Technical Memorandum

Hydroplaning Crash Study and Mitigation Strategies Phase I

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FLORIDA'S TURNPIKE

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1. Introduction

Florida's Turnpike Enterprise (FTE) is evaluating the current practice of analyzing and possible mitigation of hydroplaning related crashes and hydroplaning risk. Dynamic hydroplaning is a condition where one or more tires of a vehicle completely lose contact with the pavement due to a layer of water film between the tire and the pavement surface. The uplift caused by this phenomenon typically occurs at high speeds, moderate to high rainfall events, and slower time of drainage during such rainfall events causing water film to accumulate. A combination of roadway geometric elements can cause water from draining off the travel lanes slower than ideal, thus contributing to a higher water film thickness. Such a water film causes a vehicle to hydroplane with the driver losing control of the vehicle completely or partially.

The study stemmed from a need for FTE to provide insight into the locations and frequency of hydroplaning crashes with wide typical sections along Florida's Turnpike facilities and to provide mitigating strategies and offset hydroplaning risks so that a more efficient process can be achieved for project coordination between FTE and design consultants. Currently, several Turnpike facilities are under design for widening, including managed lane additions. The outcomes of this study will identify any need for possible modifications in design, hydroplaning calculation strategy or establish pathways for mitigation strategies to be identified to mitigate hydroplaning risk. This report summarizes the Phase I of the two-phase study. Phase I of the study deals with analysis of hydroplaning crashes on facilities within the State of Florida and identifying the crash characteristics, spatial and temporal variations of these crashes, and traffic characteristics at the times of these crashes. In addition, Phase I also evaluates the hydroplaning theory and the formula used by FTE. Based on the findings of the Phase I study, Phase II will identify possible mitigation strategies for the hydroplaning crashes. HNTB Corporation, as the General Engineering Consultant for FTE, was tasked to perform Phase I and Phase II of this study. The Phase II study will propose mitigation strategies, provide guidelines to obtain concurrence on governing criteria for hydroplaning, provide comparison and benefit cost estimates for different mitigation strategies, and propose guidelines to address hydroplaning scenario during the design process. This Phase I technical memorandum details the study scopes and methodology, provides a summary of the crash analysis and operational characteristics for different hydroplaning crash sites.

2. Scope of the Phase I Study

The scope of the Phase I study is as follows:

- Identify existing facilities owned by the Department that have eight or more lanes (combined both direction, including auxiliary lanes) to establish specific sites;
- Review available five-year complete crash data on the selected existing facilities;
- Identify locations on the selected facilities to analyze for hydroplaning crashes;
- Correlate the crash data with relevant weather conditions data;
- Select a mix of tangent and superelevated sections based on the crash analysis;
- Provide insights into roadway and traffic characteristic of the selected sites relevant to hydroplaning;
- Evaluate the hydroplaning formula in practice for the selected sites and compare results.

3. Literature Review

Hydroplaning crashes are prevalent in different regions across the world. In the U.S., majority of the states with moderate to heavy rainfalls have reported crashes that can be related to hydroplaning scenarios. As a result, various agencies and researchers have analyzed crash patterns, weather conditions, location characteristics, operational conditions and the theory of hydroplaning. As part of this Phase I study, a comprehensive list of relevant literatures were reviewed.

Yassin et al. (2013) assessed the reliability of predicting hydroplaning risk based on crash data on several Florida interstate highways. The study also evaluated PAVDRN, a computer software package developed under the National Cooperative Highway Research Program (NCHRP) sponsorship to determine the threshold hydroplaning speeds on a given section of a highway during a specific rainfall event. The study showed that PAVDRN was accurate in predicting a hydroplaning crash more than 60% of the time. However, the study also addresses external factors associated with hydroplaning crashes that are not included in the PAVDRN's analytical model. A similar study was also performed by *Gunaratne et al. (2012)*, where the researchers performed validation of the available hydroplaning prediction models with several field studies on Florida highways at different rainfall intensities. The study observed relationships with pavement skid resistance and hydroplaning possibility. In addition, the study also analyzed hydroplaning crashes on the field study spots and compared the results with the empirical models as well as PAVDRN. They concluded that wider sections are more likely to produce hydroplaning crashes, dense-graded pavements are more likely to induce conditions conducive to hydroplaning than open-graded ones, and the field skid test results yielded similar water film thicknesses for hydroplaning thresholds as the empirical models.

Villiers et al. (2012) evaluated driver behavior in the state of Florida using a driving simulator. The study found that even though drivers slowed down during major rainfall intensities that were simulated, the speed was not significantly slow. The PAVDRN predicted hydroplaning speeds are lower than what the drivers have exhibited in the simulator study.

NCHRP 15-55 (2017) report provided guidelines to predict and mitigate dynamic hydroplaning on roadways. In this two-phase study, the investigators analyzed the approaches used for assessing hydroplaning potential on new and existing roads, for predicting the water film thickness on road surfaces, and for modeling the response of the vehicle. The study proposed a methodology for developing an integrated hydroplaning model that uses and integrates the most appropriate surface water drainage, tire, vehicle, and fluid dynamic models to predict the hydroplaning risk for new and existing roads. This study also developed an outline for a guide to assess and mitigate hydroplaning potential and a plan for developing accompanying tools and guidance. The second part of this study is currently underway and will illustrate the proposed format for a hydroplaning risk assessment tool to apply the results of the integrated model in practice in addition to a guide mitigating hydroplaning potential.

The purpose of the *NCHRP 1-29 (1998)* study was to identify techniques to improve the drainage of multi-lane highway pavements and to develop guidelines for implementing the most promising of these techniques. This study conducted laboratory skid testing on different concrete and asphalt surfaces. The study used the surface MTD, water film thicknesses and friction values obtained from the controlled tests on various surfaces in the field and used them in the PAVDRN formula to predict hydroplaning threshold speeds.

Ivey et al. (1975) researched the reduction of visibility due to different rainfall intensities. The researchers provided experimental designs and compared the levels of visibility at incremental rainfall intensities. Based on the study results, the researchers recommended using different rainfall intensities for specific designs of highways. *Ekram (2009)* conducted research on reduced visibility related crashes due to inclement weather and provided a crash severity model based on historical crashes within the State of Florida. In addition, this study also developed a sliding window analysis methodology for identifying crash clusters/ "hotspots" along any facility. For a list of the references that has been used in this Phase I study, refer to the "References" section at the end of this document.

4. Study Methodology

Phase I of this study was based on the following methodology:

- Selection of corridors for initial sites with good sample size of wet weather crashes
- Data collection:
    a. Crash data for the latest available five years
    b. Weather data from weather stations at close proximity to the crash sites
    c. Traffic speed data at the time of the crashes
    d. After initial screening of crashes, collection of crash reports to identify relevant crashes
    e. After the initial selection of sites, collection of roadway data (e.g., as-built plans, typical sections, survey data as available)
    f. SunGuide speed data was also collected to analyze the mean vehicle speed and 85th percentile speed at the time of the crash
- Creation of GIS maps for all the wet weather-related crashes for selected facilities
- Based on clustering method used in previous research, identify crash clusters/"hotspots" for wet weather crashes in sections with four-lanes or more in each direction
- Initial selection of sites based on the identified clusters
- Further screening of number of crashes by removing unrelated crashes by reviewing the crash reports
- Present results of the final selected locations for:
    a. Frequency of hydroplaning crashes and all crashes per location
    b. Location of crash lanes
    c. Crash frequency by rainfall intensities
    d. Theoretical speed threshold by using hydroplaning formula
    e. Wet weather rate of crashes

- For a controlled experiment for comparison, identify non-wide sections (three-lanes each way) for the same facility within the closest proximity of the selected hydroplaning crash sites
- Provide comparative analysis for the selected sites with hydroplaning crashes vs. the control sites.

Figure 1 illustrates a brief schematic diagram of the study methodology.

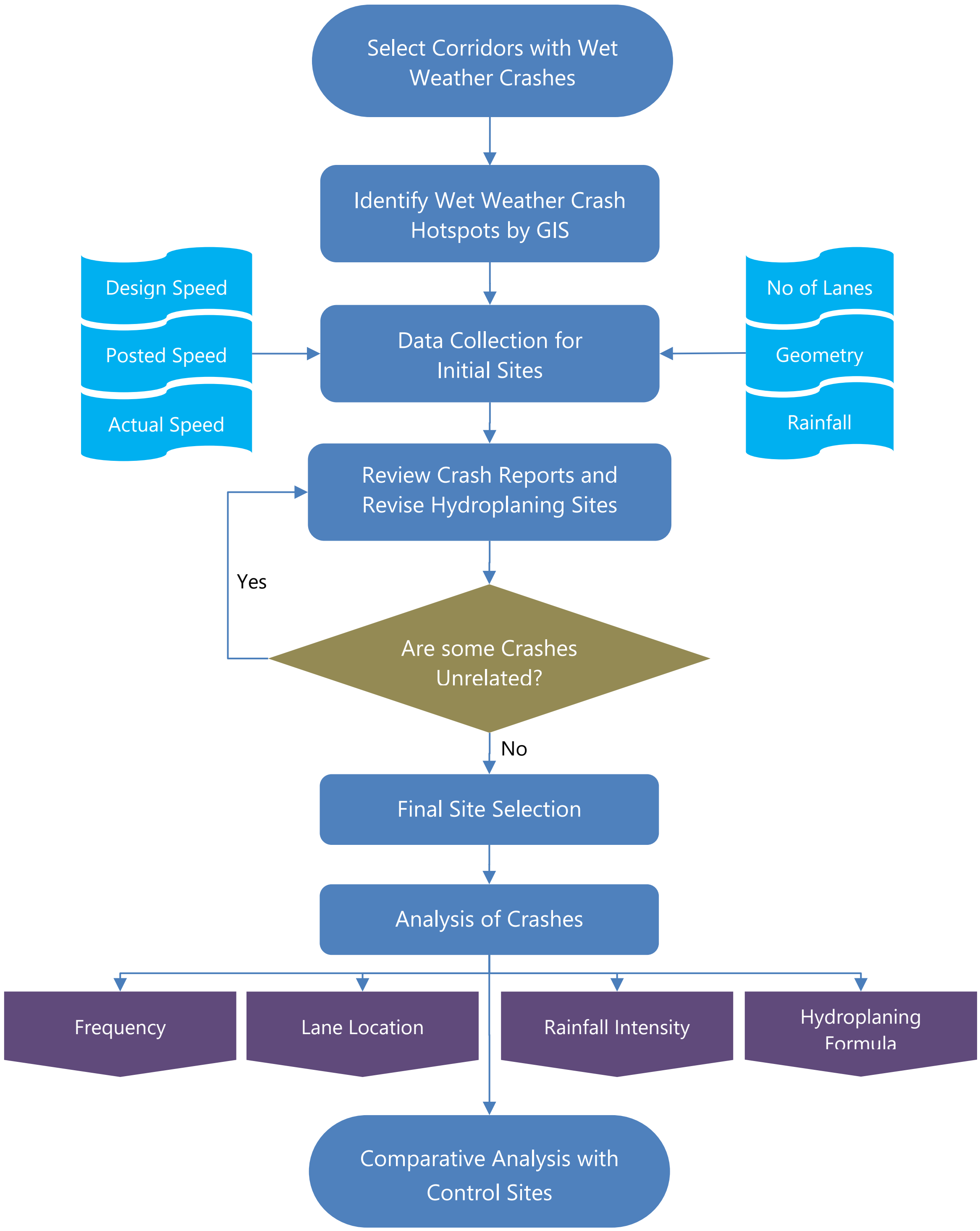


Figure 1. Study Methodology

5. Data Collection and Preparation

This section discusses the data collection sources, process of data acquisition and preparation of the data for various stages of analysis. Crash data, rainfall intensities, crash reports, roadway characteristics inventory data, GIS data layers, traffic speed data, and roadway geometry data were obtained.

5.1. Five-Year Crash Data

Crash data was obtained for the interstate and Turnpike facilities for the latest available five years from 2011 to 2015. Crash data was obtained from FDOT Crash Analysis Reporting System (CARS) as well as Signal Four Analytics crash data inventory. The primary purpose of this study was to identify locations with wide sections (four-lanes or more each direction) with high free-flow speeds that are potentially susceptible to hydroplaning and, thereby, hydroplaning related crashes. As such, an initial reconnaissance was performed to identify corridors with high frequency of wet weather crashes. Based on this initial survey, the following corridors were selected for initial site selections:

- Florida's Turnpike (including Homestead Extension of Florida's Turnpike [HEFT])
- I-95 (from US 1 to Florida/Georgia State line)
- I-275 (from I-4 to I-75)
- I-4 (from I-275 to I-95)

Crash data was obtained for these corridors from 2011 to 2015. The number of lanes was verified with the typical sections present at the time of the crash between 2011 to 2015. Crash data was filtered based on the following parameters in the crash database relevant to hydroplaning study:

- Number of lanes at the time of crash occurrence
    - Four lanes or higher in each direction
    - Auxiliary lanes included
- Weather
    - Rain
- Visibility
    - Vision not obstructed
    - Inclement weather
- Road surface condition
    - Standing water
- Maximum posted speeds
    - Values greater than 55 mph (initial selection)
- Alcohol/drug involvement
    - None

5.2. Rainfall Data

Based on previous research, the possibility of hydroplaning increases with the increase in rainfall intensity. This study looked at the frequency of moderate to heavy rainfall events that can induce potential hydroplaning. To correlate wet weather crash data with the rainfall intensity, rainfall data was downloaded from the closest weather stations available within a 10-mile radius or less from the selected sites. Rainfall site selection algorithm was based on modified Thiessen Polygons method, derived based on the research by *Jayasooriya et al. (2013)*. By employing Thiessen polygons, this study assumed that the weather condition within the polygon is represented by the weather data that would have been collected at a weather station at the centroid of the polygon and the weather is uniform throughout the polygon. These assumptions are appropriate for a sufficient number of weather stations within a polygon, and the polygons are to be accurately representative of the average weather condition within them. However, a few polygons demarcated in this study are significantly large due to the relatively large spacing of weather stations in some areas. In this study, a smaller buffer radial length of 10 miles was used to capture more accurate rainfall intensities. The available rainfall data had various degree of resolutions ranging from 15-min intervals to 1-hr intervals. To maintain accuracy of the time of crash occurrence, the lowest available resolution of data was used for the correlation of rainfall to the crashes. The following sources of data were used for rainfall intensities:

- South Florida Water Management District historical rainfall records (provision 15-minute rainfall)
- National Centers of Environmental Information (a NOAA repository) (15-minutes or 1-hr rainfall as available)
- Weather Underground weather data inventory (www.wunderground.com)

Prevalence of the various degrees of rainfalls were categorized based on the previous researches within Florida and the theoretical rainfall intensities used in the hydroplaning calculations by FDOT. **Appendix A** provides a map of the weather stations within the proximity of the sites of hydroplaning crashes.

5.3. Speed Data

Traffic speed was collected from the Regional Integrated Transportation Information System (RITIS) data repository. RITIS is a data-driven platform for transportation analysis, monitoring, and data visualization that collects and stored data from the DOTs. Speed data in RITIS is provided by the FDOT maintained SunGuide software.

In order to analyze the prevailing speeds of the crashes that was reported to have occurred due to hydroplaning, speed data was an important parameter to investigate. Historical speeds from 2011 to 2015 were recorded from the nearest SunGuide detectors that are available in the proximity of the crash sites. From the detectors, data was extracted for the closest possible timestamp just before the recorded occurrence of the crash so that a reasonable speed of the traffic stream can be related to the traveling vehicles involved in the crash. Crash reports were also investigated to record the speed of the vehicles involved. However, due to the inconsistencies observed in the speed values in the crash reports, SunGuide data was deemed more reliable and was assigned to each crash event for further analysis. Outlier speeds (i.e., bad data detection or unrealistic speeds) were excluded from the statistics.

5.4. Roadway Geometry Data

After the review of the crash reports and traffic data, roadway geometry data was collected from FTE for the final selected sites. The relevant data was provided in the form of as-built plans, existing plans or surveys, as available.

6. Hydroplaning Theory

6.1. Background

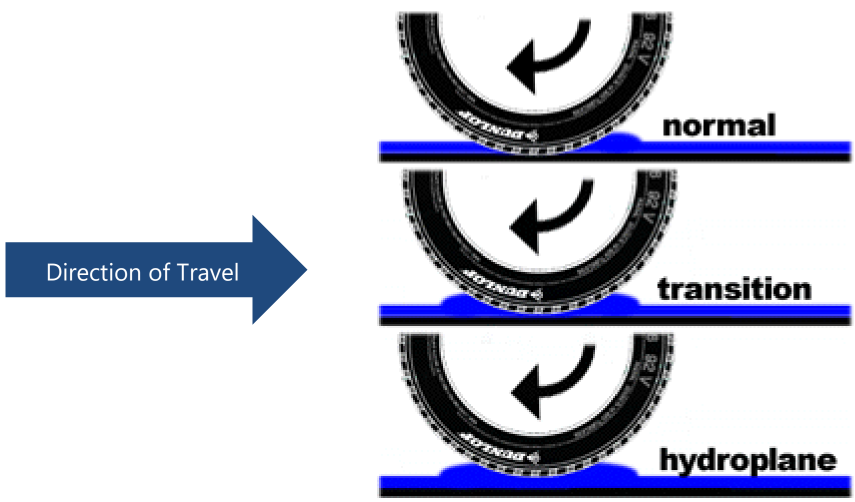
The purpose of this section is to provide a technical detail of the hydroplaning phenomenon and the factors that directly or indirectly affect this phenomenon. If dynamic hydroplaning occurs to all wheels simultaneously, the vehicle loses all traction and can be susceptible to crash. As the tire moves over a wet surface, the bulk of the water is normally removed by the normal force of the tire squeezing the water from beneath the tire footprint through the grooves in the tire and the texture in the pavement. Dynamic hydroplaning usually occurs at speeds above 45 mph *(Glennon, 2015)*.

Drivers who experience hydroplaning are surprised by the sudden loss of directional control due to such phenomena. Hydroplaning occurs under a wide variety of wet weather conditions. Although sudden loss of control can occur under heavy rainfall with high vehicle speeds, it can also occur after rainfall ceases with moderately high vehicle speeds on pavements with very little texture. In addition, hydroplaning can occur with moderate rainfall and moderate speeds where pavement wheel ruts with long pavement drainage paths allow critical water film thickness depths. Crashes involving hydroplaning becomes more apparent as roadway speeds increases, wider pavements are built, and greater pavement wear occurs because of greater traffic and heavier loads. Although hydroplaning is a very complex phenomenon, it is known to be associated with several factors. The likelihood of hydroplaning on wet pavements increases with roadway and environmental factors that increase water film thickness and with driver and vehicle factors that increase the sensitivity to water film thickness. The major factors are:

- Roadway
    - Width of contributing pavement
    - Roadway curvature
    - Pavement cross-slope
    - Longitudinal depressions
    - Compacted wheel ruts
    - Pavement texture and material
    - Longitudinal pavement slope

- Driver factors
    - Speed
    - Acceleration
    - Braking
    - Steering
- Environmental factors
    - Rainfall intensity
    - Rainfall duration
    - Oil, fuel and other contaminants on the pavement surface
- Vehicle factors
    - Tire Treadwear, traction and temperature ratings
    - Tire pressure
    - Vehicle type

Figure 2 provides a schematic diagram of the hydroplaning phenomena.



Source: crashforensics.com

Figure 2. Hydroplaning Phenomena

6.2. Florida Practice for Hydroplaning

To assure road safety and predict hydroplaning scenarios, different model combinations have been developed to estimate the dynamic hydroplaning risk. At very early stages during the above development, studies focused more on the empirical relationships, while more analytical methods have been developed subsequently. Agencies in Florida use a computer software, PAVDRN, which was initially developed by the Pennsylvania Transportation Institute as part of the *NCHRP project 1-29*. The program is used widely by highway engineers to estimate critical hydroplaning speeds along roadway sections. PAVDRN's mathematical model uses data of rainfall intensity, horizontal alignment of the road, cross section information, and pavement surface properties to calculate a water film thickness along the roadway cross section. Then, PAVDRN can estimate the threshold speed at which hydroplaning would be triggered.

PAVDRN uses an empirical form of the *Galloway (1979)* proposed equation for water film thickness and an empirical equation for hydroplaning speed prediction. The equations are:

$$t = \frac{0.003726 L^{0.519} I^{0.562} MTD^{0.125}}{S^{0.364}} - MTD$$

where t = Water film thickness (in)

L = Plane length of flow path (ft)

MTD = Mean texture depth (in)

I = Rainfall intensity (in/hr)

S = Pavement slope (ft/ft)

$$v_p = 26.04 t^{-0.259}, for\ film\ thickness < 0.1\ inch$$

$$v_p = 3.09 A, for\ film\ thickness > 0.1\ inch$$

$$A = higher\ of \begin{cases} \left[\frac{10.409}{t^{0.06}} + 3.507\right] \\ \left[\frac{28.952}{t^{0.06}} - 7.817\right] MTD^{0.14} \end{cases}$$

where v_p = Hydroplaning speed (mph)

t = Water film thickness (in)

MTD = Mean texture depth (in)

7. Site Selection Results

7.1. Initial Screening by Hotspot Mapping

All hydroplaning crashes between 2011 and 2015 were plotted in GIS using the spatial information obtained from the FDOT CARS and Signal Four Analytics website. To identify crash clusters for further site selection, previously established methodology for spatial analysis tools were investigated. Previous researchers (*Chainey and Tatcliffe, 2005; Ekram, 2008*) have used Kernel Density Estimation (KDE) spatial analysis technique to identify crash clusters on the basis of spatial dependency. The KDE method was used in combination with sliding window technique to minimize computation time.

Sliding window analysis is a method that identifies roadway segments/spots with high frequency of crashes. The segment length (the sliding window size) and the increment length were defined by the several iterations between 0.5-mile to 2-mile window. The end result in this case was a suitable length where the number of crashes is maximum keeping the roadway segment of uniform characteristics. The frequencies of hydroplaning crashes were counted within the window. It was found that a 0.5-mile segment length is optimum which serves both the purposes of uniform segment and number of hydroplaning related crashes to the maximum. A GIS map was then plotted with the segments being color-coded according to the frequency of hydroplaning crashes in each 0.5-mile window.

KDE method was applied to identify the crash clusters within the GIS. The GIS analysis was supplemented with the data from Roadway Characteristics Inventory (RCI) with posted speeds and number of lanes for the analysis corridors. **Figures 3 through 6** provide the results of the clusters identified for Florida's Turnpike, I-95, I-275 and I-4, respectively.

Based on the cluster analysis, 18 sites were selected for further evaluation of hydroplaning crashes and roadway characteristics. **Table 1** provides the summary of the sites for Turnpike and **Table 2** provides the summary of the sites for other corridors.

Table 1. Initial Selected Sites – Florida's Turnpike

No	Location Description		Mile point	Speed Limit (mph)	No of lanes	Type of Section
1	Florida's Turnpike	HEFT- North of Coral Reef Dr	16.5	60	8	Curve
2		HEFT- North of Coral Way	24.5	60	8	Tangent
3		HEFT- Tamiami Trail	25.5	60	9	Tangent
4		North of Miami Gardens Dr	1.75	65	12	Curve
5		South of County Line Rd	2.5	65	10	Tangent
6		North of 595	56.5	65	12	Tangent
7		North of Oakland Park Blvd	62.0	65	8	Curve
8		SR 528	256.0	70	8	Curve
9		East of Daniel Weber Parkway	267.0	70	12	Curve

Table 2. Initial Selected Sites – Other Corridors

No	Location Description		Mile point	Speed Limit (mph)	No of lanes	Type of Section
1	I-95	Hallandale Beach Blvd	17.0	65	10	Curve
2		South of Taft St	21.0	65	10	Curve
3		North pf Sunrise Blvd	33.5	65	12	Curve
4		Hillsborough Blvd	42.0	65	8	Curve
5		South of Glades Rd	45.5	65	10	Curve
6		South of Forest Hill Blvd	66.0	65	12	Curve
7	I-275	13th Avenue North	23.0	65	8	Curve
8		N of 13th Ave North	25.3	65	8	Curve
9	I-4	Central Florida Parkway	70.5	60	8	Tangent

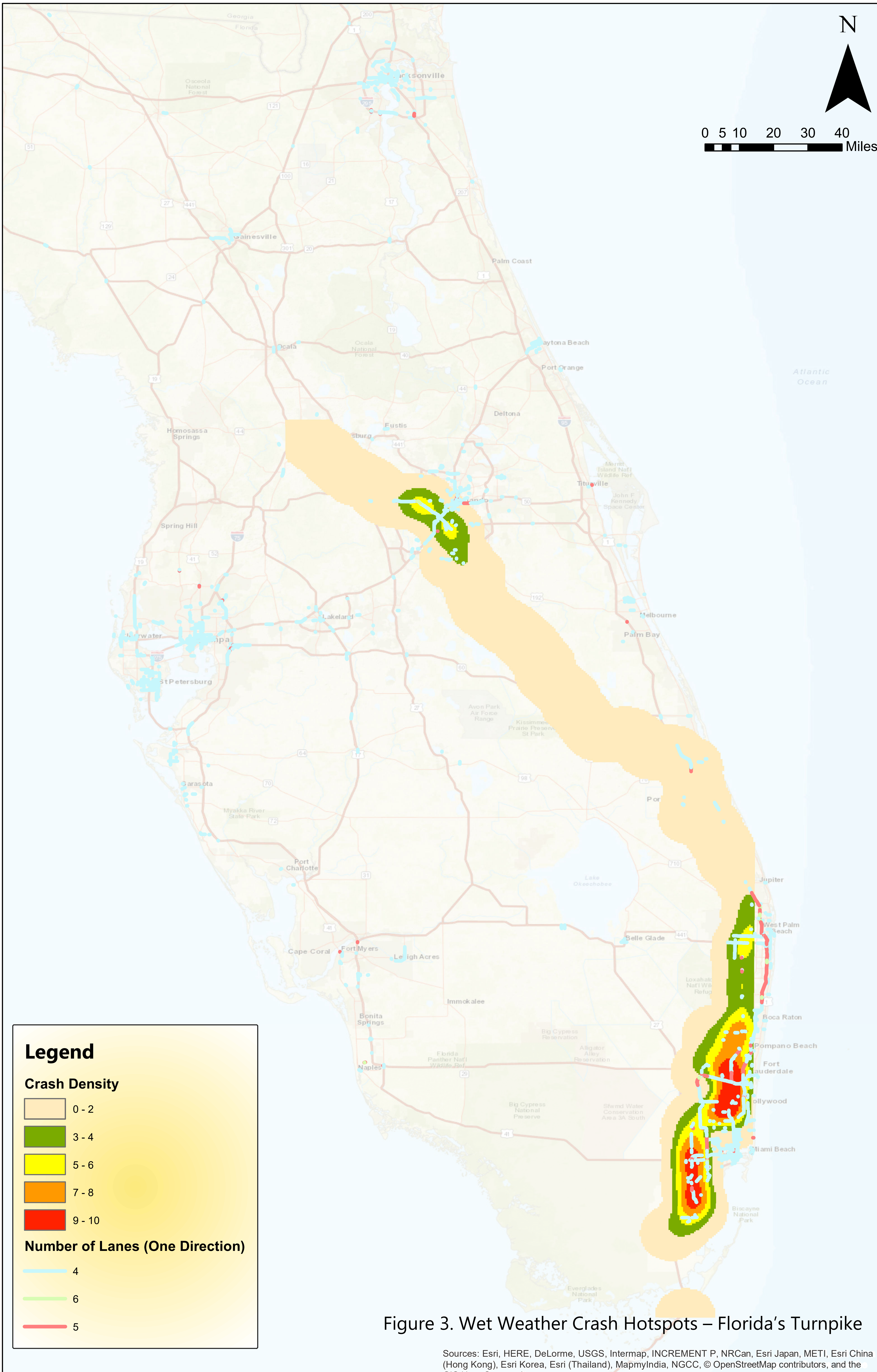


Figure 3. Wet Weather Crash Hotspots – Florida's Turnpike

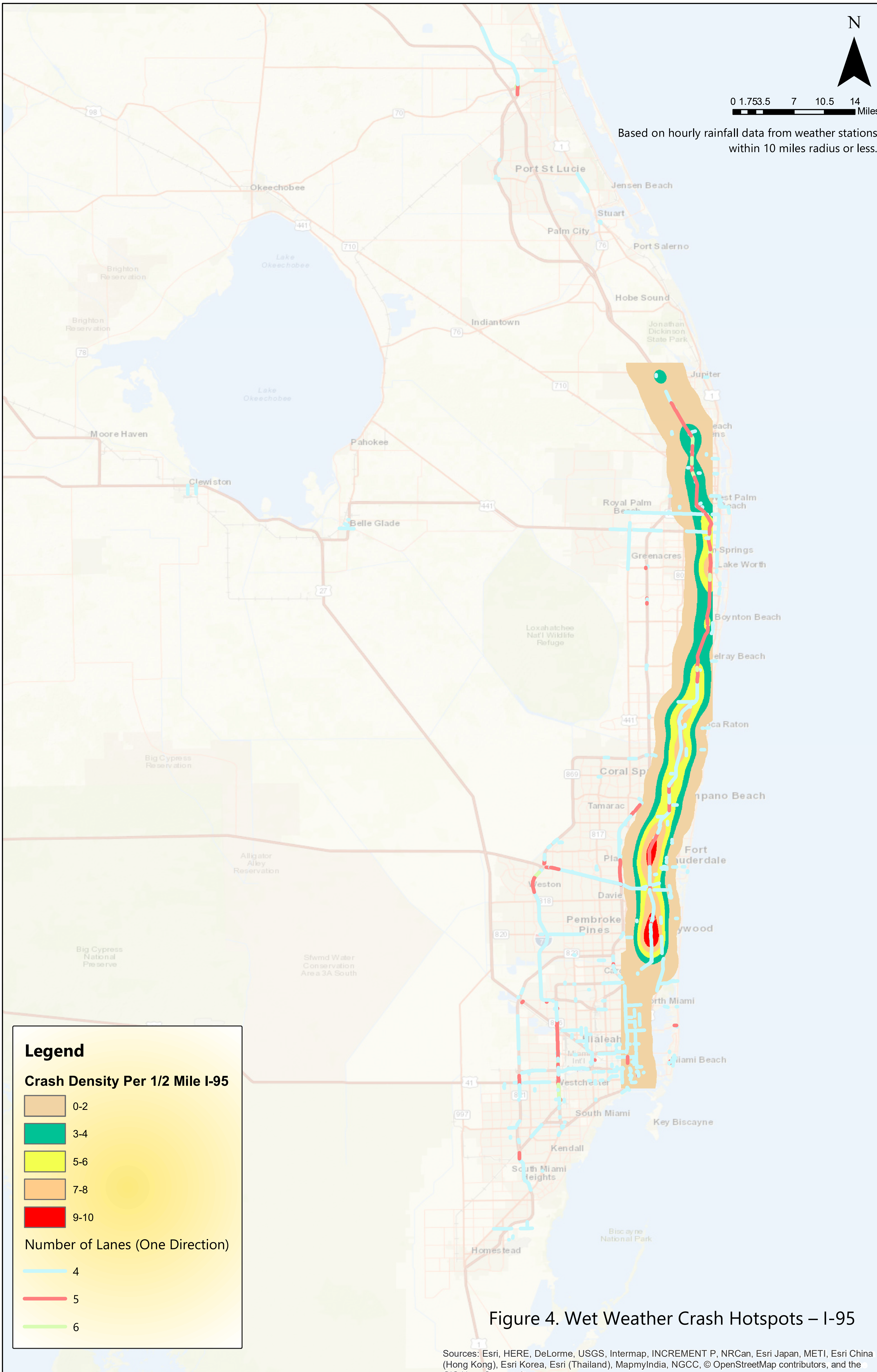


Figure 4. Wet Weather Crash Hotspots – I-95

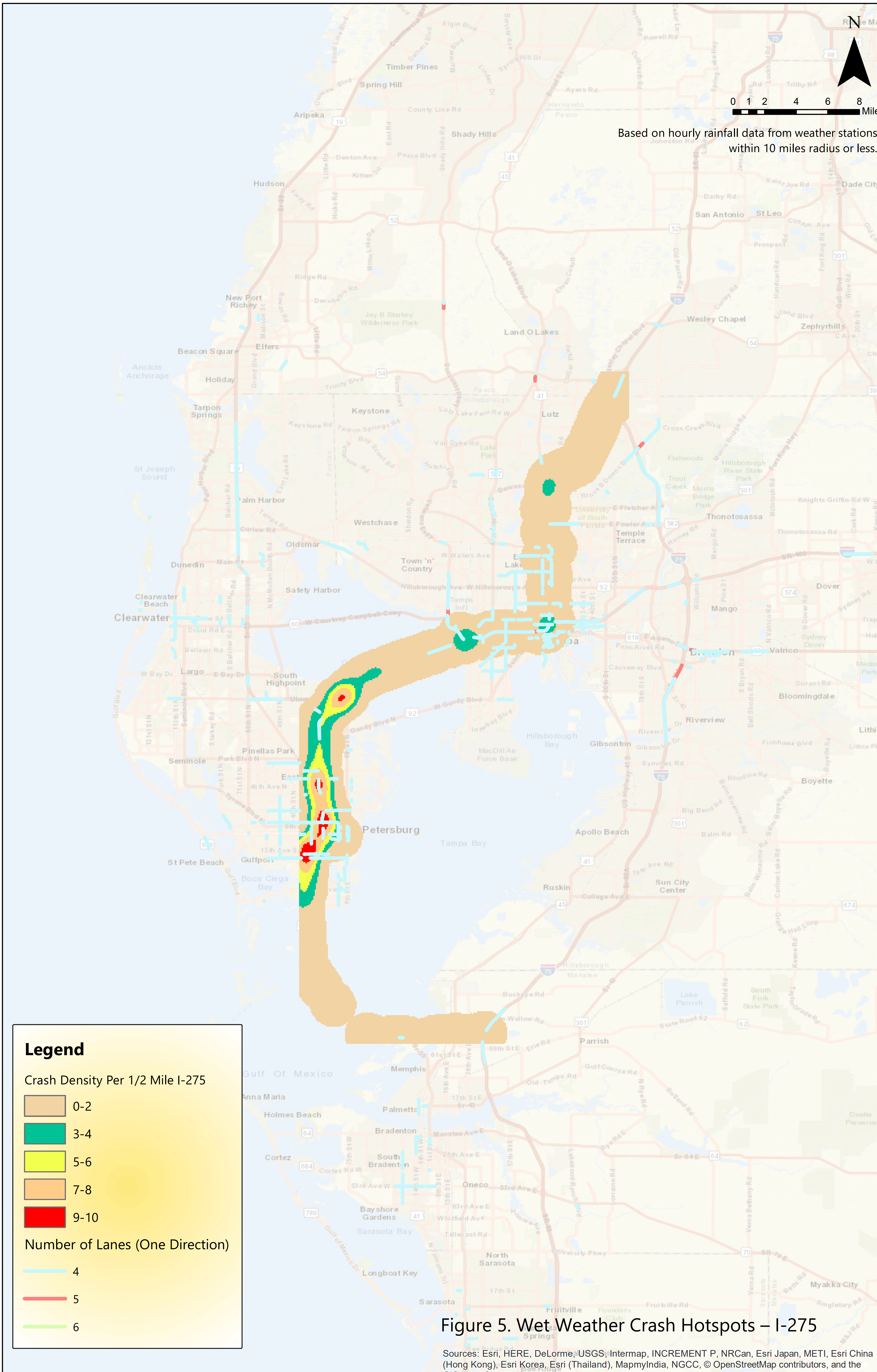


Figure 5. Wet Weather Crash Hotspots – I-275

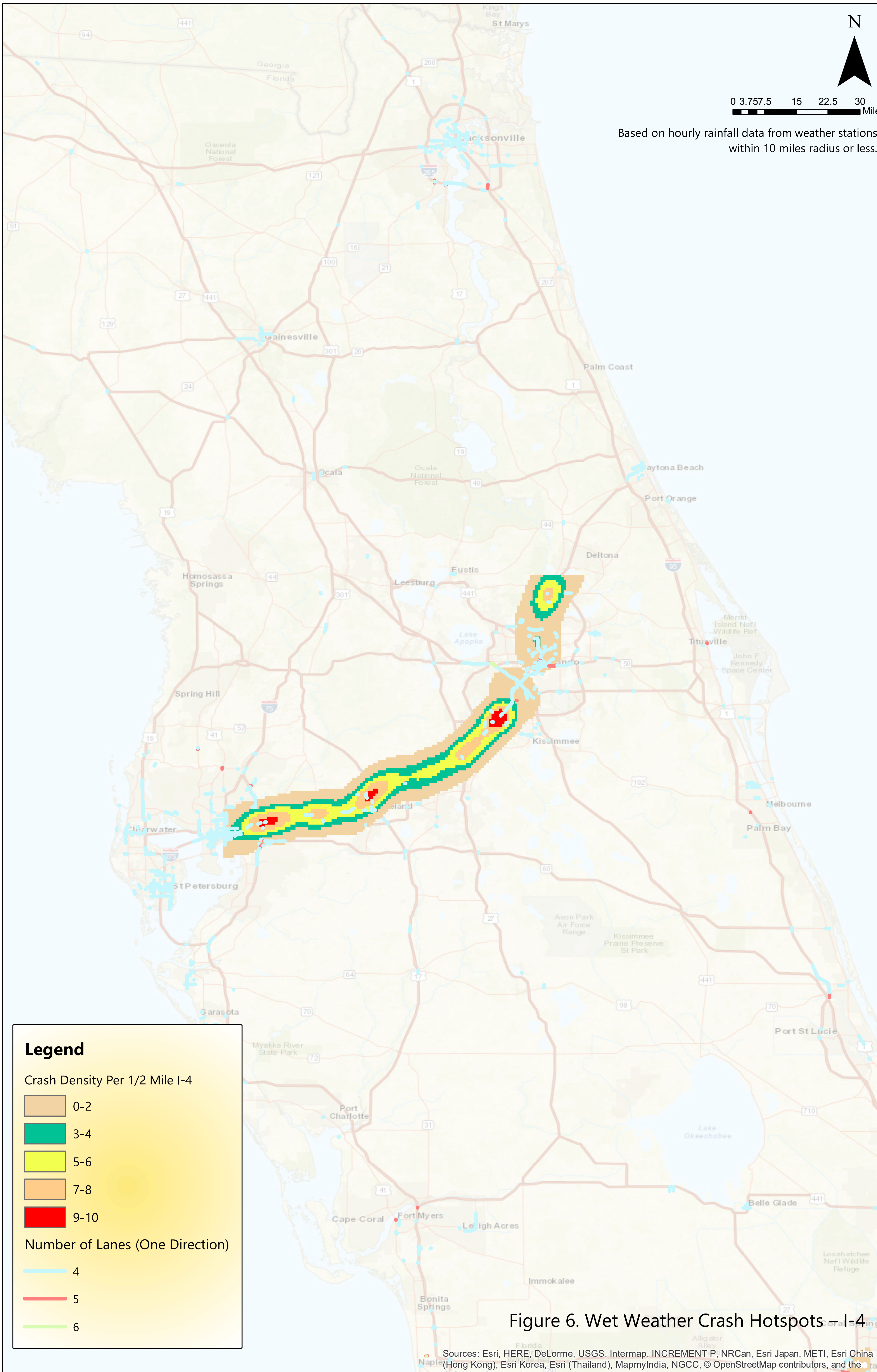


Figure 6. Wet Weather Crash Hotspots – I-4

7.2. Final Site Selections

After the initial selection of the 18 sites among Turnpike and other corridors, crash reports were obtained for all the wet weather crashes that occurred within the clusters of these sites. The main purpose of the investigation of the crash reports were to identify "false positives" in the crash database (i.e., crashes that are not related to possible hydroplaning). In addition, construction zones were identified for the analysis time periods and crashes were eliminated for the time periods when a selected site was under any type of construction. The primary factors that were identified as false positives for further screening of hydroplaning crashes are:

<u>Low visibility due to rain</u>: Drivers have reported that they did not apply brake or made any correction to the path of travel when the crash occurred, and the primary reason according to the driver was that the visibility was obstructed due to heavy rainfall. As such, hydroplaning was not a contributing factor to these crashes even though the rainfall intensity at the time of these crashes could induce hydroplaning. These crashes were eliminated from the final selection of crashes.

<u>Alcohol and/or drug use</u>: Crashes that were reported to have occurred under the influence of alcohol, drug or both were eliminated from the final selection.

<u>Distracted driving</u>: Crashes where distracted driving was the primary reason during the crash and brakes were not applied before the crashes have occurred were removed from the final selection of crashes.

<u>Vehicle malfunction unrelated to hydroplaning</u>: Some drivers reported pre-existing vehicular conditions related to brakes at the time of the crashes. Vehicular conditions that were unrelated to hydroplaning induction were identified as false positives. Such crashes were removed from the final selection of crashes.

Other than the false positives, sites were also investigated and revised based on non-recurring events (very low frequency of wet weather crashes).

After reviewing of the crash reports and eliminating false positives, a total of 12 sites were selected for all the corridors. Out of the 12, six sites were selected on Turnpike and the remaining sites were on the other corridors. The following sections detail the locations and crash characteristics.

7.2.1 Florida's Turnpike

7.2.1.1 Summary of Selected Sites

Six sites were identified along Florida's Turnpike that were prone to hydroplaning crashes between 2011 and 2015. Majority of the sites were located in the South Florida region with one site in the Central Florida region. Of the six sites, three were located within tangent sections and the others were located within curve sections. **Table 3** lists the sites along Florida's Turnpike along with the characteristics obtained from the plans and surveys between year 2011 and 2015. **Appendix B** contains the typical sections of the Turnpike corridor, and **Appendix C** provides the crash data for the sites.

A total of 427 wet weather crashes were recorded at the six Turnpike sites. Out of the 427 crashes, 160 crashes were related to hydroplaning. Of the 160 crashes, 52 were reported as injury crashes and the remaining 108 crashes were property damage only. No fatal crashes were reported among these sites. All the sites were listed in the FTE produced high crash locations list for 2011-2013 (**Appendix D**).

The hydroplaning formula (discussed in Section 6.2) was applied to each of the sites based on the geometric characteristics. A rainfall intensity of 2 inch/hour was used for the theoretical hydroplaning calculations. The 2 inch/hour stems from the fact that the correlation of more crashes with higher rainfall intensities is consistent with the 2 inch/hour rainfall event being the controlling storm intensity in hydroplaning calculations. The formula used were based on the PAVDRN software for hydroplaning speed calculations. The PAVDRN provides hydroplaning threshold speeds, which were then compared to the predicted driver speeds at the rainfall intensity. The predicted driver speeds are obtained by anticipated reductions from the design speeds based on the rainfall intensity. The results showed that sites 3 to 6 predict hydroplaning based on the formula for the design speed of 70 mph. For Site 1, formula results do not predict hydroplaning to occur based on design speeds of 60 or 65 mph. For Site 2, the formula does not predict hydroplaning to occur for design speed of 60 mph, but does predict hydroplaning for a design speed of 65 mph. **Table 3** also shows the results for the theoretical hydroplaning for the sites along Turnpike. **Appendix E** provides the values used in the PAVDRN hydroplaning formula and the results.

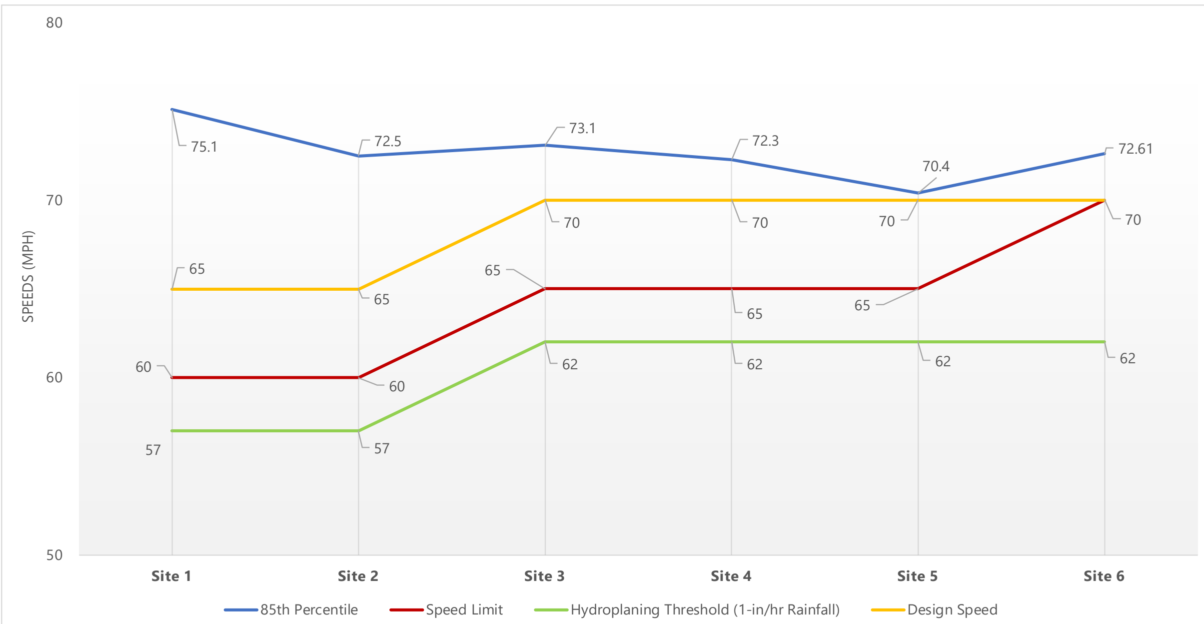
Table 3. Hydroplaning Crash and Theoretical Hydroplaning – Florida's Turnpike Sites

#	Location	Mile point	Speed Limit (mph)	No of lanes	Type of Section	Design Speed (mph)	Total Wet Weather Crashes	No of Hydro-planing Crashes	Cross Slope	Longi tudinal Slope	e	Hydro-planing Risk by Formula
1	HEFT- North of Coral Reef Dr	16.5	60	8	Curve	60/65*	94	17	2-6.7%	0.5%	6.7%	No/No
2	HEFT- Tamiami Trail	25.5	60	9	Tangent	60/65*	76	30	2-3%	0%	-	No/Yes
3	North of Miami Gardens Dr	1.75	65	12	Curve	70	21	11	2.8%	0%	2.8%	Yes
4	South of County Line Rd	2.5	65	10	Tangent	70	13	7	2-3%	0.2%	-	Yes
5	North of 595	56.5	65	12	Tangent	70	179	61	2-3%	0.02%	-	Yes
6	East of Daniel Webster Pkwy	267.0	70	12	Curve	70	44	34	2-4.5%	0.05%	4.5%	Yes

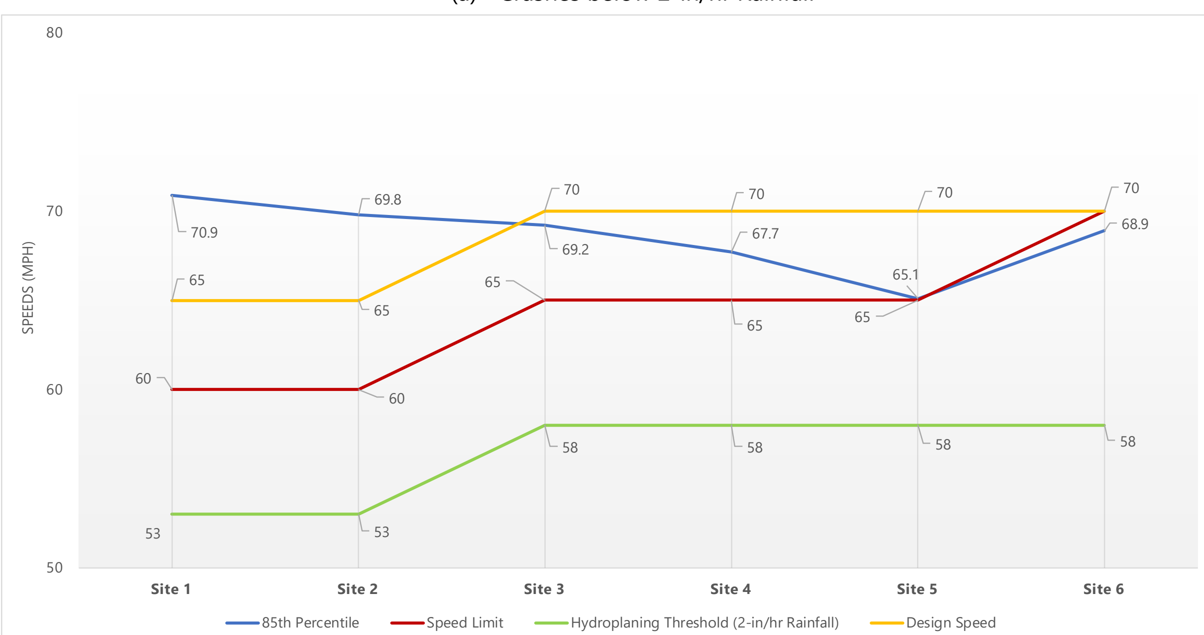
** Design speeds obtained from initial design and updated design plans*

7.2.1.2 Speed Profile

Traffic stream speeds were obtained for the time just prior to the occurrence of the hydroplaning event so that the speed recorded is representative of the crash at a site. Closest available speed detectors were located from the SunGuide based on the locations of the crash sites and the 85th percentile speeds were calculated for all the crash events that occurred at a site. The speeds were verified with the police reports as available. **Figure 7** illustrates a plot of the recorded speeds in relation to the posted speeds, design speeds and hydroplaning threshold speeds for 1 inch/hour and 2 inch/hour rainfall events. The threshold speeds are calculated based on the PAVDRN software formula as discussed in Section 6.2.



(a) Crashes below 2-in/hr Rainfall



(b) Crashes at or above 2-in/hr Rainfall

Figure 7. Speed Profile at the Time of Crash – Florida's Turnpike Sites

The figure is split into **Figure 7a** and **7b** to clearly distinguish the speed profiles above and below the 2 inch/hour rainfall event. From **Figure 7a**, the 85th percentile speeds at the time of crash indicate that the hydroplaning crashes have occurred at speeds above 70 mph for all the sites for the rainfall events of below 2 inch/hour. In **Figure 7b**, the 85th percentile speeds show that drivers were traveling at slightly reduced speeds during rainfall events of 2 inch/hour or higher compared to **Figure 7a**. The observations show that drivers were traveling above the posted speed limits at all the sites. The traveling speeds were also above the theoretical predicted hydroplaning threshold speeds of 53 mph (for 65 mph design speed) and 58 mph (for 70 mph design speed) at 2 inch/hour rainfall events, and above the theoretical predicted hydroplaning threshold speeds of 57 mph (for 65 mph design speed) and 62 mph (for 70 mph design speed) at 1 inch/hour rainfall events. The observed speeds support the fact that the 58 mph and 62 mph hydroplaning threshold speeds are justified for design purposes, as no crash was observed occurring at speeds below the hydroplaning threshold speeds.

Crashes occurring well above the hydroplaning threshold suggests that the presence of modern safety technologies such as advanced tires, Vehicle Stability Assist (VSA), Electronic Stability Control (ESC), and traction control systems perhaps have improved the performance of the vehicles during the hydroplaning events at lower speeds. Also, the evolution of tire technologies possibly have assisted the drivers in recovering during hydroplaning situations at lower speeds *(Fwa et al., 2009)*, thereby avoiding a crash occurrence.

7.2.1.3 Crash Distribution by Rainfall Intensity

Previous studies showed that the majority of the hydroplaning crashes occurred at moderate to heavy rainfall events. Most of the previous research have taken empirical rainfall intensities for hydroplaning scenarios, as the hydroplaning inducing rainfall threshold can vary based on the site conditions. For this study, a minimum rainfall intensity of 1 inch/hour was initially used as a filter for hydroplaning crashes, as defined by a recent research study within Florida *(Gunaratne et al., 2012)*. For the current study, a review of the wet weather crash reports revealed that several weather stations along the study corridors reported 0.9-1 inch/hour of rainfall during hydroplaning scenarios. As such, wet weather crashes were also reviewed below the stated hydroplaning rainfall event. Based on historical rainfall distributions in the State of Florida and rainfall intensities associated to hydroplaning occurrences, crashes were distributed between rainfalls of 0.9 inch/hour to over 2 inch/hour rainfalls. **Table 4** presents the crash frequencies by rainfall intensities for Turnpike sites.

Table 4. Crash Frequency by Rainfall – Florida's Turnpike Sites

#	Location Description		Mile point	Total Hydrop-laning Crashes	0.9-1 in/hr	1-1.5 in/hr	1.5-2 in/hr	>=2 in/hr
1	Florida's Turnpike	HEFT- North of Coral Reef Dr	16.5	17	4	3	8	2
2		HEFT- Tamiami Trail	25.5	30	3	6	9	12
3		North of Miami Gardens Dr	1.75	11	1	4	3	3
4		South of County Line Rd	2.5	7	1	2	2	2
5		North of 595	56.5	61	10	26	2	23
6		East of Daniel Webster Pkwy	267.0	34	4	11	8	11
				Overall	**23 (14%)**	**52 (33%)**	**32 (20%)**	**53 (33%)**

Crash distribution in **Table 4** indicates that over 50% of the hydroplaning related crashes occurred at rainfall intensities of 1.5 inch/hour or over. This is consistent with the use of 2 inch/hour of rainfall intensities in the PAVDRN empirical formula. As noted before, correlation of more crashes with higher rainfall intensities is consistent with the 2 inch/hour rainfall event being the controlling storm intensity in hydroplaning calculations, and not the only intensity that can be used in the PAVDRN formula.

7.2.1.4 Crash Distribution by Lane

Table 5 provides a distribution of the crashes by travel lane locations. Refer to **Appendix B** for the typical sections of the Turnpike sites. Based on the theory of hydroplaning, the lowest elevation of a typical section should be susceptible to the highest degree of hydroplaning. Therefore, the lowest elevation lanes (i.e., innermost lanes on a left-turning curve, outermost lanes on a right-turning curve) are expected to have the higher frequencies of hydroplaning crashes. The data shown in **Table 5** supports this assumption, as the majority of the crashes (about 76% of total) have occurred in the lowest lane or adjacent to the lowest lane for the sites. Some of the sites showed slightly higher crash frequencies for the adjacent lane compared to the lowest lanes. It is possible that the higher crashes were due to speed differentials, maneuvers because of auxiliary lane presence, or simply due to higher traffic in the adjacent lane. However, the crash frequencies in the lower lanes are much higher than the highest lanes for all the sites.

Table 5. Crash Frequency by Lanes – Florida's Turnpike Sites

#	Location Description		Mile point	Type of Section	Total Hydrop-laning Crashes	Lowest Lane	Adjacent to Lowest Lane	Middle Lanes	Adjacent to Highest Lane	Highest Lane
1	Florida's Turnpike	HEFT-North of Coral Reef Dr	16.5	Curve	17	5	6	4	1	1
2		HEFT-Tamiami Trail	25.5	Tangent	30	7	14	7	0	2
3		North of Miami Gardens Dr	1.75	Curve	11	5	3	2	1	0
4		South of County Line Rd	2.5	Tangent	7	3	4	0	0	0
5		North of 595	56.5	Tangent	61	21	27	7	3	3
6		East of Daniel Webster Pkwy	267.0	Curve	34	11	14	5	2	2
					Overall	**52 (33%)**	**68 (43%)**	**25 (16%)**	**7 (4%)**	**8 (5%)**

7.2.1.5 Economic Value of Crash

Hydroplaning crash costs were calculated based on the FDOT Plans Preparation Manual (PPM) historical cost method *(PPM Chapter 23-29,* see **Appendix F**). **Table 6** provides the cost per site for the Turnpike corridors. Based on the PPM cost for Turnpike facilities, a total of $40.78 million is estimated to be the cost of the hydroplaning crashes that have occurred in these six sites between 2011 and 2015.

Table 6. Economic Value of Crashes – Florida's Turnpike Sites

#	Location Description		Mile point	Type of Section	Hydrop-laning Crashes	All Crashes	Cost of Hydroplaning Crashes * (in $Million)
1	Florida's Turnpike	HEFT- North of Coral Reef Dr	16.5	Curve	17	56	$4.33
2		HEFT- Tamiami Trail	25.5	Tangent	30	62	$7.65
3		North of Miami Gardens Dr	1.75	Curve	11	21	$2.80
4		South of County Line Rd	2.5	Tangent	7	13	$1.78
5		North of 595	56.5	Tangent	61	179	$15.55
6		East of Daniel Webster Parkway	267.0	Curve	34	44	$8.67

** Note: Average Crash Cost based on FDOT PPM 2017 (23-29) for Turnpike - $254,951*

7.2.2 Other Corridors

7.2.2.1 Summary of Selected Sites

Six sites were identified along the other corridors that were prone to hydroplaning crashes between 2011 and 2015. Majority of the sites were located in the south Florida region on I-95, with two sites in the west Florida region on I-275. All six sites were located within curve sections. **Table 7** lists the sites along the other corridors including site characteristics that were obtained from the plans and surveys between year 2011 and 2015. **Appendix G** contains the typical sections of the other corridors.

A total of 647 wet weather crashes were recorded at the six sites. Out of the 647 crashes, 136 crashes were related to hydroplaning. Of the 136 crashes, 58 were reported as injury crashes and the remaining 78 crashes were property damage only. No fatal crashes were reported among these sites. **Appendix H** contains the hydroplaning crash data for these sites.

The hydroplaning formula (discussed in Section 6.2) was applied to each of the sites based on the geometric characteristics. A rainfall intensity of 2 inch/hour was used for the theoretical hydroplaning calculations. The 2 inch/hour stems from the fact that the correlation of more crashes with higher rainfall intensities is consistent with the 2 inch/hour rainfall event being the controlling storm intensity in hydroplaning calculations. The formula used were based on the PAVDRN software for hydroplaning speed calculations. The PAVDRN provides hydroplaning threshold speeds, which were then compared to the predicted driver speeds at the rainfall intensity. The predicted driver speeds are obtained by anticipated reductions from the design speeds based on the rainfall intensity. The results indicated that for sites 2, 3 and 4, the formula predicted hydroplaning for the design speed of 70 mph. the formula did not predict hydroplaning to occur for Site 1, 5 and 6 based on design speed of 65 mph. **Table 7** shows the results for the theoretical hydroplaning for the sites along the other corridors. **Appendix E** provides the values used in the PAVDRN hydroplaning formula and the results.

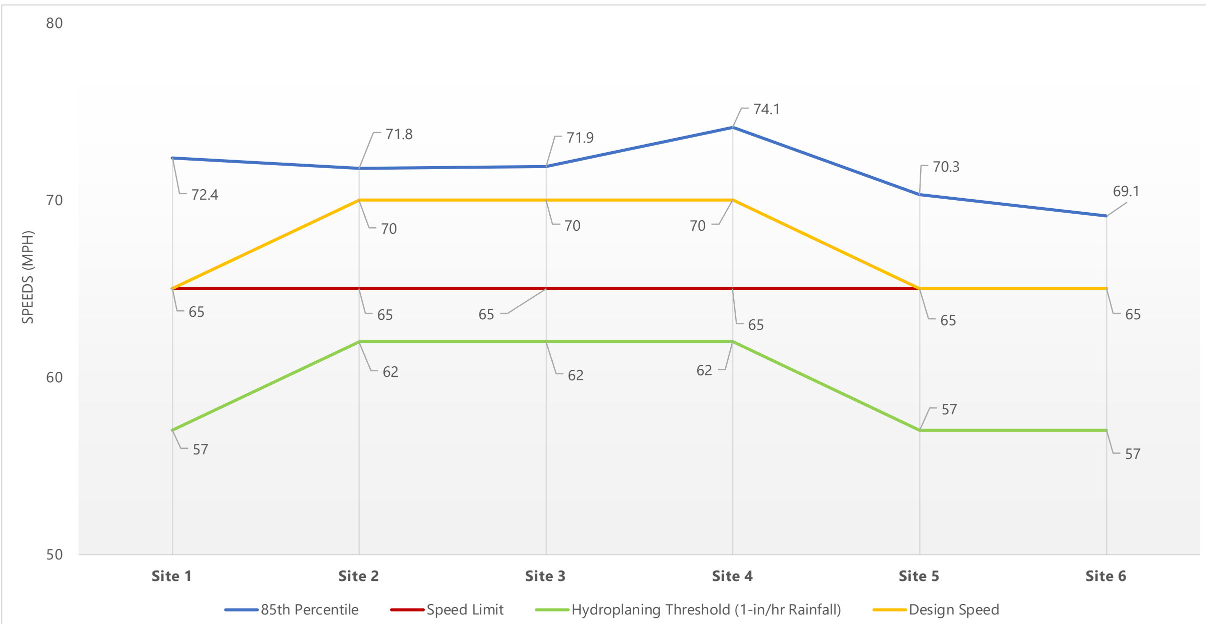
Table 7. Hydroplaning Crash and Theoretical Hydroplaning – Other Corridors

#	Location Description		Mile point	Speed Limit (mph)	No of lanes	Type of Section	Design Speed (mph)	Total Wet Weather Crashes	No of Hydro-planing Crashes	Cross Slope	Longi tudinal Slope	e	Hydro-planing Risk by Formula
1	I-95	Hallandale Beach Blvd	17.0	65	10	Curve	60/65*	340	22	2-3%	2.7%	3%	No/No
2		North of Sunrise Blvd	33.5	65	12	Curve	70	73	23	2%	0.1%	4.7%	Yes
3		South of Glades Rd	45.5	65	10	Curve	70	64	12	2-3%	0.18%	3.7%	Yes
4		South of Forest Hill Blvd	66.0	65	12	Curve	70	68	29	2-3%	0.08%	5.4%	Yes
5	I-275	13th Avenue North	23.0	65	8	Curve	65	54	24	2%	0.2%	6.2%	No
6		N of 13th Ave North	25.3	65	8	Curve	65	48	26	2%	0.2%	6.2%	No

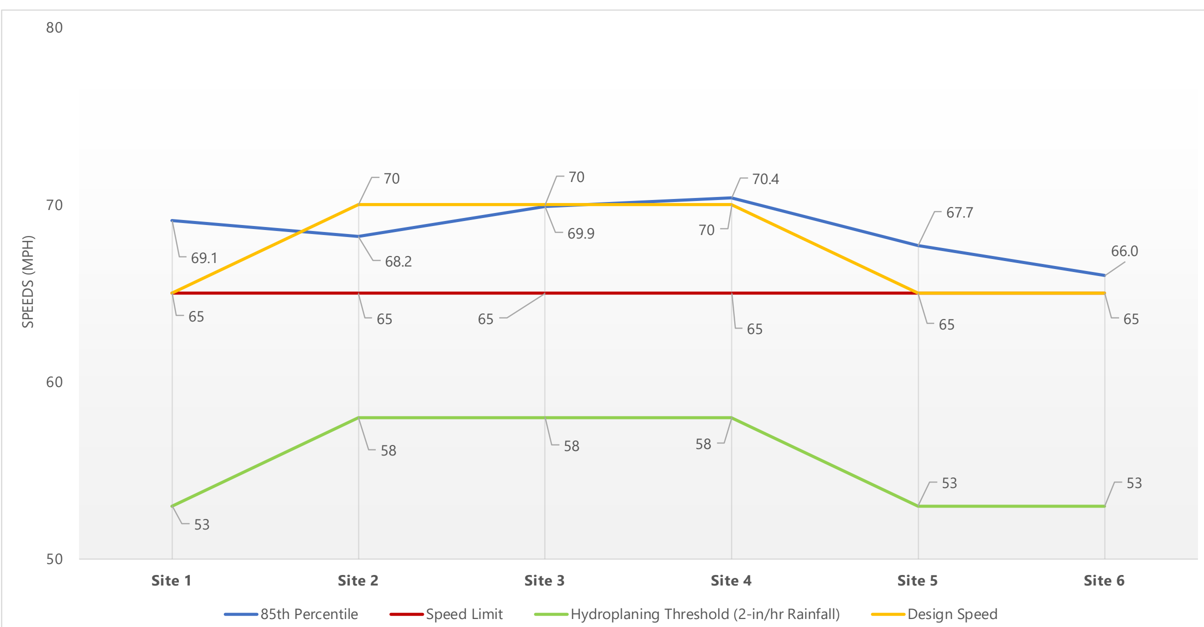
** Design speeds obtained from initial design and updated design plans*

7.2.2.2 Speed Profile

Traffic stream speeds were obtained just prior to the occurrence of the hydroplaning event so that the speed recorded is representative of the crash at a site. Closest available speed detectors were located from the SunGuide based on the locations of the crash sites and the 85th percentile speeds were calculated for all the crash events that occurred at a site. The speeds were verified with the police reports as available. **Figure 8** provides a plot of the recorded speeds in relation to the posted speeds, design speeds and hydroplaning threshold speeds for 1 inch/hour and 2 inch/hour rainfall events. The threshold speeds are calculated based on the PAVDRN software formula as discussed in Section 6.2.



(a) Crashes below 2-in/hr Rainfall



(b) Crashes below 2-in/hr Rainfall

Figure 8. Speed Profile at the Time of Crash – Other Corridor Sites

The figure is split into **Figure 8a** and **8b** to clearly distinguish the speed profiles above and below the 2 inch/hour rainfall event. From **Figure 8a**, the 85th percentile speeds at the time of crash show that the hydroplaning crashes have occurred at speeds of around 70 mph for the sites in the I-95 and I-275 for the rainfall events of below 2 inch/hour. In **Figure 8b**, the 85th percentile speeds show that drivers were traveling at slightly reduced speeds during rainfall events of 2 inch/hour or higher compared to **Figure 8a**. The observations show that drivers were traveling above the posted speed limits at all the sites. The traveling speeds were also above the theoretical predicted hydroplaning threshold speeds of 53 mph (for 65 mph design speed) and 58 mph (for 70 mph design speed) at 2 inch/hour rainfall events, and above the theoretical predicted hydroplaning threshold speeds of 57 mph (for 65 mph design speed) and 62 mph (for 70 mph design speed) at 1 inch/hour rainfall events. The observed speeds support the fact that the 58 mph and 62 mph hydroplaning threshold speeds are justified for design purposes, as no crash was observed occurring at speeds below the hydroplaning threshold speeds.

Similar to the Florida's Turnpike sites, crashes occurring well above the hydroplaning threshold depicts that presence of modern safety technologies such as advanced tires, VSA, ESC and traction control systems perhaps have improved the performance of the vehicles during the hydroplaning events at lower speeds. Also, the evolution of tire technologies possibly have assisted the driver in recovering during hydroplaning situations at lower speeds *(Fwa et al., 2009)*, thereby avoiding a crash occurrence.

7.2.2.3 Crash Distribution by Rainfall Intensity

Similar to the sites along Florida's Turnpike, for the current study, a review of the wet weather crash reports revealed that several weather stations along the study corridors reported 0.9-1 inch/hour of rainfall during hydroplaning scenarios. As such, wet weather crashes were also reviewed below the stated hydroplaning rainfall event. Based on historical rainfall distributions in Florida and rainfall intensities associated to hydroplaning occurrences, crashes along the other corridors were distributed between rainfalls of 0.9 inch/hour to over 2 inch/hour rainfalls. **Table 8** presents the crash frequencies by rainfall intensities for the other corridors.

Crash distribution in **Table 8** shows that over 60% of the hydroplaning related crashes occurred at rainfall intensities of 1.5 inch/hour or over. This is consistent with the use of 2 inch/hour of rainfall intensities in the PAVDRN empirical formula. As noted before, correlation of more crashes with higher rainfall intensities is consistent with the 2 inch/hour rainfall event being the controlling storm intensity in hydroplaning calculations, and not the only intensity that can be used in the PAVDRN formula.

Table 8. Crash Frequency by Rainfall – Other Corridor Sites

#		Location Description	Mile point	Total Hydropl-aning Crashes	0.9-1 in/hr	1-1.5 in/hr	1.5-2 in/hr	>=2 in/hr
1	I-95	Hallandale Beach Blvd	17.0	22	3	8	6	5
2		North of Sunrise Blvd	33.5	23	3	5	6	9
3		South of Glades Rd	45.5	12	3	2	4	3
4		South of Forest Hill Blvd	66.0	29	3	9	7	10
5	I-275	13th Avenue North	23.0	24	1	6	8	9
6		N of 13th Ave North	25.3	26	2	7	10	7
				Overall	**15 (11%)**	**37 (27%)**	**41 (30%)**	**43 (32%)**

7.2.2.4 Crash Distribution by Lane

Table 9 provides a distribution of the crashes by the location of the lanes. Refer to **Appendix G** for the typical sections of the other corridor sites. Based on the theory of hydroplaning, the lowest elevation of a typical section should be susceptible to the highest degree of hydroplaning. Therefore, the lowest elevation lanes (i.e., innermost lanes on a left-turning curve, outermost lanes on a right-turning curve) are expected to have the higher frequencies of hydroplaning crashes. The data in **Table 9** supports this assumption, as majority of the crashes (about 76% of total) have occurred at the lowest lane or adjacent to the lowest lane for the sites. Some of the sites showed slightly higher crash frequencies for the adjacent lane compared to the lowest lanes. It is possible that the higher crashes were due to speed differentials, maneuvers because of auxiliary lane presence, or simply due to higher traffic in the adjacent lane. However, the crash frequencies in the lower lanes are much higher than the highest lanes for all the sites.

Table 9. Crash Frequency by Lanes – Other Corridor Sites

#	Location Description		Mile point	Type of Section	Total Hydropl-aning Crashes	Lowest Lane	Adjacent to Lowest Lane	Middle Lanes	Adjacent to Highest Lane	Highest Lane
1	I-95	Hallandale Beach Blvd	17.0	Curve	22	5	9	5	2	1
2	I-95	North of Sunrise Blvd	33.5	Curve	23	10	6	3	2	2
3	I-95	South of Glades Rd	45.5	Curve	12	7	3	2	0	0
4	I-95	South of Forest Hill Blvd	66.0	Curve	29	13	8	4	2	2
5	I275	13th Avenue North	23.0	Curve	24	14	7	1	1	1
6	I275	N of 13th Ave North	25.3	Curve	26	16	5	2	2	1
					Overall	**65 (48%)**	**38 (28%)**	**17 (13%)**	**9 (7%)**	**7 (5%)**

7.2.2.5 Economic Value of Crash

Hydroplaning crash costs were calculated based on the FDOT Plans Preparation Manual historical cost method *(PPM 2017, Chapter 23-29,* see **Appendix F***)*. **Table 10** provides the cost per site for the other corridors. Based on the PPM cost for interstate facilities, a total of $46.48 million is estimated to be the cost of the hydroplaning crashes that have occurred in these six sites between 2011 and 2015.

Table 10. Economic Value of Crashes – Other Corridor Sites

#	Location Description		Mile point	Type of Section	Hydrop-laning Crashes	All Crashes	Cost of Hydroplaning Crashes (in $Million)
1	I-95	Hallandale Beach Blvd	17.0	Curve	22	73	$7.52
2	I-95	North of Sunrise Blvd	33.5	Curve	23	73	$7.86
3	I-95	South of Glades Rd	45.5	Curve	12	53	$4.10
4	I-95	South of Forest Hill Blvd	66.0	Curve	29	68	$9.91
5	I-275	13th Avenue North	23.0	Curve	24	54	$8.20
6	I-275	N of 13th Ave North	25.3	Curve	26	48	$8.89

* *Note: Average Crash Cost based on FDOT PPM 2017 (23-29) for Interstate - $341,754*

8. Comparative Study – Control Sites

The purpose of the Phase I study was to identify crash sites with four or more lanes in each direction that have exhibited hydroplaning induced crashes. Based on the observations discussed in Chapter 7, several sites were found with recurrent hydroplaning related crashes along Florida's Turnpike, I-95 and I-275. However, a comparison of crash rates for hydroplaning crashes as a percentage of wet weather crashes can be performed between the selected sites and sections with six lanes (both directions), so that a magnitude of crash rates can be determined. The regular sections with six lanes therefore can be cited as control sites, and hydroplaning crash rates were compared against the crash rates of the control sites. This section describes the results of this comparison study.

8.1. Control Site Selection

Controls sites were selected along the Turnpike with a combination of straight segment and curve segment for a fair sample size. Six-lane sites were sought in close proximity to the hydroplaning crash sites along the Turnpike within the south Florida region so that the weather conditions were similar to what were observed at the crash sites during the same time frames between 2011 and 2015. The following six lane (i.e., three lanes each way) sections were selected as control sites:

- Turnpike north of Atlantic Boulevard – Mile point 67.0, curve section
- Turnpike south of Copans Road – Mile point 69.0, curve section
- Turnpike south of Glades Road – Mile point 45.5, tangent section

Appendix I contains the typical sections for the control sites.

8.2. Crash Rate Comparison

A comparative risk assessment was performed for the hydroplaning crashes for the different width of roadway typical sections. Crash rate comparisons were performed using an empirical modeling method as well as from the actual wet weather crash rates obtained for the control sites and study sites. The following subsections describes the methods and the results.

8.2.1 Predictive Method

Predictive methods for crash analysis are used to predict crash rates for different roadway features. American Association of State Highway and Transportation Officials (AASHTO) has published a guidebook, Highway Safety Manual (2010) to provide empirical models and crash modification factors so that practitioners can use them to predict crash rates. For this study, HSM 2010 predictive methods for freeways (as published in *NCHRP 17-45*) were used to estimate expected crash rates among different alternatives of roadway number of lanes between six-lane, eight-lane and ten-lane roadways.

Although the purpose of this predictive method analysis was to provide crash rates, HSM 2010 does not provide any safety performance function (SPF) for modifying number of lanes. Moreover, no SPF and CMF exists for hydroplaning type of crashes. As such, Annual Average Daily Traffic (AADT) was used as a surrogate safety parameter to predict the crash rate. The AADTs were obtained for the selected crash sites along the Turnpike and the control sites on the same facility.

Based on the HSM 2010 methods, total crash rates were calculated for the six, eight and ten-lane sections along the Turnpike. The hydroplaning crash rates were calculated by applying the hydroplaning crash ratios for the six, eight and ten-lane typical sections to the total crash rates that were obtained from the HSM method.

Table 11 provides the results of the expected crash analysis. From the results, it is evident that the rate of hydroplaning crash increase at a much higher degree from a six to eight and eight to ten-lane sections compared to the rates for the total crashes between these sections. Based on these findings, it can be surmised that during a hydroplaning inducing wet weather condition, rate of occurrence of hydroplaning crashes is much higher in wide roadway sections of eight lanes or more compared to narrow sections of six lanes or less.

Table 11. HSM Predictive Method – Expected Crash Rates

#	Location Description		HSM 2010 Predicted Annual Crash Rate (All Types of Crashes)	Predicted Hydroplaning Annual Crash Rate
1	Florida's Turnpike	Typical Six Lane Section	58.8	6.9
2		Typical Eight Lane Section	81.1 (38% increase over 6-lane)	22.7 (229% increase over 6-lane)
3		Typical Ten Lane Section	96.5 (19% increase over 8-lane)	30.7 (35% increase over 8-lane)

Appendix J provides the spreadsheets for the HSM predictive analysis for this study.

8.2.2 Wet Weather Crash Rate Comparison

Crash rates were compared for the sites along Turnpike and other corridors with the crash rates of the control sites. **Tables 12 through 14** summarize the wet weather crash rates for the selected sites and the control sites. For the Turnpike sites, the average wet weather crash rate between 2011 and 2015 was about 33.7%. For the sites in the other corridors, the average wet weather crash rate was about 33.8%. However, for the control sites, the average wet weather crash rate was about 11.6% for the period between 2011 and 2015.

The results show there is an increased likelihood of hydroplaning induced crashes for wide roadway sections with eight lanes or more (i.e., four lanes or more in each direction) compared to six lane sections (i.e., three lanes in each direction) during moderate to heavy rainfall events. These results are in line with the predictive crash analysis that were shown in **Table 11**.

Table 12. Wet Weather Crash Rate – Florida's Turnpike Sites

#		Location Description	Type of Section	Mile point	Wet Weather Crash % (Out of Total)
1	Florida's Turnpike	HEFT- North of Coral Reef Dr	Curve	16.5	26.9%
2		HEFT- Tamiami Trail	Tangent	25.5	43.9%
3		North of Miami Gardens Dr	Curve	1.75	22.6%
4		South of County Line Rd	Tangent	2.5	20.3%
5		North of 595	Tangent	56.5	48.5%
6		East of Daniel Webster Pkwy	Curve	267.0	40.0%

Table 13. Wet Weather Crash Rate – Other Corridor Sites

#		Location Description	Type of Section	Mile point	Wet Weather Crash % (Out of Total)
1	I-95	Hallandale Beach Blvd	Curve	17.0	29.7%
2		North of Sunrise Blvd	Curve	33.5	29.6%
3		South of Glades Rd	Curve	45.5	31.7%
4		South of Forest Hill Blvd	Curve	66.0	39.5%
5	I-275	13^{th} Avenue North	Curve	23.0	37.2%
6		N of 13^{th} Ave North	Curve	25.3	35.0%

Table 14. Wet Weather Crash Rate – Control Sites (Six Lanes)

#		Location Description	Type of Section	Mile point	Wet Weather Crash % (Out of Total)
1	Florida's Turnpike	North of Atlantic Blvd	Curve	67.0	13.1%
2		South of Copans Rd	Curve	69.0	14.7%
3		South of Glades Rd	Tangent	45.5	7.1%

9. Conclusions

FTE initiated a hydroplaning crash study to provide insight into the locations and frequency of hydroplaning crashes with wide typical sections along Florida's Turnpike facilities so that a more efficient process can be achieved for project coordination between FTE and design consultants. Currently, several Turnpike facilities are under design for widening, including additions of managed lanes. The output of this study will identify any need for possible modifications in design, hydroplaning calculation strategy or establish pathways for mitigation strategies to be identified to mitigate hydroplaning related crashes. This report summarizes the Phase I of the two-phase study. Phase I deals with analysis of hydroplaning crashes on facilities within the State of Florida and identifying the crash characteristics, spatial and temporal variations of these crashes, and traffic characteristics at the times of these crashes. Phase I also evaluates the hydroplaning theory and the formula that is used by FTE.

This Phase I study identified existing facilities owned by the Department that have eight or more lanes (combined both direction, including auxiliary lanes) and selected a total of 12 sites that experienced hydroplaning induced crashes from year 2011 to 2015. The crash data were combined with relevant weather conditions data to provide insights into roadway and traffic characteristic of the selected sites relevant to hydroplaning. This study also evaluated the PAVDRN empirical formula in practice for the selected sites and compared results against the actual hydroplaning crash rates. Finally, crash rates for the selected sites were compared to crash rates for six-lane control sites within the same timeframe and weather conditions. In addition, HSM 2010 predictive method was utilized with surrogate safety measures to assess crash rates between different number of lanes on Turnpike.

The key observations of this Phase I study are:

- Based on comparative statistics with the control sites (which are six-lane facilities in the proximity of the selected sites), selected wider sections had about 33.7% of wet weather crashes compared to about 11.6% of wet weather crashes in the six-lane sections;
- Expected hydroplaning crash rate increases about 229% from a six-lane to an eight-lane section, and about 35% from an eight-lane to a ten-lane section;
- Hydroplaning crash frequencies were greater in the lower lanes than the higher lanes;
- For some of the sections, adjacent lane to the lowest lane had slightly higher crash frequency than the lowest lane as some of the lowest lanes are auxiliary lanes;
- For majority of the study sites, a design speed of 65 mph triggers hydroplaning in the PAVDRN empirical hydroplaning formula;
- Speeds observed at the time of the hydroplaning induced crashes showed that drivers were travelling at greater than posted speed limits at the time of crashes. It is possible that modern technologies in vehicle safety features as well as improved tires have prevented some possible crashes in hydroplaning conditions at lower speeds;
- The observed speeds were also above the PAVDRN empirical hydroplaning threshold speeds for 1 inch/hour and 2 inch/hour rainfall intensities;

- More than 50% of the hydroplaning crashes occurred during rainfall intensities of 1.5 inch/hour or over. This is consistent with the use of 2 inch/hour of rainfall intensities in the PAVDRN empirical formula. It is important to note that correlation of more crashes with higher rainfall intensities is consistent with the 2 inch/hour rainfall event being the controlling storm intensity in hydroplaning calculations, and not the only intensity that can be used in the PAVDRN formula.

Based on the outcome of this Phase I study, Phase II of the study will propose mitigation strategies, provide guidelines to obtain concurrence on governing criteria for hydroplaning, provide comparison and benefit cost estimates for different mitigation strategies, and propose guidelines to address hydroplaning scenario during the design process.

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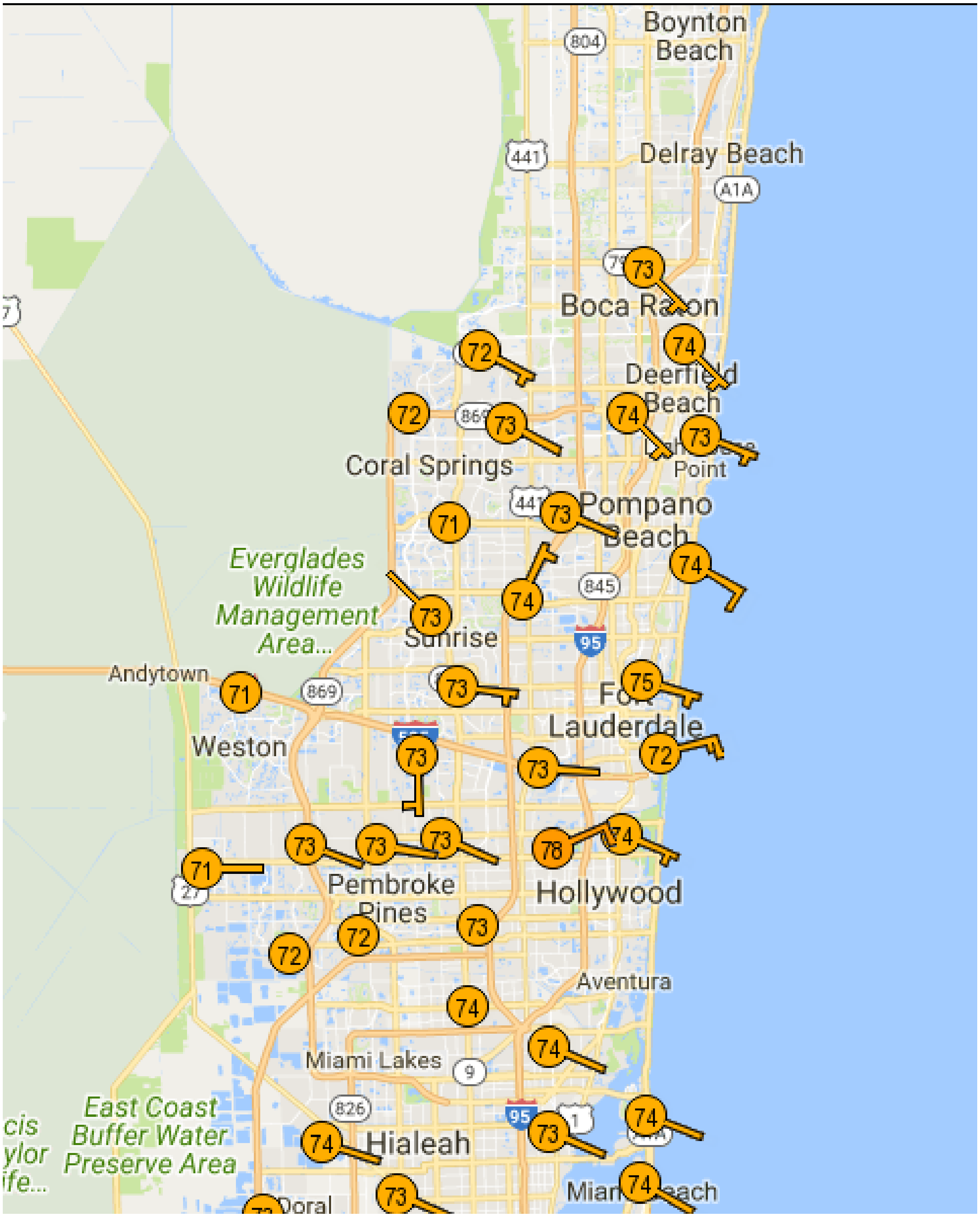
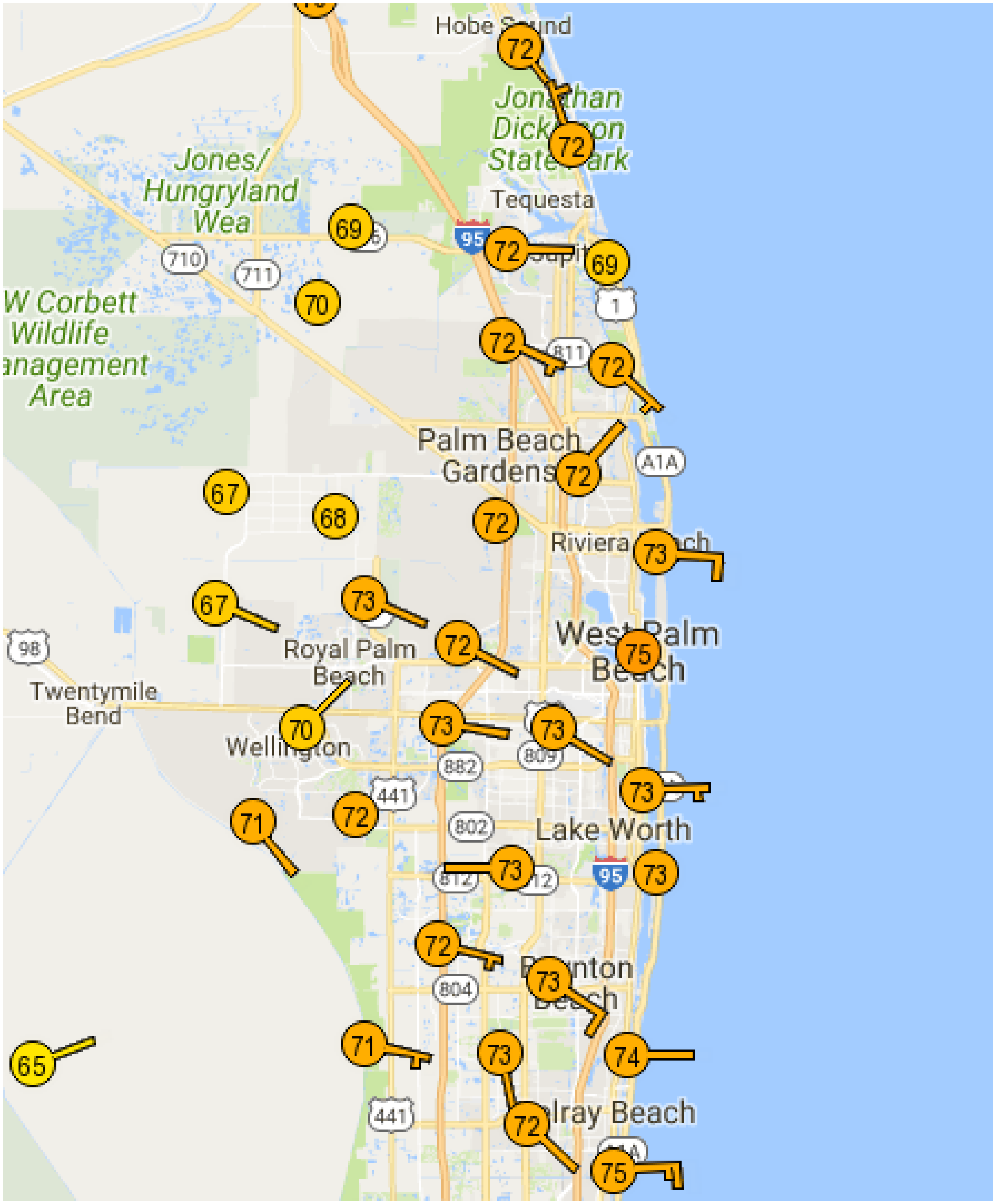
Appendix A

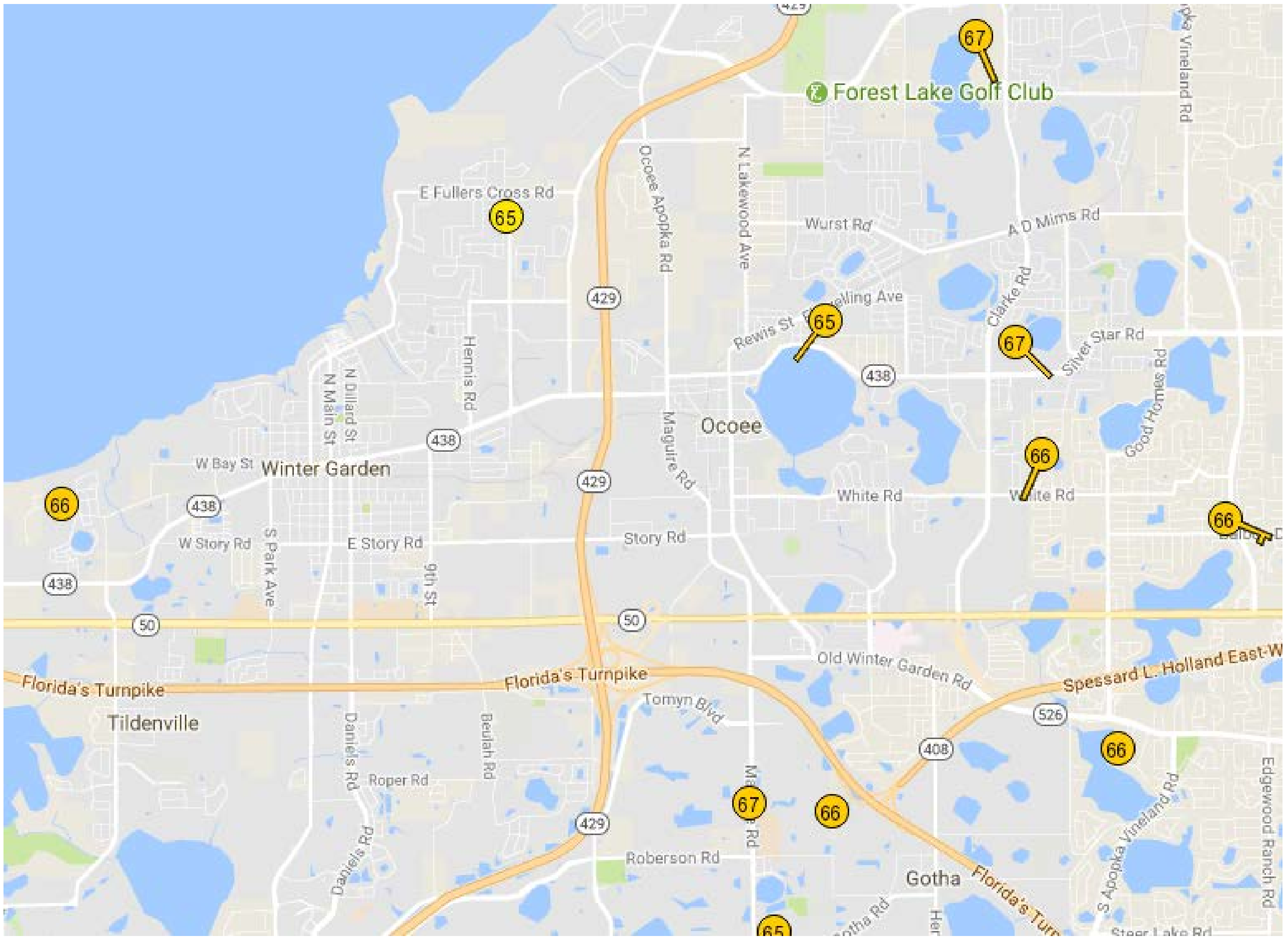
Map of Weather Stations



Source: wunderground.com



Source: wunderground.com

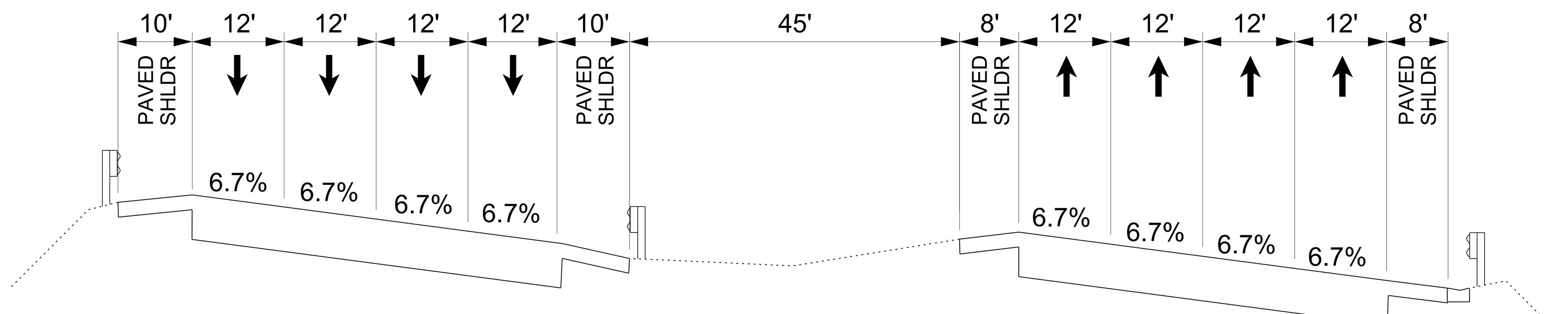


Source: wunderground.com

Appendix B

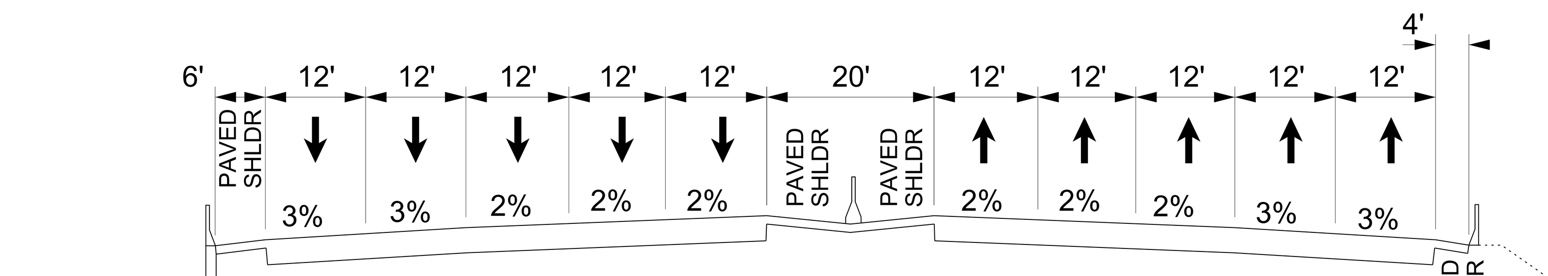
Typical Sections for Florida's Turnpike Sites

SITE 1- HEFT - N OF CORAL REEF DR



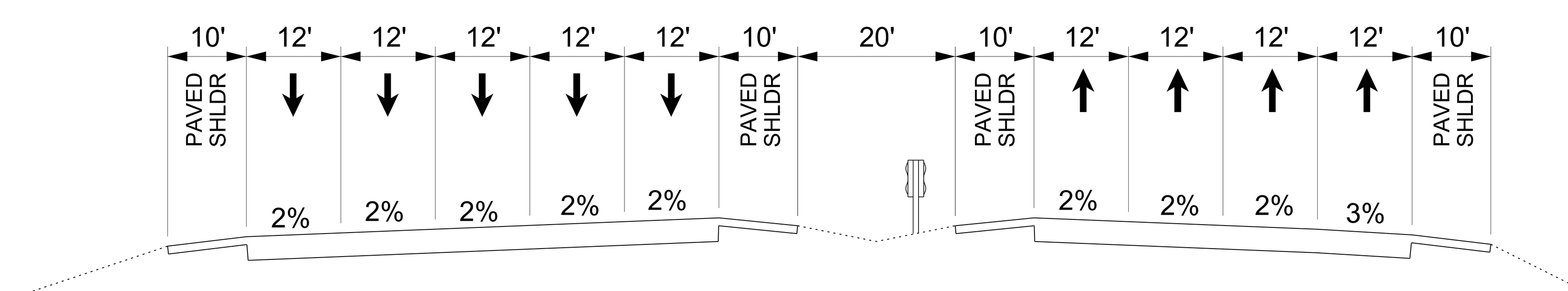
CURVE DATA
D=2° 30' 00"
R=2,291.83'
T=646.79'
L=1,290.79'
e=6.7%
DESIGN SPEED=60 MPH

SITE 4- FLORIDA'S TURNPIKE S OF COUNTY LINE RD



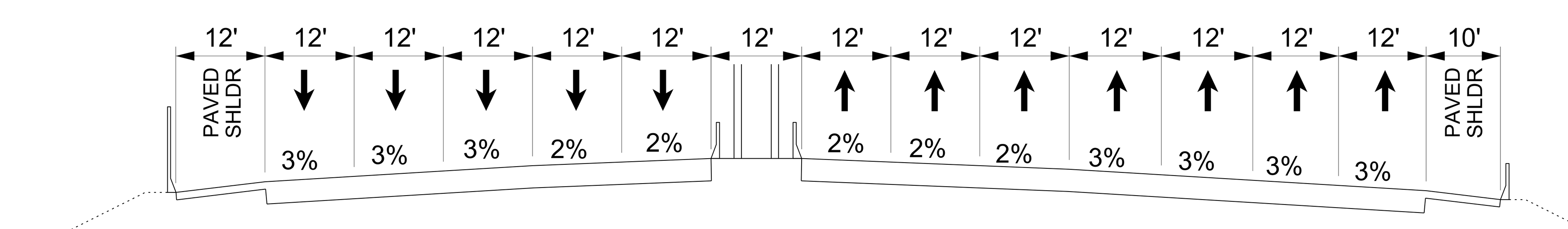
TANGENT SECTION
DESIGN SPEED=70 MPH

SITE 2-HEFT AT TAMIAMI TR



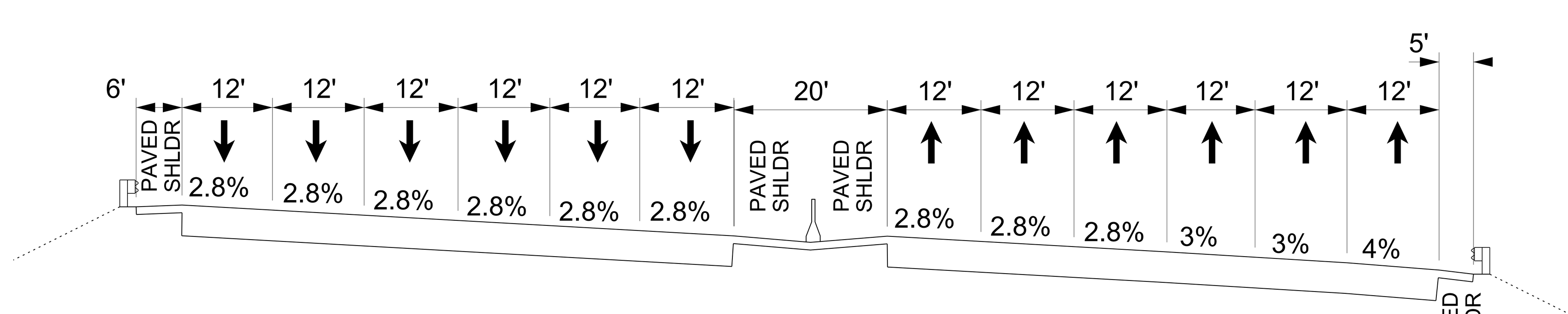
TANGENT SECTION
DESIGN SPEED=60 MPH

SITE 5- FLORIDA'S TURNPIKE N OF I-595



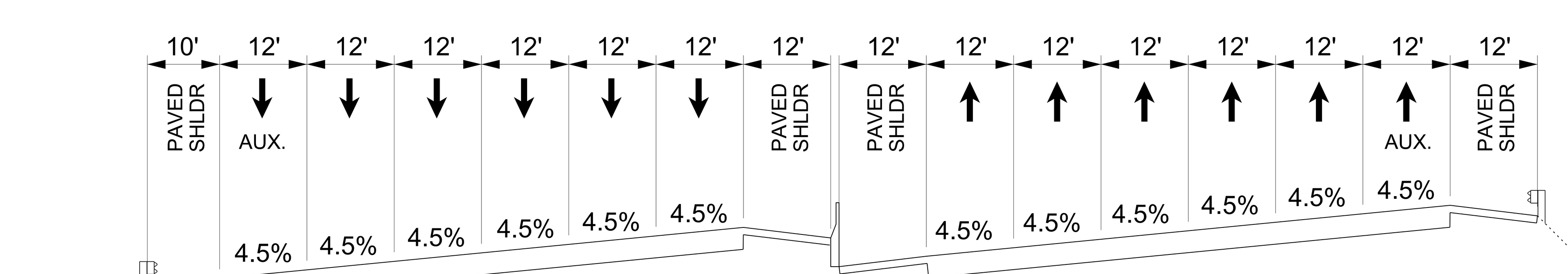
TANGENT SECTION
DESIGN SPEED=70 MPH

SITE 3-FLORIDA'S TURNPIKE N OF MIAMI GARDENS DR



CURVE DATA
D=0° 45' 00"
R=7,651.44'
T=749.61'
L=1,494.46'
e=2.8%
DESIGN SPEED=70 MPH

SITE 6- FLORIDA'S TURNPIKE E OF DANIEL WEBSTER PKWY



CURVE DATA
D=1° 14' 00"
R=4,645.60'
T=2,581.28'
L=4,712.16'
e=4.5%
DESIGN SPEED=70 MPH

Appendix C

Crash Data for 6 Sites – Florida's Turnpike

Crash_Num	Calendar_Y	Event_Cras	Event_Cr_1	Dhsmv_Day	Managing_D	Dept_Of_T	Roadway_I	Crsh_Loc_I	Final_Ref	Crsh_Loc_1	Final_Meas	Crash_Loca
819869340	2011	5/14/2011	1500	6	7	15	15190000	5.336	1209	0	MI	N
828250770	2011	9/6/2011	1855	2	7	15	15190000	5.346	1227	0	MI	S
820902060	2011	6/24/2011	2238	5	7	15	15190000	5.389	1227	0	MI	N
828250840	2011	9/10/2011	1230	6	7	15	15190000	5.56	1077	0	MI	N
820730680	2011	10/31/2011	605	1	7	15	15190000	5.573	1077	0	MI	N
828254410	2011	9/22/2011	2308	4	7	15	15190000	6.027	1081	0	MI	N
831706820	2012	6/25/2012	220	1	7	15	15190000	5.478	3678	0	MI	S
829099240	2012	6/1/2012	1008	5	7	15	15190000	5.599	1077	0	MI	N
820437450	2012	6/24/2012	1300	7	7	15	15190000	5.877	1080	0	MI	N
831565420	2012	5/24/2012	2127	4	7	15	15190000	6.144	1083	0	MI	S
833124670	2013	7/5/2013	1506	5	7	15	15190000	5.346	1227	0	MI	S
833051160	2013	5/1/2013	1510	3	7	15	15190000	5.484	3678	0		
837843470	2014	6/10/2014	1954	2	7	15	15190000	5.539	4180	0	MI	S
837480030	2014	3/24/2014	815	1	7	15	15190000	5.589	1077	0	MI	N
844873000	2014	8/22/2014	1323	5	7	15	15190000	5.819	1079	0	MI	N
845468800	2015	3/23/2015	835	1	7	15	15190000	5.308	1209	0	MI	S
848721420	2015	2/28/2015	1033	6	7	15	15190000	5.319	1209	0	MI	N
845550730	2015	4/28/2015	938	2	7	15	15190000	5.478	3678	0	MI	S
851519120	2015	8/31/2015	1330	1	7	15	15190000	5.589	1077	0	MI	N
851510040	2015	9/29/2015	36	2	7	15	15190000	5.819	1079	0	MI	N
851512060	2015	8/15/2015	1555	6	7	15	15190000	5.819	1079	0	MI	N
852001500	2015	11/22/2015	1220	7	7	15	15190000	5.819	1079	0	MI	N
851600880	2015	9/27/2015	1610	7	7	15	15190000	5.824	1079	0	MI	N
851195580	2015	7/14/2015	1135	2	7	15	15190000	5.828	1079	0	MI	N

Crash_Numb	Calendar_Y	Event_Cras	Event_Cr_1	Dhsmv_Day	Managing_D	Dept_Of_Tr	Roadway_Id	Crsh_Loc_F	Final_Ref	Crsh_Loc_1	Final_Meas	Crash_Loca
822536070.0	2011.0000	7/17/2011	2018.0	7.0	4.0	86.0	86070000.0	0.5	1476.0	0.0	MI	S
822566310.0	2011.0	9/29/2011	650.0	4.0	4.0	86.0	86070000.0	0.5	1476.0	0.0	MI	S
828219240.0	2011.0	10/8/2011	910.0	6.0	4.0	86.0	86070000.0	0.5	1476.0	0.0	MI	S
828229910.0	2011.0	12/13/2011	15.0	2.0	4.0	86.0	86070000.0	0.5	1476.0	0.0	MI	S
820001610.0	2011.0	4/5/2011	2339.0	2.0	4.0	86.0	86070000.0	0.6	1524.0	0.1	MI	N
828137570.0	2011.0	10/19/2011	1805.0	3.0	4.0	86.0	86070000.0	0.9	1477.0	0.1	MI	S
820934730.0	2011.0	3/29/2011	19.0	2.0	4.0	86.0	86070000.0	1.0	1523.0	0.0	MI	S
822459760.0	2011.0	8/24/2011	859.0	3.0	4.0	86.0	86070000.0	1.0	1523.0	0.0	MI	S
820004100.0	2011.0	1/21/2011	1547.0	5.0	4.0	86.0	86070000.0	1.1	1523.0	0.0	MI	N
820308950.0	2011.0	1/26/2011	948.0	3.0	4.0	86.0	86070000.0	1.3	1522.0	0.0	MI	N
820648560.0	2011.0	3/28/2011	2055.0	1.0	4.0	86.0	86070000.0	1.3	1522.0	0.0	MI	N
820943920.0	2011.0	5/6/2011	412.0	5.0	4.0	86.0	86070000.0	1.4	1478.0	0.0	MI	N
822743590.0	2011.0	8/1/2011	1637.0	1.0	4.0	86.0	86070000.0	1.4	1478.0	0.1	MI	N
828538430.0	2011.0	12/10/2011	246.0	6.0	4.0	86.0	86070000.0	1.6	1875.0	0.0	MI	N
820874760.0	2011.0	4/24/2011	133.0	7.0	4.0	86.0	86070000.0	1.7	1875.0	0.1	MI	N
828445880.0	2011.0	11/20/2011	825.0	7.0	4.0	86.0	86070000.0	3.6	1484.0	0.0	MI	S
845210890.0	2014.0	12/5/2014	937.0	5.0	4.0	86.0	86070000.0	0.2	8008.0	0.2	MI	N
844848050.0	2014.0	10/4/2014	1650.0	6.0	4.0	86.0	86070000.0	1.0	1523.0	0.0	MI	S
838144280.0	2014.0	9/20/2014	434.0	6.0	4.0	86.0	86070000.0	1.6	1875.0	0.0		
844827060.0	2014.0	9/20/2014	449.0	6.0	4.0	86.0	86070000.0	1.6	1875.0	0.1	MI	N
838144260.0	2014.0	9/18/2014	2249.0	4.0	4.0	86.0	86070000.0	1.7	1875.0	0.1	MI	N
837573290.0	2014.0	3/25/2014	340.0	2.0	4.0	86.0	86070000.0	1.4	1478.0	0.0	MI	N

Crash_Numb	Calendar_Y	Event_Cras	Event_Cr_1	Dhsmv_Day	Managing_D	Dept_Of_Tr	Roadway_Id	Crsh_Loc_F	Final_Ref	Crsh_Loc_1	Final_Meas	Crash_Loca
822735290	2011	40791	1647	1	4	86	86070000	12	1890	0	MI	N
820308790	2011	40669	940	5	4	86	86070000	12	1890	0	MI	N
820710770	2011	40733	856	6	4	86	86070000	12	1890	0	MI	N
822733690	2011	40764	2018	2	4	86	86070000	12	1890	0	MI	N
819969410	2011	40586	1135	6	4	86	86070000	12	1525	0	MI	S
831818220	2012	41175	439	7	4	86	86070000	12	1890	0	MI	N
831855040	2012	41242	709	4	4	86	86070000	12	1890	0	MI	N
828890450	2012	41047	1950	5	4	86	86070000	12	1890	0	MI	N
831548490	2012	41157	1918	3	4	86	86070000	12	1890	0	MI	N
828757440	2012	41083	2013	6	4	86	86070000	12	1525	0	MI	S
831458840	2012	41080	41	3	4	86	86070000	12	1525	0	MI	S
833279630	2013	41483	315	7	4	86	86070000	12	1890	0	MI	N
837177820	2013	41599	9	4	4	86	86070000	12	1890	0	MI	N
837177840	2013	41599	140	4	4	86	86070000	12	1890	0	MI	N
836730630	2013	41542	1336	3	4	86	86070000	12	1890	0	MI	N
836824930	2013	41586	2035	5	4	86	86070000	12	1525	0	MI	S
838164990	2014	41826	911	7	4	86	86070000	12	1936	0	MI	S
845194240	2014	41953	316	1	4	86	86070000	12	1890	0	MI	N
845030330	2014	41896	400	7	4	86	86070000	12	1890	0	MI	N
845562340	2014	41999	1709	5	4	86	86070000	12	1890	0	MI	N
845706590	2015	42141	1009	7	4	86	86070000	12	1890	0	MI	N
851755810	2015	42269	2115	2	4	86	86070000	12	1890	0	MI	N
852250290	2015	42343	230	6	4	86	86070000	12	1890	0	MI	N

Crash_Numb	Calendar_Y	Event_Cras	Event_Cr_1	Dhsmv_Day	Managing_D	Dept_Of_Tr	Roadway_Id	Crsh_Loc_F	Final_Ref	Crsh_Loc_1	Final_Meas	Crash_Loca
838151640	2014	41899	1720	3	4	93	93220000	2	2127	0	MI	N
822443550	2011	40677	1755	6	4	93	93220000	2	2158	0	MI	S
828233120	2011	40804	17	7	4	93	93220000	2	2158	0	MI	S
836427630	2013	41459	2238	4	4	93	93220000	2	2158	0	MI	S
837096300	2013	41599	300	4	4	93	93220000	2	2158	0	MI	S
848840790	2015	42202	1902	5	4	93	93220000	2	2158	0	MI	S
819891040	2011	40678	10	7	4	93	93220000	3	2158	0	MI	S
836886600	2013	41609	2210	7	4	93	93220000	3	2158	0	MI	S
822443740	2011	40726	2355	6	4	93	93220000	3	2227	0	MI	S
837074190	2013	41587	255	6	4	93	93220000	3	2227	0	MI	S
836744460	2014	41676	127	4	4	93	93220000	3	2227	0	MI	S
845023170	2014	41908	730	5	4	93	93220000	3	2227	0	MI	S

`	Calendar_Y	Event_Cras	Event_Cr_1	Dhsmv_Day	Managing_D	Dept_Of_Tr	Roadway_Id	Crsh_Loc_F	Final_Ref	Crsh_Loc_1	Final_Meas	Crash_Loca
852226750	2015	12/4/2015	15	5	4	93	93220000	22	4269	0	MI	N
820152620	2011	7/18/2011	1105	1	4	93	93220000	23	2259	0	MI	S
828956990	2012	9/15/2012	1337	6	4	93	93220000	23	2259	0	MI	S
844854960	2014	10/23/2014	340	4	4	93	93220000	23	2215	0	MI	S
828813680	2012	8/11/2012	1839	6	4	93	93220000	23	2259	0	MI	S
819765260	2012	8/12/2012	1520	7	4	93	93220000	23	4272	0	MI	N
828673750	2012	2/7/2012	1155	2	4	93	93220000	23	4272	0	MI	N
829068450	2013	7/10/2013	354	3	4	93	93220000	23	4272	0	MI	N
833029020	2013	7/19/2013	612	5	4	93	93220000	23	4272	0	MI	N
833029360	2013	11/9/2013	933	6	4	93	93220000	23	4272	0	MI	N
837352960	2014	4/11/2014	1637	5	4	93	93220000	23	4272	0	MI	N
838168800	2014	7/15/2014	1200	2	4	93	93220000	23	4272	0	MI	N
845009940	2014	9/18/2014	2140	4	4	93	93220000	23	4272	0	MI	N
833148620	2015	9/17/2015	830	4	4	93	93220000	23	4272	0	MI	N
820150070	2013	1/17/2013	55	4	4	93	93220000	23	2260	0	MI	S
832824610	2013	2/16/2013	56	6	4	93	93220000	23	2260	0	MI	S
848841730	2015	6/3/2015	1330	3	4	93	93220000	23	2216	0	MI	N
836922240	2013	12/14/2013	446	6	4	93	93220000	23	2260	0	MI	S
831726340	2012	8/25/2012	400	6	4	93	93220000	23	2216	0	MI	N
836561550	2013	9/13/2013	430	5	4	93	93220000	23	2216	0	MI	N
837086760	2013	11/20/2013	710	3	4	93	93220000	23	2216	0	MI	N
845009820	2014	9/11/2014	2321	4	4	93	93220000	23	2217	0	MI	S
833054870	2013	6/9/2013	1416	7	4	93	93220000	23	2217	0	MI	S
828150870	2012	4/13/2012	330	5	4	93	93220000	23	2217	0	MI	S
831770330	2012	10/2/2012	1711	2	4	93	93220000	23	2217	0	MI	S
831964110	2012	9/22/2012	1115	6	4	93	93220000	23	2217	0	MI	S
836847430	2013	9/17/2013	1025	2	4	93	93220000	24	2218	0	MI	S
828374670	2012	1/24/2012	500	2	4	93	93220000	24	2218	0	MI	N
844807010	2014	7/15/2014	1300	2	4	93	93220000	24	2262	0	MI	N

Crash_Numb	Calendar_Y	Event_Cras	Event_Cr_1	Dhsmv_Day	Managing_D	Dept_Of_Tr	Roadway_Id	Crsh_Loc_F	Final_Ref	Crsh_Loc_1	Final_Meas	Crash_Loca
822402970	2011	6/24/2011	1230	5	7	15	15190000	7.409	1993	0	MI	N
822639420	2011	8/28/2011	2108	7	7	15	15190000	7.447	1993	0	MI	N
828154890	2011	8/9/2011	1253	2	7	15	15190000	7.541	2022	0	MI	S
822658630	2011	7/16/2011	1600	6	7	15	15190000	7.602	1994	0	MI	N
822679230	2011	8/16/2011	210	2	7	15	15190000	7.602	1994	0	MI	N
828154880	2011	8/9/2011	1425	2	7	15	15190000	7.672	1994	0	MI	N
822773010	2011	9/7/2011	0	3	7	15	15190000	7.842	4182	0	MI	S
831476420	2012	6/22/2012	2110	5	7	15	15190000	7.371	1993	0	MI	N
833368820	2013	6/29/2013	1200	6	7	15	15190000	7.452	2022	0	MI	S
833218590	2013	6/25/2013	2234	2	7	15	15190000	7.541	2022	0	MI	S
833132130	2013	9/24/2013	848	2	7	15	15190000	7.552	2022	0	MI	N
833384450	2013	7/17/2013	1643	3	7	15	15190000	7.602	1994	0	MI	N
837175380	2013	12/29/2013	1446	7	7	15	15190000	7.806	1994	0	MI	N
833283590	2013	7/13/2013	1727	6	7	15	15190000	7.818	1994	0	MI	N
832897460	2013	4/29/2013	59	1	7	15	15190000	8.092	2020	0	MI	N
836722510	2013	9/14/2013	1555	6	7	15	15190000	8.242	1996	0	MI	N
836544970	2013	7/26/2013	1031	5	7	15	15190000	8.304	2018	0	MI	S
844783870	2014	9/17/2014	923	3	7	15	15190000	7.55	2022	0		
844742740	2014	8/23/2014	1500	6	7	15	15190000	7.827	1994	0	MI	N
851876280	2015	8/30/2015	2139	7	7	15	15190000	7.409	1993	0	MI	N
851519050	2015	7/17/2015	1048	5	7	15	15190000	7.552	2022	0	MI	N
837825300	2015	3/27/2015	1800	5	7	15	15190000	7.602	1994	0	MI	N
845366550	2015	2/28/2015	1100	6	7	15	15190000	7.731	1994	0	MI	N
851891180	2015	9/28/2015	1811	1	7	15	15190000	7.818	1994	0	MI	N
845247670	2015	2/9/2015	1520	1	7	15	15190000	7.823	1994	0	MI	N
851165010	2015	6/9/2015	2321	2	7	15	15190000	8.19	1996	0	MI	S

Appendix D

High Crash Segment List (2011-2013) - Florida's Turnpike

2011-2013 High Crash Segment List

State Road	From MP	To MP	Total # of Crashes	AADT	No of Yrs Analyzed	Crash Rate/Crash Frequency				Economic Cost					Rank	
						Crash Rate	Crash Rate Rank	Crash Freq (per year)	Crash Freq Rank	PDO	Injury	Fatal	Total Cost	Rank	Sum of Ranks	Final Rank
SR 91	0	1	281	75800	3	3.385501	1	93.67	1	$1,404,000	$23,433,258	$ -	$ 24,837,258	14	16	**2**
SR 91	1	2	65	75800	3	0.783123	40	21.67	34	$ 292,500	$ 7,210,233	$ -	$ 7,502,733	111	185	**46**
SR 91	2	3	46	82000	3	0.512306	129	15.33	66	$ 182,000	$ 6,489,210	$ -	$ 6,671,210	124	319	**87**
SR 91	3	4	19	82300	3	0.210834	375	6.33	188	$ 78,000	$ 2,523,582	$ -	$ 2,601,582	238	801	**286**
SR 91	47	48	36	107500	3	0.30583	297	12.00	91	$ 149,500	$ 4,686,652	$ -	$ 4,836,152	162	550	**175**
SR 91	48	49	36	107500	3	0.30583	297	12.00	91	$ 149,500	$ 4,686,652	$ -	$ 4,836,152	162	550	**175**
SR 91	49	50	96	111200	3	0.78841	38	32.00	18	$ 448,500	$ 9,733,815	$ -	$ 10,182,315	94	150	**34**
SR 91	50	51	89	111700	3	0.72765	59	29.67	21	$ 357,500	$12,257,397	$ -	$ 12,614,897	67	147	**32**
SR 91	51	52	59	111700	3	0.482375	149	19.67	43	$ 234,000	$ 8,291,768	$ -	$ 8,525,768	107	299	**82**
SR 91	52	53	62	111700	3	0.506902	133	20.67	39	$ 234,000	$ 9,373,303	$ -	$ 9,607,303	100	272	**72**
SR 91	53	54	105	111700	3	0.858464	29	35.00	13	$ 403,000	$15,141,490	$10,100,000	$ 25,644,490	10	52	**9**
SR 91	54	55	138	103300	3	1.220014	12	46.00	5	$ 565,500	$17,665,072	$20,200,000	$ 38,430,572	3	20	**3**
SR 91	55	56	139	103300	3	1.228854	10	46.33	4	$ 630,500	$15,141,490	$ -	$ 15,771,990	48	62	**15**
SR 91	56	57	122	103300	3	1.078563	19	40.67	9	$ 500,500	$16,223,025	$ -	$ 16,723,525	40	68	**16**
SR 91	57	58	57	103300	3	0.503919	136	19.00	45	$ 260,000	$ 5,768,187	$10,100,000	$ 16,128,187	46	227	**60**
SR 91	58	59	64	103300	3	0.565803	99	21.33	37	$ 260,000	$ 8,291,768	$10,100,000	$ 18,651,768	33	169	**39**
SR 91	59	60	53	102400	3	0.472674	158	17.67	51	$ 247,000	$ 5,407,675	$ -	$ 5,654,675	143	352	**101**
SR 91	60	61	36	102400	3	0.321062	278	12.00	91	$ 110,500	$ 6,849,722	$ -	$ 6,960,222	120	489	**147**
SR 91	61	62	55	102400	3	0.490511	147	18.33	48	$ 182,000	$ 9,733,815	$ -	$ 9,915,815	96	291	**80**
SR 91	62	63	49	92000	3	0.486401	148	16.33	58	$ 156,000	$ 9,012,792	$ -	$ 9,168,792	103	309	**84**
SR 91	63	64	74	92000	3	0.734564	54	24.67	27	$ 299,000	$10,094,327	$ -	$ 10,393,327	92	173	**40**
SR 91	64	65	30	92000	3	0.297796	304	10.00	120	$ 104,000	$ 5,047,163	$ -	$ 5,151,163	159	583	**190**
SR 91	65	66	35	92000	3	0.347429	254	11.67	97	$ 130,000	$ 5,407,675	$ -	$ 5,537,675	148	499	**148**
SR 91	66	67	43	79000	3	0.497081	142	14.33	77	$ 162,500	$ 6,489,210	$ -	$ 6,651,710	125	344	**96**
SR 91	67	68	30	82000	3	0.334113	268	10.00	120	$ 97,500	$ 5,407,675	$ -	$ 5,505,175	151	539	**169**
SR 91	68	69	41	82000	3	0.456621	174	13.67	80	$ 162,500	$ 5,768,187	$ -	$ 5,930,687	134	388	**112**
SR 91	69	70	53	73700	3	0.656741	66	17.67	51	$ 156,000	$10,094,327	$10,100,000	$ 20,350,327	28	145	**30**
SR 91	70	71	40	73700	3	0.495654	143	13.33	81	$ 162,500	$ 4,686,652	$20,200,000	$ 25,049,152	13	237	**63**
SR 91	71	72	70	87400	3	0.73143	56	23.33	31	$ 227,500	$12,617,908	$ -	$ 12,845,408	63	150	**34**
SR 91	72	73	50	87400	3	0.52245	126	16.67	55	$ 162,500	$ 9,012,792	$ -	$ 9,175,292	102	283	**77**
SR 91	73	74	44	87400	3	0.459756	170	14.67	71	$ 149,500	$ 7,570,745	$ -	$ 7,720,245	110	351	**99**
SR 91	74	75	57	87400	3	0.595593	87	19.00	45	$ 247,000	$ 6,849,722	$ -	$ 7,096,722	115	247	**66**
SR 91	75	76	68	87400	3	0.710532	61	22.67	32	$ 273,000	$ 9,373,303	$ -	$ 9,646,303	98	191	**47**
SR 91	76	77	46	81100	3	0.517992	128	15.33	66	$ 182,000	$ 6,128,698	$10,100,000	$ 16,410,698	44	238	**64**
SR 91	77	78	24	81100	3	0.270257	339	8.00	157	$ 71,500	$ 4,686,652	$ -	$ 4,758,152	170	666	**230**
SR 91	78	79	30	81100	3	0.337821	258	10.00	120	$ 97,500	$ 5,407,675	$ -	$ 5,505,175	151	529	**165**
SR 91	79	80	37	81100	3	0.416646	196	12.33	88	$ 123,500	$ 6,128,698	$10,100,000	$ 16,352,198	45	329	**90**
SR 91	80	81	25	81100	3	0.281517	330	8.33	149	$ 104,000	$ 3,244,605	$ -	$ 3,348,605	207	686	**235**
SR 91	81	82	30	81100	3	0.337821	258	10.00	120	$ 84,500	$ 6,128,698	$ -	$ 6,213,198	131	509	**152**
SR 91	82	83	44	76000	3	0.528719	122	14.67	71	$ 188,500	$ 5,407,675	$ -	$ 5,596,175	144	337	**92**
SR 91	83	84	62	76000	3	0.745013	52	20.67	39	$ 208,000	$10,815,350	$ -	$ 11,023,350	85	176	**42**

State Road	From MP	To MP	Total # of Crashes	AADT	No of Yrs Analyzed	Crash Rate/Crash Frequency				Economic Cost					Rank	
						Crash Rate	Crash Rate Rank	Crash Freq (per year)	Crash Freq Rank	PDO	Injury	Fatal	Total Cost	Rank	Sum of Ranks	Final Rank
SR 91	84	85	40	76000	3	0.480654	151	13.33	81	$ 136,500	$ 6,849,722	$ -	$ 6,986,222	118	350	**98**
SR 91	85	86	44	76000	3	0.528719	122	14.67	71	$ 175,500	$ 6,128,698	$ -	$ 6,304,198	128	321	**88**
SR 91	86	87	28	76000	3	0.336458	262	9.33	133	$ 97,500	$ 4,686,652	$ -	$ 4,784,152	168	563	**183**
SR 91	87	88	32	63700	3	0.458771	171	10.67	114	$ 84,500	$ 6,849,722	$ -	$ 6,934,222	121	406	**124**
SR 91	88	89	35	63700	3	0.501781	138	11.67	97	$ 117,000	$ 6,128,698	$ -	$ 6,245,698	130	365	**106**
SR 91	89	90	33	63700	3	0.473108	157	11.00	106	$ 130,000	$ 4,686,652	$ -	$ 4,816,652	164	427	**133**
SR 91	90	91	30	63700	3	0.430098	184	10.00	120	$ 104,000	$ 5,047,163	$ -	$ 5,151,163	159	463	**142**
SR 91	91	92	32	63700	3	0.458771	171	10.67	114	$ 104,000	$ 5,768,187	$ -	$ 5,872,187	139	424	**130**
SR 91	92	93	44	63700	3	0.630811	75	14.67	71	$ 110,500	$ 9,373,303	$10,100,000	$ 19,583,803	30	176	**42**
SR 91	93	94	35	60100	3	0.531838	121	11.67	97	$ 136,500	$ 5,047,163	$ -	$ 5,183,663	155	373	**110**
SR 91	94	95	47	60100	3	0.714183	60	15.67	63	$ 117,000	$10,094,327	$10,100,000	$ 20,311,327	29	152	**36**
SR 91	95	96	19	60000	3	0.289193	311	6.33	188	$ 65,000	$ 3,244,605	$ -	$ 3,309,605	212	711	**244**
SR 91	96	97	49	60000	3	0.745814	49	16.33	58	$ 188,500	$ 7,210,233	$ -	$ 7,398,733	112	219	**58**
SR 91	97	98	64	60000	3	0.974125	21	21.33	37	$ 247,000	$ 9,373,303	$ -	$ 9,620,303	99	157	**37**
SR 91	98	99	27	60000	3	0.410959	199	9.00	138	$ 149,500	$ 1,442,047	$ -	$ 1,591,547	309	646	**222**
SR 91	99	100	33	56000	3	0.53816	112	11.00	106	$ 130,000	$ 4,686,652	$ -	$ 4,816,652	164	382	**111**
SR 91	100	101	50	56200	3	0.812493	32	16.67	55	$ 175,500	$ 7,931,257	$10,100,000	$ 18,206,757	35	122	**26**
SR 91	101	102	34	56200	3	0.552495	105	11.33	102	$ 123,500	$ 5,407,675	$ -	$ 5,531,175	149	356	**102**
SR 91	102	103	31	56200	3	0.503746	137	10.33	118	$ 110,500	$ 5,047,163	$ -	$ 5,157,663	158	413	**126**
SR 91	103	104	26	56200	3	0.422496	193	8.67	141	$ 91,000	$ 4,326,140	$ -	$ 4,417,140	177	511	**155**
SR 91	104	105	39	56200	3	0.633744	74	13.00	85	$ 123,500	$ 7,210,233	$ -	$ 7,333,733	113	272	**72**
SR 91	105	106	22	50200	3	0.400226	203	7.33	168	$ 65,000	$ 4,326,140	$ -	$ 4,391,140	183	554	**179**
SR 91	106	107	30	50200	3	0.545762	108	10.00	120	$ 104,000	$ 4,686,652	$10,100,000	$ 14,890,652	53	281	**76**
SR 91	107	108	33	50200	3	0.600338	86	11.00	106	$ 91,000	$ 6,489,210	$10,100,000	$ 16,680,210	41	233	**61**
SR 91	108	109	28	50200	3	0.509378	130	9.33	133	$ 78,000	$ 5,768,187	$ -	$ 5,846,187	142	405	**122**
SR 91	109	110	21	50200	3	0.382034	220	7.00	172	$ 65,000	$ 3,965,628	$ -	$ 4,030,628	189	581	**187**
SR 91	110	111	18	39000	3	0.421496	194	6.00	195	$ 58,500	$ 3,244,605	$ -	$ 3,303,105	213	602	**200**
SR 91	111	112	17	39000	3	0.39808	205	5.67	207	$ 39,000	$ 3,965,628	$ -	$ 4,004,628	194	606	**205**
SR 91	112	113	21	39000	3	0.491746	144	7.00	172	$ 110,500	$ 1,442,047	$ -	$ 1,552,547	310	626	**209**
SR 91	113	114	25	39000	3	0.585412	89	8.33	149	$ 104,000	$ 2,884,093	$10,100,000	$ 13,088,093	60	298	**81**
SR 91	114	115	8	39000	3	0.187332	391	2.67	333	$ 32,500	$ 1,081,535	$ -	$ 1,114,035	354	1078	**374**
SR 91	115	116	14	39000	3	0.32783	272	4.67	239	$ 45,500	$ 2,523,582	$ -	$ 2,569,082	245	756	**265**
SR 91	116	117	13	39000	3	0.304414	300	4.33	257	$ 26,000	$ 3,244,605	$ -	$ 3,270,605	216	773	**274**
SR 91	118	119	8	35500	3	0.205801	380	2.67	333	$ 32,500	$ 1,081,535	$ -	$ 1,114,035	354	1067	**369**
SR 91	119	120	12	35500	3	0.308702	294	4.00	274	$ 39,000	$ 2,163,070	$ -	$ 2,202,070	272	840	**301**
SR 91	120	121	12	35500	3	0.308702	294	4.00	274	$ 39,000	$ 2,163,070	$ -	$ 2,202,070	272	840	**301**
SR 91	121	122	8	35500	3	0.205801	380	2.67	333	$ 39,000	$ 721,023	$ -	$ 760,023	382	1095	**380**
SR 91	122	123	15	35500	3	0.385877	216	5.00	224	$ 78,000	$ 1,081,535	$ -	$ 1,159,535	336	776	**278**
SR 91	123	124	18	35500	3	0.463052	163	6.00	195	$ 52,000	$ 3,244,605	$10,100,000	$ 13,396,605	57	415	**127**
SR 91	124	125	11	35500	3	0.282976	327	3.67	286	$ 45,500	$ 1,442,047	$ -	$ 1,487,547	317	930	**335**
SR 91	125	126	10	35500	3	0.257251	348	3.33	302	$ 32,500	$ 1,802,558	$ -	$ 1,835,058	298	948	**336**
SR 91	126	127	9	35500	3	0.231526	360	3.00	320	$ 39,000	$ 1,081,535	$ -	$ 1,120,535	351	1031	**356**

State Road	From MP	To MP	Total # of Crashes	AADT	No of Yrs Analyzed	Crash Rate/Crash Frequency				Economic Cost					Rank	
						Crash Rate	Crash Rate Rank	Crash Freq (per year)	Crash Freq Rank	PDO	Injury	Fatal	Total Cost	Rank	Sum of Ranks	Final Rank
SR 91	127	128	15	35500	3	0.385877	216	5.00	224	$ 45,500	$ 2,884,093	$ -	$ 2,929,593	227	667	**231**
SR 91	128	129	11	35500	3	0.282976	327	3.67	286	$ 52,000	$ 721,023	$10,100,000	$ 10,873,023	86	699	**240**
SR 91	129	130	12	35500	3	0.308702	294	4.00	274	$ 45,500	$ 1,442,047	$10,100,000	$ 11,587,547	76	644	**220**
SR 91	130	131	15	35500	3	0.385877	216	5.00	224	$ 78,000	$ 1,081,535	$ -	$ 1,159,535	336	776	**278**
SR 91	131	132	11	35500	3	0.282976	327	3.67	286	$ 52,000	$ 1,081,535	$ -	$ 1,133,535	343	956	**340**
SR 91	132	133	13	35500	3	0.334427	267	4.33	257	$ 45,500	$ 2,163,070	$ -	$ 2,208,570	269	793	**283**
SR 91	133	134	14	35500	3	0.360152	240	4.67	239	$ 52,000	$ 2,163,070	$ -	$ 2,215,070	268	747	**262**
SR 91	134	135	18	40400	3	0.40689	202	6.00	195	$ 52,000	$ 3,605,117	$ -	$ 3,657,117	202	599	**199**
SR 91	135	136	12	40400	3	0.27126	337	4.00	274	$ 58,500	$ 1,081,535	$ -	$ 1,140,035	341	952	**338**
SR 91	136	137	14	40400	3	0.31647	288	4.67	239	$ 45,500	$ 2,523,582	$ -	$ 2,569,082	245	772	**272**
SR 91	137	138	14	38000	3	0.336458	262	4.67	239	$ 45,500	$ 2,523,582	$ -	$ 2,569,082	245	746	**260**
SR 91	138	139	14	38000	3	0.336458	262	4.67	239	$ 78,000	$ 721,023	$ -	$ 799,023	380	881	**316**
SR 91	139	140	17	38000	3	0.408556	200	5.67	207	$ 39,000	$ 3,244,605	$20,200,000	$ 23,483,605	19	426	**132**
SR 91	140	141	15	38000	3	0.36049	239	5.00	224	$ 71,500	$ 1,442,047	$ -	$ 1,513,547	311	774	**275**
SR 91	141	142	13	38000	3	0.312425	290	4.33	257	$ 32,500	$ 2,884,093	$ -	$ 2,916,593	230	777	**280**
SR 91	142	143	17	38000	3	0.408556	200	5.67	207	$ 58,500	$ 2,884,093	$ -	$ 2,942,593	223	630	**212**
SR 91	143	144	10	32600	3	0.280136	332	3.33	302	$ 26,000	$ 2,163,070	$ -	$ 2,189,070	278	912	**325**
SR 91	144	145	18	32600	3	0.504244	135	6.00	195	$ 78,000	$ 2,163,070	$ -	$ 2,241,070	260	590	**194**
SR 91	145	146	19	32600	3	0.532258	120	6.33	188	$ 78,000	$ 2,523,582	$ -	$ 2,601,582	238	546	**173**
SR 91	146	147	8	32600	3	0.224108	362	2.67	333	$ 39,000	$ 721,023	$ -	$ 760,023	382	1077	**373**
SR 91	147	148	8	32600	3	0.224108	362	2.67	333	$ 6,500	$ 2,523,582	$ -	$ 2,530,082	255	950	**337**
SR 91	148	149	8	32600	3	0.224108	362	2.67	333	$ 26,000	$ 1,442,047	$ -	$ 1,468,047	322	1017	**354**
SR 91	149	150	9	32600	3	0.252122	349	3.00	320	$ 39,000	$ 1,081,535	$ -	$ 1,120,535	351	1020	**355**
SR 91	150	151	10	32600	3	0.280136	332	3.33	302	$ 26,000	$ 2,163,070	$ -	$ 2,189,070	278	912	**325**
SR 91	151	152	13	32600	3	0.364176	237	4.33	257	$ 39,000	$ 2,523,582	$ -	$ 2,562,582	250	744	**257**
SR 91	152	153	23	32600	3	0.644312	68	7.67	162	$ 91,000	$ 3,244,605	$ -	$ 3,335,605	208	438	**136**
SR 91	153	154	13	26900	3	0.441344	180	4.33	257	$ 45,500	$ 2,163,070	$ -	$ 2,208,570	269	706	**243**
SR 91	154	155	15	26900	3	0.509243	131	5.00	224	$ 65,000	$ 1,802,558	$ -	$ 1,867,558	287	642	**217**
SR 91	155	156	14	25700	3	0.497486	140	4.67	239	$ 71,500	$ 1,081,535	$ -	$ 1,153,035	338	717	**246**
SR 91	156	157	13	25700	3	0.461951	164	4.33	257	$ 65,000	$ 1,081,535	$ -	$ 1,146,535	340	761	**268**
SR 91	157	158	9	25700	3	0.319812	279	3.00	320	$ 32,500	$ 1,442,047	$ -	$ 1,474,547	318	917	**329**
SR 91	158	159	21	25700	3	0.746229	47	7.00	172	$ 84,500	$ 2,523,582	$10,100,000	$ 12,708,082	64	283	**77**
SR 91	159	160	12	25700	3	0.426417	188	4.00	274	$ 58,500	$ 1,081,535	$ -	$ 1,140,035	341	803	**287**
SR 91	160	161	9	25700	3	0.319812	279	3.00	320	$ 32,500	$ 1,442,047	$ -	$ 1,474,547	318	917	**329**
SR 91	162	163	12	25700	3	0.426417	188	4.00	274	$ 45,500	$ 1,802,558	$ -	$ 1,848,058	294	756	**265**
SR 91	163	164	10	25700	3	0.355347	242	3.33	302	$ 45,500	$ 1,081,535	$ -	$ 1,127,035	346	890	**318**
SR 91	164	165	11	25700	3	0.390882	208	3.67	286	$ 32,500	$ 1,802,558	$10,100,000	$ 11,935,058	74	568	**184**
SR 91	165	166	15	25700	3	0.533021	115	5.00	224	$ 58,500	$ 2,163,070	$ -	$ 2,221,570	265	604	**202**
SR 91	166	167	15	25700	3	0.533021	115	5.00	224	$ 71,500	$ 1,081,535	$10,100,000	$ 11,253,035	80	419	**129**
SR 91	167	168	16	25700	3	0.568555	94	5.33	215	$ 65,000	$ 2,163,070	$ -	$ 2,228,070	263	572	**185**
SR 91	169	170	11	25700	3	0.390882	208	3.67	286	$ 39,000	$ 1,802,558	$ -	$ 1,841,558	296	790	**282**
SR 91	171	172	13	25700	3	0.461951	164	4.33	257	$ 32,500	$ 2,884,093	$ -	$ 2,916,593	230	651	**225**

						Crash Rate/Crash Frequency				Economic Cost					Rank	
State Road	From MP	To MP	Total # of Crashes	AADT	No of Yrs Analyzed	Crash Rate	Crash Rate Rank	Crash Freq (per year)	Crash Freq Rank	PDO	Injury	Fatal	Total Cost	Rank	Sum of Ranks	Final Rank
SR 91	172	173	18	25700	3	0.639625	71	6.00	195	$ 84,500	$ 1,802,558	$ -	$ 1,887,058	285	551	**177**
SR 91	173	174	13	25700	3	0.461951	164	4.33	257	$ 32,500	$ 2,884,093	$ -	$ 2,916,593	230	651	**225**
SR 91	174	175	16	25700	3	0.568555	94	5.33	215	$ 45,500	$ 3,244,605	$ -	$ 3,290,105	214	523	**162**
SR 91	175	176	13	25700	3	0.461951	164	4.33	257	$ 58,500	$ 1,442,047	$ -	$ 1,500,547	313	734	**251**
SR 91	176	177	15	25700	3	0.533021	115	5.00	224	$ 58,500	$ 2,163,070	$ -	$ 2,221,570	265	604	**202**
SR 91	177	178	17	25700	3	0.60409	84	5.67	207	$ 97,500	$ 721,023	$ -	$ 818,523	379	670	**232**
SR 91	178	179	16	25700	3	0.568555	94	5.33	215	$ 84,500	$ 1,081,535	$ -	$ 1,166,035	335	644	**220**
SR 91	179	180	12	25700	3	0.426417	188	4.00	274	$ 39,000	$ 2,163,070	$ -	$ 2,202,070	272	734	**251**
SR 91	180	181	17	25700	3	0.60409	84	5.67	207	$ 39,000	$ 3,965,628	$ -	$ 4,004,628	194	485	**146**
SR 91	182	183	16	25700	3	0.568555	94	5.33	215	$ 52,000	$ 2,884,093	$ -	$ 2,936,093	225	534	**167**
SR 91	183	184	15	25700	3	0.533021	115	5.00	224	$ 52,000	$ 2,523,582	$ -	$ 2,575,582	243	582	**188**
SR 91	184	185	25	25700	3	0.888368	26	8.33	149	$ 123,500	$ 2,163,070	$ -	$ 2,286,570	257	432	**134**
SR 91	185	186	14	25700	3	0.497486	140	4.67	239	$ 52,000	$ 1,802,558	$10,100,000	$ 11,954,558	73	452	**139**
SR 91	187	188	8	25700	3	0.284278	317	2.67	333	$ 26,000	$ 1,442,047	$ -	$ 1,468,047	322	972	**343**
SR 91	188	189	10	25700	3	0.355347	242	3.33	302	$ 45,500	$ 1,081,535	$ -	$ 1,127,035	346	890	**318**
SR 91	191	192	9	25700	3	0.319812	279	3.00	320	$ 32,500	$ 1,442,047	$ -	$ 1,474,547	318	917	**329**
SR 91	192	193	8	25700	3	0.284278	317	2.67	333	$ 32,500	$ 721,023	$10,100,000	$ 10,853,523	87	737	**253**
SR 91	193	194	36	25700	3	1.27925	6	12.00	91	$ 130,000	$ 5,047,163	$20,200,000	$ 25,377,163	11	108	**21**
SR 91	194	195	10	25700	3	0.355347	242	3.33	302	$ 13,000	$ 2,523,582	$10,100,000	$ 12,636,582	66	610	**207**
SR 91	195	196	9	25700	3	0.319812	279	3.00	320	$ 13,000	$ 2,163,070	$10,100,000	$ 12,276,070	71	670	**232**
SR 91	197	198	9	25700	3	0.319812	279	3.00	320	$ 32,500	$ 1,442,047	$ -	$ 1,474,547	318	917	**329**
SR 91	199	200	13	25700	3	0.461951	164	4.33	257	$ 19,500	$ 3,605,117	$ -	$ 3,624,617	205	626	**209**
SR 91	203	204	16	25700	3	0.568555	94	5.33	215	$ 65,000	$ 1,442,047	$20,200,000	$ 21,707,047	24	333	**91**
SR 91	204	205	19	25700	3	0.675159	64	6.33	188	$ 52,000	$ 3,965,628	$ -	$ 4,017,628	192	444	**137**
SR 91	205	206	18	25700	3	0.639625	71	6.00	195	$ 78,000	$ 2,163,070	$ -	$ 2,241,070	260	526	**164**
SR 91	207	208	11	25700	3	0.390882	208	3.67	286	$ 52,000	$ 1,081,535	$ -	$ 1,133,535	343	837	**299**
SR 91	208	209	8	25700	3	0.284278	317	2.67	333	$ 32,500	$ 721,023	$10,100,000	$ 10,853,523	87	737	**253**
SR 91	209	210	9	25700	3	0.319812	279	3.00	320	$ 45,500	$ 360,512	$10,100,000	$ 10,506,012	89	688	**236**
SR 91	214	215	8	25700	3	0.284278	317	2.67	333	$ 19,500	$ 1,802,558	$ -	$ 1,822,058	304	954	**339**
SR 91	215	216	10	25700	3	0.355347	242	3.33	302	$ 39,000	$ 1,081,535	$10,100,000	$ 11,220,535	82	626	**209**
SR 91	216	217	13	25700	3	0.461951	164	4.33	257	$ 58,500	$ 1,081,535	$10,100,000	$ 11,240,035	81	502	**150**
SR 91	219	220	10	25700	3	0.355347	242	3.33	302	$ 32,500	$ 1,802,558	$ -	$ 1,835,058	298	842	**305**
SR 91	221	222	15	25700	3	0.533021	115	5.00	224	$ 39,000	$ 3,244,605	$ -	$ 3,283,605	215	554	**179**
SR 91	222	223	10	25700	3	0.355347	242	3.33	302	$ 19,500	$ 2,523,582	$ -	$ 2,543,082	254	798	**285**
SR 91	223	224	8	25700	3	0.284278	317	2.67	333	$ 39,000	$ 721,023	$ -	$ 760,023	382	1032	**357**
SR 91	224	225	11	25700	3	0.390882	208	3.67	286	$ 32,500	$ 2,163,070	$ -	$ 2,195,570	276	770	**270**
SR 91	226	227	8	25700	3	0.284278	317	2.67	333	$ 26,000	$ 1,442,047	$ -	$ 1,468,047	322	972	**343**
SR 91	227	228	10	25700	3	0.355347	242	3.33	302	$ 32,500	$ 1,802,558	$ -	$ 1,835,058	298	842	**305**
SR 91	228	229	18	25700	3	0.639625	71	6.00	195	$ 39,000	$ 3,605,117	$20,200,000	$ 23,844,117	17	283	**77**
SR 91	230	231	11	25700	3	0.390882	208	3.67	286	$ 19,500	$ 2,884,093	$ -	$ 2,903,593	234	728	**250**
SR 91	231	232	8	25700	3	0.284278	317	2.67	333	$ 39,000	$ 721,023	$ -	$ 760,023	382	1032	**357**
SR 91	232	233	11	25700	3	0.390882	208	3.67	286	$ 26,000	$ 2,523,582	$ -	$ 2,549,582	252	746	**260**

State Road	From MP	To MP	Total # of Crashes	AADT	No of Yrs Analyzed	Crash Rate/Crash Frequency				Economic Cost					Rank	
						Crash Rate	Crash Rate Rank	Crash Freq (per year)	Crash Freq Rank	PDO	Injury	Fatal	Total Cost	Rank	Sum of Ranks	Final Rank
SR 91	234	235	8	25700	3	0.284278	317	2.67	333	$ 32,500	$ 1,081,535	$ -	$ 1,114,035	354	1004	**348**
SR 91	235	236	8	25700	3	0.284278	317	2.67	333	$ 32,500	$ 1,081,535	$ -	$ 1,114,035	354	1004	**348**
SR 91	236	237	34	25700	3	1.20818	14	11.33	102	$ 117,000	$ 5,407,675	$10,100,000	$ 15,624,675	49	165	**38**
SR 91	237	238	11	34000	3	0.295461	305	3.67	286	$ 26,000	$ 2,523,582	$ -	$ 2,549,582	252	843	**307**
SR 91	239	240	14	34000	3	0.376041	222	4.67	239	$ 13,000	$ 3,965,628	$10,100,000	$ 14,078,628	54	515	**157**
SR 91	240	241	16	34000	3	0.429761	185	5.33	215	$ 65,000	$ 2,163,070	$ -	$ 2,228,070	263	663	**229**
SR 91	241	242	11	34000	3	0.295461	305	3.67	286	$ 32,500	$ 2,163,070	$ -	$ 2,195,570	276	867	**312**
SR 91	242	243	20	34000	3	0.537201	113	6.67	181	$ 84,500	$ 2,523,582	$ -	$ 2,608,082	237	531	**166**
SR 91	243	244	20	32800	3	0.556855	103	6.67	181	$ 65,000	$ 3,244,605	$10,100,000	$ 13,409,605	56	340	**95**
SR 91	244	245	23	48900	3	0.429541	187	7.67	162	$ 65,000	$ 4,686,652	$ -	$ 4,751,652	171	520	**159**
SR 91	245	246	21	48900	3	0.39219	207	7.00	172	$ 52,000	$ 4,686,652	$ -	$ 4,738,652	173	552	**178**
SR 91	246	247	20	48900	3	0.373514	230	6.67	181	$ 58,500	$ 3,965,628	$ -	$ 4,024,128	191	602	**200**
SR 91	247	248	18	48900	3	0.336163	265	6.00	195	$ 65,000	$ 2,884,093	$ -	$ 2,949,093	221	681	**234**
SR 91	248	249	23	56200	3	0.373747	229	7.67	162	$ 65,000	$ 4,686,652	$ -	$ 4,751,652	171	562	**182**
SR 91	249	250	47	56200	3	0.763743	44	15.67	63	$ 136,500	$ 9,012,792	$10,100,000	$ 19,249,292	31	138	**29**
SR 91	250	251	30	63400	3	0.432133	182	10.00	120	$ 71,500	$ 6,849,722	$ -	$ 6,921,222	122	424	**130**
SR 91	251	252	20	63400	3	0.288089	313	6.67	181	$ 71,500	$ 3,244,605	$ -	$ 3,316,105	211	705	**241**
SR 91	252	253	25	63400	3	0.360111	241	8.33	149	$ 97,500	$ 3,605,117	$ -	$ 3,702,617	198	588	**193**
SR 91	253	254	24	63400	3	0.345707	255	8.00	157	$ 84,500	$ 3,605,117	$10,100,000	$ 13,789,617	55	467	**143**
SR 91	254	255	33	63400	3	0.475347	153	11.00	106	$ 123,500	$ 4,686,652	$10,100,000	$ 14,910,152	52	311	**85**
SR 91	255	256	52	63400	3	0.749031	46	17.33	54	$ 227,500	$ 5,407,675	$20,200,000	$ 25,835,175	9	109	**22**
SR 91	256	257	29	72900	3	0.363292	238	9.67	129	$ 91,000	$ 5,047,163	$10,100,000	$ 15,238,163	51	418	**128**
SR 91	257	258	29	68800	3	0.384942	219	9.67	129	$ 97,500	$ 5,047,163	$ -	$ 5,144,663	161	509	**152**
SR 91	258	259	31	68800	3	0.41149	198	10.33	118	$ 104,000	$ 5,047,163	$10,100,000	$ 15,251,163	50	366	**107**
SR 91	259	260	47	68800	3	0.623872	78	15.67	63	$ 130,000	$ 9,733,815	$ -	$ 9,863,815	97	238	**64**
SR 91	260	261	25	68800	3	0.331847	271	8.33	149	$ 91,000	$ 3,965,628	$ -	$ 4,056,628	187	607	**206**
SR 91	261	262	23	68800	3	0.305299	299	7.67	162	$ 71,500	$ 4,326,140	$ -	$ 4,397,640	182	643	**219**
SR 91	262	263	20	68800	3	0.265477	345	6.67	181	$ 78,000	$ 2,884,093	$ -	$ 2,962,093	219	745	**259**
SR 91	263	264	24	68800	3	0.318573	285	8.00	157	$ 91,000	$ 3,605,117	$ -	$ 3,696,117	200	642	**217**
SR 91	264	265	17	97500	3	0.159232	412	5.67	207	$ 65,000	$ 2,523,582	$ -	$ 2,588,582	240	859	**310**
SR 91	265	266	16	97500	3	0.149865	418	5.33	215	$ 71,500	$ 1,802,558	$ -	$ 1,874,058	286	919	**333**
SR 91	266	267	40	97500	3	0.374663	228	13.33	81	$ 162,500	$ 5,407,675	$ -	$ 5,570,175	146	455	**140**
SR 91	267	268	24	59100	3	0.37086	232	8.00	157	$ 117,000	$ 2,163,070	$ -	$ 2,280,070	258	647	**223**
SR 91	268	269	20	68100	3	0.268206	344	6.67	181	$ 91,000	$ 1,802,558	$10,100,000	$ 11,993,558	72	597	**196**
SR 91	269	270	14	68100	3	0.187744	389	4.67	239	$ 58,500	$ 1,802,558	$ -	$ 1,861,058	288	916	**327**
SR 91	270	271	14	68100	3	0.187744	389	4.67	239	$ 58,500	$ 1,802,558	$ -	$ 1,861,058	288	916	**327**
SR 91	271	272	28	68100	3	0.375489	225	9.33	133	$ 149,500	$ 1,802,558	$ -	$ 1,952,058	283	641	**216**
SR 91	272	273	36	41200	3	0.797978	35	12.00	91	$ 143,000	$ 5,047,163	$ -	$ 5,190,163	154	280	**75**
SR 91	273	274	25	41200	3	0.554152	104	8.33	149	$ 143,000	$ 1,081,535	$ -	$ 1,224,535	334	587	**192**
SR 91	274	275	13	41200	3	0.288159	312	4.33	257	$ 19,500	$ 3,605,117	$ -	$ 3,624,617	205	774	**275**
SR 91	275	276	14	41200	3	0.310325	291	4.67	239	$ 32,500	$ 2,884,093	$10,100,000	$ 13,016,593	62	592	**195**
SR 91	276	277	10	41200	3	0.221661	367	3.33	302	$ 26,000	$ 1,802,558	$10,100,000	$ 11,928,558	75	744	**257**

State Road	From MP	To MP	Total # of Crashes	AADT	No of Yrs Analyzed	Crash Rate/Crash Frequency				Economic Cost					Rank	
						Crash Rate	Crash Rate Rank	Crash Freq (per year)	Crash Freq Rank	PDO	Injury	Fatal	Total Cost	Rank	Sum of Ranks	Final Rank
SR 91	277	278	16	41200	3	0.354657	249	5.33	215	$ 52,000	$ 2,884,093	$ -	$ 2,936,093	225	689	**237**
SR 91	279	280	15	41200	3	0.332491	270	5.00	224	$ 45,500	$ 2,884,093	$ -	$ 2,929,593	227	721	**249**
SR 91	280	281	14	41200	3	0.310325	291	4.67	239	$ 58,500	$ 1,802,558	$ -	$ 1,861,058	288	818	**292**
SR 91	281	282	11	41200	3	0.243827	355	3.67	286	$ 52,000	$ 1,081,535	$ -	$ 1,133,535	343	984	**346**
SR 91	282	283	15	32200	3	0.425423	191	5.00	224	$ 52,000	$ 2,523,582	$ -	$ 2,575,582	243	658	**228**
SR 91	283	284	26	32200	3	0.7374	53	8.67	141	$ 84,500	$ 4,686,652	$ -	$ 4,771,152	169	363	**105**
SR 91	284	285	39	32200	3	1.106101	18	13.00	85	$ 156,000	$ 5,407,675	$ -	$ 5,563,675	147	250	**67**
SR 91	285	286	24	32200	3	0.680677	63	8.00	157	$ 78,000	$ 4,326,140	$ -	$ 4,404,140	181	401	**119**
SR 91	286	287	17	32200	3	0.482146	150	5.67	207	$ 65,000	$ 2,523,582	$ -	$ 2,588,582	240	597	**196**
SR 91	288	289	45	32200	3	1.27627	8	15.00	70	$ 188,500	$ 5,768,187	$ -	$ 5,956,687	133	211	**54**
SR 91	289	290	21	37000	3	0.518327	127	7.00	172	$ 78,000	$ 3,244,605	$ -	$ 3,322,605	210	509	**152**
SR 91	290	291	10	37000	3	0.246822	354	3.33	302	$ 52,000	$ 721,023	$ -	$ 773,023	381	1037	**362**
SR 91	291	292	14	37000	3	0.345551	256	4.67	239	$ 65,000	$ 1,442,047	$ -	$ 1,507,047	312	807	**290**
SR 91	292	293	15	36500	3	0.375305	226	5.00	224	$ 58,500	$ 2,163,070	$ -	$ 2,221,570	265	715	**245**
SR 91	293	294	11	36500	3	0.275224	336	3.67	286	$ 19,500	$ 2,884,093	$ -	$ 2,903,593	234	856	**308**
SR 91	294	295	12	36500	3	0.300244	303	4.00	274	$ 45,500	$ 1,802,558	$ -	$ 1,848,058	294	871	**313**
SR 91	295	296	9	36500	3	0.225183	361	3.00	320	$ 39,000	$ 1,081,535	$ -	$ 1,120,535	351	1032	**357**
SR 91	296	297	21	36500	3	0.525427	124	7.00	172	$ 84,500	$ 2,884,093	$ -	$ 2,968,593	218	514	**156**
SR 91	297	298	18	36500	3	0.450366	176	6.00	195	$ 78,000	$ 2,163,070	$ -	$ 2,241,070	260	631	**213**
SR 91	298	299	13	36500	3	0.325264	275	4.33	257	$ 52,000	$ 1,802,558	$ -	$ 1,854,558	292	824	**296**
SR 91	299	300	13	36500	3	0.325264	275	4.33	257	$ 52,000	$ 1,802,558	$ -	$ 1,854,558	292	824	**296**
SR 91	300	301	14	36500	3	0.350285	251	4.67	239	$ 45,500	$ 2,163,070	$10,100,000	$ 12,308,570	70	560	**181**
SR 91	301	302	18	36500	3	0.450366	176	6.00	195	$ 52,000	$ 3,605,117	$ -	$ 3,657,117	202	573	**186**
SR 91	304	305	19	34100	3	0.508845	132	6.33	188	$ 71,500	$ 2,884,093	$ -	$ 2,955,593	220	540	**170**
SR 91	305	306	11	34100	3	0.294594	307	3.67	286	$ 39,000	$ 1,802,558	$ -	$ 1,841,558	296	889	**317**
SR 91	306	307	13	34100	3	0.348157	253	4.33	257	$ 58,500	$ 1,442,047	$ -	$ 1,500,547	313	823	**294**
SR 91	307	308	14	34100	3	0.374938	227	4.67	239	$ 71,500	$ 1,081,535	$ -	$ 1,153,035	338	804	**289**
SR 417	1	2	10	14200	3	0.643128	69	3.33	302	$ 45,500	$ 1,081,535	$ -	$ 1,127,035	346	717	**246**
SR 417	38	39	29	52300	3	0.506387	134	9.67	129	$ 84,500	$ 5,768,187	$ -	$ 5,852,687	141	404	**120**
SR 417	41	42	22	40900	3	0.49123	145	7.33	168	$ 84,500	$ 3,244,605	$ -	$ 3,329,105	209	522	**160**
SR 417	42	43	9	40900	3	0.200958	382	3.00	320	$ 32,500	$ 1,081,535	$10,100,000	$ 11,214,035	83	785	**281**
SR 417	43	44	12	39000	3	0.280998	331	4.00	274	$ 32,500	$ 2,523,582	$ -	$ 2,556,082	251	856	**308**
SR 417	44	45	14	39000	3	0.32783	272	4.67	239	$ 45,500	$ 2,523,582	$ -	$ 2,569,082	245	756	**265**
SR 417	45	46	9	39000	3	0.210748	376	3.00	320	$ 19,500	$ 2,163,070	$ -	$ 2,182,570	281	977	**345**
SR 417	47	48	10	39000	3	0.234165	358	3.33	302	$ 32,500	$ 1,802,558	$ -	$ 1,835,058	298	958	**341**
SR 417	48	49	12	32100	3	0.341399	257	4.00	274	$ 39,000	$ 2,163,070	$ -	$ 2,202,070	272	803	**287**
SR 417	50	51	10	32100	3	0.284499	316	3.33	302	$ 45,500	$ 1,081,535	$ -	$ 1,127,035	346	964	**342**
SR 417	52	53	8	30500	3	0.239539	357	2.67	333	$ 32,500	$ 1,081,535	$ -	$ 1,114,035	354	1044	**364**
SR 429	5	6	8	9800	3	0.745504	50	2.67	333	$ 32,500	$ 1,081,535	$ -	$ 1,114,035	354	737	**253**
SR 429	7	8	11	12500	3	0.803653	34	3.67	286	$ 39,000	$ 1,442,047	$10,100,000	$ 11,581,047	77	397	**117**
SR 528	0	1	77	80000	3	0.878995	27	25.67	25	$ 279,500	$12,257,397	$ -	$ 12,536,897	68	120	**24**
SR 528	1	2	48	77900	3	0.562717	101	16.00	61	$ 188,500	$ 6,489,210	$10,100,000	$ 16,777,710	39	201	**51**

						Crash Rate/Crash Frequency				Economic Cost					Rank	
State Road	From MP	To MP	Total # of Crashes	AADT	No of Yrs Analyzed	Crash Rate	Crash Rate Rank	Crash Freq (per year)	Crash Freq Rank	PDO	Injury	Fatal	Total Cost	Rank	Sum of Ranks	Final Rank
SR 528	2	3	26	80700	3	0.294229	310	8.67	141	$ 97,500	$ 3,965,628	$ -	$ 4,063,128	186	637	**215**
SR 528	3	4	33	69900	3	0.431144	183	11.00	106	$ 143,000	$ 3,965,628	$ -	$ 4,108,628	185	474	**144**
SR 528	4	5	28	69900	3	0.365819	233	9.33	133	$ 104,000	$ 4,326,140	$ -	$ 4,430,140	176	542	**171**
SR 528	5	6	12	69900	3	0.15678	413	4.00	274	$ 52,000	$ 1,442,047	$ -	$ 1,494,047	315	1002	**347**
SR 528	6	7	21	86200	3	0.222484	366	7.00	172	$ 91,000	$ 2,523,582	$ -	$ 2,614,582	236	774	**275**
SR 528	7	8	14	86200	3	0.148322	419	4.67	239	$ 45,500	$ 2,523,582	$ -	$ 2,569,082	245	903	**321**
SR 528	8	9	9	86200	3	0.09535	440	3.00	320	$ 26,000	$ 1,442,047	$10,100,000	$ 11,568,047	79	839	**300**
SR 568	2	3.2	10	10200	3	0.746113	48	3.33	302	$ 32,500	$ 1,802,558	$ -	$ 1,835,058	298	648	**224**
SR 570	0	1	10	21500	3	0.424764	192	3.33	302	$ 45,500	$ 1,081,535	$ -	$ 1,127,035	346	840	**301**
SR 570	2	3	8	24200	3	0.301898	301	2.67	333	$ 39,000	$ 721,023	$ -	$ 760,023	382	1016	**353**
SR 570	6	7	8	25700	3	0.284278	317	2.67	333	$ 32,500	$ 1,081,535	$ -	$ 1,114,035	354	1004	**348**
SR 570	8	9	12	27500	3	0.398506	204	4.00	274	$ 52,000	$ 1,442,047	$ -	$ 1,494,047	315	793	**283**
SR 589	2	3	26	60400	3	0.393117	206	8.67	141	$ 91,000	$ 4,326,140	$ -	$ 4,417,140	177	524	**163**
SR 589	3	4	33	63500	3	0.474598	154	11.00	106	$ 110,500	$ 5,768,187	$ -	$ 5,878,687	138	398	**118**
SR 589	4	5	38	66200	3	0.524217	125	12.67	87	$ 143,000	$ 5,768,187	$ -	$ 5,911,187	135	347	**97**
SR 589	5	6	27	59400	3	0.41511	197	9.00	138	$ 97,500	$ 3,605,117	$20,200,000	$ 23,902,617	16	351	**99**
SR 589	6	7	104	54500	3	1.7427	3	34.67	14	$ 357,500	$17,304,560	$10,100,000	$ 27,762,060	7	24	**4**
SR 589	7	8	32	50500	3	0.578688	91	10.67	114	$ 123,500	$ 4,686,652	$ -	$ 4,810,152	166	371	**109**
SR 589	8	9	21	50500	3	0.379764	221	7.00	172	$ 65,000	$ 3,965,628	$ -	$ 4,030,628	189	582	**188**
SR 589	9	10	25	50500	3	0.4521	175	8.33	149	$ 97,500	$ 3,605,117	$ -	$ 3,702,617	198	522	**160**
SR 589	10	11	44	50500	3	0.795696	36	14.67	71	$ 156,000	$ 6,849,722	$10,100,000	$ 17,105,722	38	145	**30**
SR 589	11	12	34	45400	3	0.683926	62	11.33	102	$ 123,500	$ 5,407,675	$ -	$ 5,531,175	149	313	**86**
SR 589	12	13	25	35200	3	0.648609	67	8.33	149	$ 84,500	$ 4,326,140	$ -	$ 4,410,640	180	396	**115**
SR 589	13	14	13	35200	3	0.337277	261	4.33	257	$ 32,500	$ 2,884,093	$ -	$ 2,916,593	230	748	**263**
SR 589	18	19	23	23600	3	0.890024	25	7.67	162	$ 97,500	$ 2,884,093	$ -	$ 2,981,593	217	404	**120**
SR 589	19	20	8	23600	3	0.309574	293	2.67	333	$ 39,000	$ 721,023	$ -	$ 760,023	382	1008	**351**
SR 589	23	24	9	23600	3	0.34827	252	3.00	320	$ 26,000	$ 1,802,558	$ -	$ 1,828,558	303	875	**315**
SR 589	25	26	14	23600	3	0.541754	109	4.67	239	$ 58,500	$ 1,802,558	$ -	$ 1,861,058	288	636	**214**
SR 589	26	27	33	23600	3	1.276991	7	11.00	106	$ 123,500	$ 5,047,163	$ -	$ 5,170,663	157	270	**71**
SR 589	27	28	16	23600	3	0.619147	79	5.33	215	$ 58,500	$ 2,523,582	$ -	$ 2,582,082	242	536	**168**
SR 589	28	29	23	17000	3	1.235563	9	7.67	162	$ 78,000	$ 3,965,628	$ -	$ 4,043,628	188	359	**103**
SR 589	29	30	10	17000	3	0.537201	113	3.33	302	$ 26,000	$ 2,163,070	$ -	$ 2,189,070	278	693	**239**
SR 589	31	32	8	17000	3	0.429761	185	2.67	333	$ 26,000	$ 1,442,047	$ -	$ 1,468,047	322	840	**301**
SR 589	36	37	11	17000	3	0.590921	88	3.67	286	$ 39,000	$ 1,442,047	$10,100,000	$ 11,581,047	77	451	**138**
SR 589	40	41	8	9800	3	0.745504	50	2.67	333	$ 26,000	$ 1,442,047	$ -	$ 1,468,047	322	705	**241**
SR 821	1	2	18	35000	3	0.469667	160	6.00	195	$ 45,500	$ 3,965,628	$ -	$ 4,011,128	193	548	**174**
SR 821	2	3	35	35000	3	0.913242	23	11.67	97	$ 136,500	$ 5,047,163	$ -	$ 5,183,663	155	275	**74**
SR 821	3	4	34	54100	3	0.573941	93	11.33	102	$ 156,000	$ 3,605,117	$ -	$ 3,761,117	196	391	**113**
SR 821	4	5	20	54100	3	0.337613	260	6.67	181	$ 78,000	$ 2,523,582	$10,100,000	$ 12,701,582	65	506	**151**
SR 821	5	6	50	62200	3	0.734117	55	16.67	55	$ 169,000	$ 8,652,280	$ -	$ 8,821,280	105	215	**56**
SR 821	6	7	73	73400	3	0.908265	24	24.33	28	$ 273,000	$10,815,350	$10,100,000	$ 21,188,350	26	78	**17**
SR 821	7	8	37	77600	3	0.435438	181	12.33	88	$ 136,500	$ 5,768,187	$ -	$ 5,904,687	136	405	**122**

State Road	From MP	To MP	Total # of Crashes	AADT	No of Yrs Analyzed	Crash Rate/Crash Frequency				Economic Cost					Rank	
						Crash Rate	Crash Rate Rank	Crash Freq (per year)	Crash Freq Rank	PDO	Injury	Fatal	Total Cost	Rank	Sum of Ranks	Final Rank
SR 821	8	9	40	77600	3	0.470743	159	13.33	81	$ 149,500	$ 6,128,698	$ -	$ 6,278,198	129	369	**108**
SR 821	9	10	65	77600	3	0.764958	43	21.67	34	$ 266,500	$ 8,652,280	$ -	$ 8,918,780	104	181	**44**
SR 821	10	11	27	77600	3	0.317752	287	9.00	138	$ 71,500	$ 5,047,163	$20,200,000	$ 25,318,663	12	437	**135**
SR 821	11	12	77	116400	3	0.604121	83	25.67	25	$ 260,000	$12,978,420	$10,100,000	$ 23,338,420	20	128	**27**
SR 821	12	13	103	116400	3	0.808109	33	34.33	15	$ 377,000	$16,223,025	$ -	$ 16,600,025	42	90	**20**
SR 821	13	14	78	116400	3	0.611966	80	26.00	23	$ 305,500	$10,815,350	$10,100,000	$ 21,220,850	25	128	**27**
SR 821	14	15	198	140800	3	1.284247	5	66.00	2	$ 741,000	$29,922,468	$10,100,000	$ 40,763,468	2	9	**1**
SR 821	15	16	73	140800	3	0.473485	156	24.33	28	$ 253,500	$12,257,397	$ -	$ 12,510,897	69	253	**69**
SR 821	16	17	151	168600	3	0.81791	31	50.33	3	$ 494,000	$27,038,375	$ -	$ 27,532,375	8	42	**8**
SR 821	17	18	114	90400	3	1.151655	15	38.00	12	$ 377,000	$20,188,653	$ -	$ 20,565,653	27	54	**11**
SR 821	18	19	128	90400	3	1.293086	4	42.67	7	$ 435,500	$21,991,212	$ -	$ 22,426,712	22	33	**6**
SR 821	19	20	62	90400	3	0.626339	77	20.67	39	$ 221,000	$10,094,327	$ -	$ 10,315,327	93	209	**53**
SR 821	20	21	134	100400	3	1.218869	13	44.67	6	$ 442,000	$23,793,770	$ -	$ 24,235,770	15	34	**7**
SR 821	21	22	78	124000	3	0.574459	92	26.00	23	$ 273,000	$12,978,420	$ -	$ 13,251,420	58	173	**40**
SR 821	22	23	53	124000	3	0.390337	214	17.67	51	$ 195,000	$ 7,931,257	$10,100,000	$ 18,226,257	34	299	**82**
SR 821	23	24	120	138300	3	0.792401	37	40.00	10	$ 442,000	$18,386,095	$10,100,000	$ 28,928,095	6	53	**10**
SR 821	24	25	117	138300	3	0.772591	42	39.00	11	$ 357,500	$21,630,700	$20,200,000	$ 42,188,200	1	54	**11**
SR 821	25	26	92	153400	3	0.547707	107	30.67	19	$ 364,000	$12,617,908	$10,100,000	$ 23,081,908	21	147	**32**
SR 821	26	27	127	101200	3	1.146065	16	42.33	8	$ 494,000	$18,386,095	$ -	$ 18,880,095	32	56	**13**
SR 821	27	28	100	106300	3	0.859118	28	33.33	16	$ 357,500	$16,223,025	$ -	$ 16,580,525	43	87	**19**
SR 821	28	29	54	106300	3	0.463924	161	18.00	50	$ 227,500	$ 6,849,722	$ -	$ 7,077,222	116	327	**89**
SR 821	29	30	91	106300	3	0.781797	41	30.33	20	$ 344,500	$13,338,932	$10,100,000	$ 23,783,432	18	79	**18**
SR 821	30	31	68	106300	3	0.5842	90	22.67	32	$ 266,500	$ 9,733,815	$ -	$ 10,000,315	95	217	**57**
SR 821	31	32	58	98100	3	0.539939	110	19.33	44	$ 247,000	$ 6,849,722	$10,100,000	$ 17,196,722	37	191	**47**
SR 821	32	33	30	98100	3	0.279279	335	10.00	120	$ 130,000	$ 3,605,117	$ -	$ 3,735,117	197	652	**227**
SR 821	33	34	65	98100	3	0.605104	82	21.67	34	$ 227,500	$10,094,327	$20,200,000	$ 30,521,827	4	120	**24**
SR 821	34	35	61	91800	3	0.606838	81	20.33	42	$ 234,000	$ 9,012,792	$ -	$ 9,246,792	101	224	**59**
SR 821	35	36	100	91800	3	0.994817	20	33.33	16	$ 435,500	$11,536,373	$10,100,000	$ 22,071,873	23	59	**14**
SR 821	36	37	46	85600	3	0.490761	146	15.33	66	$ 188,500	$ 6,128,698	$ -	$ 6,317,198	127	339	**93**
SR 821	37	38	21	85600	3	0.224043	365	7.00	172	$ 78,000	$ 2,884,093	$10,100,000	$ 13,062,093	61	598	**198**
SR 821	38	39	43	85600	3	0.458755	173	14.33	77	$ 182,000	$ 5,407,675	$ -	$ 5,589,675	145	395	**114**
SR 821	39	40	71	85600	3	0.757479	45	23.67	30	$ 312,000	$ 8,291,768	$ -	$ 8,603,768	106	181	**44**
SR 821	40	41	48	47500	3	0.922855	22	16.00	61	$ 195,000	$ 6,489,210	$ -	$ 6,684,210	123	206	**52**
SR 821	41	42	28	47500	3	0.538332	111	9.33	133	$ 143,000	$ 2,163,070	$ -	$ 2,306,070	256	500	**149**
SR 821	42	43	26	47500	3	0.49988	139	8.67	141	$ 110,500	$ 2,884,093	$10,100,000	$ 13,094,593	59	339	**93**
SR 821	43	44	56	65100	3	0.785585	39	18.67	47	$ 253,500	$ 6,128,698	$ -	$ 6,382,198	126	212	**55**
SR 821	44	45	36	39500	3	0.832322	30	12.00	91	$ 104,000	$ 7,210,233	$ -	$ 7,314,233	114	235	**62**
SR 821	45	46	49	39500	3	1.132882	17	16.33	58	$ 169,000	$ 7,931,257	$10,100,000	$ 18,200,257	36	111	**23**
SR 821	46	47	81	39500	3	1.872724	2	27.00	22	$ 357,500	$ 8,652,280	$20,200,000	$ 29,209,780	5	29	**5**
SR 821	47	48	43	61100	3	0.642707	70	14.33	77	$ 169,000	$ 5,768,187	$10,100,000	$ 16,037,187	47	194	**49**
SR 869	0	1	55	88900	3	0.564998	100	18.33	48	$ 208,000	$ 8,291,768	$ -	$ 8,499,768	108	256	**70**
SR 869	1	2	26	75500	3	0.314494	289	8.67	141	$ 71,500	$ 5,407,675	$ -	$ 5,479,175	153	583	**190**

State Road	From MP	To MP	Total # of Crashes	AADT	No of Yrs Analyzed	Crash Rate/Crash Frequency				Economic Cost					Rank	
						Crash Rate	Crash Rate Rank	Crash Freq (per year)	Crash Freq Rank	PDO	Injury	Fatal	Total Cost	Rank	Sum of Ranks	Final Rank
SR 869	2	3	32	69600	3	0.419881	195	10.67	114	$ 123,500	$ 4,686,652	$ -	$ 4,810,152	166	475	**145**
SR 869	3	4	26	74600	3	0.318288	286	8.67	141	$ 91,000	$ 4,326,140	$ -	$ 4,417,140	177	604	**202**
SR 869	4	5	22	74600	3	0.269321	341	7.33	168	$ 65,000	$ 4,326,140	$ -	$ 4,391,140	183	692	**238**
SR 869	5	6	46	66600	3	0.630768	76	15.33	66	$ 156,000	$ 7,931,257	$ -	$ 8,087,257	109	251	**68**
SR 869	6	7	19	66600	3	0.260535	347	6.33	188	$ 91,000	$ 1,802,558	$ -	$ 1,893,558	284	819	**293**
SR 869	7	8	30	57300	3	0.478137	152	10.00	120	$ 91,000	$ 5,768,187	$ -	$ 5,859,187	140	412	**125**
SR 869	8	9	22	57300	3	0.350634	250	7.33	168	$ 78,000	$ 3,605,117	$ -	$ 3,683,117	201	619	**208**
SR 869	9	10	13	57300	3	0.207193	379	4.33	257	$ 45,500	$ 2,163,070	$ -	$ 2,208,570	269	905	**322**
SR 869	10	11	15	47800	3	0.286582	314	5.00	224	$ 45,500	$ 2,884,093	$ -	$ 2,929,593	227	765	**269**
SR 869	11	12	15	47800	3	0.286582	314	5.00	224	$ 32,500	$ 3,605,117	$ -	$ 3,637,617	204	742	**256**
SR 869	12	13	8	57600	3	0.126839	432	2.67	333	$ 13,000	$ 2,163,070	$ -	$ 2,176,070	282	1047	**368**
SR 869	13	14	17	57600	3	0.269533	340	5.67	207	$ 58,500	$ 2,884,093	$ -	$ 2,942,593	223	770	**270**
SR 869	14	15	19	57600	3	0.301243	302	6.33	188	$ 84,500	$ 2,163,070	$ -	$ 2,247,570	259	749	**264**
SR 869	15	16	26	71200	3	0.333487	269	8.67	141	$ 58,500	$ 6,128,698	$ -	$ 6,187,198	132	542	**171**
SR 869	16	17	37	71200	3	0.474578	155	12.33	88	$ 117,000	$ 6,849,722	$ -	$ 6,966,722	119	362	**104**
SR 869	17	18	18	67900	3	0.242097	356	6.00	195	$ 65,000	$ 2,884,093	$ -	$ 2,949,093	221	772	**272**
SR 869	18	19	33	67900	3	0.443844	178	11.00	106	$ 136,500	$ 4,326,140	$ -	$ 4,462,640	174	458	**141**
SR 869	19	20	29	67900	3	0.390044	215	9.67	129	$ 110,500	$ 4,326,140	$ -	$ 4,436,640	175	519	**158**
SR 869	20	21	35	69000	3	0.463239	162	11.67	97	$ 123,500	$ 5,768,187	$ -	$ 5,891,687	137	396	**115**
SR 869	21	22	44	32900	3	1.221357	11	14.67	71	$ 162,500	$ 6,849,722	$ -	$ 7,012,222	117	199	**50**

Appendix E

Hydroplaning Formula Calculation Results for Each Site

#	Design Speed (mph)	Intensity (in/hr)	xslope (ft/ft)	Longitudinal slope (ft/ft)	Width (ft)	MTD (mm)	Slope along path	L (ft) along path	MTD (in)	Gallaway H20 t (in)	A1	A2	Greater A	Max Speed (mph)	Predicted Driver Speed (mph)	Speed Diff (mph)	Hydroplaning
Turnpike Sites																	
1	65	2	0.067	0.005	48	1.5	0.067	48.1	0.0591	0.01802	16.753	19.532	19.532	73.69	53	20.69	No
2	65	2	0.02	0	60	1.5	0.020	60.0	0.0591	0.07526	15.664	17.494	17.494	50.89	53	-2.11	Yes
3	70	2	0.028	0	72	1.5	0.028	72.0	0.0591	0.07157	15.700	17.563	17.563	51.55	58	-6.45	Yes
4	70	2	0.03	0.002	60	1.5	0.030	60.1	0.0591	0.05687	15.870	17.880	17.880	54.72	58	-3.28	Yes
5	70	2	0.03	0.0002	60	1.5	0.030	60.0	0.0591	0.05683	15.870	17.881	17.881	54.73	58	-3.27	Yes
6	70	2	0.045	0.02	72	1.5	0.049	78.8	0.0591	0.05240	15.931	17.994	17.994	55.89	58	-2.11	Yes
Other Corridors																	
I-95 1	60	2	0.03	0.027	62	1.5	0.040	83.4	0.0591	0.06436	15.778	17.708	17.708	52.99	48	4.99	No
I-95 2	70	2	0.047	0.001	76	1.5	0.047	76.0	0.0591	0.05221	15.933	17.999	17.999	55.94	58	-2.06	Yes
I-95 3	70	2	0.037	0.0018	62	1.5	0.037	62.1	0.0591	0.05017	15.963	18.054	18.054	56.52	58	-1.48	Yes
I-95 4	70	2	0.054	0.03	76	1.5	0.062	86.9	0.0591	0.04895	15.982	18.089	18.089	56.89	58	-1.11	Yes
I-275 5	65	2	0.062	0.002	60	1.5	0.062	60.0	0.0591	0.02993	16.355	18.788	18.788	64.62	53	11.62	No
I-275 6	65	2	0.062	0.002	60	1.5	0.062	60.0	0.0591	0.02993	16.355	18.788	18.788	64.62	53	11.62	No

Appendix F

Excerpts from FDOT Plans Preparation Manual Crash Cost

Table 23.6.1 FDOT Average Crash Costs by Facility Type

FACILITY TYPE	DIVIDED			UNDIVIDED		
	URBAN	SUBURBAN	RURAL	URBAN	SUBURBAN	RURAL
2-3 Lanes	$109,686	$187,990	$342,662	$125,974	$245,281	$526,887
4-5 Lanes	$119,072	$216,234	$464,901	$107,908	$161,173	$115,320
6+ Lanes	$117,867	$153,957	$313,317	$62,606	n/a	n/a
Interstate	$153,963	n/a	$341,754	n/a	n/a	n/a
Turnpike	$147,939	n/a	$254,951	n/a	n/a	n/a

Average Cost/Crash: **$155,695**

The above values were derived from 2010 through 2014 traffic crash and injury severity data for crashes on state roads in Florida using the formulation described in ***FHWA Technical Advisory "Motor Vehicle Accident Costs", T 7570.2, dated October 31, 1994*** and from a memorandum from USDOT, ***Revised Departmental Guidance: Treatment of the Value of Preventing Fatalities and Injuries in Preparing Economic Analyses, dated February 5, 2008*** updating the value of life saved to $5.8 million, updated from $5.8 million to $6 million on March 18, 2009, to $6.2 million on July 29, 2011, and to $9.1 million on February 28, 2013.

http://www.dot.gov/sites/dot.dev/files/docs/VSL%20Guidance%202013.pdf

When utilizing predictive methods or crash severity distributions for analysis, the following crash severity level costs should be used:

Table 23.6.2 FDOT KABCO Crash Costs

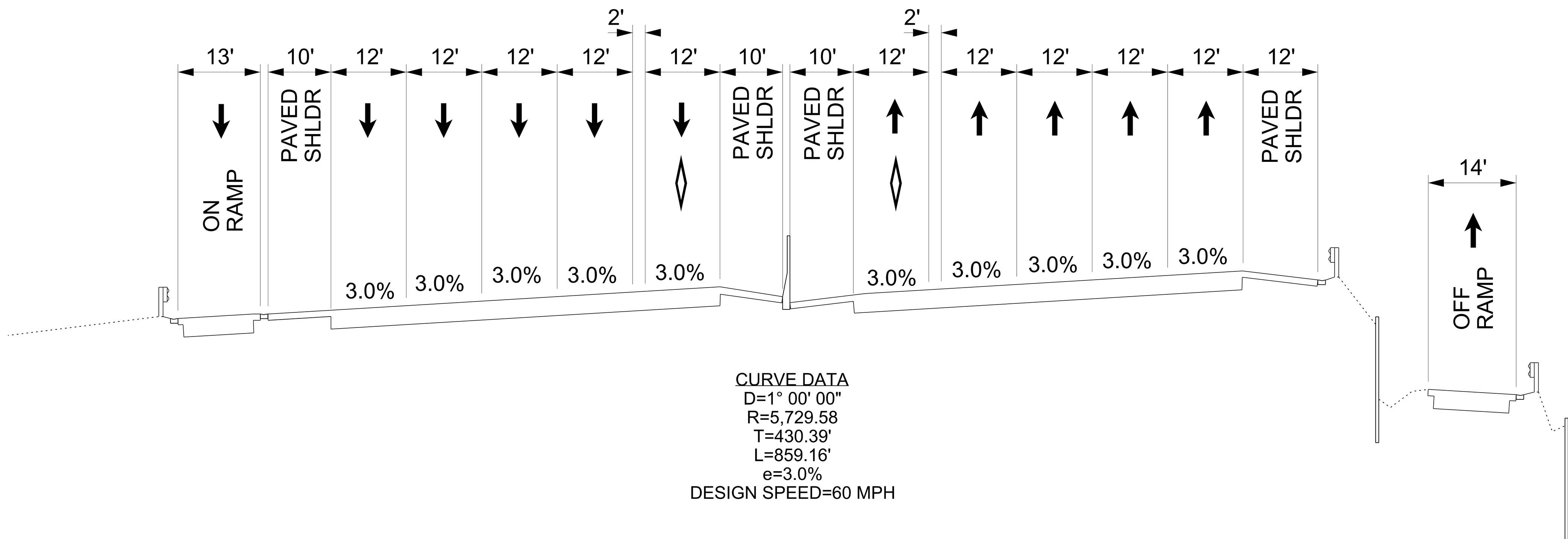
Crash Severity	Comprehensive Crash Cost
Fatal (K)	$10,230,000
Severe Injury (A)	$580,320
Moderate Injury (B)	$157,170
Minor Injury (C)	$97,650
Property Damage Only (O)	$7,600

Source: Florida Department of Transportation Crash Analysis Reporting (C.A.R.) System, analysis years 2010 through 2014.

Appendix G

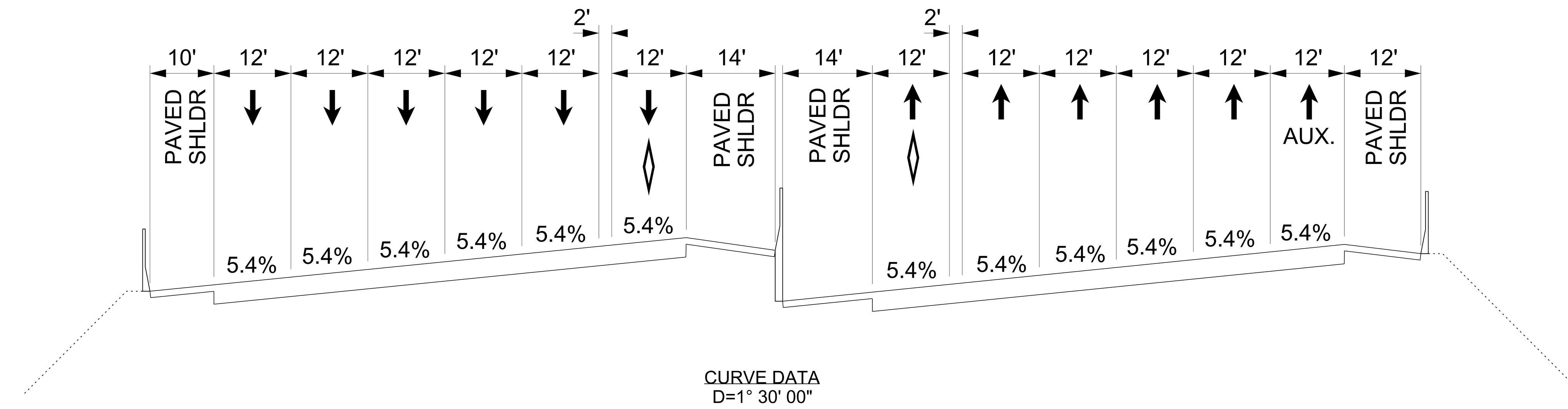
Typical Sections for Other Corridor Sites

SITE 1-I-95 AT HALLANDALE BEACH BLVD



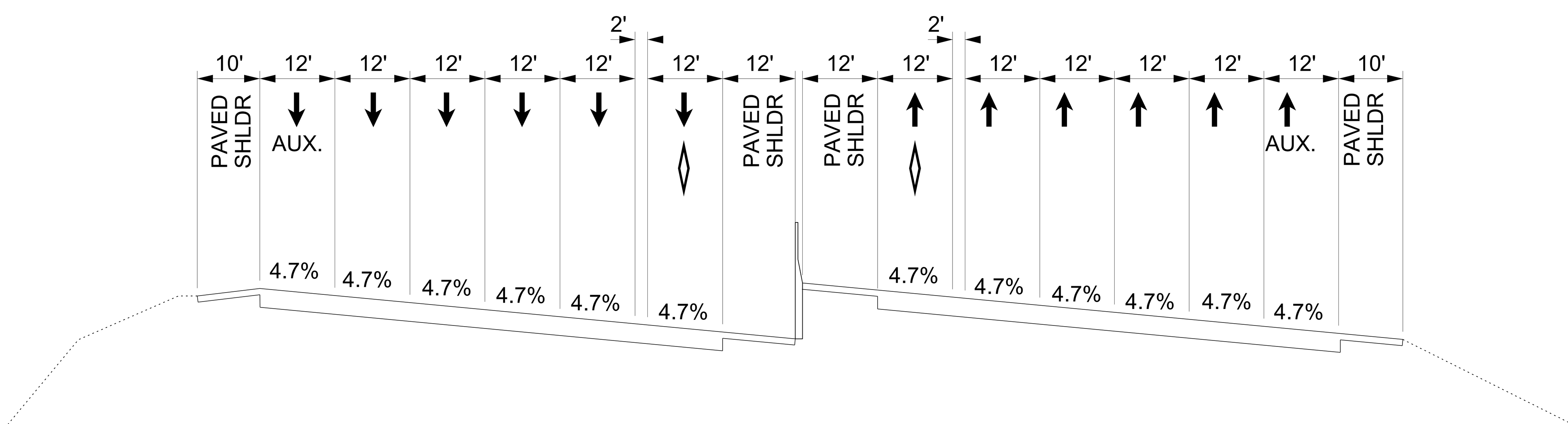
CURVE DATA
D=1° 00' 00"
R=5,729.58
T=430.39'
L=859.16'
e=3.0%
DESIGN SPEED=60 MPH

SITE 4-I-95 S OF FOREST HILL BLVD



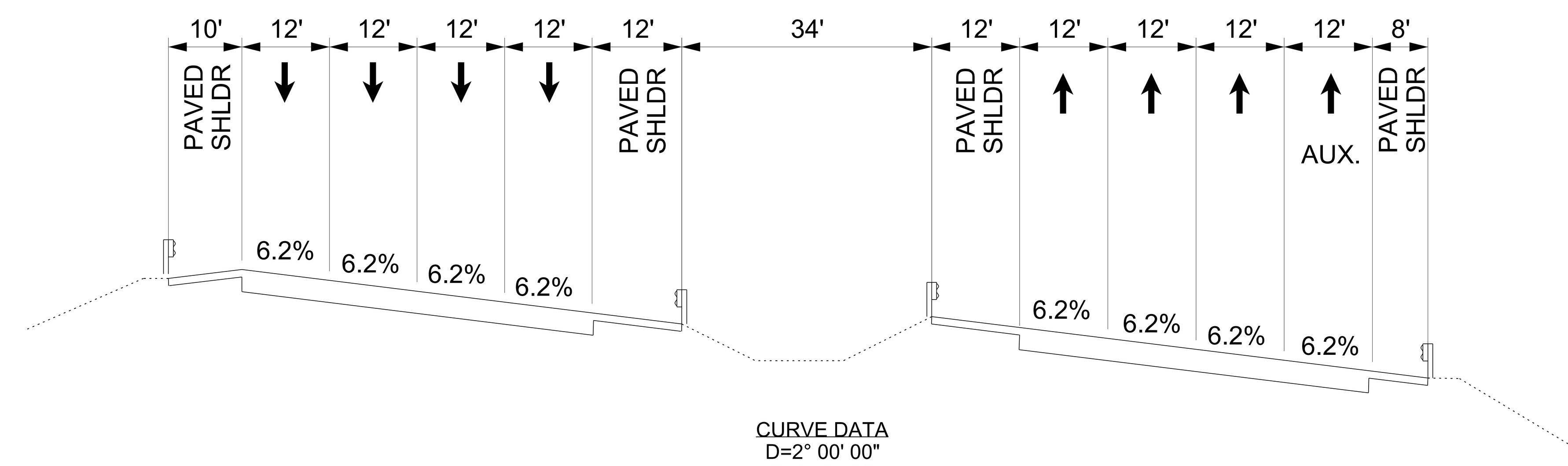
CURVE DATA
D=1° 30' 00"
R=3,819.72'
T=673.52'
L=1,333.33
e=5.4%
DESIGN SPEED=70 MPH

SITE 2-I-95 AT N OF SUNRISE BLVD



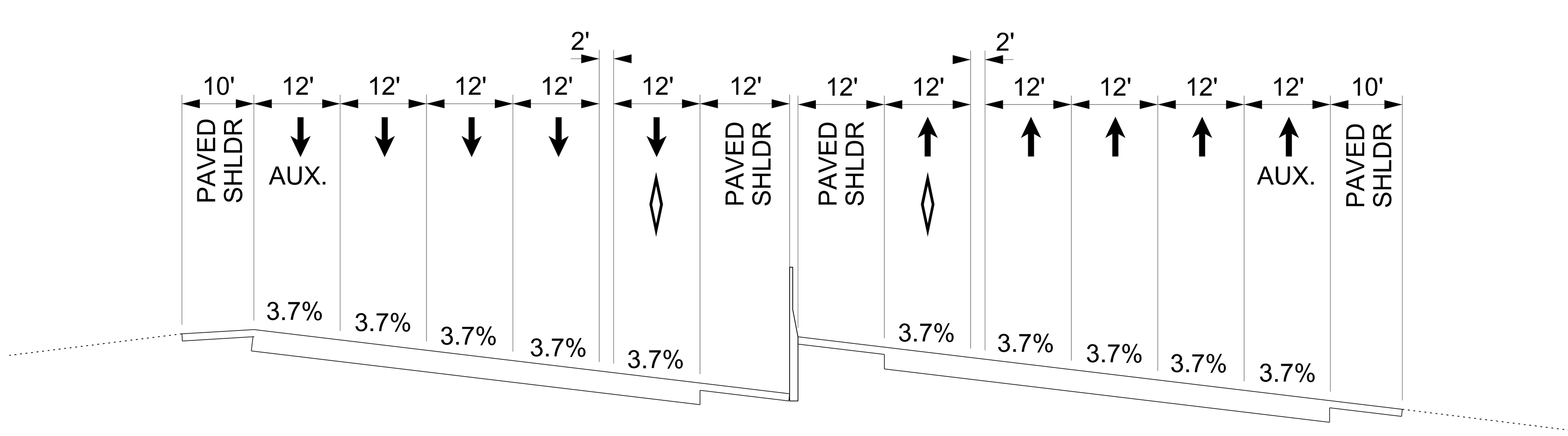
CURVE DATA
D=1° 15' 00"
R=4,583.66
T=1,040.45'
L=2,046.23
e=4.7%
DESIGN SPEED=70 MPH

SITE 5- I-275 AT 13TH AVE N



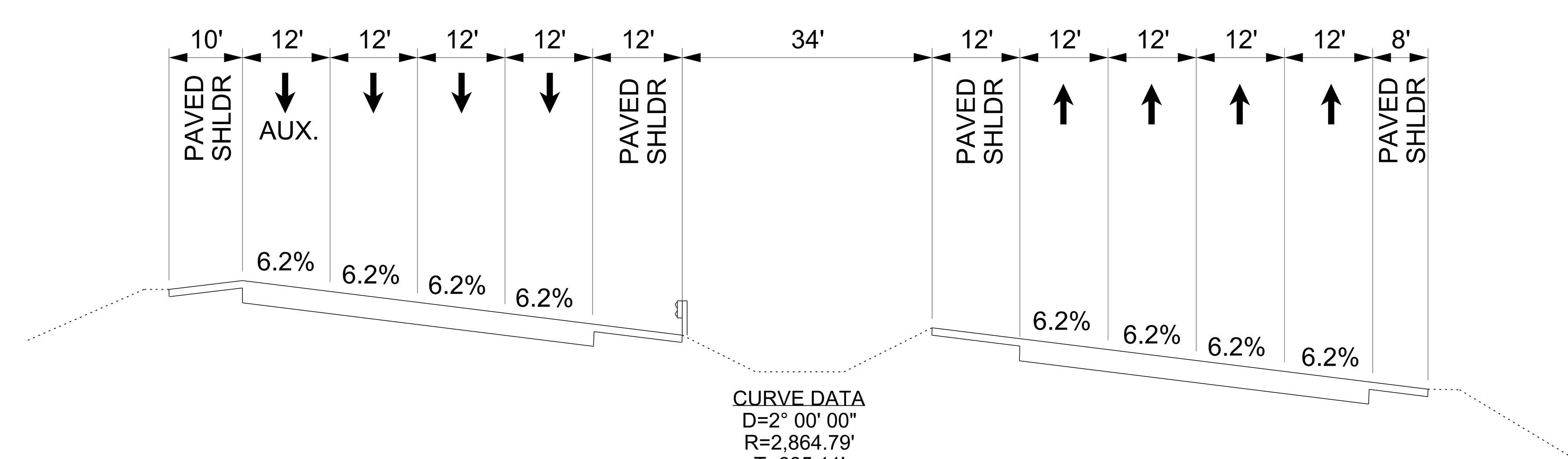
CURVE DATA
D=2° 00' 00"
R=2,864.79'
T=123.99'
L=247.82'
e=6.2%
DESIGN SPEED=65 MPH

SITE 3-I-95 S OF GLADES RD



CURVE DATA
D=1° 00' 00"
R=5,729.578'
T=1,721.605'
L=3,344.86
e=3.7%
DESIGN SPEED=70 MPH

SITE 6- I-275 N OF 13TH AVE N



CURVE DATA
D=2° 00' 00"
R=2,864.79'
T=685.11'
L=362.66
e=6.2%
DESIGN SPEED=65 MPH

Appendix H

Crash Data for 6 Sites – Other Corridors

Crash_Numb	Calendar_Y	Event_Cras	Event_Cr_1	Dhsmv_Day	Managing_D	Dept_Of_Tr	Roadway_Id	Crsh_Loc_F	Final_Ref	Crsh_Loc_1	Final_Meas	Crash_Loca
822536070.0	2011.0000	7/17/2011	2018.0	7.0	4.0	86.0	86070000.0	0.5	1476.0	0.0	MI	S
822566310.0	2011.0	9/29/2011	650.0	4.0	4.0	86.0	86070000.0	0.5	1476.0	0.0	MI	S
828219240.0	2011.0	10/8/2011	910.0	6.0	4.0	86.0	86070000.0	0.5	1476.0	0.0	MI	S
828229910.0	2011.0	12/13/2011	15.0	2.0	4.0	86.0	86070000.0	0.5	1476.0	0.0	MI	S
820001610.0	2011.0	4/5/2011	2339.0	2.0	4.0	86.0	86070000.0	0.6	1524.0	0.1	MI	N
828137570.0	2011.0	10/19/2011	1805.0	3.0	4.0	86.0	86070000.0	0.9	1477.0	0.1	MI	S
820934730.0	2011.0	3/29/2011	19.0	2.0	4.0	86.0	86070000.0	1.0	1523.0	0.0	MI	S
822459760.0	2011.0	8/24/2011	859.0	3.0	4.0	86.0	86070000.0	1.0	1523.0	0.0	MI	S
820004100.0	2011.0	1/21/2011	1547.0	5.0	4.0	86.0	86070000.0	1.1	1523.0	0.0	MI	N
820308950.0	2011.0	1/26/2011	948.0	3.0	4.0	86.0	86070000.0	1.3	1522.0	0.0	MI	N
820648560.0	2011.0	3/28/2011	2055.0	1.0	4.0	86.0	86070000.0	1.3	1522.0	0.0	MI	N
820943920.0	2011.0	5/6/2011	412.0	5.0	4.0	86.0	86070000.0	1.4	1478.0	0.0	MI	N
822743590.0	2011.0	8/1/2011	1637.0	1.0	4.0	86.0	86070000.0	1.4	1478.0	0.1	MI	N
828538430.0	2011.0	12/10/2011	246.0	6.0	4.0	86.0	86070000.0	1.6	1875.0	0.0	MI	N
820874760.0	2011.0	4/24/2011	133.0	7.0	4.0	86.0	86070000.0	1.7	1875.0	0.1	MI	N
828445880.0	2011.0	11/20/2011	825.0	7.0	4.0	86.0	86070000.0	3.6	1484.0	0.0	MI	S
845210890.0	2014.0	12/5/2014	937.0	5.0	4.0	86.0	86070000.0	0.2	8008.0	0.2	MI	N
844848050.0	2014.0	10/4/2014	1650.0	6.0	4.0	86.0	86070000.0	1.0	1523.0	0.0	MI	S
838144280.0	2014.0	9/20/2014	434.0	6.0	4.0	86.0	86070000.0	1.6	1875.0	0.0		
844827060.0	2014.0	9/20/2014	449.0	6.0	4.0	86.0	86070000.0	1.6	1875.0	0.1	MI	N
838144260.0	2014.0	9/18/2014	2249.0	4.0	4.0	86.0	86070000.0	1.7	1875.0	0.1	MI	N
837573290.0	2014.0	3/25/2014	340.0	2.0	4.0	86.0	86070000.0	1.4	1478.0	0.0	MI	N

Crash_Numb	Calendar_Y	Event_Cras	Event_Cr_1	Dhsmv_Day	Managing_D	Dept_Of_Tr	Roadway_Id	Crsh_Loc_F	Final_Ref	Crsh_Loc_1	Final_Meas	Crash_Loca
822735290	2011	40791	1647	1	4	86	86070000	12	1890	0	MI	N
820308790	2011	40669	940	5	4	86	86070000	12	1890	0	MI	N
820710770	2011	40733	856	6	4	86	86070000	12	1890	0	MI	N
822733690	2011	40764	2018	2	4	86	86070000	12	1890	0	MI	N
819969410	2011	40586	1135	6	4	86	86070000	12	1525	0	MI	S
831818220	2012	41175	439	7	4	86	86070000	12	1890	0	MI	N
831855040	2012	41242	709	4	4	86	86070000	12	1890	0	MI	N
828890450	2012	41047	1950	5	4	86	86070000	12	1890	0	MI	N
831548490	2012	41157	1918	3	4	86	86070000	12	1890	0	MI	N
828757440	2012	41083	2013	6	4	86	86070000	12	1525	0	MI	S
831458840	2012	41080	41	3	4	86	86070000	12	1525	0	MI	S
833279630	2013	41483	315	7	4	86	86070000	12	1890	0	MI	N
837177820	2013	41599	9	4	4	86	86070000	12	1890	0	MI	N
837177840	2013	41599	140	4	4	86	86070000	12	1890	0	MI	N
836730630	2013	41542	1336	3	4	86	86070000	12	1890	0	MI	N
836824930	2013	41586	2035	5	4	86	86070000	12	1525	0	MI	S
838164990	2014	41826	911	7	4	86	86070000	12	1936	0	MI	S
845194240	2014	41953	316	1	4	86	86070000	12	1890	0	MI	N
845030330	2014	41896	400	7	4	86	86070000	12	1890	0	MI	N
845562340	2014	41999	1709	5	4	86	86070000	12	1890	0	MI	N
845706590	2015	42141	1009	7	4	86	86070000	12	1890	0	MI	N
851755810	2015	42269	2115	2	4	86	86070000	12	1890	0	MI	N
852250290	2015	42343	230	6	4	86	86070000	12	1890	0	MI	N

Crash_Numb	Calendar_Y	Event_Cras	Event_Cr_1	Dhsmv_Day	Managing_D	Dept_Of_Tr	Roadway_Id	Crsh_Loc_F	Final_Ref	Crsh_Loc_1	Final_Meas	Crash_Loca
838151640	2014	41899	1720	3	4	93	93220000	2	2127	0	MI	N
822443550	2011	40677	1755	6	4	93	93220000	2	2158	0	MI	S
828233120	2011	40804	17	7	4	93	93220000	2	2158	0	MI	S
836427630	2013	41459	2238	4	4	93	93220000	2	2158	0	MI	S
837096300	2013	41599	300	4	4	93	93220000	2	2158	0	MI	S
848840790	2015	42202	1902	5	4	93	93220000	2	2158	0	MI	S
819891040	2011	40678	10	7	4	93	93220000	3	2158	0	MI	S
836886600	2013	41609	2210	7	4	93	93220000	3	2158	0	MI	S
822443740	2011	40726	2355	6	4	93	93220000	3	2227	0	MI	S
837074190	2013	41587	255	6	4	93	93220000	3	2227	0	MI	S
836744460	2014	41676	127	4	4	93	93220000	3	2227	0	MI	S
845023170	2014	41908	730	5	4	93	93220000	3	2227	0	MI	S

`	Calendar_Y	Event_Cras	Event_Cr_1	Dhsmv_Day	Managing_D	Dept_Of_Tr	Roadway_Id	Crsh_Loc_F	Final_Ref	Crsh_Loc_1	Final_Meas	Crash_Loca
852226750	2015	12/4/2015	15	5	4	93	93220000	22	4269	0	MI	N
820152620	2011	7/18/2011	1105	1	4	93	93220000	23	2259	0	MI	S
828956990	2012	9/15/2012	1337	6	4	93	93220000	23	2259	0	MI	S
844854960	2014	10/23/2014	340	4	4	93	93220000	23	2215	0	MI	S
828813680	2012	8/11/2012	1839	6	4	93	93220000	23	2259	0	MI	S
819765260	2012	8/12/2012	1520	7	4	93	93220000	23	4272	0	MI	N
828673750	2012	2/7/2012	1155	2	4	93	93220000	23	4272	0	MI	N
829068450	2013	7/10/2013	354	3	4	93	93220000	23	4272	0	MI	N
833029020	2013	7/19/2013	612	5	4	93	93220000	23	4272	0	MI	N
833029360	2013	11/9/2013	933	6	4	93	93220000	23	4272	0	MI	N
837352960	2014	4/11/2014	1637	5	4	93	93220000	23	4272	0	MI	N
838168800	2014	7/15/2014	1200	2	4	93	93220000	23	4272	0	MI	N
845009940	2014	9/18/2014	2140	4	4	93	93220000	23	4272	0	MI	N
833148620	2015	9/17/2015	830	4	4	93	93220000	23	4272	0	MI	N
820150070	2013	1/17/2013	55	4	4	93	93220000	23	2260	0	MI	S
832824610	2013	2/16/2013	56	6	4	93	93220000	23	2260	0	MI	S
848841730	2015	6/3/2015	1330	3	4	93	93220000	23	2216	0	MI	N
836922240	2013	12/14/2013	446	6	4	93	93220000	23	2260	0	MI	S
831726340	2012	8/25/2012	400	6	4	93	93220000	23	2216	0	MI	N
836561550	2013	9/13/2013	430	5	4	93	93220000	23	2216	0	MI	N
837086760	2013	11/20/2013	710	3	4	93	93220000	23	2216	0	MI	N
845009820	2014	9/11/2014	2321	4	4	93	93220000	23	2217	0	MI	S
833054870	2013	6/9/2013	1416	7	4	93	93220000	23	2217	0	MI	S
828150870	2012	4/13/2012	330	5	4	93	93220000	23	2217	0	MI	S
831770330	2012	10/2/2012	1711	2	4	93	93220000	23	2217	0	MI	S
831964110	2012	9/22/2012	1115	6	4	93	93220000	23	2217	0	MI	S
836847430	2013	9/17/2013	1025	2	4	93	93220000	24	2218	0	MI	S
828374670	2012	1/24/2012	500	2	4	93	93220000	24	2218	0	MI	N
844807010	2014	7/15/2014	1300	2	4	93	93220000	24	2262	0	MI	N

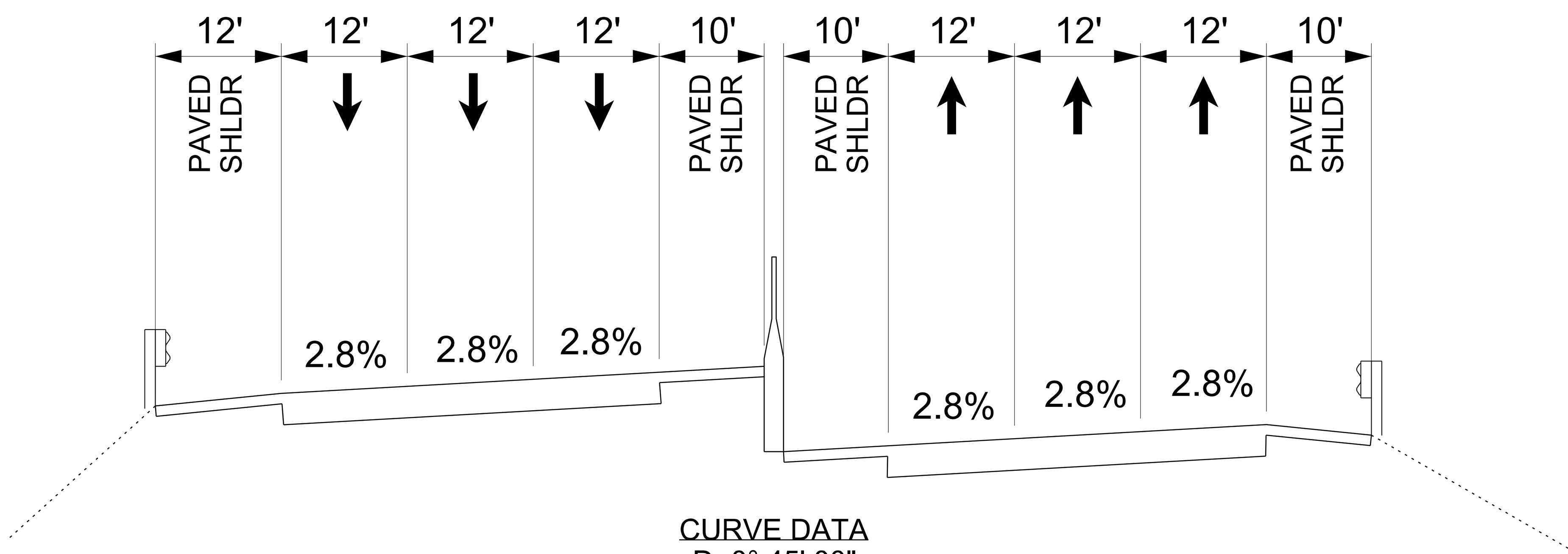
Crash_Num	Calendar_Y	Event_Cras	Event_Cr_1	Dhsmv_Day	Managing_D	Dept_Of_T	Roadway_I	Crsh_Loc_F	Final_Ref	Crsh_Loc_1	Final_Mea	Crash_Loca
819869340	2011	5/14/2011	1500	6	7	15	15190000	5.336	1209	0	MI	N
828250770	2011	9/6/2011	1855	2	7	15	15190000	5.346	1227	0	MI	S
820902060	2011	6/24/2011	2238	5	7	15	15190000	5.389	1227	0	MI	N
828250840	2011	9/10/2011	1230	6	7	15	15190000	5.56	1077	0	MI	N
820730680	2011	10/31/2011	605	1	7	15	15190000	5.573	1077	0	MI	N
828254410	2011	9/22/2011	2308	4	7	15	15190000	6.027	1081	0	MI	N
831706820	2012	6/25/2012	220	1	7	15	15190000	5.478	3678	0	MI	S
829099240	2012	6/1/2012	1008	5	7	15	15190000	5.599	1077	0	MI	N
820437450	2012	6/24/2012	1300	7	7	15	15190000	5.877	1080	0	MI	N
831565420	2012	5/24/2012	2127	4	7	15	15190000	6.144	1083	0	MI	S
833124670	2013	7/5/2013	1506	5	7	15	15190000	5.346	1227	0	MI	S
833051160	2013	5/1/2013	1510	3	7	15	15190000	5.484	3678	0		
837843470	2014	6/10/2014	1954	2	7	15	15190000	5.539	4180	0	MI	S
837480030	2014	3/24/2014	815	1	7	15	15190000	5.589	1077	0	MI	N
844873000	2014	8/22/2014	1323	5	7	15	15190000	5.819	1079	0	MI	N
845468800	2015	3/23/2015	835	1	7	15	15190000	5.308	1209	0	MI	S
848721420	2015	2/28/2015	1033	6	7	15	15190000	5.319	1209	0	MI	N
845550730	2015	4/28/2015	938	2	7	15	15190000	5.478	3678	0	MI	S
851519120	2015	8/31/2015	1330	1	7	15	15190000	5.589	1077	0	MI	N
851510040	2015	9/29/2015	36	2	7	15	15190000	5.819	1079	0	MI	N
851512060	2015	8/15/2015	1555	6	7	15	15190000	5.819	1079	0	MI	N
852001500	2015	11/22/2015	1220	7	7	15	15190000	5.819	1079	0	MI	N
851600880	2015	9/27/2015	1610	7	7	15	15190000	5.824	1079	0	MI	N
851195580	2015	7/14/2015	1135	2	7	15	15190000	5.828	1079	0	MI	N

Crash_Numb	Calendar_Y	Event_Cras	Event_Cr_1	Dhsmv_Day	Managing_D	Dept_Of_Tr	Roadway_Id	Crsh_Loc_F	Final_Ref	Crsh_Loc_1	Final_Meas	Crash_Loca
822402970	2011	6/24/2011	1230	5	7	15	15190000	7.409	1993	0	MI	N
822639420	2011	8/28/2011	2108	7	7	15	15190000	7.447	1993	0	MI	N
828154890	2011	8/9/2011	1253	2	7	15	15190000	7.541	2022	0	MI	S
822658630	2011	7/16/2011	1600	6	7	15	15190000	7.602	1994	0	MI	N
822679230	2011	8/16/2011	210	2	7	15	15190000	7.602	1994	0	MI	N
828154880	2011	8/9/2011	1425	2	7	15	15190000	7.672	1994	0	MI	N
822773010	2011	9/7/2011	0	3	7	15	15190000	7.842	4182	0	MI	S
831476420	2012	6/22/2012	2110	5	7	15	15190000	7.371	1993	0	MI	N
833368820	2013	6/29/2013	1200	6	7	15	15190000	7.452	2022	0	MI	S
833218590	2013	6/25/2013	2234	2	7	15	15190000	7.541	2022	0	MI	S
833132130	2013	9/24/2013	848	2	7	15	15190000	7.552	2022	0	MI	N
833384450	2013	7/17/2013	1643	3	7	15	15190000	7.602	1994	0	MI	N
837175380	2013	12/29/2013	1446	7	7	15	15190000	7.806	1994	0	MI	N
833283590	2013	7/13/2013	1727	6	7	15	15190000	7.818	1994	0	MI	N
832897460	2013	4/29/2013	59	1	7	15	15190000	8.092	2020	0	MI	N
836722510	2013	9/14/2013	1555	6	7	15	15190000	8.242	1996	0	MI	N
836544970	2013	7/26/2013	1031	5	7	15	15190000	8.304	2018	0	MI	S
844783870	2014	9/17/2014	923	3	7	15	15190000	7.55	2022	0		
844742740	2014	8/23/2014	1500	6	7	15	15190000	7.827	1994	0	MI	N
851876280	2015	8/30/2015	2139	7	7	15	15190000	7.409	1993	0	MI	N
851519050	2015	7/17/2015	1048	5	7	15	15190000	7.552	2022	0	MI	N
837825300	2015	3/27/2015	1800	5	7	15	15190000	7.602	1994	0	MI	N
845366550	2015	2/28/2015	1100	6	7	15	15190000	7.731	1994	0	MI	N
851891180	2015	9/28/2015	1811	1	7	15	15190000	7.818	1994	0	MI	N
845247670	2015	2/9/2015	1520	1	7	15	15190000	7.823	1994	0	MI	N
851165010	2015	6/9/2015	2321	2	7	15	15190000	8.19	1996	0	MI	S

Appendix I

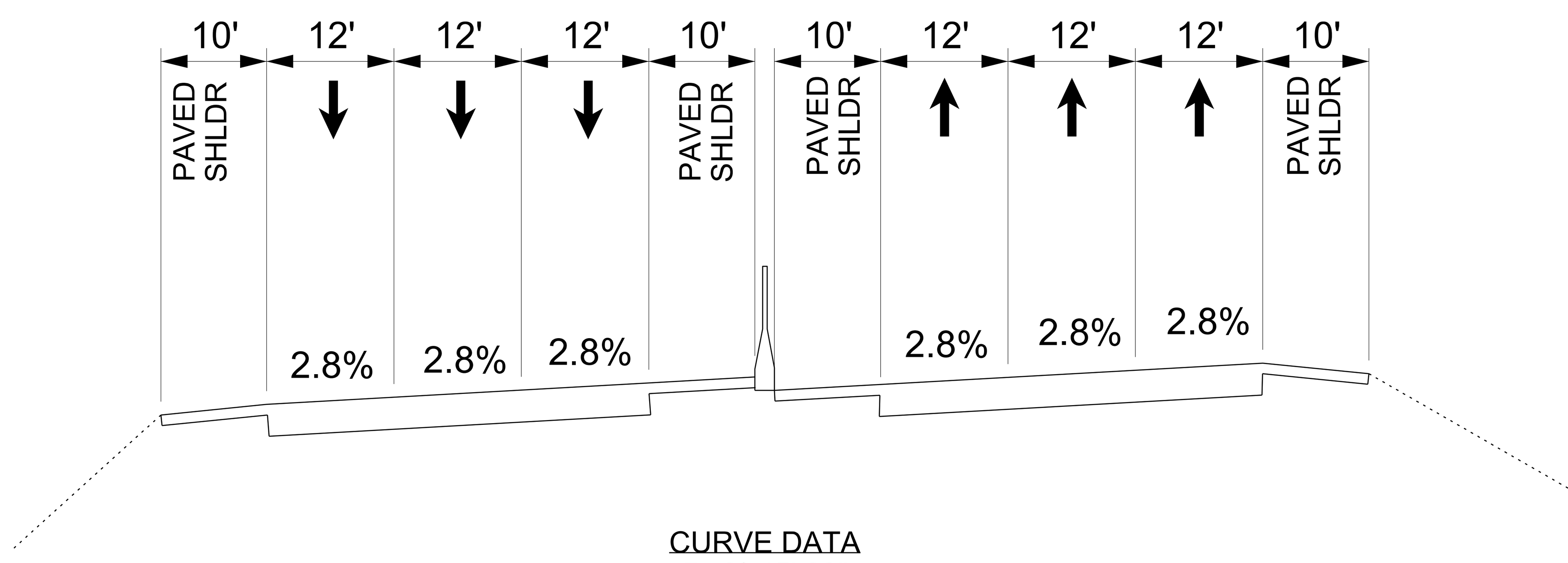
Typical Sections for the Control Sites

CONTROL SITE 1- FLORIDA'S TURNPIKE N OF ATLANTIC BLVD



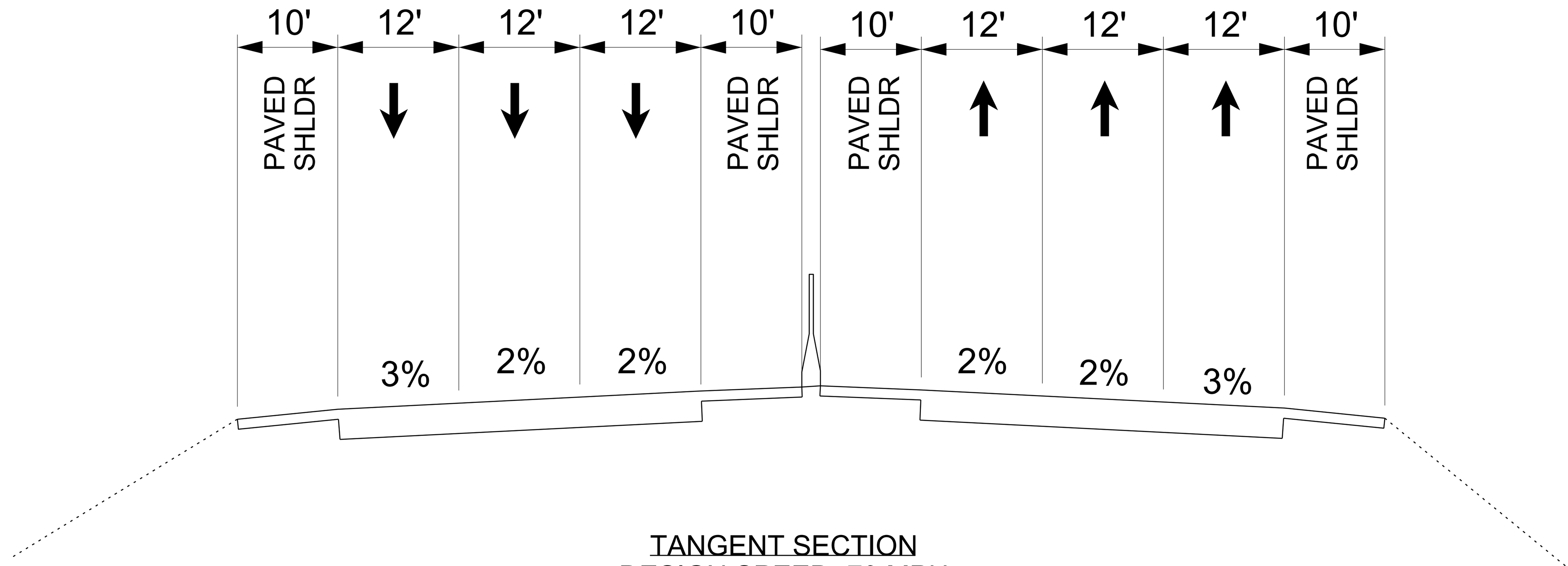
CURVE DATA
D=0° 45' 00"
R=7,639.437'
T=2,686.52'
L=5,166.67'
e=2.8%
DESIGN SPEED=70 MPH

CONTROL SITE 2- FLORIDA'S TURNPIKE S OF COPAN'S RD



CURVE DATA
D=0° 45' 00"
R=7,639.437'
T=876.60'
L=1,745.44'
e=2.8%
DESIGN SPEED=70 MPH

CONTROL SITE 3- FLORIDA'S TURNPIKE S OF GLADES RD



TANGENT SECTION
DESIGN SPEED=70 MPH

Appendix J

Highway Safety Manual (2010) Expected Crash Rate Analysis Outputs

Input Worksheet for Freeway Segments				
Clear / Echo Input Values (View results in Column AV) / Check Input Values (View results in Advisory Messages)		Segment 1 **Study Period**	Segment 2 **Study Period**	Segment 3 **Study Period**
Basic Roadway Data				
Number of through lanes (n):		6		
Freeway segment description:		6-In Typical Section		
Segment length (L), mi:		0.01		
Alignment Data				
Horizontal Curve Data ↖See note				
1	Horizontal curve in segment?:	No		
	Curve radius (R_1), ft:			
	Length of curve (L_{c1}), mi:			
	Length of curve in segment ($L_{c1,seg}$), mi:			
2	Horizontal curve in segment?:			
	Curve radius (R_2), ft:			
	Length of curve (L_{c2}), mi:			
	Length of curve in segment ($L_{c2,seg}$), mi:			
3	Horizontal curve in segment?:			
	Curve radius (R_3), ft:			
	Length of curve (L_{c3}), mi:			
	Length of curve in segment ($L_{c3,seg}$), mi:			
Cross Section Data				
Lane width (W_l), ft:		12		
Outside shoulder width (W_s), ft:		10		
Inside shoulder width (W_{is}), ft:		10		
Median width (W_m), ft:		20		
Rumble strips on outside shoulders?:		Yes		
	Length of rumble strips for travel in increasing milepost direction, mi:			
	Length of rumble strips for travel in decreasing milepost direction, mi:			
Rumble strips on inside shoulders?:		Yes		
	Length of rumble strips for travel in increasing milepost direction, mi:			
	Length of rumble strips for travel in decreasing milepost direction, mi:			
Presence of barrier in median:		Center		
1	Length of barrier ($L_{ib,1}$), mi:	0.01		
	Distance from edge of traveled way to barrier face ($W_{off,in,1}$), ft:			
2	Length of barrier ($L_{ib,2}$), mi:	0.01		
	Distance from edge of traveled way to barrier face ($W_{off,in,2}$), ft:			
3	Length of barrier ($L_{ib,3}$), mi:	0.01		
	Distance from edge of traveled way to barrier face ($W_{off,in,3}$), ft:			
4	Length of barrier ($L_{ib,4}$), mi:	0.01		
	Distance from edge of traveled way to barrier face ($W_{off,in,4}$), ft:			
5	Length of barrier ($L_{ib,5}$), mi:	0.01		
	Distance from edge of traveled way to barrier face ($W_{off,in,5}$), ft:			
Median barrier width (W_{ib}), ft:		0		
Nearest distance from edge of traveled way to barrier face (W_{near}), ft:				

Roadside Data				
Clear zone width (W_{hc}), ft:		30		
Presence of barrier on roadside:		None		
1	Length of barrier ($L_{ob,1}$), mi:			
	Distance from edge of traveled way to barrier face ($W_{off,o,1}$), ft:			
2	Length of barrier ($L_{ob,2}$), mi:			
	Distance from edge of traveled way to barrier face ($W_{off,o,2}$), ft:			
3	Length of barrier ($L_{ob,3}$), mi:			
	Distance from edge of traveled way to barrier face ($W_{off,o,3}$), ft:			
4	Length of barrier ($L_{ob,4}$), mi:			
	Distance from edge of traveled way to barrier face ($W_{off,o,4}$), ft:			
5	Length of barrier ($L_{ob,5}$), mi:			
	Distance from edge of traveled way to barrier face ($W_{off,o,5}$), ft:			
Distance from edge of traveled way to barrier face, increasing milepost ($W_{off,inc}$), ft:				
Distance from edge of traveled way to barrier face, decreasing milepost ($W_{off,dec}$), ft:				
Ramp Access Data				
Travel in Increasing Milepost Direction				
Entrance Ramp	Ramp entrance in segment? (If yes, indicate type.):	No		
	Distance from begin milepost to upstream entrance ramp gore ($X_{b,ent}$), mi:			
	Length of ramp entrance ($L_{en,inc}$), mi:			
	Length of ramp entrance in segment ($L_{en,seg,inc}$), mi:			
	Entrance side?:			
Exit Ramp	Ramp exit in segment? (If yes, indicate type.):	No		
	Distance from end milepost to downstream exit ramp gore ($X_{e,ext}$), mi:			
	Length of ramp exit ($L_{ex,inc}$), mi:			
	Length of ramp exit in segment ($L_{ex,seg,inc}$), mi:			
	Exit side?:			
Weave	Type B weave in segment?:	No		
	Length of weaving section ($L_{wev,inc}$), mi:			
	Length of weaving section in segment ($L_{wev,seg,inc}$), mi:			
Travel in Decreasing Milepost Direction				
Entrance Ramp	Ramp entrance in segment? (If yes, indicate type.):	No		
	Distance from end milepost to upstream entrance ramp gore ($X_{e,ent}$), mi:			
	Length of ramp entrance ($L_{en,dec}$), mi:			
	Length of ramp entrance in segment ($L_{en,seg,dec}$), mi:			
	Entrance side?:			
Exit Ramp	Ramp exit in segment? (If yes, indicate type.):	No		
	Distance from begin milepost to downstream exit ramp gore ($X_{b,ext}$), mi:			
	Length of ramp exit ($L_{ex,dec}$), mi:			
	Length of ramp exit in segment ($L_{ex,seg,dec}$), mi:			
	Exit side?:			
Weave	Type B weave in segment?:	No		
	Length of weaving section ($L_{wev,dec}$), mi:			
	Length of weaving section in segment ($L_{wev,seg,dec}$), mi:			
Traffic Data	**Year**			
Proportion of AADT during high-volume hours (P_{hv}):		0.15		
Freeway Segment Data	2011	70000		

Average daily traffic ($AADT_{fs}$) by year, veh/d:	2012	75000		
(enter data only for those years for which	2013	80000		
it is available, leave other years blank)	2014	85000		
	2015	89000		
	2016			
	2017			
	2018			
	2019			
	2020			
	2021			
	2022			
	2023			
	2024			
	2025			
	2026			
	2027			
	2028			
	2029			
	2030			
	2031			
	2032			
	2033			
	2034			
Entrance Ramp Data for Travel in Increasing Milepost Dir.	**Year**			
Average daily traffic ($AADT_{b,ent}$) by year, veh/d:	2011			
(enter data only for those years for which	2012			
it is available, leave other years blank)	2013			
	2014			
	2015			
	2016			
	2017			
	2018			
	2019			
	2020			
	2021			
	2022			
	2023			
	2024			
	2025			
	2026			
	2027			
	2028			
	2029			
	2030			
	2031			
	2032			
	2033			
	2034			
Exit Ramp Data for Travel in Increasing Milepost Direction	**Year**			
Average daily traffic ($AADT_{e,ext}$) by year, veh/d:	2011			
(enter data only for those years for which	2012			

Output Summary

General Information

Project description:	Hydroplaning Study - 6-In Expected Crash Outcome				
Analyst:	AE	Date:	9/1/2018	Area type:	Urban
First year of analysis:	2011				
Last year of analysis:	2015				

Crash Data Description

Freeway segments	Segment crash data available?	No	First year of crash data:	
	Project-level crash data available?	No	Last year of crash data:	
Ramp segments	Segment crash data available?	No	First year of crash data:	
	Project-level crash data available?	No	Last year of crash data:	
Ramp terminals	Segment crash data available?	No	First year of crash data:	
	Project-level crash data available?	No	Last year of crash data:	

Estimated Crash Statistics

Crashes for Entire Facility	Total	K	A	B	C	PDO
Estimated number of crashes during Study Period, crashes:	294.1	0.8	3.3	22.4	68.0	199.6
Estimated average crash freq. during Study Period, crashes/yr:	58.8	0.2	0.7	4.5	13.6	39.9

Crashes by Facility Component	Nbr. Sites	Total	K	A	B	C	PDO
Freeway segments, crashes:	1	135.1	0.6	1.6	10.8	22.7	99.4
Ramp segments, crashes:	6	7.5	0.1	0.2	1.1	1.7	4.4
Crossroad ramp terminals, crashes:	6	151.5	0.1	1.5	10.5	43.6	95.8

Crashes for Entire Facility by Year	Year	Total	K	A	B	C	PDO
Estimated number of crashes during the Study Period, crashes:	2011	53.0	0.1	0.6	4.1	12.8	35.4
	2012	55.8	0.1	0.6	4.3	13.2	37.6
	2013	58.8	0.2	0.7	4.5	13.6	39.9
	2014	61.9	0.2	0.7	4.7	14.0	42.4
	2015	64.6	0.2	0.7	4.9	14.4	44.4
	2016						
	2017						
	2018						
	2019						
	2020						
	2021						
	2022						
	2023						
	2024						
	2025						
	2026						
	2027						
	2028						
	2029						
	2030						
	2031						
	2032						
	2033						
	2034						

Distribution of Crashes for Entire Facility

Crash Type	Crash Type Category	Estimated Number of Crashes During the Study Period					
		Total	K	A	B	C	PDO
Multiple vehicle	Head-on crashes:	1.8	0.0	0.0	0.2	0.7	0.9
	Right-angle crashes:	41.7	0.0	0.5	3.3	13.0	24.9
	Rear-end crashes:	179.2	0.5	2.1	14.5	43.2	118.9
	Sideswipe crashes:	48.4	0.1	0.3	2.4	5.8	39.7
	Other multiple-vehicle crashes:	6.0	0.0	0.1	0.5	1.2	4.3
	Total multiple-vehicle crashes:	277.2	0.7	3.0	20.9	63.9	188.7
Single vehicle	Crashes with animal:	0.0	0.0	0.0	0.0	0.0	0.0
	Crashes with fixed object:	13.0	0.1	0.2	1.1	2.8	9.0
	Crashes with other object:	0.4	0.0	0.0	0.0	0.1	0.3
	Crashes with parked vehicle:	0.4	0.0	0.0	0.0	0.1	0.3
	Other single-vehicle crashes	3.0	0.0	0.1	0.4	1.2	1.3
	Total single-vehicle crashes:	16.9	0.1	0.3	1.5	4.1	10.9
	Total crashes:	294.1	0.8	3.3	22.4	68.0	199.6

Input Worksheet for Freeway Segments

Clear | Echo Input Values (View results in Column AV) | Check Input Values (View results in Advisory Messages)

		Segment 1 Study Period	Segment 2 Study Period	Segment 3 Study Period
Basic Roadway Data				
Number of through lanes (n):		8		
Freeway segment description:		8-In Typical Section		
Segment length (L), mi:		0.01		
Alignment Data				
Horizontal Curve Data	See note			
1	Horizontal curve in segment?:	No		
	Curve radius (R_1), ft:			
	Length of curve (L_{c1}), mi:			
	Length of curve in segment ($L_{c1,seg}$), mi:			
2	Horizontal curve in segment?:			
	Curve radius (R_2), ft:			
	Length of curve (L_{c2}), mi:			
	Length of curve in segment ($L_{c2,seg}$), mi:			
3	Horizontal curve in segment?:			
	Curve radius (R_3), ft:			
	Length of curve (L_{c3}), mi:			
	Length of curve in segment ($L_{c3,seg}$), mi:			
Cross Section Data				
Lane width (W_l), ft:		12		
Outside shoulder width (W_s), ft:		10		
Inside shoulder width (W_{is}), ft:		10		
Median width (W_m), ft:		20		
Rumble strips on outside shoulders?:		Yes		
	Length of rumble strips for travel in increasing milepost direction, mi:			
	Length of rumble strips for travel in decreasing milepost direction, mi:			
Rumble strips on inside shoulders?:		Yes		
	Length of rumble strips for travel in increasing milepost direction, mi:			
	Length of rumble strips for travel in decreasing milepost direction, mi:			
Presence of barrier in median:		Center		
1	Length of barrier ($L_{ib,1}$), mi:	0.01		
	Distance from edge of traveled way to barrier face ($W_{off,in,1}$), ft:			
2	Length of barrier ($L_{ib,2}$), mi:	0.01		
	Distance from edge of traveled way to barrier face ($W_{off,in,2}$), ft:			
3	Length of barrier ($L_{ib,3}$), mi:	0.01		
	Distance from edge of traveled way to barrier face ($W_{off,in,3}$), ft:			
4	Length of barrier ($L_{ib,4}$), mi:	0.01		
	Distance from edge of traveled way to barrier face ($W_{off,in,4}$), ft:			
5	Length of barrier ($L_{ib,5}$), mi:	0.01		
	Distance from edge of traveled way to barrier face ($W_{off,in,5}$), ft:			
Median barrier width (W_{ib}), ft:		0		
Nearest distance from edge of traveled way to barrier face (W_{near}), ft:				

Roadside Data				
Clear zone width (W_{hc}), ft:		30		
Presence of barrier on roadside:		None		
1	Length of barrier ($L_{ob,1}$), mi:			
	Distance from edge of traveled way to barrier face ($W_{off,o,1}$), ft:			
2	Length of barrier ($L_{ob,2}$), mi:			
	Distance from edge of traveled way to barrier face ($W_{off,o,2}$), ft:			
3	Length of barrier ($L_{ob,3}$), mi:			
	Distance from edge of traveled way to barrier face ($W_{off,o,3}$), ft:			
4	Length of barrier ($L_{ob,4}$), mi:			
	Distance from edge of traveled way to barrier face ($W_{off,o,4}$), ft:			
5	Length of barrier ($L_{ob,5}$), mi:			
	Distance from edge of traveled way to barrier face ($W_{off,o,5}$), ft:			
Distance from edge of traveled way to barrier face, increasing milepost ($W_{off,inc}$), ft:				
Distance from edge of traveled way to barrier face, decreasing milepost ($W_{off,dec}$), ft:				
Ramp Access Data				
Travel in Increasing Milepost Direction				
Entrance Ramp	Ramp entrance in segment? (If yes, indicate type.):	No		
	Distance from begin milepost to upstream entrance ramp gore ($X_{b,ent}$), mi:			
	Length of ramp entrance ($L_{en,inc}$), mi:			
	Length of ramp entrance in segment ($L_{en,seg,inc}$), mi:			
	Entrance side?:			
Exit Ramp	Ramp exit in segment? (If yes, indicate type.):	No		
	Distance from end milepost to downstream exit ramp gore ($X_{e,ext}$), mi:			
	Length of ramp exit ($L_{ex,inc}$), mi:			
	Length of ramp exit in segment ($L_{ex,seg,inc}$), mi:			
	Exit side?:			
Weave	Type B weave in segment?:	No		
	Length of weaving section ($L_{wev,inc}$), mi:			
	Length of weaving section in segment ($L_{wev,seg,inc}$), mi:			
Travel in Decreasing Milepost Direction				
Entrance Ramp	Ramp entrance in segment? (If yes, indicate type.):	No		
	Distance from end milepost to upstream entrance ramp gore ($X_{e,ent}$), mi:			
	Length of ramp entrance ($L_{en,dec}$), mi:			
	Length of ramp entrance in segment ($L_{en,seg,dec}$), mi:			
	Entrance side?:			
Exit Ramp	Ramp exit in segment? (If yes, indicate type.):	No		
	Distance from begin milepost to downstream exit ramp gore ($X_{b,ext}$), mi:			
	Length of ramp exit ($L_{ex,dec}$), mi:			
	Length of ramp exit in segment ($L_{ex,seg,dec}$), mi:			
	Exit side?:			
Weave	Type B weave in segment?:	No		
	Length of weaving section ($L_{wev,dec}$), mi:			
	Length of weaving section in segment ($L_{wev,seg,dec}$), mi:			
Traffic Data	**Year**			
Proportion of AADT during high-volume hours (P_{hv}):		0.15		
Freeway Segment Data	2011	111000		

Average daily traffic ($AADT_{fs}$) by year, veh/d: (enter data only for those years for which it is available, leave other years blank)	2012	116000		
	2013	121000		
	2014	126000		
	2015	131000		
	2016			
	2017			
	2018			
	2019			
	2020			
	2021			
	2022			
	2023			
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	2025			
	2026			
	2027			
	2028			
	2029			
	2030			
	2031			
	2032			
	2033			
	2034			
Entrance Ramp Data for Travel in Increasing Milepost Dir.	**Year**			
Average daily traffic ($AADT_{b,ent}$) by year, veh/d: (enter data only for those years for which it is available, leave other years blank)	2011			
	2012			
	2013			
	2014			
	2015			
	2016			
	2017			
	2018			
	2019			
	2020			
	2021			
	2022			
	2023			
	2024			
	2025			
	2026			
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	2028			
	2029			
	2030			
	2031			
	2032			
	2033			
	2034			
Exit Ramp Data for Travel in Increasing Milepost Direction	**Year**			
Average daily traffic ($AADT_{e,ext}$) by year, veh/d: (enter data only for those years for which	2011			
	2012			

Output Summary

General Information

Project description:	Hydroplaning Study - 8-In Expected Crash Outcome				
Analyst:	AE	Date:	9/1/2018	Area type:	Urban
First year of analysis:	2011				
Last year of analysis:	2015				

Crash Data Description

Freeway segments	Segment crash data available?	No	First year of crash data:	
	Project-level crash data available?	No	Last year of crash data:	
Ramp segments	Segment crash data available?	No	First year of crash data:	
	Project-level crash data available?	No	Last year of crash data:	
Ramp terminals	Segment crash data available?	No	First year of crash data:	
	Project-level crash data available?	No	Last year of crash data:	

Estimated Crash Statistics

Crashes for Entire Facility	Total	K	A	B	C	PDO
Estimated number of crashes during Study Period, crashes:	405.7	1.2	4.5	30.7	85.5	283.7
Estimated average crash freq. during Study Period, crashes/yr:	81.1	0.2	0.9	6.1	17.1	56.7

Crashes by Facility Component	Nbr. Sites	Total	K	A	B	C	PDO
Freeway segments, crashes:	1	246.7	1.1	2.7	19.2	40.2	183.5
Ramp segments, crashes:	6	7.5	0.1	0.2	1.1	1.7	4.4
Crossroad ramp terminals, crashes:	6	151.5	0.1	1.5	10.5	43.6	95.8

Crashes for Entire Facility by Year	Year	Total	K	A	B	C	PDO
Estimated number of crashes during the Study Period, crashes:	2011	73.8	0.2	0.8	5.7	16.1	51.0
	2012	77.4	0.2	0.9	5.9	16.6	53.8
	2013	81.0	0.2	0.9	6.1	17.1	56.6
	2014	84.8	0.3	0.9	6.4	17.6	59.6
	2015	88.7	0.3	1.0	6.6	18.1	62.7
	2016						
	2017						
	2018						
	2019						
	2020						
	2021						
	2022						
	2023						
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	2032						
	2033						
	2034						

Distribution of Crashes for Entire Facility

Crash Type	Crash Type Category	Estimated Number of Crashes During the Study Period					
		Total	K	A	B	C	PDO
Multiple vehicle	Head-on crashes:	2.2	0.0	0.0	0.3	0.8	1.1
	Right-angle crashes:	44.1	0.1	0.5	3.5	13.5	26.4
	Rear-end crashes:	257.7	0.9	3.0	20.8	56.3	176.8
	Sideswipe crashes:	75.7	0.2	0.6	3.9	9.0	62.1
	Other multiple-vehicle crashes:	8.9	0.0	0.1	0.7	1.7	6.3
	Total multiple-vehicle crashes:	388.6	1.2	4.2	29.2	81.3	272.7
Single vehicle	Crashes with animal:	0.0	0.0	0.0	0.0	0.0	0.0
	Crashes with fixed object:	13.2	0.1	0.2	1.1	2.8	9.1
	Crashes with other object:	0.4	0.0	0.0	0.0	0.1	0.3
	Crashes with parked vehicle:	0.4	0.0	0.0	0.0	0.1	0.3
	Other single-vehicle crashes	3.1	0.0	0.1	0.4	1.2	1.3
	Total single-vehicle crashes:	17.1	0.1	0.3	1.6	4.2	11.0
	Total crashes:	405.7	1.2	4.5	30.7	85.5	283.7

Input Worksheet for Freeway Segments					
Clear	Echo Input Values (View results in Column AV)	Check Input Values (View results in Advisory Messages)	Segment 1 **Study Period**	Segment 2 **Study Period**	Segment 3 **Study Period**
Basic Roadway Data					
Number of through lanes (n):			10		
Freeway segment description:			10-ln Typical Section		
Segment length (L), mi:			0.01		
Alignment Data					
Horizontal Curve Data		See note			
1	Horizontal curve in segment?:		No		
	Curve radius (R_1), ft:				
	Length of curve (L_{c1}), mi:				
	Length of curve in segment ($L_{c1,seg}$), mi:				
2	Horizontal curve in segment?:				
	Curve radius (R_2), ft:				
	Length of curve (L_{c2}), mi:				
	Length of curve in segment ($L_{c2,seg}$), mi:				
3	Horizontal curve in segment?:				
	Curve radius (R_3), ft:				
	Length of curve (L_{c3}), mi:				
	Length of curve in segment ($L_{c3,seg}$), mi:				
Cross Section Data					
Lane width (W_l), ft:			12		
Outside shoulder width (W_s), ft:			10		
Inside shoulder width (W_{is}), ft:			10		
Median width (W_m), ft:			20		
Rumble strips on outside shoulders?:			Yes		
	Length of rumble strips for travel in increasing milepost direction, mi:				
	Length of rumble strips for travel in decreasing milepost direction, mi:				
Rumble strips on inside shoulders?:			Yes		
	Length of rumble strips for travel in increasing milepost direction, mi:				
	Length of rumble strips for travel in decreasing milepost direction, mi:				
Presence of barrier in median:			Center		
1	Length of barrier ($L_{ib,1}$), mi:		0.01		
	Distance from edge of traveled way to barrier face ($W_{off,in,1}$), ft:				
2	Length of barrier ($L_{ib,2}$), mi:		0.01		
	Distance from edge of traveled way to barrier face ($W_{off,in,2}$), ft:				
3	Length of barrier ($L_{ib,3}$), mi:		0.01		
	Distance from edge of traveled way to barrier face ($W_{off,in,3}$), ft:				
4	Length of barrier ($L_{ib,4}$), mi:		0.01		
	Distance from edge of traveled way to barrier face ($W_{off,in,4}$), ft:				
5	Length of barrier ($L_{ib,5}$), mi:		0.01		
	Distance from edge of traveled way to barrier face ($W_{off,in,5}$), ft:				
Median barrier width (W_{ib}), ft:			0		
Nearest distance from edge of traveled way to barrier face (W_{near}), ft:					

Roadside Data				
Clear zone width (W_{hc}), ft:		30		
Presence of barrier on roadside:		None		
1	Length of barrier ($L_{ob,1}$), mi:			
	Distance from edge of traveled way to barrier face ($W_{off,o,1}$), ft:			
2	Length of barrier ($L_{ob,2}$), mi:			
	Distance from edge of traveled way to barrier face ($W_{off,o,2}$), ft:			
3	Length of barrier ($L_{ob,3}$), mi:			
	Distance from edge of traveled way to barrier face ($W_{off,o,3}$), ft:			
4	Length of barrier ($L_{ob,4}$), mi:			
	Distance from edge of traveled way to barrier face ($W_{off,o,4}$), ft:			
5	Length of barrier ($L_{ob,5}$), mi:			
	Distance from edge of traveled way to barrier face ($W_{off,o,5}$), ft:			
Distance from edge of traveled way to barrier face, increasing milepost ($W_{off,inc}$), ft:				
Distance from edge of traveled way to barrier face, decreasing milepost ($W_{off,dec}$), ft:				
Ramp Access Data				
Travel in Increasing Milepost Direction				
Entrance Ramp	Ramp entrance in segment? (If yes, indicate type.):	No		
	Distance from begin milepost to upstream entrance ramp gore ($X_{b,ent}$), mi:			
	Length of ramp entrance ($L_{en,inc}$), mi:			
	Length of ramp entrance in segment ($L_{en,seg,inc}$), mi:			
	Entrance side?:			
Exit Ramp	Ramp exit in segment? (If yes, indicate type.):	No		
	Distance from end milepost to downstream exit ramp gore ($X_{e,ext}$), mi:			
	Length of ramp exit ($L_{ex,inc}$), mi:			
	Length of ramp exit in segment ($L_{ex,seg,inc}$), mi:			
	Exit side?:			
Weave	Type B weave in segment?:	No		
	Length of weaving section ($L_{wev,inc}$), mi:			
	Length of weaving section in segment ($L_{wev,seg,inc}$), mi:			
Travel in Decreasing Milepost Direction				
Entrance Ramp	Ramp entrance in segment? (If yes, indicate type.):	No		
	Distance from end milepost to upstream entrance ramp gore ($X_{e,ent}$), mi:			
	Length of ramp entrance ($L_{en,dec}$), mi:			
	Length of ramp entrance in segment ($L_{en,seg,dec}$), mi:			
	Entrance side?:			
Exit Ramp	Ramp exit in segment? (If yes, indicate type.):	No		
	Distance from begin milepost to downstream exit ramp gore ($X_{b,ext}$), mi:			
	Length of ramp exit ($L_{ex,dec}$), mi:			
	Length of ramp exit in segment ($L_{ex,seg,dec}$), mi:			
	Exit side?:			
Weave	Type B weave in segment?:	No		
	Length of weaving section ($L_{wev,dec}$), mi:			
	Length of weaving section in segment ($L_{wev,seg,dec}$), mi:			
Traffic Data	**Year**			
Proportion of AADT during high-volume hours (P_{hv}):		0.15		
Freeway Segment Data	2011	151000		

Average daily traffic ($AADT_{fs}$) by year, veh/d: (enter data only for those years for which it is available, leave other years blank)	2012	156000		
	2013	161000		
	2014	166000		
	2015	171000		
	2016			
	2017			
	2018			
	2019			
	2020			
	2021			
	2022			
	2023			
	2024			
	2025			
	2026			
	2027			
	2028			
	2029			
	2030			
	2031			
	2032			
	2033			
	2034			
Entrance Ramp Data for Travel in Increasing Milepost Dir.	**Year**			
Average daily traffic ($AADT_{b,ent}$) by year, veh/d: (enter data only for those years for which it is available, leave other years blank)	2011			
	2012			
	2013			
	2014			
	2015			
	2016			
	2017			
	2018			
	2019			
	2020			
	2021			
	2022			
	2023			
	2024			
	2025			
	2026			
	2027			
	2028			
	2029			
	2030			
	2031			
	2032			
	2033			
	2034			
Exit Ramp Data for Travel in Increasing Milepost Direction	**Year**			
Average daily traffic ($AADT_{e,ext}$) by year, veh/d: (enter data only for those years for which	2011			
	2012			

Output Summary

General Information

Project description:	Hydroplaning Study - 10-In Expected Crash Outcome				
Analyst:	AE	Date:	9/1/2018	Area type:	Urban
First year of analysis:	2011				
Last year of analysis:	2015				

Crash Data Description

Freeway segments	Segment crash data available?	No	First year of crash data:	
	Project-level crash data available?	No	Last year of crash data:	
Ramp segments	Segment crash data available?	No	First year of crash data:	
	Project-level crash data available?	No	Last year of crash data:	
Ramp terminals	Segment crash data available?	No	First year of crash data:	
	Project-level crash data available?	No	Last year of crash data:	

Estimated Crash Statistics

Crashes for Entire Facility	**Total**	**K**	**A**	**B**	**C**	**PDO**
Estimated number of crashes during Study Period, crashes:	482.5	1.5	5.2	35.4	95.3	345.1
Estimated average crash freq. during Study Period, crashes/yr:	96.5	0.3	1.0	7.1	19.1	69.0

Crashes by Facility Component	**Nbr. Sites**	**Total**	**K**	**A**	**B**	**C**	**PDO**
Freeway segments, crashes:	1	323.5	1.3	3.4	23.9	50.0	244.9
Ramp segments, crashes:	6	7.5	0.1	0.2	1.1	1.7	4.4
Crossroad ramp terminals, crashes:	6	151.5	0.1	1.5	10.5	43.6	95.8

Crashes for Entire Facility by Year	**Year**	**Total**	**K**	**A**	**B**	**C**	**PDO**
Estimated number of crashes during the Study Period, crashes:	2011	89.2	0.3	1.0	6.6	18.1	63.2
	2012	92.8	0.3	1.0	6.9	18.6	66.0
	2013	96.4	0.3	1.0	7.1	19.1	68.9
	2014	100.1	0.3	1.1	7.3	19.5	71.9
	2015	103.9	0.3	1.1	7.5	20.0	75.0
	2016						
	2017						
	2018						
	2019						
	2020						
	2021						
	2022						
	2023						
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	2030						
	2031						
	2032						
	2033						
	2034						

Distribution of Crashes for Entire Facility

Crash Type	**Crash Type Category**	**Estimated Number of Crashes During the Study Period**					
		Total	**K**	**A**	**B**	**C**	**PDO**
Multiple vehicle	Head-on crashes:	2.5	0.0	0.0	0.3	0.9	1.2
	Right-angle crashes:	45.6	0.1	0.5	3.7	13.8	27.5
	Rear-end crashes:	311.5	1.0	3.5	24.3	63.6	219.0
	Sideswipe crashes:	94.7	0.2	0.7	4.7	10.7	78.4
	Other multiple-vehicle crashes:	10.8	0.0	0.1	0.9	2.0	7.8
	Total multiple-vehicle crashes:	465.2	1.4	4.9	33.9	91.1	333.9
Single vehicle	Crashes with animal:	0.0	0.0	0.0	0.0	0.0	0.0
	Crashes with fixed object:	13.3	0.1	0.2	1.1	2.8	9.2
	Crashes with other object:	0.4	0.0	0.0	0.0	0.1	0.3
	Crashes with parked vehicle:	0.4	0.0	0.0	0.0	0.1	0.3
	Other single-vehicle crashes	3.1	0.0	0.1	0.4	1.3	1.3
	Total single-vehicle crashes:	17.3	0.1	0.3	1.6	4.2	11.2
Total crashes:		482.5	1.5	5.2	35.4	95.3	345.1