown roadway	Rain	Rte 6		2		One-way, not divided	0	283761.887	832609.448	337082
2410729	5/27/2008	7:08 AM	SANDWICH	SANDWICH	Property damage only (none injured)	V1:E / V2:E	Wet	Dawn	Rain	Rte 6 W		2		Two-way, divided, positive median	65	283761.887	832609.448	337082
2439706	12/12/2008	12:00 AM	SANDWICH	SANDWICH	Non-fatal injury	V1:8	Wet	Dark - roadway not lighted	Cloudy	Rte 6 W		2		Two-way, divided, positive median	60	283761.887	832609.448	337082
2237511	10/8/2007	1:30 PM	SANDWICH	SANDWICH	Property damage only (none injured)	V1:W / V2:W /	Wet	Daylight	Rain	Rte 6 W		2		Two-way, divided, unprotected median	60	283763.955	832609.383	337082
2195205	4/17/2007	9:25 AM	SANDWICH	SANDWICH	Property damage only (none injured)	V1:E / V2:E	Wet	Daylight	Rain/Cloudy	ROUTE 6A				Two-way, not divided	35	283768.622	832589.429	335533
2404612	4/12/2007	3:00 AM	SANDWICH	SANDWICH	Property damage only (none injured)	V1:W / V2:W	Wet	Daylight	Rain	Rte 6 W	3000 feet E of	2		Two-way, divided, positive median	0	284671.255	832528.854	337069
2053982	4/2/2006	10:00 PM	SANDWICH	SANDWICH	Property damage only (none injured)	V1:E	Wet	Dark - roadway not lighted	Clear/Clear	Rte 6 E		3		Two-way, divided, positive median	0	286520.631	831796.364	335505
2095643	6/24/2006	8:10 AM	SANDWICH	SANDWICH	Property damage only (none injured)	V1:E	Wet	Daylight	Rain/Cloudy	Rte 6 E		3	59.4	Two-way, divided, unprotected median	55	286520.631	831796.364	335505
2134029	12/4/2006	8:30 AM	SANDWICH	SANDWICH	Non-fatal injury	V1:E	Wet	Daylight	Cloudy/Snow	Rte 6 E		3		Two-way, divided, unprotected median	55	286520.631	831796.364	335505
2149260	1/5/2007	3:02 PM	SANDWICH	SANDWICH	Property damage only (none injured)	V1:W	Wet	Daylight	Rain/Rain	Rte 6 E		3		Two-way, divided, positive median	55	286520.631	831796.364	335505
2187876	4/27/2007	6:10 PM	SANDWICH	SANDWICH	Property damage only (none injured)	V1:E	Wet	Daylight	Rain/Rain	Rte 6 E		3		Two-way, divided, positive median	55	286520.631	831796.364	335505
2301224	3/28/2008	2:16 AM	SANDWICH	SANDWICH	Non-fatal injury	V1:E	Wet	Dark - roadway not lighted	Rain	Rte 6 E		3		One-way, not divided	55	286639.722	831732.732	335534
2336084	7/15/2007	9:30 AM	SANDWICH	SANDWICH	Property damage only (none injured)	V1:E	Wet	Dark - roadway not lighted	Rain	Rte 6		3		Two-way, divided, unprotected median	0	286639.722	831732.732	335534
2384463	3/16/2007	6:30 AM	SANDWICH	SANDWICH	Property damage only (none injured)	V1:8	Wet	Dark - roadway not lighted	Rain	Rte 6		3		Two-way, divided, positive median	0	286722.498	831724.799	337083
2366594	8/8/2008	7:13 PM	SANDWICH	SANDWICH	Property damage only (none injured)	V1:E / V2:E	Wet	Dusk	Cloudy	MID CAPE				Two-way, divided, positive median	55	286723.89	831724.157	337083
2220005	4/2/2007	6:40 AM	SANDWICH	SANDWICH	Property damage only (none injured)	V1:W	Wet	Dark - roadway not lighted	Rain/Rain	Rte 6 W	200 feet E of		61.4	Two-way, divided, positive median	55	287642.301	831499.665	337012
2236072	9/15/2007	7:35 AM	SANDWICH	SANDWICH	Property damage only (none injured)	V1:E	Wet	Daylight	Rain	Rte 6 E			62.8	Two-way, divided, positive median	55	289506.369	830409.698	334608
2194469	11/24/2006	2:30 AM	SANDWICH	SANDWICH	Property damage only (none injured)	V1:E / V2:E	Wet	Dark - roadway not lighted	Rain	Rte 6		4		Not reported	0	289736.339	830238.583	335646
2224426	7/18/2007	2:45 PM	BARNSTABLE	BARNSTABLE	Property damage only (none injured)	V1:E	Wet	Daylight	Rain	Rte 6		4		Two-way, divided, positive median	0	289736.364	830238.567	335646
2320421	4/17/2007	8:10 PM	SANDWICH	SANDWICH	Non-fatal injury	V1:E / V2:E	Wet	Dark - roadway not lighted	Rain	Rte 6		4		One-way, not divided	0	289736.364	830238.567	335646
2334547	6/2/2008	2:16 AM	SANDWICH	SANDWICH	Property damage only (none injured)	V1:E	Wet	Dark - roadway not lighted	Clear	Rte 6 E		4		Two-way, divided, positive median	55	289736.364	830238.567	335646
2133671	10/28/2006	11:05 AM	BARNSTABLE	BARNSTABLE	Non-fatal injury	V1:W	Wet	Daylight	Rain/Severe	Rte 6 W			63	Two-way, divided, positive median	55	289777.999	830240.183	337084
2313854	4/29/2008	4:22 PM	BARNSTABLE	BARNSTABLE	Property damage only (none injured)	V1:W	Wet	Daylight	Cloudy/Severe	Rte 6 W		4		Two-way, divided, unprotected median	55	289825.156	830205.973	337084
2410741	9/26/2008	11:40 AM	SANDWICH	SANDWICH	Property damage only (none injured)	V1:W	Wet	Daylight	Rain	Rte 6 W		4		Two-way, divided, positive median	55	289825.156	830205.973	337084
2274373	1/18/2008	8:05 AM	SANDWICH	SANDWICH	Property damage only (none injured)	V1:W	Wet	Daylight	Cloudy/Rain	Rte 6 W		4		Two-way, divided, unprotected median	55	289826.811	830204.793	337084
2188518	4/12/2007	3:15 PM	SANDWICH	SANDWICH	Non-fatal injury	V1:E	Wet	Daylight	Rain	MID CAPE	1500 feet E of	4		Two-way, divided, positive median	55	290096.725	829957.693	334704
2057627	5/9/2006	3:40 PM	BARNSTABLE	BARNSTABLE	Property damage only (none injured)	V1:W	Wet	Daylight	Rain/Cloudy	MID CAPE	5280 feet W of	5		Two-way, divided, positive median	55	291658.397	828755.395	30451
2279290	2/5/2008	12:45 PM	BARNSTABLE	BARNSTABLE	Non-fatal injury	V1:E	Wet	Daylight	Rain	Rte 6 E			64.7	Two-way, divided, unprotected median	55	291901.885	828551.901	24174
2066429	6/24/2006	4:55 PM	BARNSTABLE	BARNSTABLE	Non-fatal injury	V1:E / V2:E	Wet	Daylight	Rain	MID CAPE	2500 feet W of	5		Two-way, divided, positive median	55	292063.563	828445.719	24174
2188536	4/17/2007	6:55 PM	BARNSTABLE	BARNSTABLE	Property damage only (none injured)	V1:E	Wet	Dark - roadway not lighted	Rain	Rte 6 E	2500 feet W of	5		Two-way, divided, positive median	55	292128.261	828403.731	24174
2133746	11/17/2006	6:08 AM	BARNSTABLE	BARNSTABLE	Property damage only (none injured)	V1:E	Wet	Dawn	Rain/Severe	Rte 6 E		5		Two-way, divided, positive median	55	292702.122	828029.934	24174
2149096	1/19/2007	4:20 AM	BARNSTABLE	BARNSTABLE	Property damage only (none injured)	V1:E	Water	Dark - roadway not lighted	Rain/Other	Rte 6 E		5		Two-way, divided, positive median	55	292702.122	828029.934	24174
2188470	3/16/2007	6:23 PM	BARNSTABLE	BARNSTABLE	Property damage only (none injured)	V1:E	Wet	Dusk	Sleet, hail	Rte 6 E	200 feet W of	5		Two-way, divided, positive median	55	292715.491	828020.843	23073
2133350	10/28/2006	12:45 PM	BARNSTABLE	BARNSTABLE	Non-fatal injury	V1:W / V2:W	Wet	Daylight	Rain/Severe	Rte 6 W			64.8	Two-way, divided, positive median	55	292726.96	828077.138	30448
2213028	6/4/2007	2:16 AM	BARNSTABLE	BARNSTABLE	Property damage only (none injured)	V1:E	Wet	Dark - roadway not lighted	Rain	Rte 6 E		5		Two-way, divided, positive median	55	292766.589	827987.603	23077
2226038	7/6/2007	5:22 AM	BARNSTABLE	BARNSTABLE	Property damage only (none injured)	V1:E	Wet	Daylight	Rain	Rte 6 E		5		Two-way, divided, positive median	55	292766.589	827987.603	23077
2237552	9/15/2007	6:09 AM	BARNSTABLE	BARNSTABLE	Non-fatal injury	V1:E	Wet	Dawn	Rain	Rte 6 E		5		Two-way, divided, unprotected median	55	292766.589	827987.603	23077
2267195	12/19/2007	8:25 AM	BARNSTABLE	BARNSTABLE	Property damage only (none injured)	V1:E	Wet	Daylight	Cloudy	Rte 6 E		5		Two-way, divided, positive median	55	292766.589	827987.603	23077
2279113	1/27/2008	4:02 PM	BARNSTABLE	BARNSTABLE	Property damage only (none injured)	V1:E	Wet	Daylight	Snow	Rte 6 E		5		Two-way, divided, unprotected median	55	292766.589	827987.603	23077
2280849	2/1/2008	2:27 PM	BARNSTABLE	BARNSTABLE	Non-fatal injury	V1:E	Wet	Daylight	Cloudy/Rain	Rte 6 E		5		Two-way, divided, positive median	55	292766.589	827987.603	23077
2301776	2/26/2008	8:56 PM	BARNSTABLE	BARNSTABLE	Non-fatal injury	V1:E	Water	Dark - roadway not lighted	Rain	Rte 6 E		5		Two-way, divided, positive median	55	292766.602	827987.594	23077
2395677	11/16/2008	4:33 AM	BARNSTABLE	BARNSTABLE	Non-fatal injury	V1:E	Wet	Dark - roadway not lighted	Rain	Rte 6 E		5		Two-way, divided, positive median	55	292766.602	827987.594	23077
2334027	5/16/2008	8:50 PM	BARNSTABLE	BARNSTABLE	Non-fatal injury	V1:W	Wet	Dark - roadway not lighted	Rain	Rte 6 W		5		Two-way, divided, positive median	55	292868.594	827984.648	30551
2342086	6/23/2008	7:28 PM	BARNSTABLE	BARNSTABLE	Non-fatal injury	V1:W	Water	Dusk	Rain	Rte 6 W		5		Two-way, divided, positive median	55	292868.594	827984.648	30551
2381210	9/26/2008	10:12 AM	BARNSTABLE	BARNSTABLE	Property damage only (none injured)	V1:W	Water	Daylight	Rain	Rte 6 W		5		Two-way, divided, unprotected median	55	292868.594	827984.648	30551
2188403	2/26/2007	8:40 AM	BARNSTABLE	BARNSTABLE	Non-fatal injury	V1:W	Wet	Daylight	Rain/Cloudy	MID CAPE		5		Two-way, divided, unprotected median	55	292870.289	827983.525	30551
2203582	10/1/2006	4:30 PM	BARNSTABLE	HYANNIS	Property damage only (none injured)	V1:W / V2:W	Wet	Dusk	Rain	Rte 6 W		5		One-way, not divided	0	292870.289	827983.525	30551
2213027	6/3/2007	9:20 AM	BARNSTABLE	BARNSTABLE	Non-fatal injury	V1:W	Water	Daylight	Rain	Rte 6 W		5		Two-way, divided, positive median	55	292870.289	827983.525	30551

Crash Number	Crash Date	Crash Time	City/Town	Locality	Crash Severity	Vehicle Travel Directions	Road Surface	Ambient Light	Weather Condition	Roadway	Distance And Direction From Exit Number	Exit Number	Milemarker	Traffic Way	Speed Limit	X	Y	Road Segment ID
2219466	5/16/2007	9:57 PM	BARNSTABLE	BARNSTABLE	Property damage only (none injured)	V1:E	Water	Dawn	Cloudy/Cloudy	MID CAPE	500 feet E of	5		Two-way, divided, positive median	55	292892.818	827902.25	27008
2188396	2/14/2007	1:28 PM	BARNSTABLE	BARNSTABLE	Property damage only (none injured)	V1:W	Wet	Daylight	Rain/Cloudy	MID CAPE	100 feet E of	5		Two-way, divided, unprotected median	55	292893.978	827967.814	30551
2133979	11/23/2006	2:00 PM	BARNSTABLE	BARNSTABLE	Non-fatal injury	V1:E / V2:E	Wet	Daylight	Rain	MID CAPE	60 feet W of		65	Two-way, divided, positive median	55	292894.69	827900.969	24174
2219473	5/20/2007	7:25 PM	BARNSTABLE	BARNSTABLE	Property damage only (none injured)	V1:W	Wet	Dusk	Rain	MID CAPE				Two-way, divided, positive median	0	293013.031	827887.625	30551
2133794	12/1/2006	4:25 AM	BARNSTABLE	BARNSTABLE	Non-fatal injury	V1:W	Wet	Dark - roadway not lighted	Cloudy/Rain	MID CAPE		5		Two-way, divided, unprotected median	55	293013.183	827887.505	30448
2149087	1/13/2007	11:30 AM	BARNSTABLE	BARNSTABLE	Property damage only (none injured)	V1:E	Wet	Daylight	Rain	MID CAPE	2640 feet E of	5		Two-way, divided, positive median	0	293355.983	827561.594	24174
2188540	4/15/2007	11:25 PM	BARNSTABLE	BARNSTABLE	Non-fatal injury	V1:E	Water	Dark - roadway not lighted	Rain/Rain	Rte 6 E	2640 feet E of	5		Two-way, divided, positive median	55	293417.309	827514.82	24163
2188544	4/17/2007	9:10 PM	BARNSTABLE	BARNSTABLE	Non-fatal injury	V1:E / V2:E	Wet	Dark - roadway not lighted	Rain/Cloudy	MID CAPE	2640 feet E of	5		Two-way, divided, positive median	55	293417.309	827514.82	24163
2258921	11/15/2007	11:48 PM	BARNSTABLE	BARNSTABLE	Non-fatal injury	V1:E	Water	Dark - roadway not lighted	Rain	MID CAPE		5		Two-way, divided, unprotected median	55	293523.677	827435.708	24163
2334029	5/17/2008	1:22 AM	BARNSTABLE	BARNSTABLE	Property damage only (none injured)	V1:E	Wet	Dark - roadway not lighted	Rain	Rte 6 E			66	Two-way, divided, positive median	55	293621.031	827361.578	24163
2603252	5/19/2010	2:10 AM	BARNSTABLE	BARNSTABLE	Property damage only (none injured)	V1:E	Wet	Dark - roadway not lighted	Cloudy/Rain	Rte 6 E			66.2	Two-way, divided, positive median	55	293881.094	827186.265	24163
2603253	5/19/2010	5:56 AM	BARNSTABLE	BARNSTABLE	Non-fatal injury	V1:E	Wet	Dawn	Cloudy/Rain	Rte 6 E			66.2	Two-way, divided, positive median	55	293881.094	827186.265	24163
2133387	11/8/2006	5:46 PM	BARNSTABLE	BARNSTABLE	Property damage only (none injured)	V1:E	Wet	Dark - roadway not lighted	Cloudy/Rain	MID CAPE	5280 feet E of	5		Two-way, divided, positive median	55	294017.219	827104.802	24163
2133986	11/24/2006	12:00 AM	BARNSTABLE	BARNSTABLE	Non-fatal injury	V1:E	Water	Dark - roadway not lighted	Cloudy/Rain	Rte 6 E	5280 feet E of	5		Two-way, divided, positive median	55	294017.219	827104.802	24163
2057629	5/12/2006	11:45 PM	BARNSTABLE	BARNSTABLE	Non-fatal injury	V1:W / V2:W	Wet	Dark - roadway not lighted	Rain	MID CAPE	5280 feet E of	5		Two-way, divided, positive median	55	294337.941	826978.081	30555
2335139	6/15/2008	1:00 PM	BARNSTABLE	BARNSTABLE	Non-fatal injury	V1:W / V2:W	Wet	Daylight	Rain	Rte 6 W			66.6	Two-way, divided, positive median	55	294484.854	826892.958	30448
2258888	10/20/2007	1:40 AM	BARNSTABLE	BARNSTABLE	Property damage only (none injured)	V1:E	Wet	Dark - roadway not lighted	Rain	MID CAPE				Two-way, divided, positive median	55	295282.738	826617.125	27005
2114271	9/28/2006	9:00 PM	BARNSTABLE	BARNSTABLE	Property damage only (none injured)	V1:E / V2:E	Wet	Dark - roadway not lighted	Cloudy/Fog,	MID CAPE	2500 feet W of	6		Two-way, divided, positive median	0	295819.665	826645.846	24163
2161758	1/15/2007	11:02 AM	BARNSTABLE	BARNSTABLE	Non-fatal injury	V1:W	Wet	Daylight	Cloudy	MID CAPE	100 feet E of		67	Two-way, divided, positive median	0	295883.519	826741.927	30552
2094154	8/29/2006	9:55 PM	BARNSTABLE	BARNSTABLE	Non-fatal injury	V1:E	Wet	Dark - roadway not lighted	Cloudy	Rte 6 E	1500 feet W of	6		Two-way, divided, positive median	55	296102.855	826756.19	24163
2133721	11/1/2006	8:39 AM	BARNSTABLE	BARNSTABLE	Property damage only (none injured)	V1:E / V2:E /	Wet	Daylight	Rain	MID CAPE	300 feet W of	6		Two-way, divided, positive median	55	296439.019	826899.123	27005
2133201	10/23/2006	4:52 AM	BARNSTABLE	BARNSTABLE	Property damage only (none injured)	V1:W	Wet	Dark - roadway not lighted	Rain	Rte 6 W	2640 feet W of	6		Two-way, divided, positive median	55	296609.164	826977.921	30453
2372246	11/15/2007	11:50 PM	BARNSTABLE	BARNSTABLE	Non-fatal injury	V1:E	Wet	Dark - roadway not lighted	Rain	Rte 6		6		Two-way, divided, positive median	0	296827.413	827013.952	27000
2386987	12/7/2007	7:36 PM	BARNSTABLE	BARNSTABLE	Non-fatal injury	V1:E / V2:E	Wet	Dark - roadway not lighted	Rain	Rte 6		6		Not reported	0	296827.413	827013.952	27000
2265688	12/11/2007	11:35 PM	BARNSTABLE	BARNSTABLE	Fatal injury	V1:E / V2:E	Wet	Dark - roadway not lighted	Rain	Rte 6 E		6		Two-way, divided, positive median	55	296827.467	827013.968	27000
2270762	12/31/2007	1:09 AM	BARNSTABLE	BARNSTABLE	Property damage only (none injured)	V1:E	Wet	Dark - roadway not lighted	Rain	Rte 6 E		6		One-way, not divided	55	296827.467	827013.968	27000
2301779	3/8/2008	3:15 PM	BARNSTABLE	BARNSTABLE	Non-fatal injury	V1:W / V2:W	Wet	Daylight	Rain	Rte 6 W		6		Two-way, divided, positive median	55	296886.606	827064.511	30552
2301781	3/8/2008	10:18 PM	BARNSTABLE	BARNSTABLE	Property damage only (none injured)	V1:W	Wet	Dark - roadway not lighted	Rain	Rte 6 W		6		Two-way, divided, positive median	55	296886.606	827064.511	30552
2397401	11/19/2008	6:19 AM	BARNSTABLE	BARNSTABLE	Fatal injury	V1:W	Wet	Dawn	Cloudy/Sleet,	Rte 6 W		6		Two-way, divided, unprotected median	55	296886.606	827064.511	30552
2422301	2/22/2008	3:15 AM	BARNSTABLE	BARNSTABLE	Property damage only (none injured)	V1:W / V2:W	Wet	Daylight	Snow	MID CAPE		6		Not reported	0	296886.606	827064.511	30552
2258908	10/27/2007	5:50 AM	BARNSTABLE	BARNSTABLE	Property damage only (none injured)	V1:W / V2:W	Wet	Dark - roadway not lighted	Rain	Rte 6 W		6		Two-way, divided, positive median	55	296888.629	827065.236	30552
2260203	11/3/2007	10:15 PM	BARNSTABLE	BARNSTABLE	Property damage only (none injured)	V1:W	Water	Dark - roadway not lighted	Rain	Rte 6 W		6		Two-way, divided, positive median	55	296888.629	827065.236	30552
2015822	1/23/2006	12:03 PM	BARNSTABLE	BARNSTABLE	Property damage only (none injured)	V1:W	Wet	Daylight	Rain	MID CAPE	1500 feet W of	6		Two-way, divided, positive median	55	296939.755	827084.298	30454
2658777	11/7/2010	9:12 PM	BARNSTABLE	BARNSTABLE	Non-fatal injury	V1:W	Wet	Dark - roadway not lighted	Rain	Rte 6 W		6		One-way, not divided	55	297267.224	827220.121	30493
2015898	2/13/2006	11:15 AM	BARNSTABLE	BARNSTABLE	Property damage only (none injured)	V1:W / V2:W	Wet	Daylight	Clear	MID CAPE	100 feet W of	6		Two-way, divided, positive median	55	297335.105	827244.574	30454
2313994	11/1/2007	2:12 PM	BARNSTABLE	BARNSTABLE	Not Reported/Unknown	V1:E / V2:E	Wet	Dark - roadway not lighted	Sleet, hail	Rte 6 E		6		One-way, not divided	0	297363.406	827253.625	30493
2603251	5/18/2010	10:58 PM	BARNSTABLE	BARNSTABLE	Property damage only (none injured)	V1:W	Wet	Dark - roadway not lighted	Rain	Rte 6 W			68.8	Two-way, divided, positive median	55	297809.497	827359.631	451508
2149073	1/8/2007	7:37 AM	BARNSTABLE	BARNSTABLE	Property damage only (none injured)	V1:W	Wet	Daylight	Rain	Rte 6 W	2500 feet E of	6		Two-way, divided, positive median	55	298111.835	827385.977	30454
2188529	4/12/2007	6:40 PM	BARNSTABLE	BARNSTABLE	Property damage only (none injured)	V1:W	Wet	Dusk	Rain	MID CAPE	5260 feet E of	6		Two-way, divided, positive median	0	298440.941	827375.197	30454
2188549	4/27/2007	8:20 AM	BARNSTABLE	BARNSTABLE	Non-fatal injury	V1:W	Water	Daylight	Rain	MID CAPE	5280 feet E of	6		Two-way, divided, positive median	55	298447.004	827374.584	30454
2057592	1/31/2006	10:35 PM	BARNSTABLE	BARNSTABLE	Property damage only (none injured)	V1:W	Wet	Dark - roadway not lighted	Clear	MID CAPE	5280 feet E of	6		Two-way, divided, positive median	55	298949.106	827278.802	30593
2057625	5/2/2006	8:40 PM	BARNSTABLE	BARNSTABLE	Property damage only (none injured)	V1:W	Wet	Dark - roadway not lighted	Rain	MID CAPE	5280 feet E of	6		Two-way, divided, unprotected median	55	298949.106	827278.802	30593
2133711	10/28/2006	2:00 PM	BARNSTABLE	BARNSTABLE	Property damage only (none injured)	V1:W	Wet	Daylight	Rain	Rte 6 W	5280 feet E of	6		Two-way, divided, positive median	55	298949.106	827278.802	30593
2260183	10/8/2007	8:30 AM	BARNSTABLE	BARNSTABLE	Property damage only (none injured)	V1:W	Wet	Daylight	Rain	Rte 6 W			71.7	Two-way, divided, unprotected median	55	302432.399	827190.062	30553
2667633	11/8/2010	9:05 AM	BARNSTABLE	BARNSTABLE	Property damage only (none injured)	V1:W	Wet	Daylight	Sleet, hail	Rte 6 W			72	Two-way, divided, positive median	55	302914.482	827157.494	451517
2267198	12/23/2007	11:39 PM	YARMOUTH	YARMOUTH	Property damage only (none injured)	V1:E	Wet	Dark - roadway not lighted	Rain/Severe	Rte 6 E		7		Two-way, divided, positive median	55	303386.221	827069.263	447749
2133353	10/28/2006	1:40 PM	YARMOUTH	YARMOUTH	Property damage only (none injured)	V1:W	Wet	Daylight	Rain/Severe	Rte 6 W	1320 feet W of	7		Two-way, divided, positive median	55	303388.273	827108.269	451521
2133976	11/23/2006	1:18 AM	YARMOUTH	YARMOUTH	Non-fatal injury	V1:E	Wet	Dark - roadway not lighted	Cloudy/Rain	Rte 6 E	20 feet W of	7		Two-way, divided, positive median	55	303391.486	827068.829	27003
2133785	11/17/2006	6:00 AM	YARMOUTH	YARMOUTH	Property damage only (none injured)	V1:E	Wet	Daylight	Rain	MID CAPE		7		Two-way, divided, positive median	55	303397.561	827068.326	27003
2410376	12/16/2008	11:50 PM	YARMOUTH	YARMOUTH	Not Reported/Unknown	V1:W	Wet	Dark - roadway not lighted	Sleet, hail	Rte 6 W		7		Two-way, divided, positive median	55	303485.5	827098.306	451521
2258913	11/10/2007	12:00 AM	YARMOUTH	YARMOUTH	Non-fatal injury	V1:W	Wet	Dark - roadway not lighted	Rain	Rte 6 W		7		Two-way, divided, positive median	55	303487.582	827098.108	451521
2279117	2/1/2008	2:55 PM	YARMOUTH	YARMOUTH	Property damage only (none injured)	V1:W	Wet	Daylight	Rain	Rte 6 W		7		Two-way, divided, positive median	55	303487.582	827098.108	451521
2133739	11/12/2006	2:00 AM	YARMOUTH	YARMOUTH	Property damage only (none injured)	V1:E	Wet	Dark - lighted roadway	Cloudy	MID CAPE	50 feet W of		71.9	Two-way, divided, positive median	55	303493.56	827059.654	27003
2066375	5/10/2006	10:50 AM	YARMOUTH	YARMOUTH	Non-fatal injury	V1:W	Wet	Daylight	Rain/Fog, smog,	MID CAPE		7		Two-way, divided, unprotected median	55	303884.888	827060.138	451508
2133781	10/17/2006	7:43 PM	YARMOUTH	YARMOUTH	Property damage only (none injured)	V1:W	Wet	Dark - roadway not lighted	Rain/Unknown	Rte 6 W		7		Two-way, divided, positive median	30	303884.888	827060.138	451508
2188414	3/15/2007	7:55 PM	YARMOUTH	YARMOUTH	Non-fatal injury	V1:W	Wet	Dark - roadway not lighted	Rain	MID CAPE	2640 feet E of	7		Two-way, divided, positive median	55	304288.536	827021.136	451508
2675203	12/19/2010	8:30 PM	YARMOUTH	YARMOUTH	Non-fatal injury	V1:W	Wet	Dark - roadway not lighted	Rain/Snow	Rte 6 W			74.2	Two-way, divided, unprotected median	55	306374.809	827403.906	117169
2255352	4/3/2007	12:20 PM	YARMOUTH	YARMOUTH	Property damage only (none injured)	V1:E / V2:E	Wet	Not reported	Cloudy	Rte 6 E	1000 feet W of	8		Two-way, divided, positive median	55	306633.747	827399.707	449679
2226704	8/28/2006	1:30 PM	YARMOUTH	WEST	Non-fatal injury	V1:8 / V2:8	Wet	Daylight	Clear	MID CAPE				Not reported	0	306641.375	827400.938	449679
2293092	2/7/2008	3:10 PM	YARMOUTH	YARMOUTH	Property damage only (none injured)	V1:E	Wet	Daylight	Rain/Sleet, hail	Rte 6 E		8		Two-way, divided, positive median	55	306936.253	827436.321	449678

Crash Number	Crash Date	Crash Time	City/Town	Locality	Crash Severity	Vehicle Travel Directions	Road Surface	Ambient Light	Weather Condition	Roadway	Distance And Direction From Exit Number	Exit Number	Milemarker	Traffic Way	Speed Limit	X	Y	Road Segment ID
2314479	4/21/2008	10:58 PM	YARMOUTH	YARMOUTH	Property damage only (none injured)	V1:E / V2:E	Wet	Dark - roadway not lighted	Clear	Rte 6 E		8		Two-way, divided, positive median	55	306936.253	827436.321	449678
2257506	11/14/2007	7:10 AM	YARMOUTH	YARMOUTH	Non-fatal injury	V1:N / V2:S	Wet	Daylight	Fog, smog,	Rte 6 W /				Two-way, not divided	30	306996.335	827479.743	451518
2313850	4/28/2008	6:58 PM	YARMOUTH	YARMOUTH	Property damage only (none injured)	V1:W	Wet	Dusk	Rain	Rte 6 W		8		Two-way, divided, unprotected median	55	306998.742	827479.949	451518
2412557	12/24/2008	8:30 PM	YARMOUTH	YARMOUTH	Property damage only (none injured)	V1:E	Wet	Dark - roadway not lighted	Cloudy	Rte 6 W		8		Two-way, divided, unprotected median	55	306998.742	827479.949	451518
2228843	8/10/2007	1:35 PM	YARMOUTH	YARMOUTH	Property damage only (none injured)	V1:W / V2:W	Wet	Daylight	Rain	Rte 6 W		8		Two-way, divided, positive median	55	307000.816	827480.125	451518
2260197	10/27/2007	10:00 AM	YARMOUTH	YARMOUTH	Non-fatal injury	V1:E	Wet	Daylight	Cloudy	Rte 6 W		9	74.8	Two-way, divided, positive median	55	307333.433	827511.034	451443
2188519	4/12/2007	4:05 PM	YARMOUTH	YARMOUTH	Property damage only (none injured)	V1:W	Wet	Daylight	Cloudy/Rain	MID CAPE	3000 feet E of	8		Two-way, divided, positive median	55	307911.41	827562.75	451443
2334030	5/17/2008	6:31 AM	YARMOUTH	YARMOUTH	Property damage only (none injured)	V1:W	Wet	Dawn	Rain	Rte 6 W			76.5	Two-way, divided, positive median	55	310053.647	827774.823	451517
2015910	3/7/2006	7:14 AM	YARMOUTH	YARMOUTH	Property damage only (none injured)	V1:W	Wet	Daylight	Cloudy/Cloudy	MID CAPE				Two-way, divided, positive median	55	310701.518	827942.531	451452
2672166	12/13/2010	9:00 PM	DENNIS	DENNIS	Not Reported/Unknown	V1:W	Wet	Dark - roadway not lighted	Cloudy	Rte 6 W			77.4	Two-way, divided, unprotected median	55	311452.033	828154.783	174325
2066321	5/3/2006	11:39 PM	DENNIS	DENNIS	Non-fatal injury	V1:E / V2:E	Wet	Dark - roadway not lighted	Rain	MID CAPE	1320 feet W of	9		Two-way, divided, positive median	55	311612.532	828185.065	115905
2015806	1/12/2006	12:00 AM	DENNIS	DENNIS	Property damage only (none injured)	V1:E	Wet	Dark - roadway not lighted	Rain/Fog, smog,	MID CAPE	50 feet W of		77.1	Two-way, divided, positive median	55	311681.963	828218.935	449677
2236103	7/5/2007	2:40 AM	DENNIS	DENNIS	Non-fatal injury	V1:E	Wet	Dark - roadway not lighted	Rain	Rte 6 E		9		Two-way, divided, positive median	50	311974.694	828360.171	115906
2260202	11/3/2007	3:00 PM	DENNIS	DENNIS	Non-fatal injury	V1:E	Water	Daylight	Rain/Severe	Rte 6 E		9		Two-way, divided, positive median	55	311974.694	828360.171	115906
2368562	9/6/2008	11:28 PM	DENNIS	DENNIS	Non-fatal injury	V1:E	Wet	Dark - roadway not lighted	Rain/Severe	Rte 6 E		9		Two-way, divided, positive median	55	311974.8	828360.218	115906
2133394	11/8/2006	10:00 PM	DENNIS	DENNIS	Property damage only (none injured)	V1:E	Wet	Dark - roadway not lighted	Rain	MID CAPE	1000 feet E of	9		Two-way, divided, positive median	55	312259.897	828467.171	453629
2234920	8/31/2007	5:13 PM	DENNIS	DENNIS	Property damage only (none injured)	V1:E / V2:E /	Wet	Daylight	Cloudy	MID CAPE				Two-way, divided, unprotected median	55	312471.498	828529.553	453629
2363095	8/6/2008	1:50 AM	HARWICH	HARWICH	Non-fatal injury	V1:E / V2:E	Wet	Daylight	Rain	Rte 6	5280 feet W of	10		Two-way, divided, positive median	0	316914.877	828671.757	174326
2057602	4/4/2006	9:50 AM	HARWICH	HARWICH	Property damage only (none injured)	V1:E	Wet	Daylight	Rain	MID CAPE	300 feet W of	10		Two-way, not divided	50	317958.109	829038.692	174326
2133728	11/9/2006	7:50 AM	HARWICH	HARWICH	Property damage only (none injured)	V1:W / V2:W	Wet	Daylight	Rain	Rte 6 W	1320 feet W of	10		Two-way, divided, positive median	50	318414.023	829356.788	173270
2280852	2/7/2008	3:35 PM	HARWICH	HARWICH	Non-fatal injury	V1:W / V2:W /	Wet	Daylight	Cloudy/Rain	Rte 6 W		10		Two-way, not divided	50	318437.974	829378.26	174325
2114227	9/24/2006	8:40 PM	HARWICH	HARWICH	Property damage only (none injured)	V1:W	Wet	Dark - roadway not lighted	Rain	MID CAPE	5500 feet E of	10		Two-way, not divided	50	320127.5	830470.197	173285
2066406	6/9/2006	6:05 PM	HARWICH	HARWICH	Non-fatal injury	V1:W	Wet	Daylight	Cloudy/Rain	MID CAPE	5280 feet W of	11		Two-way, divided, unprotected median	50	320846.202	830696.807	173285
2066458	7/12/2006	4:00 PM	HARWICH	HARWICH	Non-fatal injury	V1:W / V2:W	Wet	Daylight	Cloudy/Rain	Rte 6 W				Two-way, divided, unprotected median	50	321805.285	831229.091	173284
2338063	6/24/2008	3:00 PM	HARWICH	HARWICH	Non-fatal injury	V1:E / V2:E	Wet	Daylight	Cloudy/Rain	Rte 6 E		11		Two-way, divided, unprotected median	50	321832.751	831250.758	174323
2219445	2/22/2007	7:10 PM	ORLEANS	ORLEANS	Property damage only (none injured)	V1:W	Wet	Dark - roadway not lighted	Snow	MID CAPE	2112 feet W of	12		Two-way, divided, unprotected median	50	324574.18	836900.455	294550
2114215	9/15/2006	3:55 PM	ORLEANS	ORLEANS	Non-fatal injury	V1:E	Wet	Daylight	Rain/Cloudy	Rte 6 E		12		Two-way, divided, unprotected median	50	324494.741	837162.053	294550
2237549	9/20/2007	1:50 AM	ORLEANS	ORLEANS	Non-fatal injury	V1:E	Wet	Dark - roadway not lighted	Rain	Rte 6 E				Two-way, divided, positive median	50	324629.604	839149.43	294728
2066404	6/7/2006	6:13 AM	BARNSTABLE	BARNSTABLE	Non-fatal injury	V1:E	Wet	Daylight	Rain	MID CAPE				Two-way, divided, positive median	55			
2095631	6/7/2006	8:30 AM	BOURNE	BOURNE	Non-fatal injury	V1:E	Wet	Daylight	Rain/Rain	Rte 6 E				Two-way, not divided	50			
2113673	5/3/2006	3:15 AM	BOURNE	BOURNE	Property damage only (none injured)	V1:S / V2:S	Wet	Daylight	Rain	CRANBERRY	100 feet S of			Two-way, not divided	0			
2114536	8/28/2006	5:00 PM	BOURNE	BOURNE	Non-fatal injury	V1:E	Water	Daylight	Rain/Rain	Rte 6 W				Two-way, not divided	55			
2203546	10/20/2006	7:50 AM	BOURNE	BOURNE	Not Reported/Unknown	V1:W / V2:W	Wet	Daylight	Rain	Rte 6 / HOLT				Not reported	0			
2220260	5/20/2007	2:40 AM	BOURNE	BOURNE	Non-fatal injury	V1:E	Wet	Dark - roadway not lighted	Rain	Rte 6				Two-way, divided, positive median	55			
2219468	5/18/2007	9:12 AM	YARMOUTH	YARMOUTH	Property damage only (none injured)	V1:W	Water	Not reported	Rain/Rain	MID CAPE				Two-way, divided, unprotected median	55			
2253651	10/27/2007	12:00 PM	BOURNE	BOURNE	Non-fatal injury	V1:W / V2:W /	Wet	Daylight	Clear	MID CAPE				Two-way, not divided	40			
2260187	10/11/2007	8:31 PM	BARNSTABLE	BARNSTABLE	Non-fatal injury	V1:E	Water	Dark - roadway not lighted	Rain	Rte 6 E				Two-way, divided, positive median	55			
2289183	4/16/2007	8:00 AM	BOURNE	SAGAMORE	Property damage only (none injured)	V1:S	Wet	Daylight	Rain	MID CAPE	200 feet E of	1		Two-way, divided, positive median	0			
2289214	2/22/2008	4:00 PM	YARMOUTH	YARMOUTH	Property damage only (none injured)	V1:E / V2:E	Wet	Daylight	Snow/Sleet, hail	Rte 6 E				Two-way, divided, positive median	55			
2355640	9/15/2007	3:00 PM	SANDWICH	SANDWICH	Property damage only (none injured)	V1:E / V2:E	Wet	Daylight	Cloudy/Other	Rte 6				One-way, not divided	0			
2364277	6/1/2007	2:30 AM	BOURNE	BOURNE	Non-fatal injury	V1:E	Wet	Dark - roadway not lighted	Clear	Rte 6				Two-way, divided, positive median	0			
2381183	9/14/2008	10:08 AM	BARNSTABLE	BARNSTABLE	Non-fatal injury	V1:W	Wet	Daylight	Cloudy/Rain	Rte 6 W				Two-way, divided, positive median	55			
2387913	12/2/2007	8:52 PM	SANDWICH	SANDWICH	Non-fatal injury	V1:W / V2:W /	Wet	Dark - lighted roadway	Sleet, hail	MID CAPE				Two-way, divided, positive median	0			
2397844	11/15/2008	9:20 AM	BARNSTABLE	BARNSTABLE	Property damage only (none injured)	V1:W	Wet	Daylight	Rain	Rte 6 W				Two-way, divided, positive median	55			
2466903	5/7/2009	4:48 AM	BOURNE	BOURNE	Property damage only (none injured)	V1:W / V2:W	Water	Dark - roadway not lighted	Rain	Rte 6				Two-way, divided, positive median	45			
2476699	6/5/2009	3:25 PM	HARWICH	HARWICH	Non-fatal injury	V1:E / V2:E /	Wet	Daylight	Rain	Rte 6 E				Two-way, not divided	50			
2488427	11/15/2008	2:05 AM	BOURNE	SAGAMORE	Not Reported/Unknown	V1:W	Water	Dark - unknown roadway	Rain/Severe	Rte 6				Two-way, divided, unprotected median	0			
2497860	6/29/2008	10:20 AM	BARNSTABLE	HYANNIS	Property damage only (none injured)	V1:N	Wet	Daylight	Cloudy	Rte 6				One-way, not divided	0			
2531281	10/27/2009	10:50 PM	YARMOUTH	YARMOUTH	Property damage only (none injured)	V1:E	Wet	Dark - roadway not lighted	Cloudy	Rte 6 E				Two-way, divided, unprotected median	55			
2602158	8/30/2009	11:00 AM	SANDWICH	SANDWICH	Property damage only (none injured)	V1:E / V2:W	Wet	Daylight	Rain	Rte 6				Two-way, divided, positive median	0			
2605697	7/18/2009	2:30 AM	SANDWICH	SANDWICH	Property damage only (none injured)	V1:E	Water	Dark - roadway not lighted	Rain	MID CAPE				Two-way, divided, positive median	0			
2620690	7/14/2010	6:15 PM	BARNSTABLE	BARNSTABLE	Non-fatal injury	V1:W	Wet	Daylight	Rain	Rte 6 W				One-way, not divided	55			
2620725	7/23/2010	4:00 PM	BOURNE	BOURNE	Property damage only (none injured)	V1:E / V2:E	Wet	Daylight	Rain	Rte 6 E				Two-way, divided, unprotected median	55			
2649482	10/6/2010	2:38 PM	BARNSTABLE	BARNSTABLE	Property damage only (none injured)	V1:W	Wet	Daylight	Cloudy/Rain	Rte 6 W				Two-way, divided, positive median	55			
2662432	11/4/2010	8:30 PM	BOURNE	BOURNE	Property damage only (none injured)	V1:N / V2:N	Wet	Dark - lighted roadway	Rain	BOURNE				Two-way, not divided	0			
2672979	12/13/2010	4:53 PM	BOURNE	BOURNE	Property damage only (none injured)	V1:W / V2:W	Wet	Dark - lighted roadway	Rain	Rte 6				Two-way, not divided	45			
2922164	10/6/2010	6:37 AM	BOURNE	BOURNE	Non-fatal injury	V1:W	Wet	Dawn	Rain/Cloudy	CRANBERRY				Two-way, divided, unprotected median	50			

APPENDIX B: PUDDLE INVENTORY RAW DATA AND RATING PROCEDURE

Date	Corridor	Direction	Between Exits		Mile	Road Side Puddle Location	Time	Puddle Rating	Rain Rating	Antecedent Precip. in. (Depth from previous Day)	24 hr. Rainfall Depth in.	Second Run (Standing Water Apparent)	Comment
6/3/2013	6	W	9	8	76	LR		4	4	0	2.771654	N	
6/3/2013	6	W	9	8	75.2	LR		3	4			N	
6/3/2013	6	W	8	7	74.8	LR		4	3			N	
6/3/2013	6	W	8	7	73.8	R		2	3			N	
6/3/2013	6	W	8	7	73	LR		3	3			N	
6/3/2013	6	W	8	7	72.6	L		2	3			N	
6/3/2013	6	W	7	6	72	LR		3	3			N	
6/3/2013	6	W	7	6	71.8			4	3			N	
6/3/2013	6	W	7	6	70.8	LR		4	2			N	Precipitation caused slowed traffic.
6/3/2013	6	E	1	2	59	R		1	2			N	At Exit 2 on Ramp
6/3/2013	6	E	2	3	59.8	R		2	2			N	
6/3/2013	6	E	3	4	62.2	LR		3	2			Y	
6/3/2013	6	E	4	5	63.6	R		4	2			Y	
6/3/2013	6	E	5	6	65.4	R		2	3			Y	
6/3/2013	6	E	5	6	66.2	R		4	3			Y	
6/3/2013	6	E	8	9A	77	L		2	3			N	
6/3/2013	6	E	9	10	74.4			2	3			N	Bad along fog line.
6/3/2013	6	E	11	12	88.4			2	4			N	Bad along fog line.
6/3/2013	6	E	11	12	88.6			3	4			N	
6/3/2013	6	E	12	Circle	89.6			3	4			N	
6/3/2013	6	E	12	Circle	90			2	4			N	
6/3/2013	6	E	12	Circle	90.8			3	3			N	Before rotary.
6/3/2013	6	E	11	12	87.8			3	3			N	
6/3/2013	6	E	9	10	78.8			2	2			Y	
6/3/2013	6	W	6	5	67.2	R		2	4			N	Multiple Puddles
6/3/2013	6	W	5	4	65	L		2	5			N	Multiple Puddles
6/3/2013	6	W	5	4	64.5	R		1	5			N	
6/3/2013	6	W	4	3	62.7	R		2	4			N	On the on Ramp (4)
6/3/2013	6	W	4	3	62			3	4			N	
6/3/2013	6	W	4	3	61.2	LR		3	4			N	Multiple Puddles
6/3/2013	6	W	3	2	61			2	4			N	
6/3/2013	6	W	3	2	59.6			3	3			N	
6/3/2013	6	W	2	1	58.8			2	3			N	
6/3/2013	6	W	Circle	12	90.8			3	3			N	
6/3/2013	6	W	Circle	12	90.2			4	3			Y	for about 1/4 mile
6/3/2013	6	W	Circle	12	89.6			4	3			Y	
6/3/2013	6	W	12	11	86.6			2	3			N	
6/3/2013	6	W	10	9A	80.2			2	3			N	Bad along fogline.
6/3/2013	6	W	10	9A	79.8			3	4			N	Bad along fogline.
6/3/2013	6	W	10	9A	79.4			3	4			N	Bad along fogline.
6/3/2013	6	W	10	9A	79			5	3			N	Covered Lane (IMG_0661)
6/3/2013	6	W	10	9A	78.6			4	3			N	Covered half of lane (IMG_0657)
6/3/2013	6	W	9	8	78.2			2				N	
6/3/2013	6	W	9	8	77.6	R		4				N	Exit 9A of Ramp.
6/3/2013	6	W	9	8	77.2	LR		4				N	
6/14/2013	6	W	7	6			10:35			0.448818898	1.059055		Heavy rain until 10am. Travel lanes d
6/14/2013	6	W	6	5			10:39						
6/14/2013	6	W	5	4	66		10:41	2					Puddle into left travel lane.
6/14/2013	6	W	4	3			10:43						No Puddles.
6/14/2013	6	W	3	2			10:45						No Puddles.
6/14/2013	6	W	2	1C			10:50						No Puddles.
6/14/2013	6	E	1	2			10:57						No standing water.
6/14/2013	6	E	2	3			10:58						No standing water.
6/14/2013	6	E	3	4			11:00						No standing water.
6/14/2013	6	E	4	5			11:03						No standing water.
6/14/2013	6	E	5	6	66.3	R	11:04	1					Rain stopped 1 hour ago. Puddle still
6/14/2013	6	E	6	7			11:09						No standing water.
6/14/2013	6	E	7	8			11:11						No standing water.
6/14/2013	6	E	8	9			11:14						No standing water.

Date	Corridor	Direction	Between Exits		Mile	Road Side Puddle Location	Time	Puddle Rating	Rain Rating	Antecedent Precip. in. (Depth from previous Day)	24 hr. Rainfall Depth in.	Second Run (Standing Water Apparent)	Comment
7/26/2013	6	E	1	2	58.2	L	9:28	2	1	0.271653543	1.389764		
7/26/2013	6	E	2	3	59.8	LR	9:30	2	2				
7/26/2013	6	E	3	4	61	LR	9:31	2	2				
7/26/2013	6	E	3	4	62.2	LR	9:33	3	2				
7/26/2013	6	E	4	5	63.8	LR	9:34	3	3				
7/26/2013	6	E	5	6	66.6	L	9:37	2	3				
7/26/2013	6	E	5	6	67.2	L	9:38	2	3				
7/26/2013	6	E	5	6	67.4	LR	9:38	4	3				
7/26/2013	6	E	9	10	78.8		9:50	2	2				
7/26/2013	6	E	9	10	79		9:50	2	2				
7/26/2013	6	E	9	10	79.2		9:50	3	2				
7/26/2013	6	E	9	10	80.2		9:50	3	2				
7/26/2013	6	E	9	10	81		9:51	2	2				
7/26/2013	6	E	10	11	82.2		9:53	2	2				
7/26/2013	6	E	11	12	88.2		10:00	2	1				
7/26/2013	6	E	12	Circle	89.8		10:02	2	1				
7/26/2013	6	E	12	Circle	89.8		10:02	3	1				
7/26/2013	6	E	12	Circle	90.8		10:03	2	1				
7/26/2013	6	W	5	4	66.8	L	9:01	2	3				
7/26/2013	6	W	4	3	61.2	L	9:06	2	3				
7/26/2013	6	W	4	3	61	L	9:06	2	3				
7/26/2013	6	W	Circle	12	90.8	L	10:04	2	1				Water on left side of lane.
7/26/2013	6	W	Circle	12	90.2		10:04	3	1				
7/26/2013	6	W	Circle	12	89.4		10:05	2	1				
7/26/2013	6	W	12	11	87.8		10:07	2	1				
7/26/2013	6	W	12	11	86.8		10:09	2	1				
7/26/2013	6	W	11	10	83.6		10:17	2	1				
7/26/2013	6	W	10	9	79		10:27	3	2				
7/26/2013	6	W	10	9	78.8		10:27	1	2				
7/26/2013	6	W	7	6	71.6	LR	10:35	1	1				
8/2/2013	6	E	6	7			10:34	0	2	0.078740157	0.57874		No puddles.
8/2/2013	6	E	7	8			10:37	0	2				No puddles.
8/2/2013	6	E	8	9B			10:41	0	3				No puddles.
8/2/2013	6	E	9B	10	79	R	10:44	1	1				Puddle in single lane right side
8/2/2013	6	E	10	11			10:50	0	2				Standing water in shoulder.
8/2/2013	6	E	11	12			10:53	0	1				Standing water in shoulder.
8/2/2013	6	E	12	Circle			10:58	0	1				No puddles.
8/2/2013	6	W	Circle	12			11:03	0	1				Standing water in shoulder.
8/2/2013	6	W	12	11			11:05	0	1				No puddles.
8/2/2013	6	W	11	10			11:24	0	1				No puddles.
8/2/2013	6	W	10	9B			11:32	0	0				No puddles.
8/2/2013	6	W	9B	8			11:38	0	1				No puddles.
8/2/2013	6	W	8	7			11:41	0	1				No puddles.
8/2/2013	6	W	7	6			11:43	0	0				No puddles.
8/2/2013	6	W	6	5			11:47	0	0				Dry travel lanes.
8/2/2013	6	W	5	4			11:50	0	0				No puddles.
8/2/2013	6	W	4	3			11:52	0	0				No puddles.
8/2/2013	6	W	3	2			11:54	0	0				No puddles.
8/2/2013	6	W	2	Bridge			11:57	0	0				No puddles.

RATING PROCEDURE

In July- August 2013 a puddle inventory was performed along the Rt. 6 corridor from the Sagamore Bridge to the Eastham rotary to determine potential hydroplaning locations. A field sheet was prepared to note the date, corridor (EB or WB), inter-exit puddle location, the mile number the puddle was located closest to, the time, a puddle rating, rain rating, and any comments. Comments would include the shoulder side puddle location and any other unusual findings. The puddle and rain ratings are defined below. Field surveys were conducted during, or shortly after rain events. When surveying puddles between the Sagamore Bridge and exit 9B technicians changed lanes to get passing and traveling lane perspectives.

PUDDLE RATING

0. Water is not present in the shoulder, can be standing on the road during rain
1. Water is collecting at the shoulder but does not exceed fog line
2. Puddle exceeds fog line but does not slow traffic
3. Puddle exceeds fog line and slows traffic slightly
4. Puddle covers about half of lane or slows traffic moderately
5. Deep Puddle covers lane or slows traffic significantly

RAIN RATING

0. It is not raining
1. Mist collects and road is wet
2. Rain drops are present but are not causing water to stand on road
3. Rain drops are present and causing water to stand on road
4. Rain drops inhibit visibility and traffic is moderately slowed
5. Rain causes severely inhibits visibility and traffic is significantly slowed

CAPE COD COMMISSION

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