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Traffic and Safety Context Sensitive Solutions Assessment

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14. ABSTRACT: The George Washington Memorial Parkway (GWMP) is a scenic and historic roadway that runs along the south bank of the Potomac River between Mount Vernon and I-495. This study is a traffic and safety assessment, focusing on nine intersections located in the southern segment between the City of Alexandria and Mount Vernon. The purpose is to identify potential alternatives for enhancing traffic safety that are also appropriate (context sensitive) for a national park setting. The report presents existing traffic conditions and crash experience for all nine intersections. It also summarizes the the process for identifying and screening alternatives, and recommendations for each intersection.

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Acronyms and Abbreviations

AASHTO	American Association of State Highway and Transportation Officials
ASE	Automated Speed Enforcement
CDOT	Colorado Department of Transportation
CMF	Crash Modification Factors
DMS	Dynamic Message Sign
DUI	Driving Under the Influence
EFL	Eastern Federal Lands
FARS	Fatality Analysis Reporting System
FAT	Fatality
FHWA	Federal Highway Administration
GWMP	George Washington Memorial Parkway
HCM	Highway Capacity Manual
HQ	Headquarters
H&R	Hit and Run
INJ	Injury
LOS	Level of Service
MPH	Miles Per Hour
MUTCD	Manual on Uniform Traffic Control
MVBOS	Mount Vernon Board of Supervisors
MVCCA	Mount Vernon Council of Citizens' Associations, Inc.
MVMH	Mount Vernon Memorial Highway
MVT	Mount Vernon Trail
NCPPC	National Capital Park and Planning Commission
NCR	National Capital Region
NEPA	National Environmental Policy Act
NHTSA	National Highway Traffic Safety Administration

NPS	National Park Service
OUI	Operating Under the Influence
PDO	Property Damage Only
PEP-C	Planning, Environment and Public Comment
ROW	Right-of-Way
RRFB	Rectangular Rapid Flash Beacon
TNC	Transportation Network Company
USDOT	U.S. Department of Transportation
USPP	U.S. Park Police
V/C Ratio	Volume to Capacity Ratio
VDOT	Virginia Department of Transportation
WTI	Western Transportation Institute

Preface

The George Washington Memorial Parkway (Parkway) occupies more than 7,300 acres of land in Virginia, Maryland, and the District of Columbia. The Parkway is overseen by an administrative unit of the National Park Service (NPS). This unit is also known as the George Washington Memorial Parkway but is referred to as GWMP. GWMP manages more than two dozen associated park sites, many of which have their own enabling legislation.

This scenic parkway was developed to help preserve the Potomac River Gorge and shoreline, while serving as a memorial to the first President of the United States, George Washington. The Potomac Gorge is one of the most significant natural areas in the United States and is home to hundreds of occurrences of many rare species and communities (Walsh, et al., 2016). The park also houses several unique habitats, including a major river system with numerous tributaries, noteworthy stands of upland forest, seeps and springs harboring rare groundwater fauna, and abundant wetlands (Allen & Flack, 2001). Today, the Parkway connects some of the most important historic, natural, and cultural sites from Mount Vernon to Great Falls Park, and provides a sanctuary for many rare and unique plant and animal species in the urbanized Washington, D.C. metropolitan area (National Park Service, 2014). The park runs 28 miles along the western shore of the Potomac River through the District of Columbia and portions of northern Virginia. Within the park there are 27 sites associated with George Washington's life, and the nation he helped establish. The Parkway is a key transportation artery in northern Virginia, providing access to Washington, D.C., Arlington County, Fairfax County, and the City of Alexandria. Many neighboring communities consider the Parkway a commuter route, however from its inception, the parkway was established as a recreational and environmental conservation area (National Park Service, 2008). Unlike Shenandoah with its large size, a parkway is an attenuated (thin) park with a road through it, but a park, nonetheless. The road itself, serves as a means for the visitor to experience the park, much as a trail is the means to experience the mountains.

Foundational to the park's existence is understanding the congressional intent in creating the Parkway and the significance of this NPS unit to the nation. Public Law 69-158 (June 6, 1924) provided for a comprehensive development of the park and playground system of the Nation's capital. The law constituted the National Capital Park Commission "to prevent pollution of Rock Creek and the Potomac and Anacostia Rivers, to preserve forests and natural scenery in and about Washington, and to provide for the comprehensive systematic, and continuous development of the park, parkway, and playground system of the National Capital" (Walsh, et al., 2016). The Capper-Cramton Act of May 29, 1930 (46 Stat. 482) followed and allowed for the acquisition, establishment, and development of the Parkway along the Potomac River from Mount Vernon and Fort Washington to Great Falls, Virginia (National Park Service, 2014).

The Parkway was built in stages between 1929 and 1970. Originally known as the Mount Vernon Memorial Highway (MVMH), construction on the MVMH portion of the new roadway was completed in three years, opening in 1932 for the bicentennial of Washington's birth (Walsh, et al., 2016). The northern section of the Parkway, from Arlington Memorial Bridge to I-495, was built in stages starting in the 1940s and reaching completion in 1965. This northern section displayed the latest in road engineering methods for its time—a wide, gently curving roadway with a grassy median, low stone guide walls, and soaring steel-and-concrete arched bridges. Much, if not all of this character remains today.

The National Capital Park & Planning Commission (NCP&PC) in 1927 indicated: "There are and should be in the development of plans, a number of things which may be called parkways, to serve as lines of pleasure traffic; but in another sense part of the thoroughfare system of the District. There is overlapping there of the two types of functions. We need to be careful that it does not extend too far."

In addition to the legislative intent of Congress, the Parkway has two other distinctions. In 2005, the U.S. Department of Transportation designated the Parkway as an All-American Road in the National Scenic Byways Program. This program recognizes selected roadways throughout the U.S. based on their archeological, cultural, historic, natural, recreational, and scenic qualities and seeks to protect them (National Park Service, 2005). The Parkway is part of a multiple property listing on the National Register of Historic Places. Its designation is based upon two evaluation criteria: properties that are associated with the lives of persons significant in our past; properties that embody the distinctive characteristics of a type, period, or method of construction, or that represent the work of a master, or that possess high artistic values, or that represent a significant and distinguishable entity whose components may lack individual distinction.

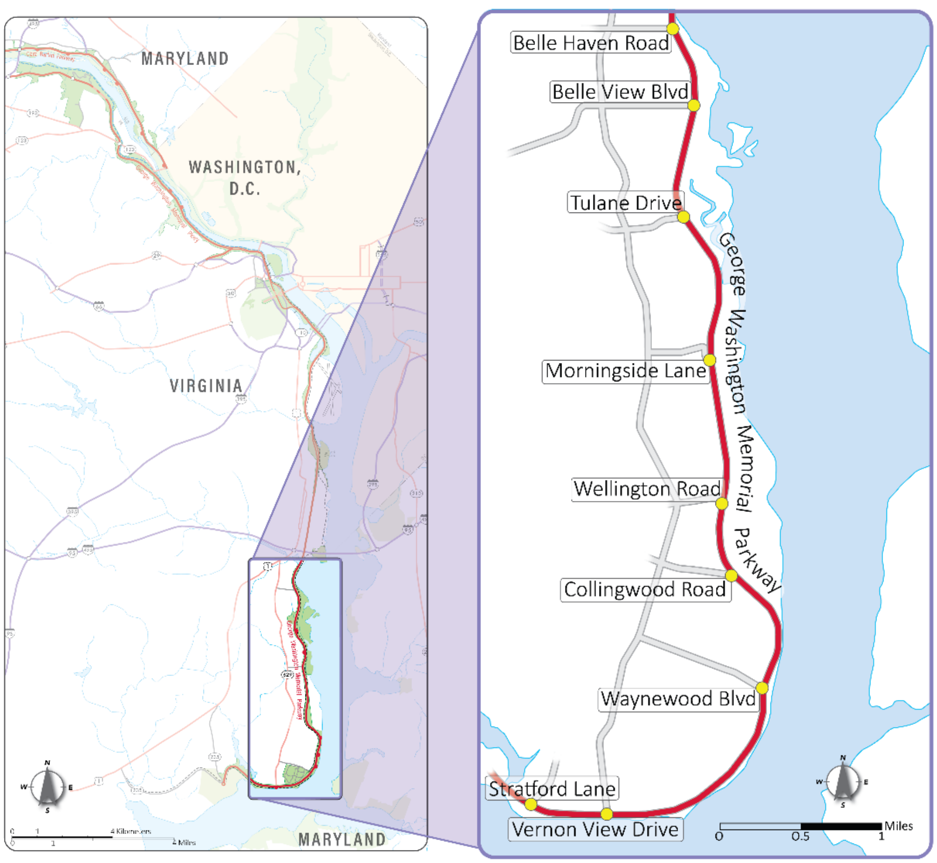
The mission of the Parkway's administrative unit, GWMP, is to develop, manage, and preserve the park, parkway, and playground system of the National Capital area; protect and preserve a wide variety of individual cultural, natural, recreational, and scenic resources throughout the parkway; and promote opportunities for the public to learn about and experience parkway resources.

Rather than apply a traditional highway design solution, the park will need to scale appropriately and to be ever attentive to context sensitivity. It is this context that the NPS would use to review, evaluate, and consider changes to the roadway. Likewise, potential solutions that are not consistent with parkway design have been screened out for further consideration. Construction, repair and ground or visual disturbances require the NPS to meet Section 106 of the National Historic Preservation Act as well as any other laws or policies. In Chapter 5, the study describes the importance of context sensitivity when evaluating changes and presents roadway design features that are part of the parkway character. Road facilities are thought of not for their function alone, but how they lay on the land, are seen by the motorist, framed in the viewshed, affect the tree canopy, impact sensitive archeological sites, and become part of the transportation system. A treatment (i.e. sign) or change is not only specific to an intersection but examined for its cumulative effects on the park. As the park implements the various recommendations within the study, adaptations need to be context sensitive. In doing so, park management is mindful of and dutiful to make decisions, such that the National Capital Park & Planning Commissions admonishment that we need be careful that the overlapping of functions does not extend too far. There can then be reasonable assurance that the Parkway's character and visitor experience remains and the NPS has fulfilled its stewardship responsibilities.

Executive Summary

The George Washington Memorial Parkway (Parkway) was established as a recreational and environmental conservation area. A parkway is an attenuated (narrow) park with a road through it, but a park, nonetheless. The road serves as a means for the visitor to experience the park, much as a trail is the means to experience the mountains. On the National Register of Historic Places, the Parkway is a scenic and historic roadway that runs along the south bank of the Potomac River between Mount Vernon and I-495. This study is a traffic and safety assessment, focusing on the following nine intersections spanning 6.3 miles along the southern segment between the City of Alexandria and Mount Vernon:

1) Belle Haven Road
2) Belle View Boulevard
3) Tulane Drive
4) Morningside Lane
5) Wellington Road
6) Collingwood Road
7) Waynewood Boulevard
8) Vernon View Drive
9) Stratford Lane



Chapter 1, **Introduction**, introduces the project and outlines the tasks performed to complete the work. It also highlights the unique characteristics of the Parkway. The design of the roadway includes gradual rises and falls with gentle horizontal curvature; these features were included to showcase the beauty of the area as a visitor travels from site to site. In short, there is a need to fully consider the context sensitive nature of this national asset. The Parkway is a heavily used commuter route with no traffic control on the Parkway itself. Furthermore, commercial vehicles (without a permit), bicycles, and pedestrians are prohibited from traveling along the Parkway. Nonetheless, because the Parkway often separates the residential area to the west of the Parkway from the Mount Vernon Trail (MVT) to the east of the Parkway, there are many crossings by pedestrians and bicyclists to the MVT and to bus stops heading north on the Parkway.

Chapter 2, **Study Intersections and Existing Traffic & Roadway Conditions** presents background information associated with the studied Parkway corridor. *Understanding existing conditions allows for a data-driven approach when providing recommendations.* Existing traffic and roadway condition data that was collected included: traffic control at intersections, locations of transit stops in the corridor, locations of bicycle and pedestrian facilities, traffic counts, observed speeds, traffic capacity, queuing (the line of vehicles waiting to turn onto the Parkway), stop delay, and parking lot capacity.

Most of the study corridor has a posted speed limit of 45 mph; only the areas immediately around the heavily congested intersections of Belle Haven Road and Belle View Boulevard have a lower posted speed limit of 35 mph. However, collected data has indicated that the median speed is above the posted speed limits, with the 85^{th} percentile speed ranging from 8-12 mph above the posted speed limits.

While traffic on the Parkway is free flow throughout the corridor, the side streets typically have stop control, with a few access roadways having yield control. Queuing, a measure of the number of vehicles waiting at a traffic control device to enter a traffic stream, was greatest during the AM peak period for the side streets accessing the Parkway, with the largest queues seen at the northern intersections along the corridor.

Throughout most of the corridor, the lanes along the Parkway are narrow, measuring only about 10 feet in width. Some intersections have wide medians with trees (e.g. Stratford Lane) whereas other intersections have only a double yellow line separating two lanes of traffic in each direction (e.g. Morningside Lane). There is currently no lighting anywhere along the Parkway.

The MVT can be found on both the east and west side of the Parkway. On the west side of the Parkway, the MVT parallels the Parkway, often with only a short distance between them. A vehicle turning from the Parkway onto a side street may not perceive a crossing pedestrian/bicyclist.

Chapter 3, **Traffic Safety Evaluation & Crash Experience**, discusses an analysis of the historic crash data, taken from two separate periods: 2005-2015 and 2018-2019. Three hundred eighty-nine crashes were identified across the nine intersections; these crashes could be between vehicles, between vehicles and a fixed object (e.g. tree), between vehicles and an animal, and between vehicles and a vulnerable road user (e.g. bicycle and pedestrian). Belle View Boulevard had the largest count with Stratford Lane having the fewest. Overall, at some intersections with the fewest crashes, the severity of the crashes is unexpectedly high.

A significant challenge of analyzing the data was that information was missing and the data was only provided in tabular format: no crash reports were provided. Crash reports have additional details, like a sketch of the intersection and a narrative that can provide more information regarding factors contributing to crashes.

Overall, the majority of crashes occurred between 12 PM and 12 AM (Eastern Time); however, when considering a single hour, most of the crash occurrence was during an hour within the AM or PM peak across all nine intersections.

April was the month with the greatest number of crashes. This could represent additional road users frequenting the Parkway during this time period (e.g. bicyclist, pedestrians, motorcyclists). It could also represent a change in visibility. When trees and shrubs are leafing out, it may be more difficult for drivers to see approaching vehicles while they are waiting to turn onto the Parkway.

Friday was the day on which the majority of the intersections reported the greatest number of crashes.

The four intersections with the greatest crash count are: 1) Belle Haven Road, 2) Belle View Boulevard, 3) Morningside Lane, and 4) Collingwood Road. However, considering severity of crashes, Waynewood Boulevard and Vernon View Drive have fewer crashes, but higher severity. Morningside Lane stands out when considering all intersections in that it has both a high crash count and high severity.

Bicycle and pedestrian crashes were found in the crash data at: 1) Belle Haven Road, 2) Belle View Boulevard, 3) Wellington Road, and 4) Collingwood Road. However, due to the way that the crash data was presented, there could be underrepresentation regarding the true number of crashes involving these vulnerable road users.

All intersections, except for Vernon View Drive and Stratford Lane, had animal/vehicle crashes. Most often, they occurred at night during October and November (which corresponds with GWMP's Natural Resource Manager indicating that deer are most active in October and November).

Providing intersection illumination has been found to be associated with an approximately forty percent reduction in crashes. The Parkway does not have any illumination along the corridor. The researchers looked at time of day during which crashes occurred. For those crashes occurring during the day, they also looked at anticipated reductions in light (e.g. presence of rain). By combining these numbers, they obtained the number of crashes that could be potentially mitigated by the presence of illumination. Therefore, the lack of lighting at the intersections was implied as a factor contributing to crashes across almost all of the intersections within the corridor. More importantly, because research suggests that providing illumination at several intersections in a corridor and not at others can actually result in an increase in crashes at the intersections without illumination, a global application of illumination of the intersections within the corridor is recommended.

Most crashes were angle or between a vehicle and an object, like a tree/shrub. The causal factor for the majority of crashes was failure to yield right-of-way (ROW), suggesting that there is either a lack of clarity regarding who has ROW, or that excessive speeds may make it difficult for a vehicle trying to enter the roadway.

Driving under the influence (DUI) appeared to be particularly problematic at Tulane Drive and Collingwood Road. At Tulane Drive, these types of crashes most often resulted in the vehicle striking a tree. Yet, across the corridor, there were many hit-and-run crashes, which are often associated with DUI, suggesting that it is a broader problem than the data truly captures. It seems that a DUI is often only recorded when striking a tree renders the vehicle immobile.

Chapter 4, **Stakeholder & Public Engagement Process**, discusses the stakeholder engagement process. Two sets of public, stakeholder and elected official meetings were held. The first, in July 2019, introduced the project and requested feedback from the public, stakeholders and elected officials regarding traffic and safety concerns for the intersections under study in the corridor. The second, in December 2019, presented the public, stakeholders, and elected officials with potential solutions identified through the data collected and the input provided.

Chapter 5, **Alternatives Development**, discusses how context sensitive solutions were identified and how they were further analyzed to prioritize those finally selected. Eighty-nine potential solutions were identified, including suggestions from the public, stakeholders, and elected officials. They were defined by nine categories: 1) driver behavior, 2) signs & markings, 3) operational changes, 4) multimodal improvements, 5) geometric modifications, 6) roadway departure countermeasures, 7) maintenance, 8) environmental, and 9) Fort Belvoir. These potential solutions were first whittled down using two filters: the first filtered out potential solutions that were outside of this project’s focus (e.g. vehicles hitting the stone arche bridge), and the second filtered out potential solutions that were not consistent with the context sensitivity considerations of the parkway.

The remaining potential solutions were then screened using the following criteria: 1) traffic safety benefit, 2) law, policy, & regulatory compatibility, 3) implementation timeline, 4) traffic operational benefits, 5) supporting analysis, 6) construction cost, 7) responsible agency for implementation, 8) right-of-way (ROW), and 9) community support. After screening, the twenty-six alternatives which were categorized into engineering, education, and enforcement solutions (following the 3E approach to safety). A range of alternatives was identified, as each intersection will likely need a custom solution (or mix of solutions) to address its specific traffic and safety capacity issues.

The following list shows the three highest ranking (and preferred) alternatives within each category:

1. Engineering (specifically geometric modifications)
    a. Roundabout
    b. Road Diet
    c. Longitudinal Rumble/Mumblestrips
2. Education
    a. Speed Public Awareness Campaign
    b. Pedestrian Safety Public Awareness Campaign
    c. Distracted Driving Public Awareness Campaign
3. Enforcement
    a. Commercial Vehicle Enforcement/Educational Campaigns
    b. Increased Enforcement of Speeding, Driving Under the Influence, and Distracted Driving
    c. Automated Speed Enforcement (ASE) (Speed Cameras)

Chapter 6, **Engineering, Education, and Enforcement**, discusses engineering, education and enforcement solutions developed further for the corridor.

Per the Alternatives Development process described in Chapter 5, and with input from the Stakeholder & Public Engagement Process described in Chapter 4, the detailed engineering design concepts are shown for the following four solutions that rose to the top:

1. Access Management
2. Road Diets
3. Roundabouts
4. Pedestrian/Bike Refuge Islands.

For each of these engineering design solutions, a description is provided, expected safety benefits are identified, potential intersection location applications for the treatment are suggested based on operational and site data, and generalized cost estimates are provided. Illustrative renderings, pictures of precedent applications and concept drawings of these treatments are provided. It should be noted that based on final engineering design, funding levels and stakeholder input, recommended locations or types of engineering measures may change prior to implementation. It is important to note that a treatment like pedestrian/bike refuge islands cannot be done in isolation; rather, there is a need to address the speeding in the corridor before implementing such a treatment. A road diet example is one such complementary treatment.

In addition to these major geometric modifications, other minor engineering measures are discussed including enhanced signage/ pavement markings, lighting, rumblestrips/mumblestrips and roadway maintenance such as selective repaving, vegetation trimming, and drainage cleaning.

For education, several examples of educational campaigns are presented that can provide solutions to some of the crash causes. For example, it is recommended that a speed management plan be developed for the corridor, as the data showed that both the median and 85th percentile speeds are well above the posted speed limits at multiple locations within the corridor. Similarly, animal/vehicle crashes were identified as occurring most typically in October and November during the overnight hours (roughly 5 PM to 9 AM Eastern Time). Therefore, the Western Transportation Institute (WTI) Team recommends using dynamic message signs to provide warnings to motorists regarding the potential presence of wildlife during these times periods (and keeping the signs dark otherwise). This approach has been effectively used elsewhere in Virginia.

For enforcement, the WTI Team identifies collaboration between the NPS, United States Park Police (USPP) and Virginia law enforcement as a strategy to enforce driving under the influence infractions, which were identified as a problem in the corridor. Furthermore, the Parkway is encouraged to continue to identify the potential for automated speed enforcement (ASE) to support speed enforcement efforts, as USPP staff members are limited in number.

The NPS and USPP policies and practices associated with ASE were not examined in this study. A feasibility and capability review are recommended to determine the current requirements for ASE and aid management in evaluating this countermeasure. Traffic enforcement fines are not retained by the NPS or the USPP; therefore, collateral fine forfeiture does not provide a mechanism for program costs. Legal, financial, policy, or other considerations suggest ASE would be a multi-year endeavor, thus it does not provide short-term benefits.

Chapter 7, **Summary & Conclusions**, summarizes key findings presented in the prior chapters, highlighting how different solutions may be applied to the intersections in the corridor.

The following are global recommendations for this corridor:

1. Implement lighting at the intersections throughout the corridor.
2. Trim trees and shrubs; ensure this is a reoccurring program throughout the period of the year when foliage is present and grows.
3. Reduction of excessive speed through Education and Enforcement Measures
    a. Speed Management Action Plan
    b. Public Awareness Campaign of the National Parkway Context
    c. Manual and Automated Speed Enforcement
4. Reapply the pavement markings for improved conspicuity. Develop a plan to reapply on a regular basis.
5. Enforcement of driving under the influence (DUI) offenses
6. Re-evaluate crash data collection within the corridor. Detailed crash data provides significant value in understanding crash causes along with demonstrating impacts as a result of implemented solutions.
7. Apply mumblestrips to keep vehicles on the roadway.
8. Utilize dynamic message signs (DMS) to alert drivers to the presence of wildlife along the corridor from Belle Haven Road to Waynewood Boulevard, from mid-October through the end of November, providing the information between 5:30pm and 9am. The DMS could remain dark outside of these times periods to increase conspicuity.
9. Develop a public awareness educational campaign starting at the end of March to remind motorists about the increasing presence of pedestrians, bicycles and motorcycles who are also using the corridor.

The following are key recommendations by intersection, where treatments are needed beyond the above global recommendations:

1. Belle Haven Road
    a. Channelize left turns in the median
    b. Create an acceleration lane at the U-turn location at Belle Haven Marina

2. Belle View Boulevard
   a. Implement a median U-turn
3. Tulane Drive
   a. Implement a roundabout; ensure that high quality access to the Mount Vernon Trail that currently exists is retained (e.g. investigate the possibility for bicycle/pedestrian roundabout outside of the vehicular roundabout)
4. Morningside Lane, Wellington Road, Collingwood Road, Waynewood Boulevard, and Vernon View Drive
   a. Implement a road diet throughout these intersections to calm vehicle speeds and provide a center turn lane
   b. For Wellington Road, implement a rectangular rapid flash beacon with a refuge island to address pedestrian/bicycle crossings.

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1. Introduction

The George Washington Memorial Parkway (Parkway) was established as a recreational and environmental conservation area. A parkway is an attenuated (narrow) park with a road through it, but a park, nonetheless. The road serves as a means for the visitor to experience the park, much as a trail is the means to experience the mountains. On the National Register of Historic Places, the Parkway is a scenic and historic roadway that runs along the south bank of the Potomac River between Mount Vernon and I-495. This study is a traffic and safety assessment, focusing on the following intersections located in the southern segment (approximately 6.3 miles) between the City of Alexandria and Mount Vernon (Figure 1):

- Belle Haven Road
- Belle View Boulevard
- Tulane Drive
- Morningside Lane
- Wellington Road
- Collingwood Road
- Waynewood Boulevard
- Vernon View Drive
- Stratford Lane

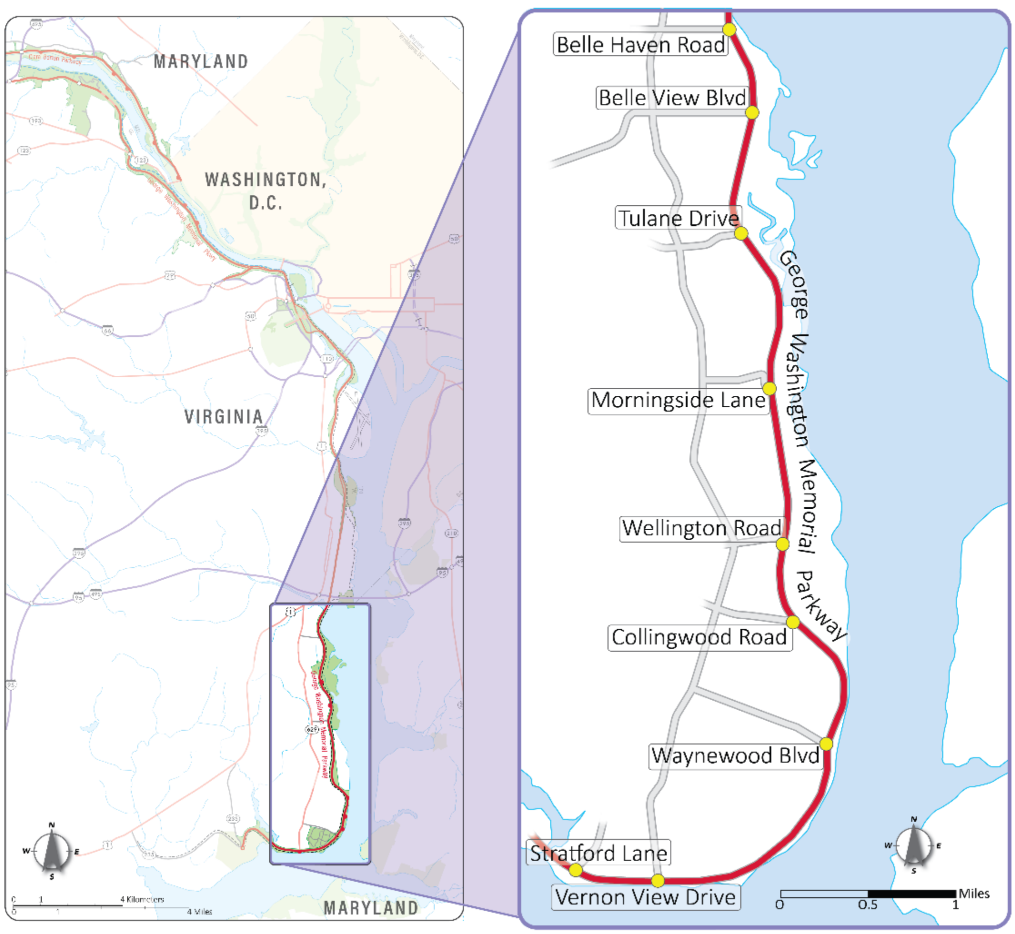


Figure 1: Map of the nine study intersections along the Parkway.

Commercial vehicle access is prohibited along the roadway without a permit from the National Park Service (NPS) (Code of Federal Regulations, 2012) (Code of Federal Regulations, 1997).

Bicycles are prohibited (National Park Service, 2011) and there are no sidewalks along the roadway, however, the adjacent Mount Vernon Trail (MVT) provides multi-modal access. In addition to vehicular traffic traveling to see the sites along the corridor, the roadway is heavily used as a commuter route. The heavy commuter traffic flow can create challenges for vehicular traffic traveling between sites, commuters egressing adjacent neighborhoods onto the Parkway, as well as pedestrians and bicyclists crossing the Parkway to access recreational facilities, bus stops and the MVT. Furthermore, the design of the roadway itself was not intended for the point to point travel that many commuters prefer – the roadway includes trees along the corridor, gradual rises and falls, and gentle curvature to allow the driver to see the beauty of the surrounding landscape. The Parkway was also developed at a time when vehicles traveled at slower speeds. There have been previous efforts to recommend safety solutions at specific locations within the southern corridor; however, the frequency and severity of crashes persists (Ocel, 2019). The purpose of this traffic and pedestrian safety context sensitive solutions assessment is to respond to community concerns about traffic safety and develop context sensitive solutions to enhance safety while maintaining the Parkway's scenic and historic character.

This study included a stakeholder team of transportation safety professionals including the NPS, Federal Highway Administration (FHWA), Eastern Federal Lands (EFL) Highway Division, U.S. Park Police (USPP), Virginia Department of Transportation (VDOT), City of Alexandria and Fairfax County. Input was solicited from elected officials, community groups (e.g. Mount Vernon Council of Citizens' Associations, Inc.), individual members of the public, and advocacy groups such as the Friends of the Mount Vernon Trail.

The study process included numerous tasks to develop a deep understanding of traffic safety and operational conditions along the Parkway including:

- Creating project base maps
- Collecting multi-modal traffic data at study locations including car, bus, truck, pedestrian and bicycle traffic volumes, transit boardings and parking utilization
- Performing a roadway safety field audit of existing roadway design features
- Conducting field measurements of traffic conditions such as speeds, queues, and gaps for entering traffic
- Completing field observations of risky behavior by motorists, pedestrians, and bicycles
- Assessing existing traffic capacity and creating a traffic model of the corridor
- Obtaining, reviewing, and analyzing tabular crash data
- Developing and screening a menu of potential engineering and enforcement traffic safety treatments, with input from the stakeholders, elected officials, and public
- Conducting two rounds of public engagement
- Evaluating a retained list of engineering, enforcement, and educational traffic safety solutions for context-appropriateness, cost, traffic operations, safety performance and geometric design
- Identifying a final set of recommendations for implementation

Potential solutions must be carefully considered to ensure that they are context sensitive. Furthermore, potential impacts on traffic operations and traffic safety, costs, and maintenance for the NPS also must be considered. The findings and recommendations in this report are intended to help the NPS make informed decisions when considering traffic and safety mitigation actions and future planning decisions for the Parkway.

2. Study Intersections and Existing Traffic & Roadway Conditions

This study focused on nine key intersections along the George Washington Memorial Parkway (Parkway) between the City of Alexandria and Mount Vernon. The following intersections within the Parkway, as well as parkway segments between them, were evaluated in this report:

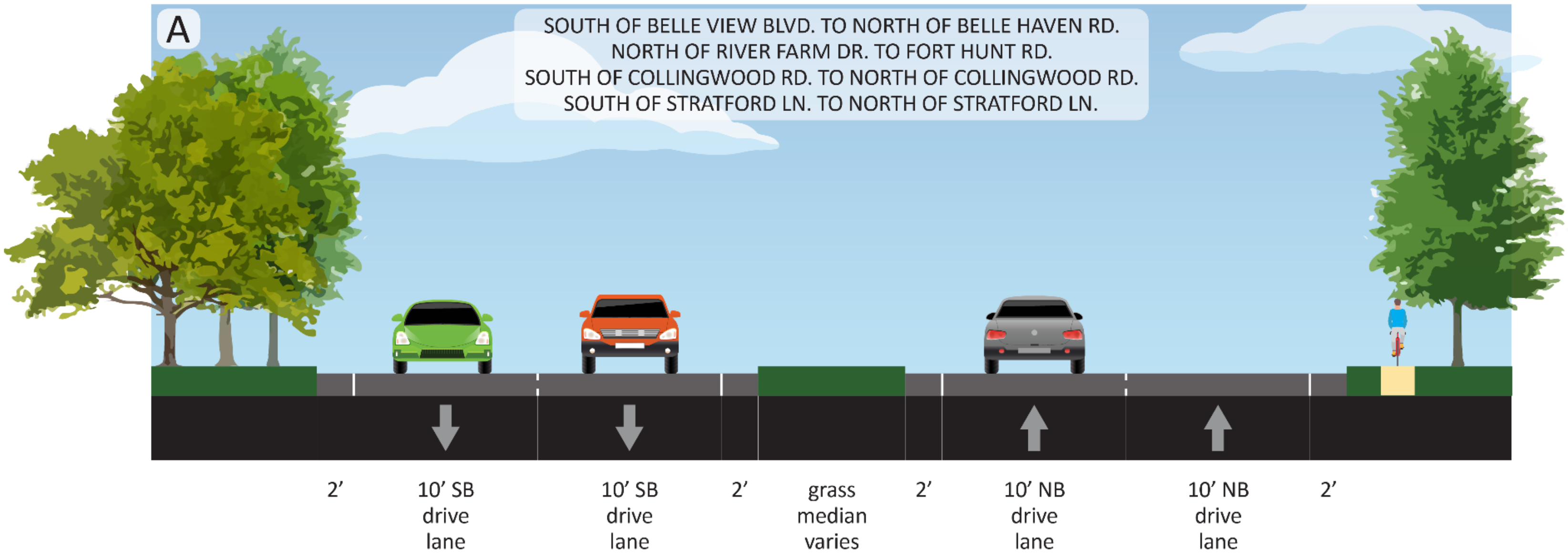
1) Belle Haven Road
2) Belle View Boulevard
3) Tulane Drive
4) Morningside Lane
5) Wellington Road
6) Collingwood Road (including Collingwood Road and East and West Boulevard Drive)
7) Waynewood Boulevard
8) Vernon View Drive (VA 629)
9) Stratford Lane

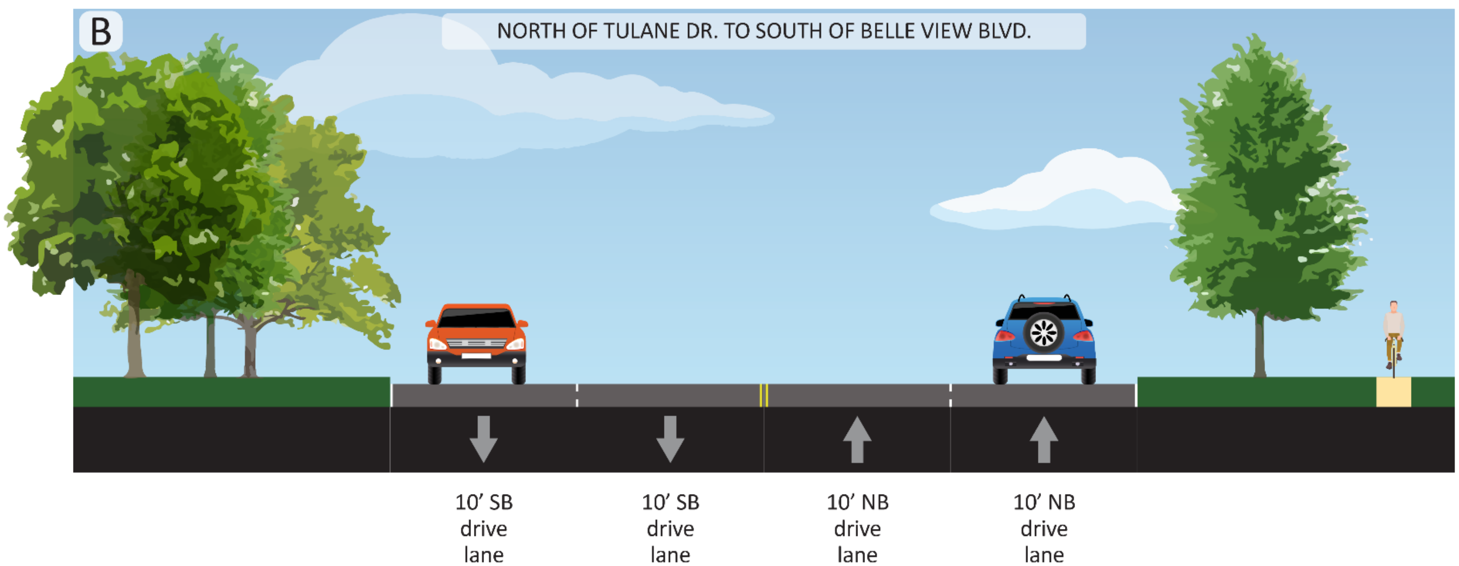
A study area map, with the traffic control from each approach and posted speed limits identified, is shown in Figure 2.

Figure 2: Study Corridor: Traffic Controls and Speed Limits

2.1 Roadway Design Elements

At the time of initial construction, the Parkway's roadway design was forward-thinking; however, design standards have significantly (Harwood, Potts, & Prosser, 2002) changed along with vehicle capabilities (e.g. vehicles can travel at significantly faster speeds). While right and left-turn auxiliary lanes and medians are present at several locations in the corridor, some intersections with a large number of crashes do not have a median or left-turn lanes. Typical travel lane widths are 10' wide, while raised and marked median widths vary, along with the distance between the Mount Vernon Trail and the Parkway. The roadway section is bounded with mountable curb and has storm drains to collect rainwater. Existing typical roadway sections, labeled A, B, C, and D are shown in Figure 3. Measurements were taken at four select locations, representing where distinct transitions in configurations were found (e.g. from a section with a median to a section without a median); therefore, some variability may be found within the identified typical roadway section (e.g. indications are that pavement widths may be as narrow as 8' in select locations).


A
SOUTH OF BELLE VIEW BLVD. TO NORTH OF BELLE HAVEN RD.
NORTH OF RIVER FARM DR. TO FORT HUNT RD.
SOUTH OF COLLINGWOOD RD. TO NORTH OF COLLINGWOOD RD.
SOUTH OF STRATFORD LN. TO NORTH OF STRATFORD LN.
2'
10' SB drive lane
10' SB drive lane
2'
grass median varies
2'
10' NB drive lane
10' NB drive lane
2'


B
NORTH OF TULANE DR. TO SOUTH OF BELLE VIEW BLVD.
10' SB drive lane
10' SB drive lane
10' NB drive lane
10' NB drive lane

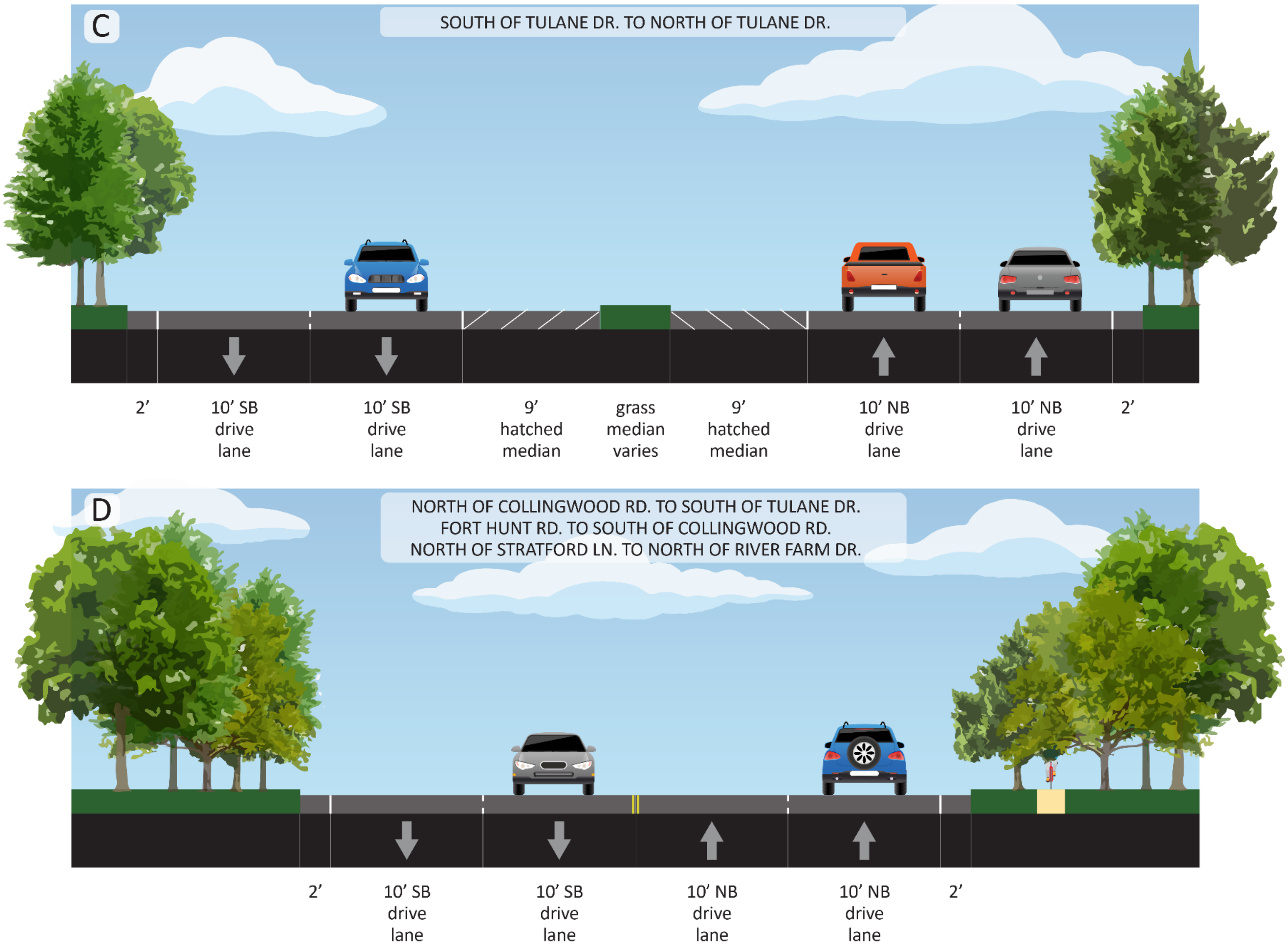


Figure 3: The Parkway's Existing Typical Roadway Sections

The posted speed limit of this section of the Parkway varies from 45 miles per hour at the south end near Stratford Lane to 35 miles per hour just prior to some of the most heavily trafficked intersections, Belle View Boulevard and Belle Haven Road, at the north end of the corridor. For traffic entering from the cross streets, all study intersections are controlled by stop signs. No roadway lighting exists. There are several horizontal and vertical curves along the roadway within the study segment; these were part of the original roadway design, incorporated as part of the intended experience of the Parkway. The roadway is paralleled for much of the study segment by the MVT, a paved surface multi-use trail. Crossings of the trail occur along several side streets within approximately 200 feet of the mainline Parkway. No sidewalks exist along the Parkway; however, many intersecting streets provide sidewalks for pedestrian access. The Parkway is served by the Metrobus 11Y route, with six northbound and six southbound stops. Many of the bus stops have lay-bys so that the bus can pull out of the travel lane for passenger boarding and alighting. All bus stops are marked with flag signs. However, other bus stop infrastructure, such as benches, landing pads or lighting, is extremely limited, with the exception of a few rustic bus stop shelters.

Base maps of each study intersection illustrating existing curb lines, pavement marking, signing and right-of-way information are included in Appendix A: Intersection Existing Conditions Mapping**.**

2.2 Parkway Traffic Volumes

Intersection traffic counts were collected in March and June of 2019. The network AM and PM peak hours for the study intersections occurred between 7:00 AM and 8:00 AM and from 5:00 PM to 6:00 PM, respectively. Traffic volumes experience directional peaks, with a northbound peak in the AM of approximately 1,700 vehicles per hour at Belle View Boulevard and 2,000 vehicles per hour southbound in the PM at Belle Haven Road. The heaviest side street volume entering the Parkway is from Collingwood Road with approximately 350 vehicles per hour. The traffic volumes indicate that some of the traffic may be using the Parkway as a bypass to US Route 1, based on the heavy northbound left-turn volumes in the AM at Belle View Boulevard. Additionally, heavier left-turn volumes entering the Parkway in the AM from side streets such as Collingwood Road do not mirror the returning southbound right-turn volumes, which are heaviest at Belle Haven Road and Morningside Lane, indicating that drivers may be traversing the neighborhoods to enter the Parkway further south in order to avoid congested intersections further north. Detailed peak hour traffic volume diagrams for each intersection and traffic count reports are included in Appendix B: Peak Hour Traffic Volumes and Appendix C: Intersection Traffic Counts.

Pneumatic tubes were used to collect multi-day volume, classification, and speed counts for one full week in March 2019 near Morningside Lane and Collingwood Road and in June 2019 near Belle View Boulevard. Table 1 summarizes the Average Daily and Average Weekday Traffic Volumes. Full traffic count reports are included in Appendix D: Average Daily Traffic Counts**.**

Table 1: Average Daily Traffic on the Parkway

Count Location	Average Daily Traffic (vehicles per day)			Average Weekday Daily Traffic (vehicles per weekday)			Percent Heavy Vehicles
	Northbound	Southbound	Total	Northbound	Southbound	Total	
The Parkway South of Belle View Boulevard	10,895	12,651	23,546	11,943	13,639	25,581	2.4%
The Parkway South of Morningside Lane	8,316	8,458	16,775	9,190	9,181	18,371	1.7%
The Parkway south of Collingwood Road	5,442	5,600	11,042	5,948	6,050	11,998	1.8%

Traffic averages and the heavy vehicle (buses and trucks) percentages decrease in the southern sections of the corridor.

2.3 Pedestrian and Bicycle Traffic

As shown in Table 2, pedestrian and bicycle traffic volumes were higher in the PM peak hour than in the AM peak hour. The data collection counted more than 600 combined pedestrians and bicyclists at the locations along the MVT during the 12-hour study. For further information on trail conditions, safety concerns, and maintenance needs and opportunities, please reference Mount Vernon Trail Corridor Study: George Washington Memorial Parkway (Daddio, Baas, Crayton, Galton, & Navarrete, 2019). Figure 4 illustrates the existing pedestrian and bicycle network including the MVT, and Figure 5 illustrates the existing transit routes, stops and daily boardings.

Table 2: Pedestrian and Bicycle Traffic on the Parkway

Mt Vernon Trail Crossing Location	Pedestrians			Bicycles		
	AM Peak Hour	PM Peak Hour	Total 12 Hours	AM Peak Hour	PM Peak Hour	Total 12 Hours
Collingwood Road west of the Parkway	7	22	137	0	17	204
Wellington Road west of the Parkway	7	16	134	0	22	212

Figure 4: Existing Pedestrian Infrastructure & Bicycle Routes

Figure 5: Existing Transit Routes, Stops and Daily Boardings

2.3.1 Vehicle Speeds

The results of the speed study indicate that the 85th-percentile speed (the speed at which a majority of drivers travel at or below) at all three sampled locations was 8 – 12 mph above the posted speed limit. The median speed at these locations was also above the posted speed limit, indicating that a majority of vehicles on the Parkway are traveling above the posted speed limit. Table 3 summarizes vehicle speed profiles (e.g. posted speed, median speed, 85th percentile, 10 mph pace, percent in pace and percent enforceable) and Figure 6 illustrates speed distributions compared to the posted speed limit.

Table 3: Speed Study

Location and Direction	Posted Speed	Median Speed [1]	85th-Percentile Speed [2]	10 MPH Pace [3]	Percent in Pace [4]	Percent Enforceable [5]
The Parkway, South of Belle View Boulevard						
Northbound	45 mph	47 mph	53 mph	41-50 mph	64.9%	6.7%
Southbound	45 mph	47 mph	52 mph	41-50 mph	68.3%	4.8%
The Parkway, South of Morningside Lane						
Northbound	45 mph	48 mph	54 mph	46-55 mph	63.7%	12.9%
Southbound	45 mph	49 mph	55 mph	46-55 mph	67.3%	17.1%
The Parkway, South of Collingwood Road						
Northbound	45 mph	47 mph	53 mph	46-55 mph	60.7%	9.2%
Southbound	45 mph	50 mph	57 mph	46-55 mph	63.7%	21.9%

1. Median speed is the speed at which an equal number of vehicles were traveling above and below.
2. The 85th percentile speed is the speed at which 85 percent of the vehicles were traveling below when unaffected by other vehicles. It is used by engineers as a good indication of the speed that the majority of motorists find safe and reasonable.
3. The 10 mile-per-hour pace is the range of speeds containing the greatest number of observed vehicles.
4. The percent in the 10 mile-per-hour pace reflects the percentage of vehicles that were traveling within this pace and is a good indicator of the range of speeds along a particular segment of roadway.
5. Percent enforceable refers to the percentage of vehicles traveling 10 mph or more above the speed limit.

In Figure 6, the top half of the bar shows green when vehicles are traveling at speeds at or below the speed limit and red where they are above. The bottom half of the bar further breaks down the speeds of the vehicles by the percentage of the total sample according to the following eight categories: 1-35 mph, 36-40mph, 41-45 mph, 46-50 mph, 51-55 mph, 56-60 mph, 61-65 mph, and greater than 65 mph.

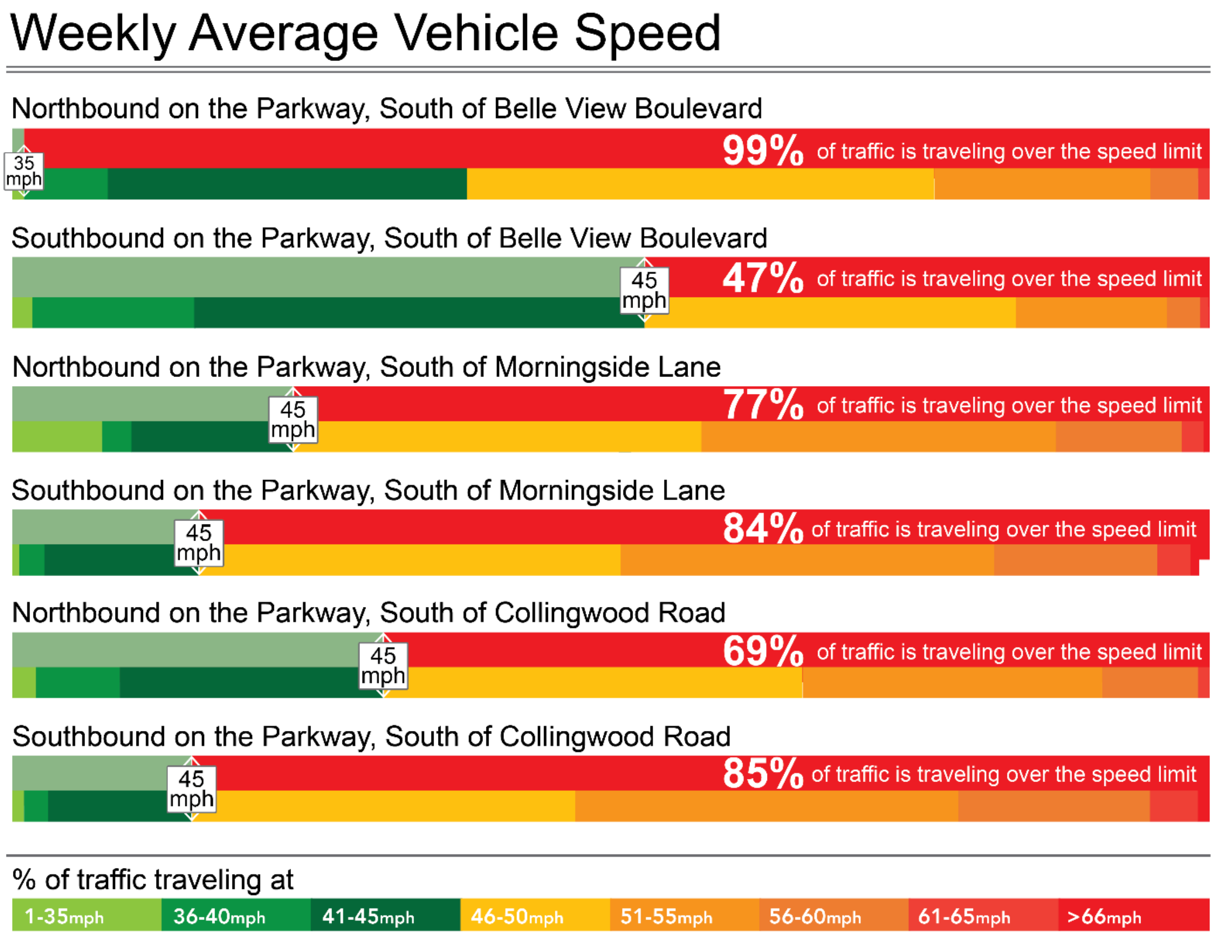


Figure 6: Weekly Average Vehicle Speed on the Parkway: South of Belle View Boulevard, South of Morningside Lane, and South of Collingwood Road

2.4 Traffic Capacity Analysis

All study intersections were coded into a traffic operations model (Synchro) of the study area network to perform capacity analysis. Synchro is a deterministic and macroscopic signal analysis computer software program that models arterial street networks and implements the methodology of the National Academy of Sciences Transportation Research Board's Highway Capacity Manual (HCM). The model inputs were geometric data such as number of lanes, lane configuration, storage lengths, tapers, and distances between intersections. The model was calibrated based on adjusting gap acceptance parameters, using field-measured data so that queues and delays observed in the field were accurately replicated in the model. A queue is defined as a "line of vehicles, bicycles, or persons waiting to be served by the system in which the flow rate from the front of the queue determines the average speed within the queue" (American Association of State Highway and Transportation Officials (AASHTO), 2010). Intersection capacity analyses were performed using the industry standard HCM methodology for all study intersections. Performance measures of effectiveness include level of service, volume-to-capacity ratio, and average vehicle delay. Key performance measures are defined as follows:

Level of Service (LOS) is a qualitative measure describing operational conditions of an intersection or any other transportation facility. LOS measures the quality of traffic service, and may be determined for intersections, roadway segments, or arterial corridors on the basis of delay, congested speed, volume to capacity (v/c) ratio, or vehicle density by functional class. At intersections, LOS is a letter designation that corresponds to a certain range of roadway operating conditions. The levels of service range from 'A' to 'F', with 'A' indicating the best operating conditions and 'F' indicating the worst, or a failing, operating condition.

Volume-to-capacity ratio (v/c ratio) is the ratio of current flow rate to the capacity of the intersection. This ratio is often used to evaluate capacity on a given roadway. Generally speaking, a ratio of 1.0 indicates that the roadway is operating at capacity. A ratio of greater than 1.0 indicates that the facility is operating above capacity, as the number of vehicles exceeds the roadway capacity.

Delay (Control delay) is the portion of delay attributed to traffic signal operation for signalized intersections or stop/yield signs for stop or roundabout-controlled intersections. Control delay (overall delay) can be categorized into deceleration delay, stopped delay, and acceleration delay. Figure 7 and Figure 8 show the LOS for each movement at each study intersection on a map view for AM Peak and PM Peak respectively. During the AM Peak, the approach from Belle Haven Road, Belle View Boulevard, and Morningside Lane all experienced an LOS F (Figure 7). Wellington Road and eastbound Collingwood Road experienced an LOS E (Figure 7). The Waynewood Boulevard approach experienced an LOS D (Figure 7). During the PM Peak, the situation became more congested at Belle Haven Road, with the left-turn from the Parkway to Belle Haven Road experiencing an LOS F (Figure 8). The Belle View Boulevard and Morningside Lane approaches remained consistent in the PM Peak to that in the AM Peak with an LOS F (Figure 8). The Wellington Road, eastbound Collingwood Road, and Waynewood Boulevard approaches all improved during the PM Peak, with an LOS D; LOS A, B, C; and LOS A, B, C; respectively (Figure 8).

The following intersections have an approach that operates with an LOS E or LOS F during at least one peak hour:

- Belle Haven Road – LOS F during AM and PM peak hour
- Belle View Boulevard – LOS F during AM and PM peak hour
- Morningside Lane – LOS F during AM and PM peak hour
- Collingwood Road – LOS E during AM peak hour

Figure 7: AM Peak Level of Service per Lane at Study Intersections

Many of the intersections in the northern portion of the study corridor have an approach that experiences high vehicle delays. As an example, eastbound Belle View Boulevard experienced 95.4 seconds of Average Delay per Approach Vehicle in the PM peak hour (see the red arrow to the right in Figure 8 at the Belle View Boulevard intersection). A delay of 95 seconds for a stop sign controlled approach is considered excessive based on the Highway Capacity Manual, which grades delays of greater than 50 seconds (about half of what drivers approaching the Parkway on Belle View Boulevard experience) as failing level of service for stop signs. Lowering the delay threshold can help reduce the variability in waiting time that motorists currently experience at stop signs when trying to find an adequate gap to safely enter traffic.

Figure 8: PM Peak Level of Service per Lane at Study Intersections

Table 4 shows the LOS and the corresponding delay values for the AM and PM peak hours at all study intersections.

Table 4: Existing Capacity Analysis

Node	Intersection	Approach	Existing Conditions AM (PM) Delay	LOS	V/C
1	The Parkway and Belle Haven Road	**Control Type**	**Stop (T Int)**		
		Eastbound	76.0 (51.5)	F (F)	0.95 (0.80)
		NB Parkway LT	1.7 (15.3)	A (C)	0.50 (0.87)
		SB Parkway	0.0 (0.0)	A (A)	0.20 (0.65)
2	The Parkway and Belle View Boulevard	**Control Type**	**Stop (T Int)**		
		Eastbound	52.4 (97.6)	F (F)	0.74 (0.95)
		NB Parkway LT	0.2 (1.8)	A (A)	0.54 (0.27)
		SB Parkway	0.0 (0.0)	A (A)	0.21 (0.53)
3	The Parkway and Tulane Drive	**Control Type**	**Stop (2-Way)**		
		Eastbound LT	20.5 (19.0)	C (C)	0.53 (0.28)
		Eastbound RT	9.2 (11.2)	A (B)	0.01 (0.03)
		Westbound	13.4 (18.5)	B (C)	0.00 (0.05)
		NB Parkway LT	9.2 (17.8)	A (C)	0.01 (0.07)
		SB Parkway	0.0 (0.0)	A (A)	0.21 (0.52)
4	The Parkway and Morningside Lane	**Control Type**	**Stop (T Int)**		
		Eastbound	87.8 (32.4)	F (D)	0.89 (0.42)
		NB Parkway LT	0.1 (0.3)	A (A)	0.00 (0.01)
		SB Parkway	0.0 (0.0)	A (A)	0.14 (0.65)
5	The Parkway and Wellington Road	**Control Type**	**Stop (T Int)**		
		Eastbound	49.5 (22.6)	E (C)	0.68 (0.19)
		NB Parkway LT	0.0 (0.1)	A (A)	0.48 (0.32)
		SB Parkway	0.0 (0.0)	A (A)	0.14 (0.65)
6	E Boulevard Dr & Collingwood Road	**Control Type**	**Stop (2-Way)**		
		Eastbound	7.2 (7.1)	A (A)	0.01 (0.01)
		Northbound	0.0 (7.0)	A (A)	0 (0.01)
		Southbound	6.4 (6.6)	A (A)	0 (0.01)
7	The Parkway and Collingwood Road	**Control Type**	**Stop (2-Way)**		
		Eastbound	42.3 (25.9)	E (D)	0.84 (0.36)
		Westbound	17.8 (17.0)	C (C)	0.01 (0.02)
		NB Parkway LT	8.1 (10.3)	A (B)	0.00 (0.02)
		SB Parkway LT	9.9 (8.4)	A (A)	0.00 (0.00)
8	W Boulevard Dr & Collingwood Rd	**Control Type**	**Stop (2-Way)**		
		Eastbound	0.6 (0.6)	A (A)	0.01 (0.00)
		Westbound	1.7 (1.6)	A (A)	0.01 (0.03)
		Northbound	11.6 (10.4)	B (B)	0.14 (0.06)
		Southbound	11.7 (11.1)	B (B)	0.01 (0.03)

Node	Intersection	Approach	Existing Conditions		
			AM (PM)		
			Delay	LOS	V/C
9	The Parkway and Waynewood Boulevard	**Control Type**	**Stop (T Int)**		
		Eastbound	28.0 (12.8)	D (B)	0.53 (0.10)
		NB Parkway LT	0.5 (9.6)	A (A)	0.01 (0.02)
		SB Parkway	0.0 (0.0)	A (A)	0.13 (0.50)
10	The Parkway and Vernon View Drive	**Control Type**	**Stop (T Int)**		
		EB Parkway LT	4.2 (9.9)	A (A)	0.12 (0.16)
		WB Parkway	0.0 (0.0)	A (A)	0.13 (0.44)
		Southbound	10.3 (13.2)	B (B)	0.21 (0.24)
11	The Parkway and Stratford Lane	**Control Type**	**Stop (2-Way)**		
		EB Parkway LT	8.8 (9.9)	A (A)	0.04 (0.10)
		WB Parkway LT	9.0 (9.0)	A (A)	0.00 (0.01)
		Northbound	23.1 (14.6)	C (B)	0.03 (0.06)
		Southbound	9.6 (15.2)	A (C)	0.14 (0.18)

2.5 Queues and Stopped Delays

Vehicular queue lengths and stopped delays were measured for each approach roadway during the AM and PM peak hours for the same time periods when the traffic count was recorded. The longest observed queue was at eastbound Belle Haven Road, with a 21-vehicle long queue in the AM peak hour. Average vehicle delays of greater than one minute were observed for Belle Haven Road (AM and PM), Belle View Boulevard (AM and PM), Tulane Drive (AM) and Morningside Lane (AM and PM). Table 5 summarizes the field-measured queues and delays; Figure 9 illustrates maximum observed peak hour queues.

Table 5: Queue and Delay Study

The Parkway Approach	Total Delay (vehicle-hours)		Average Delay per Stopped Vehicle (seconds)		Average Delay per Approach Vehicle (seconds)		Maximum Observed Queue (vehicles)	
	AM	PM	AM	PM	AM	PM	AM	PM
Eastbound Belle Haven Road	5.8	3.3	82.9	58.5	71.7	51.8	21	13
Eastbound Belle View Boulevard	2.7	5.1	65.5	101.3	55.0	95.4	11	13
Eastbound Tulane Drive	4.6	0.8	75.4	33.5	69.9	26.9	10	6
Eastbound Morningside Lane	4.34	2.25	96.4	61.4	90.3	54.4	9	10
Eastbound Wellington Road	2.25	0.27	59.2	28.7	54.8	18.8	7	4
Eastbound Collingwood Road	4.82	0.58	48.8	23.3	44.9	16.7	10	6
Westbound Collingwood Road	0.03	0.05	17.1	24.4	13.3	17.7	1	2
Eastbound Waynewood Boulevard	1.2	0.2	37.2	25.4	27.9	12.7	9	3

The Parkway Approach	Total Delay (vehicle-hours)		Average Delay per Stopped Vehicle (seconds)		Average Delay per Approach Vehicle (seconds)		Maximum Observed Queue (vehicles)	
	AM	PM	AM	PM	AM	PM	AM	PM
Southbound Vernon View Drive	0.5	0.4	20.7	20.0	10.7	11.2	6	5
Northbound Stratford Lane	0.0	0.1	25.0	20.8	21.4	12.3	1	1
Southbound Stratford Lane	0.3	0.2	18.5	20.0	9.5	11.1	4	2

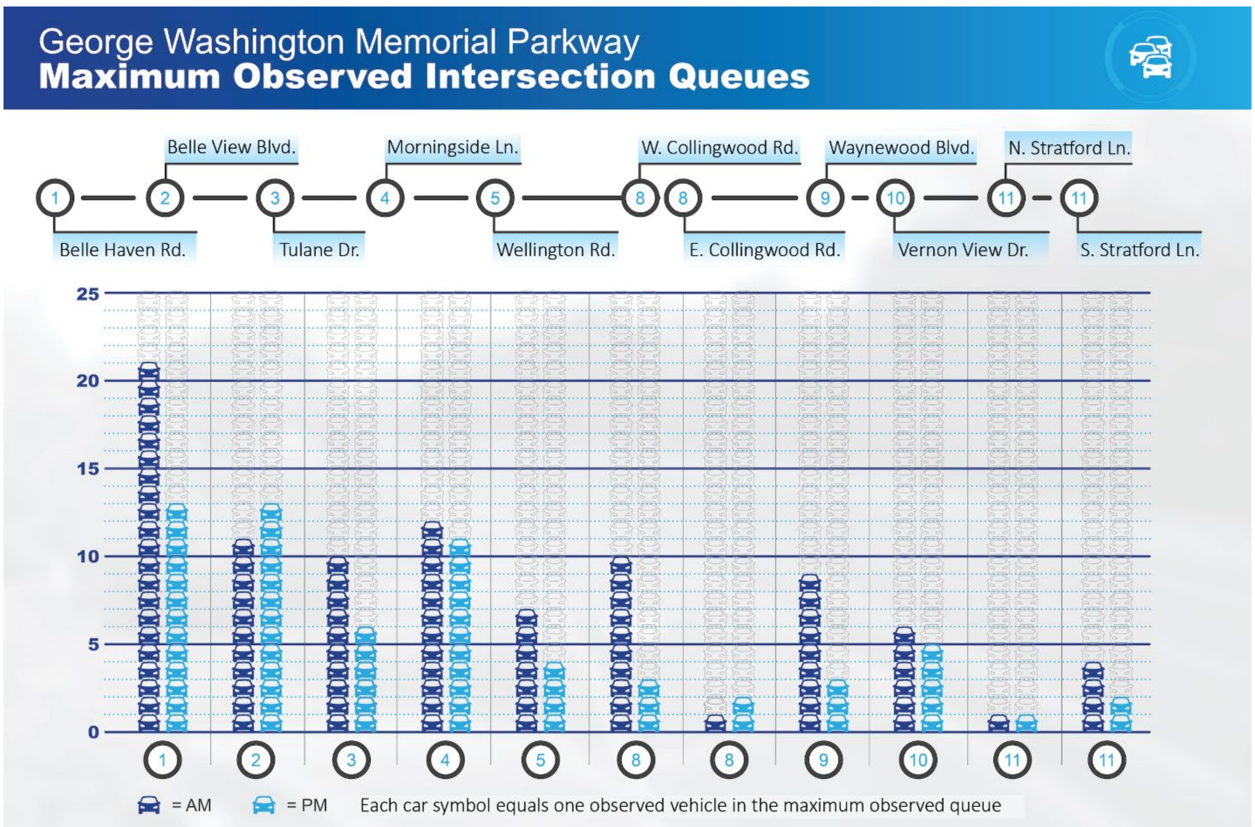


Figure 9: Maximum observed peak hour queues approaching the GWMP

2.5.1 Gaps to Enter the Parkway from Cross Streets

A gap study was performed along the Parkway at each study intersection. This study determines the number, length, and frequency of available gaps in each direction of traffic and in the combined traffic of the Parkway to assess the ability of vehicles to enter from a stopped position on each side street. The length (in seconds) of the gaps indicates whether vehicles have enough time to enter the Parkway safely. The study was performed during the same peak hours as the traffic count.

The American Association of State Highway and Transportation Officials (AASHTO) recommends a critical gap of 8.5 seconds (AASHTO, 2018) for a left-turn from a minor street onto a four-lane major street for passenger cars. The number of simultaneous gaps of 8 seconds or longer for automobiles to cross or enter the Parkway from many cross streets, particularly the more northern study intersections, is very low. Comparing the gaps with the peak hour demand volumes for these movements shows that an insufficient number of gaps are available during the AM and PM peak hours to accommodate the number of turns. A lack of adequate gaps can cause long queues and delays at an intersection. Figure 10 illustrates the gap availability; Table 6-14 summarize the gap data.

Table 6: Gap Study at Belle Haven Road

Gap Size (sec)	Northbound		Southbound		Simultaneous Northbound & Southbound	
	# Gaps	% Gaps	# Gaps	% Gaps	# Gaps	% Gaps
	AM (PM)	AM (PM)	AM (PM)	AM (PM)	AM (PM)	AM (PM)
< 5	311 (160)	91% (83%)	201 (273)	61% (86%)	314 (154)	95% (95%)
6 – 11	24 (19)	7% (10%)	53 (19)	16% (6%)	12 (7)	4% (4%)
12 – 17	7 (10)	2% (5%)	34 (11)	10% (3%)	4 (1)	1% (1%)
18 – 23	1 (15)	0% (8%)	39 (15)	12% (5%)	0 (0)	0% (0%)
24 – 29	0 (1)	0% (1%)	8 (3)	2% (1%)	0 (0)	0% (0%)
> 29	0 (0)	0% (0%)	15 (2)	5% (1%)	0 (0)	0% (0%)
> 8 [car turns]	32 (32)	9% (17%)	126 (45)	39% (14%)	16 (8)	5% (5%)
Avg. Gap	3-4 (7-8)		8-9 (5-6)		3-4 (3-4)	

Table 7: Gap Study at Belle View Boulevard

Gap Size (sec)	Northbound		Southbound		Simultaneous Northbound & Southbound	
	# Gaps	% Gaps	# Gaps	% Gaps	# Gaps	% Gaps
	AM (PM)	AM (PM)	AM (PM)	AM (PM)	AM (PM)	AM (PM)
< 5	390 (256)	92% (76%)	251 (313)	66% (83%)	368 (240)	92% (87%)
6 – 11	23 (53)	5% (16%)	62 (31)	16% (8%)	30 (31)	8% (11%)
12 – 17	10 (19)	2% (6%)	35 (24)	9% (6%)	1 (5)	0% (2%)
18 – 23	1 (8)	0% (2%)	32 (8)	8% (2%)	0 (1)	0% (0%)
24 – 29	0 (3)	0% (1%)	2 (0)	1% (0%)	0 (0)	0% (0%)
> 29	0 (0)	0% (0%)	12 (4)	3% (1%)	0 (0)	0% (0%)
> 8 [car turns]	34 (82)	8% (24%)	129 (63)	34% (17%)	10 (16)	3% (6%)
Avg. Gap	4-5 (5-6)		7-8 (5-6)		3-4 (3-4)	

Table 8: Gap Study at Tulane Drive

Gap Size (sec)	Northbound		Southbound		Simultaneous Northbound & Southbound	
	# Gaps	% Gaps	# Gaps	% Gaps	# Gaps	% Gaps
	AM (PM)	AM (PM)	AM (PM)	AM (PM)	AM (PM)	AM (PM)
< 5	430 (284)	87% (71%)	244 (371)	66% (85%)	392 (347)	87% (88%)
6 – 11	51 (59)	10% (15%)	58 (43)	16% (10%)	54 (41)	12% (10%)
12 – 17	11 (38)	2% (9%)	34 (17)	9% (4%)	4 (8)	1% (2%)
18 – 23	1 (7)	0% (2%)	34 (7)	9% (2%)	0 (0)	0% (0%)
24 – 29	0 (7)	0% (2%)	5 (0)	1% (0%)	0 (0)	0% (0%)
> 29	0 (2)	0% (0%)	11 (0)	3% (0%)	0 (0)	0% (0%)
> 8 [car turns]	63 (117)	13% (29%)	126 (67)	34% (15%)	27 (27)	6% (7%)
Avg. Gap	4-5 (6-7)		7-8 (4-5)		3-4 (3-4)	

Table 9: Gap Study at Morningside Lane

Gap Size (seconds)	**Northbound**		**Southbound**		**Simultaneous Northbound & Southbound**	
	# Gaps	**% Gaps**	**# Gaps**	**% Gaps**	**# Gaps**	**% Gaps**
	AM (PM)	**AM (PM)**	**AM (PM)**	**AM (PM)**	**AM (PM)**	**AM (PM)**
< 5	479 (219)	85% (52%)	169 (337)	48% (70%)	480 (404)	91% (82%)
6 – 11	81 (131)	14% (31%)	102 (111)	29% (23%)	46 (81)	9% (16%)
12 – 17	5 (48)	1% (11%)	41 (25)	12% (5%)	3 (9)	1% (2%)
18 – 23	1 (7)	0% (2%)	19 (7)	5% (1%)	0 (1)	0% (0%)
24 – 29	0 (10)	0% (2%)	7 (0)	2% (0%)	0 (0)	0% (0%)
> 29	0 (1)	0% (0%)	12 (1)	3% (0%)	0 (0)	0% (0%)
> 8 [car turns]	25 (152)	4% (36%)	147 (84)	42% (17%)	11 (36)	2% (7%)
Average Gap	3-4 (7-8)		8-9 (5-6)		3-4 (3-4)	

Table 10: Gap Study at Wellington Road

Gap Size (seconds)	**Northbound**		**Southbound**		**Simultaneous Northbound & Southbound**	
	# Gaps	**% Gaps**	**# Gaps**	**% Gaps**	**# Gaps**	**% Gaps**
	AM (PM)	**AM (PM)**	**AM (PM)**	**AM (PM)**	**AM (PM)**	**AM (PM)**
< 5	413 (216)	74% (54%)	152 (288)	45% (62%)	479 (451)	85% (81%)
6 – 11	130 (117)	23% (29%)	100 (124)	29% (27%)	84 (94)	15% (17%)
12 – 17	12 (45)	2% (11%)	41 (36)	12% (8%)	1 (10)	0% (2%)
18 – 23	3 (12)	1% (3%)	24 (12)	7% (3%)	1 (0)	0% (0%)
24 – 29	0 (6)	0% (1%)	13 (3)	4% (1%)	0 (1)	0% (0%)
> 29	0 (3)	0% (1%)	9 (1)	3% (0%)	0 (0)	0% (0%)
> 8 [car turns]	70 (141)	13% (35%)	151 (129)	45% (28%)	35 (61)	6% (11%)
Average Gap	4-5 (7-8)		8-9 (5-6)		3-4 (4-5)	

Table 11: Gap Study at Collingwood Road

Gap Size (seconds)	Northbound		Southbound		Simultaneous Northbound & Southbound	
	# Gaps	% Gaps	# Gaps	% Gaps	# Gaps	% Gaps
	AM (PM)	AM (PM)	AM (PM)	AM (PM)	AM (PM)	AM (PM)
< 5	272 (171)	59% (48%)	108 (234)	37% (56%)	379 (357)	73% (73%)
6 – 11	137 (100)	30% (28%)	78 (125)	27% (30%)	119 (105)	23% (22%)
12 – 17	40 (46)	9% (13%)	47 (45)	16% (11%)	16 (20)	3% (4%)
18 – 23	6 (11)	1% (3%)	37 (11)	13% (3%)	2 (5)	0% (1%)
24 – 29	3 (8)	1% (2%)	6 (2)	2% (0%)	0 (0)	0% (0%)
> 29	0 (8)	0% (2%)	14 (4)	5% (1%)	0 (0)	0% (0%)
> 8 [car turns]	118 (147)	26% (42%)	150 (127)	52% (30%)	75 (78)	15% (16%)
Average Gap	5-6 (8-9)		10-11 (6-7)		4-5 (4-5)	

Table 12: Gap Study at Waynewood Boulevard

Gap Size (sec)	Northbound		Southbound		Simultaneous Northbound & Southbound	
	# Gaps	% Gaps	# Gaps	% Gaps	# Gaps	% Gaps
	AM (PM)	AM (PM)	AM (PM)	AM (PM)	AM (PM)	AM (PM)
< 5	260 (212)	66% (61%)	151 (259)	52% (66%)	316 (356)	64% (72%)
6 – 11	64 (54)	16% (16%)	40 (49)	14% (13%)	137 (103)	28% (21%)
12 – 17	44 (39)	11% (11%)	39 (58)	14% (15%)	30 (31)	6% (6%)
18 – 23	25 (26)	6% (8%)	58 (26)	20% (7%)	6 (5)	1% (1%)
24 – 29	6 (12)	2% (3%)	19 (4)	7% (1%)	1 (0)	0% (0%)
> 29	5 (12)	1% (3%)	12 (5)	4% (1%)	0 (0)	0% (0%)
> 8 [car turns]	133 (133)	34% (39%)	137 (133)	48% (34%)	96 (89)	20% (18%)
Avg. Gap	7-8 (8-9)		10-11 (7-8)		5-6 (5-6)	

Table 13: Gap Study at Vernon View Drive

Gap Size (sec)	Northbound		Southbound		Simultaneous Northbound & Southbound	
	# Gaps	% Gaps	# Gaps	% Gaps	# Gaps	% Gaps
	AM (PM)	AM (PM)	AM (PM)	AM (PM)	AM (PM)	AM (PM)
< 5	238 (283)	63% (69%)	156 (223)	54% (62%)	331 (388)	68% (75%)
6 – 11	68 (65)	18% (16%)	44 (57)	15% (16%)	119 (100)	24% (19%)
12 – 17	52 (35)	14% (8%)	37 (47)	13% (13%)	32 (20)	7% (4%)
18 – 23	21 (35)	6% (8%)	53 (35)	18% (10%)	4 (5)	1% (1%)
24 – 29	6 (8)	2% (2%)	12 (6)	4% (2%)	0 (2)	0% (0%)
> 29	4 (8)	1% (2%)	20 (6)	7% (2%)	1 (0)	0% (0%)
> 8 [car turns]	141 (129)	37% (31%)	134 (139)	46% (38%)	101 (75)	21% (15%)
Avg. Gap	7-8 (7-8)		10-11 (8-9)		5-6 (4-5)	

Table 14: Gap Study at Stratford Lane

Gap Size (sec)	Northbound		Southbound		Simultaneous Northbound & Southbound	
	# Gaps	% Gaps	# Gaps	% Gaps	# Gaps	% Gaps
	AM (PM)	AM (PM)	AM (PM)	AM (PM)	AM (PM)	AM (PM)
< 5	284 (249)	70% (67%)	201 (278)	58% (68%)	384 (354)	74% (74%)
6 – 11	60 (62)	15% (17%)	50 (71)	14% (17%)	101 (108)	19% (23%)
12 – 17	40 (32)	10% (9%)	50 (39)	14% (9%)	31 (14)	6% (3%)
18 – 23	22 (23)	5% (6%)	46 (23)	13% (6%)	1 (1)	0% (0%)
24 – 29	4 (10)	1% (3%)	12 (9)	3% (2%)	1 (0)	0% (0%)
> 29	5 (4)	1% (1%)	7 (3)	2% (1%)	0 (0)	0% (0%)
> 8 [car turns]	122 (125)	30% (33%)	146 (133)	42% (32%)	85 (58)	16% (12%)
Avg. Gap	6-7 (7-8)		8-9 (7-8)		4-5 (4-5)	

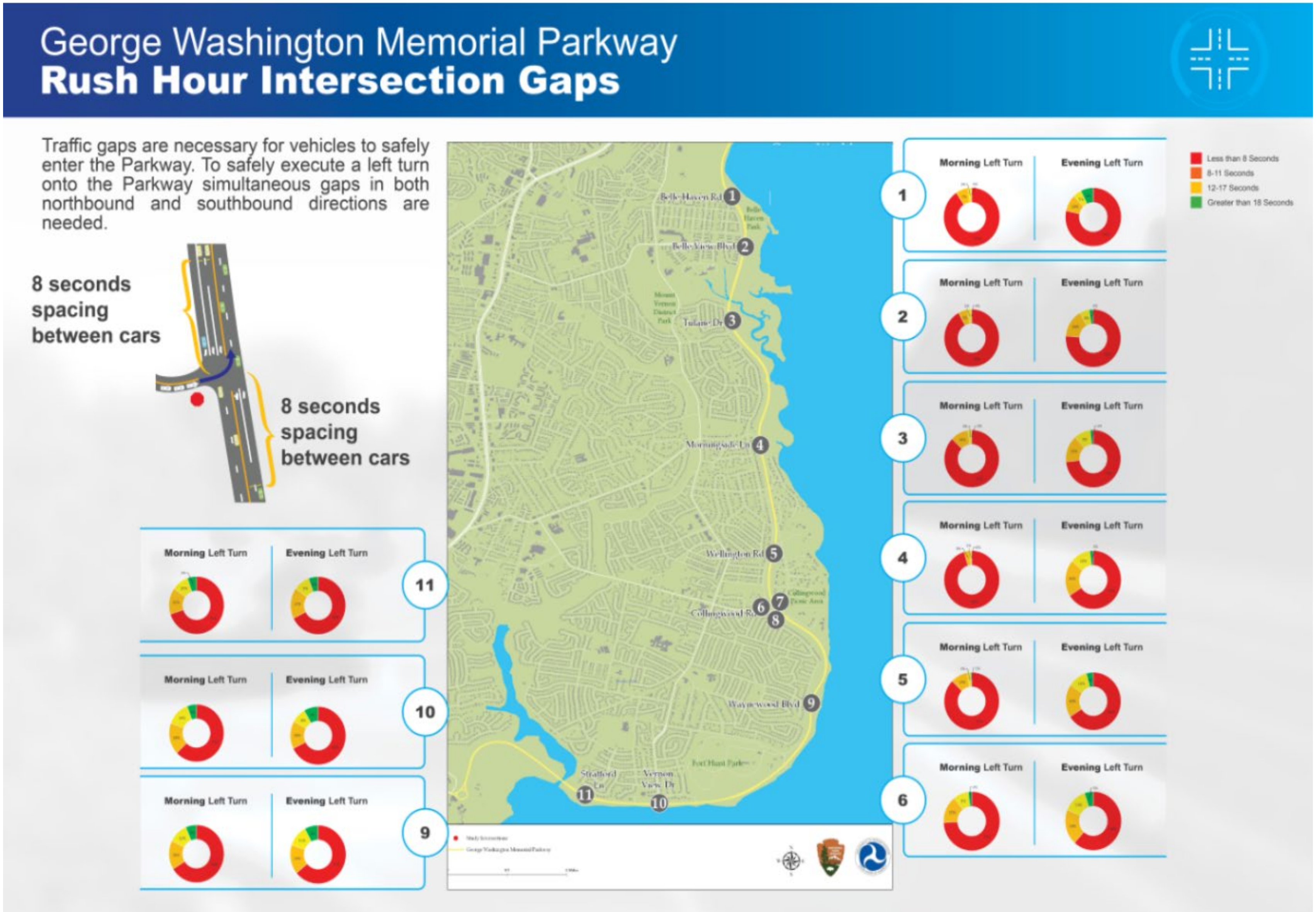


Figure 10. Gap availability during peak hours

2.6 Parking Lot Capacity and Utilization

The research team performed an inventory and utilization survey of selected parking lots in March 2019 to evaluate visitor activity. Figure 11 illustrates the parking lot locations. The largest parking lot is located near Belle Haven Road, followed by Stratford Lane. Overall, no parking lot was found to be more than approximately 50% utilized in any weekday time period. Table 15 and Figure 11 summarize the parking lot capacity and utilization data.

Table 15: Parking Lot Capacity and Utilization

Parking Lot Description	Number of Spaces	Number of Spaces Filled		
		AM Peak	Midday	PM Peak
Belle Haven Road	165	10	57	43
East of the Parkway, American Horticultural Society at River Farm, north of Wellington Road	28	0	21 in lot 5 on road	6 in lot 5 on road
East of the Parkway, Collingwood Picnic Area	16	0	0	5
East side of the Parkway, north of Waynewood Boulevard	14	0	1	0
East side of the Parkway, at Waynewood Boulevard	9	0	0	1
Stratford Lane	58	5	33	20

Figure 11. Existing Parking Lots

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3. Traffic Safety Evaluation & Crash Experience

The Western Transportation Institute (WTI) Team conducted a traffic and safety assessment of nine intersections on the Parkway and **two** that are in close proximity to the Parkway and Collingwood Road intersection: Collingwood Road and East Boulevard Drive and Collingwood Road and West Boulevard Drive. As part of this project, the team conducted a crash analysis based on the crash data provided by the FHWA EFL and the USPP. No data was provided for Collingwood Road and East Boulevard Drive and Collingwood Road and West Boulevard Drive; therefore, these intersections will not be discussed hereafter.

Overall, when crashes do occur at the intersections in the corridor, they tend to be severe. Even for intersections that have low crash counts, crashes that involve injuries and fatalities seem to be represented to a higher degree than expected. The following sections summarize the specific crash details for each intersection, with the intent of better understanding the underlying crash characteristics using the available tabular data. For each intersection, the analysis will be discussed based on the data from both crash databases (one from 2005 to 2015 and the second from April 1, 2018 through October 3, 2019 (hereafter referred to as 2018-2019)).

Three hundred eighty-nine crashes were recorded at the following nine intersections from 2005-2015 and 2018-2019; the intersections are listed north to south within the Parkway corridor:

1) Belle Haven Road
2) Belle View Boulevard
3) Tulane Drive
4) Morningside Lane
5) Wellington Road
6) Collingwood Road
7) Waynewood Boulevard
8) Vernon View Drive
9) Stratford Lane

(See Appendix F: Traffic Safety for the summary crash tables based on the tabular data that was provided as well as an explanation of similarities and differences between the 2005-2015 and 2018-2019 crash data.) Belle View Boulevard had the greatest number of crashes reported at ninety, with Stratford Lane having the fewest at twelve (Table 16).

Table 16: Summary of Number of Crashes and Rate of Crashes by Time Period

Intersection with the Parkway	Number of Crashes: 2005 to 2015	Annual Rate of Crashes: 2005 to 2015	Number of Crashes: 2018-2019	Annual Rate of Crashes: 2018-2019	TOTAL NUMBER OF CRASHES
Belle Haven Road	**68**	**4.3**	**4**	**2.6**	72
Belle View Boulevard	**81**	**5.1**	**9**	**6**	90
Tulane Drive	29	1.8	3	2	32
Morningside Lane	**64**	**4.0**	**9**	**6**	73
Wellington Road	21	1.3	2	1.3	23
Collingwood Road	41	2.6	5	3.3	46
Waynewood Boulevard	16	1.0	1	0.7	17
Vernon View Drive	22	1.4	2	1.3	24
Stratford Lane	10	0.6	2	1.3	12
TOTAL	**352**	**22**	**37**	**25**	**389**

The available tabular data presented several problems. First, it was specific to the Parkway (with a few exceptions), so it did not encompass nearby intersections on the cross streets. Second, the data did not contain the full level of detail desired (e.g. a crash report with a visual crash diagram and narrative of the crash), which limited the analysis and understanding of crash mechanisms. If a full crash report had been available, then a crash diagram for the intersection over the time period of available crash data could have been developed with greater accuracy. This analysis represents the *best interpretation* of the tabular data.

On Monday, October 28, 2019 and Tuesday, October 29, 2019, a member of the WTI Team observed the intersections within the study corridor. The times during which an intersection was observed were defined by the time windows identified during the crash analysis. Photos illustrating points in the following crash analysis; videos; and general observations of issues potentially contributing to the safety and traffic issues at these intersection were recorded.

The following intersections were observed during the following times on Monday, October 28, 2019 (all times are listed in Eastern Time):

- Stratford Lane, 9:12 AM to 9:32 AM
- Collingwood Road, 11:17 AM to 11:32 AM
- Waynewood Boulevard, 12:19 PM to 12:34 PM
- Vernon View Drive, 1:45 PM to 2 PM

The following intersections were observed during the following times on Tuesday, October 29, 2019 (all times listed in Eastern Time):

- Tulane Drive, 8:28 AM to 8:43 AM
- Morningside Lane, 9 AM to 9:15 AM

- Belle View Boulevard, 3:33 PM to 3:48 PM
- Belle Haven Road, 4:00 PM to 4:15 PM
- Wellington Road, 4:40 PM to 4:55 PM.

In addition to observing the intersections, the WTI Team member drove the corridor. License plate data was collected during several intervals at several intersections to investigate the states displayed on the vehicles. The majority of the plates were from Virginia.

The following sections discuss the crash occurrence at each of the nine intersections. Then after, a section discusses sight distance limitations. A concluding section discusses recommendations.

3.1 The Parkway & Belle Haven Road

Figure 12 shows the orientation of the Parkway and Belle Haven Road, a three-legged intersection with a median.

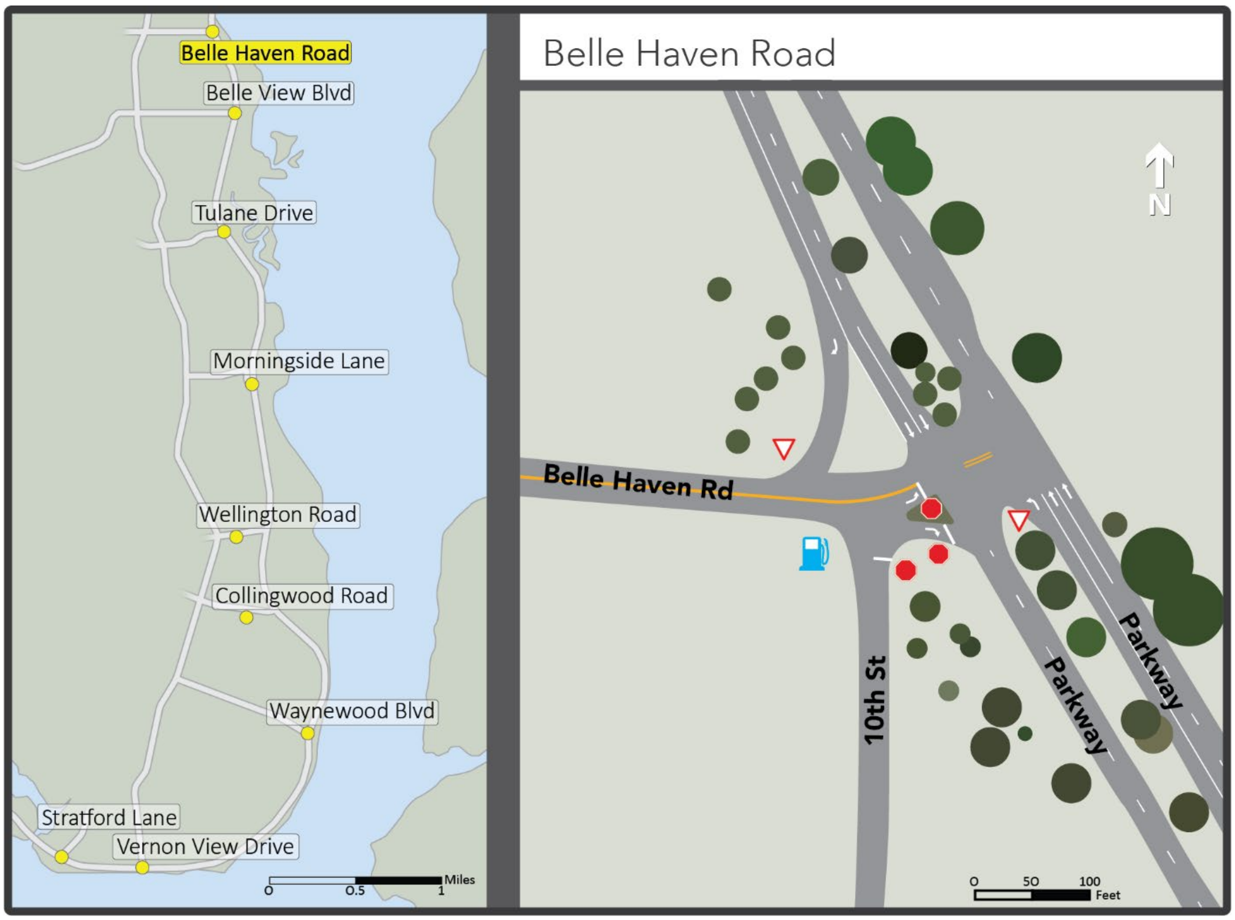

Figure 12: The Parkway & Belle Haven Road

The existing traffic control at the Parkway and Belle Haven Road does not clearly establish right-of-way (ROW), because there is a suggestion that left-turning northbound traffic should yield to left-turning eastbound traffic, as a yield sign faces the former. In theory, drivers yield here before they pull forward past the double yellow line and then cross the southbound direction of the Parkway when there is a gap. This is one of the most challenging movements, as then after they have to make sure that southbound Parkway traffic that is turning right yields at the yield sign. Furthermore, unlike the rest of the intersections in the southern section of the Parkway, there is a gas station on the southwest corner of the Belle Haven Road and 10th St intersection with access from both streets. Along the east side of the gas station is 10th Street, which provides access to residences along the road and those beyond. Considering all of the above, the intersection is very complex with numerous diverging and merging movements adding up to a total of sixteen conflict points (see Appendix F: Traffic Safety for more details about conflict points), with ROW not always clearly established.

2005-2015 had a total of **sixty-eight** crashes and 2018-2019 had a total of **four** crashes, for a grand total of **seventy-two** crashes identified at the intersection of the Parkway and Belle Haven Road. (Note: Crashes were identified in the dataset for the exit from the park to the north of this intersection and at the intersection of the Parkway and Belle Haven Marina to the south of the intersection, but these crashes were removed from the analysis herein.) Belle Haven Road was incorrectly spelled with the following versions in the 2005-2015 dataset: Belle Havin; Belle Have; Belhavn; Bellhaven; and Belle Heaven. Every crash occurrence in this dataset was reviewed for each intersection, line-by-line, to ensure that any potential crash associated with the intersection was identified. Generally speaking, the annual occurrence of crashes appears random, although **2011** had the greatest number of crashes reported (Figure 13). In 2015 there were no reported crashes at this intersection. Compared to the historical crash count, those recorded for the 2018-2019 time period seem underrepresented.

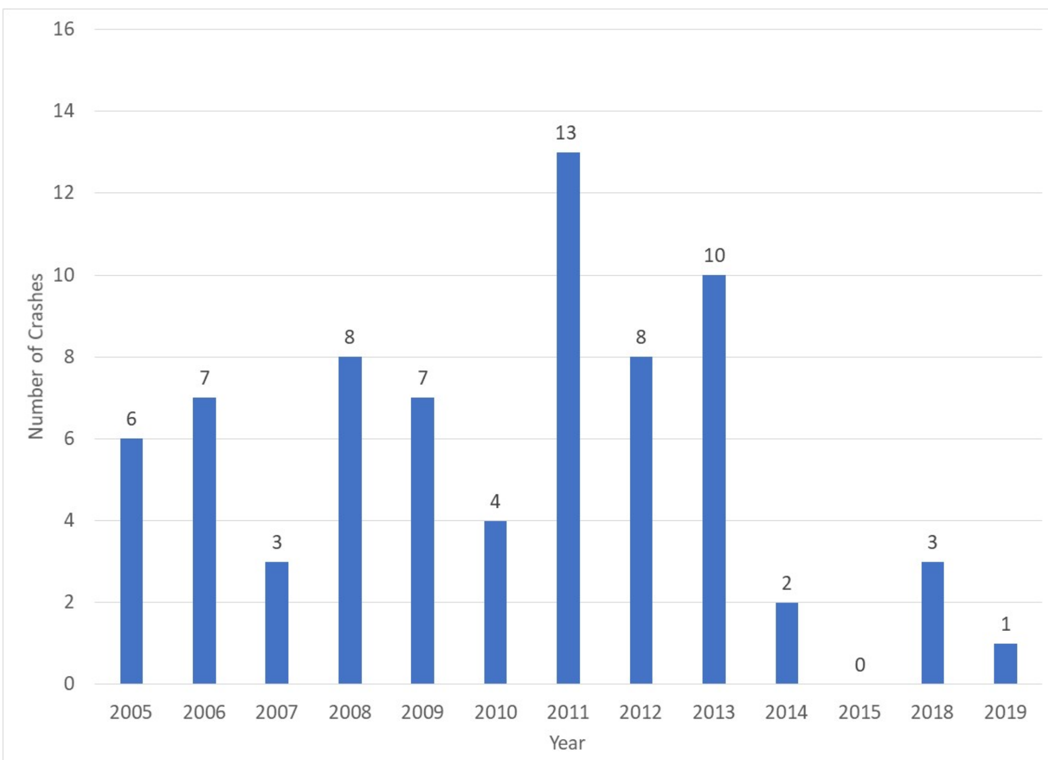

Figure 13: The Parkway & Belle Haven Road, Total Crashes by Year

3.1.1 Temporal

Based on data from the available years (2005-2015; 2018-2019), crashes occurred most frequently in January (Figure 14).

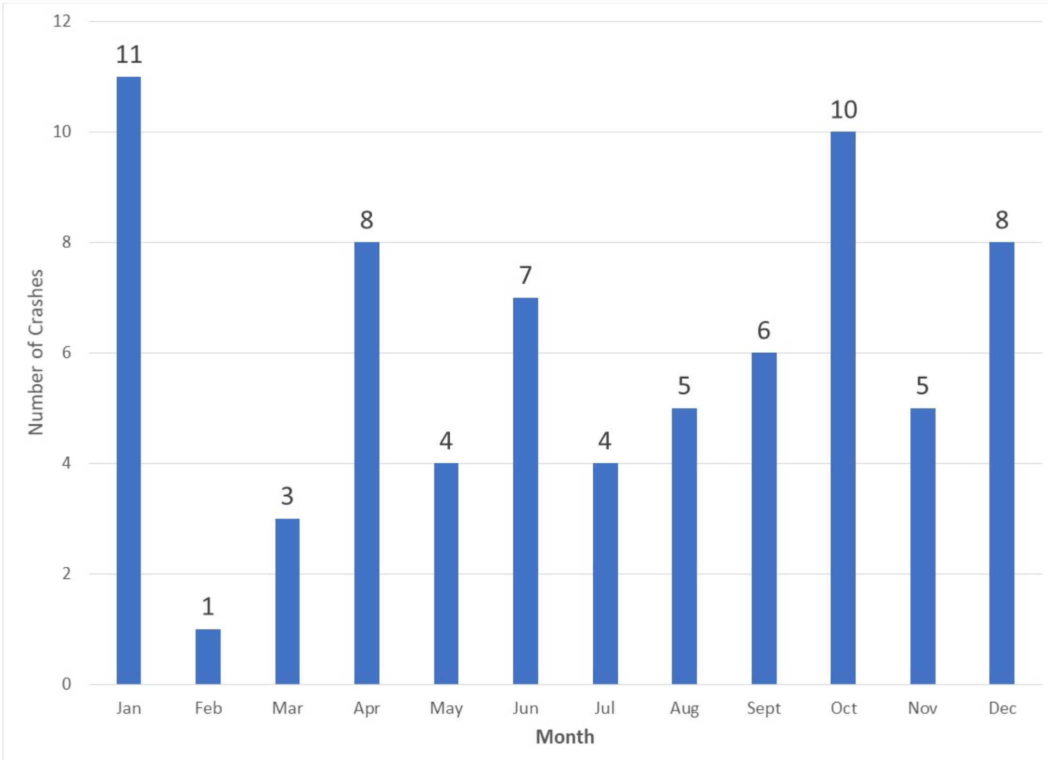

Figure 14: The Parkway & Belle Haven Road, Crashes by Month

The WTI Team separated crashes into an AM period (12 AM to 12 PM) and a PM period (12 PM to 12 AM) to investigate if crashes occurred more often in the AM or PM. **Thirty-two percent** of all crashes occurred in the AM period.

Assigning each crash to a one-hour time period across the entire day, the most frequent number of crashes occurred from **8-9 AM and 2-3 PM** (Figure 15).

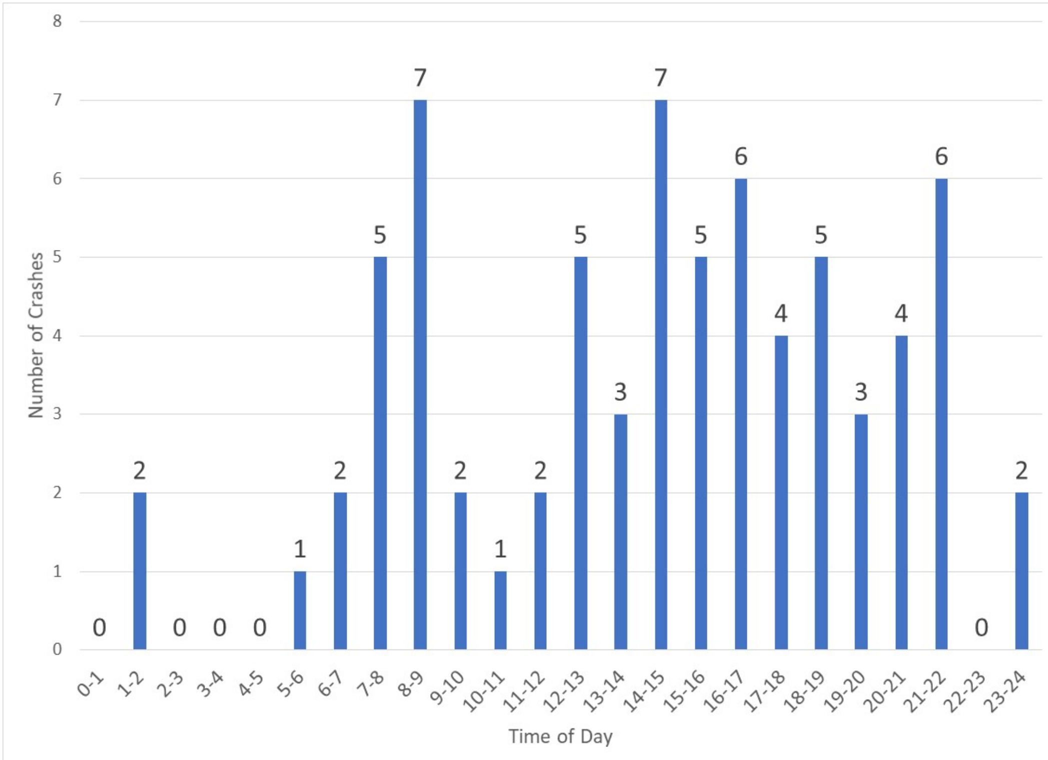

Figure 15: The Parkway & Belle Haven Road, Crashes by Time of Day

The WTI Team binned the crashes into pre-AM PEAK, AM PEAK, mid-day, PM PEAK, and post-PM PEAK crash time periods. Considering the frequency of crashes per hour, the highest rate of crashes occurred during the **PM PEAK** time period (Table 17).

Table 17: The Parkway & Belle Haven Road, Crash Counts & Rate by Time Period

Time Period		Number of Crashes	Crashes/Hour
12 AM-6 AM	pre-AM PEAK	3	0.5
6 AM-9 AM	AM PEAK	14	4.7
9 AM-3 PM	mid-day	20	3.3
3 PM-6 PM	PM PEAK	15	**5.0**
6 PM-12 AM	post-PM PEAK	19	3.3
TOTAL		72	-

The crashes at this intersection are nearly evenly distributed across the days of the week, with **Thursday** having the greatest number of crashes (Figure 16).

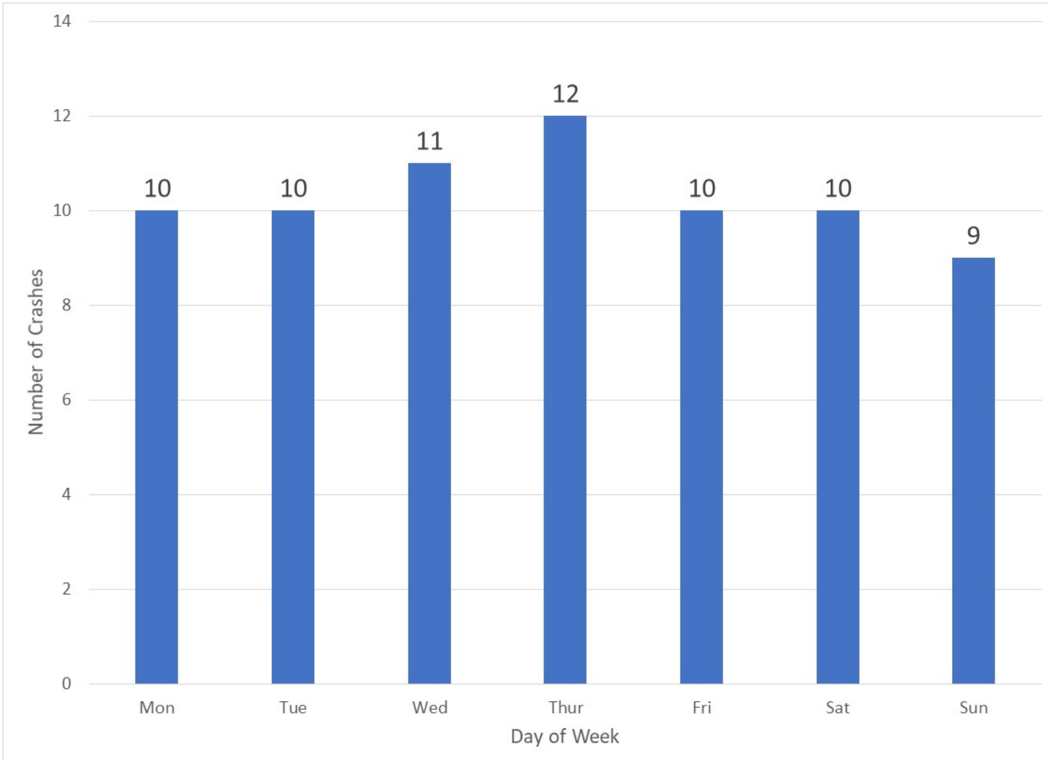

Figure 16: The Parkway & Belle Haven Road, Crashes by Day of the Week

Generally, the counts by day of the week are consistent; however, there is a potential that something on Thursday is contributing to a slightly greater crash occurrence.

3.1.2 Environment

This section discusses how lighting, weather, and the road surface may have influenced crash occurrence.

The WTI Team analyzed the lighting condition identified during a crash (Figure 17).

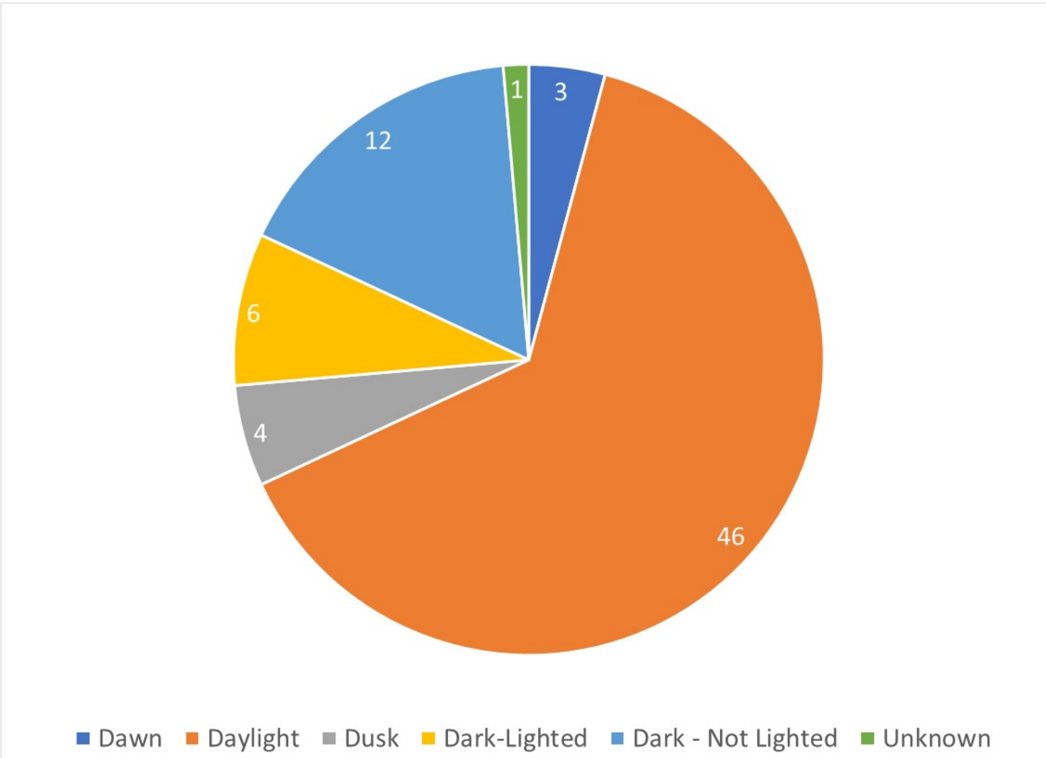

Figure 17: The Parkway & Belle Haven Road, Lighting (number of crashes during each lighting condition)

Some of the data was inconsistent. **Twelve** crashes indicated that the intersection was "Dark – Not Lighted" with **six** indicating "Dark – Lighted." The study section of the Parkway does not have lighting; therefore, "Dark – Lighted" must be a coding error.

Most crashes (**forty-six**) were identified as having occurred during "Daylight." Looking at the data in more detail, of the crashes that were identified as occurring during "Daylight," **nine** of these crashes were during periods when conditions were indicated as: 1) Cloudy or 2) Rain. These conditions would suggest that the crash occurred when there was reduced visibility. Reducing the **forty-six** crashes by these **nine** crashes results in a total of **thirty-seven** crashes remaining during "Daylight." Therefore, approximately half of the crashes occurred during hours when visibility was good, while the other half occurred during periods when it was not. This suggests that lighting may be an issue.

The researchers also considered whether the "Daylight" crashes occurred during peak periods. (Note: We anticipated that "Daylight" crashes would be reported less frequently during the 12-6 AM and 6 PM -12 AM time periods, as the sun may have set or may not have risen.) Crashes were grouped into non-peak and peak-periods: 12-6 AM, 6-9 AM (AM PEAK), 9-3 PM, 3-6 PM (PM PEAK), 6-12 AM. Table 18 shows the number of crashes within these groups.

Table 18: The Parkway & Belle Haven Road, "Daylight" Crash Counts and Rates by Time Periods

Time Period		Number of Crashes	Crashes/Hour
12 AM-6 AM	pre-AM PEAK	0	0
6 AM-9 AM	AM PEAK	12	**4.0**
9 AM-3 PM	mid-day	19	3.2
3 PM-6 PM	PM PEAK	12	**4.0**
6 PM-12 AM	post-PM PEAK	3	0.5
TOTAL "Daylight" Crashes		46	-

"Daylight" crashes were most likely to occur during the AM PEAK or PM PEAK and least likely to occur from 12 AM to 6 AM (pre-AM PEAK).

With regard to weather, the majority of the crashes (**fifty-eight)** occurred during "Clear" periods; therefore, weather does **not** appear to be a factor contributing to crashes (Figure 18).

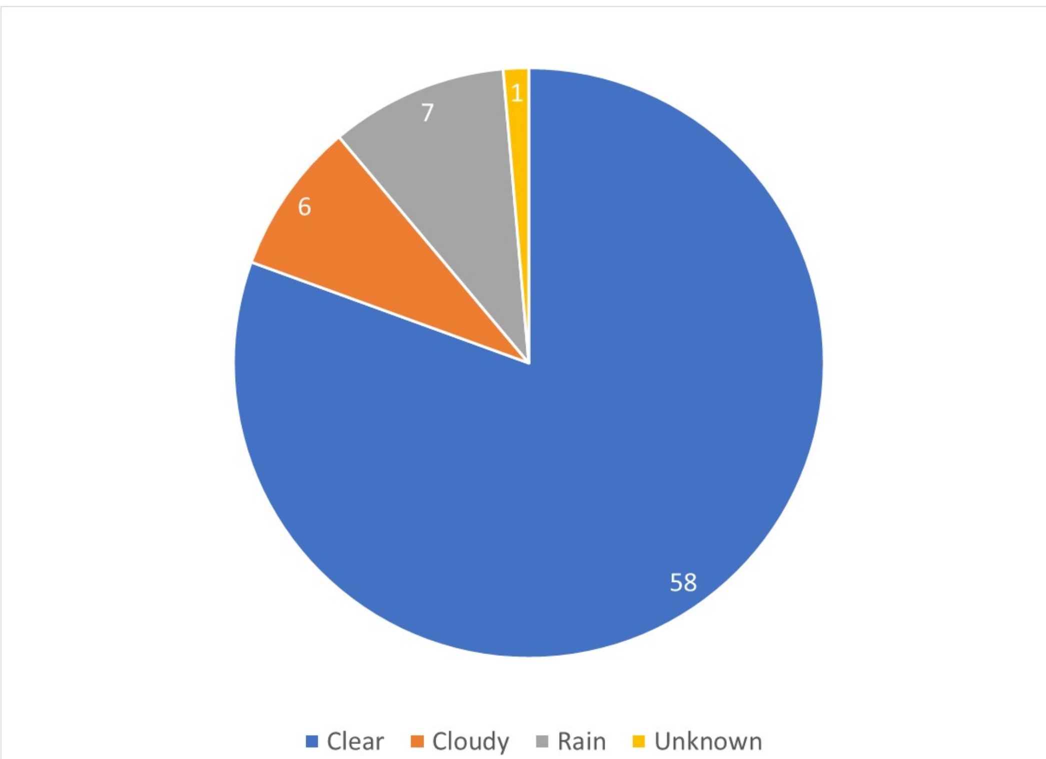

Figure 18: The Parkway & Belle Haven Road, Weather

The majority of crashes (**sixty-four**) occurred when surface conditions were "Dry," which suggests that surface condition is unlikely to be an issue (Figure 19).

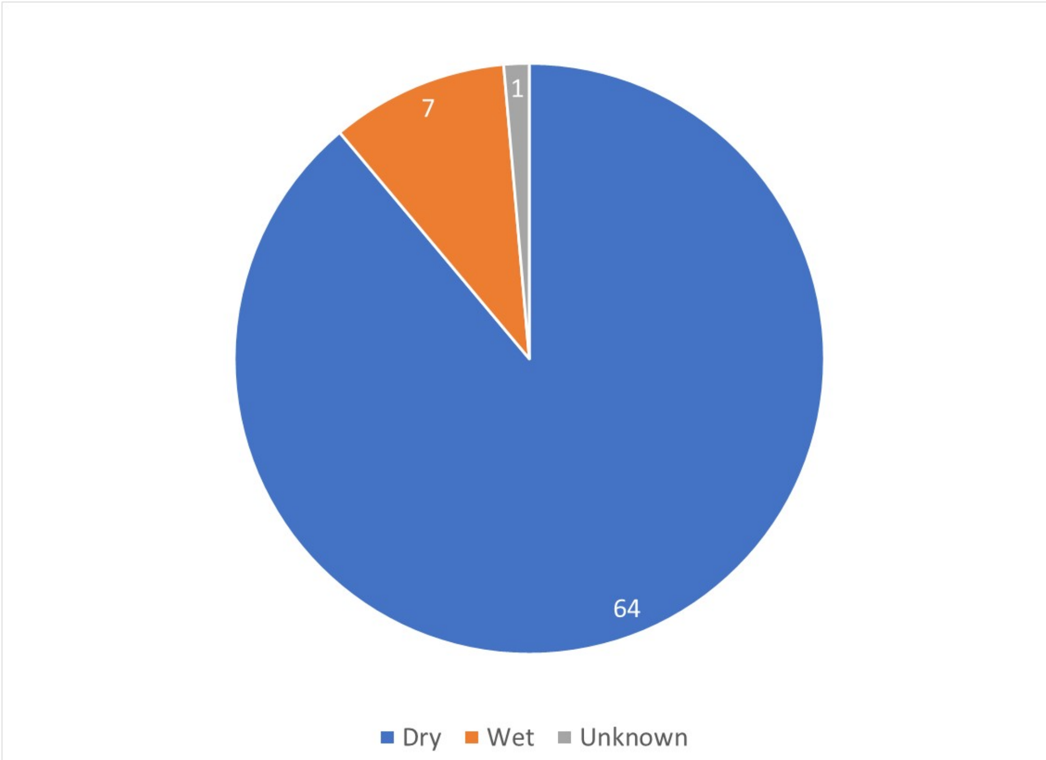

Figure 19: The Parkway & Belle Haven Road, Surface Condition

3.1.3 Factors Contributing to Crashes

This section discusses the vehicle collision type, the indicated primary cause of the crash, and whether the collision was between vehicles or with an object.

One category of the tabular data provided information about the vehicle collision type. "Angle" was the most common crash type (**thirty**) (Figure 20).

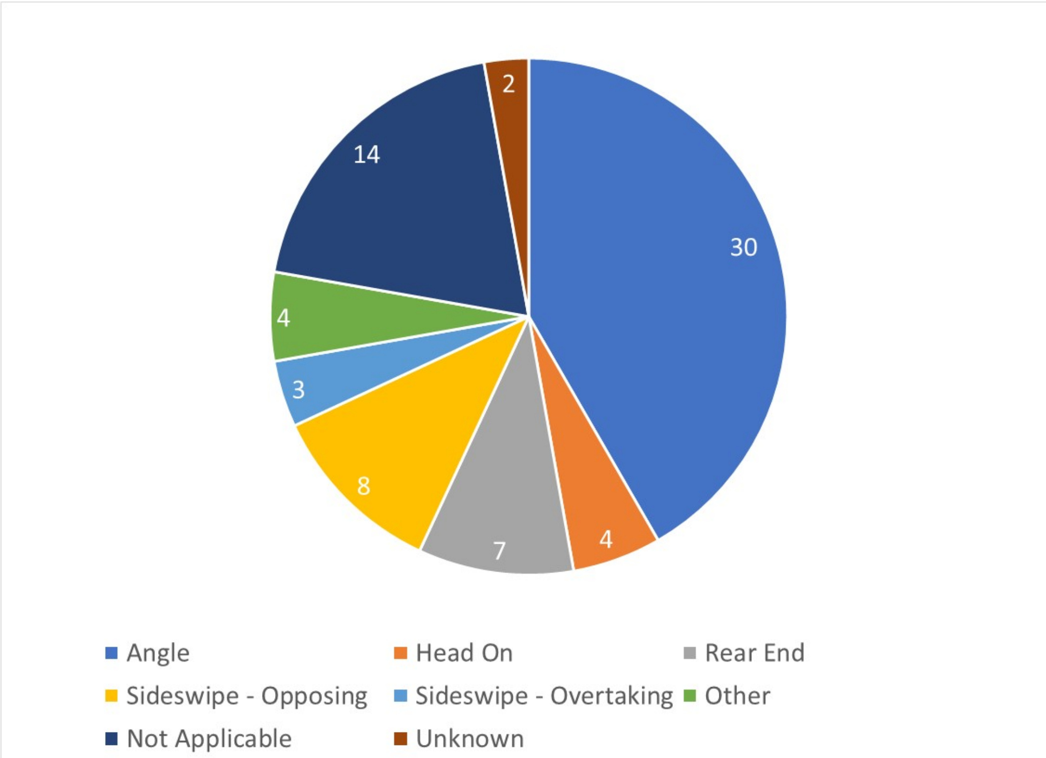

Figure 20: The Parkway & Belle Haven Road, Crash Type

Fourteen crashes were identified as "Not Applicable." In the tabular data, there is an option to include data in the "collision with?" column. The crashes were identified as having occurred with an animal (4), tree/shrub (3), pole (2), boulder (1), other fixed object (1), guardrail/barrier (1), non-collision (1), and sign (1).

By far, the most reported "Primary Cause" was "Failed to Yield Right-of-Way" (Figure 21), which was reported in **15 of the 68 crashes (22%)**. (Note: Figure 21 only shows **47 of the 72 crashes** that occurred at the intersection, as **25** crashes provided no information on the "Primary Cause.")

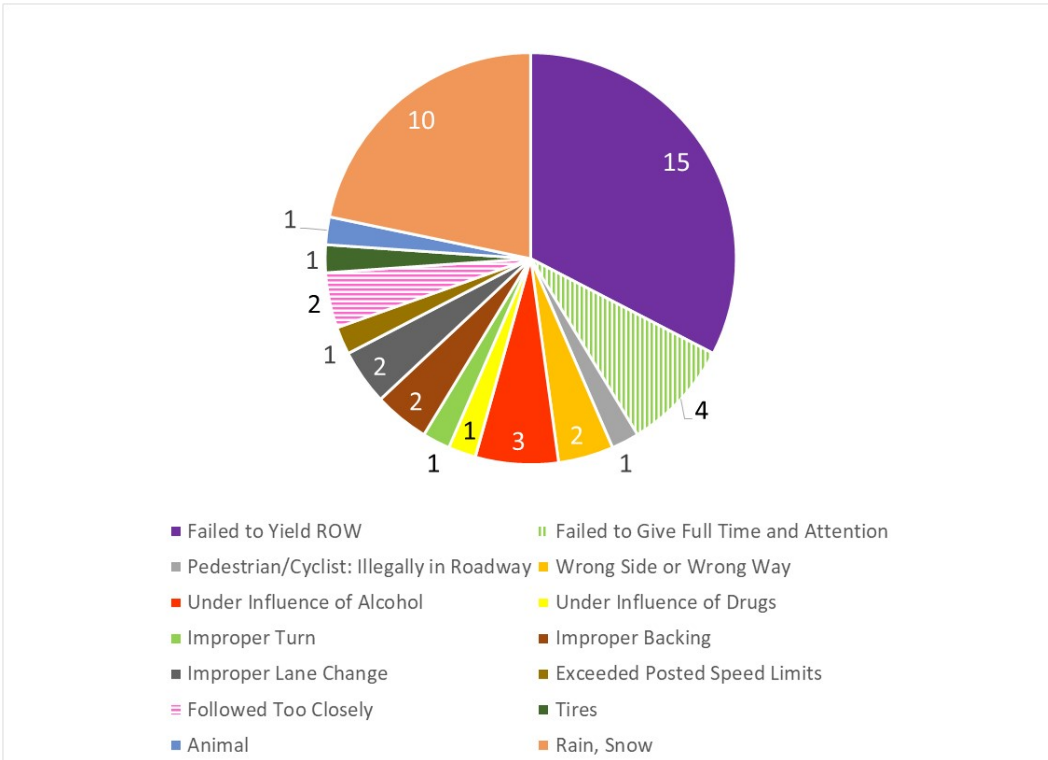

Figure 21: The Parkway & Belle Haven Road, Primary Cause

"Other" was the second most frequently identified "Primary Cause," at 10. "Failed to Give Full Time and Attention" was the third most frequently identified "Primary Cause."

3.1.4 Driving Under the Influence

This section discusses crashes that were identified as involving drugs or alcohol. As noted in the "Primary Cause" section, of the **seventy-two** crashes identified at the intersection, from 2005 through 2015, **two** crashes, or **2.8%** of all crashes at the intersection were identified as having a driver that was under the influence of alcohol.

3.1.5 Hit & Run

This section discusses crashes identified as a hit and run. Interestingly, **five** of the **seventy-two** crashes, or **6.9%** were identified as hit-and-run crashes. There are many reasons why a driver may hit an object or other vehicle and leave the scene of the crash, potentially including operating a vehicle while under the influence or if the driver is uninsured (Benson, Arnold, Tefft, & Horrey, 2017). Therefore, there is a potential that grouping these crashes with the previous category could suggest a greater concern that there are drivers passing through the intersection who are operating a vehicle under the influence.

3.1.6 Crash Severity

This section identifies the number of property damage only (PDO), injury (INJ) and fatal (FAT) crashes. The majority of crashes (**fifty-four**) that are occurring at the intersection are PDO crashes; no fatal crashes were reported at the intersection (Figure 22).

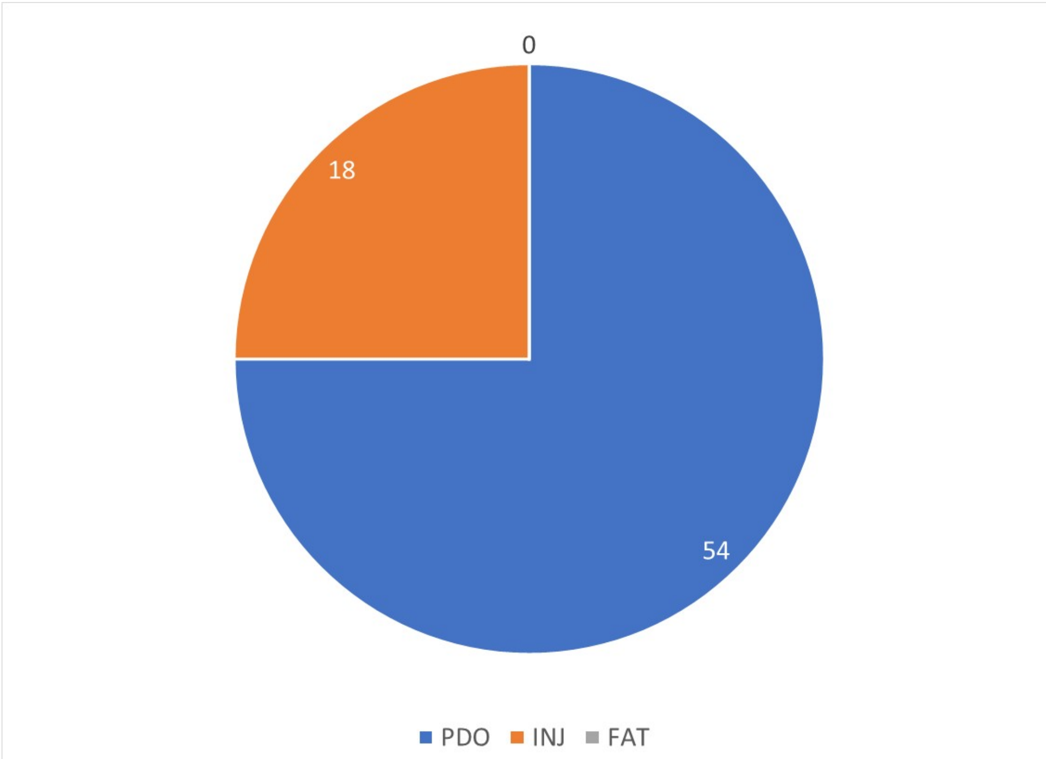

Figure 22: The Parkway & Belle Haven Road, Crash Severity

One quarter of all of the crashes at the intersection resulted in an injury (Figure 22).

A total of **thirty-two** injured people were reported across all 18 of the crashes involving injuries; no fatalities were reported.

The occurrence of the injury crashes by both month and day of the week was investigated. April and December as well as Tuesdays seem to have a higher probability of injury crashes (Figure 23 and Figure 24).

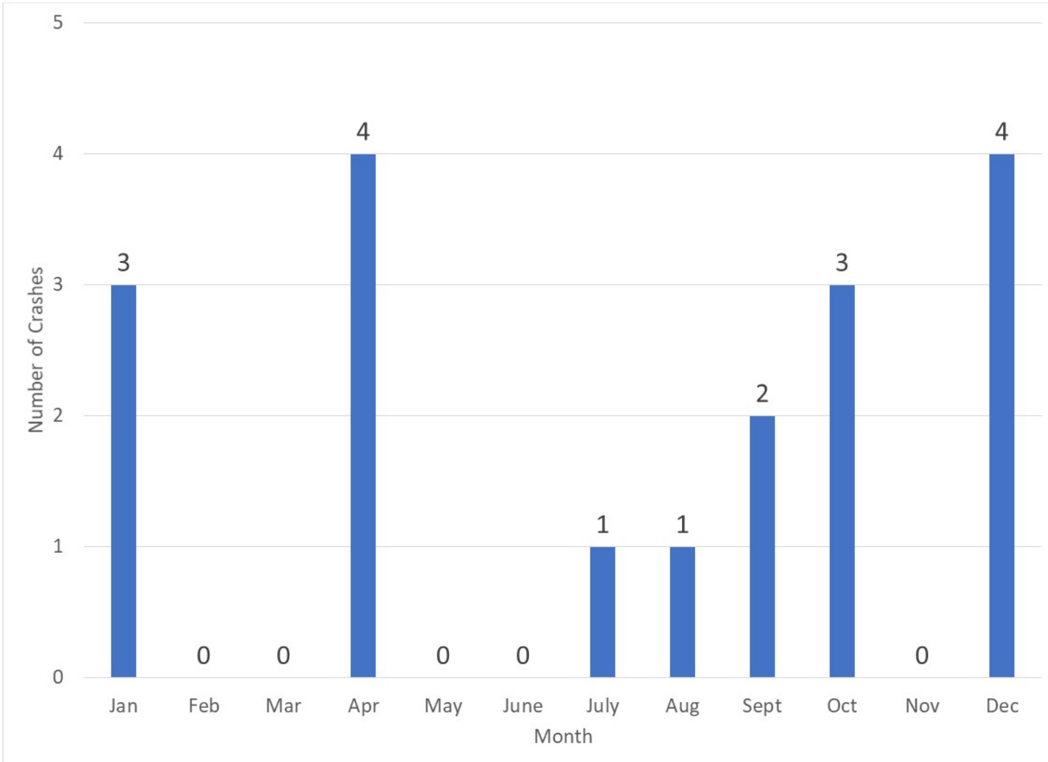

Figure 23: The Parkway & Belle Haven Road, Injury and Fatal Crashes by Month

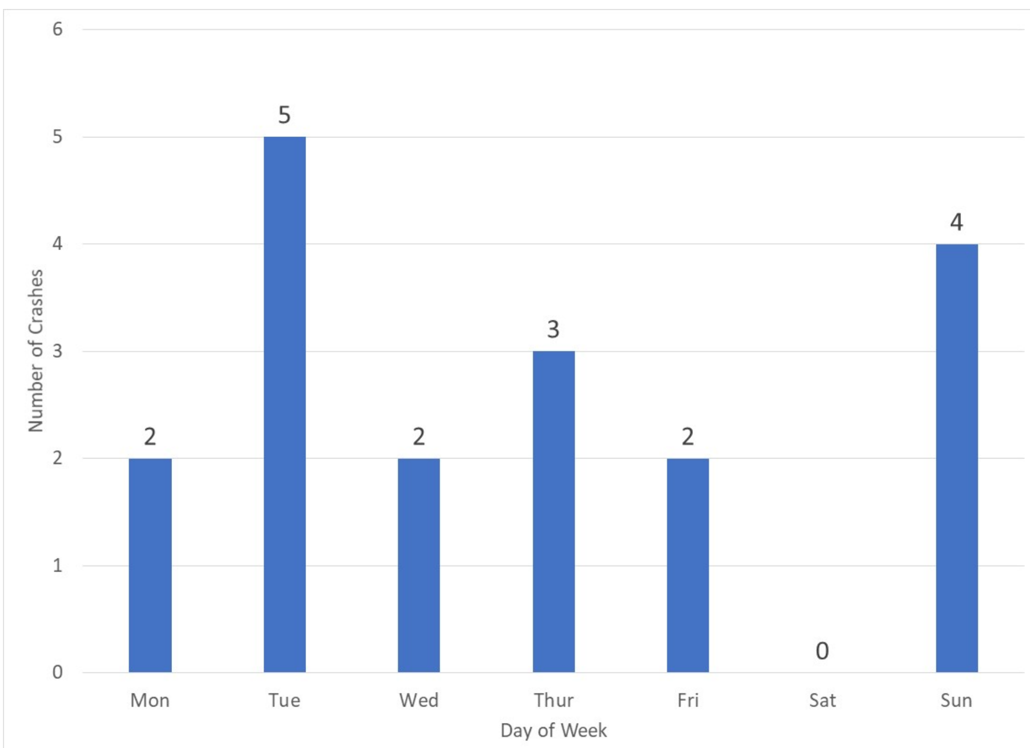

Figure 24: The Parkway & Belle Haven Road, Injury Crashes by Day of the Week

Crashes also seem to be more likely to result in injuries during both the AM and PM Peak periods (Figure 25).

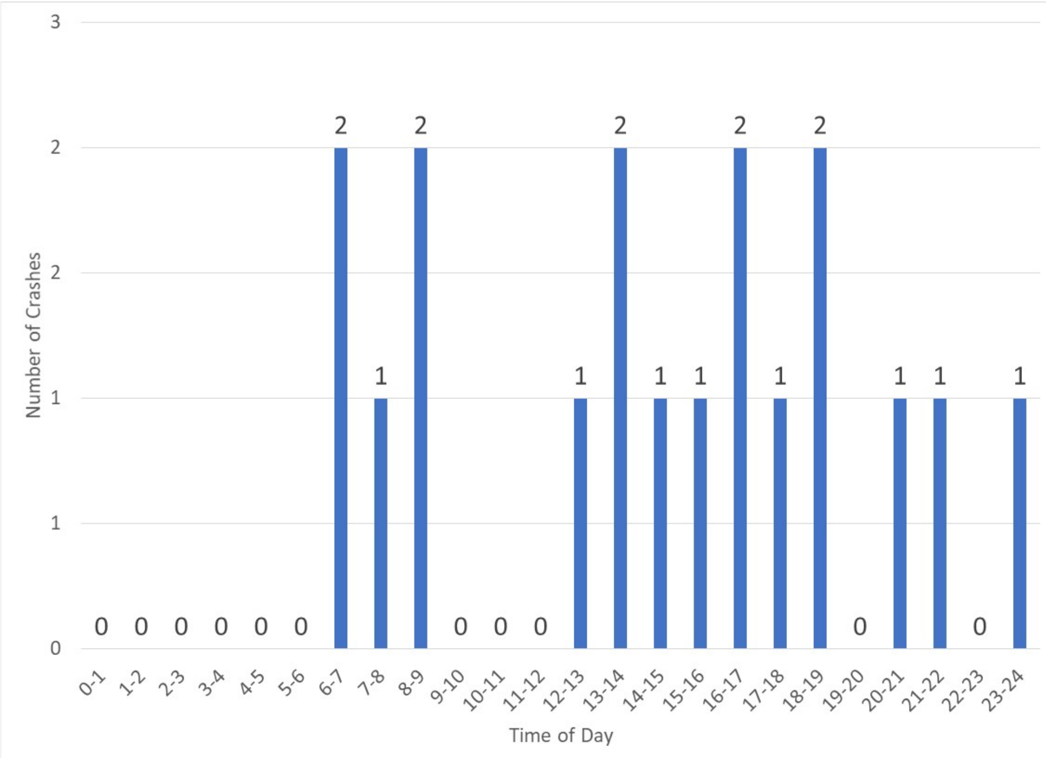

Figure 25: The Parkway & Belle Haven Road, Injury Crashes by Time of Day

3.1.7 Pedestrians & Bicycle

A "Sideswipe-Overtaking" crash was identified as having occurred between a motor vehicle and bicycle, although in the tabular column that identified whether a crash occurred with a bicycle or pedestrian, the crash was not indicated as such (e.g. the column is titled, "PED"). One had to search in the "collision with" category to identify the presence of a bicyclist. This suggests that the way that the crashes are recorded could potentially be underrepresenting the involvement of vulnerable road users (e.g. pedestrians and bicyclists).

3.1.8 Crash Diagram

The following crash diagram shows the location of crashes at the intersection for which enough information was available to place them on the map. If crash type, direction of vehicle, and other factors were provided, then they were mapped. Otherwise, after the figure is a note regarding why a crash could not be mapped. Crash reports were not available. Therefore, the diagram was created based on the pre-crash direction of the vehicle, and the stated crash type. As a separate file was provided for vehicle and persons for the more recent data (2018-2019), these crashes may be more accurate. However, complete data was not always provided. As such, there may be some variability between the actual crash and what is conveyed in the diagram. Figure 26 is **the best understanding of the crash occurrence at the intersection based on available information**.

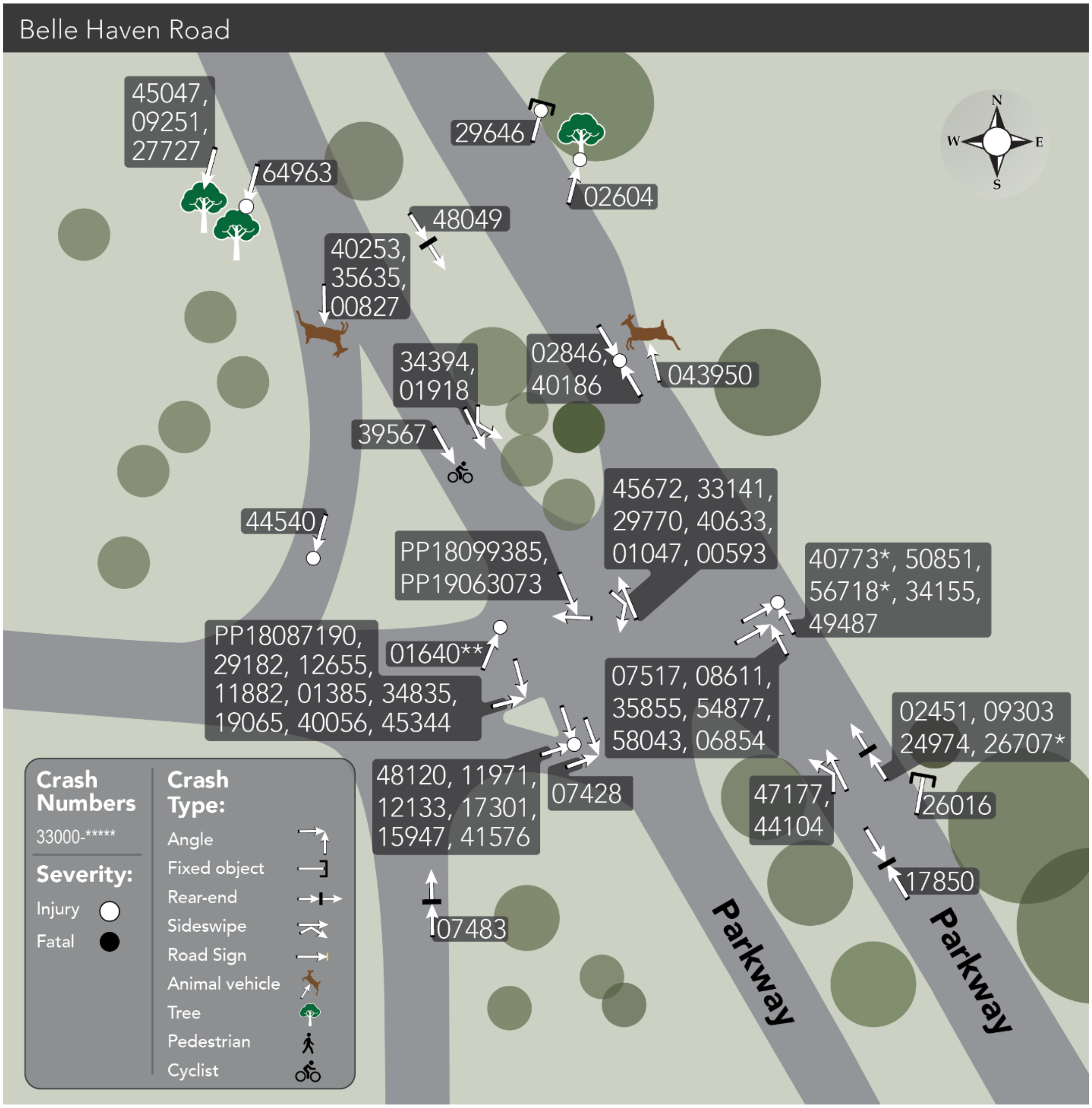

Figure 26: The Parkway & Belle Haven Road, Crash Diagram

*The assumption was made that a vehicle involved in the crash was traveling northbound, although it is not completely clear based on the tabular data.

**It is not completely clear where the crash occurred, although the tabular data seems to suggest that it was west of the intersection.

The following are additional crashes that occurred at Belle Haven Road which could not be placed on the crash diagram:

- 14051607 – no direction or crash type identified; PDO
- 3300047021 – southbound; no crash type identified; PDO
- 3300013994 – northbound, no crash type identified; PDO
- 3300046226 – southbound, no crash type identified; INJ
- 3300034012 – northbound, crash cause was “tires”; PDO
- 3300002835 – no direction, crash with a pole; PDO
- 3300015960 – southbound, says “improper turn,” although it is unclear in what direction the turn was made; PDO
- PP18053829 – says that both vehicles were traveling southbound; no crash type; PDO

The north leg of the intersection seems to be a crossing for **animals**, as all four of the crashes with animals occurred on this leg. While the animal crashes are depicted as a deer for the diagram, it is unclear if the animal crashes are in fact with deer or some other animal.

The six opposite direction sideswipe crashes suggest that the current traffic control does not clearly establish right-of-way.

3.1.9 Summary - Belle Haven Road

As summarized in Table 19, based on crash data (2005-2015; 2018-2019), the largest number of crashes occurred in 2011; during the month of January; slightly more often on Thursday; and most often during the 8-9 AM and 2-3 PM time periods. The majority of crashes were reported as occurring when the weather was clear and the road surface was dry; therefore, it would appear that weather and the presence of water on the roadway are not factors. The most frequent crash type was angle. Most often, the primary cause was identified as "Failed to Yield ROW," which suggests that there may be a lack of clarity regarding who has right-of-way.

Table 19: The Parkway & Belle Haven Road, Summary of Key Data Findings

Criteria	Count
Number of Crashes	72
Year (of greatest frequency)	2011
Month (of greatest frequency)	January
Day (of greatest frequency)	Thursday
Percent from 12 AM to 12 PM	32%
Most Frequent 1 Hour Block	8-9am; 2-3pm
Most Frequent Time Period (pre-AM PEAK; AM PEAK; mid-day; PM PEAK; post-PM PEAK)	PM Peak
Might lighting be an issue?	Yes
Is weather a contributing factor?	No
Might the surface condition be a factor?	No
Most Typical Crash Type	Angle
Most Typical Reported Cause	Failed to Yield ROW (15 of 72)
Driving Under the Influence	2.8% of crashes
Hit & Run	6.9% of crashes
Percent of Injury & Fatal Crashes (measure of severity)	25%
Total Number of People Injured in Crashes	32 people
Pedestrian/Bicycle Involved Crashes?	Yes; 1 crash (1.4%)
Animal Involved Crashes?	Yes; 4 crashes (5.6%)

3.2 The Parkway & Belle View Boulevard

Figure 27 shows the orientation of the Parkway and Belle View Boulevard, a three-legged intersection with a median.

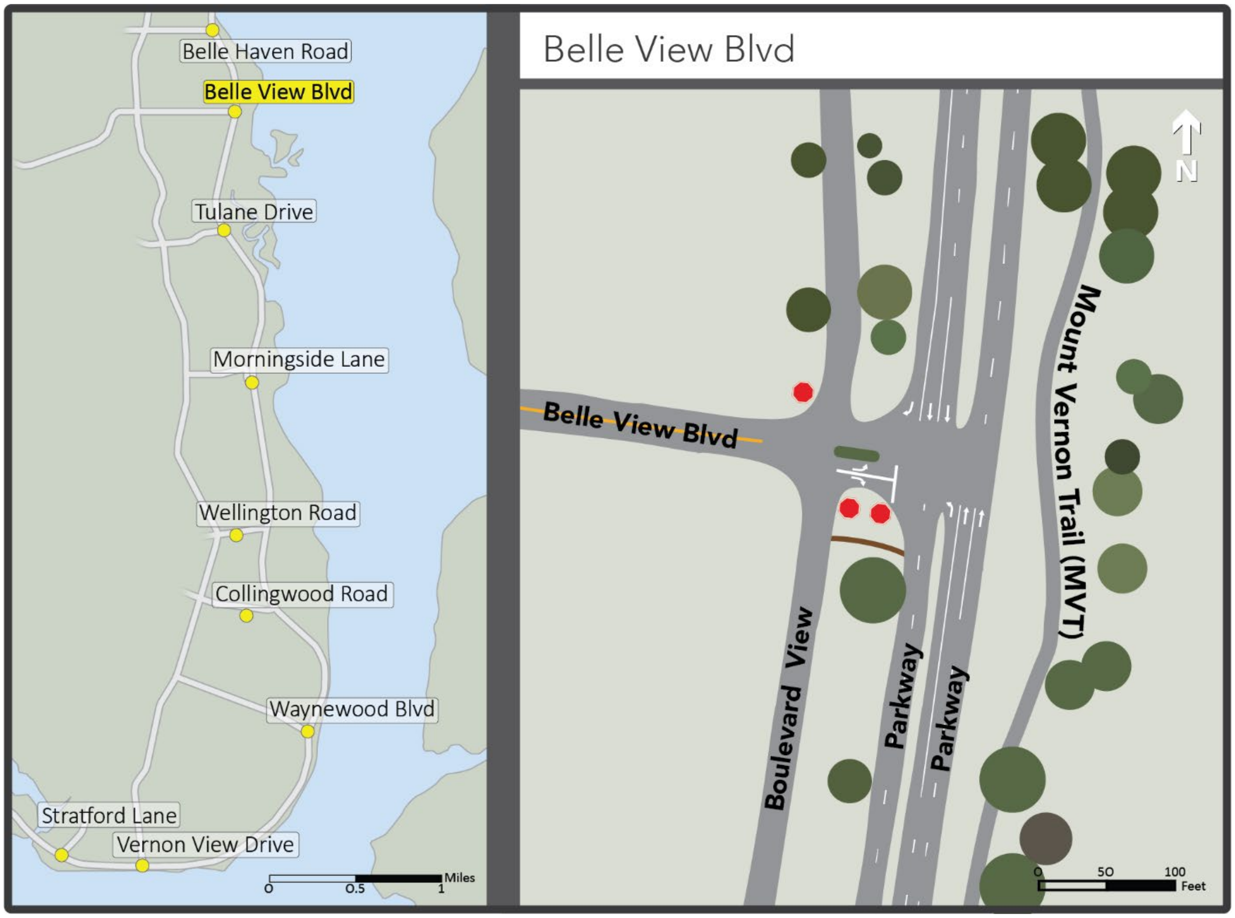

Figure 27: The Parkway & Belle View Boulevard

There are a few interesting geometric considerations at this intersection. First, Boulevard View closely parallels the Parkway; the lack of an offset between two intersections (the Parkway & Belle View Boulevard and Boulevard View & Belle View Boulevard) can be problematic from a safety perspective, as a driver at one intersection may not detect someone that is arriving at the second intersection from the first. Also, on the east side of the intersection, notice the close proximity of the MVT. While there is not an official pedestrian/bicyclist crossing, there is a dirt impression (a.k.a. social trails) that can be seen on the south side, between Boulevard View and the Parkway. Using Google Street view, one can even view a woman walking her bicycle across the Parkway leading from this path.

One of many photos taken of bicyclists/pedestrians at this intersection can be found in Figure 28. Finally, in the southbound direction of the Parkway there is a right-turn lane. This lane can potentially obstruct a driver's view who is looking to turn northbound from eastbound on Belle View Boulevard. In addition, there is the potential for confusion if someone in the right-turn lane does not commit to turning right.

Figure 28: Pedestrian, Bicyclist & Vehicle at the Parkway & Belle View Boulevard

From 2005-2015 and 2018-2019, a total of **ninety** crashes were identified at the intersection of the Parkway and Belle View Boulevard. Belle View Boulevard was incorrectly spelled with the following versions in the tabular data: Bellview, Belview, and Bellvue. Generally speaking, the annual occurrence of crashes appears random, although 2014 had the greatest number of crashes reported (Figure 29). 2015 did not have any reported crashes at this intersection.

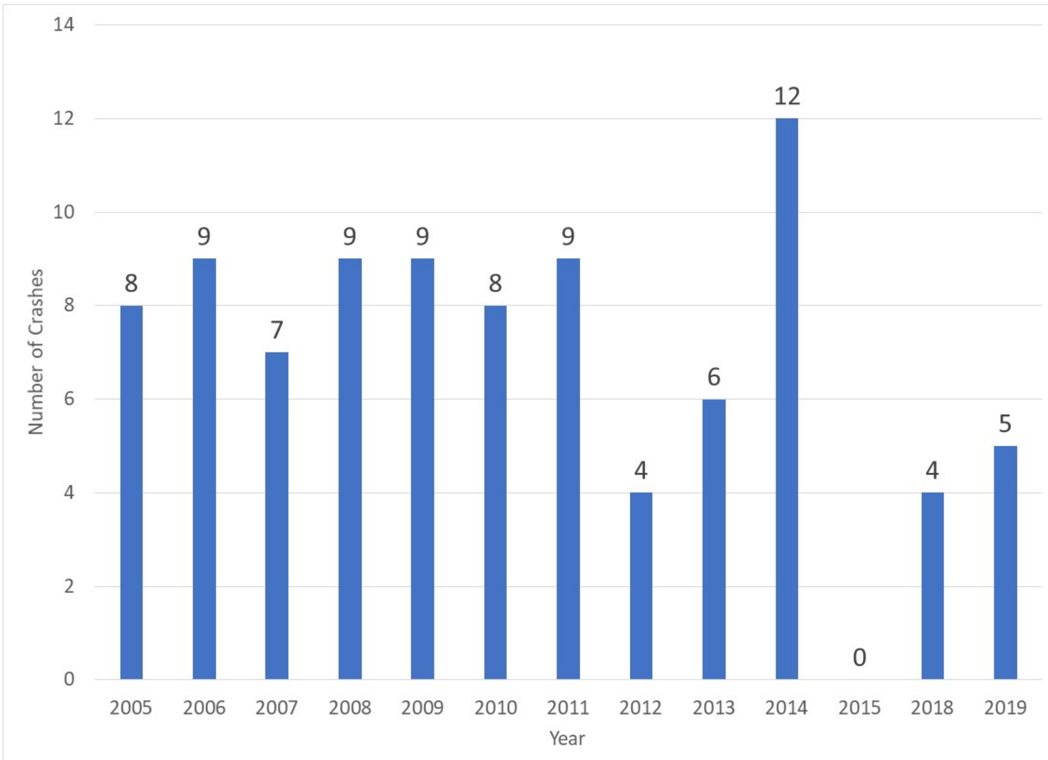

Figure 29: The Parkway & Belle View Boulevard, Total Crashes by Year

The most notable aspect of the figure is that there seems to be a drop from 2011 to 2012 and a jump in crash occurrence in 2014. It would be worth identifying if any operational or geometric changes were made in 2011 and 2013. It could, however, also suggest that there are issues with the crash data. However, while there is a gap between the more recent data and past years, there appears to be some consistency between the 2012 and 2013 data when compared with the 2018 and 2019 data. Consider, however, that what is presented for 2018 and 2019 is only partial data for the year.

3.2.1 Temporal

This section discusses patterns identified by month, time, and day of the week.

Based on data from the available years (2005-2015; 2018-2019), crashes occurred most frequently in **May** (Figure 30).

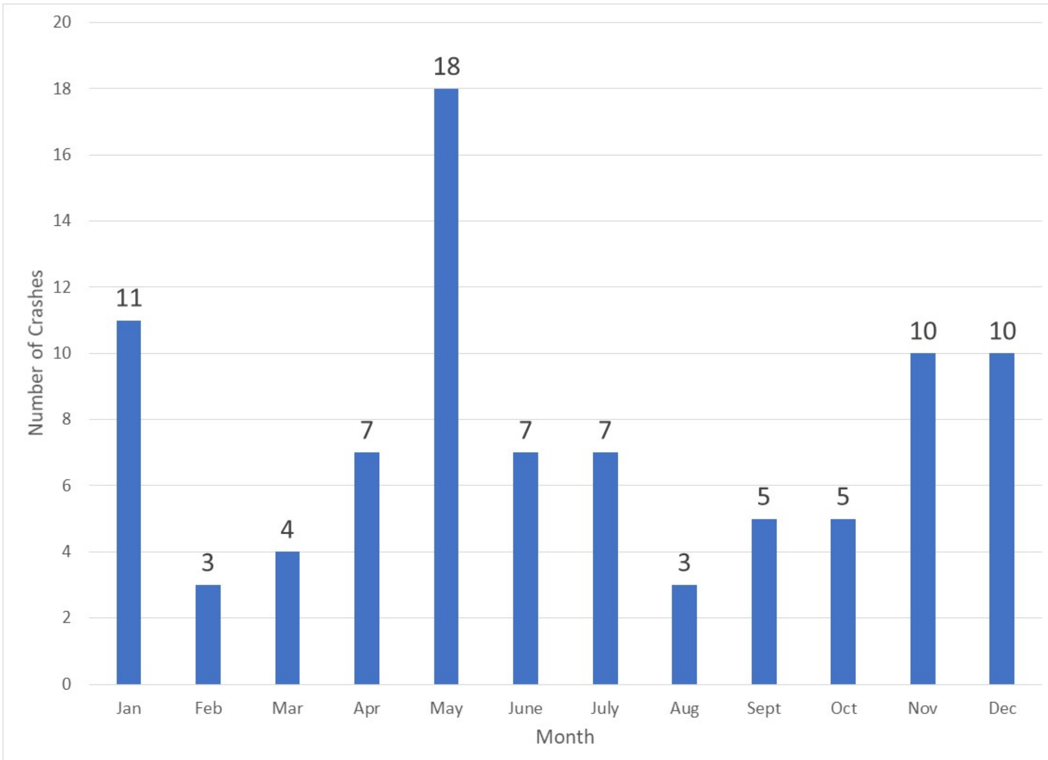

Figure 30: The Parkway & Belle View Boulevard, Crashes by Month

The WTI Team separated crashes into an AM period (12 AM to 12 PM) and a PM period (12 PM to 12 AM) to investigate if crashes occurred more often in the AM or PM. **Thirty percent** of all crashes occurred in the AM period.

Assigning each crash to a one-hour time period across the entire day, the most frequent number of crashes occurred from **3-4 PM** (Figure 31).

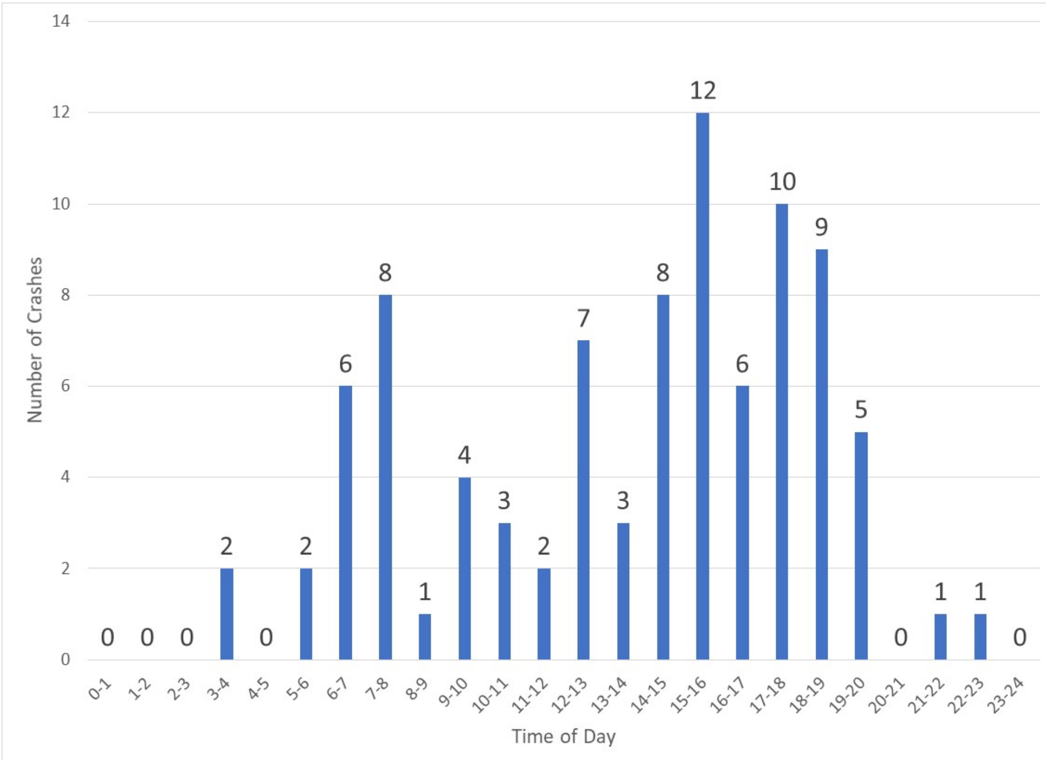

Figure 31: The Parkway & Belle View Boulevard, Crashes by Time of Day

The WTI Team binned the crashes into pre-AM PEAK, AM PEAK, mid-day, PM PEAK, and post-PM PEAK crash time periods. Considering the frequency of crashes per hour, the largest number and the highest rate of crashes occurred during the **PM PEAK** time period (Table 20).

Table 20: The Parkway & Belle View Boulevard, Crash Counts & Rate by Time Period

Time Period		Number of Crashes	Crashes/Hour
12 AM-6 AM	pre-AM PEAK	4	0.7
6 AM-9 AM	AM PEAK	15	5.0
9 AM-3 PM	mid-day	27	4.5
3 PM-6 PM	PM PEAK	**28**	**9.3**
6 PM-12 AM	post-PM PEAK	16	2.7
TOTAL		90	-

The day of the week with the greatest number of crashes is **Friday** (Figure 32).

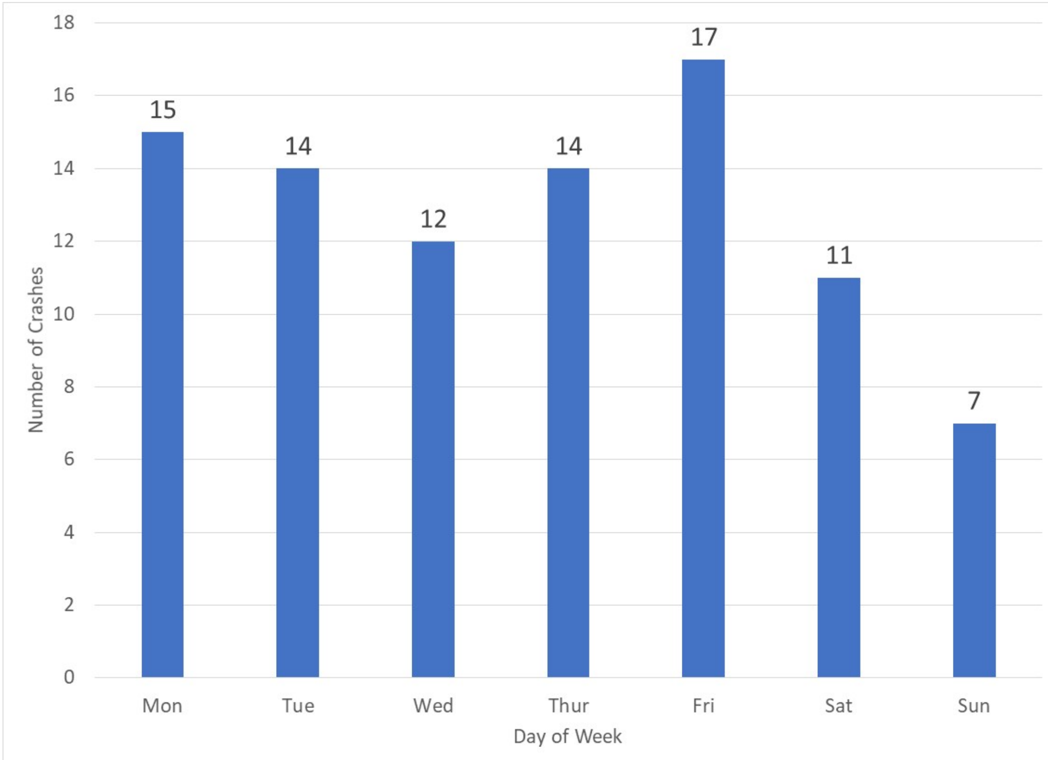

Figure 32: The Parkway & Belle View Boulevard, Crashes by Day of the Week

The results suggest the possibility of contributing factors occurring on Friday that are increasing the number of crashes.

3.2.2 Environment

This section discusses how lighting, weather, and the road surface may have influenced crash occurrence.

The WTI Team analyzed the lighting condition identified during a crash (Figure 33).

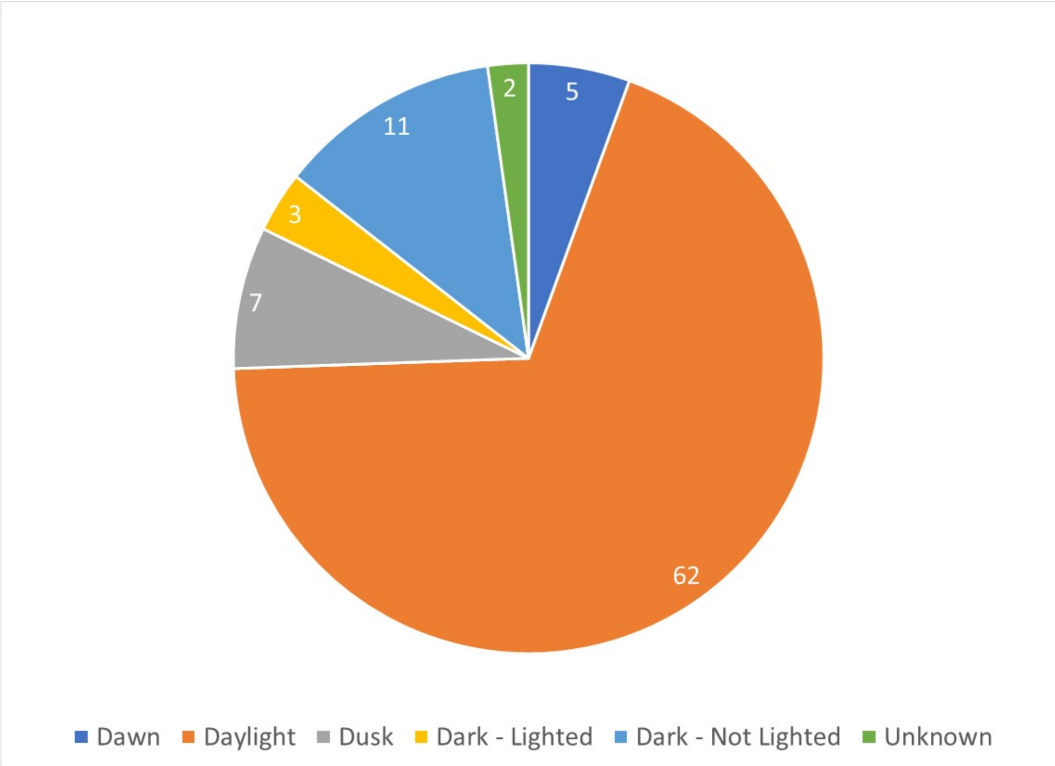

Figure 33: The Parkway & Belle View Boulevard, Lighting (number of crashes during each lighting condition)

Some of the data was inconsistent. **Eleven** crashes indicated that the intersection was "Dark – Not Lighted" with **three** indicating "Dark – Lighted." The Parkway does not have lighting on the roadway in the study section; therefore, "Dark – Lighted" must be an error.

Most crashes (**sixty-two**) were identified as having occurred during "Daylight." Looking at the data in more detail, of the crashes that occurred during "Daylight," **nineteen** of these crashes were during periods when conditions were indicated as: 1) Cloudy, 2) Rain, or 3) Sleet, Hail, Freezing Rain. These conditions would suggest that the crash occurred when there was reduced visibility. Reducing the **sixty-two** crashes by these **nineteen** crashes results in a total of **forty-three** crashes remaining during "Daylight." Therefore, a little more than half of the crashes occurred during hours when visibility was good, while the remaining crashes occurred during periods when it was not. This suggests that lighting may be an issue.

The researchers also considered whether the "Daylight" crashes occurred during peak periods. (Note: We anticipated that "Daylight" crashes would be reported less frequently during the 12 AM-6 AM and 6 PM-12 PM time periods, as the sun may have set or may not have risen.) Crashes were grouped into non-peak and peak-periods: 12 AM-6 AM, 6 AM-9 AM (AM PEAK), 9 AM-3

PM, 3 PM-6 PM (PM PEAK), 6 PM-12 AM. Table 21 shows the number of crashes within these groups.

Table 21: The Parkway & Belle View Boulevard, "Daylight" Crashes in Time Periods.

Time Period		Number of Crashes	Crashes/Hour
12 AM-6 AM	pre-AM PEAK	2	0.3
6 AM-9 AM	AM PEAK	8	2.7
9 AM-3 PM	mid-day	26	4.3
3 PM-6 PM	PM PEAK	18	**6.0**
6 PM-12 AM	post-PM PEAK	8	1.3
TOTAL "Daylight" Crashes		62	-

"Daylight" crashes were most likely to occur during the PM PEAK and least likely to occur from the 12 AM to 6 AM (pre-AM PEAK).

With regard to weather, the majority of the crashes (**fifty-three**) occurred during "Clear" periods (Figure 34); however, this was just over half. There is the potential that weather could be impacting the number of crashes; more information is needed regarding the implications of "other." This highlights some of the challenges with fully understanding factors contributing to crashes when only using tabular data.

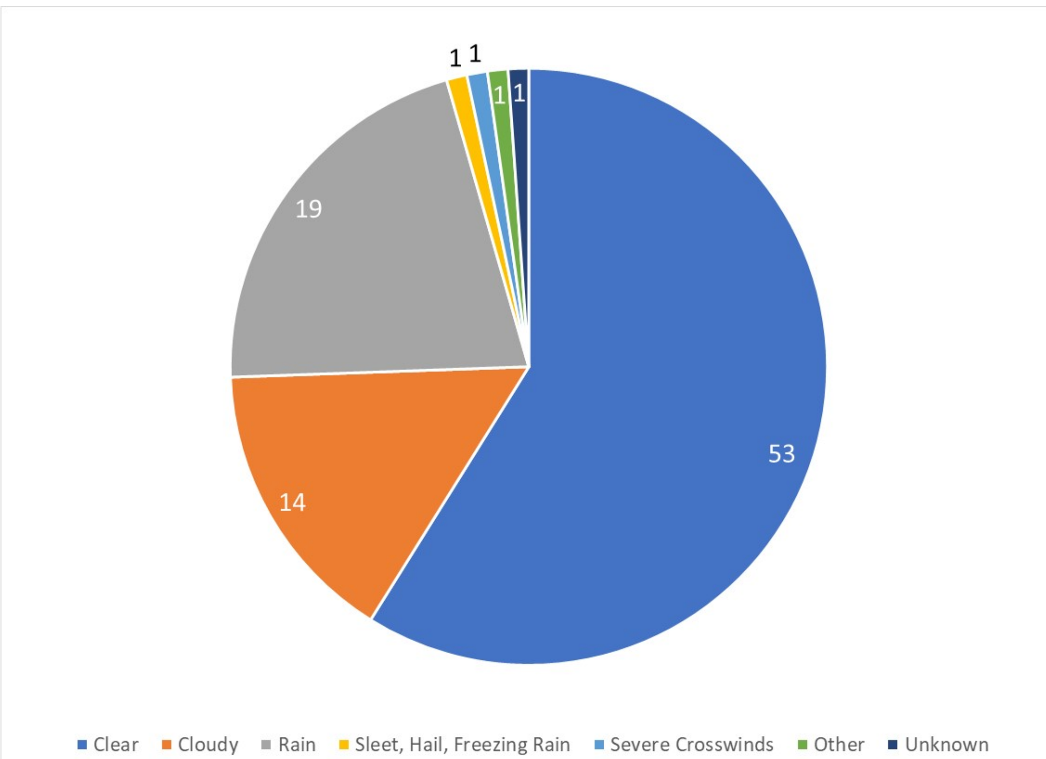

Figure 34: The Parkway & Belle View Boulevard, Weather

The majority of crashes (**sixty-six**) occurred when surface conditions were "Dry;" however, just over a quarter of them occurred when the pavement was reported as being wet. There is a potential that surface condition **could** be an issue (Figure 35).

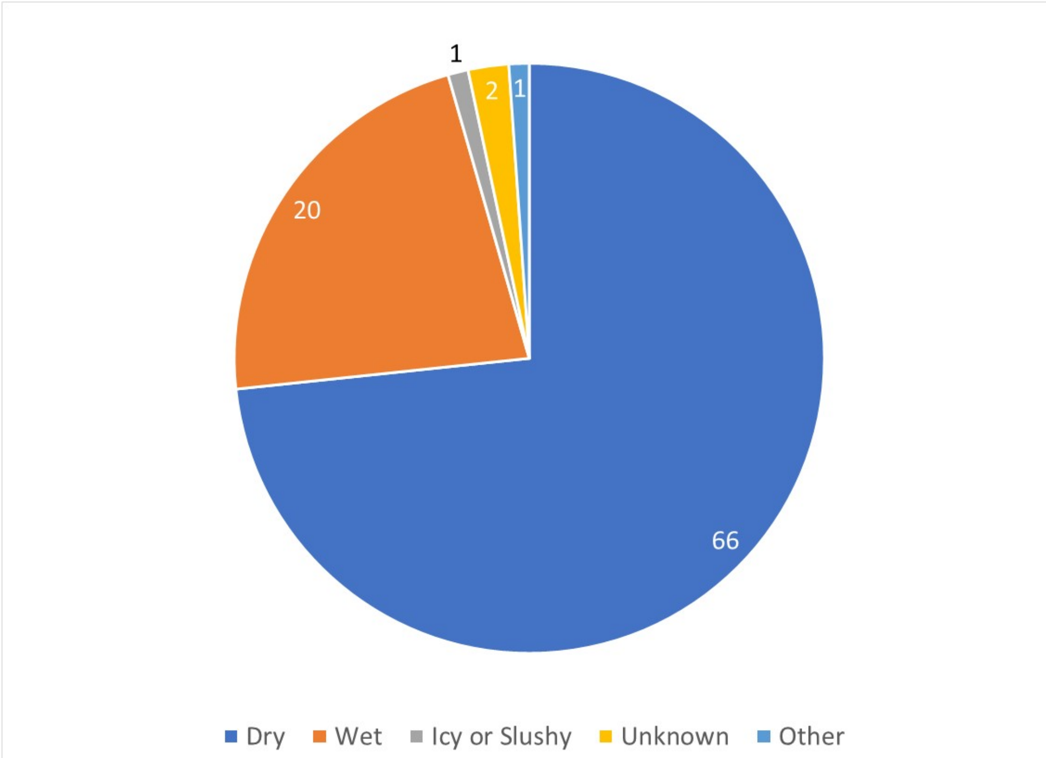

Figure 35: The Parkway & Belle View Boulevard, Surface Condition

3.2.3 Factors Contributing to Crashes

This section discusses the vehicle collision type, the indicated primary cause of the crash, and whether the collision was between vehicles or with an object.

One category of the tabular data provided information about the vehicle collision type. "Angle" was the most common crash type (**forty-six**) (Figure 36).

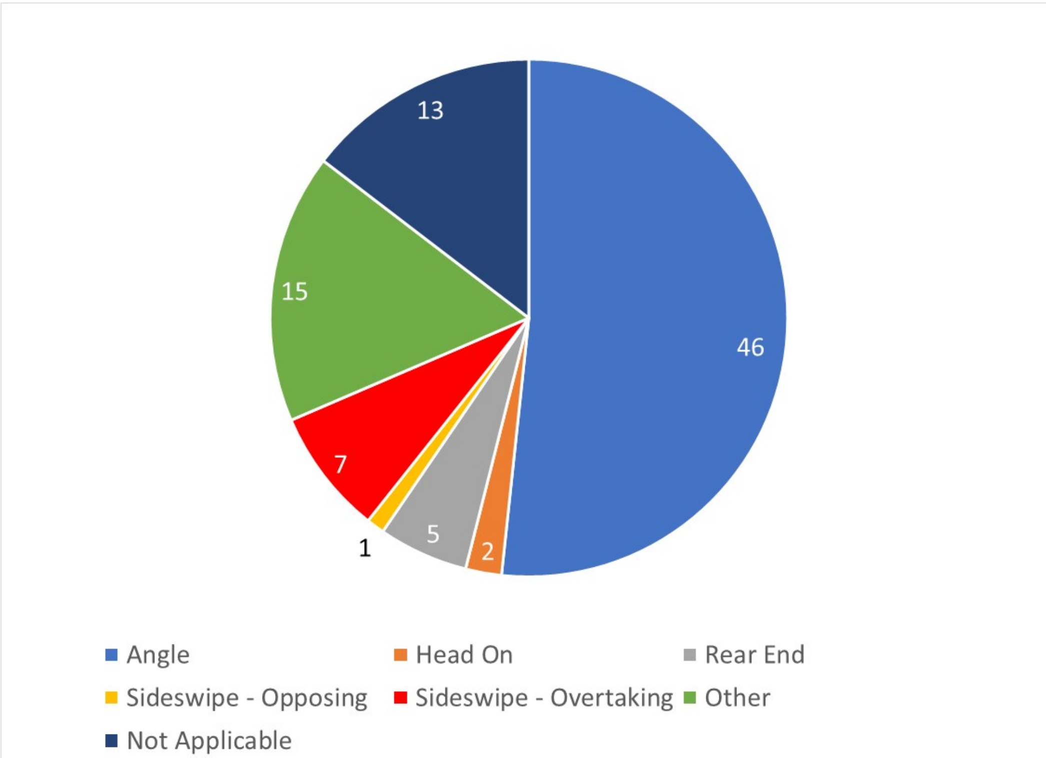

Figure 36: The Parkway & Belle View Boulevard, Crash Type

Thirteen crashes were identified as "Not Applicable." In the tabular data, there is an option to include data in the "collision with?" column. The crashes were identified as having occurred with a tree/shrub (5), animal (3), pedestrian (2), sign (1), other (1), or were identified as a "non-collision" (1). (Note: There was not enough information to better understand what a "non-collision" implies, as without crash reports, little additional information is provided.) These results suggest that addressing why vehicles are hitting trees/shrubs, animals, and pedestrians would assist with reducing the crash occurrence at the intersection.

By far, the most reported "Primary Cause" was "Failed to Yield ROW" (Figure 37), which was reported in **43 of the 90 crashes (48%)**. (Note: Figure 37 only shows **70 of the 90 crashes** that occurred at the intersection, as 20 crashes provided no information on the "Primary Cause.")

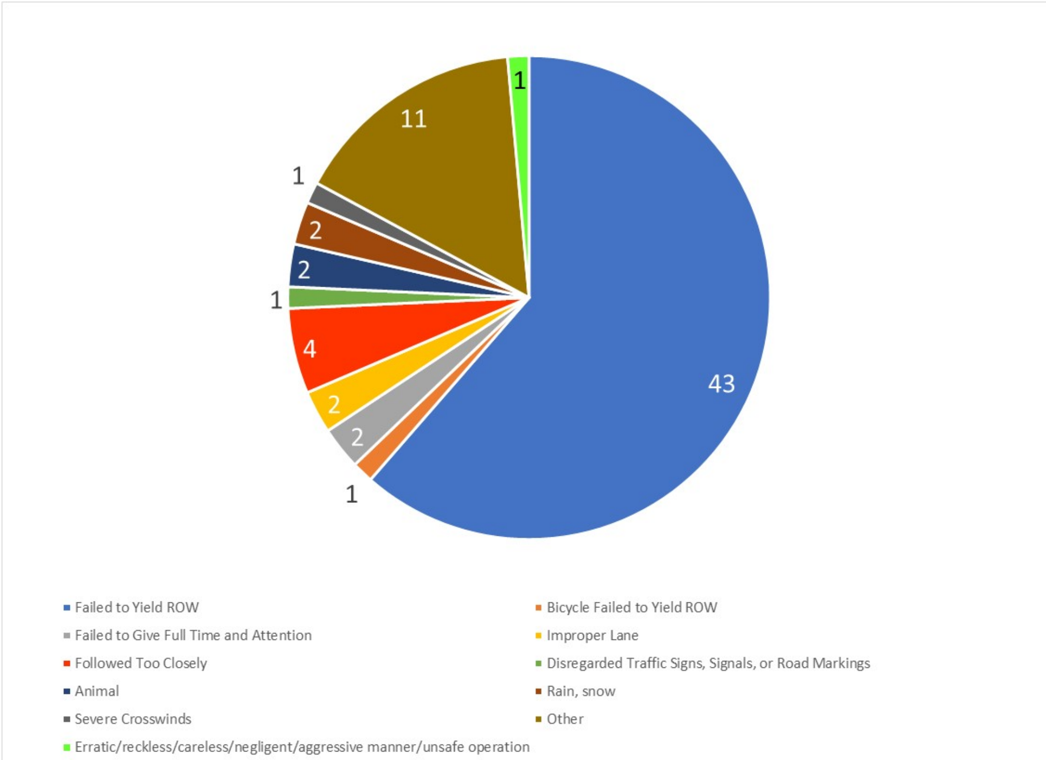

Figure 37: The Parkway & Belle View Boulevard, Primary Cause

"Other" was the second most frequently identified "Primary Cause," at 11. "Followed Too Closely" was the third most frequently identified "Primary Cause," at 4.

3.2.4 Driving Under the Influence

This section discusses crashes that were identified as involving drugs or alcohol. As noted in the "Primary Cause" section, of the **ninety** crashes identified at the intersection (2005-2015; 2018-2019), **zero** crashes were identified as having a driver that was under the influence of alcohol or other substances.

3.2.5 Hit & Run

This section discusses crashes identified as a hit and run. Interestingly, **four** of the **ninety** crashes, or **4.4%** were identified as hit-and-run crashes. There are many reasons why a driver may hit an object or other vehicle and leave the scene of the crash, potentially including operating a vehicle while under the influence or driving without insurance (Benson, Arnold, Tefft, & Horrey, 2017). Therefore, if the drivers causing the crashes are leaving the scene of a crash to avoid penalty for operating under the influence (OUI), there could be a problem with OUI not currently captured in the crash data.

3.2.6 Crash Severity

This section identifies the number of PDO, INJ and FAT crashes. While the majority of crashes (**fifty-five**) that are occurring at the intersection are PDO crashes, the overall severity is high, as shown by the presence of a **fatal** crash and **thirty-eight** percent of all crashes being injury or fatal crashes (Figure 38).

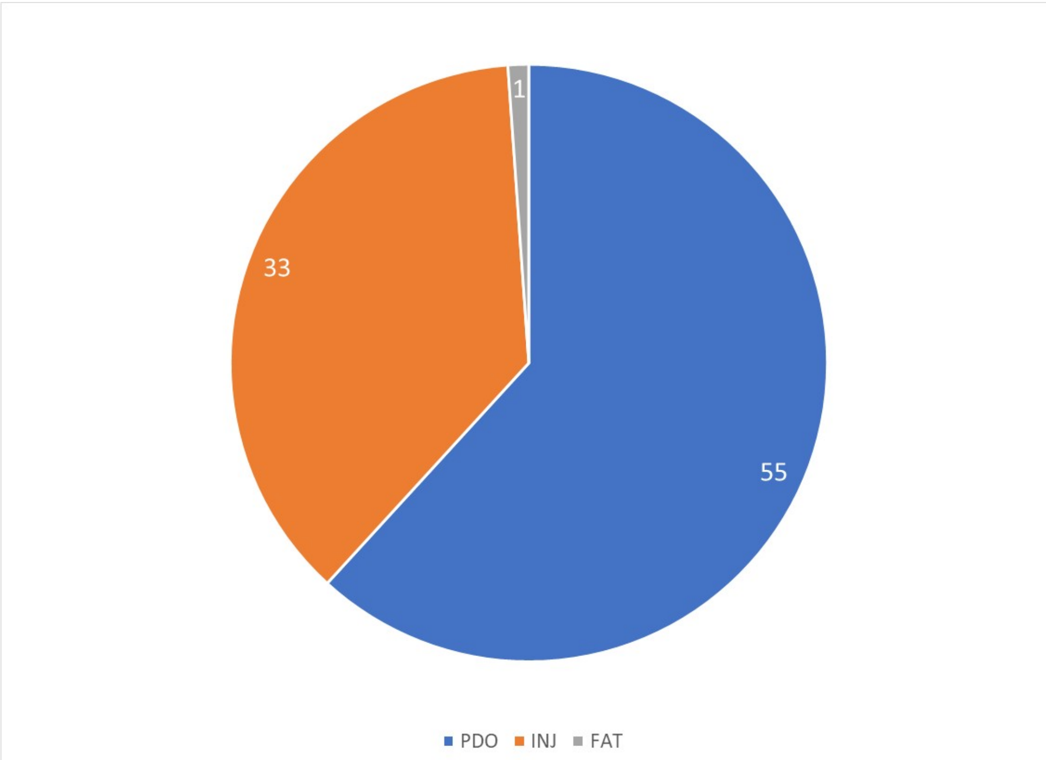

Figure 38: The Parkway & Belle View Boulevard, Crash Severity

Across the injury and fatal crashes, there were a total of **forty-seven** injuries and **one** fatality.

The occurrence of the injury and fatal crashes by month, day of week, and time of day was investigated. In Figure 39, Figure 40, and Figure 41, blue represents injury crashes and orange represents the fatal crash. There is clearly some aspect related to crashes in May that is resulting in an increase in severity of the crashes (Figure 39).

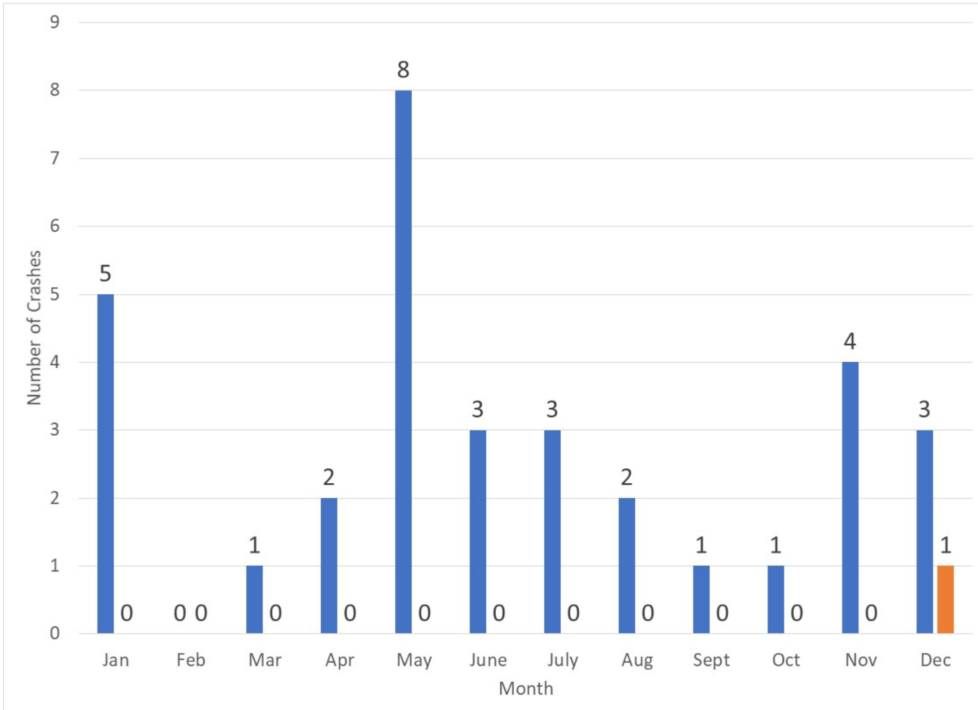

Figure 39: The Parkway & Belle View Boulevard, Injury and Fatal Crashes by Month

Friday, because of the large number of crashes, seems to have some characteristics that are contributing to crashes.

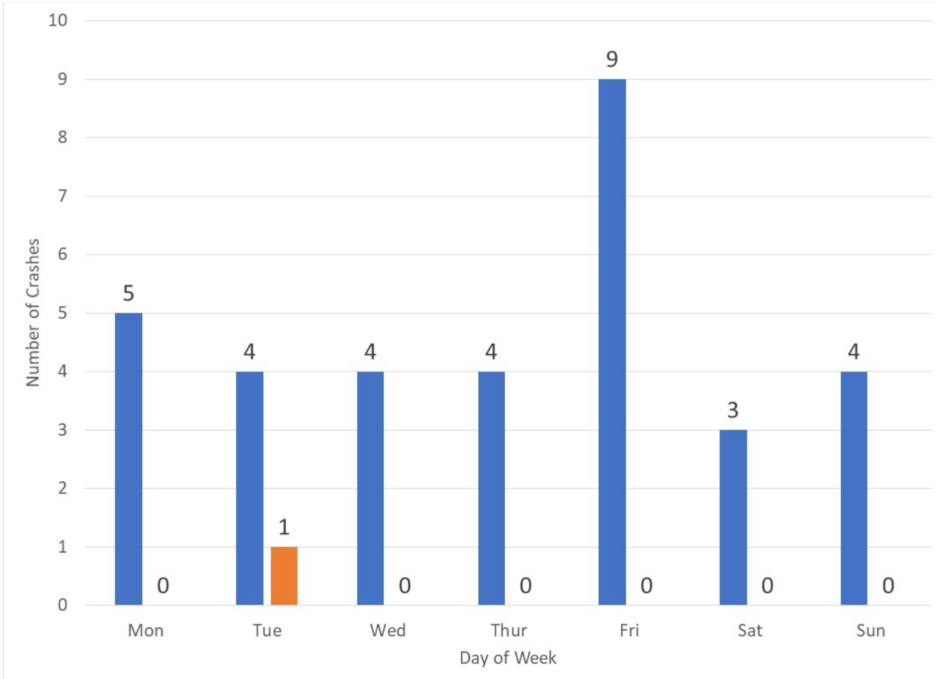

Figure 40: The Parkway & Belle View Boulevard, Injury and Fatal Crashes by Day of Week

Overall, it appears as if the PM Peak time period has a large concentration of injury and fatal crashes. There is a high likelihood of injury crashes from 3-4pm as compared with the other times of day.

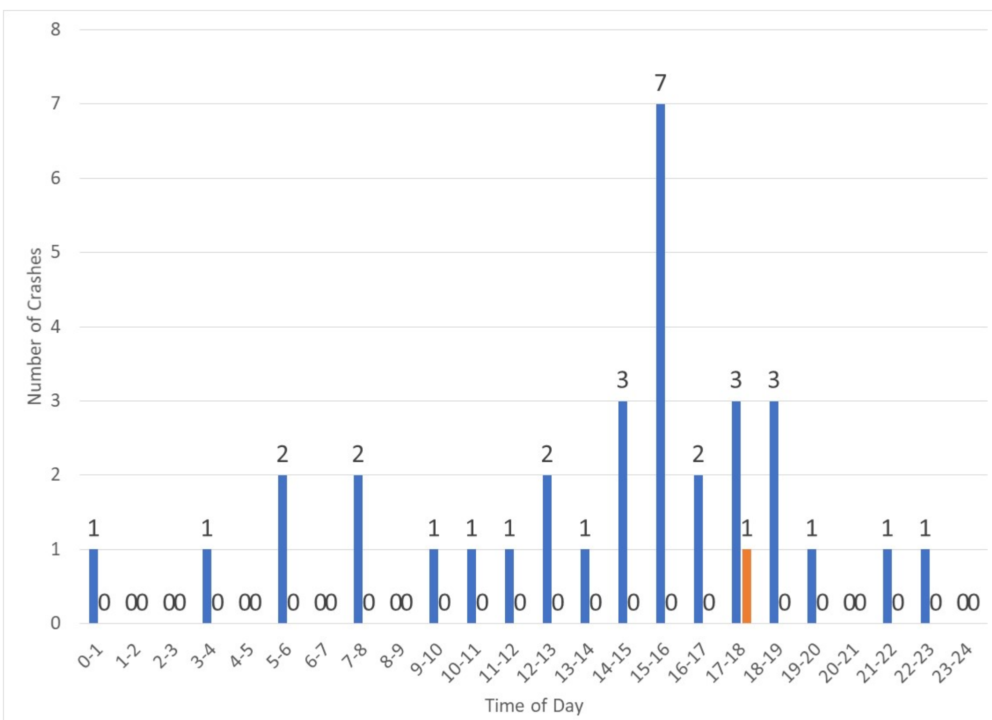

Figure 41: The Parkway & Belle View Boulevard, Injury and Fatal Crashes by Time of Day

3.2.7 Pedestrians & Bicycle

Three crashes (3.3%) involved a bicyclist and pedestrian; two of the three crashes were injury crashes. Therefore, to reduce the severity of crashes at this intersection, there is a need to address the safety of vulnerable road users.

3.2.8 Crash Diagram

The following crash diagram shows the location of crashes at the intersection for which enough information was available to place them on the map. If crash type, direction of vehicle, and other factors were provided, they were mapped. Otherwise, after the figure is a note regarding why a crash could not be mapped. Crash reports were not available. Therefore, the diagram was created based on the pre-crash direction of the vehicle, and the stated crash type. As a separate file was provided for vehicle and persons for the more recent data (2018-2019), these crashes may be more accurate. However, complete data was not always provided. As such, there may be some variability between the actual crash and what is conveyed in the diagram. Figure 42 is **the best understanding of the crash occurrence at the intersection based on available information**.

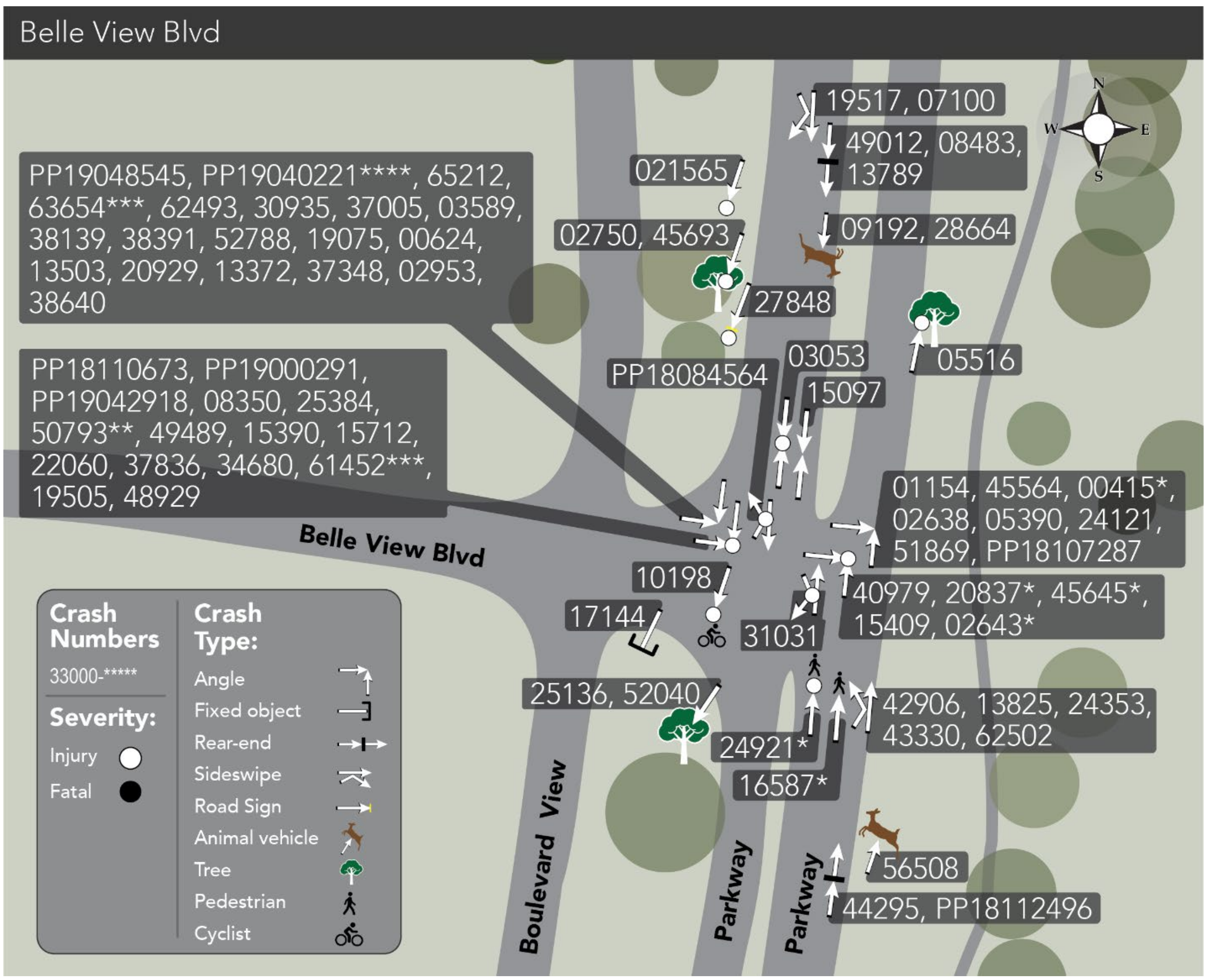

Figure 42: The Parkway & Belle View Boulevard, Crash Diagram

*The assumption was made that a vehicle involved in the crash was traveling northbound.

**It is implied that a vehicle was traveling eastbound.

***The assumption was made that a vehicle involved in the crash was traveling southbound.

****The crash says "Other," but the crash was with eastbound and southbound vehicles.

The following are additional crashes that occurred at Belle View Boulevard which could not be placed on the crash diagram:

- 3300001197 – says "other"; PDO
- 3300046188 – says "other"; INJ
- 3300044488 – says "other; southbound; FAT
- 330007878 – says "other"; southbound; PDO
- 3300014040 – says "other"; no direction; PDO
- 3300011574 – says "non-collision"; northbound; PDO
- 3300005346 – says "Made Improper Turn"; southbound; PDO
- 3300015232 – says "other"; southbound; PDO
- 3300014837 – says "other"; southbound; INJ
- 3300031614 – says "other"; southbound; INJ
- 14112997 – says "other"; southbound; PDO
- 14054019 – says "other"; southbound; PDO
- PP19076919 – no information for crash type; one vehicle was identified as going eastbound and the other one southbound; there is no information regarding severity

The majority of the crashes seem to involve those accessing the Parkway from Belle View Boulevard. There are also crashes between those leaving the roadway and hitting trees/shrubs and crashes with animals. While the animal crashes are depicted as a deer for the diagram, it is unclear if the animal crashes are in fact with deer or some other animal.

3.2.9 Summary – Belle View Boulevard

Based on crash data (2005-2015; 2018-2019), the largest number of crashes occurred in 2014; in May; between 3 PM-4 PM; and on Fridays (Table 22). Interestingly, the greatest number of injury crashes also occurred in May, between 3 PM-4 PM and on Fridays. **This information could be used for enforcement initiatives**. (Note: In contrast, with only one fatality occurring, there does not seem to be any correlation between when (month, day, or time of day) this crash occurred and other trends observed, suggesting randomness.)

Regarding bicycle and pedestrian crashes, two of the bicycle/pedestrian crashes occurred in May with the third in April. Interestingly, both of the May crashes occurred between 4 PM and 5 PM (4:24 PM and 4:54 PM). (Note: Two of the three bicycle/pedestrian crashes occurred on Sunday; one on Monday.) At the end of March, **a public awareness campaign could be done to remind drivers to be aware of pedestrian/bicyclists as there are likely more folks getting out**, walking, and bicycling at this time. With two of the crashes with bicycle/pedestrians occurring on Sundays, it should be pointed out that the day and time did not coincide with the peak crash time and day of the week (e.g. Friday and 3 PM-4 PM). Therefore, to address these crashes as compared with motor vehicle/to motor vehicle crashes, different techniques could be used. In particular, it is well-known that the speed of a vehicle at the time of collision with a bicycle/pedestrian significantly impacts the outcome regarding whether or not the vulnerable road user (cyclist/pedestrian) survives, and if so, whether or not the injury is incapacitating or something that is recoverable (see Figure 1 within Literature Review on Vehicle Travel Speeds and Pedestrian Injuries (U.S. Department of Transportation (USDOT), National Highway Traffic Safety Administration (NHTSA), 1999)).

Table 22: The Parkway & Belle View Boulevard, Summary of Key Data Findings

Criteria	Count
Number of Crashes	90
Year (of greatest frequency)	2014
Month (of greatest frequency)	May
Day (of greatest frequency)	Friday
Percent from 12 AM to 12 PM	31%
Most Frequent 1 Hour Block	3 PM-4 PM
Most Frequent Time Period (pre-AM PEAK; AM PEAK; mid-day; PM PEAK; post-PM PEAK)	PM Peak
Might lighting be an issue?	Maybe
Is weather a contributing factor?	Maybe
Might the surface condition be a factor?	Maybe
Most Typical Crash Type	Angle
Most Typical Reported Cause	Failed to Yield ROW (43 of 90)
Driving Under the Influence	0 crashes (0%)
Hit & Run	4 crashes (4.4%)
Percent of Injury & Fatal Crashes (measure of severity)	37%
Total Number of People Injured in Crashes	48 people*
Pedestrian/Bicycle Involved Crashes?	Yes; 3 crashes (3.3%)
Animal Involved Crashes?	Yes; 2 crashes (2.2%)

*47 injured; 1 died

3.3 The Parkway & Tulane Drive

Figure 43 shows the orientation of the Parkway and Tulane Drive, a three-legged intersection with a median.

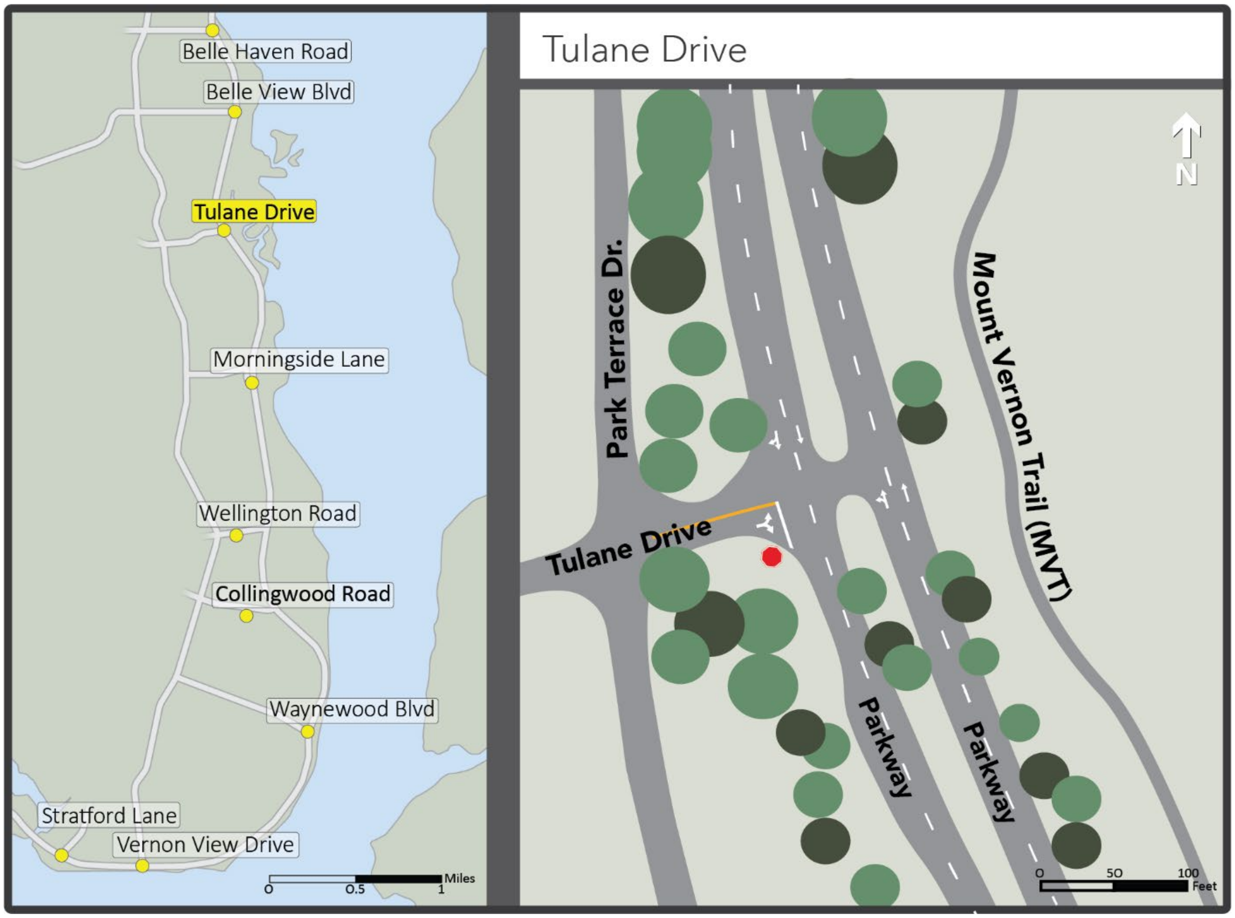

Figure 43: The Parkway and Tulane Drive

There are a few interesting geometric considerations at this intersection. First, Park Terrace Drive closely parallels the Parkway; the lack of an offset between two intersections (the Parkway & Tulane Drive and Tulane Drive & Park Terrace Drive) can be problematic from a safety perspective. Also, on the east side of the intersection, notice the close proximity of MVT. While there is not a clearly established pedestrian/bicyclist crossing, the population center to the left of these intersections and MVT to the east would make crossing appealing. Finally, in the southbound direction there is a right-turn lane. This lane can potentially obstruct a driver's view who is looking to turn northbound from eastbound on Tulane Drive. In addition, there is the potential for confusion if someone in the right-turn lane does not commit to turning right.

From 2005-2015 and 2018-2019, a total of **thirty-two** crashes were identified at the intersection of the Parkway and Tulane Drive. Generally speaking, the annual occurrence of crashes appears random, although **2007** had the greatest number of crashes reported (Figure 44). 2015 did not have any reported crashes at this intersection.

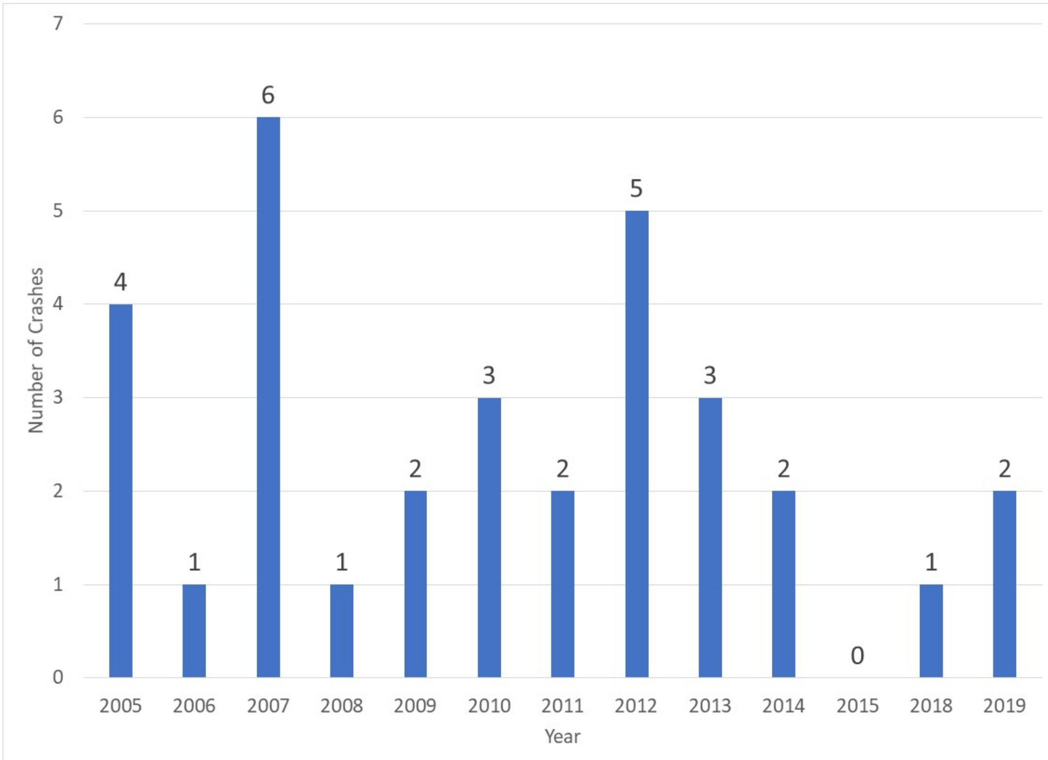

Figure 44: The Parkway & Tulane Drive, Total Crashes by Year

3.3.1 Temporal

This section discusses patterns identified by month, time, and day of the week.

Based on data from the available years (2005-2015), crashes occurred most frequently in **June, September, and October** (Figure 45).

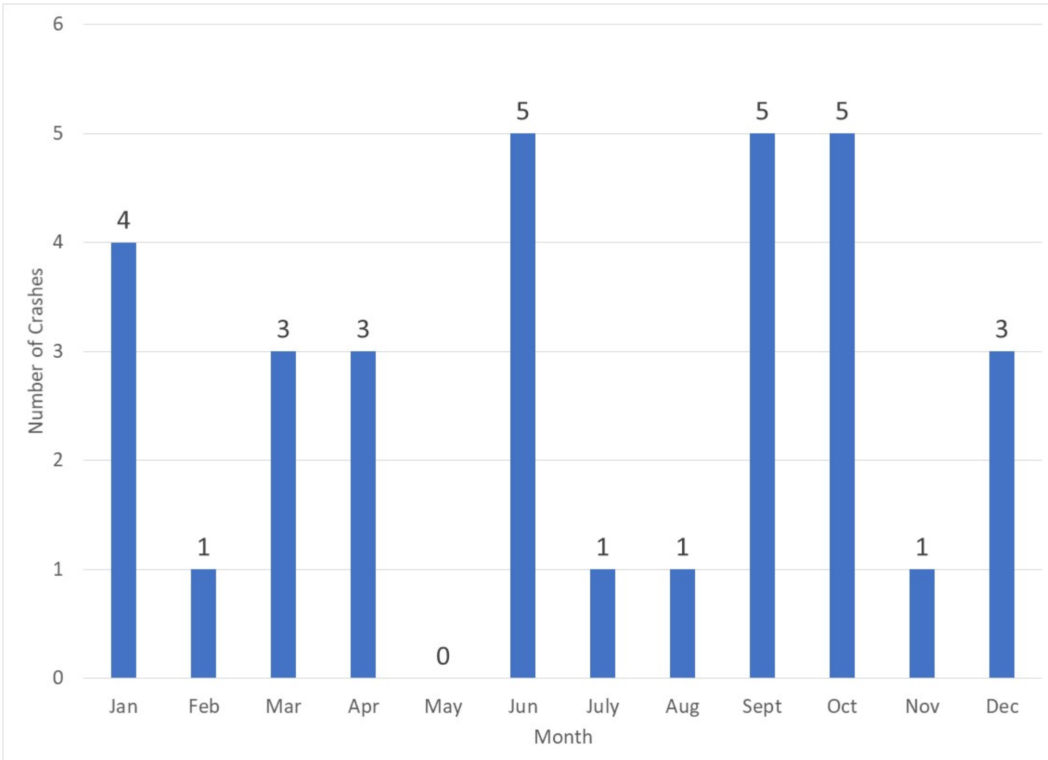

Figure 45: The Parkway & Tulane Drive, Crashes by Month

The WTI Team separated crashes into an AM period (12 AM to 12 PM) and a PM period (12pm to 12am) to investigate if crashes occurred more often in the AM or PM. **Forty-four percent** of all crashes occurred in the AM period.

Assigning each crash to a one-hour time period across the entire day, the most frequent number of crashes occurred from **3 PM-4 PM and 7 PM-8 PM** (Figure 46).

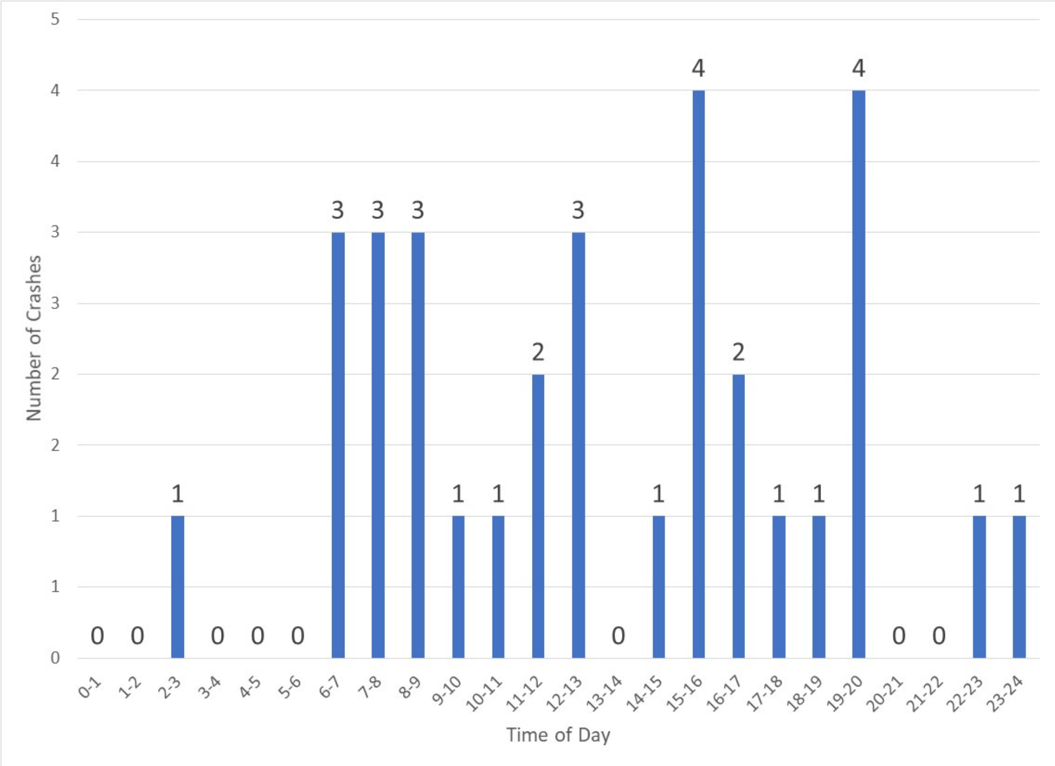

Figure 46: The Parkway & Tulane Drive, Crashes by Time of Day

The WTI Team binned the crashes into pre-AM PEAK, AM PEAK, mid-day, PM PEAK, and post-PM PEAK crash time periods. Considering the frequency of crashes per hour, the largest number and highest rate of crashes occurred during the **AM PEAK** time period (Table 23).

Table 23: The Parkway & Tulane Drive, Crash Counts & Rate by Time Period

Time Period		Number of Crashes	Crashes/Hour
12 AM-6 AM	pre-AM PEAK	1	0.2
6 AM-9 AM	AM PEAK	**9**	**3.0**
9 AM-3 PM	mid-day	8	1.3
3 PM-6 PM	PM PEAK	7	2.3
6 PM-12 AM	post-PM PEAK	7	1.2
TOTAL		32	-

The day of the week that is most represented in the crash records is **Friday** (Figure 47).

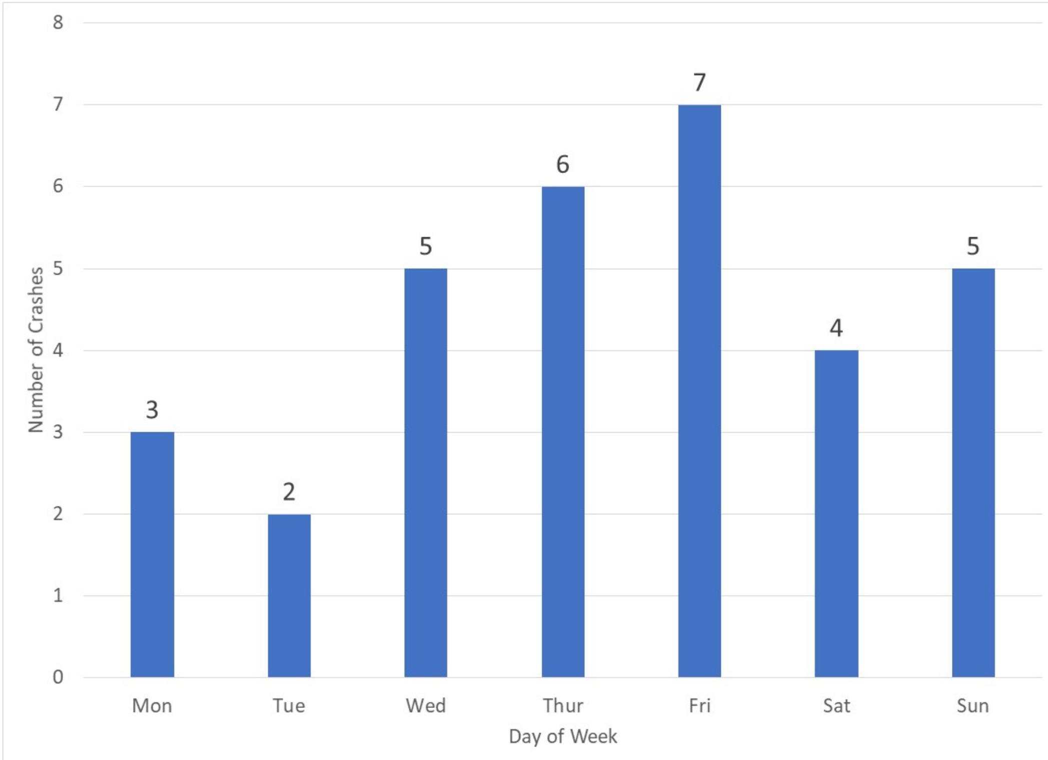

Figure 47: The Parkway & Tulane Drive, Crashes by Day of the Week

The results suggest the possibility of factors occurring on Friday that are contributing to crash occurrence.

3.3.2 Environment

This section discusses how lighting, weather, and the road surface may have influenced crash occurrence.

The WTI Team analyzed the lighting condition identified during a crash (Figure 48).

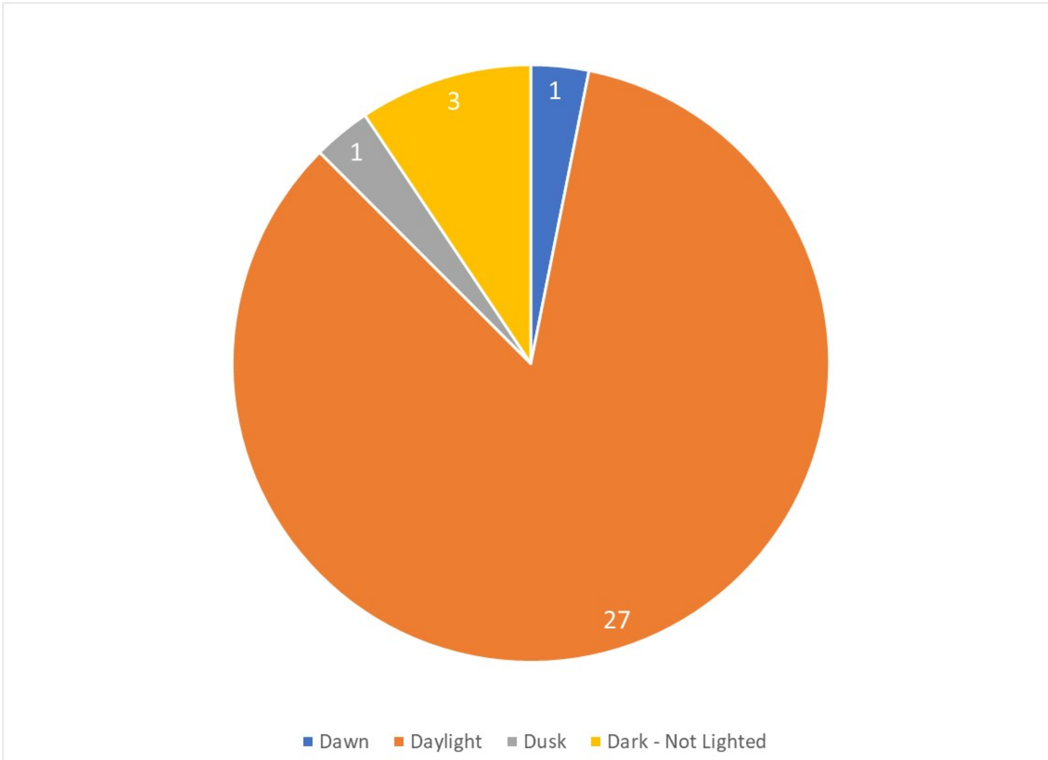

Figure 48: The Parkway & Tulane Drive, Lighting (number of crashes during each lighting condition)

Most crashes (**twenty-seven**) were identified as having occurred during "Daylight." Looking at the data in more detail, of the crashes that occurred during "Daylight," **five** of these crashes were during periods when conditions were indicated as: 1) Cloudy, 2) Rain, or 3) Sleet, Hail, Freezing Rain. These conditions would suggest that the crash occurred when there was reduced visibility. Reducing the **twenty-seven** crashes by these **five** crashes results in a total of **twenty-two** crashes remaining during "Daylight." As the majority of the crashes still occurred during "Daylight," lighting does **not** seem to be an issue at the intersection.

The researchers also considered whether the "Daylight" crashes occurred during peak periods. (Note: We anticipated that "Daylight" crashes should be reported less frequently during the 12-6 AM and 6 PM to 12 AM time periods, as the sun may have set or may not have risen.) Crashes were grouped into non-peak and peak-periods: 12 AM-6 AM, 6 AM-9 AM (AM PEAK), 9 AM-3 PM, 3 PM-6 PM (PM PEAK), 6 PM-12 AM. Table 24 shows the number of crashes within these groups.

Table 24: The Parkway & Tulane Drive, "Daylight" Crash Counts and Rates by Time Periods

Time Period		Number of Crashes	Crashes/Hour
12 AM-6 AM	pre-AM PEAK	0	0
6 AM-9 AM	AM PEAK	8	**2.7**
9 AM-3 PM	mid-day	8	1.3
3 PM-6 PM	PM PEAK	7	2.3
6 PM-12 AM	post-PM PEAK	4	0.7
TOTAL "Daylight" Crashes		27	-

"Daylight" crashes were most likely to occur during the AM PEAK and least likely to occur from 12 AM to 6 AM (pre-AM PEAK).

With regard to weather, more than three quarters of the crashes (**twenty-five**) occurred during "Clear" periods (Figure 49).

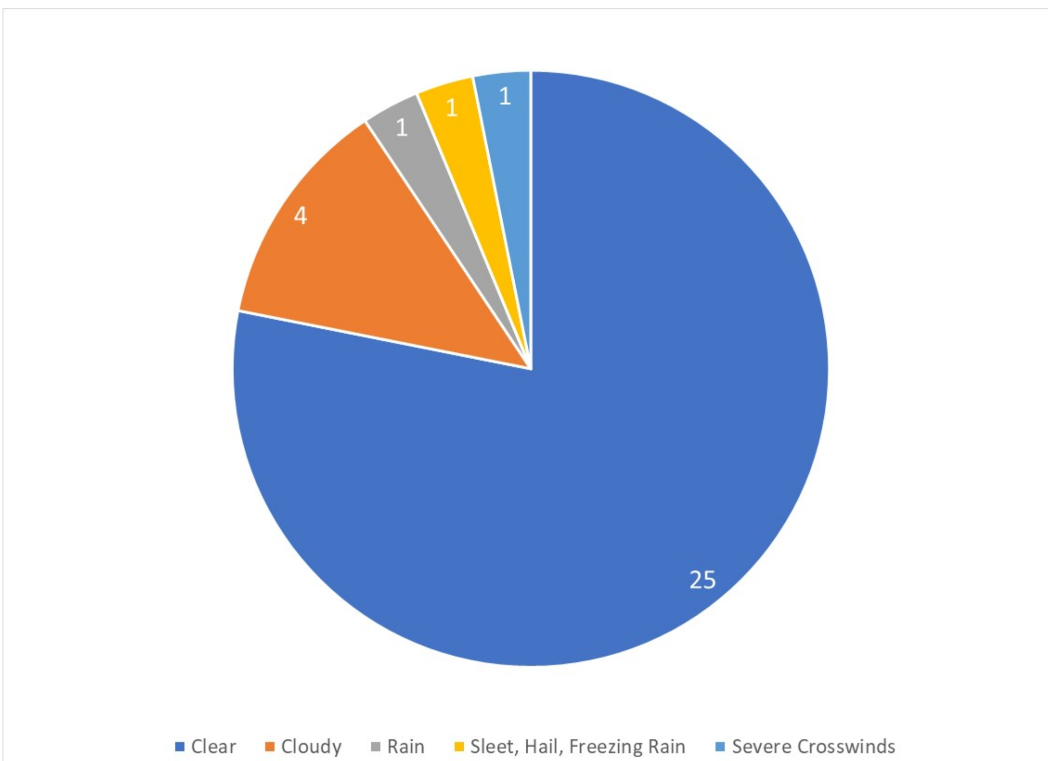

Figure 49: The Parkway & Tulane Drive, Weather

The majority of the crashes (**twenty-nine**) occurred when surface conditions were "Dry," which suggests that surface condition is unlikely to be an issue (Figure 50).

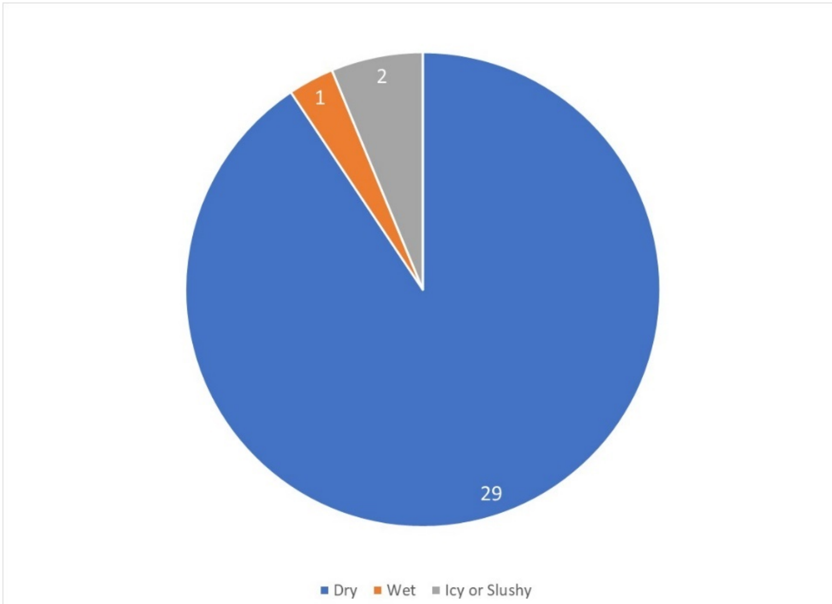

Figure 50: The Parkway & Tulane Drive, Surface Condition

3.3.3 Factors Contributing to Crashes

This section discusses the vehicle collision type, the indicated primary cause of the crash, and whether the collision was between vehicles or with an object.

One category of the tabular data provided information about the vehicle collision type. "Not Applicable" was the most common crash type (**fourteen**) (Figure 51).

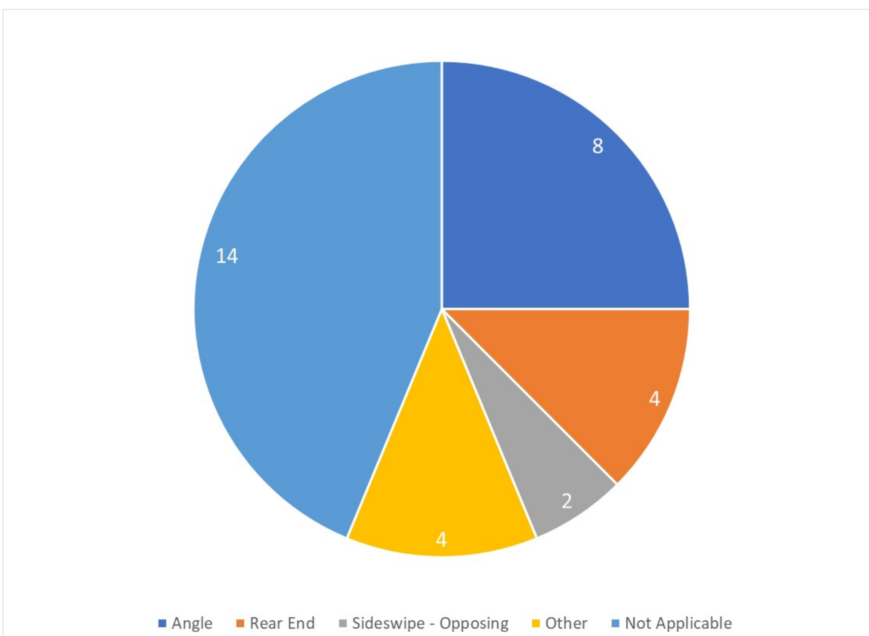

Figure 51: The Parkway & Tulane Drive, Crash Type

In the crash report, there is an option to include data in the "collision with?" column. The crashes were identified as having occurred with a tree/shrub (5), animal (3), motor vehicle (2), rock/stone wall (2), guardrail/barrier (1) and a barricade (1). It is unclear why no crash type was identified for a crash that seemed to imply that two motor vehicles were involved (e.g. "motor vehicle" was the "Not Applicable"). In the 2018-2019 crash data, where additional information was available, there was at least one instance where a vehicle reportedly crashed into a parked maintenance vehicle; this could potentially be a similar situation.

The most reported "Primary Cause" was "Failed to Yield ROW" (Figure 52), which was reported in **7 of the 32 crashes (22%)**. (Note: Figure 52 only shows **23 of the 32 crashes** that occurred at the intersection, as **9** crashes provided no information on the "Primary Cause.")

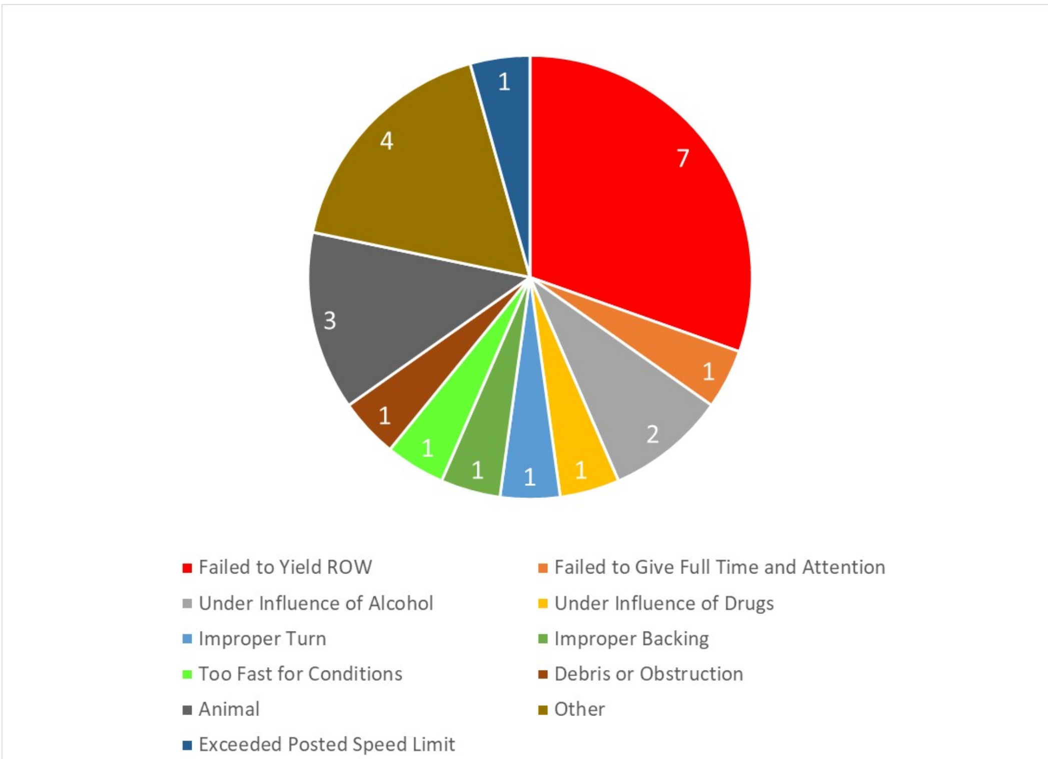

Figure 52: The Parkway & Tulane Drive, Primary Cause

3.3.4 Driving Under the Influence

This section discusses crashes that were identified as involving drugs or alcohol. As noted in the "Primary Cause" section, of the **thirty-two** crashes identified at the intersection, from 2005-2015 and 2018-2019, **three** crashes, or **9.4%** of all crashes at the intersection were identified as having a driver that was under the influence of drugs or alcohol. This seems exceptionally high, and a further investigation into what is causing the high rate of driving under the influence crashes could be conducted.

3.3.5 Hit & Run

This section discusses crashes identified as a hit and run. Interestingly, **one** of the **thirty-two** crashes (**3.1%**), was identified as a hit-and-run crash. There are many reasons why a driver may hit an object or other vehicle and leave the scene of the crash, potentially including operating a vehicle while under the influence or being an uninsured driver.

3.3.6 Crash Severity

This section identifies the number of PDO, INJ, and FAT crashes. **Twelve** of the crashes at Tulane Drive were INJ crashes (Figure 53).

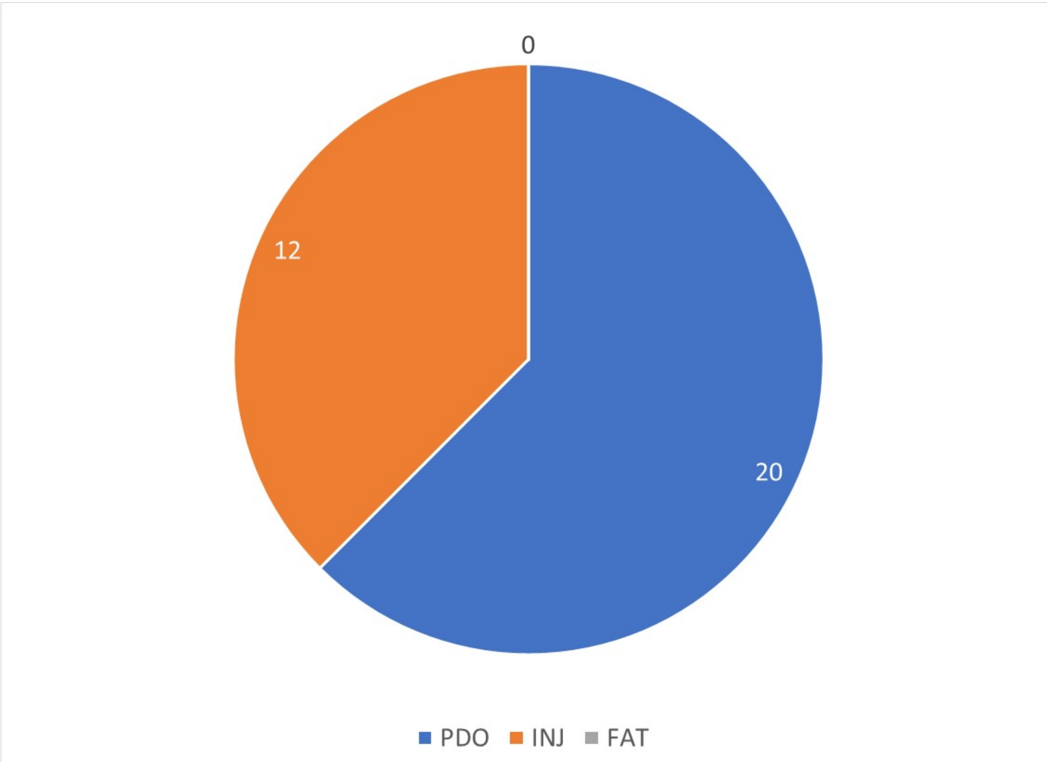

Figure 53: The Parkway & Tulane Drive, Crash Severity

Across the injury crashes, there were a total of **sixteen** injuries. The occurrence of the injury crashes by month, day of week, and time of day was investigated.

October; Fridays and Sundays; and 3 PM-4 PM seem to have a higher probably of injury crashes; however, since the difference between the peak month, day and time of day is only one when compared with the vast majority of other months, days of week, and times of day, another crash at the intersection could change the month and day on which injury crashes most frequently occur as shown in Figure 54, Figure 55, and Figure 56 over the next two pages. Yet, considering that October, Fridays, and 3 PM-4 PM also had the highest crash counts, this month, day of week, and time of day likely has contributing factors that could be investigated, with the understanding that additional crashes could change these recommendations. This is an inherent drawback with datasets that have a small number of crashes.

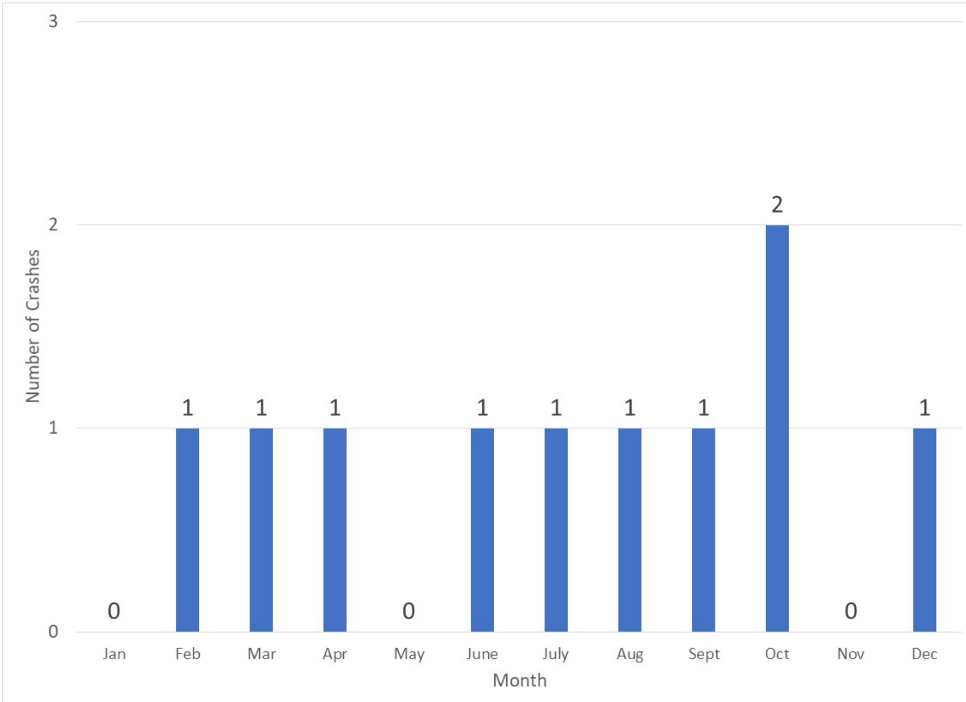

Figure 54: The Parkway & Tulane Drive, Injury and Fatal Crashes by Month

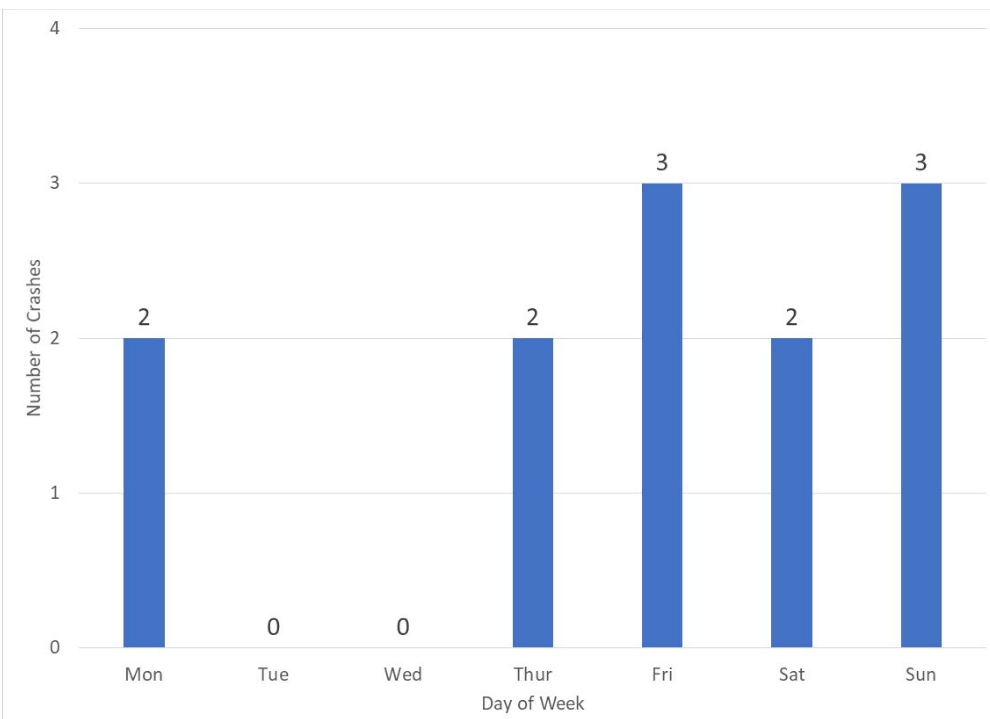

Figure 55: The Parkway & Tulane Drive, Injury Crashes by Day of the Week

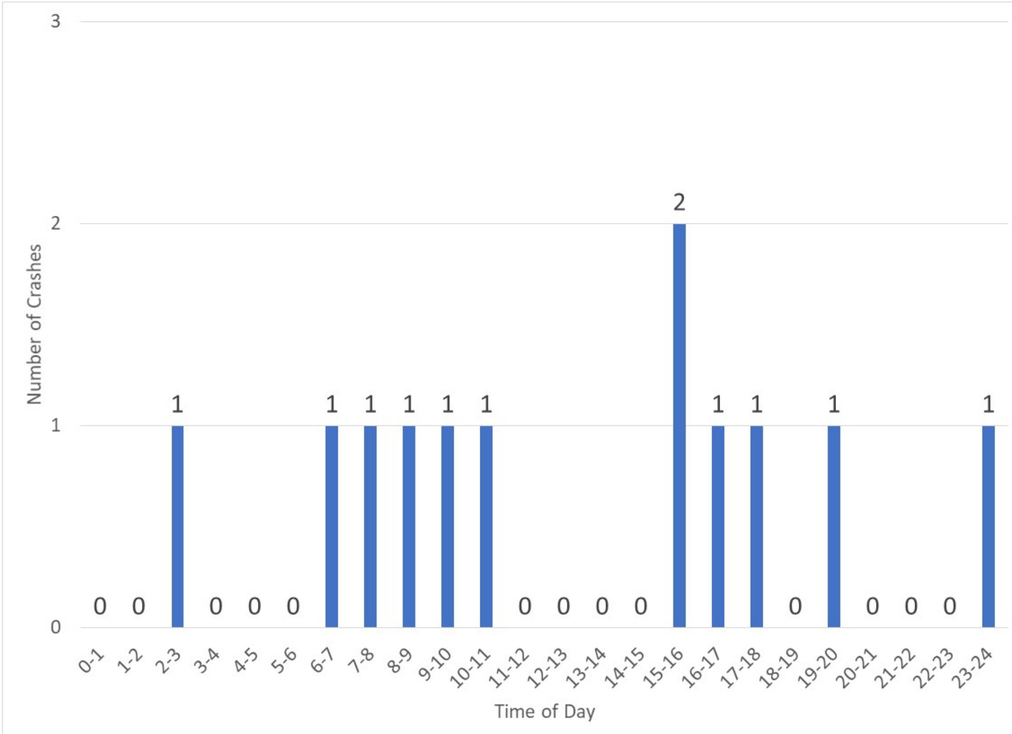

Figure 56: The Parkway & Tulane Drive, Injury Crashes by Time of Day

3.3.7 Pedestrians & Bicycle

No crashes between bicycles and pedestrians and a motor vehicle were reported at this intersection.

3.3.8 Crash Diagram

The following crash diagram shows the location of crashes at the intersection for which enough information was available to place them on the map. If crash type, direction of vehicle, and other factors were provided, they were mapped. Otherwise, after the figure is a note regarding why a crash could not be mapped. Crash reports were not available. Therefore, the diagram was created based on the pre-crash direction of the vehicle, and the stated crash type. As a separate file was provided for vehicle and persons for the more recent data (2018-2019), these crashes may be more accurate. However, complete data was not always provided. As such, there may be some variability between the actual crash and what is conveyed in the diagram. Figure 57 is **the best understanding of the crash occurrence at the intersection based on available information**.

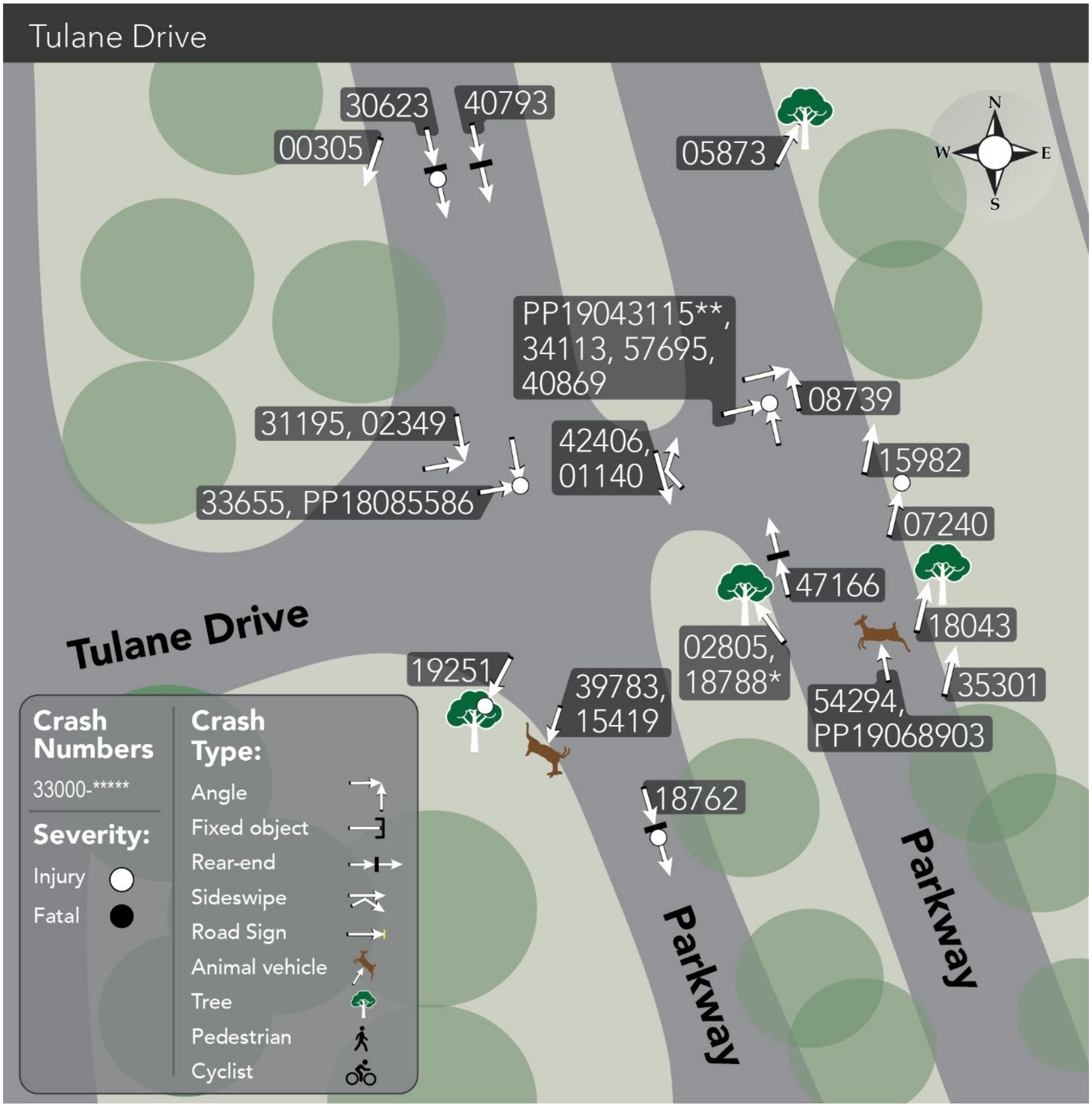

Figure 57: The Parkway and Tulane Drive, Crash Diagram

*Location was not specific; however, the crash indicated that it was with a tree, PDO.

**Information for this crash suggested that it involved a commercial bus and at least three vehicles.

The following are additional crashes that occurred at Tulane Drive, which could not be placed on the crash diagram:

- 140101456 – no information, PDO
- 3300025915 – no information on direction or type of crash, PDO
- 3300039422 – southbound direction, but no information on crash type, PDO

- 3300044036 – southbound direction, south of Tulane Drive, but no information on crash type, INJ

Several crashes with animals appear to be occurring on the southern part of the intersection; while more information is needed, alternatives could be considered that would help with reducing animal/vehicle crashes. While the animal crashes are depicted as a deer for the diagram, it is unclear if the animal crashes are in fact with deer or some other animal. Keeping vehicles within the roadway may be a problem that is contributing to the number of collisions with a fixed object (e.g. tree/shrub). There are several rear-end crashes, which may suggest that a vehicle entered from Tulane Drive and did not accelerate fast enough. It may also suggest that a vehicle was slowing down to access Tulane Drive and was rear-ended by someone traveling in close proximity to the leading vehicle and/or that the driver did not anticipate the lead vehicle slowing down.

3.3.9 Summary – Tulane Drive

Based on crash data from 2005-2015 and 2018-2019, the largest number of crashes occurred in 2007; June, September, and October; between 3 PM-4 PM and 7 PM-8 PM; and on Friday (Table 25). The most concerning statistic about this intersection is the large number (and percentage) of crashes that involved driving under the influence.

Table 25: The Parkway & Tulane Drive, Summary of Key Data Findings

Criteria	Count
Number of Crashes	32
Year (of greatest frequency)	2007
Month (of greatest frequency)	June, September, & October
Day (of greatest frequency)	Friday
Percent from 12 AM to 12 PM	44%
Most Frequent 1 Hour Block	3 PM-4 PM; 7 PM-8 PM
Most Frequent Time Period (pre-AM PEAK; AM PEAK; mid-day; PM PEAK; post-PM PEAK)	AM Peak
Might lighting be an issue?	No
Is weather a contributing factor?	No
Might the surface condition be a factor?	No
Most Typical Crash Type	Not Applicable
Most Typical Reported Cause	Failed to Yield ROW (7 of 32)
Driving Under the Influence	**9.4% of crashes** (3 of 32)
Hit & Run	3.1% of crashes (1 of 32)
Percent of Injury & Fatal Crashes (measure of severity)	38% (12 of 32)
Total Number of People Injured in Crashes	16 people
Pedestrian/Bicycle Involved Crashes?	No
Animal Involved Crashes?	Yes; 9.4% (3 of 32)

3.4 The Parkway & Morningside Lane

The Parkway and Morningside Lane is a three-legged intersection, with a horizontal and vertical curve along Morningside Lane (Figure 58).

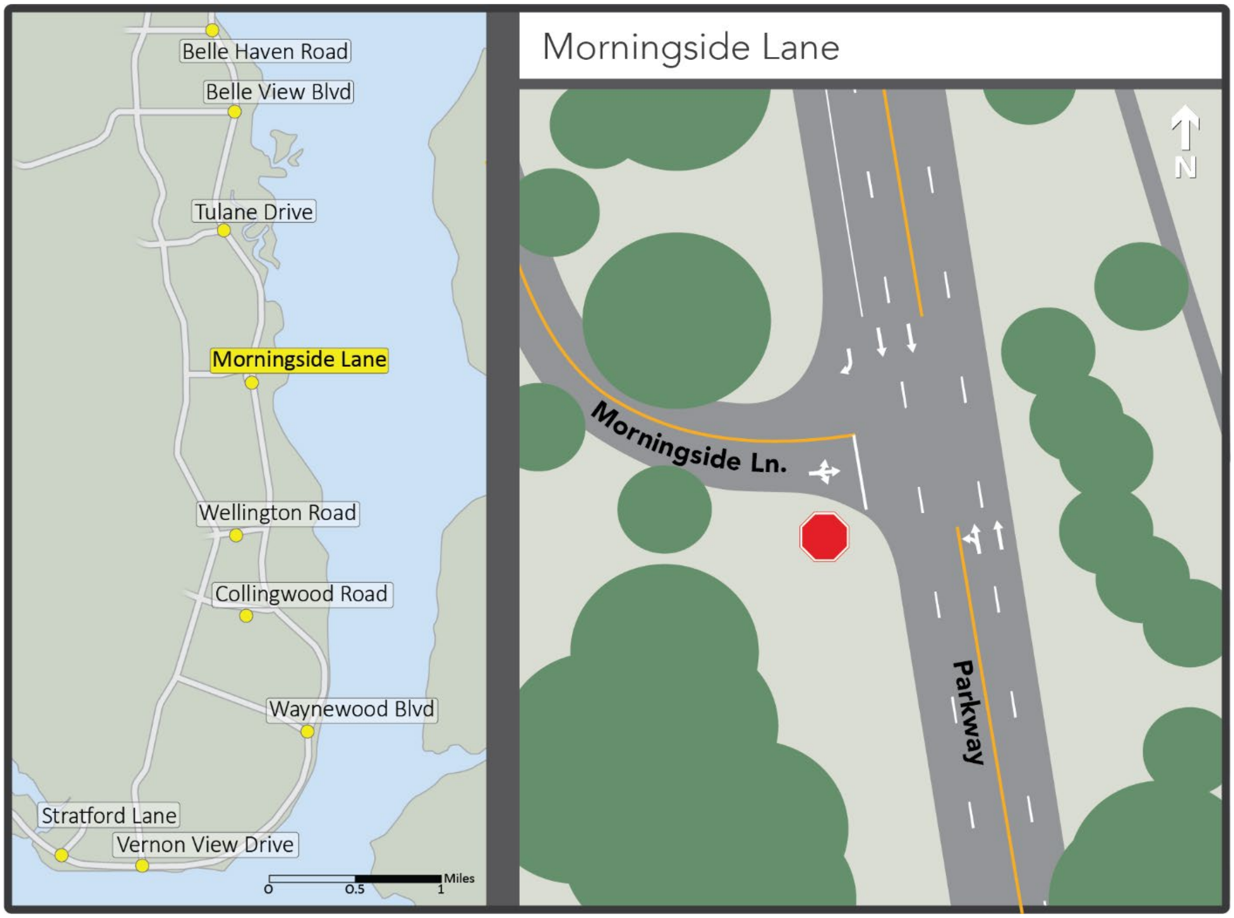

Figure 58: The Parkway & Morningside Lane

Morningside Lane is stop-controlled. Morningside Lane itself seems to be slightly down-sloped (Figure 59); there is a right-turn lane in the southbound direction on the Parkway turning onto Morningside Lane (Figure 60).

Figure 59: The Parkway & Morningside Lane, Looking north

Figure 60: The Parkway & Morningside Lane, looking south

From 2005-2015 and 2018-2019, a total of **seventy-three** crashes were identified at the intersection of the Parkway and Morningside Lane. Generally speaking, the annual occurrence of crashes appears random, although **2009** had the greatest number of crashes reported (Figure 61). 2015 did not have any reported crashes at this intersection.

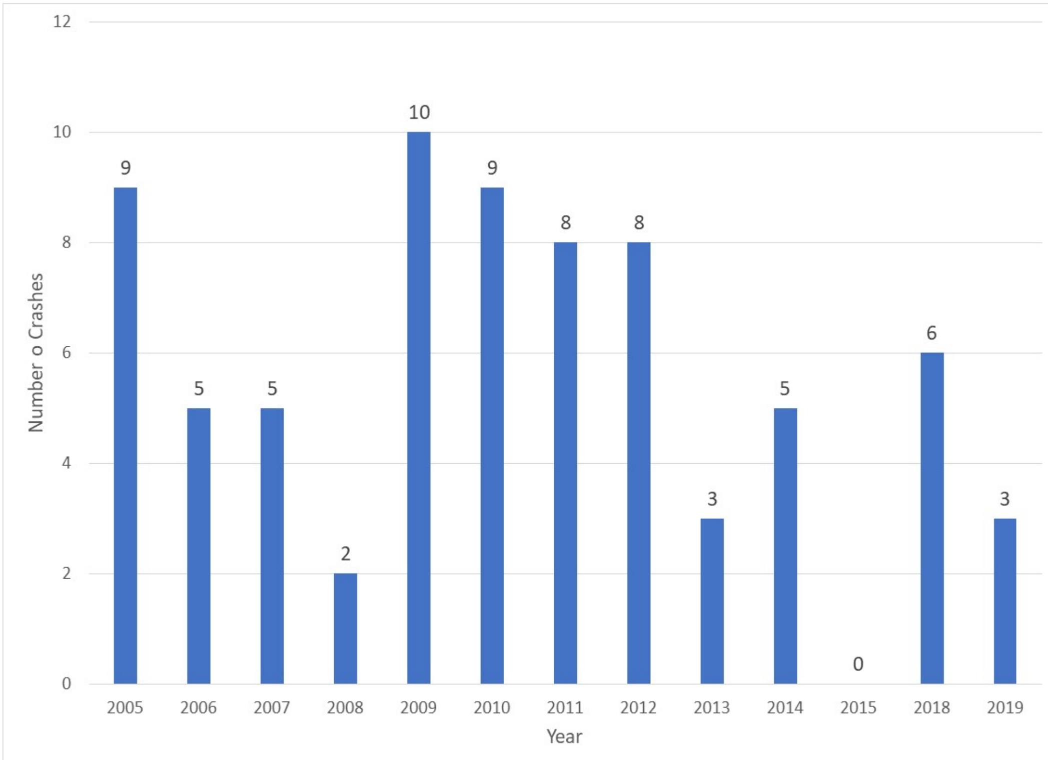

Figure 61: The Parkway & Morningside Lane, Total Crashes by Year

Based on available historical images from the intersection for 2007, 2014 and 2015 (see Appendix F: Traffic Safety), it does not appear that any significant geometric changes were made, although it does appear that supplementary signage (e.g. a sign beneath the stop sign) was present in 2014 that is no longer present in 2019. The information on the sign appears to be restricting people from accessing the Parkway during certain time periods.

3.4.1 Temporal

This section discusses patterns identified by month, time, and day of the week.

Based on data from the available years (2005-2015, 2018-2019), crashes occurred most frequently in **April** (Figure 62).

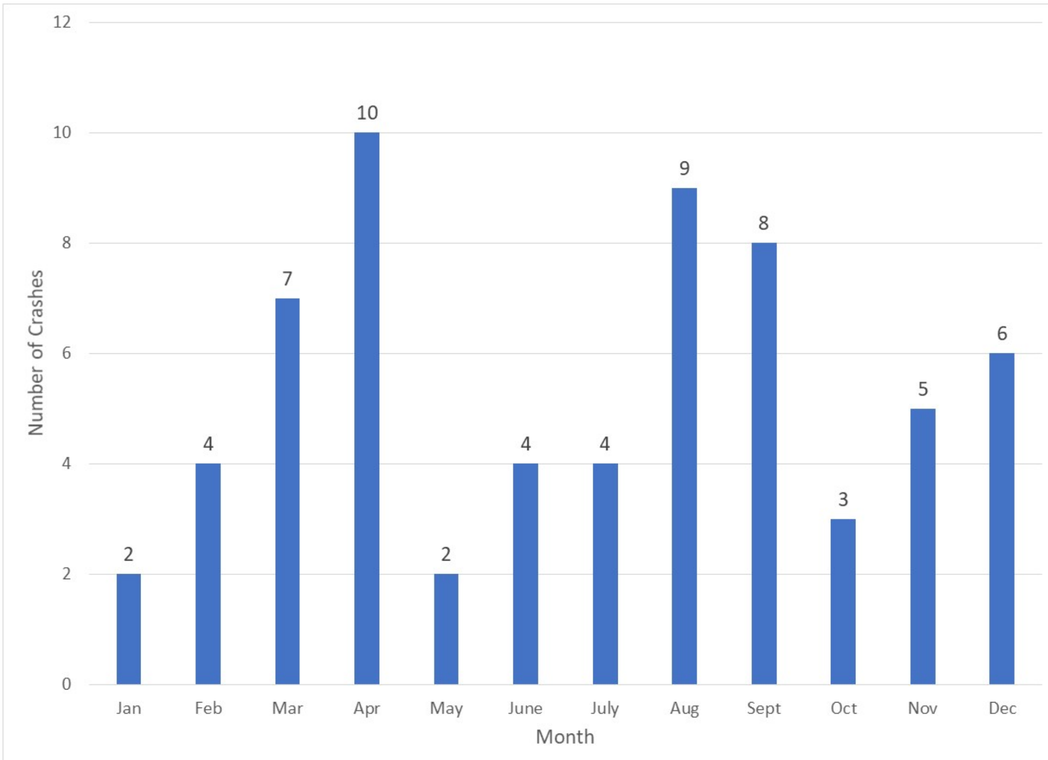

Figure 62: The Parkway & Morningside Lane, Crashes by Month

The WTI Team separated crashes into an AM period (12 AM to 12 PM) and a PM period (12 PM to 12 AM) to investigate if crashes occurred more often in the AM or PM. **Forty** percent of all crashes occurred in the AM period.

Assigning each crash to a one-hour time period across the entire day, the most frequent number of crashes occurred from **8 AM-9 AM** (Figure 63).

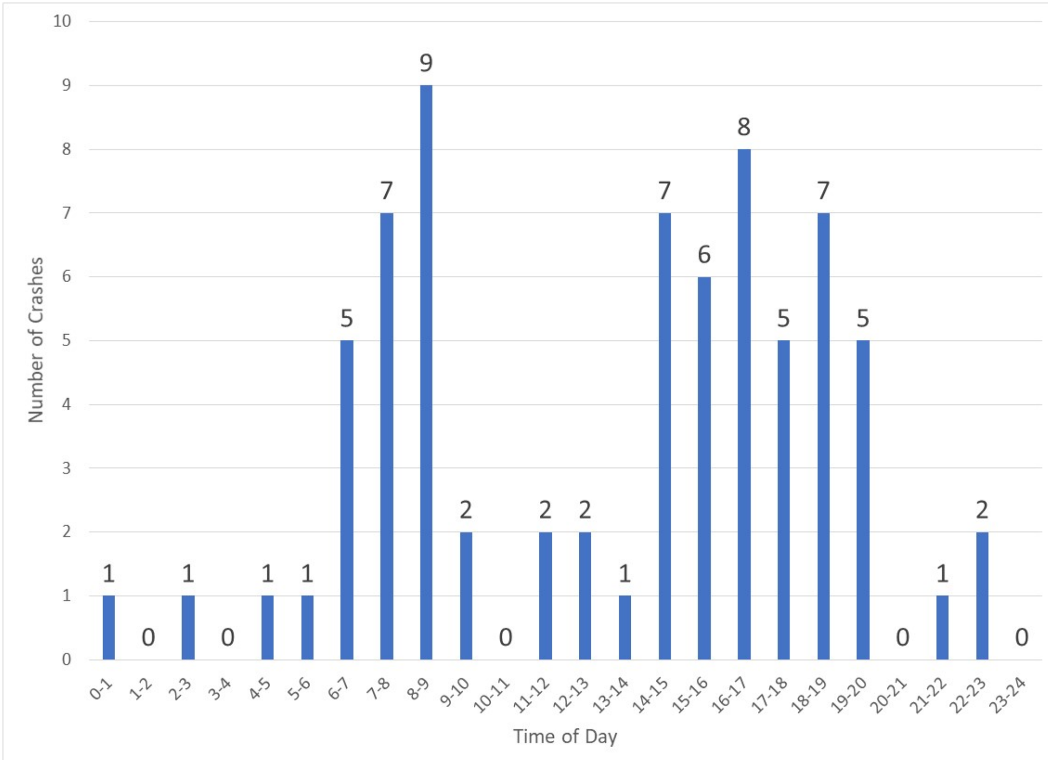

Figure 63: The Parkway & Morningside Lane, Crashes by Time of Day

In addition, there seems to be a peak in the number of crashes from 6 AM-9 AM and 2 PM-7 PM, which are roughly equivalent to the AM and PM PEAK time periods.

The WTI Team binned the crashes into pre-AM PEAK, AM PEAK, mid-day, PM PEAK, and post-PM PEAK crash time periods. Considering the frequency of crashes per hour, the largest number and highest rate of crashes occurred during the **AM PEAK** time period (Table 26).

Table 26: The Parkway & Morningside Lane, Crash Counts & Rate by Time Period

Time Period		Number of Crashes	Crashes/Hour
12 AM-6 AM	pre-AM PEAK	4	0.7
6 AM-9 AM	AM PEAK	**21**	**7.0**
9 AM-3 PM	mid-day	14	2.3
3 PM-6 PM	PM PEAK	19	6.3
6 PM-12 AM	post-PM PEAK	15	2.5
TOTAL		64	-

The day of the week most represented in the crash records is **Friday** (Figure 64).

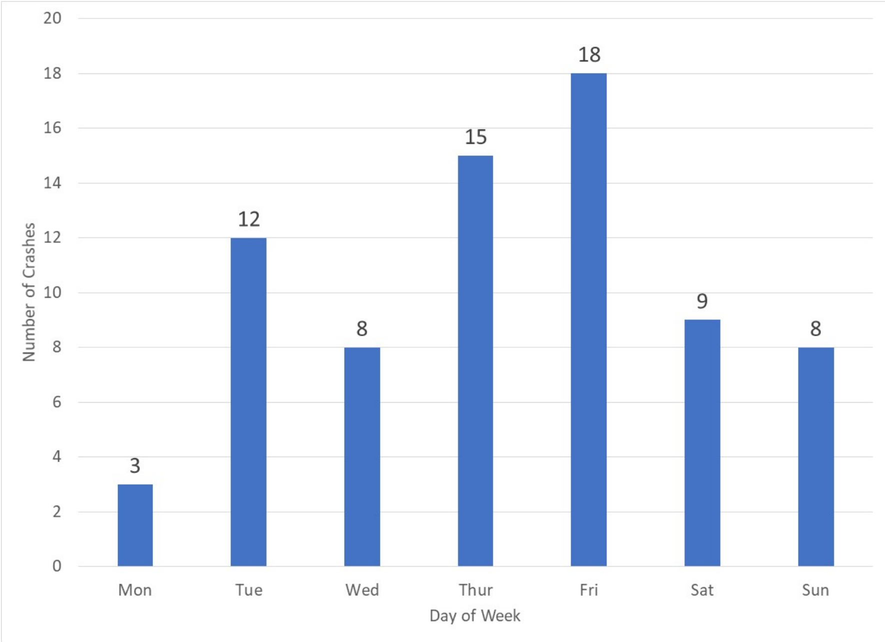

Figure 64: The Parkway & Morningside Lane, Crashes by Day of the Week

The results suggest the possibility of contributing factors occurring on Friday that are increasing the number of crashes.

3.4.2 Environment

This section discusses how lighting, weather, and the road surface may have influenced crash occurrence. The WTI Team analyzed the lighting condition identified during a crash (Figure 65).

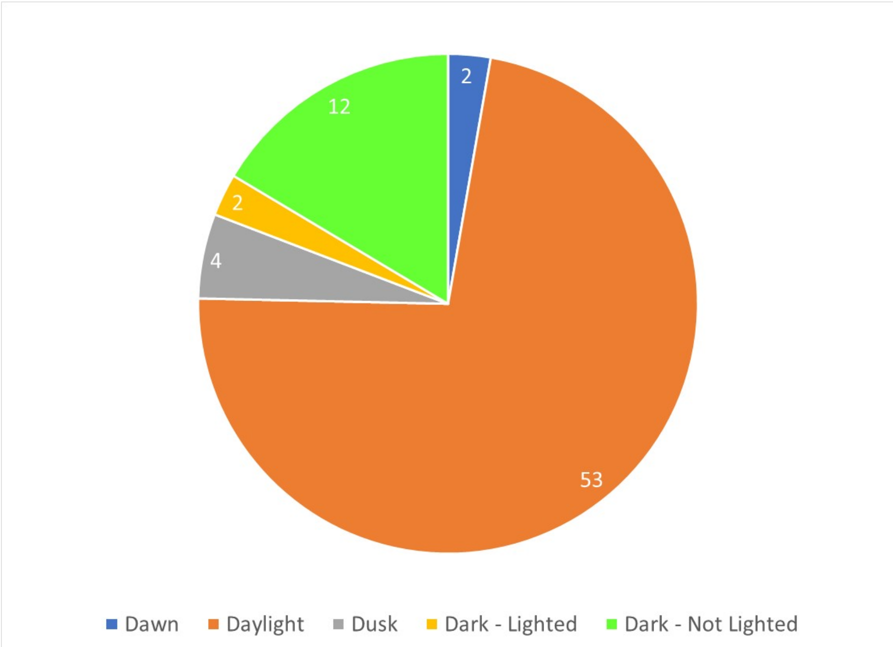

Figure 65: The Parkway & Morningside Lane, Lighting (number of crashes during each lighting condition)

Some of the data was inconsistent. **Twelve** crashes indicated that the intersection was "Dark – Not Lighted" with **two** indicating "Dark – Lighted." The Parkway does not have lighting on the roadway in the study section; therefore, "Dark – Lighted" must be an error.

Most crashes (**fifty-three**) were identified as having occurred during "Daylight." Looking at the data in more detail, of the crashes that occurred during "Daylight," **fifteen** of these crashes were during periods when conditions were indicated as: 1) Cloudy, 2) Fog, Smog, Smoke, 3) Rain, or 4) Snow. These conditions suggest that the crash occurred when there was reduced visibility. Reducing the **fifty-three** crashes by these **fifteen** crashes results in a total of **thirty-eight** crashes remaining during "Daylight." Therefore, approximately half of the crashes occurred during hours when visibility was good, while the other half occurred during periods when it was not. This suggests that lighting may be an issue.

The researchers also considered whether the "Daylight" crashes occurred during peak periods. (Note: We anticipated that "Daylight" crashes should be reported less frequently during the 12 AM-6 AM and 6 PM-12 AM time periods, as the sun may have set or may not have risen.) Crashes were grouped into non-peak and peak-periods: 12 AM-6 AM, 6 AM-9 AM (AM PEAK), 9 AM-3 PM, 3 PM-6 PM (PM PEAK), 6 PM-12 AM. Table 27 shows the number of crashes within these groups.

Table 27: The Parkway & Morningside Lane, "Daylight" Crash Counts and Rates by Time Periods

Time Period		Number of Crashes	Crashes/Hour
12 AM-6 AM	pre-AM PEAK	0	0
6 AM-9 AM	AM PEAK	16	5.3
9 AM-3 PM	mid-day	14	2.3
3 PM-6 PM	PM PEAK	**18**	**6.0**
6 PM-12 AM	post-PM PEAK	5	0.8
TOTAL "Daylight" Crashes		53	-

"Daylight" crashes were most likely to occur during the PM PEAK and least likely to occur from 12 AM to 6 AM (pre-AM PEAK).

With regard to weather, the majority of the crashes (**fifty-two**) occurred during "Clear" periods (Figure 66).

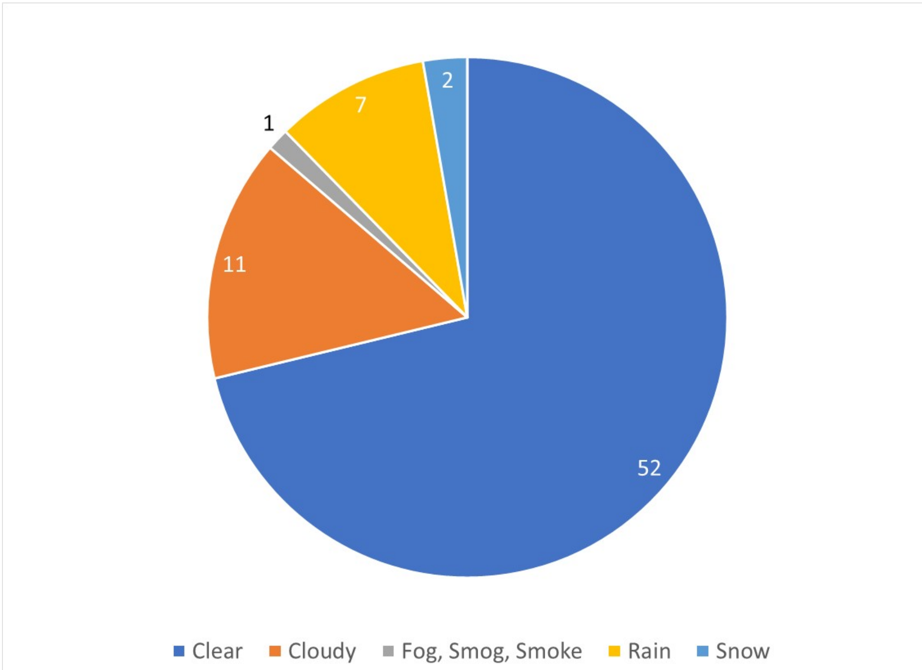

Figure 66: The Parkway & Morningside Lane, Weather

The majority of the crashes (**sixty-one**) occurred when surface conditions were "Dry," which suggests that surface condition is unlikely to be an issue (Figure 67).

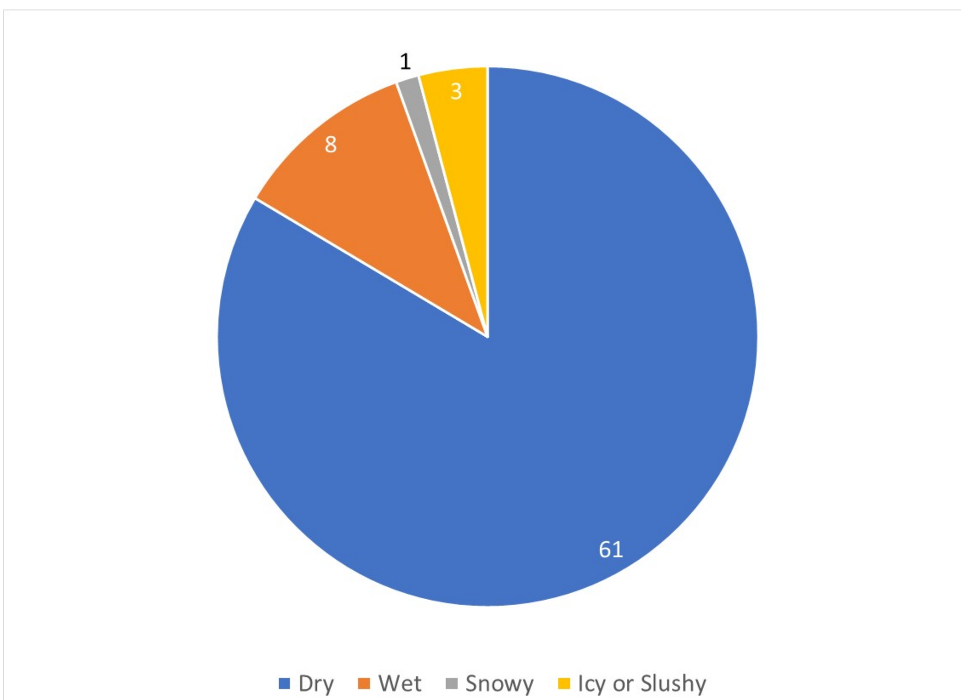

Figure 67: The Parkway & Morningside Lane, Surface Condition

3.4.3 Factors Contributing to Crashes

This section discusses the vehicle collision type, the indicated primary cause of the crash, and whether the collision was between vehicles or with an object.

One category of the tabular data provided information about the vehicle collision type. "Angle" was the most common crash type (**thirty-two**) (Figure 68).

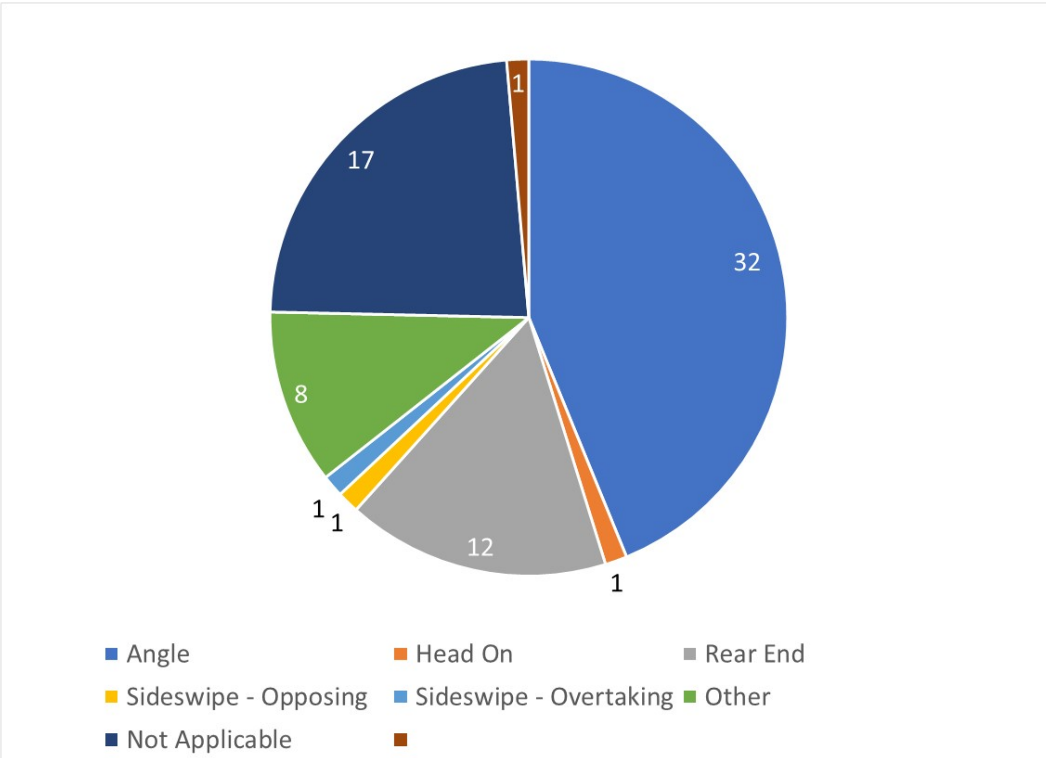

Figure 68: The Parkway & Morningside Lane, Crash Type

Seventeen crashes were identified as "Not Applicable." In the tabular data, there is an option to include data in the "collision with?" column. The crashes were identified as having occurred with a tree/shrub (6), sign (3), ditch (2), drainage structure (1), bridge structure (1), animal (1), motor vehicle (1), other fixed object (1), and non-collision (1). It is unclear why a collision that appears to be between two motor vehicles did not have a crash type identified with it. Similarly, it is unclear what is meant by a "non-collision."

By far, the most reported "Primary Cause" was "Failed to Yield ROW" (Figure 69), which was reported in **21 of the 73 crashes (29%)**. (Note: Figure 69 only shows **55 of the 73 crashes** that occurred at the intersection, as **18 crashes** provided no information on the "Primary Cause.")

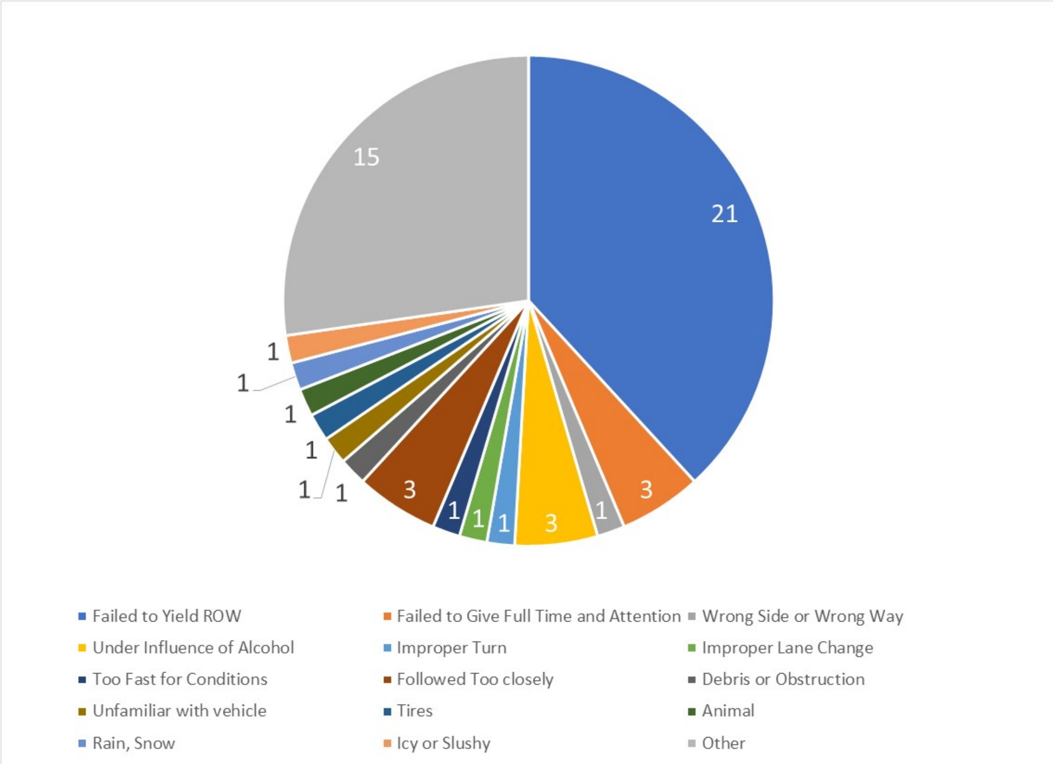

Figure 69: The Parkway & Morningside Lane, Primary Cause

3.4.4 Driving Under the Influence

This section discusses crashes that were identified as involving drugs or alcohol. As noted in the "Primary Cause" section, of the **seventy-three** crashes identified at the intersection, from 2005 through 2015, **three** crashes, or **4.1%** of all crashes were identified as having a driver that was under the influence of alcohol.

3.4.5 Hit & Run

This section discusses crashes identified as a hit and run. Interestingly, **two** of the **seventy-three** crashes, or **2.7%** were identified as hit-and-run crashes. There are many reasons why a driver may hit an object or other vehicle and leave the scene of the crash, potentially including operating a vehicle while under the influence or being an uninsured driver. Therefore, there is a potential that grouping these crashes with the previous category could suggest a greater concern that there are drivers passing through the intersection who are operating a vehicle under the influence.

3.4.6 Crash Severity

This section identifies the number of PDO, INJ, and FAT crashes. The majority of crashes (**forty**) that are occurring at the intersection are PDO crashes (Figure 70). (Note: Three of the crashes from 2018-2019 did not provide a severity level.)

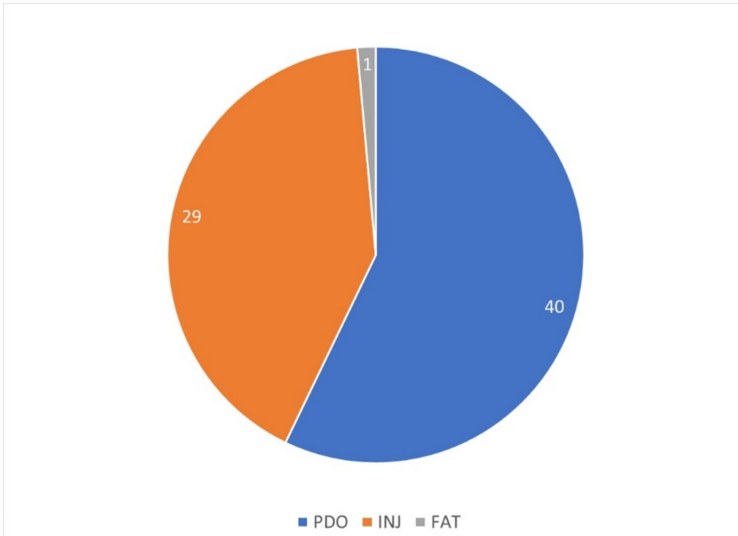

Figure 70: The Parkway & Morningside Lane, Crash Severity

Almost half of the crashes occurring at the intersection resulted in injuries or a fatality.

There was a total of **forty** injuries and **one** fatality that occurred at the intersection.

In Figure 71, Figure 72, and Figure 73, blue represents injury crashes and orange represents the fatal crash. March, April, August and September have the largest count of injury crashes, although June, with comparably fewer injury crashes, also has the only fatal crash (Figure 71).

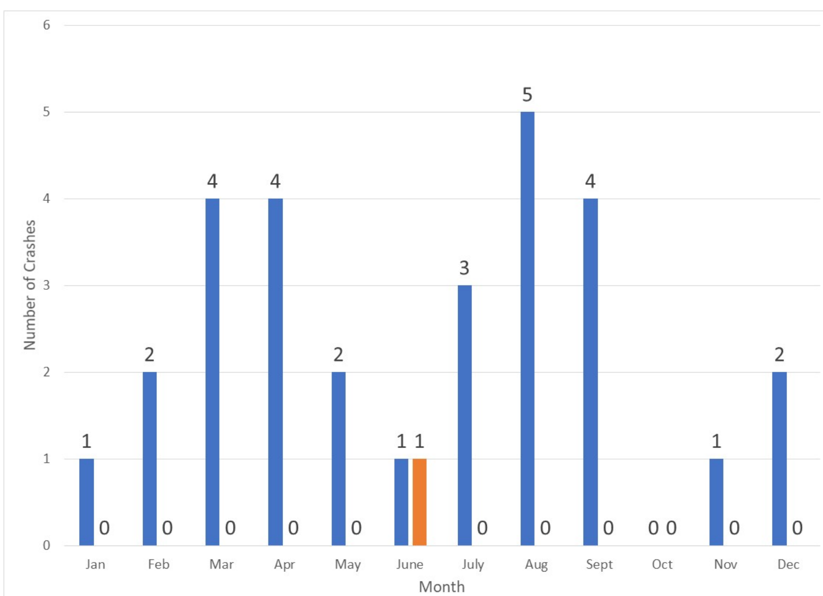

Figure 71: The Parkway & Morningside Lane, Injury and Fatal Crashes by Month

April had the greatest number of crashes and the second greatest (tied) number of injury crashes; August had the largest number of injury crashes.

There was an injury crash every day of the week; however, Tuesday had the largest number of injury crashes. Friday has almost as many injury crashes and also has the only fatal crash (Figure 72).

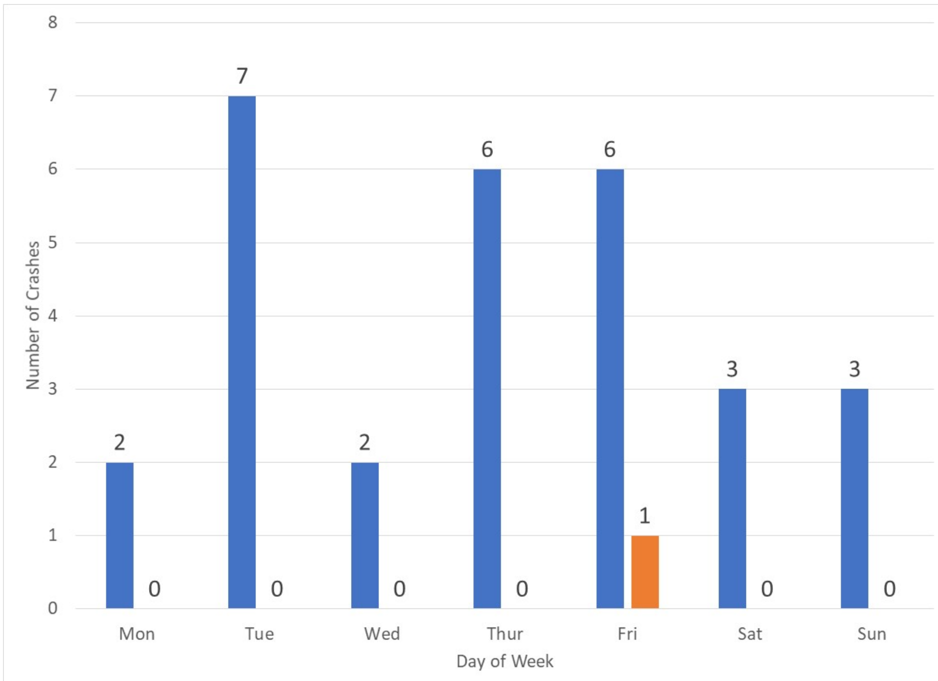

Figure 72: The Parkway & Morningside Lane, Injury and Fatal Crashes by Day of Week

While Friday had the largest number of crashes, it had the second largest number of injury crashes (tied with Thursday). However, Friday only had one less injury crash than Tuesday, which was the day of the week with the most injury crashes.

Overall, the AM and PM Peak time periods were associated with a greater occurrence of injury and fatal crashes, with 4 PM-5 PM having the greatest count (Figure 73).

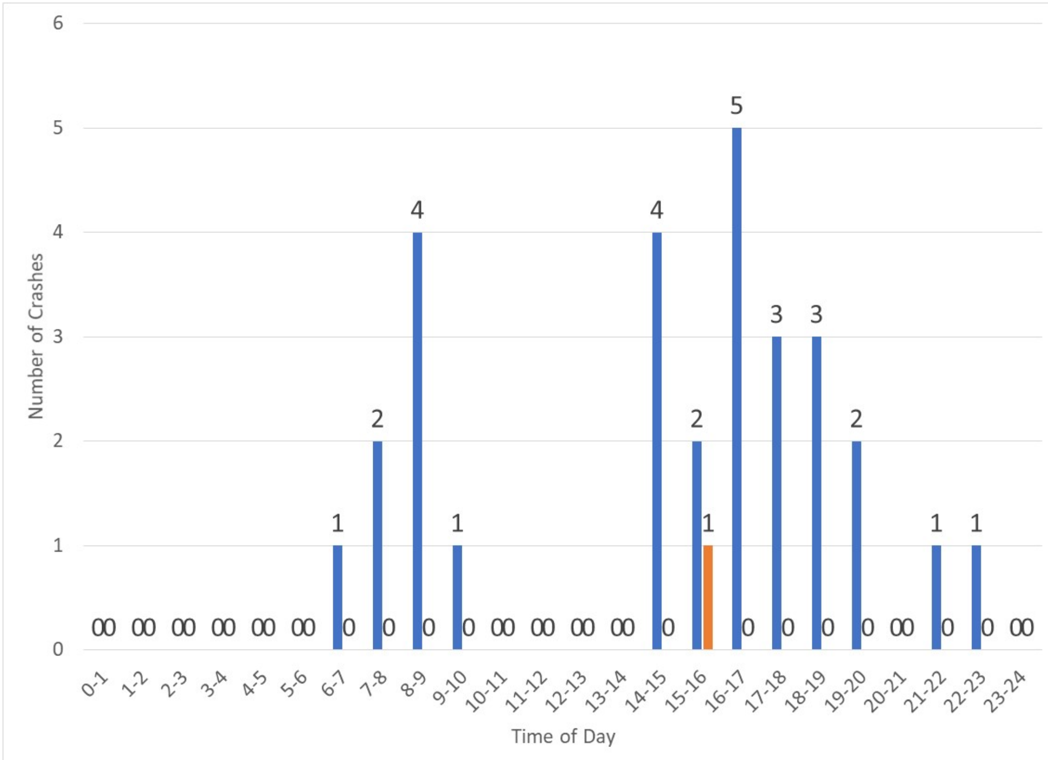

Figure 73: The Parkway & Morningside Lane, Injury and Fatal Crashes by Time of Day

The time period of 8 AM-9 AM had the largest number of crashes and the second largest number (tied with 2 PM-3 PM) of injury crashes.

Overall, there appears to be consistency between the months, days of week, and times of day with the greatest number of crashes to the greatest number of injury crashes.

3.4.7 Pedestrians & Bicycle

No crashes were identified as involving bicyclists or pedestrians. Therefore, it appears that the crashes were primarily between two motor vehicles or between a motor vehicle and a fixed object. There is no access between this intersection and the MVT to the east.

3.4.8 Crash Diagram

The following crash diagram shows the location of crashes at the intersection for which enough information was available to place them on the map. If crash type, direction of vehicle, and other factors were provided, they were mapped. Otherwise, after the figure is a note regarding why a crash could not be mapped. Crash reports were not available. Therefore, the diagram was created based on the pre-crash direction of the vehicle, and the stated crash type. As a separate file was provided for vehicle and persons for the more recent data (2018-2019), these crashes may be more accurate. However, complete data was not always provided. As such, there may be some variability between the actual crash and what is conveyed in the diagram. Figure 74 is **the best understanding of the crash occurrence at the intersection based on available information**.

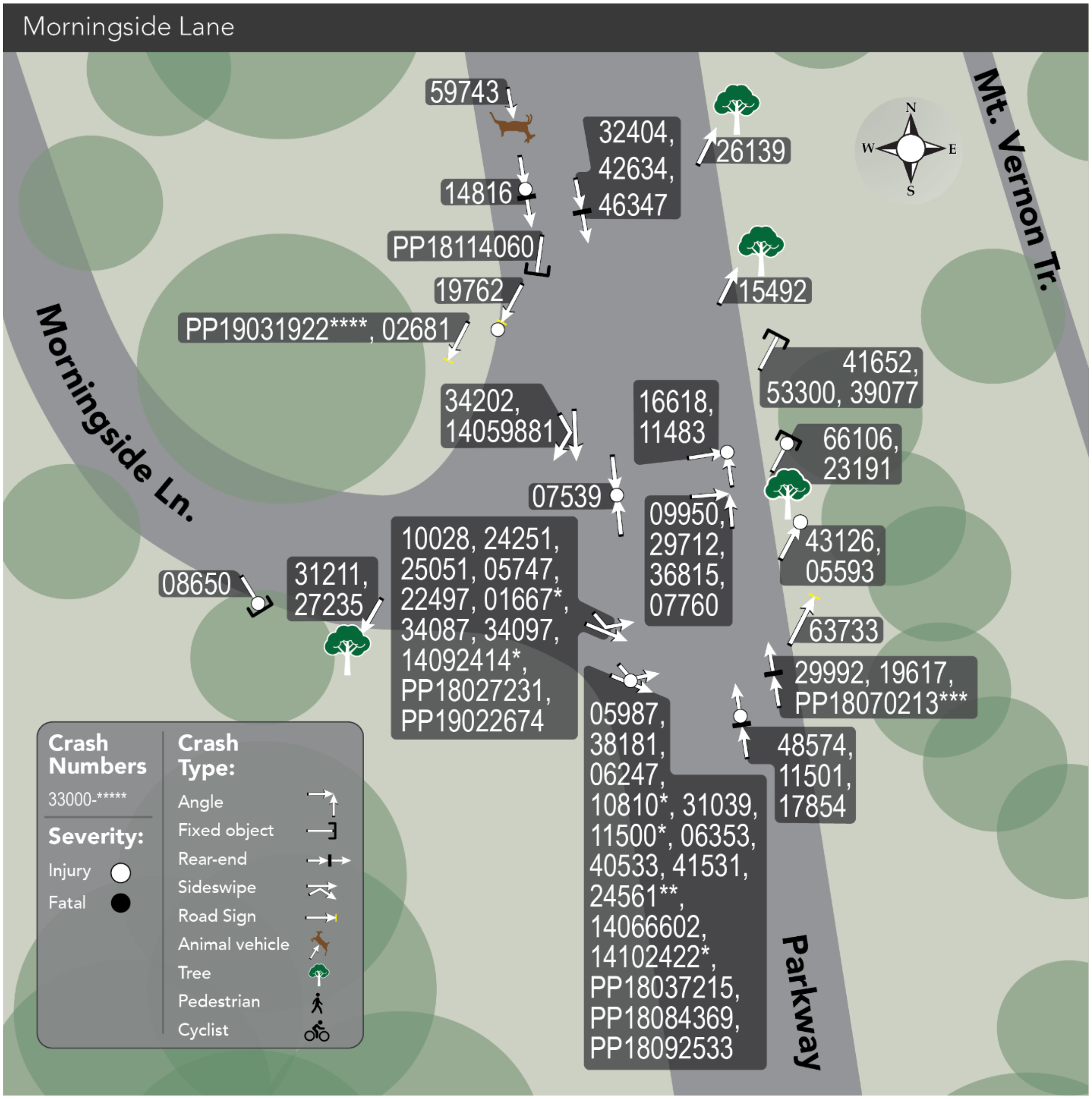

Figure 74: The Parkway & Morningside Lane, Crash Diagram

*The assumption was made that a vehicle involved in the crash was traveling southbound.

**This crash report says that a crash occurred both with a motor vehicle and tree/shrub. There is the possibility that the vehicles crashed and then the force took one or both vehicles into a tree/shrub.

***No severity was provided; it was assigned to PDO to show the crash on the diagram.

****Crash is indicated as single vehicle motorcycle crash in the southbound direction; no information regarding severity was provided.

The following are additional crashes that occurred at Morningside Lane, which could not be placed on the crash diagram:

- 14085848 – rear-end crash, injury crash; no direction information
- 3300030855 – southbound, injury crash, tire failure.
- 3300042920 – collision with another vehicle, PDO crash; other
- 3300006413 – collision with another vehicle, injury crash; other
- 3300035967 – collision with another vehicle, PDO crash; other
- 3300011633 – collision with another vehicle, PDO crash; other
- 3300042974 – collision with another vehicle, PDO crash; other
- 3300014203 – collision with another vehicle, PDO crash; "not applicable"
- 3300017069 – northbound, says it collided with another vehicle, fatal crash
- PP19042029 – southbound, it says it was between two vehicles; no information on severity; crash was identified as being an angle crash

While the animal crashes are depicted as a deer for the diagram, it is unclear if the animal crashes are in fact with deer or some other animal.

By far, it appears that the most common problem is the interaction between vehicles traveling southbound on the Parkway and vehicles entering the Parkway from Morningside Lane. It could be that the drivers on Morningside Lane erroneously assume that some of the southbound traffic is turning right or the speed that they are traveling at is faster than those entering from Morningside Lane are anticipating.

3.4.9 Summary – Morningside Lane

Based on crash data from 2005-2015 and 2018-2019, the largest number of crashes occurred in 2009; during the month of April; on Fridays; and most often between 8 AM-9 AM (Table 28).

In terms of crash types and contributing factors, pedestrians or bicyclists were not associated with crashes at the intersection. Low lighting at the intersection could potentially be a problem. There could also be a problem with drivers on Morningside Lane who assume that Parkway traffic heading southbound will turn right or move into the right turn lane but then back into the through lanes. Furthermore, while driving under the influence (DUI) crashes only accounted for about five percent of the *reported* crashes, the only fatality at the intersection was associated with a driver operating under the influence, so this factor may warrant further investigation.

Table 28: The Parkway & Morningside Lane, Summary of Key Data Findings

Criteria	Count
Number of Crashes	73
Year (of greatest frequency)	2009
Month (of greatest frequency)	April
Day (of greatest frequency)	Friday
Percent from 12 AM to 12 PM	40%
Most Frequent 1 Hour Block	8 AM-9 AM*
Most Frequent Time Period (pre-AM PEAK; AM PEAK; mid-day; PM PEAK; post-PM PEAK)	AM Peak
Might lighting be an issue?	Yes
Is weather a contributing factor?	No
Might the surface condition be a factor?	No
Most Typical Crash Type	Angle
Most Typical Reported Cause	Failed to Yield ROW (21 of 73)
Driving Under the Influence	4.1% of crashes (3 of 73)
Hit & Run	2.7% of crashes (2 of 73)
Percent of Injury & Fatal Crashes (measure of severity)	41% (30 of 73)
Total Number of People Injured in Crashes	41 people**
Pedestrian/Bicycle Involved Crashes?	No
Animal Involved Crashes?	Yes; 1.4% (1 of 73)

*While this is the time period with the greatest count, there seems to be a broader trend for a higher crash count during the AM PEAK and PM PEAK time periods.

**40 injured; 1 died

3.5 The Parkway & Wellington Road

Figure 75 shows the orientation of the Parkway and Wellington Road, a three-legged intersection.

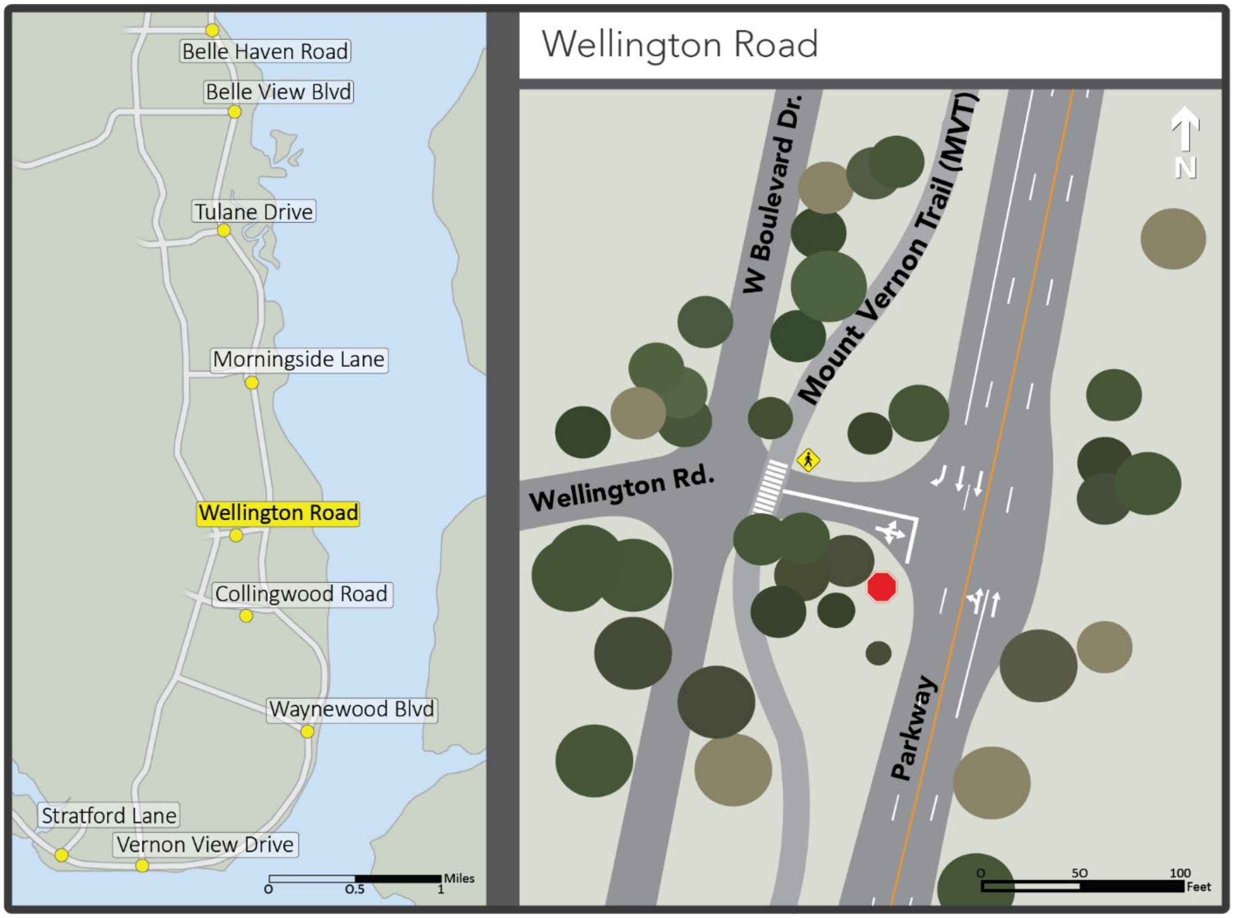

Figure 75:The Parkway & Wellington Road

Notice the close proximity between the Parkway and the parallel roadway (West Boulevard Drive) and to the MVT. There is no advance warning to motorists traveling southbound and turning right that the MVT is present. A pedestrian warning sign (W11-2 from the Manual on Uniform Traffic Control Devices (MUTCD) (USDOT/FHWA, 2017)) is just east of the crossing.

From 2005-2015 and 2018-2019, a total of **twenty-three** crashes were identified at the intersection of the Parkway and Wellington Road. Generally, there have been two crashes annually, although **2011** has the greatest number of crashes reported (Figure 76).

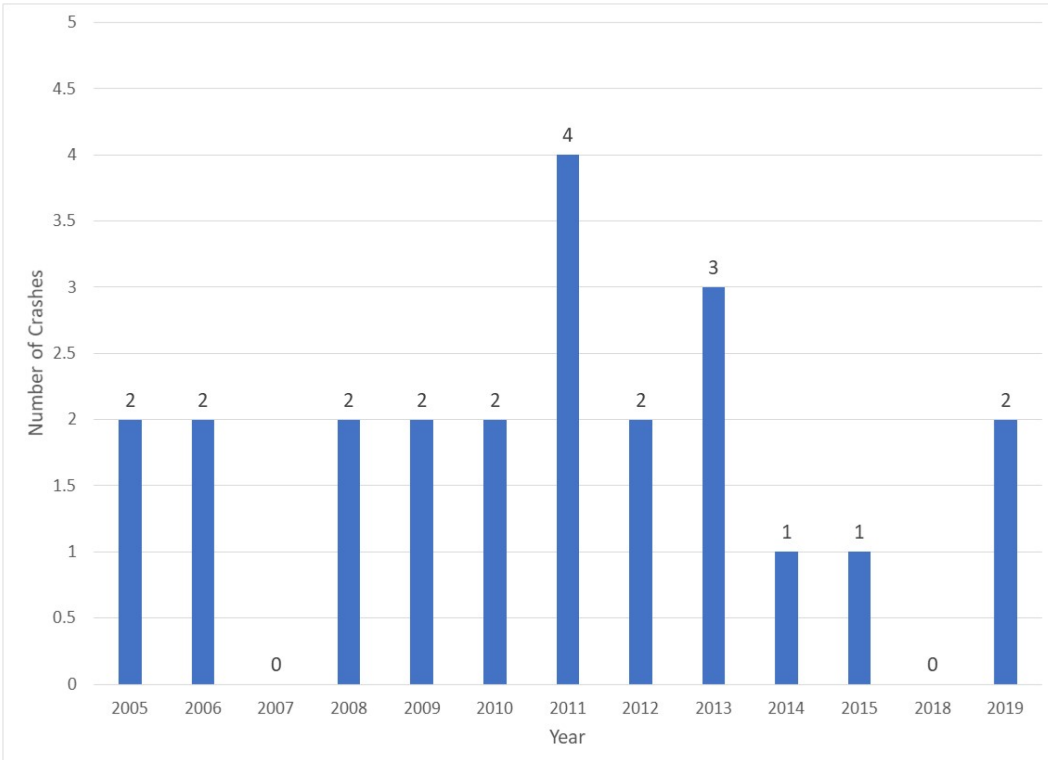

Figure 76: The Parkway & Wellington Road, Total Crashes by Year

3.5.1 Temporal

This section discusses patterns identified by month, time, and day of the week.

Based on data from the available years (2005-2015, 2018-2019), crashes occurred most frequently in **April** (Figure 77).

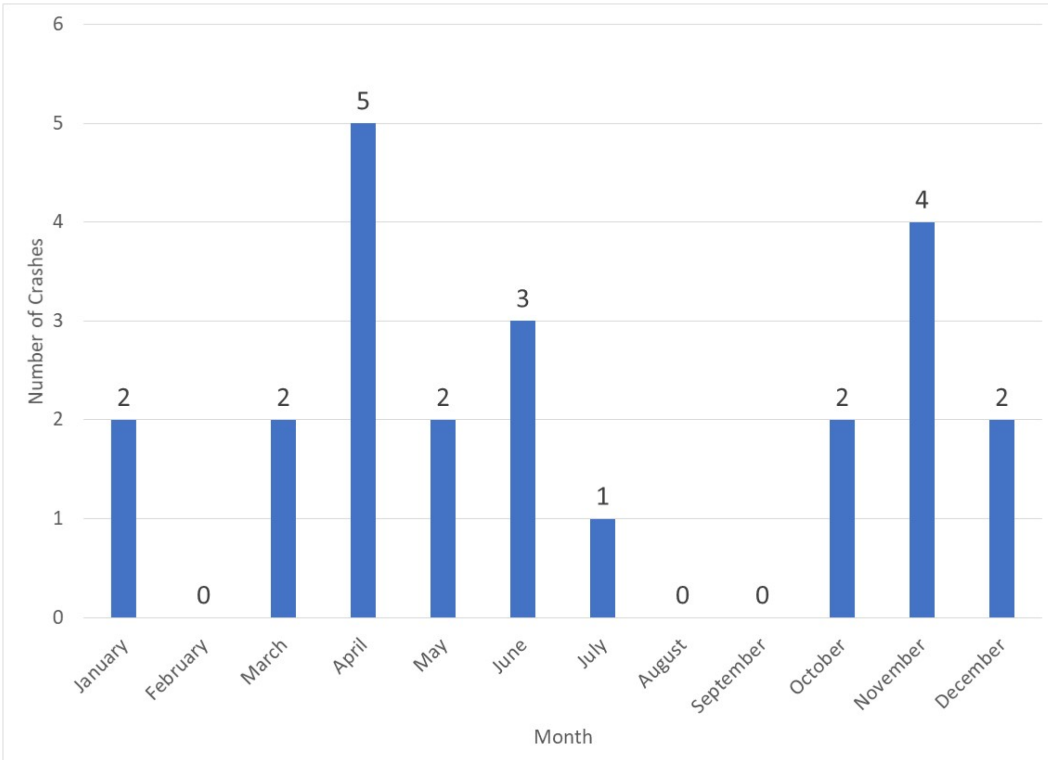

Figure 77: The Parkway & Wellington Road, Crashes by Month

The WTI Team separated crashes into an AM period (12 AM to 12 PM) and a PM period (12 PM to 12 AM) to investigate if crashes occurred more often in the AM or PM. **Twenty-six** percent of crashes occurred in the AM period.

Assigning each crash to a one-hour time period across the entire day, the most frequent number of crashes occurred from **4 PM-5 PM** (Figure 78).

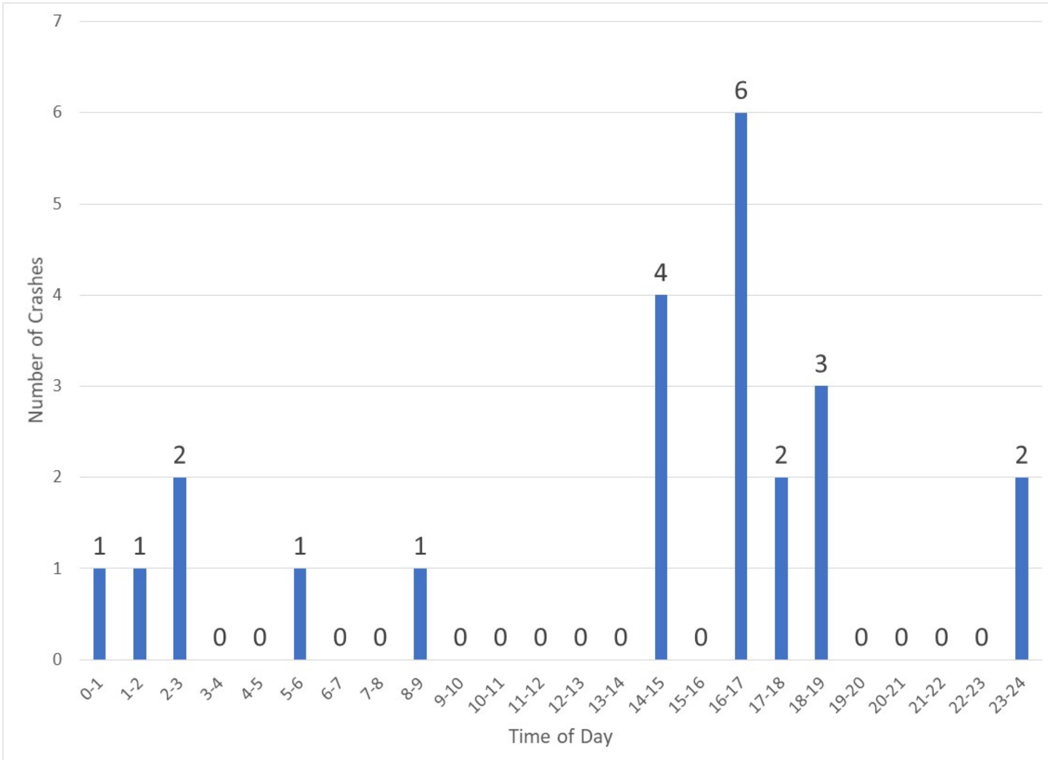

Figure 78: The Parkway & Wellington Road, Crashes by Time of Day

The WTI Team binned the crashes into pre-AM PEAK, AM PEAK, mid-day, PM PEAK, and post-PM PEAK crash time periods. Considering the frequency of crashes per hour, the largest number and highest rate of crashes occurred during the **PM PEAK** time period (Table 29).

Table 29: The Parkway & Wellington Road, Crash Counts & Rate by Time Period

Time Period		Number of Crashes	Crashes/Hour
12 AM-6 AM	pre-AM PEAK	5	0.8
6 AM-9 AM	AM PEAK	1	0.3
9 AM-3 PM	mid-day	4	0.7
3 PM-6 PM	PM PEAK	**8**	**2.7**
6 PM-12 AM	post-PM PEAK	5	0.8
TOTAL		23	-

The day of the week that is most represented in the crash records is **Friday** (2005-2015) (Figure 79).

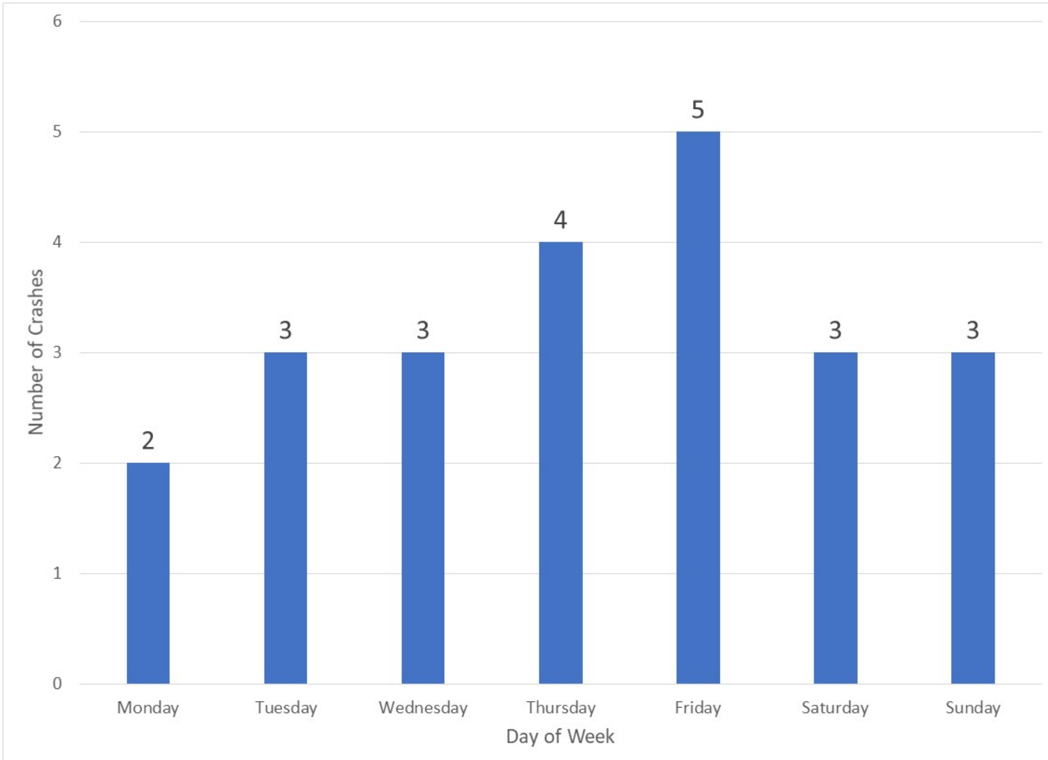

Figure 79: The Parkway & Wellington Road, Crashes by Day of Week

The results suggest the possibility of factors occurring on Friday that are contributing to crash occurrence.

3.5.2 Environment

This section discusses how lighting, weather, and the road surface may have influenced crash occurrence.

The WTI Team analyzed the lighting condition identified during a crash (Figure 80).

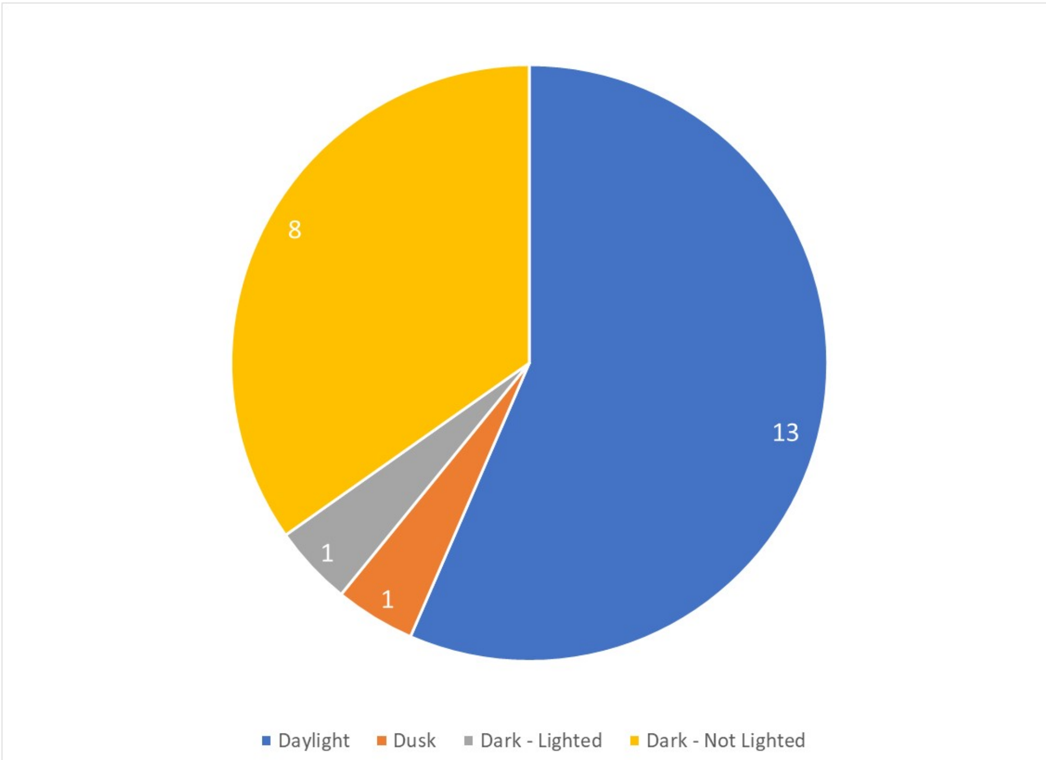

Figure 80: The Parkway & Wellington Road, Lighting (number of crashes during each lighting condition)

Most crashes (**thirteen**) were identified as having occurred during "Daylight." None of the reported "Daylight" crashes had conditions that would have limited visibility (e.g. cloudy, rain, etc.), therefore, lighting does **not** seem to be an issue at the intersection. The "Dark – Lighted" categorization was likely miscoded, as there currently are no lights along the Parkway in the study corridor.

The researchers also considered whether the "Daylight" crashes occurred during peak periods. (Note: We anticipated that "Daylight" crashes should be reported less frequently during the 12 AM-6 AM and 6 PM to 12 AM time periods, as the sun may have set or may not have risen.) Crashes were grouped into non-peak and peak-periods: 12 AM-6 AM, 6 AM-9 AM (AM PEAK), 9 AM-3 PM, 3 PM-6 PM (PM PEAK), 6 PM-12 AM. Table 30 shows the number of crashes within these groups.

Table 30: The Parkway & Wellington Road, "Daylight" Crash Counts and Rates by Time Periods

Time Period		Number of Crashes	Crashes/Hour
12 AM-6 AM	pre-AM PEAK	2	0.3
6 AM-9 AM	AM PEAK	1	0.3
9 AM-3 PM	mid-day	4	0.7
3 PM-6 PM	PM PEAK	**6**	**2.0**
6 PM-12 AM	post-PM PEAK	0	0
TOTAL "Daylight" Crashes		13	-

"Daylight" crashes were most likely to occur during the PM PEAK and least likely to occur from 6 PM to 12 AM (post-PM PEAK).

With regard to weather, all but three crashes occurred during "Clear" periods (Figure 81).

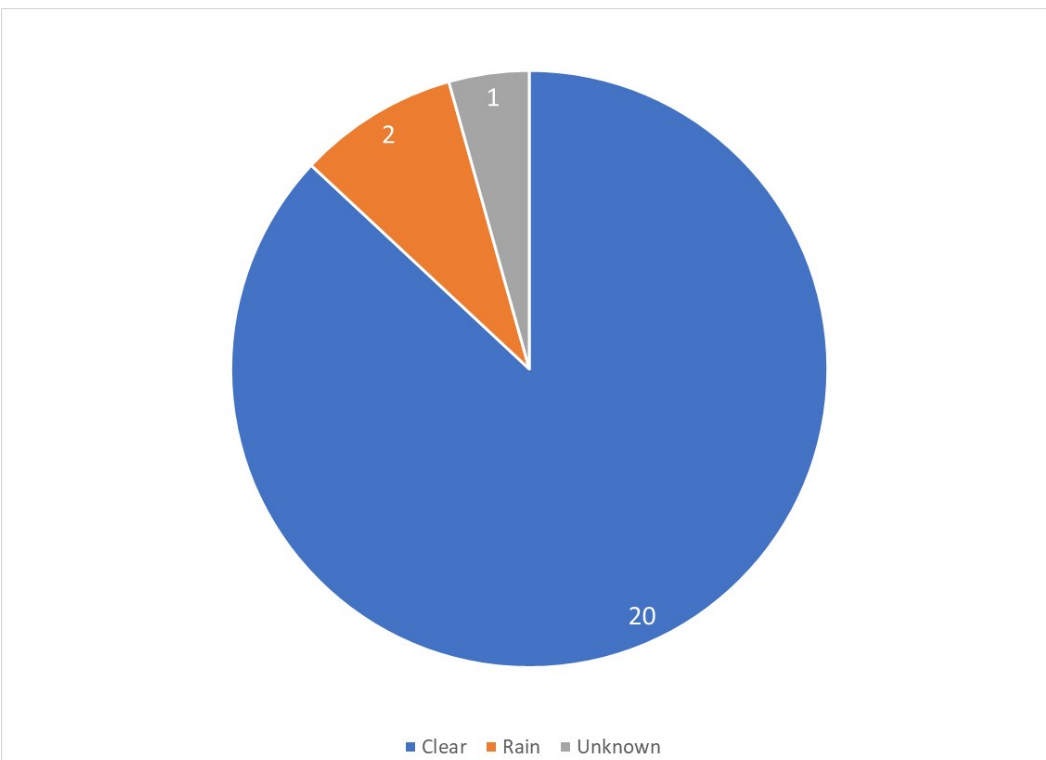

Figure 81: The Parkway & Wellington Road, Weather

Therefore, weather does not seem to be a contributing factor to crash occurrence.

The majority of the crashes (**twenty**) occurred when the road conditions were identified as "Dry," which suggests that surface condition is unlikely to be an issue (Figure 82).

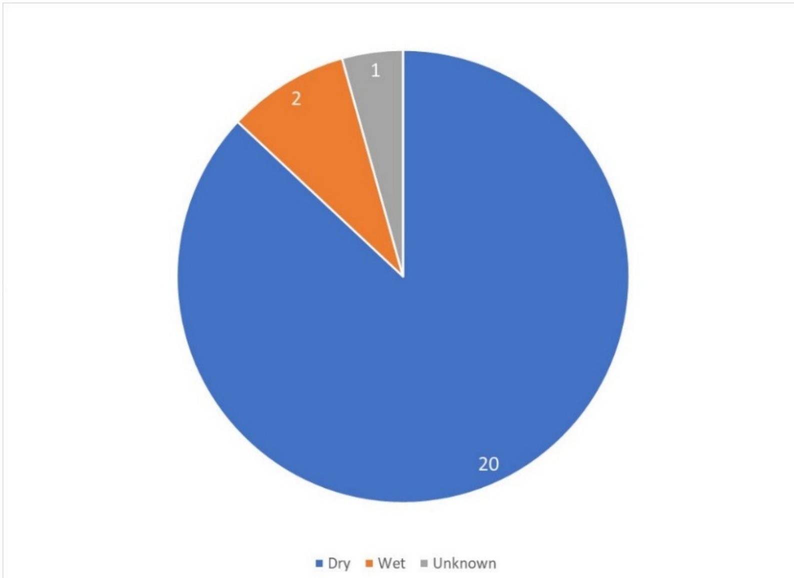

Figure 82: The Parkway & Wellington Road, Surface Condition

3.5.3 Factors Contributing to Crashes

This section discusses the type of crash, the primary cause of the crash, and whether the collision was between vehicles or with an object.

One category of the tabular data provided information about the vehicle collision type. "Rear End" was the most frequently identified crash type (**six**) (Figure 83).

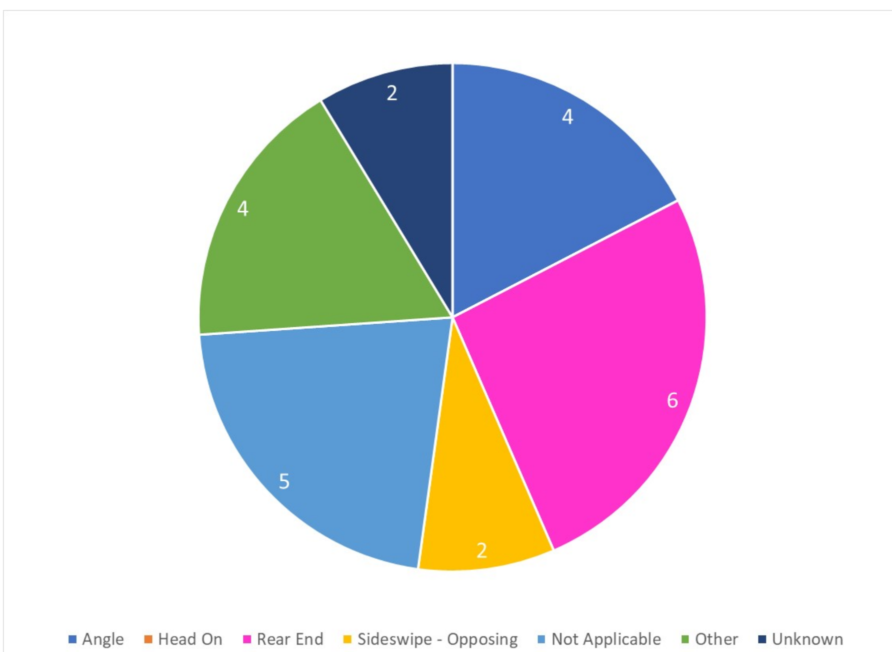

Figure 83: The Parkway & Wellington Road, Crash Type

The second most common crash type was "Not Applicable." In the crash report, there is an option to include data in the "collision with?" column. The "Not Applicable" crashes were identified as having occurred with a tree/shrub (3) and animal (2).

The most reported "Primary Causes" were "Failed to Yield ROW" and "Other" (Figure 84), which was reported in **4 of the 23 (17%)** crashes each. (Note: Figure 84 only shows **17 of the 23 crashes** that occurred at the intersection, as **6 crashes** provided no information on the "Primary Cause.")

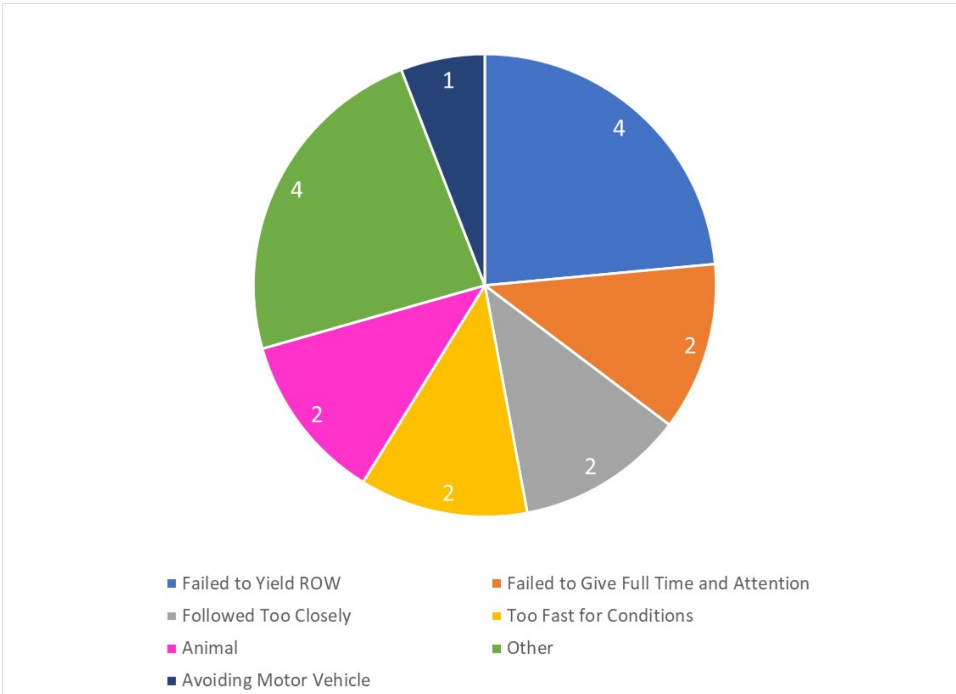

Figure 84: The Parkway & Wellington Road, Primary Cause

3.5.4 Driving Under the Influence

Zero crashes at this intersection were attributed to a driver operating a vehicle under the influence of drugs or alcohol.

3.5.5 Hit & Run

This section identifies if the crash was a hit and run. **One** of the **twenty-three** crashes (**4.3%)**, was identified as a hit-and-run crash. There are many reasons why a driver may hit an object or other vehicle and leave the scene of a crash, including operating a vehicle while under the influence or being an uninsured driver.

3.5.6 Crash Severity

This section identifies the number of PDO, INJ, and FAT crashes. More than a quarter of the crashes (**7**) at Wellington Road were INJ/FAT crashes (Figure 85).

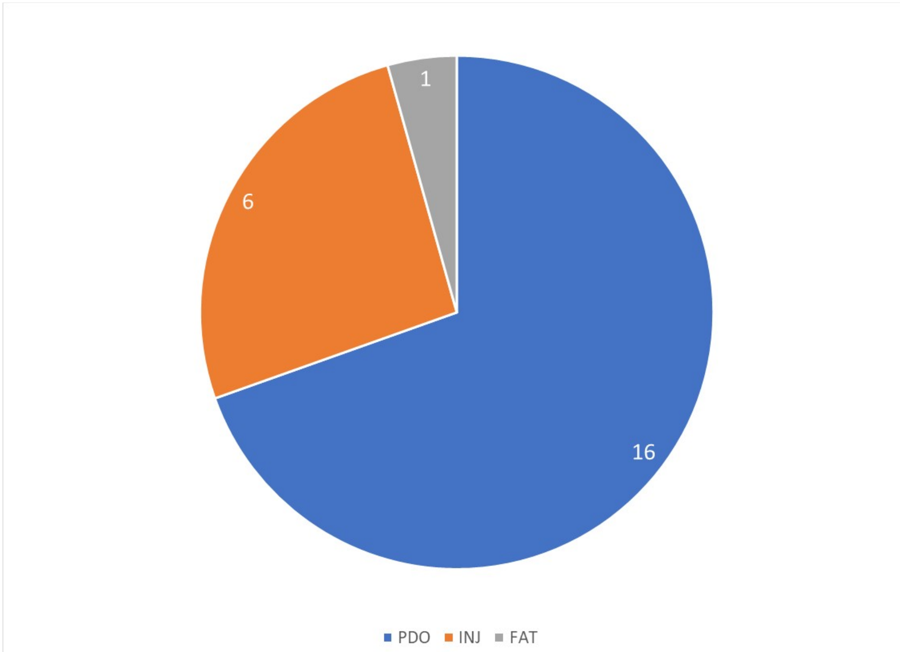

Figure 85: The Parkway & Wellington Road, Crash Severity

Across the injury and fatal crashes, there were a total of **eleven injuries** and **one fatality**.

The occurrence of the injury and fatal crashes by month, day of week, and time of day was investigated. In Figure 86, Figure 87, and Figure 88, blue represents injury crashes and orange represents the fatal crash.

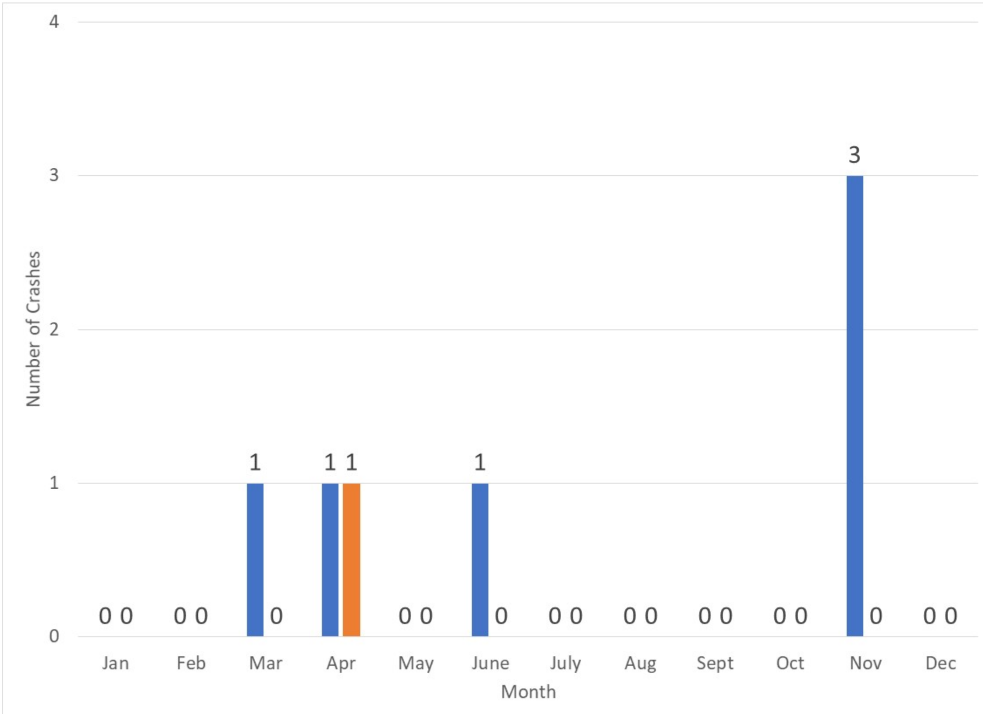

Figure 86: The Parkway & Wellington Road, Injury and Fatal Crashes by Month

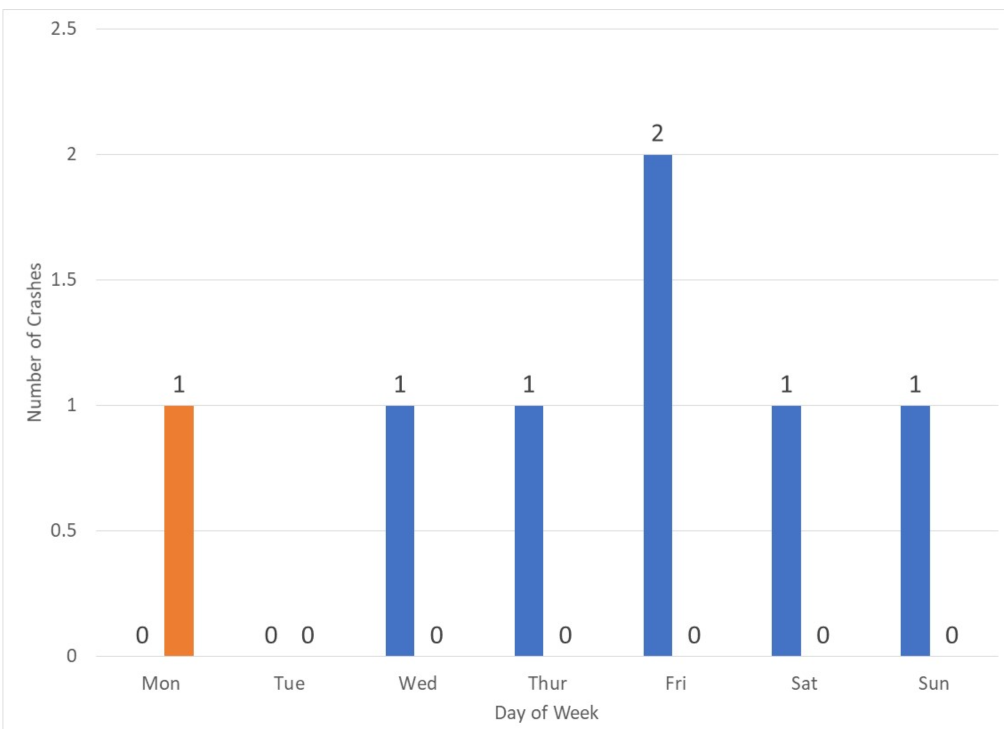

Figure 87: The Parkway & Wellington Road, Injury and Fatal Crashes by Day of the Week

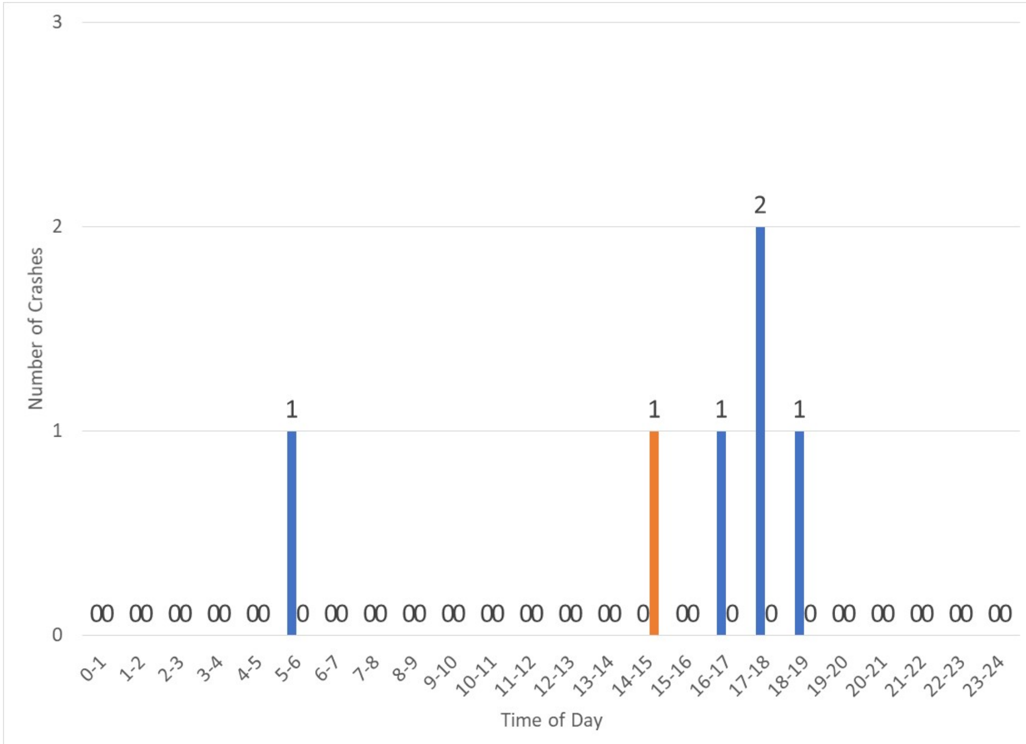

Figure 88: The Parkway & Wellington Road, Injury and Fatal Crashes by Time of Day

While November has the greatest number of injury crashes, April has both an injury crash and fatal crash, making it the second most severe month for Wellington Road (Figure 86). Similarly, while Fridays have the largest number of injury crashes, the only fatal crash occurred on a Monday (and the total count was only one less than Friday) (Figure 87). Finally, while the 5 PM-6 PM hour has the greatest number of injury crashes, overall, it seems there is a greater probability of an injury or fatal crash during the period from 2 PM to 7 PM (Figure 88).

Considering that the largest crash count was in April, on Friday and from 4 PM-5 PM, it appears as while it does not perfectly map, the higher crash count month, day of week, and time of day are also associated with more severe crashes.

3.5.7 Pedestrians & Bicycle

One of the crashes (**4.3%**) at the intersection was with a pedestrian. As noted previously, the MVT crossing is just after one turns from the Parkway onto Wellington Road.

3.5.8 Crash Diagram

The following crash diagram shows the location of crashes at the intersection for which enough information was available to place them on the map. If crash type, direction of vehicle, and other factors were provided, they were mapped. Otherwise, after the figure is a note regarding why a crash could not be mapped. Crash reports were not available. Therefore, the diagram was created based on the pre-crash direction of the vehicle, and the stated crash type. As a separate file was provided for vehicle and persons for the more recent data (2018-2019), these crashes may be more accurate. However, complete data was not always provided. As such, there may be some variability between the actual crash and what is conveyed in the diagram. Figure 89 is **the best understanding of the crash occurrence at the intersection based on available information**. (Note: The crash outlined in red, 15005864, does not have the 33000 prefix like all of the other crashes.)

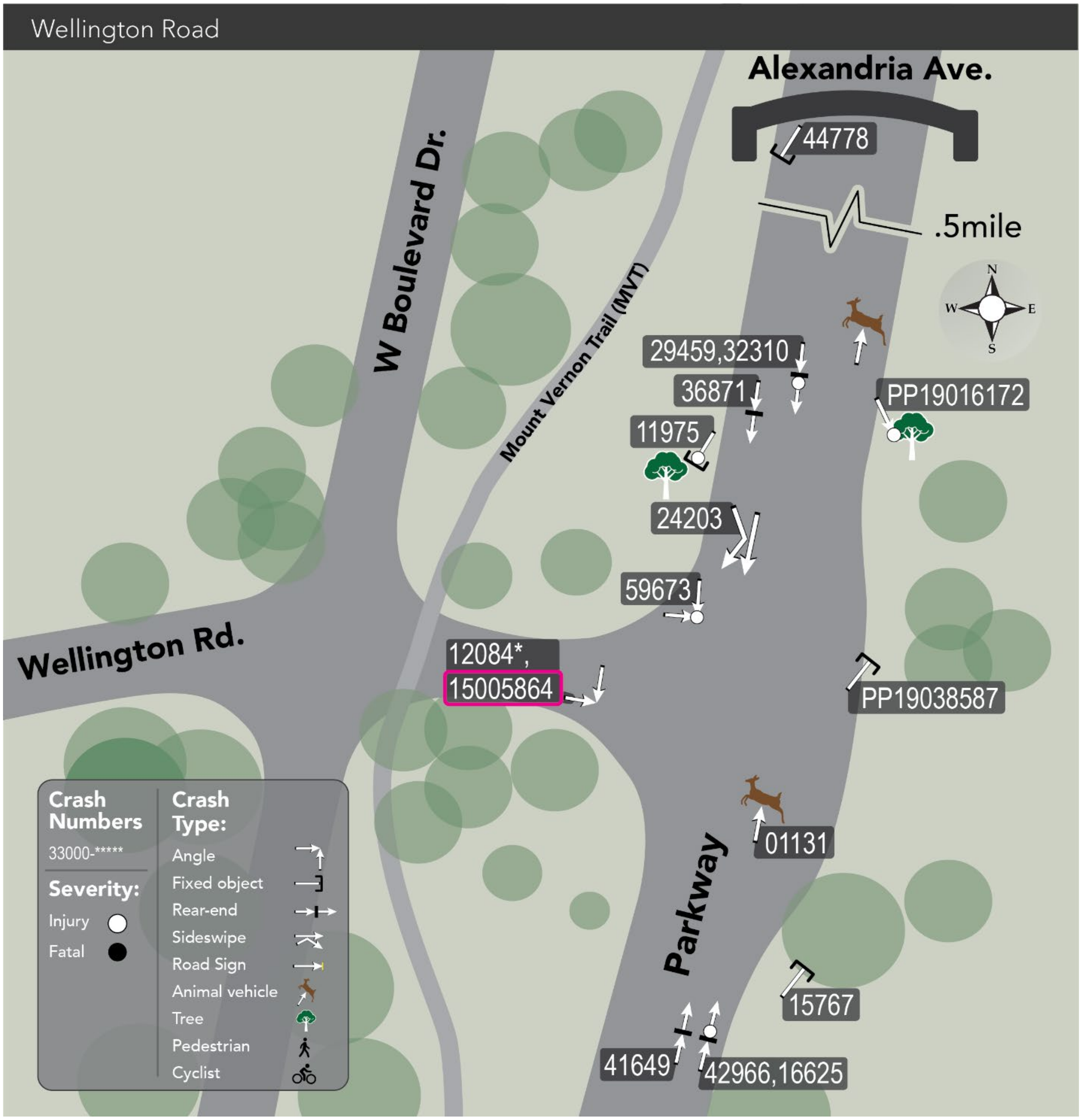

Figure 89: The Parkway & Wellington Road, Crash Diagram

*There was no indication if the pre-crash was northbound or southbound; this direction was assumed.

The following crashes did not have enough information to allow them to be placed on the crash diagram:

- 3300011399 – FAT
- 3300059683 – PDO

The crash diagram does not show one clear type of crash or recurring location. Two of the **twenty-three** crashes were with an **animal (8.7%)**. While the animal crashes are depicted as a deer for the diagram, it is unclear if the animal crashes are in fact with deer or some other animal.

Rear-end crashes are occurring in both the northbound and southbound directions of the Parkway, and overall have the greatest representation among crash types. These crashes could be the result of turning movements or speeding.

3.5.9 Summary – Wellington Road

Of the **twenty-three** crashes recorded for Wellington Road, most occurred in 2011, in April, and on Fridays (Table 31). While there are few crashes that occur at this intersection, they are relatively severe. Driving under the influence was not reported. Weather and road conditions do not seem to be contributing factors.

Table 31: The Parkway & Wellington Road, Summary of Key Data Findings

Criteria	Count
Number of Crashes	23
Year (of greatest frequency)	2011
Month (of greatest frequency)	April
Day (of greatest frequency)	Friday
Percent from 12 AM to 12 PM	26%
Most Frequent 1 Hour Block	4 PM-5 PM
Most Frequent Time Period (pre-AM PEAK; AM PEAK; mid-day; PM PEAK; post-PM PEAK)	PM Peak
Might lighting be an issue?	No
Is weather a contributing factor?	No
Might the surface condition be a factor?	No
Most Typical Crash Type	Rear End
Most Typical Reported Cause	Failed to Yield ROW; Other (4 of 23, respectively)
Driving Under the Influence	Zero crashes (0 of 23)
Hit & Run	4.3% of crashes (1 of 23)
Percent of Injury & Fatal Crashes (measure of severity)	30% (7 of 23)
Total Number of People Injured in Crashes	12 people*
Pedestrian/Bicycle Involved Crashes?	Yes; 4.3% (1 of 23)
Animal Involved Crashes?	Yes; 8.7% (2 of 23)

*11 injured; 1 died

3.6 The Parkway & Collingwood Road

Figure 90 shows the orientation of the Parkway and Collingwood Road, a four-legged intersection with a median.

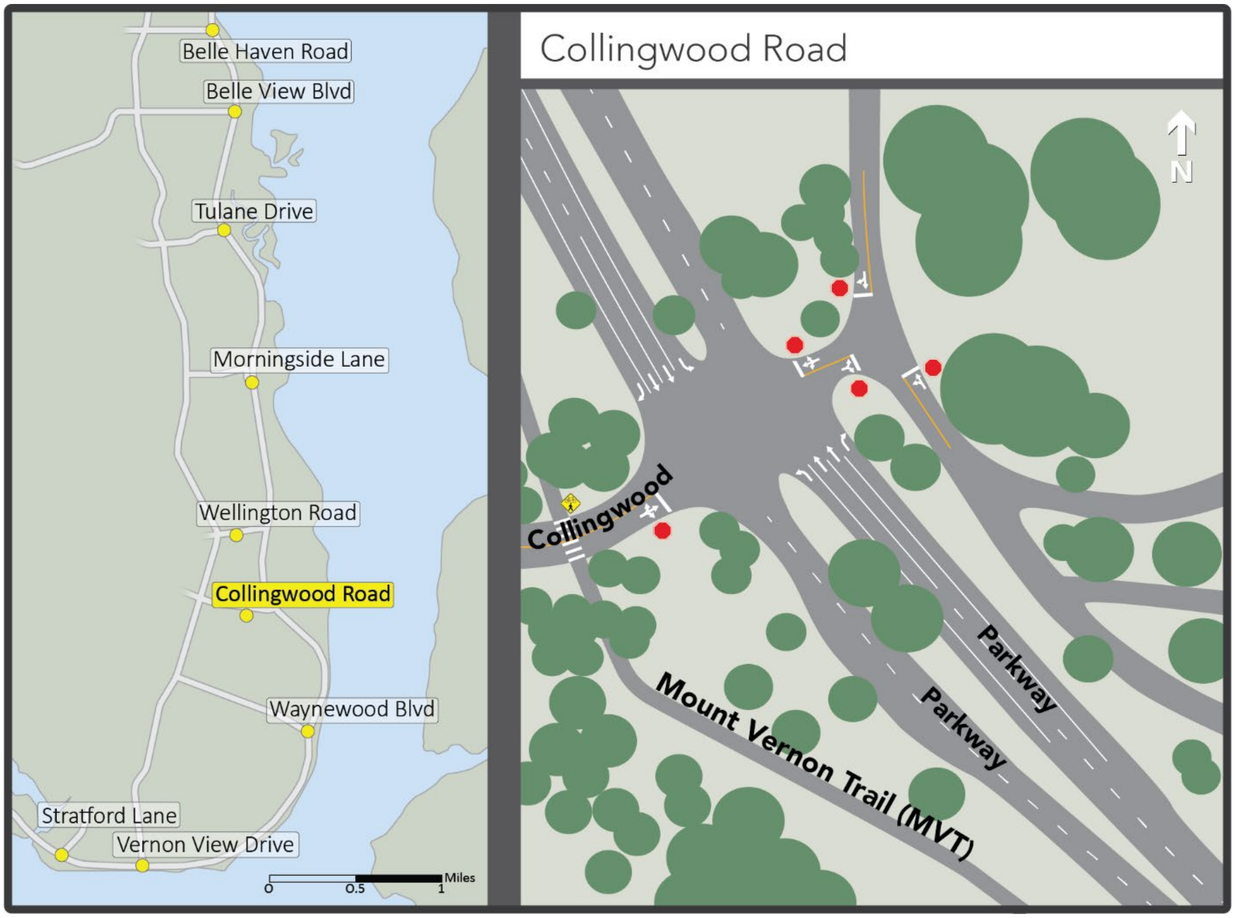

Figure 90: Intersection of the Parkway & Collingwood Road

There are a few interesting geometric considerations at this intersection. First, there is an intersection in close proximity to the main one on either side of the Parkway & Collingwood Road intersection, along with the MVT crossing on the south leg. The intersection to the northeast is Collingwood Road and East Boulevard Drive and the intersection to the southwest is Collingwood Road and West Boulevard Drive.

From 2005-2015 and 2018-2019, a total of **forty-six** crashes were identified at the intersection of the Parkway and Collingwood Road. Generally speaking, the annual occurrence of crashes appears random, although **2006** had the greatest number of crashes reported (Figure 91). 2015 did not have any crashes at this intersection. Furthermore, either the change in crash reporting has impacted the number of crashes recorded, or there seems to be a downward trend.

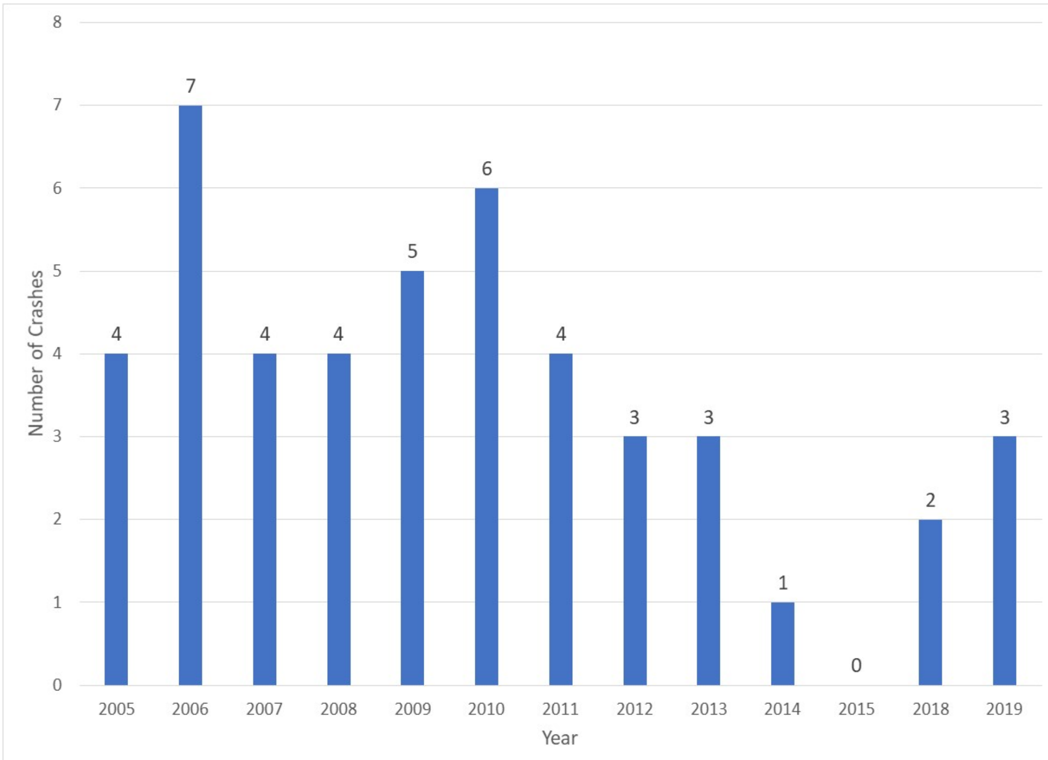

Figure 91: The Parkway & Collingwood Road, Total Crashes by Year

3.6.1 Temporal

This section discusses patterns identified by month, time, and day of the week.

Based on the data from the available years (2005-2015, 2018-2019), crashes occurred most frequently in **April** (Figure 92).

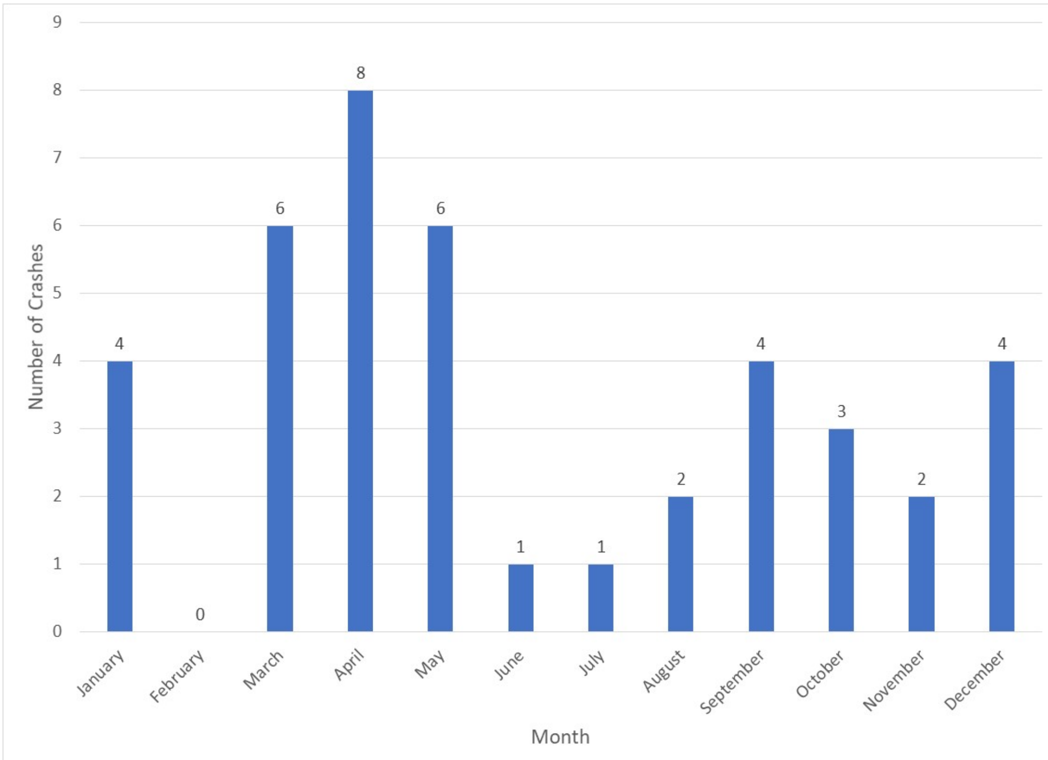

Figure 92: The Parkway & Collingwood Road, Crashes by Month

The WTI Team separated crashes into an AM period (12 AM to 12 PM) and a PM period (12 PM to 12 AM) to investigate if crashes occurred more often in the AM or PM. **Fifty percent** of all crashes occurred in the AM period.

Assigning each crash to a one-hour time period across the entire day, there were two time periods that had the most frequent number of crashes: **7 AM-8 AM, and 8 AM-9 AM** (Figure 93).

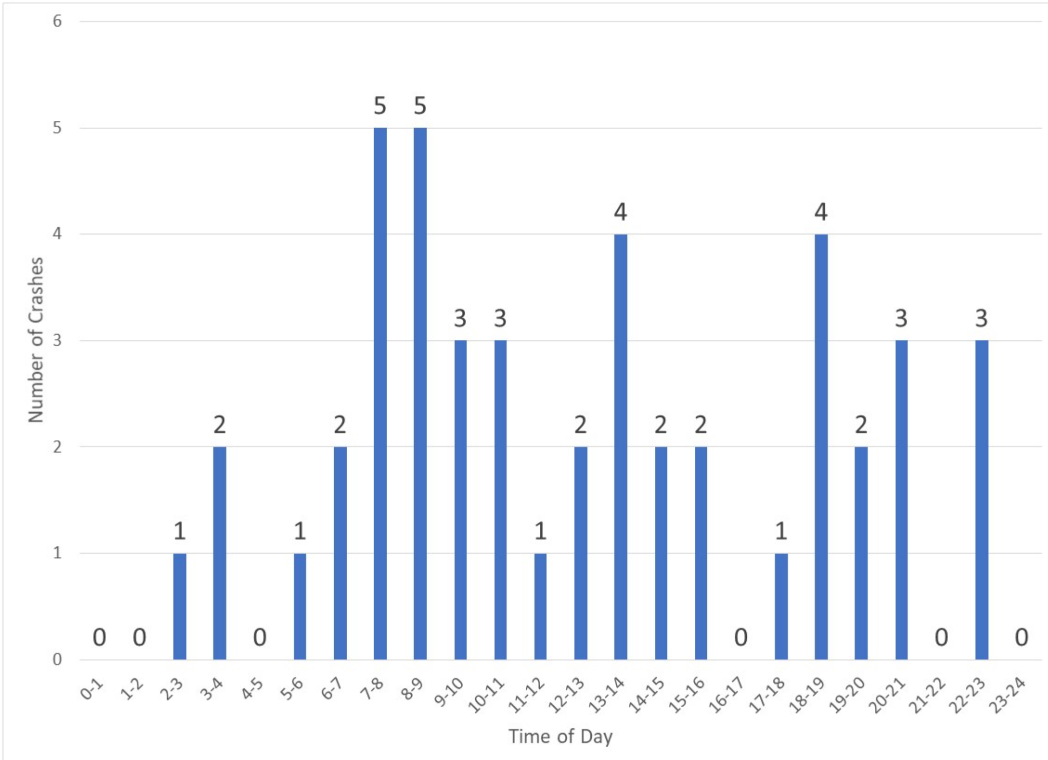

Figure 93: The Parkway & Collingwood Road, Crashes by Time of Day

The WTI Team binned the crashes into pre-AM PEAK, AM PEAK, mid-day, PM PEAK, and post-PM PEAK crash time periods. Considering the frequency of crashes per hour, the highest rate of crashes occurred during the **AM PEAK** time period (Table 32).

Table 32: The Parkway & Collingwood Road, Crash Counts & Rate by Time Period

Time Period		Number of Crashes	Crashes/Hour
12 AM-6 AM	pre-AM PEAK	4	0.7
6 AM-9 AM	AM PEAK	12	**4.0**
9 AM-3 PM	mid-day	15	2.5
3 PM-6 PM	PM PEAK	3	1.0
6 PM-12 AM	post-PM PEAK	12	2.0
TOTAL		46	-

The day of the week that is most represented in the crash records is **Friday** (Figure 94). Monday was close in count, with one fewer crash.

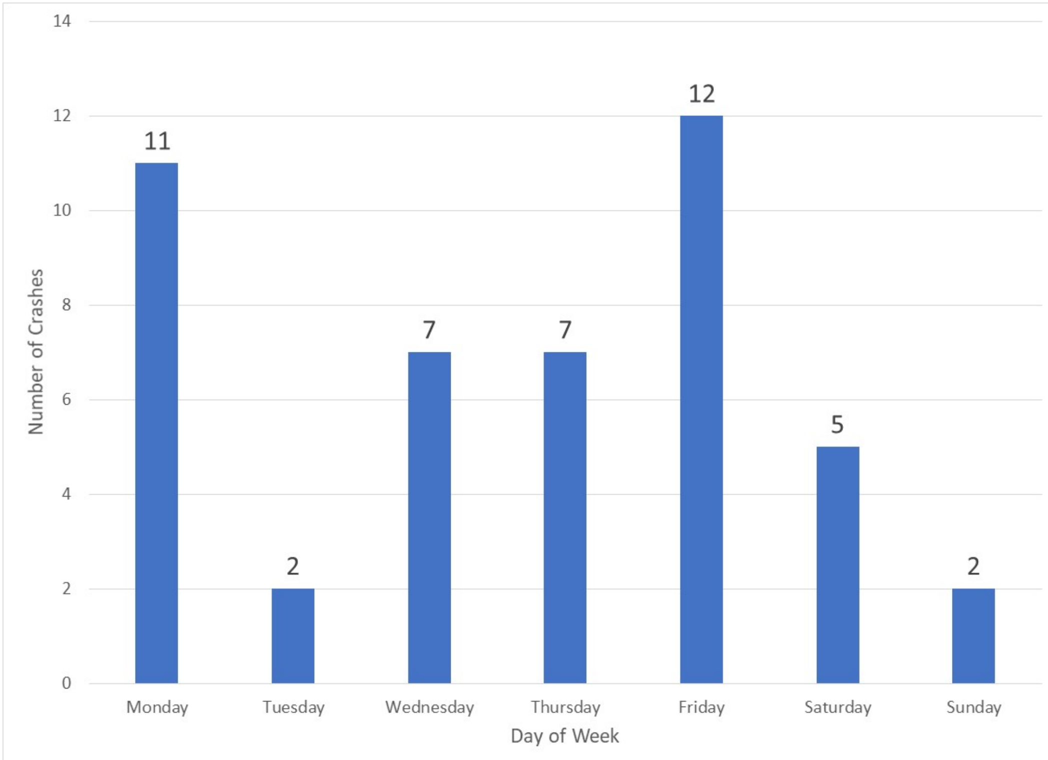

Figure 94: The Parkway & Collingwood Road, Crashes by Day of Week

The results suggest the possibility of factors occurring on Friday and Monday that are contributing to crash occurrence.

3.6.2 Environment

This section discusses how lighting, weather, and the road surface may have influenced crash occurrence.

The WTI Team analyzed the lighting condition identified during a crash (Figure 95).

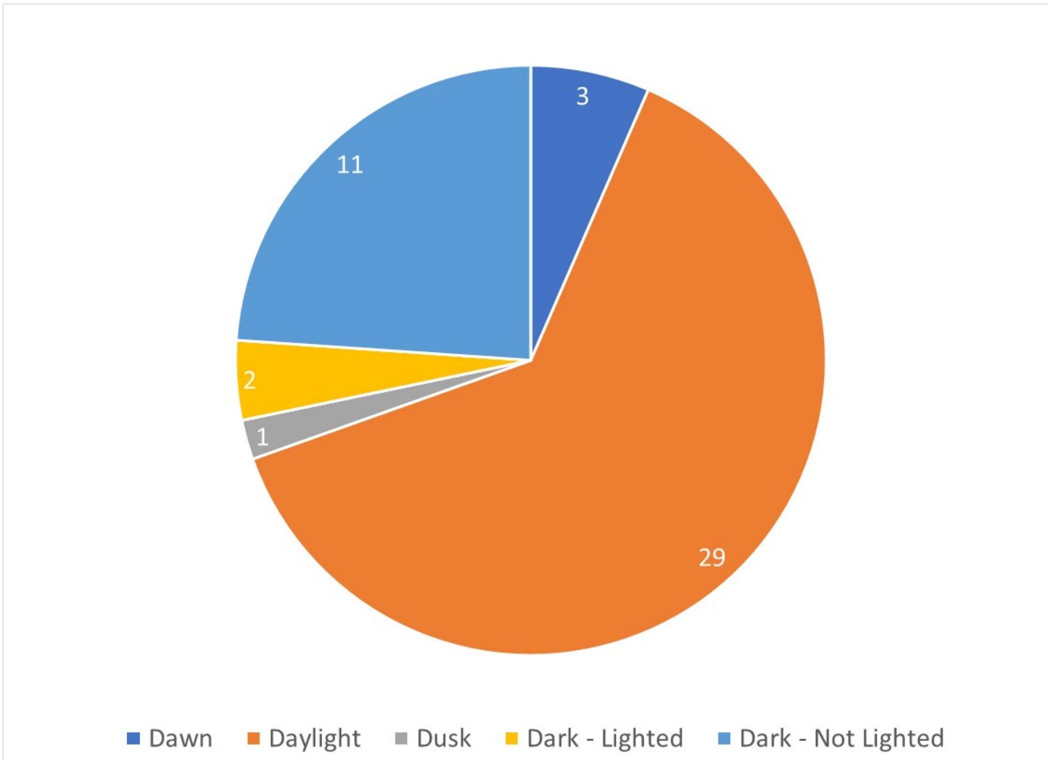

Figure 95: The Parkway & Collingwood Road, Lighting (number of crashes during each lighting condition)

Most crashes (**twenty-nine**) were identified as having occurred during “Daylight.” Looking at the crashes in more detail, of the crashes that occurred during “Daylight,” **nine** of these crashes were indicated as: 1) Cloudy or 2) Rain. These crashes would suggest that the crash occurred when there was reduced visibility. Reducing the **twenty-nine** crashes by these **nine** crashes results in a total of **twenty** crashes remaining during “Daylight.” As the majority of the crashes (about 57%) occurred during conditions with reduced lighting, lighting could potentially be a problem.

The researchers also considered whether the “Daylight” crashes occurred during peak periods. (Note: We anticipated that “Daylight” crashes should be reported less frequently during the 12 AM-6 AM and 6 PM to 12 AM time periods, as the sun may have set or may not have risen.) Crashes were grouped into non-peak and peak-periods: 12 AM-6 AM, 6 AM-9 AM (AM PEAK), 9 AM-3 PM, 3 PM-6 PM (PM PEAK), 6 PM-12 AM.

Table 33 shows the number of crashes within these groups.

Table 33: The Parkway & Collingwood Road, "Daylight" Crash counts and Rates by Time Periods

Time Period		Number of Crashes	Crashes/Hour
12 AM-6 AM	pre-AM PEAK	0	0
6 AM-9 AM	AM PEAK	8	**2.7**
9 AM-3 PM	mid-day	15	2.5
3 PM-6 PM	PM PEAK	3	1
6 PM-12 AM	post-PM PEAK	3	0.5
TOTAL "Daylight" Crashes		29	-

"Daylight" crashes were most likely to occur during the **AM PEAK** from a rate perspective and mid-day based on count and least likely to occur from 12 AM to 6 AM.

With regard to weather, a slight majority of the crashes (**thirty**) occurred during "Clear" periods (Figure 96).

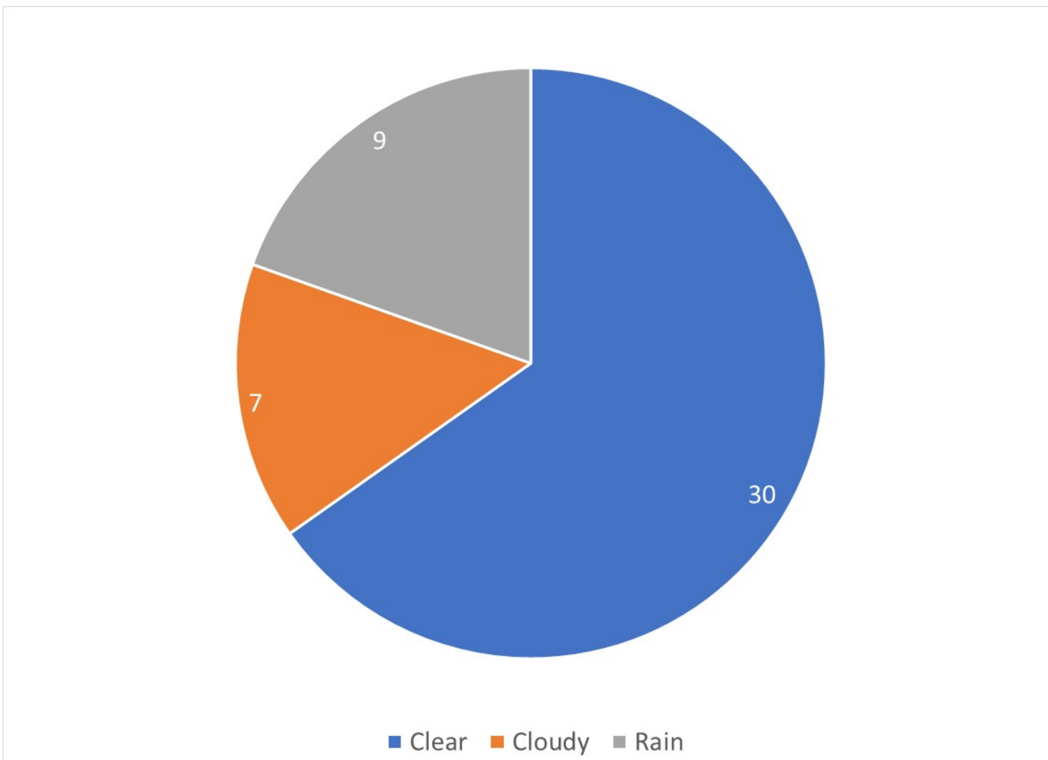

Figure 96: The Parkway & Collingwood Road, Weather

There is some suggestion that weather may be contributing to crash occurrence.

The majority of crashes (**thirty-seven**) occurred when surface conditions were "Dry," which suggests that surface condition is unlikely to be an issue (Figure 97).

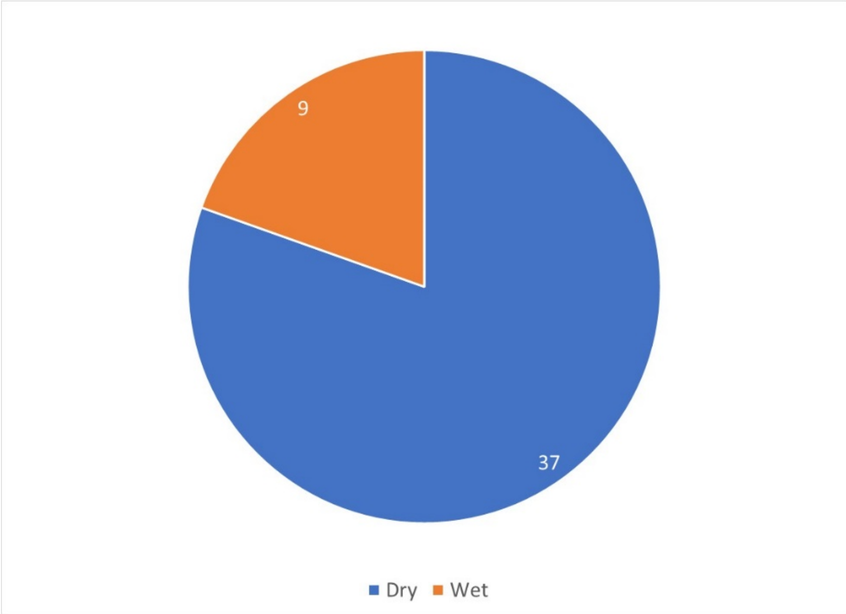

Figure 97: The Parkway & Collingwood Road, Surface Condition

3.6.3 Factors Contributing to Crashes

This section discusses the type of crash, the primary cause of the crash, and whether the crash was between vehicles or with an object.

One category of the tabular data provided information about the vehicle crash type. The most frequently identified vehicle collision was "Not Applicable" (Figure 98).

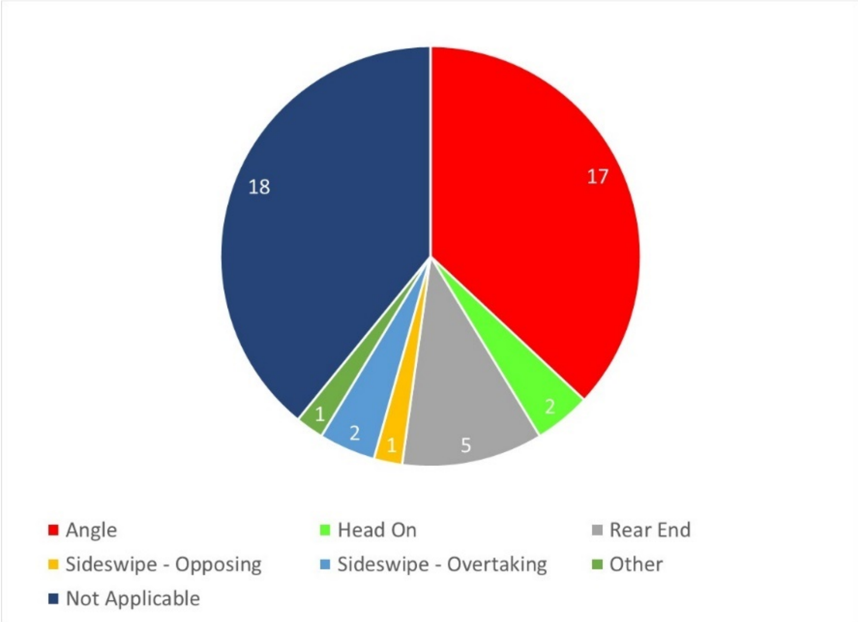

Figure 98: The Parkway & Collingwood Road, Crash Type

In the crash report, there is an option to include data in the "collision with?" column. The crashes were identified as having occurred with a tree/shrub (10), sign (3), animal (2), other fixed object (2), and drainage structure (1).

The most reported "Primary Cause" was "Failed to Yield ROW" (Figure 99), which was reported in **9 of 46 crashes (20%)**. (Note: Figure 99 only shows **32 of the 46 crashes** that occurred at the intersection, as **14 crashes** provided no information on the "Primary Cause.")

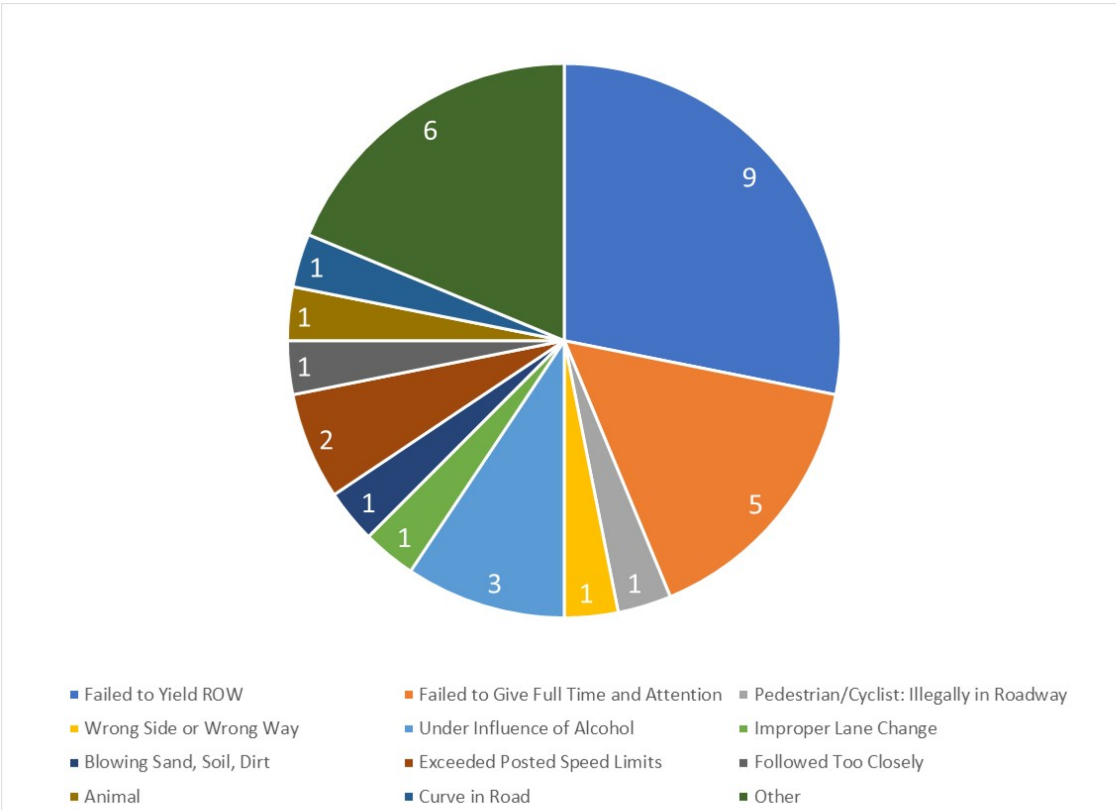

Figure 99: The Parkway & Collingwood Road, Primary Cause

3.6.4 Driving Under the Influence

This section describes crashes that were identified as involving drugs or alcohol. The tabular data provided information about whether or not a crash involved driving under the influence in the "Primary Cause" column. Of the **forty-six** crashes identified at the intersection, from 2005-2015 and 2018-2019, **three** crashes, or **6.5%** of all crashes at the intersection were identified as having a driver that was under the influence of drugs or alcohol. This seems relatively high, and a further investigation as to what is causing the high rate of driving under the influence crashes could be conducted.

3.6.5 Hit & Run

This section discusses crashes identified as a hit and run. Interestingly, **four** of the **forty-six** crashes **(8.7%)** were identified as hit-and-run crashes. There are many reasons why a driver may hit an object or other vehicle and leave the scene of the crash, potentially including operating a vehicle while under the influence or being an uninsured driver.

3.6.6 Crash Severity

This section identifies the number of PDO, INJ, and FAT crashes. Nearly **a quarter** of the crashes (**11**) at Collingwood Road were injury crashes (Figure 100). (Note: One of the crashes from 2018-2019 did not provide severity.)

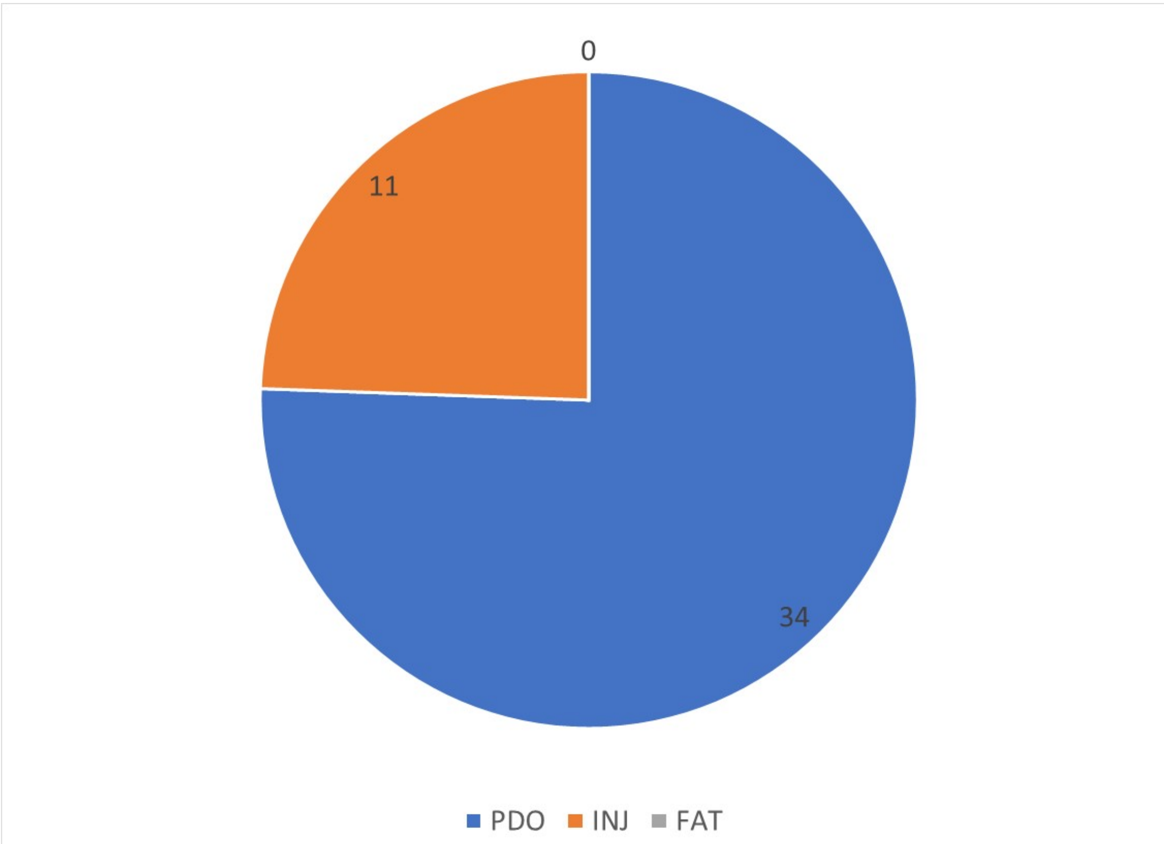

Figure 100: The Parkway & Collingwood Road, Crash Severity

Across the injury crashes, there were a total of **twelve** injuries.

The occurrence of the injury crashes by month, day of week, and time of day was investigated (Figure 101, Figure 102, and Figure 103). Overall, the occurrence of injury crashes by month seems randomly distributed, as the greatest difference between the count in a month is two; however, April, August and September have the greatest counts (Figure 101). April also had the greatest count of total crashes.

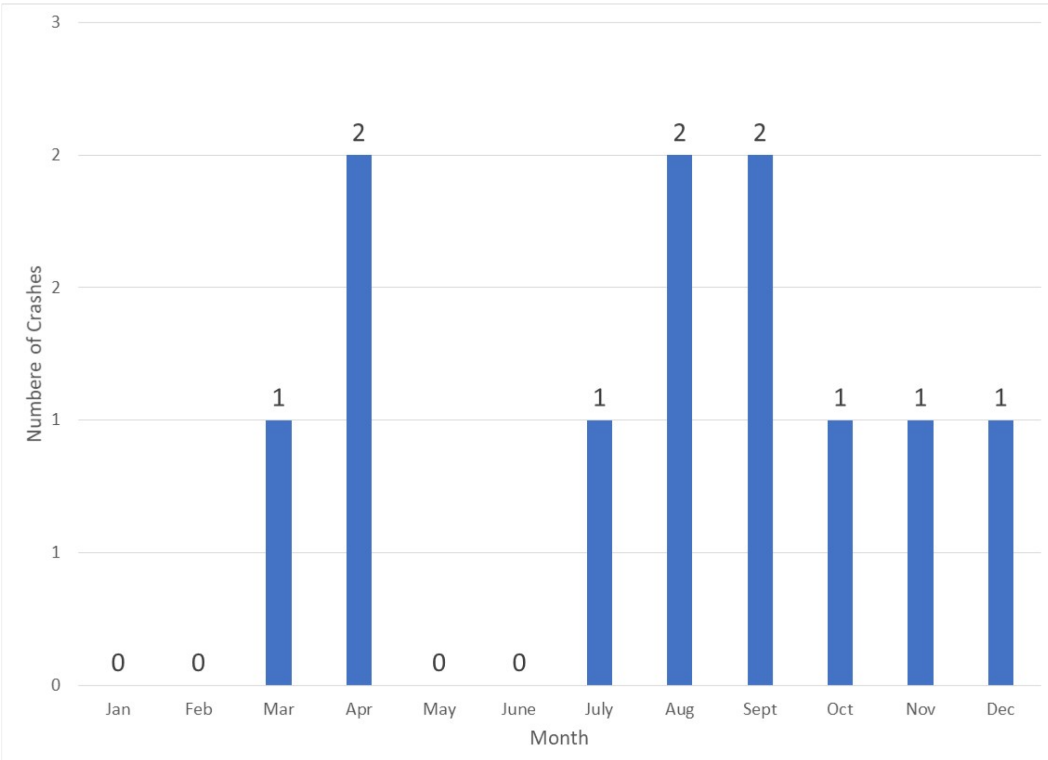

Figure 101: The Parkway & Collingwood Road, Injury Crashes by Month

Overall, it would appear that there are contributing factors to injury crashes on Mondays. Wednesday also has a relatively high count of injury crashes. These days could be further investigated to determine what might be contributing to a larger count of injury crashes (Figure 102). This is different from the day, Friday, with the largest counts of crashes.

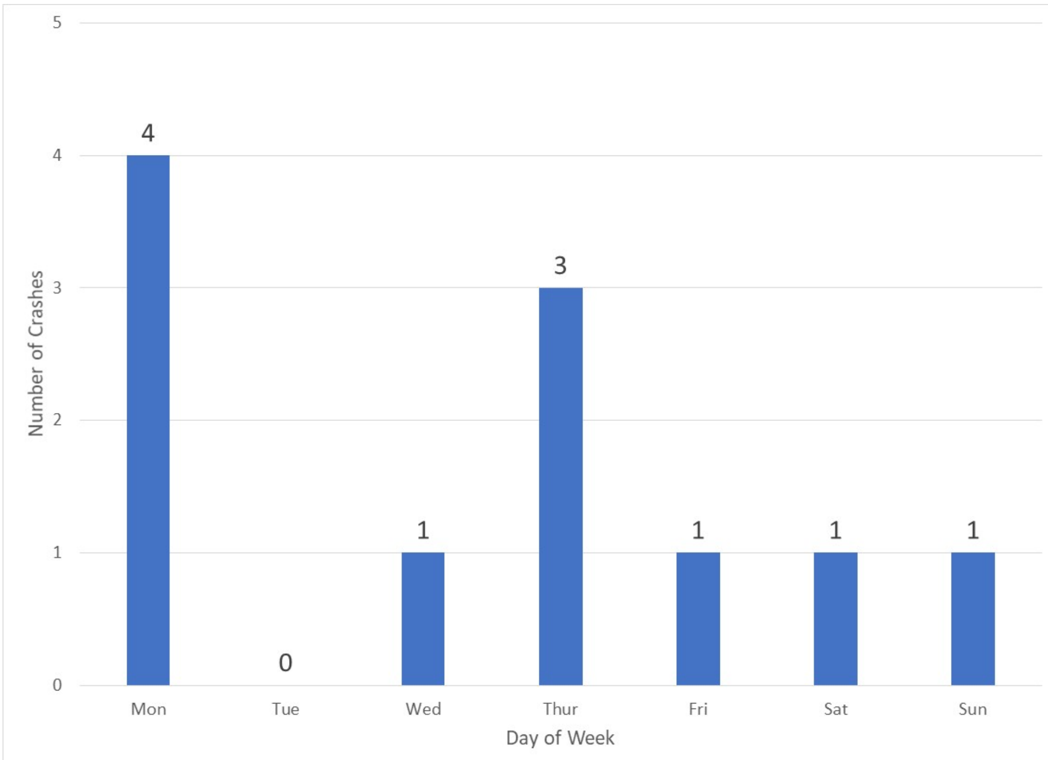

Figure 102: The Parkway & Collingwood Road, Injury Crashes by Day of the Week

There is a suggestion that 6 PM-7 PM might have some contributing factors to injury crash occurrence (Figure 103); again, this is different from the peak periods of 7 AM-8 AM and 8 AM-9 AM (which had the highest counts for crashes overall), although the 6 PM-7 PM period was a close second in count.

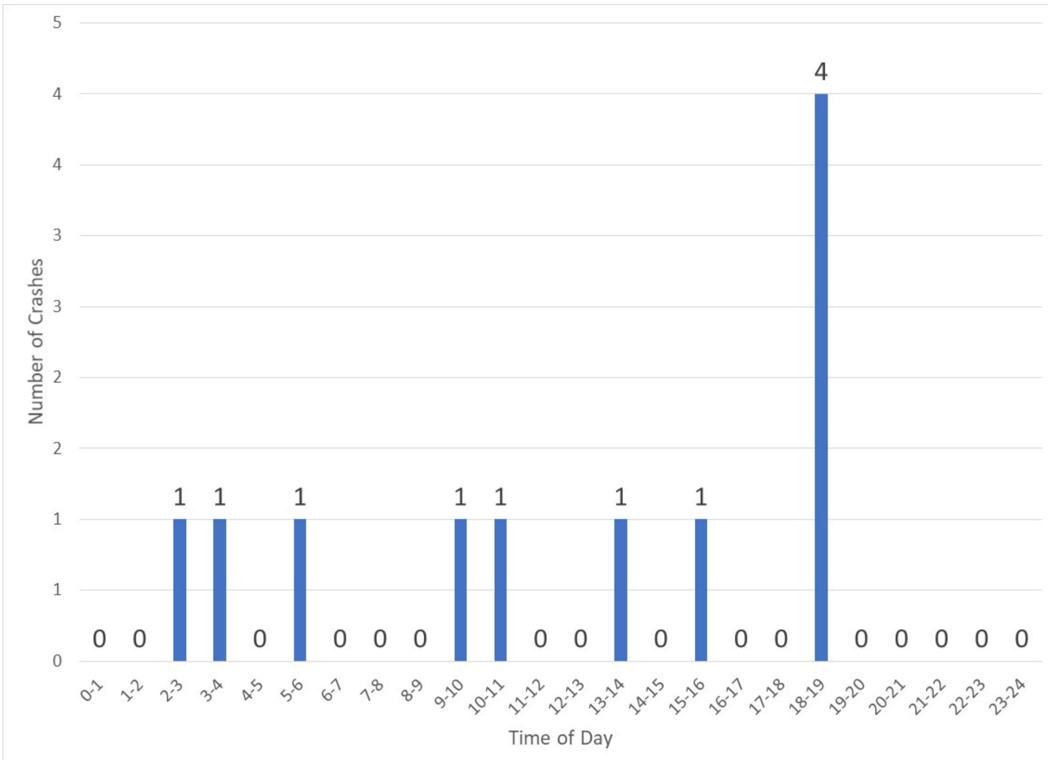

Figure 103: The Parkway & Collingwood Road, Injury Crashes by Time of Day

3.6.7 Pedestrians & Bicycle

One crash (**2.2%**) was reported as occurring between a vehicle and a bicyclist. The tabular data indicated that the bicyclist was illegally present in the roadway. (Note: Bicyclists are currently not allowed on the roadway.)

3.6.8 Crash Diagram

The following crash diagram shows the location of crashes at the intersection for which enough information was available to place them on the map. If crash type, direction of vehicle, and other factors were provided, they were mapped. Otherwise, after the figure is a note regarding why a crash could not be mapped. Crash reports were not available. Therefore, the diagram was created based on the pre-crash direction of the vehicle, and the stated crash type. As a separate file was provided for vehicle and persons for the more recent data (2018-2019), these crashes may be more accurate. However, complete data was not always provided. As such, there may be some variability between the actual crash and what is conveyed in the diagram. Figure 104 is **the best understanding of the crash occurrence at the intersection based on available information**.

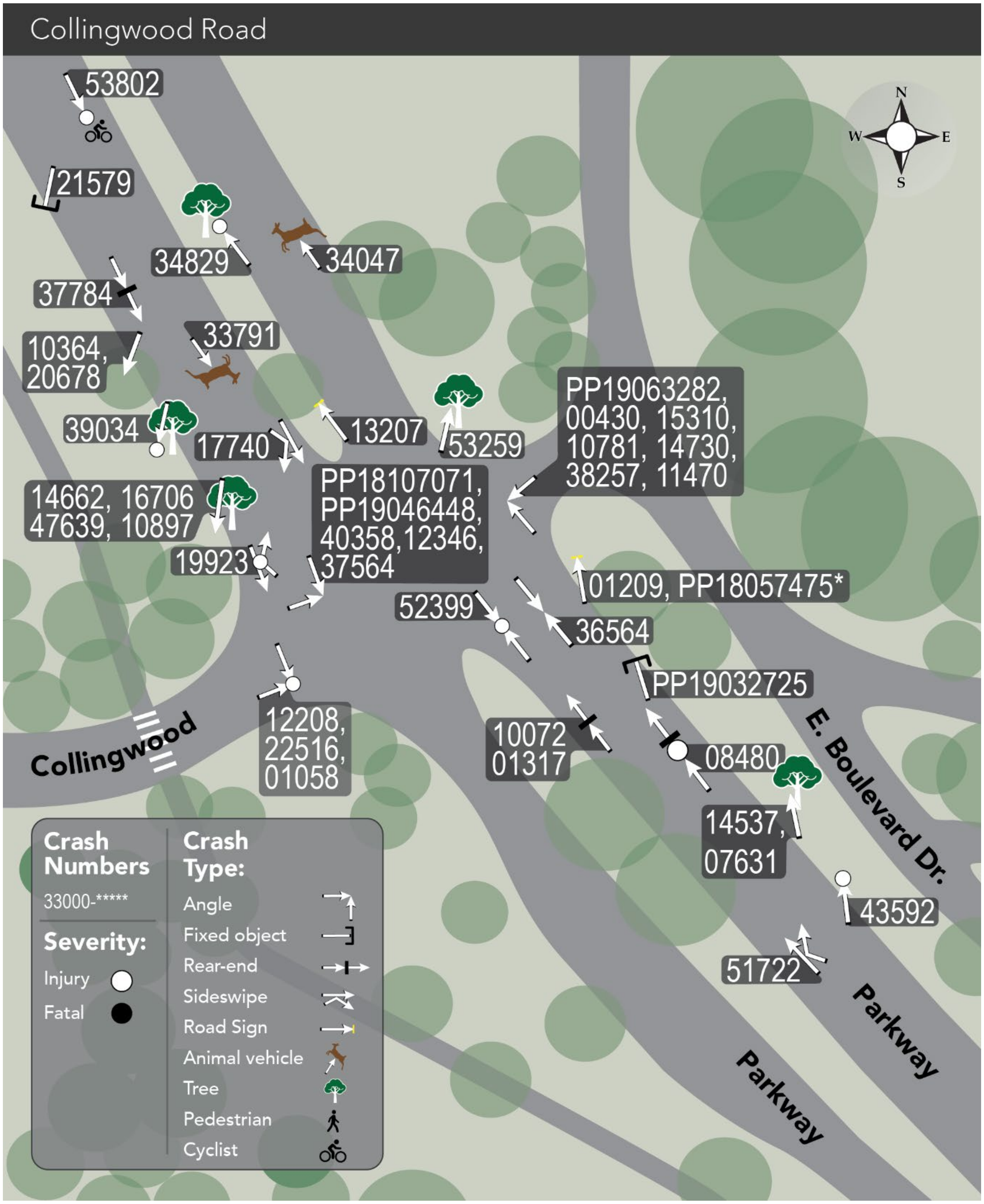

Figure 104: The Parkway & Collingwood Road, Crash Diagram

*Severity information was unavailable for this crash.

Only one crash is not shown in Figure 104: 3300041567. In the tabular data, it was identified as an “other” collision and was noted as being a PDO crash.

While the animal crashes are depicted as a deer for the diagram, it is unclear if the animal crashes are in fact with deer or some other animal.

Many of the crashes at this intersection appear to involve drivers not staying on the road (e.g. crashing with trees, drainage structures, signs). Therefore, it would be of value to consider a different type of lane markings or a more defined schedule for reapplication of typical lane markings . Furthermore, there could be a review to determine if existing signage warns approaching motorists of the horizontal curvature found at the intersection. There are also a relatively high number of angle crashes between vehicles traveling northbound on the Parkway and vehicles traveling westbound on Collingwood Road. Similarly, for vehicles traveling southbound on the Parkway and eastbound on Collingwood Road, there are a fairly high number of crashes, including more injury crashes.

3.6.9 Summary – Collingwood Road

This section summarizes some primary findings for the Parkway and Collingwood Road intersection. A total of forty-six crashes were identified from 2005-2015 and 2018-2019, with 2006, April and Fridays representing the largest counts (Table 34). There were no fatal crashes at this intersection. Hit and run crashes and driving under the influence (both alcohol and drugs) resulted in crashes at the intersection. There is some indication that lighting may be an issue at the intersection. There is also a suggestion that navigating the curve is a problem; this could be the result of delineation or the speed of traffic traveling on the Parkway. The speed of traffic on the Parkway could also explain the large number of angle collisions.

Table 34: The Parkway & Collingwood Road, Summary of Key Data Findings

Criteria	Count
Number of Crashes	46
Year (of greatest frequency)	2006
Month (of greatest frequency)	April
Day (of greatest frequency)	Friday
Percent from 12 AM to 12 PM	50%
Most Frequent 1 Hour Block	7 AM-8 AM; 8 AM-9 AM
Most Frequent Time Period (pre-AM PEAK; AM PEAK; mid-day; PM PEAK; post-PM PEAK)	AM Peak
Might lighting be an issue?	Yes
Is weather a contributing factor?	Maybe
Might the surface condition be a factor?	No
Most Typical Crash Type	Not Applicable
Most Typical Reported Cause	Failed to Yield ROW (9 of 46)
Driving Under the Influence	6.5% of crashes (3 of 46)
Hit & Run	8.7% of crashes (4 of 46)
Percent of Injury & Fatal Crashes (measure of severity)	24% (11 of 46)
Total Number of People Injured in Crashes	12 people
Pedestrian/Bicycle Involved Crashes?	Yes; 2.2% (1 of 46)
Animal Involved Crashes?	Yes; 4.3% (2of 46)

3.7 The Parkway & Waynewood Boulevard

Figure 105 shows the orientation of the Parkway and Waynewood Boulevard, a three-legged intersection without a median.

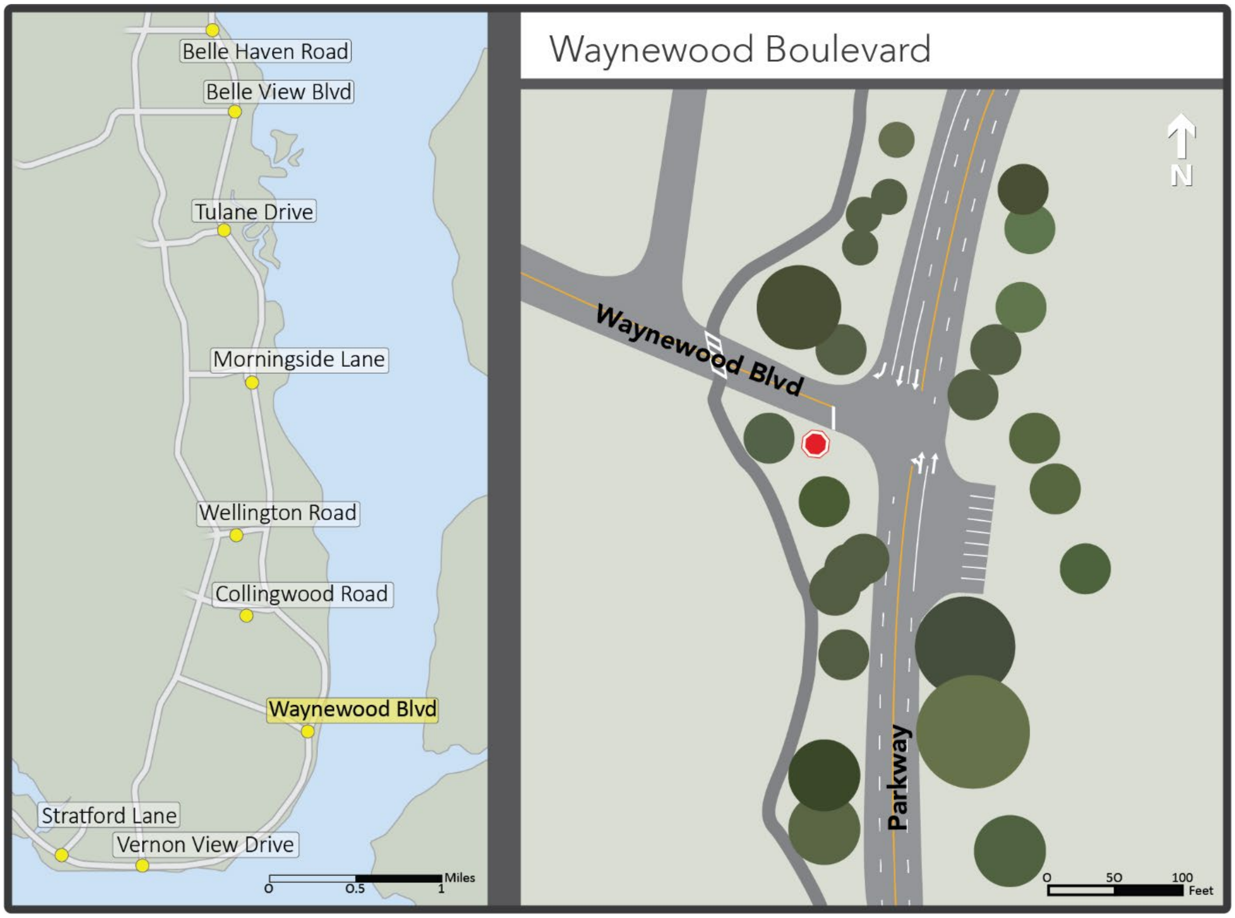

Figure 105: The Parkway & Waynewood Boulevard

There are a few interesting geometric considerations at this intersection. First, MVT crosses Waynewood Boulevard approximately 150 feet west of Waynewood Boulevard's intersection with the Parkway. There is also a parking lot on the east side of the intersection that does not have a single point of entry, as one can pull into any of the parking spaces that are marked.

From 2005-2015 and 2018-2019, a total of **seventeen** crashes were identified at the intersection of the Parkway and Waynewood Boulevard. Generally speaking, the annual occurrence of crashes appears random, although both **2010 and 2011** had the greatest number of crashes reported (Figure 106). 2015 and 2019 did not have any reported crashes at Waynewood Boulevard.

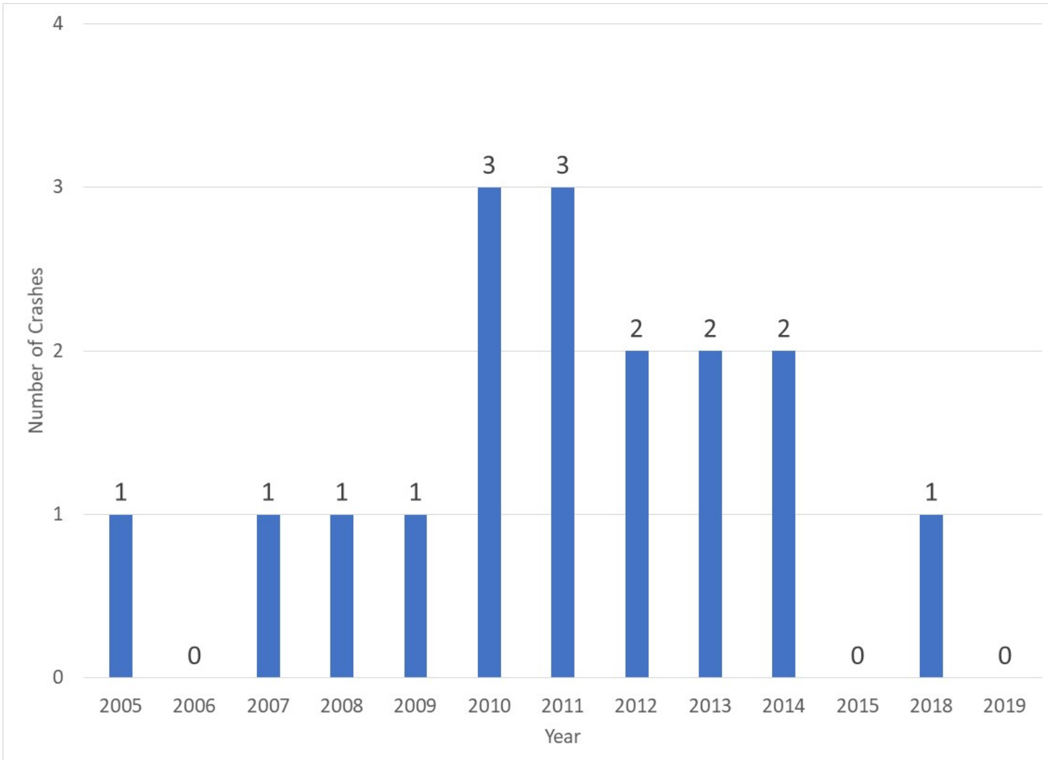

Figure 106: The Parkway & Waynewood Boulevard, Total Crashes by Year

3.7.1 Temporal

This section discusses patterns identified by month, time, and day of the week.

Based on data from the available years (2005-2015, 2018-2019), crashes occurred most frequently in **October** (Figure 107).

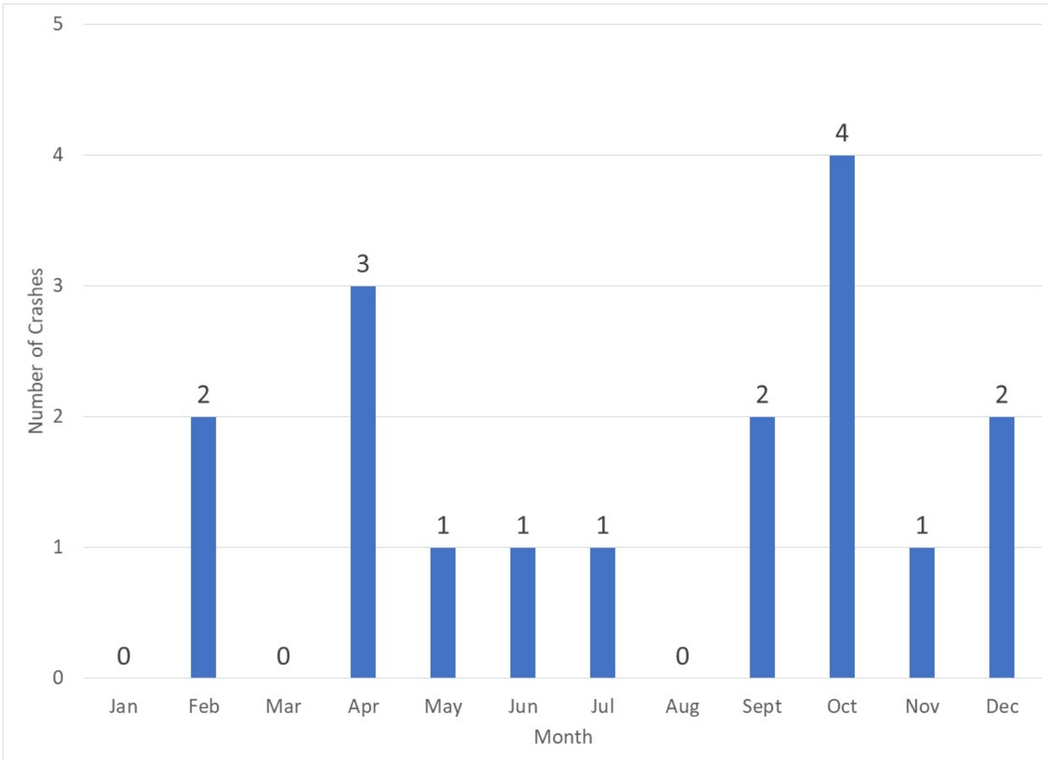

Figure 107: The Parkway & Waynewood Boulevard, Crashes by Month

The WTI Team separated crashes into an AM period (12 AM to 12 PM) and a PM period (12 PM to 12 AM) to investigate if crashes occurred more often in the AM or PM. **Eighteen percent** of all crashes occurred in the AM period.

Assigning each crash to a one-hour time period across the entire day, the most frequent number of crashes occurred from **4 PM-5 PM** (Figure 108).

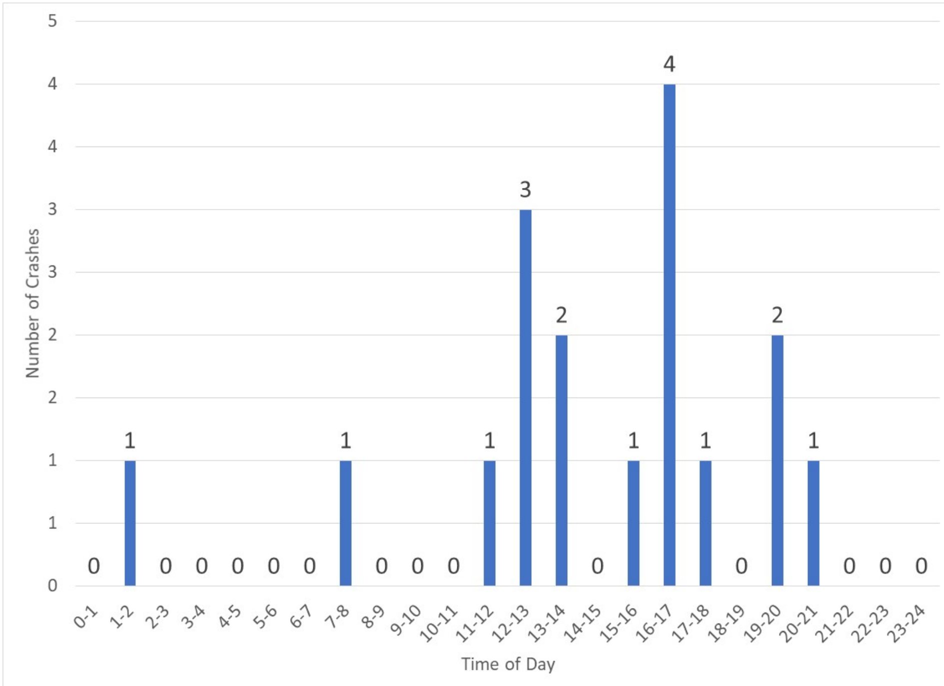

Figure 108: The Parkway & Waynewood Boulevard, Crashes by Time of Day

The WTI Team binned the crashes into pre-AM PEAK, AM PEAK, mid-day, PM PEAK, and post-PM PEAK crash time periods. Considering the frequency of crashes per hour, the highest rate of crashes occurred during the **PM PEAK** time period (Table 35).

Table 35: The Parkway & Waynewood Boulevard, Crash Counts & Rate by Time Period

Time Period		Number of Crashes	Crashes/Hour
12 AM-6 AM	pre-AM PEAK	1	0.17
6 AM-9 AM	AM PEAK	1	0.33
9 AM-3 PM	mid-day	6	1
3 PM-6 PM	PM PEAK	6	**2**
6 PM-12 AM	post-PM PEAK	3	0.5
TOTAL		16	-

The day of the week that is most represented in the crash records is **Wednesday** (Figure 109).

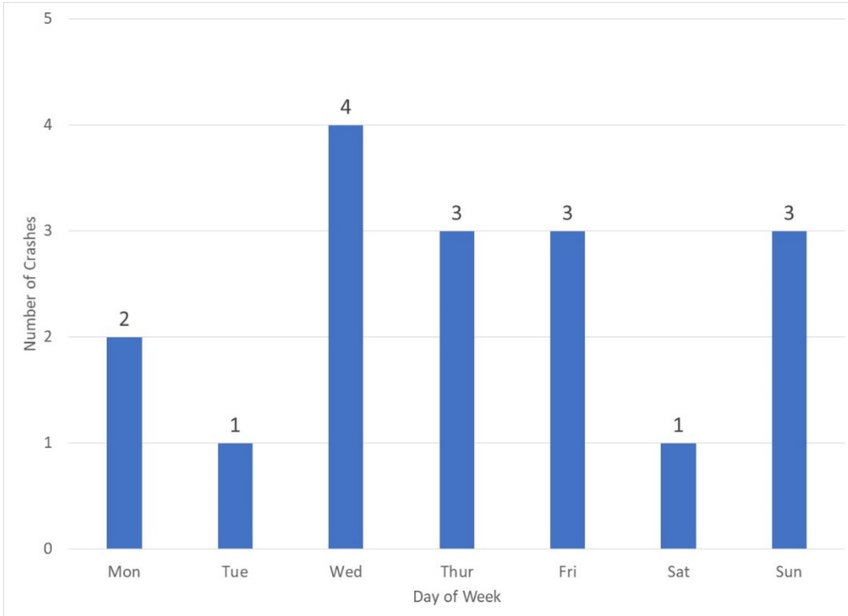

Figure 109: The Parkway & Waynewood Boulevard, Crashes by Day of the Week

The results suggest the possibility of factors occurring on Wednesday that are contributing to crash occurrence. Thursday, Friday, and Sunday have only one less crash than Wednesday.

3.7.2 Environment

This section discusses how lighting, weather, and the road surface may have influenced crash occurrence.

The WTI Team analyzed the lighting condition identified during a crash (Figure 110).

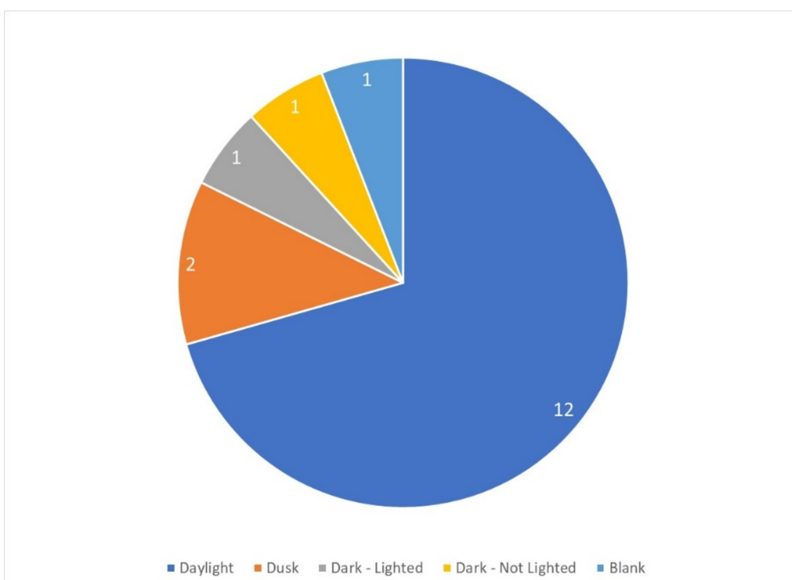

Figure 110: The Parkway & Waynewood Boulevard, Lighting (number of crashes during each lighting condition)

Most crashes (**twelve**) were identified as having occurred during "Daylight." Looking at the data in more detail, of the crashes that occurred during "Daylight," **three** of these crashes were during periods when conditions were indicated as: 1) Cloudy, 2) Rain, 3) Snow, or 4) Sleet, Hail, Freezing Rain. These conditions would suggest that the crash occurred when there was reduced visibility. Reducing the **twelve** crashes by these **three** crashes results in a total of **nine** crashes remaining during "Daylight." Therefore, approximately half of the crashes occurred during hours when visibility was good, while the other half occurred during periods when it was not. This suggests that lighting may be an issue.

The researchers also considered whether the "Daylight" crashes occurred during peak periods. (Note: We anticipated that "Daylight" crashes should be reported less frequently during the 12 AM-6 AM and 6 PM to 12AM time periods, as the sun may have set or may not have risen.) Crashes were grouped into non-peak and peak-periods: 12 AM-6 AM, 6 AM-9 AM (AM PEAK), 9 AM-3 PM, 3 PM-6 PM (PM PEAK), 6 PM-12 AM. Table 36 shows the number of crashes within these groups.

Table 36: The Parkway & Waynewood Boulevard, "Daylight" Crash Counts & Rates by Time Periods

Time Period		Number of Crashes	Crashes/Hour
12 AM-6 AM	pre-AM PEAK	0	0
6 AM-9 AM	AM PEAK	0	0
9 AM-3 PM	mid-day	6	1.0
3 PM-6 PM	PM PEAK	4	**1.3**
6 PM-12 AM	post-PM PEAK	2	0.3
TOTAL "Daylight" Crashes		12	-

"Daylight" crashes were most likely to occur during the PM PEAK and least likely to occur from 12 AM to 9 AM (pre-AM PEAK and AM PEAK).

With regard to weather, half of the crashes (**nine**) occurred during "Clear" periods (Figure 111).

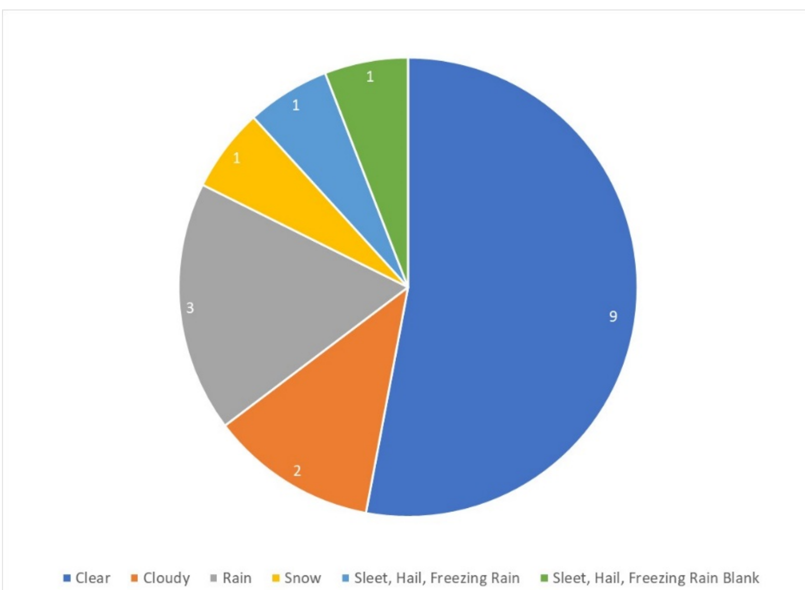

Figure 111: The Parkway & Waynewood Boulevard, Weather

The majority of the crashes (**ten**) occurred when surface conditions were “Dry,” which suggests that surface condition is unlikely to be an issue (Figure 112).

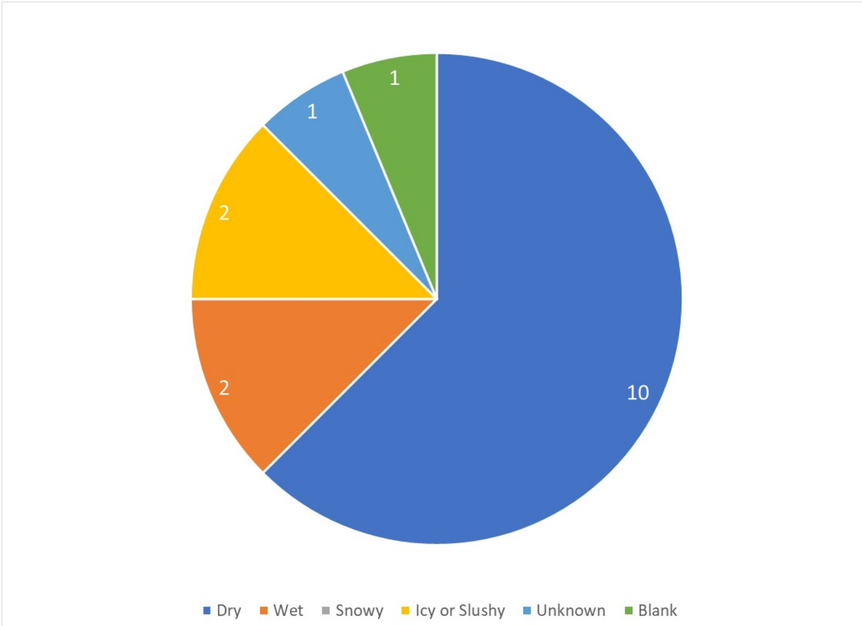

Figure 112: The Parkway & Waynewood Boulevard, Surface Condition

3.7.3 Factors Contributing to Crashes

This section discusses the vehicle collision type, the indicated primary cause of the crash, and whether the collision was between vehicles or with an object.

One category of the tabular data provided information about the vehicle collision type. “Angle” and “Not Applicable” were the most common crash types (both had **five**) (Figure 113).

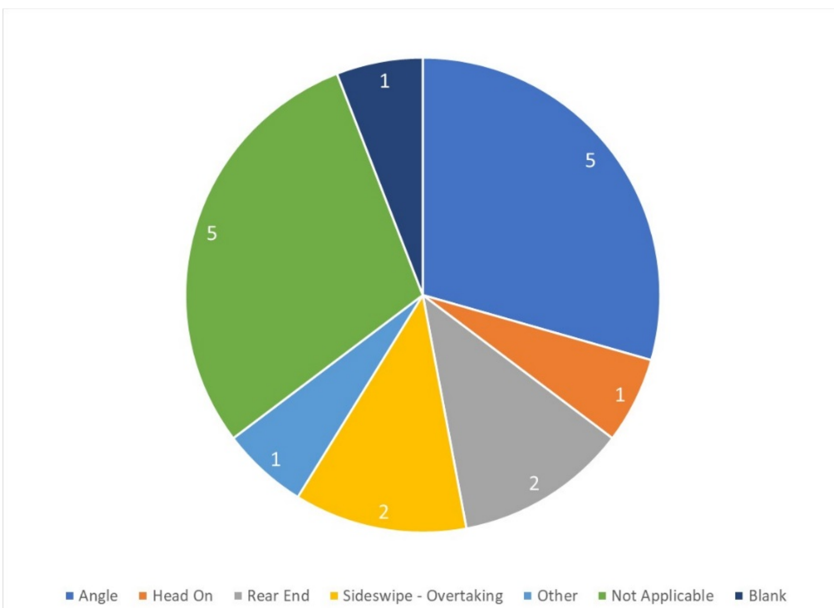

Figure 113: The Parkway & Waynewood Boulevard, Crash Type

In the crash report, there is an option to include data in the "collision with?" column. There were **five** "Not Applicable" crashes. The crashes were identified as having occurred with a tree/shrub (3), drainage structure (1), or debris or obstruction (1). The "Other" crash (which occurred in 2018), identified that the vehicle struck a median/curb, which was only identifiable because of the manner in which the new crash data was presented, with a file for crash information, vehicle information, and information about people.

The most frequently reported "Primary Cause" was "Failed to Give Full Time and Attention" (Figure 114), although by only one more crash than the other reported "Primary Causes": "Failed to Yield ROW," "Too Fast for Conditions," "Followed Too Closely," "Debris or Obstruction," "Disregarded Traffic Signs, Signals, or Road Markings," "Animal," "Sleet, Hail, Freezing Rain," or "Other." (Note: Figure 114 only shows **10 of the 17 crashes** that occurred at the intersection, as **7 crashes** provided no information on the "Primary Cause.")

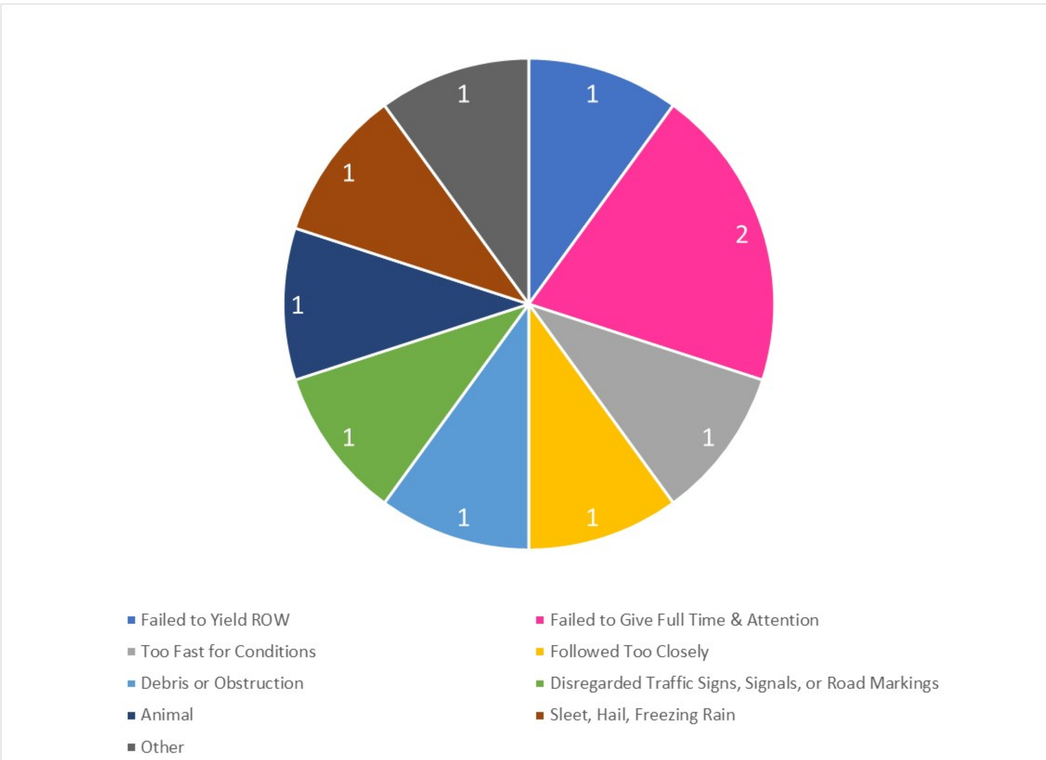

Figure 114: The Parkway & Waynewood Boulevard, Primary Cause

3.7.4 Driving Under the Influence

This section discusses crashes that were identified as involving drugs or alcohol. The tabular data provided information about whether or not a crash involved driving under the influence in the "Primary Cause" column. Of the **seventeen** crashes identified at the intersection, from 2005-2015 and 2018-2019, **zero** crashes were identified as having a driver that was under the influence of alcohol or other substances.

3.7.5 Hit & Run

This section discusses crashes identified as a hit and run. Interestingly, **one** of the **seventeen** crashes (**6.3%**) was identified as a hit-and-run crash. There are many reasons why a driver may hit an object or other vehicle and leave the scene of the crash, potentially including operating a vehicle while under the influence or being an uninsured driver.

3.7.6 Crash Severity

This section identifies the number of PDO, INJ, and FAT crashes. While Waynewood Boulevard has the second fewest number of total crashes across all study intersections, **just under half of these crashes (eight) are either injury/fatal crashes** (Figure 115).

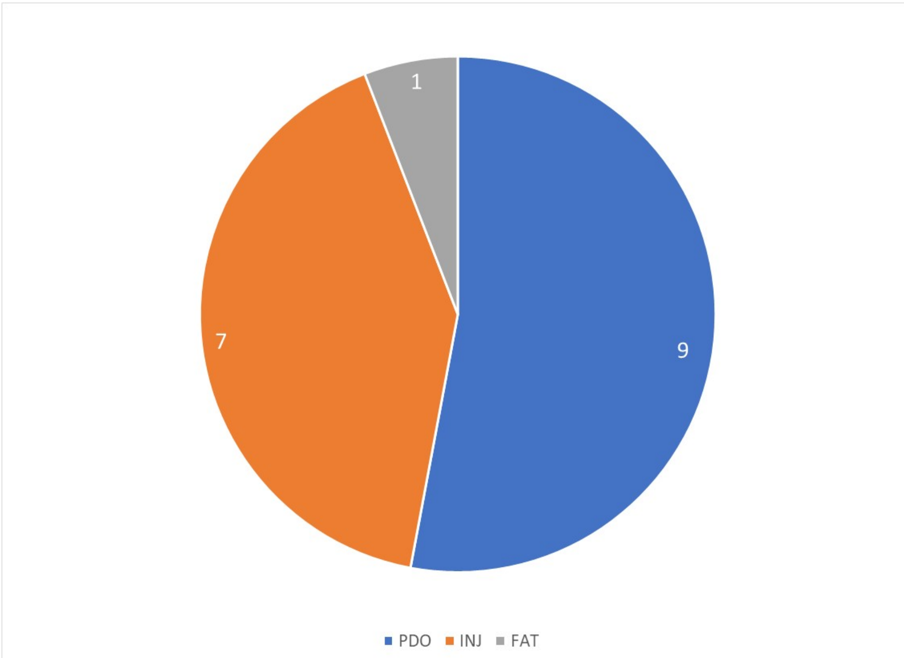

Figure 115: The Parkway & Waynewood Boulevard, Crash Severity

Across the injury and fatal crashes, there were a total of **nine** injuries and **one** fatality.

The occurrence of the injury and fatal crashes by both month, day of week, and time of day was investigated. In Figure 116, Figure 117, and Figure 118, blue represents injury crashes and orange represents the fatal crash.

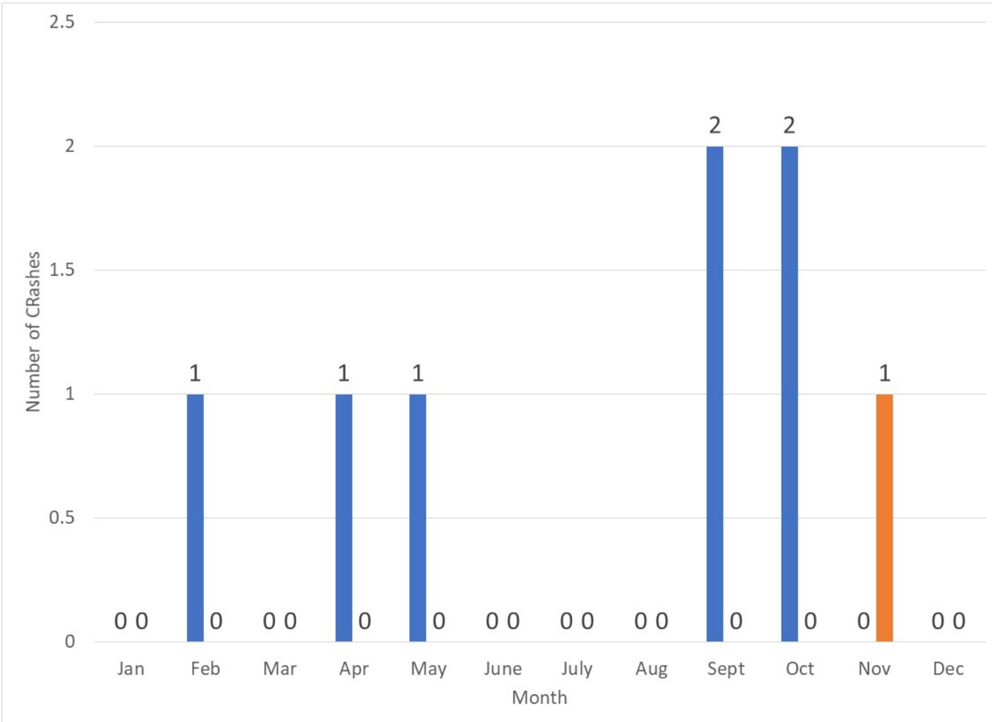

Figure 116: The Parkway & Waynewood Boulevard, Injury and Fatal Crashes by Month

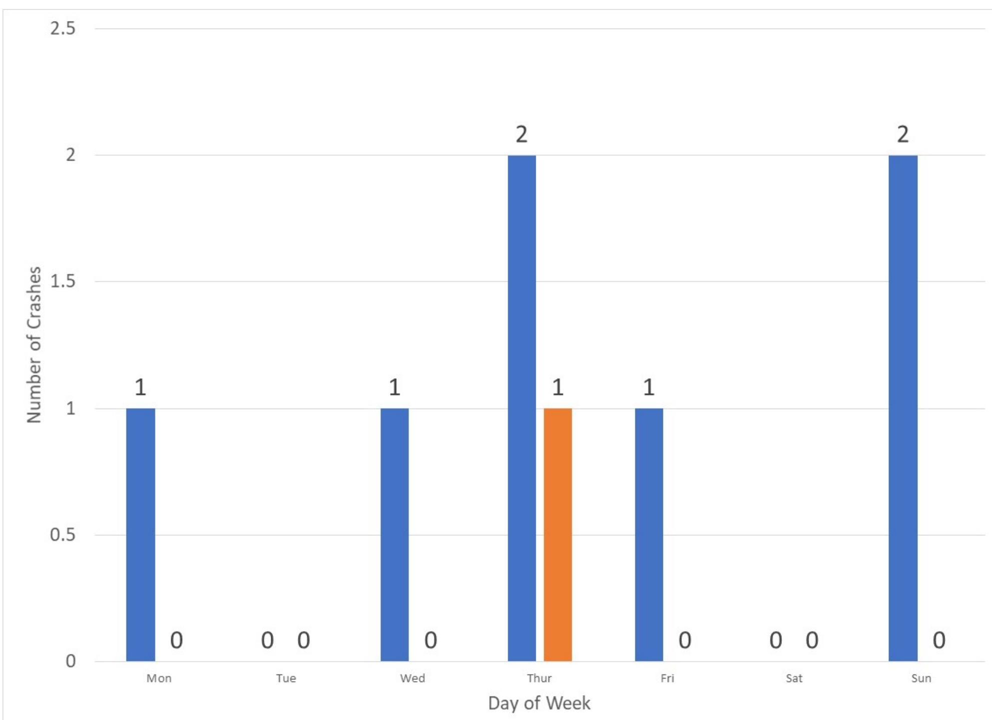

Figure 117: The Parkway & Waynewood Boulevard, Injury and Fatal Crashes by Day of the Week

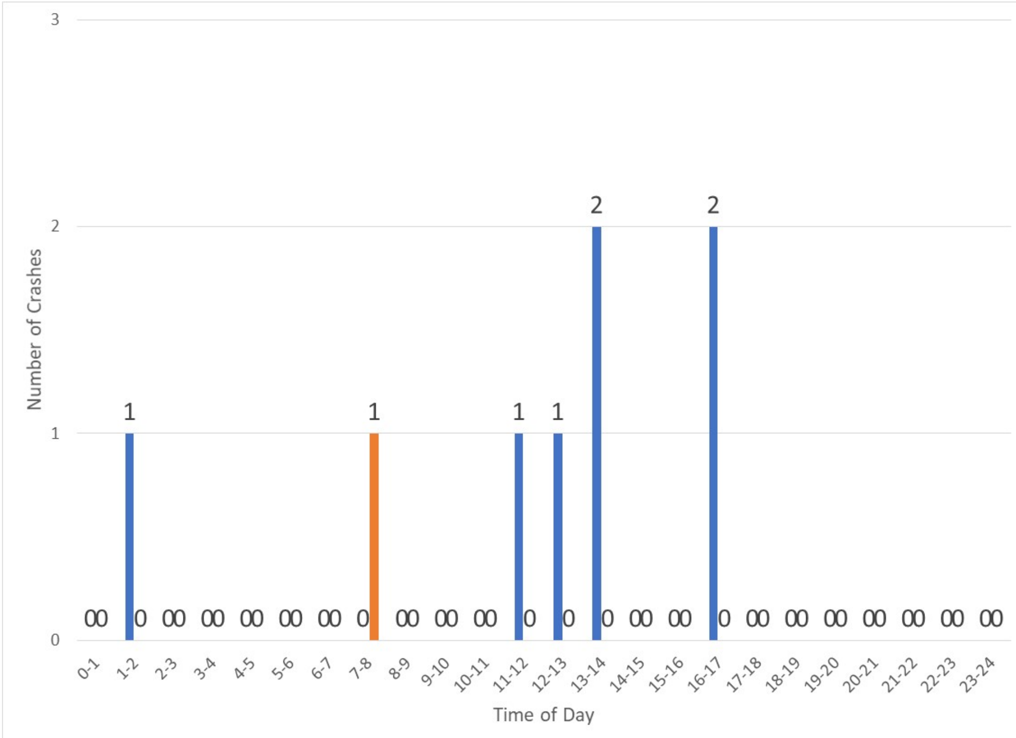

Figure 118: The Parkway & Waynewood Boulevard, Injury and Fatal Crashes by Time of Day

September and October had the greatest count of injury crashes (Figure 116); October also had the greatest number of crashes at the intersection. Considering that two injury and the only fatal crash occurred on a Thursday, an examination of why Thursdays may result in higher crash severity for this intersection may be warranted (Figure 117). Wednesday had the highest overall crash count, although Thursday only had one crash less than Wednesday. The time during which injury crashes occur appears to be random, although 1 PM-2 PM and 4 PM-5 PM have the greatest frequency (Figure 118); the 4 PM-5 PM time period was also the time period with the greatest crash count.

3.7.7 Pedestrians & Bicycle

Zero crashes between bicycles and pedestrians and a motor vehicle were reported at this intersection.

3.7.8 Crash Diagram

The following crash diagram shows the location of crashes at the intersection for which enough information was available to place them on the map. If crash type, direction of vehicle, and other factors were provided, they were mapped. Otherwise, after the figure is a note regarding why a crash could not be mapped. Crash reports were not available. Therefore, the diagram was created based on the pre-crash direction of the vehicle, and the stated crash type. As a separate file was provided for vehicle and persons for the more recent data (2018-2019), these crashes may be more accurate. However, complete data was not always provided. As such, there may be some variability between the actual crash and what is conveyed in the diagram. Figure 119 is **the best understanding of the crash occurrence at the intersection based on available information**.

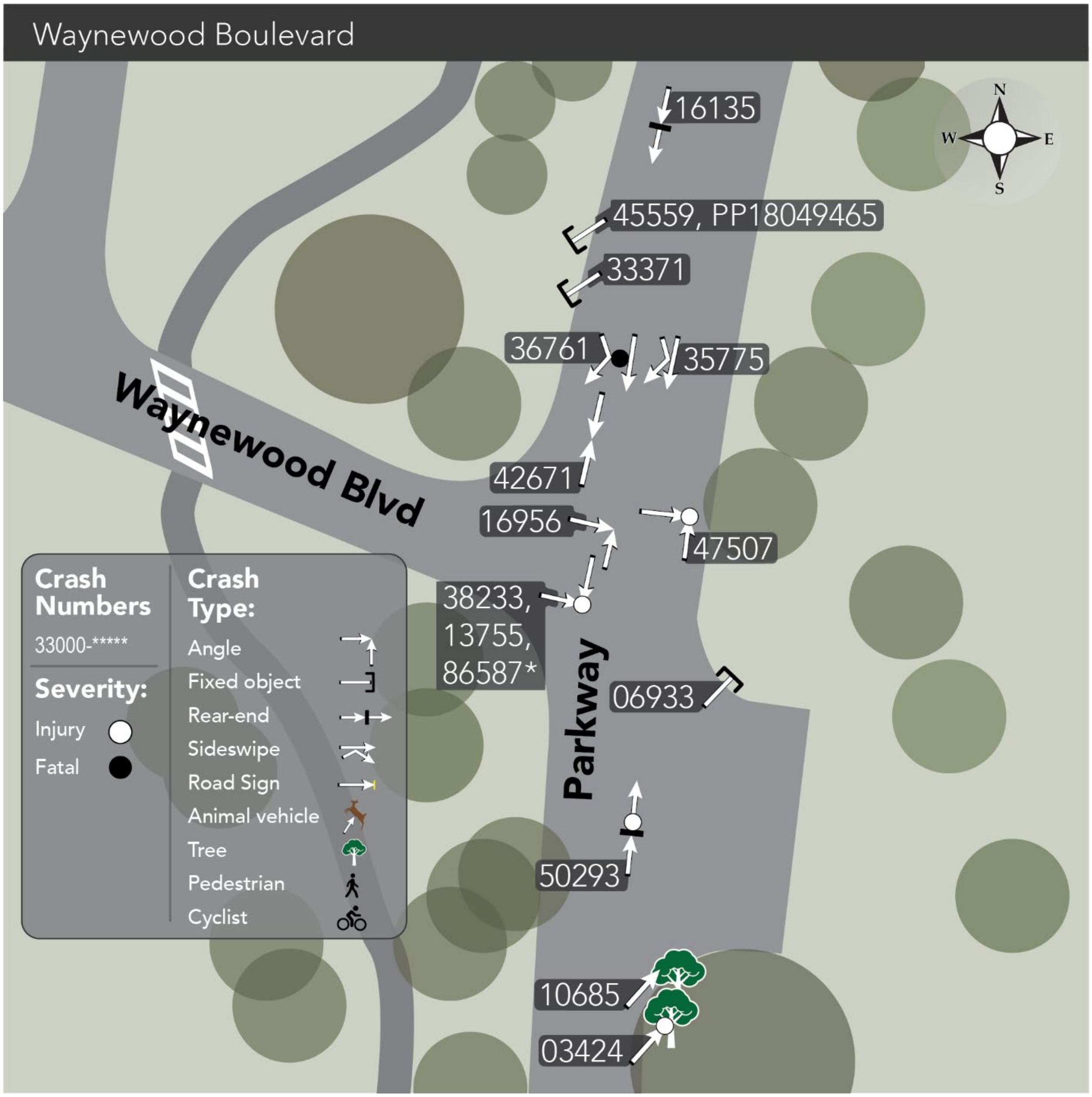

Figure 119: The Parkway & Waynewood Boulevard, Crash Diagram

*The assumption was made that a vehicle involved in the crash was traveling southbound.

A large number of the crashes occurring at this intersection appear to be from a vehicle leaving the roadway and striking an object on the roadside.

3.7.9 Summary – Waynewood Boulevard

Based on crash data from 2005-2015 and 2018-2019, the largest number of crashes occurred in 2010 and 2011; October; between 4-5pm, and on Wednesday (Table 37). What is most surprising about the crash history for this intersection is that although there are relatively few crashes, **the overall severity of the crashes is concerning**.

Table 37: The Parkway & Waynewood Boulevard, Summary of Key Data Findings

Criteria	Count
Number of Crashes	17
Year (of greatest frequency)	2010 & 2011
Month (of greatest frequency)	October
Day (of greatest frequency)	Wednesday
Percent from 12 AM to 12 PM	18%
Most Frequent 1 Hour Block	4 PM-5 PM
Most Frequent Time Period (pre-AM PEAK; AM PEAK; mid-day; PM PEAK; post-PM PEAK)	PM Peak
Might lighting be an issue?	Yes
Is weather a contributing factor?	Yes
Might the surface condition be a factor?	Unlikely
Most Typical Crash Type	Angle & Not Applicable
Most Typical Reported Cause	Failed to Yield ROW (2 of 17)
Driving Under the Influence	Zero crashes (0 of 17)
Hit & Run	5.9% of crashes (1 of 17)
Percent of Injury & Fatal Crashes (measure of severity)	47% (8 of 17)
Total Number of People Injured in Crashes	10 people*
Pedestrian/Bicycle Involved Crashes?	No; 0% (0 of 17)
Animal Involved Crashes?	Yes; 5.9% (1 of 17)

*9 injured; 1 died

3.8 The Parkway & Vernon View Drive

Figure 120 shows the orientation of the Parkway and Vernon View Drive, a three-legged intersection without a median.

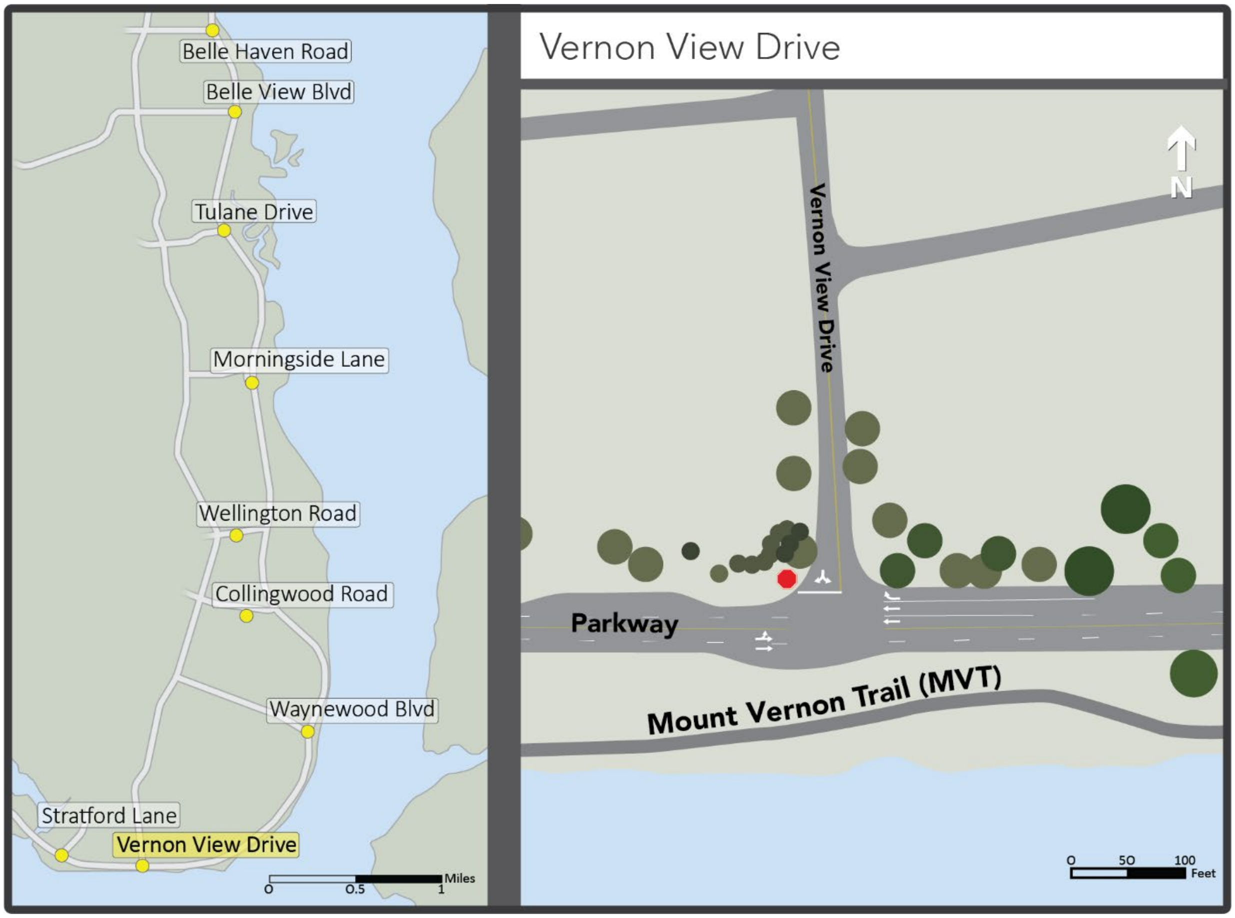

Figure 120: The Parkway & Vernon View Drive

There are a few interesting geometric considerations at this intersection. While River Farm Drive is near the intersection, there is more of a gap between the two intersections of the Parkway/Vernon View Drive and Vernon View Drive/River Farm Drive than at other intersections in the corridor where a parallel roadway exists to the Parkway. The pull out on both the north side and south side of the Parkway (which appear to be bus stops), which are west of the intersection, could potentially present challenges for drivers when following pavement markings. Also, on the south side of the intersection, notice the close proximity of MVT. While there is not a clearly established pedestrian/bicyclist crossing, there could be an interest by the residents to the east to access the MVT at this intersection.

From 2005-2015 and 2018-2019, a total of **twenty-four** crashes were identified at the intersection of the Parkway and Vernon View Drive. Generally speaking, the annual occurrence of crashes appears random, although **2009** had the greatest number of crashes reported (Figure 121). There were no reported crashes at this intersection in 2012, 2014, 2015, and 2019.

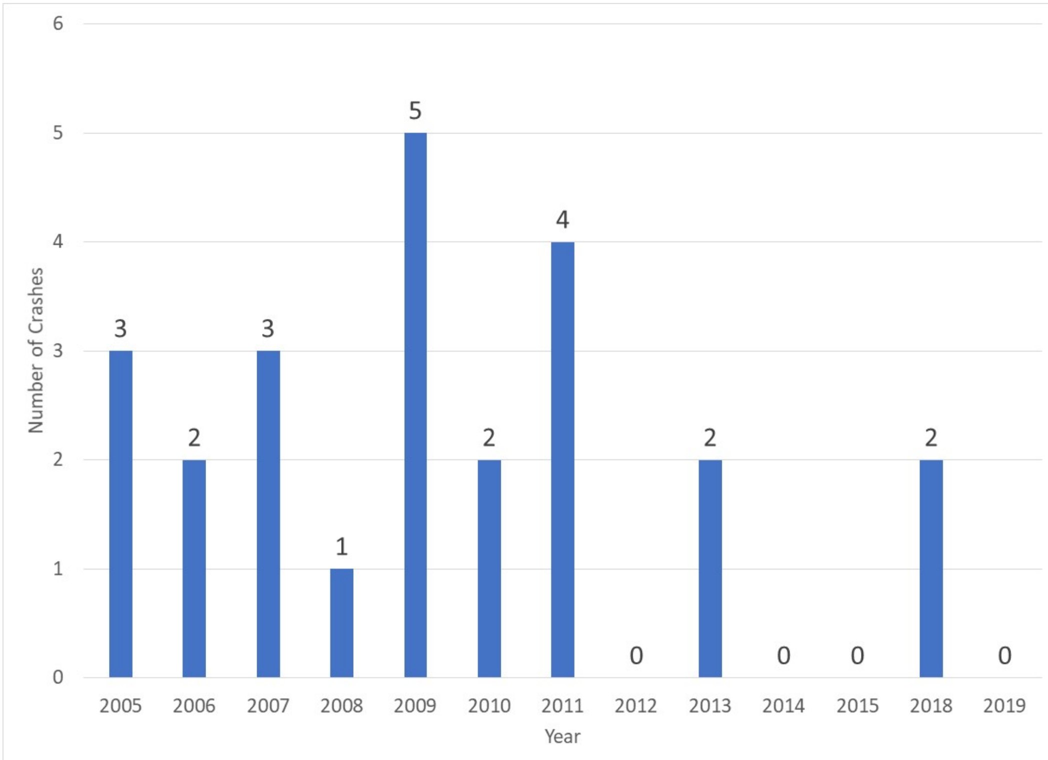

Figure 121: The Parkway & Vernon View Drive, Total Crashes by Year

3.8.1 Temporal

This section discusses patterns identified by month, time, and day of the week.

Based on data from the available years (2005-2015, 2018-2019), crashes occurred most frequently in **April** (Figure 122).

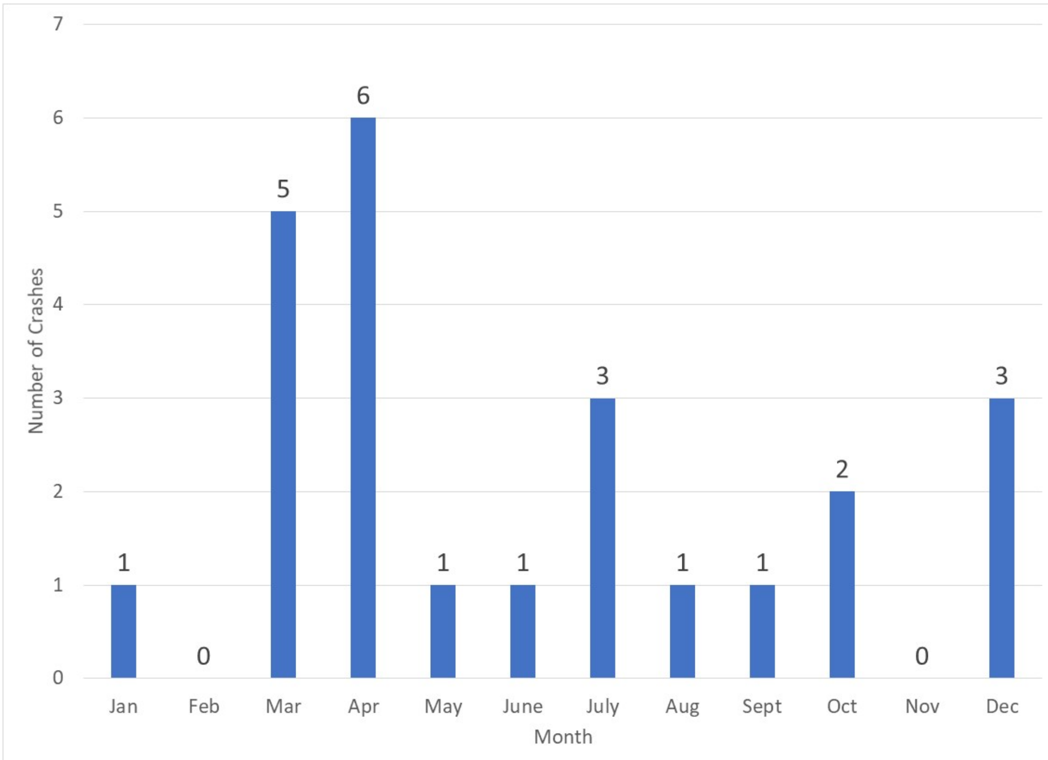

Figure 122: The Parkway & Vernon View Drive, Crashes by Month

The WTI Team separated crashes into an AM period (12 AM and 12 PM) and a PM period (12 PM and 12 AM) to investigate if crashes occurred more often in the AM or PM. **Twenty-four percent** of all crashes occurred in the AM period.

Assigning each crash to a one-hour time period across the entire day, the most frequent number of crashes occurred from **3 PM-4 PM, 5 PM-6 PM and 6 PM-7 PM** (Figure 123); generally speaking, this is during the PM Peak time period.

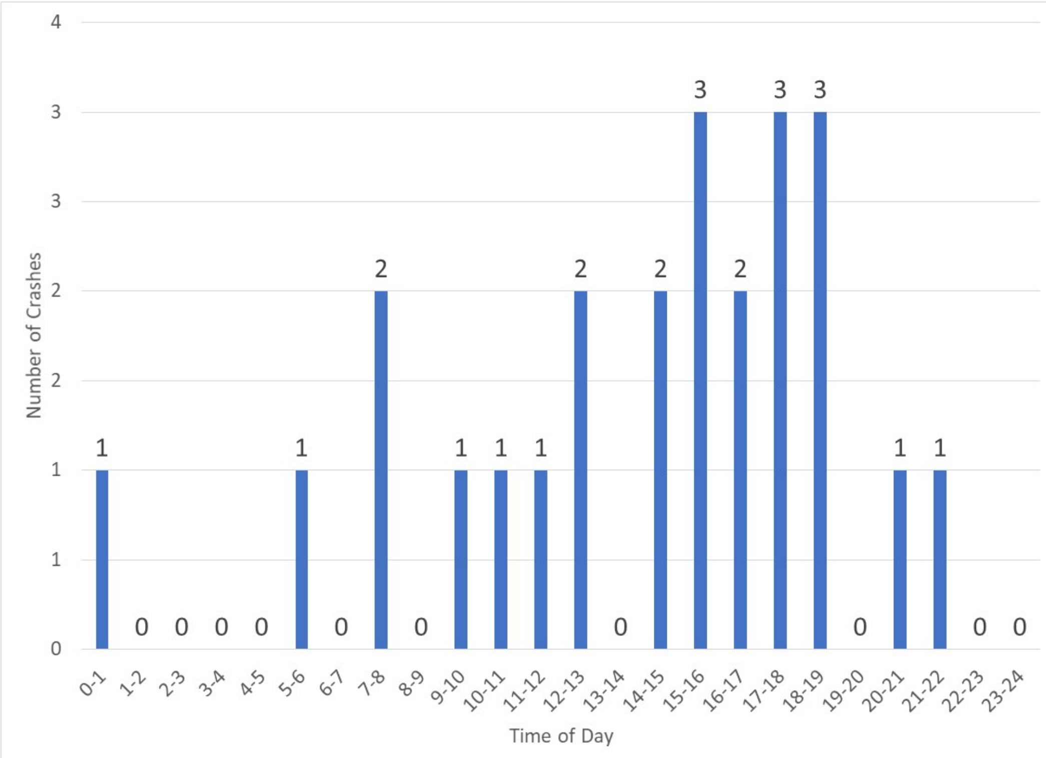

Figure 123: The Parkway & Vernon View Drive, Crashes by Time of Day

The WTI Team binned the crashes into pre-AM PEAK, AM PEAK, mid-day, PM PEAK, and post-PM PEAK crash time periods. Considering the frequency of crashes per hour, the largest number and highest rate of crashes occurred during the **PM PEAK** time period (Table 38).

Table 38: The Parkway & Vernon View Drive, Crash Counts & Rate by Time Period

Time Period		Number of Crashes	Crashes/Hour
12 AM-6 AM	pre-AM PEAK	2	0.33
6 AM-9 AM	AM PEAK	2	0.67
9 AM-3 PM	mid-day	7	1.2
3 PM-6 PM	PM PEAK	**8**	**2.3**
6 PM-12 AM	post-PM PEAK	5	0.9
TOTAL		22	-

The day of the week that is most represented in crash records is **Saturday** (Figure 124).

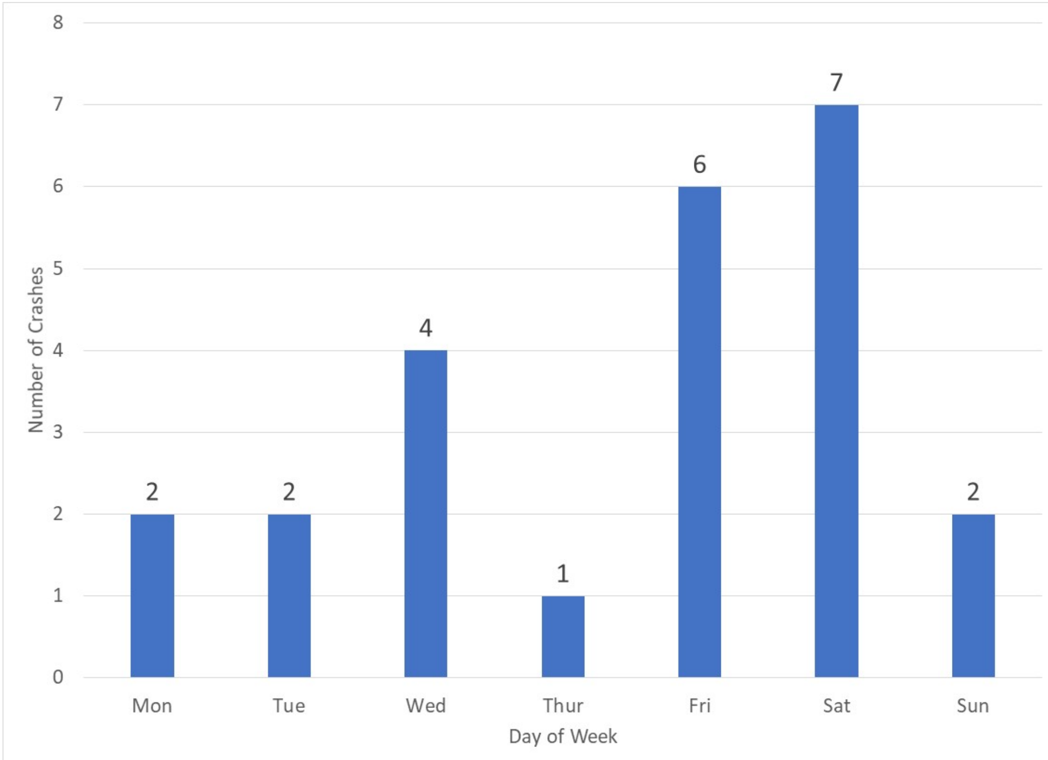

Figure 124: The Parkway & Vernon View Drive, Crashes by Day of the Week

The results suggest the possibility of factors occurring on Saturday that are contributing to crash occurrence; Friday is only one crash behind.

3.8.2 Environment

This section discusses how lighting, weather, and the road surface may have influenced crash occurrence.

The WTI Team analyzed the lighting condition identified during a crash (Figure 125).

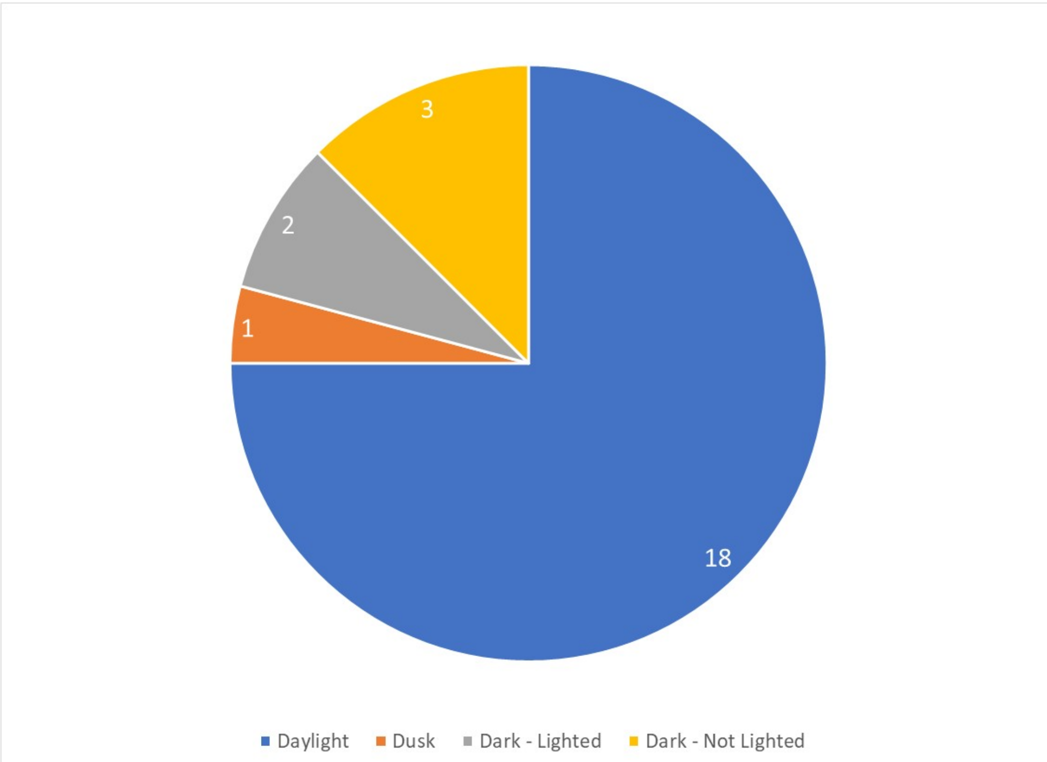

Figure 125: The Parkway & Vernon View Drive, Lighting (number of crashes during each lighting condition)

Some of the data was inconsistent. **Three** crashes indicated that the intersection was "Dark – Not Lighted" with **two** indicating "Dark – Lighted." The Parkway does not have lighting on the roadway in the study section; therefore, "Dark – Lighted" must be an error.

Most crashes (**eighteen**) were identified as having occurred during "Daylight." Looking at the data in more detail, of the crashes that occurred during "Daylight," **two** of these crashes were during periods when conditions were indicated as: 1) Cloudy or 2) Rain. These conditions would suggest that the crash occurred when there was reduced visibility. Reducing the **eighteen** crashes by these **two** crashes results in a total of **sixteen** crashes remaining during "Daylight." As the majority of crashes still occurred during "Daylight," lighting does **not** seem to be an issue at the intersection.

The researchers also considered whether the "Daylight" crashes occurred during peak periods. (Note: We anticipated that "Daylight" crashes should be reported less frequently during the 12 AM-6 AM and 6 PM to 12 PM time periods, as the sun may have set or may not have risen.) Crashes were grouped into non-peak and peak-periods: 12 AM-6 AM, 6 AM-9 AM (AM PEAK),

9 AM-3 PM, 3 PM-6 PM (PM PEAK), 6 PM-12 AM. Table 39 shows the number of crashes within these groups.

Table 39: The Parkway & Vernon View Drive, "Daylight" Crash Counts & Rates by Time Period

Time Period		Number of Crashes	Crashes/Hour
12 AM-6 AM	pre-AM PEAK	1	0.2
6 AM-9 AM	AM PEAK	1	0.3
9 AM-3PM	mid-day	7	1.2
3 PM-6 PM	PM PEAK	7	**2.3**
6 PM-12 AM	post-PM PEAK	2	0.3
TOTAL "Daylight" Crashes		18	-

"Daylight" crashes were most likely to occur during the PM PEAK and least likely to occur from 12 AM to 6 AM (pre-AM PEAK).

With regard to weather, more than three quarters (**nineteen**) occurred during "Clear" periods (Figure 126); this suggests that weather is not a contributing factor.

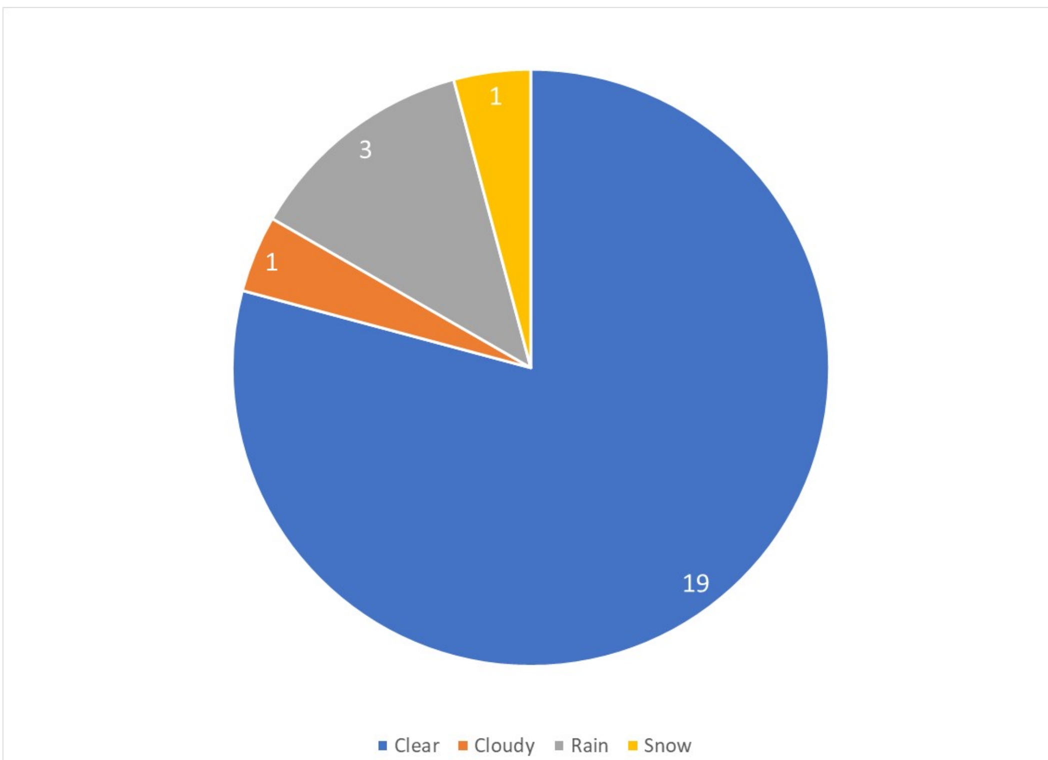

Figure 126: The Parkway & Vernon View Drive, Weather

The majority of the crashes (**twenty**) occurred when surface conditions were "Dry," which suggests that surface condition is unlikely to be an issue (Figure 127).

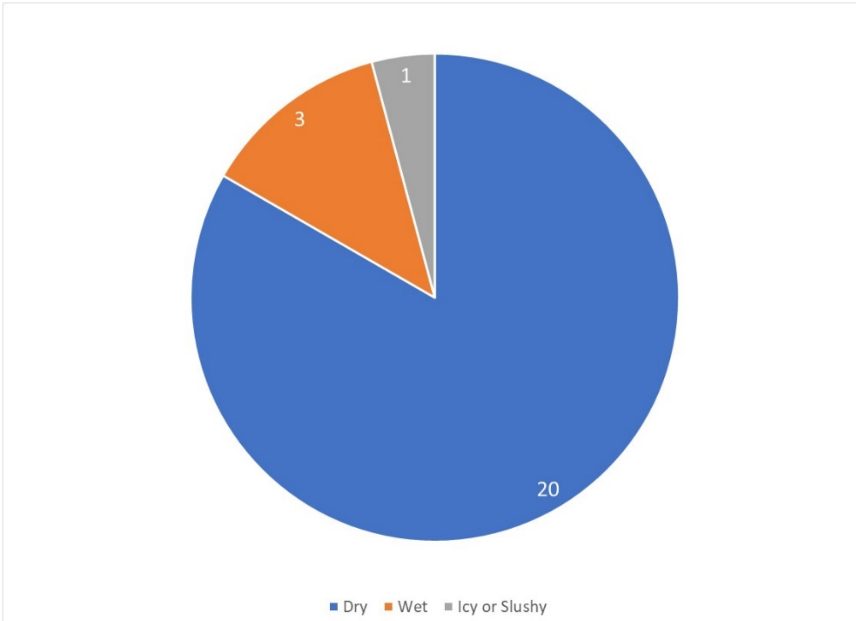

Figure 127: The Parkway & Vernon View Drive, Surface Condition

3.8.3 Crashes Contributing to Crashes

This section discusses the vehicle collision type, the indicated primary cause of the crash, and whether the collision was between vehicles or with an object.

One category of the tabular data provided information about the vehicle collision type. "Rear End" was the most common crash type (**fifteen**) (Figure 128), accounting for approximately **63%** of all crashes.

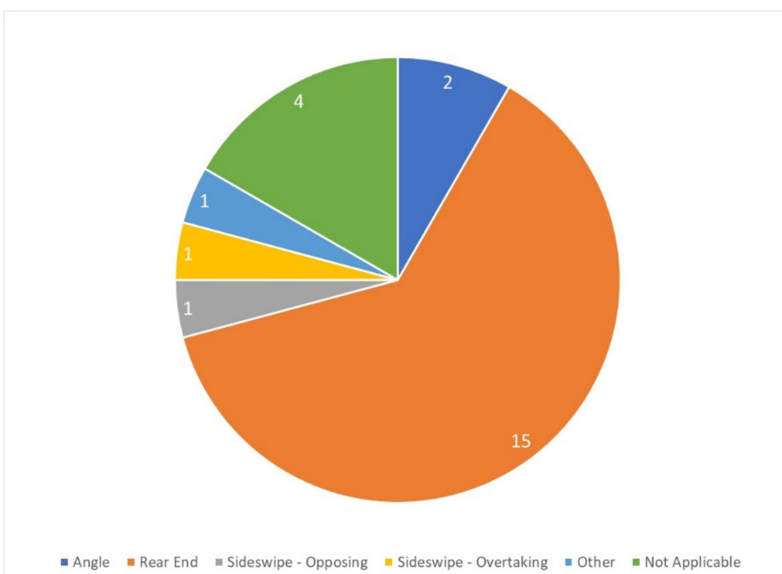

Figure 128: The Parkway & Vernon View Drive, Crash Type

Four crashes were identified as "Not Applicable." In the crash report, there is an option to include data in the "collision with?" column. The crashes were identified as having occurred with a tree/shrub (2), bridge structure (1), and ditch (1).

The most reported "Primary Cause" was "Other" (Figure 129), which was reported in **7 of the 24 crashes (29%)**. (Note: Figure 129 only shows **19 of the 24 crashes** that occurred at the intersection, as **5 crashes** provided no information on the "Primary Cause.")

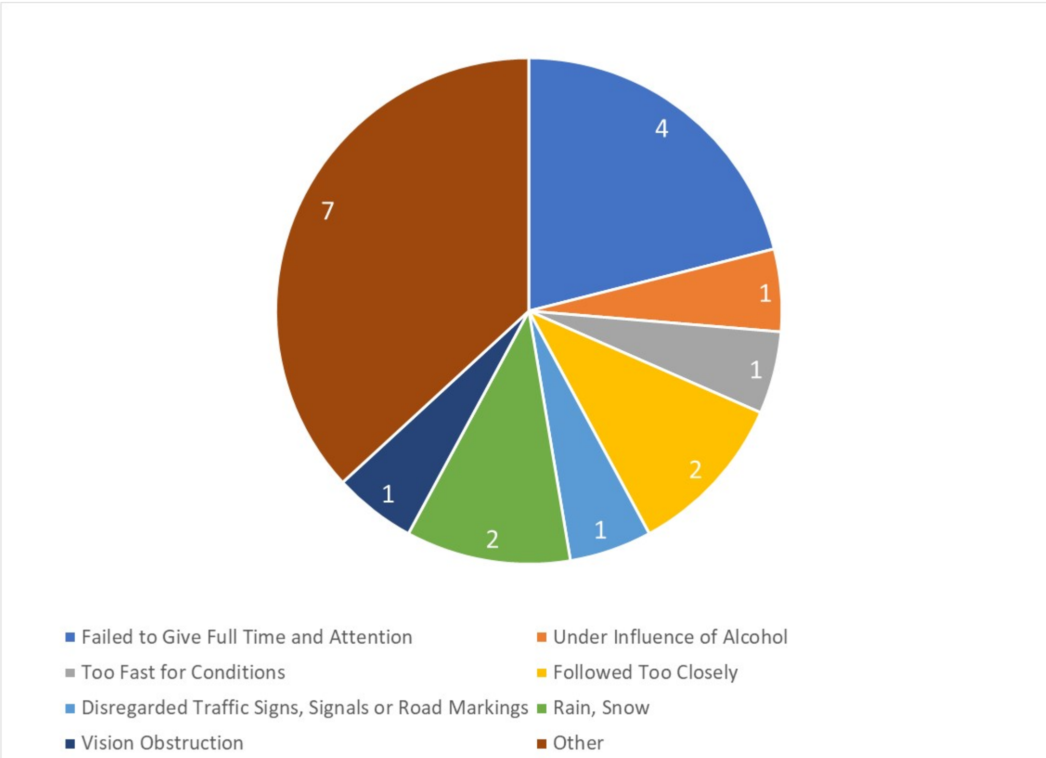

Figure 129: The Parkway & Vernon View Drive, Primary Cause

"Failed to Give Full Time and Attention" was the second most frequently identified "Primary Cause" (**four**), which is expected considering the most frequently reported crash type (i.e. rear-end).

3.8.4 Driving Under the Influence

This section discusses crashes that were identified as involving drugs or alcohol. The tabular data provided information about whether or not a crash involved driving under the influence in the "Primary Cause" column. Of the **twenty-four** crashes identified at the intersection, from 2005-2015 and 2018-2019, **one crash** (**4.2%**) was identified as having a driver that was under the influence of alcohol or other substances. However, this information was left blank on both of the 2018-2019 crashes.

3.8.5 Hit & Run

This section discusses crashes identified as a hit and run. Interestingly, **two** of the **twenty-four** crashes (**8.3%**) were identified as hit-and-run crashes. There are many reasons why a driver may hit an object or other vehicle and leave the scene of the crash, potentially including operating a vehicle while under the influence or being an uninsured driver.

3.8.6 Crash Severity

This section identifies the number of PDO, INJ, and FAT crashes. About **thirty-eight percent** of the crashes (**nine**) at Vernon View Drive were injury crashes. However, the level of severity was not provided for the 2018-2019 crashes. Overall, there is a high occurrence of severe accidents (Figure 130).

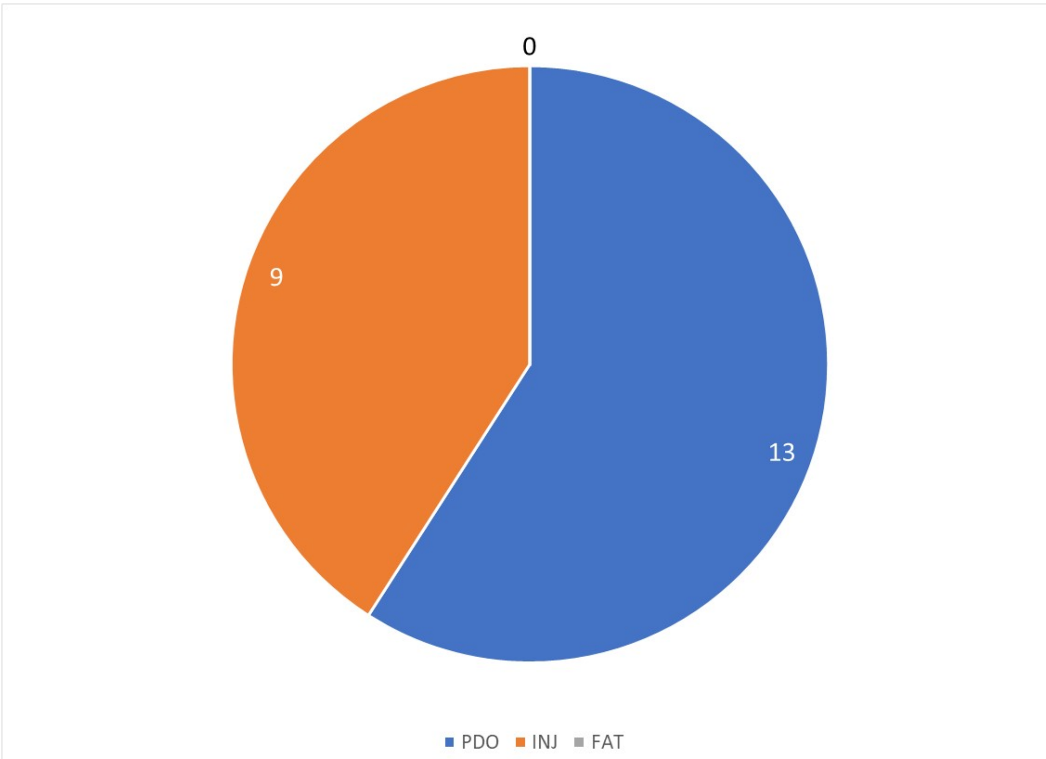

Figure 130: The Parkway & Vernon View Drive, Crash Severity

Across the injury crashes, there were a total of **fifteen** injuries; this information was not provided for the 2018-2019 crashes.

The occurrence of the injury crashes by month, day of week, and time of day was investigated (Figure 131, Figure 132, and Figure 133). (Note: This information was not provided for the 2018-2019 crashes).

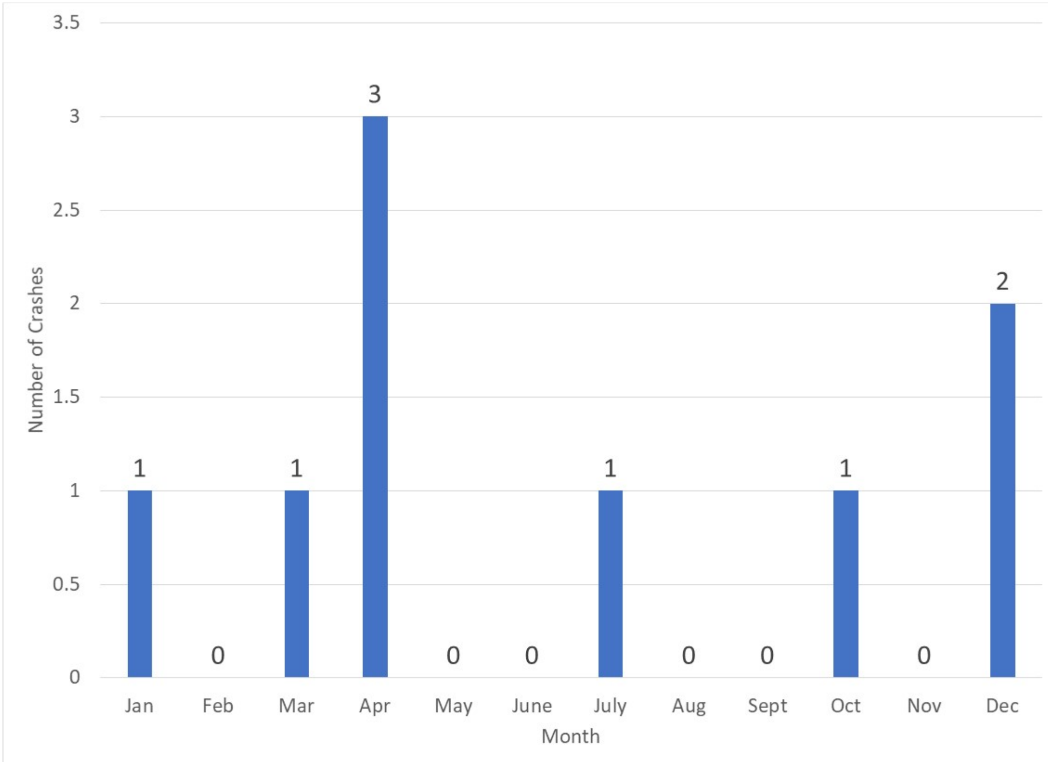

Figure 131: The Parkway & Vernon View Drive, Injury Crashes by Month

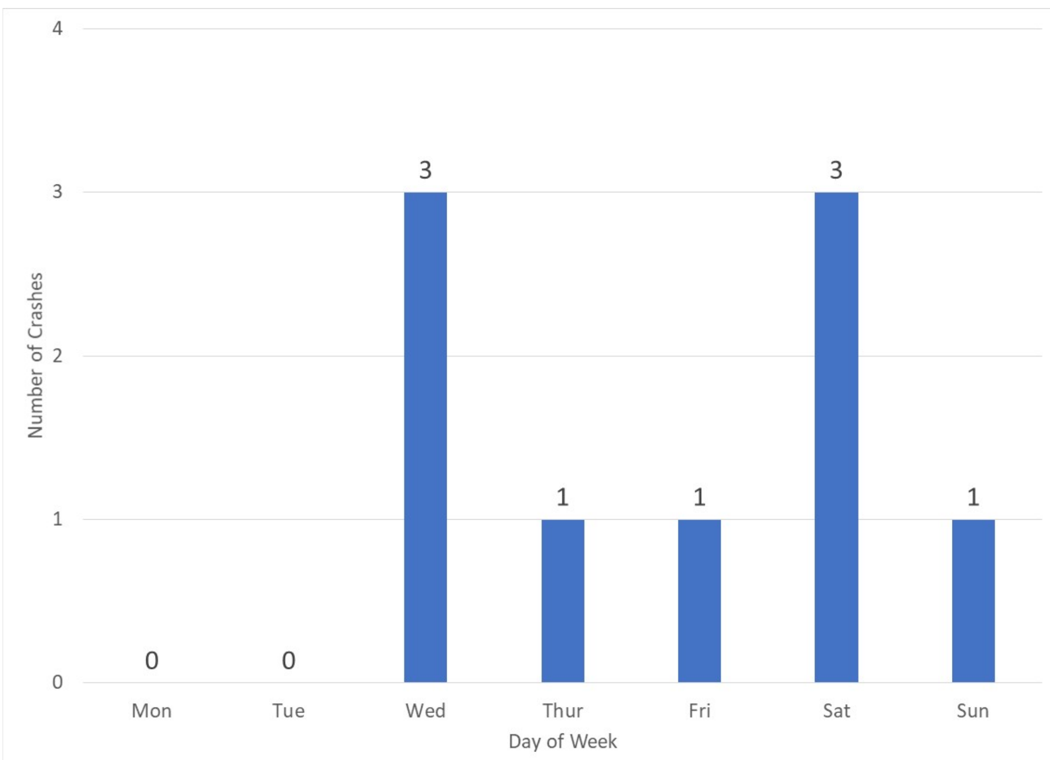

Figure 132: The Parkway & Vernon View Drive, Injury Crashes by Day of the Week

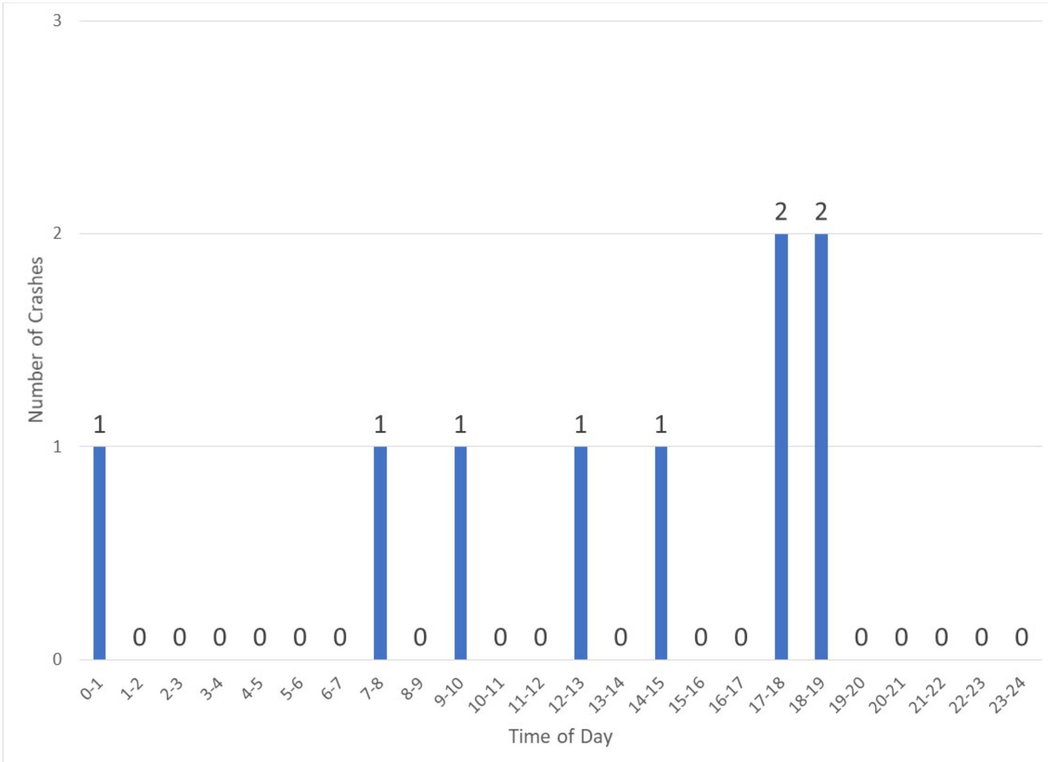

Figure 133: The Parkway & Vernon View Drive, Injury Crashes by Time of Day

April; Wednesday, and Saturday; and 5 PM-6 PM and 6 PM-7 PM seem to have a higher probability of injury crashes (Figure 131, Figure 132, and Figure 133). April was also the month with the highest crash count; Saturday was also the day of the week with the highest crash count; and 5 PM-6 PM and 6 PM-7 PM were also the time periods with the highest crash counts. This means that the month, day of the week, and time of day with the highest crash counts also have the highest potential for injury crashes.

3.8.7 Pedestrians & Bicycle

Zero crashes between bicycles/pedestrians and a motor vehicle were reported at this intersection.

3.8.8 Crash Diagram

The following crash diagram shows the location of crashes at the intersection for which enough information was available to place them on the map. If crash type, direction of vehicle, and other factors were provided, they were mapped. Otherwise, after the figure is a note regarding why a crash could not be mapped. Crash reports were not available. Therefore, the diagram was created based on the pre-crash direction of the vehicle, and the stated crash type. As a separate file was provided for vehicle and persons for the more recent data (2018-2019), these crashes may be more accurate. However, complete data was not always provided. As such, there may be some variability between the actual crash and what is conveyed in the diagram. Figure 134 is **the best understanding of the crash occurrence at the intersection based on available information**.

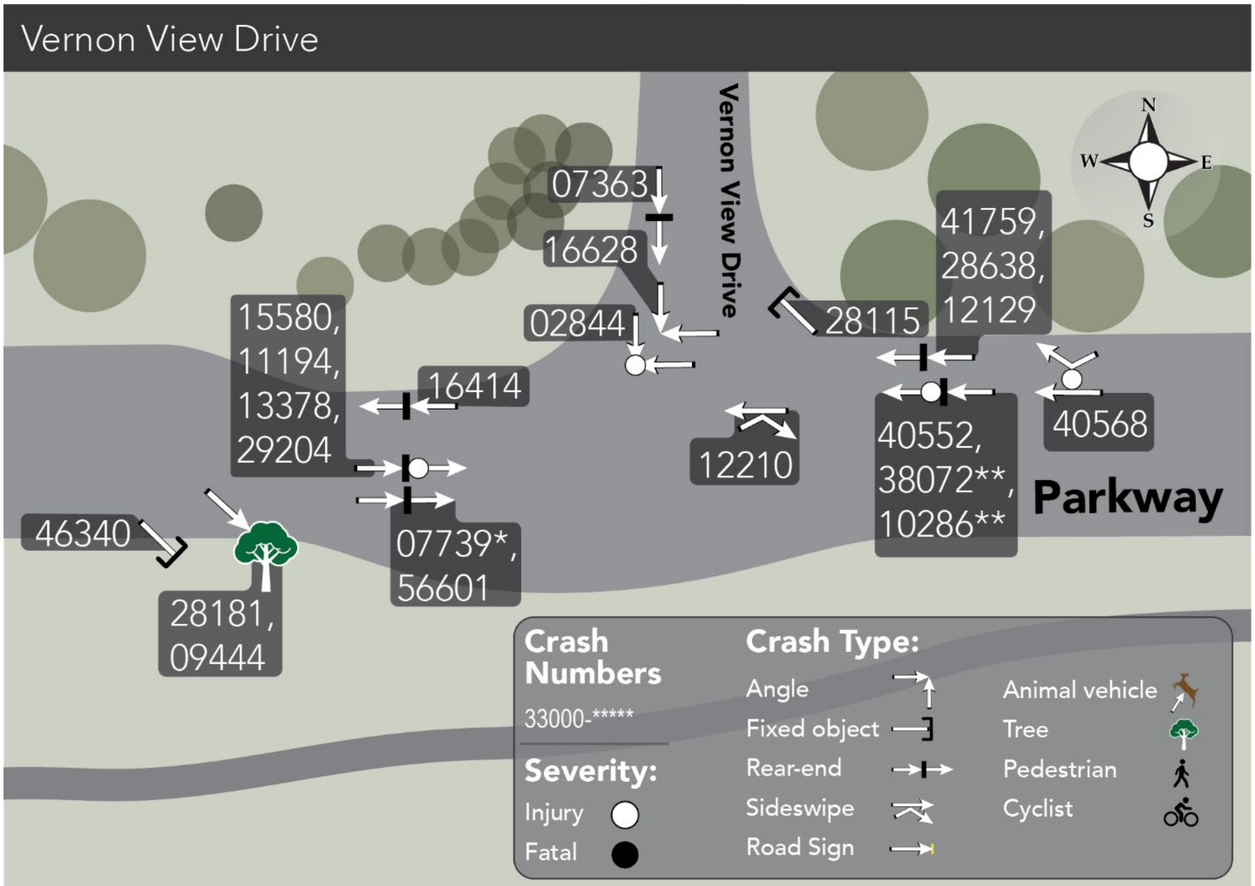

Figure 134: The Parkway & Vernon View Drive, Crash Diagram

*The assumption was made that a vehicle involved in the crash was traveling eastbound.

** The assumption was made that a vehicle involved in the crash was traveling westbound.

Neither of the two crashes from 2018-2019 could be placed. The information for PP18035665 indicated that it was a rear-end in the northbound direction. This could potentially be eastbound along the Parkway (as there is no northbound direction; it is a T-intersection); however, it is unclear. No information was available regarding severity. PP18051762 indicated that the vehicle was traveling northbound and crashed into a median/curb. No information was available regarding the severity, and it is unclear if the vehicle was heading east or was trying to turn northbound onto Vernon View Drive and hit a median/curb.

The rear-end crash type appears most frequently at the Parkway and Vernon View Drive. This could potentially suggest that vehicles may be "tailgating" (traveling with not enough distance between them given the travel speeds). This seems to be more of the concern than vehicles not being able to accelerate fast enough, as the tabular crash data seemed to suggest that the rear-end crashes occurred on the approach to the intersection, regardless of whether or not the vehicles were traveling north or south. A turn-bay to facilitate left-turns in the northbound direction could help, although a turn lane already exists in the southbound direction. Additionally, there seems to be indecision or impatience by motorists at this location because there are reported sideswipes in addition to rear-end crashes. Speed is therefore likely a factor contributing to crashes.

3.8.9 Summary – Vernon View Drive

Based on crash data from 2005-2015 and 2018-2019, the largest number of crashes occurred in 2009; April; between 3 PM-4 PM, 5 PM-6 PM and 6 PM-7 PM; and on Saturday (Table 40). Of the small number of crashes at the intersection, a notable percentage was attributed to hit-and-run crashes.

Table 40: The Parkway & Vernon View Drive, Summary of Key Data Findings

Criteria	Count
Number of Crashes	24
Year (of greatest frequency)	2009
Month (of greatest frequency)	April
Day (of greatest frequency)	Saturday
Percent from 12 AM to 12 PM	24%
Most Frequent 1 Hour Block	3 PM-4 PM, 5 PM-6 PM, 6 PM-7 PM
Most Frequent Time Period (pre-AM PEAK; AM PEAK; mid-day; PM PEAK; post-PM PEAK)	PM Peak
Might lighting be an issue?	No
Is weather a contributing factor?	No
Might the surface condition be a factor?	No
Most Typical Crash Type	Rear End
Most Typical Reported Cause	Other (7 of 24)
Driving Under the Influence	4.2% of crashes (1 of 24)
Hit & Run	8.3% of crashes (2 of 24)
Percent of Injury & Fatal Crashes (measure of severity)	38% (9 of 24)
Total Number of People Injured in Crashes	15 people
Pedestrian/Bicycle Involved Crashes?	No; 0% (0 of 24)
Animal Involved Crashes?	No; 0% (0 of 24)

3.9 The Parkway & Stratford Lane

Figure 135 shows the orientation of the Parkway and Stratford Lane, a four-legged intersection with a median.

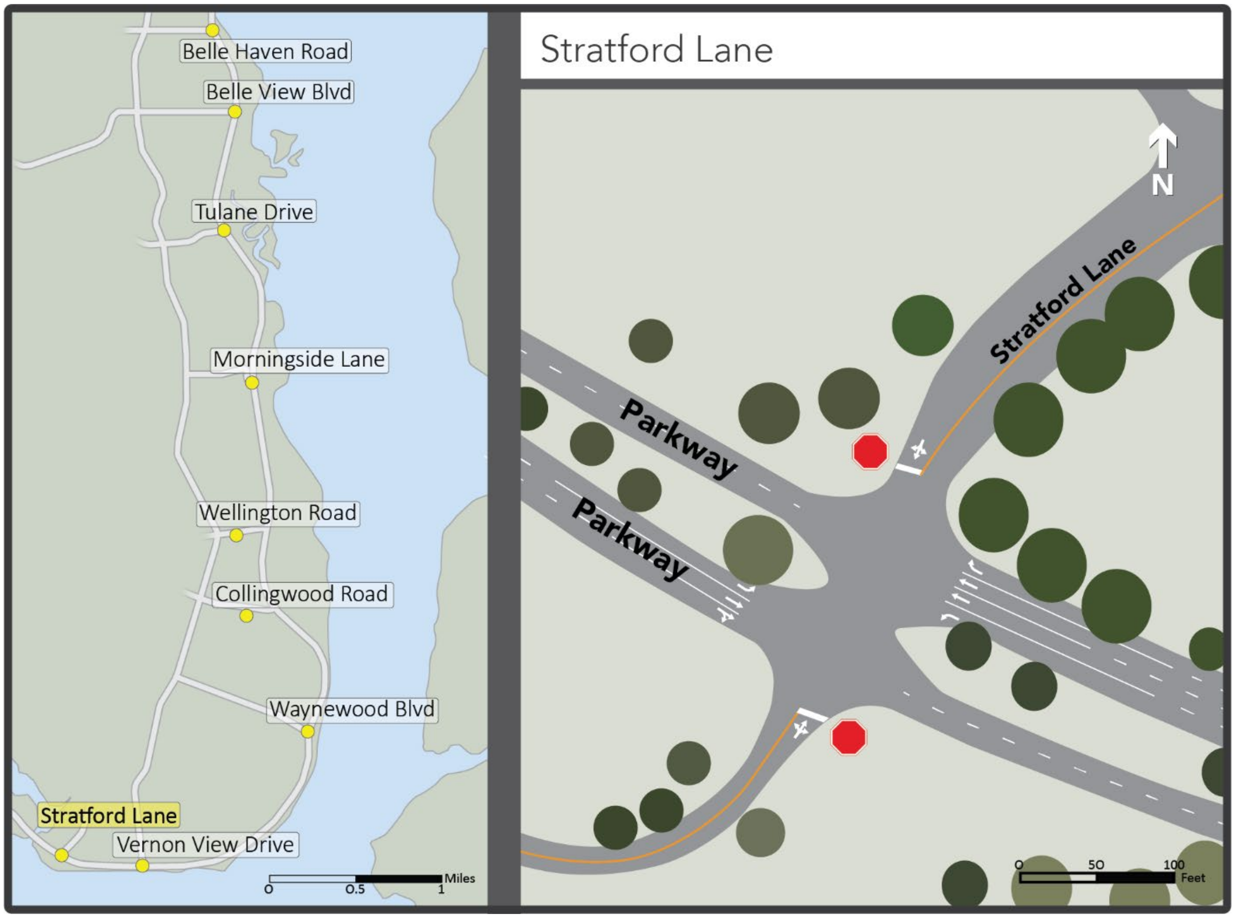

Figure 135: The Parkway & Stratford Lane

Riverside Park is accessed by the east side of this intersection; therefore, those accessing the park are likely recreational users. Just a bit north of the intersection on the west side is a bus stop with no facilities for people waiting or walking to/from the bus stop.

From 2005-2015 and 2018-2019, a total of **twelve** crashes were identified at the intersection of the Parkway and Stratford Lane; this intersection had the lowest crash occurrence. Stratford was incorrectly spelled with the following versions: Stradford, Strafford, Stratford Landing, Stradford Land, and Strathman Lane. Generally speaking, the annual occurrence of crashes appears random, although **2007** had the greatest number of crashes reported (Figure 136); if there is a trend that can be observed, it would be decreasing for this intersection. Several years did not have any crashes including 2005, 2008, 2010, 2014 and 2015.

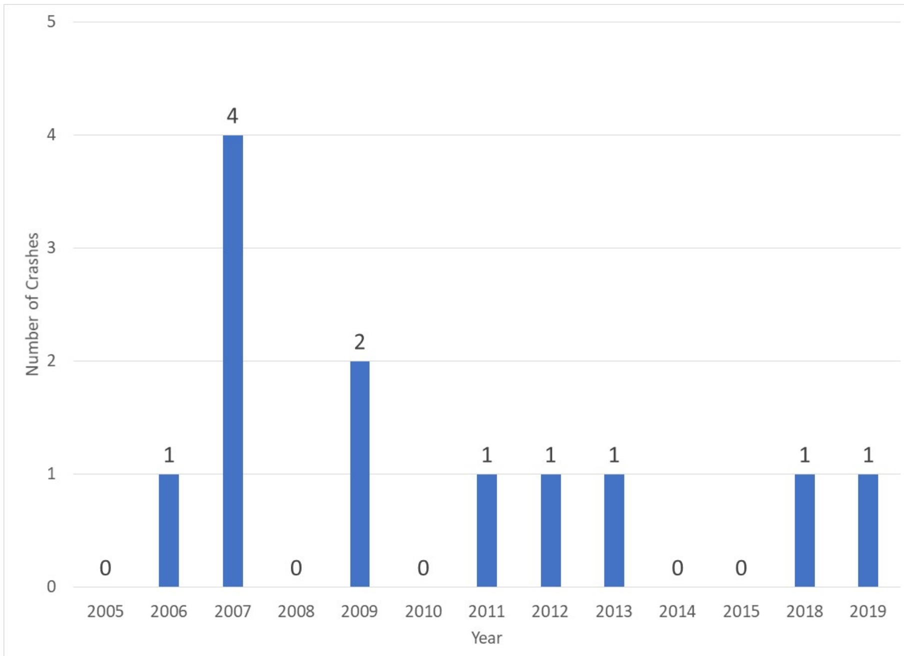

Figure 136: The Parkway & Stratford Lane, Total Crashes by Year

3.9.1 Temporal

This section discusses patterns identified by month, time, and day of the week.

Based on data from the available years (2005-2015 and 2018-2019), crash occurrence appears random, although the highest counts occurred in **February, April, September, November and December** (Figure 137).

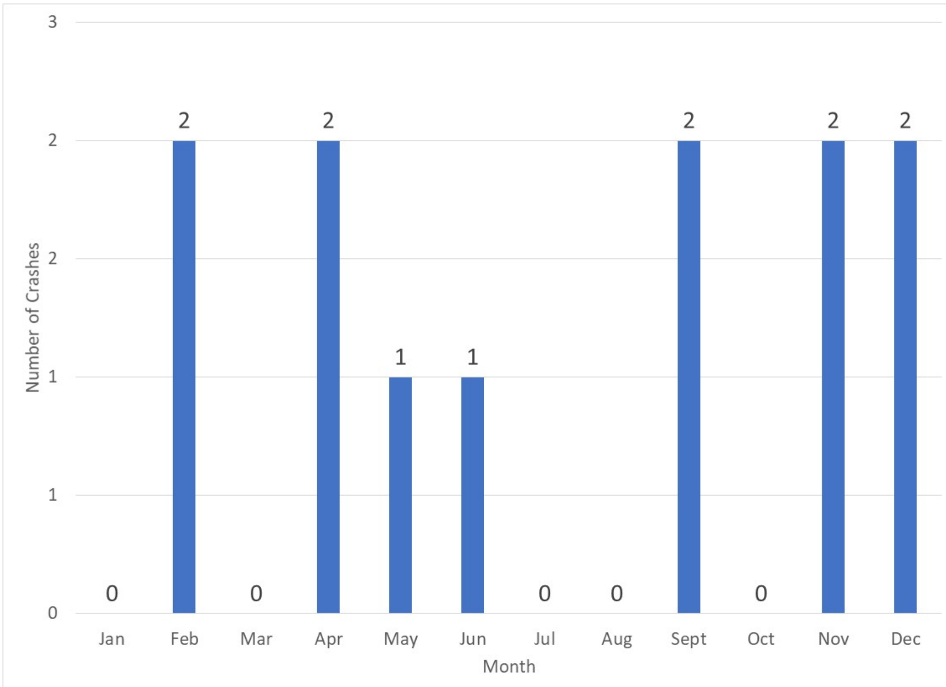

Figure 137: The Parkway & Stratford Lane, Crashes by Month

The WTI Team separated crashes into an AM period (12 AM to 12 PM) and a PM period (12 PM to 12 AM) to investigate if crashes occurred more often in the AM or PM. **Thirty-three percent** of all crashes occurred in the AM period.

Assigning each crash to a one-hour time period across the entire day, the most frequent number of crashes occurred from **9 AM-10 AM and 5 PM-6 PM**, although the count was only one greater than the rest of the time periods when a crash was recorded (Figure 138).

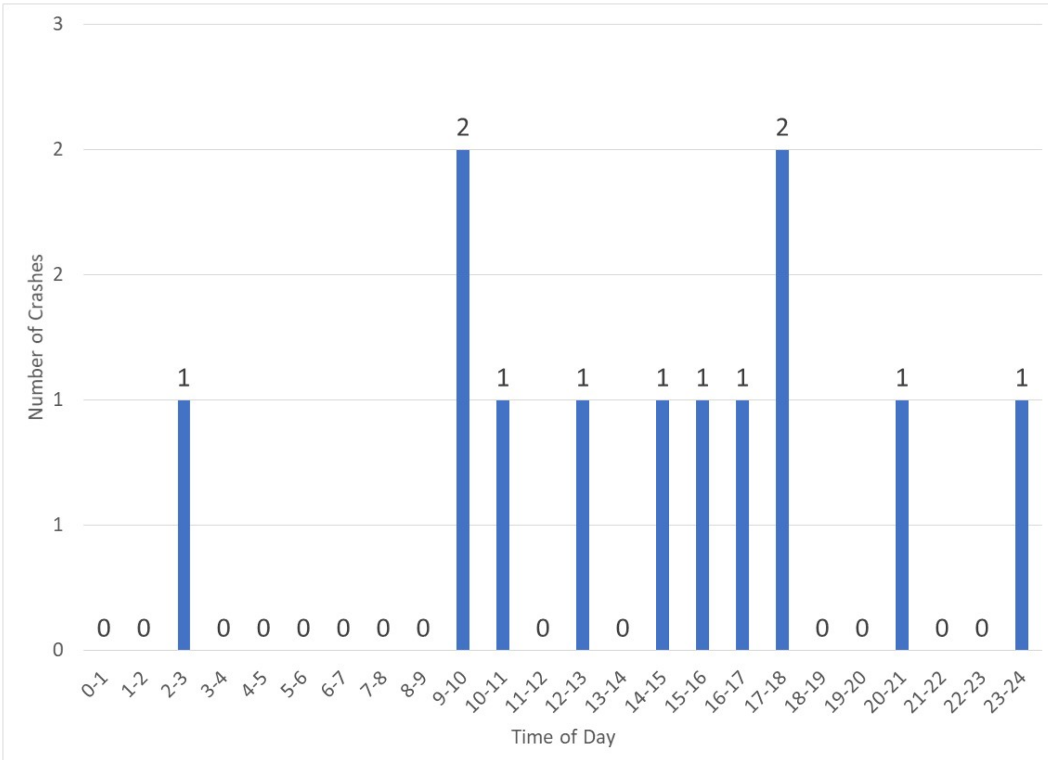

Figure 138: The Parkway & Stratford Lane, Crashes by Time of Day

The WTI Team binned the crashes into pre-AM PEAK, AM PEAK, mid-day, PM PEAK, and post-PM PEAK crash time periods. Considering the frequency of crashes per hour, the highest rate of crashes occurred during the **PM PEAK** time period (Table 41).

Table 41: The Parkway & Stratford Lane, Crash Counts & Rate by Time Period

Time Period		Number of Crashes	Crashes/Hour
12 AM-6 AM	pre-AM PEAK	1	0.2
6 AM-9 AM	AM PEAK	0	0
9 AM-3 PM	mid-day	5	0.8
3 PM-6 PM	PM PEAK	4	**1.3**
6 PM-12 AM	post-PM PEAK	2	0.3
TOTAL		10	-

The days of the week that are most represented in the crash records are **Thursday and Sunday** (Figure 139).

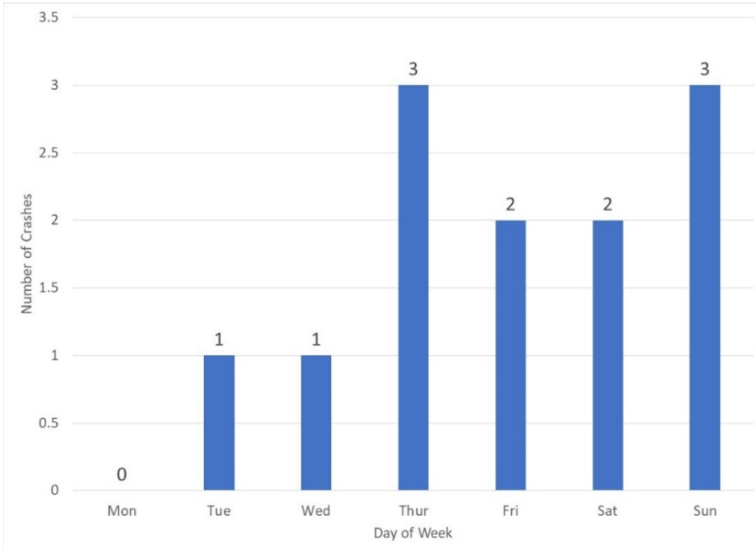

Figure 139: The Parkway & Stratford Lane, Crashes by Day of the Week

Overall, crash occurrence appears random when considering day of the week, although Monday, with no observed crashes, might have some differences as compared with the rest of the days of the week.

3.9.2 Environment

This section discusses how lighting, weather, and the road surface may have influenced crash occurrence.

The WTI Team analyzed the lighting condition identified during a crash (Figure 140). (Note: Lighting information was not provided for one of the 2018-2019 crashes.)

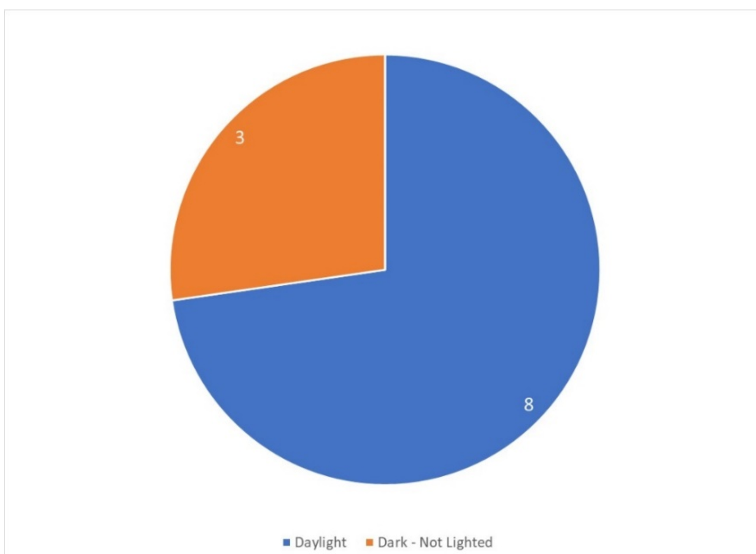

Figure 140: The Parkway & Stratford Lane, Lighting (number of crashes during each lighting condition)

Most of the crashes (**eight**) occurred during "Daylight." Looking at the data in more detail, of the crashes that occurred during "Daylight," **two** crashes were during a period when conditions were indicated as "Cloudy." Cloudy skies could potentially limit visibility. Reducing the **eight** crashes by **two** crashes results in a total of **six** crashes occurring during "Daylight." As half of the crashes are during "Daylight," **lighting may be an issue**.

The researchers also considered whether the "Daylight" crashes occurred during peak periods. (Note: We anticipated that "Daylight" crashes should be reported less frequently during the 12 AM-6 AM and 6 PM to 12 AM time periods, as the sun may have set or may not have risen.) Crashes were grouped into non-peak and peak-periods: 12 AM-6 AM, 6 AM-9 AM (AM PEAK), 9 AM-3 PM, 3 PM-6 PM (PM PEAK), 6 PM-12 AM. Table 42 shows the number of crashes within these groups.

Table 42: The Parkway & Stratford Lane, "Daylight" Crash Counts & Rates by Time Period

Time Period		Number of Crashes	Crashes/Hour
12 AM-6 AM	pre-AM PEAK	0	0
6 AM-9 AM	AM PEAK	0	0
9 AM-3PM	mid-day	**5**	0.83
3 PM-6 PM	PM PEAK	3	**1.0**
6 PM-12 AM	post-PM PEAK	0	0
TOTAL "Daylight" Crashes		8	-

"Daylight" crashes had the greatest frequency during the mid-day period (9 AM-3 PM) and the highest rate of frequency during the **PM PEAK** (3 PM-6 PM).

With regard to weather, almost three quarters of the crashes (**eight**) occurred during "Clear" periods (Figure 141). Weather does not seem to be a contributing factor. (Note: One of the 2018-2019 crashes did not provide information regarding weather.)

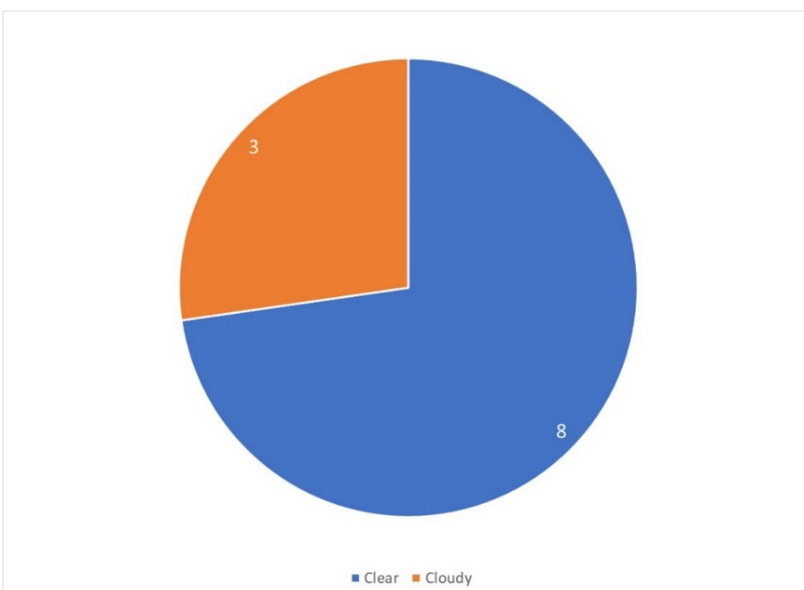

Figure 141: The Parkway & Stratford Lane, Weather

All but one crash occurred when surface conditions were "Dry," which suggests that surface condition is unlikely to be an issue (Figure 142). (Note: No information was provided for one of the 2018-2019 crashes regarding surface condition.)

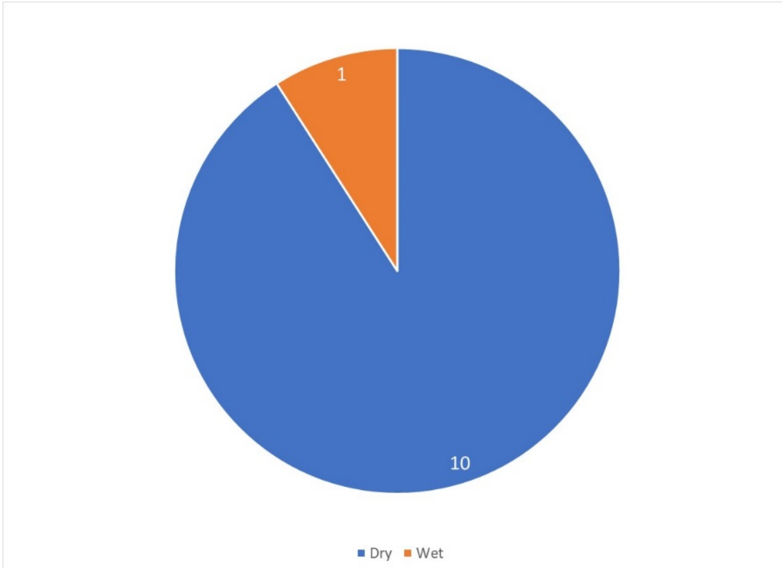

Figure 142: The Parkway & Stratford Lane, Surface Condition

3.9.3 Factors Contributing to Crashes

This section discusses the vehicle collision type, the indicated primary cause of the crash, and whether the collision was between vehicles or with an object.

One category of the tabular data provided information about the vehicle collision type. "Not Applicable" and "Angle" were the most common crash types (both with **four**) (Figure 143). (Note: One of the 2018-2019 crashes did not provide crash type.)

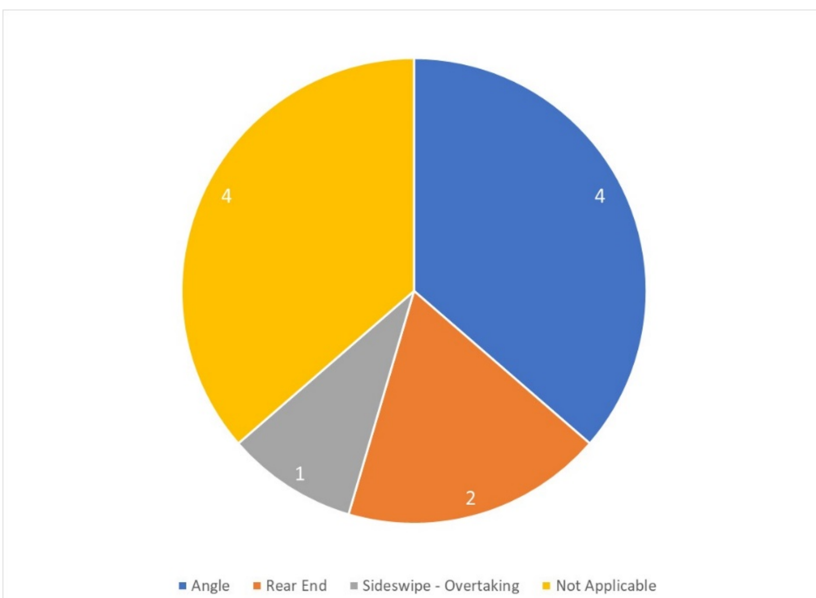

Figure 143: The Parkway & Stratford Lane, Crash Type

In the tabular data, there is an option to include data in the "collision with?" column. All "Not Applicable" crashes (**four**) involved the motorists striking a tree/shrub.

The most reported "Primary Cause" was "No Information" (Figure 144), which was reported in **3 of 12 crashes (25%)**. Because of the small number of crashes, this means that any of the other primary causes (e.g., "Failed to Give Full Time and Attention") could potentially be the primary cause resulting in a crash. (Note: Neither of the 2018-2019 crashes provided information about "Primary Cause.")

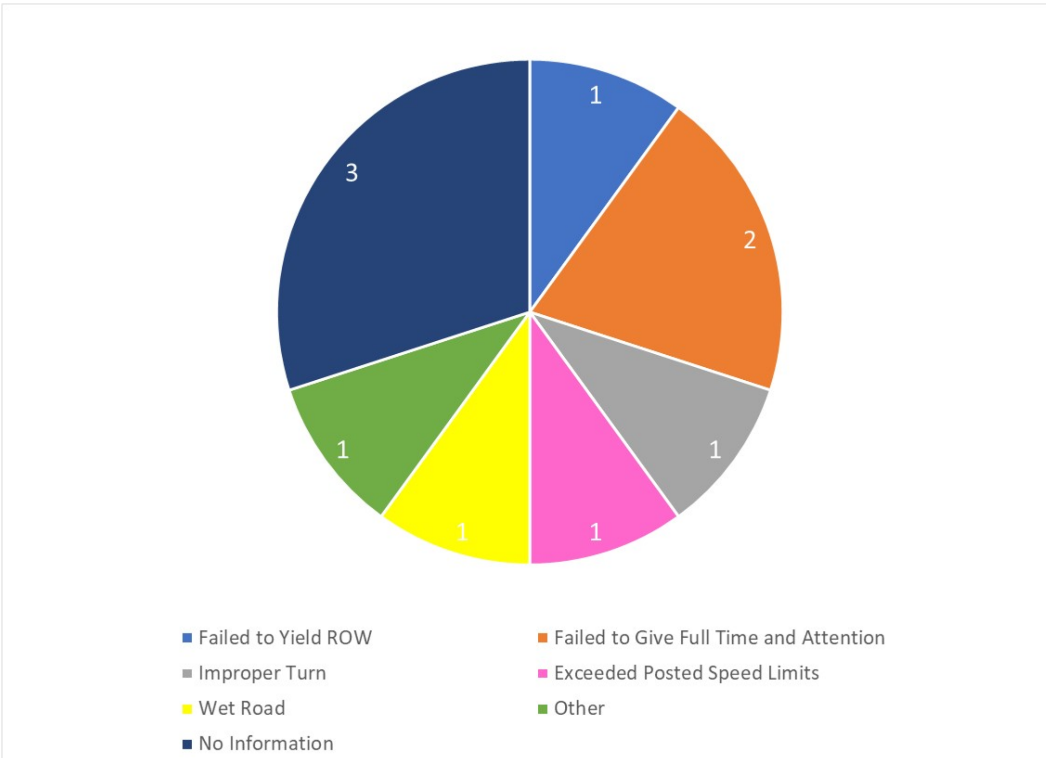

Figure 144: The Parkway & Stratford Lane, Primary Cause

3.9.4 Driving Under the Influence

This section discusses crashes that were identified as involving drugs or alcohol. The tabular data provided information about whether or not a crash involved driving under the influence in the "Primary Cause" column. Of the **twelve** crashes identified at the intersection, from 2005-2015 and 2018-2019, **zero** crashes were identified as having a driver that was under the influence of alcohol or other substances. However, with the majority of crashes having "No Information" identified as the "Primary Cause," any of these crashes could have been related to driving under the influence. (Note: One of the 2018-2019 crashes did not provide information about "Primary Cause.")

3.9.5 Hit & Run

This section discusses crashes identified as a hit and run. **Zero** of the **twelve** crashes were identified as hit and run crashes. Again, the majority of crashes had "No Information," so there could be hit-and-run crashes. (Note: One of the 2018-2019 crashes did not provide information.)

3.9.6 Crash Severity

This section identifies the number of PDO, INJ, and FAT crashes. While few crashes occurred at Stratford Lane, a third of the crashes (**four**) resulted in injuries (Figure 145).

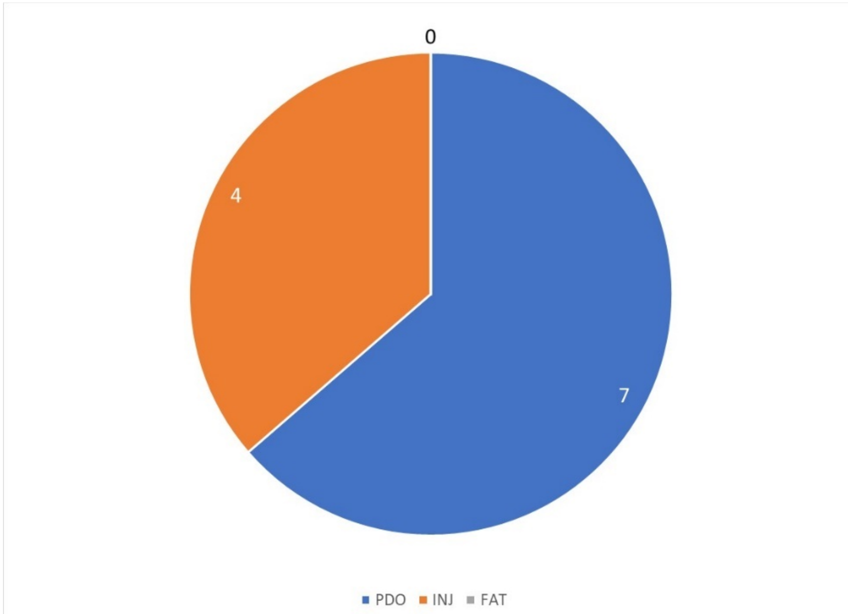

Figure 145: The Parkway & Stratford Lane, Crash Severity

Across the injury crashes, there were a total of **eight** injuries.

The occurrence of the injury crashes by month, day of week, and time of day was investigated.

Overall, there does not appear to be any dominating trend from these viewpoints (Figure 146, Figure 147, and Figure 148). Sunday does have one more crash than the other days.

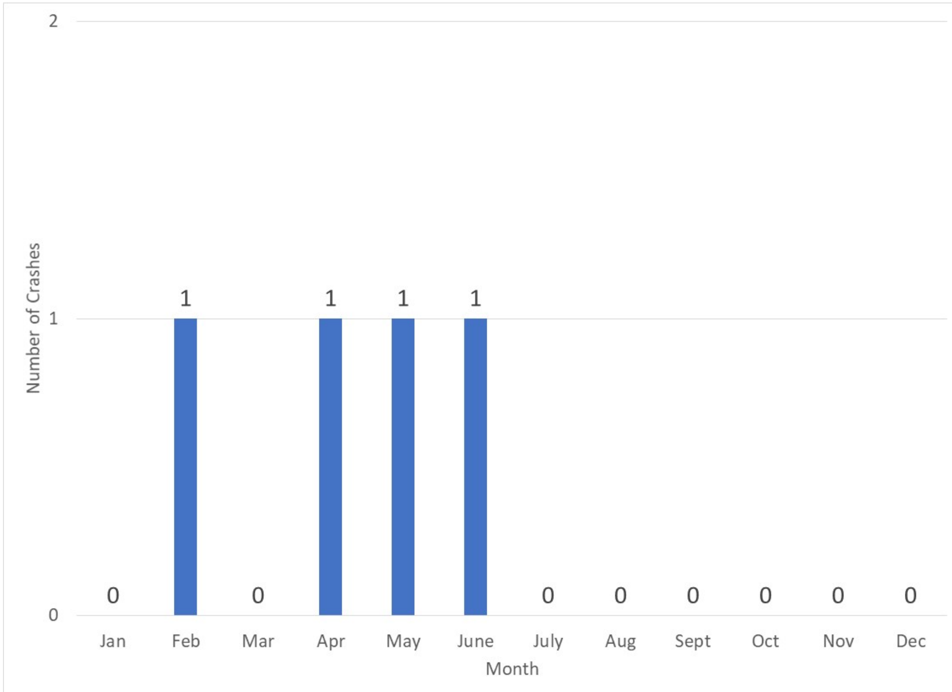

Figure 146: The Parkway & Stratford Lane, Injury Crashes by Month

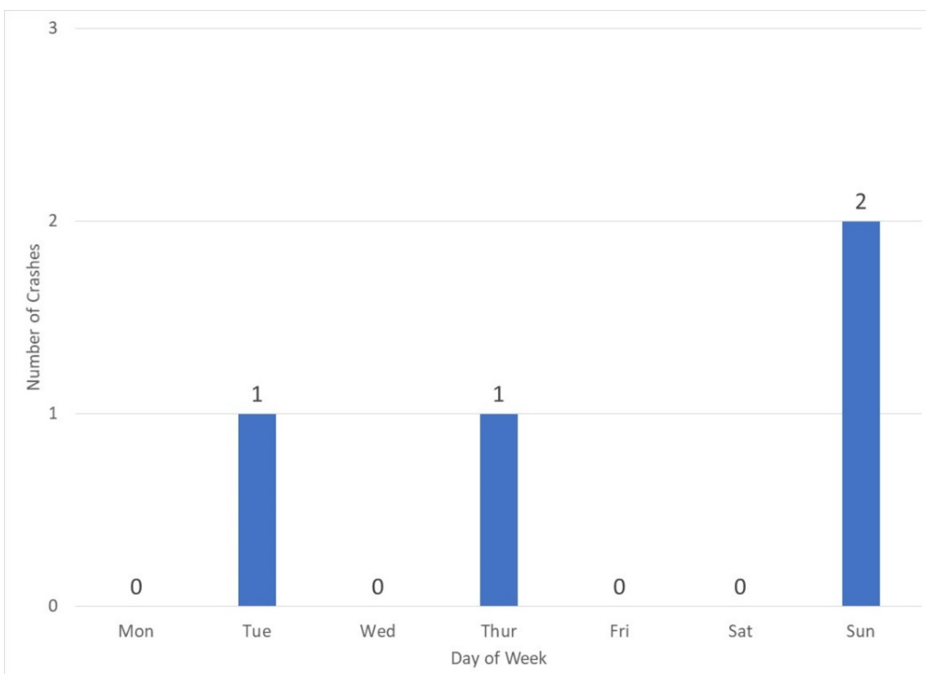

Figure 147: The Parkway & Stratford Lane, Injury Crashes by Day of Week

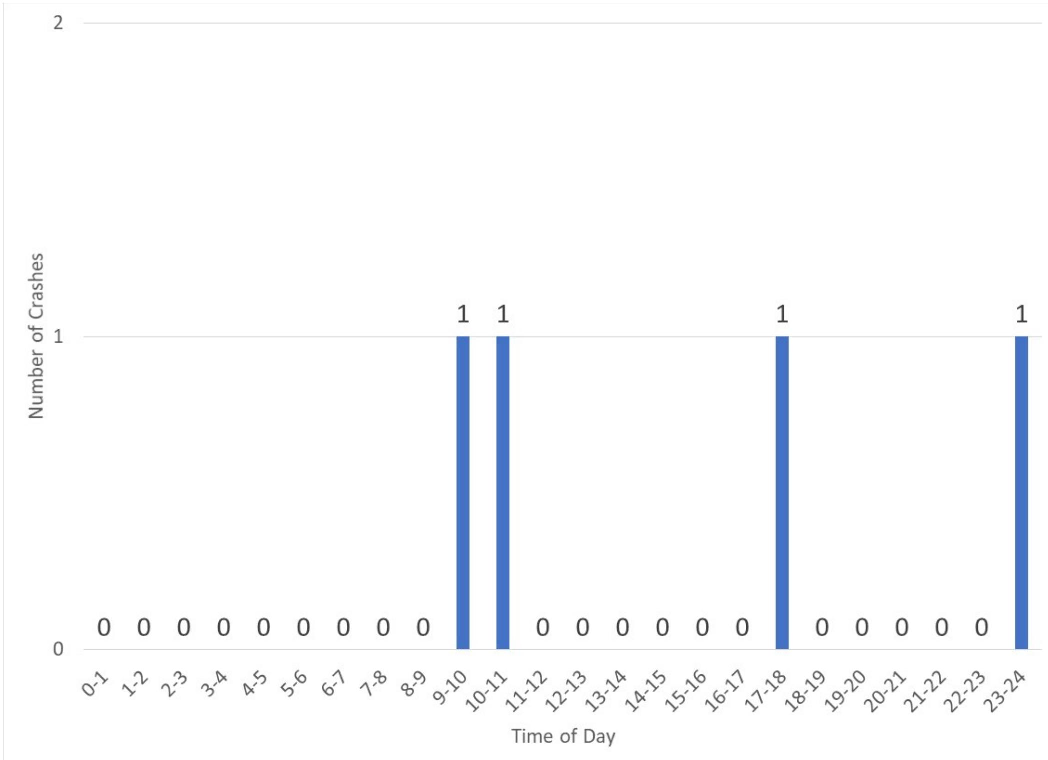

Figure 148: The Parkway & Stratford Lane, Injury Crashes by Time of Day

3.9.7 Pedestrians & Bicycle

There were no reported bicycle or pedestrian crashes at this intersection.

3.9.8 Crash Diagram

The following crash diagram shows the location of crashes at the intersection for which enough information was available to place them on the map. If crash type, direction of vehicle, and other factors were provided, they were mapped. Otherwise, after the figure is a note regarding why a crash could not be mapped. Crash reports were not available. Therefore, the diagram was created based on the pre-crash direction of the vehicle and the stated crash type. As a separate file was provided for vehicle and persons for the more recent data (2018-2019), these crashes may be more accurate. However, complete data was not always provided. As such, there may be some variability between the actual crash and what is conveyed in the diagram. Figure 149 is **the best understanding of the crash occurrence at the intersection based on available information**.

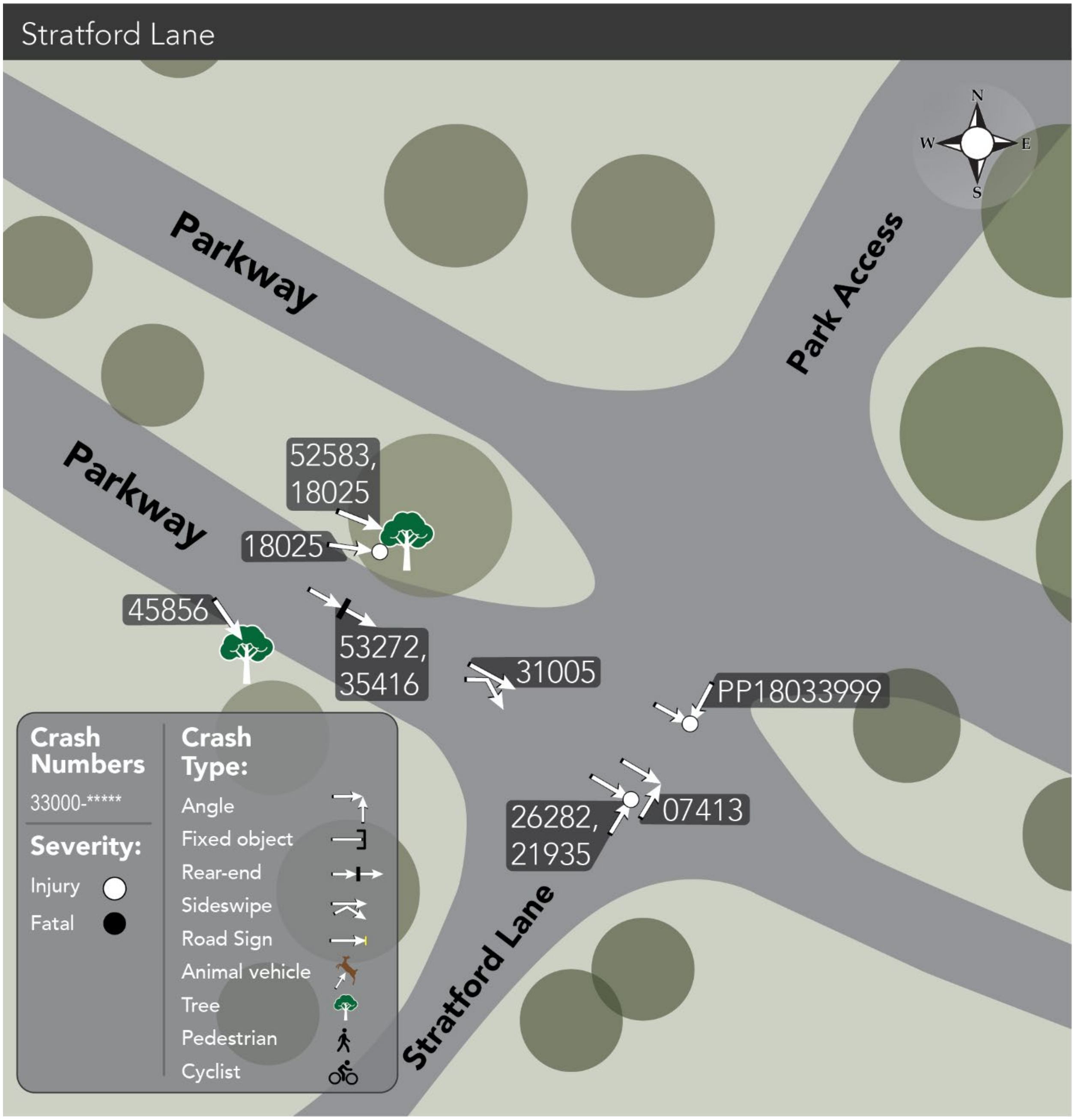

Figure 149: The Parkway & Stratford Lane, Crash Diagram

No information was provided about the severity or direction for crash PP19071055.

The most interesting observation about this intersection is that all of the crashes occurred in the southbound direction. Speed is again, likely a factor in the occurrence of crashes, as vehicles leaving the roadway can suggest that drivers are traveling at speeds too fast for their ability to remain on the roadway. Lane markings could assist vehicles with staying in the lane, as leaving the roadway seems to be a significant factor.

3.9.9 Summary – Stratford Lane

Overall, very few (12) crashes were observed at the intersection of the Parkway and Stratford Lane compared to the other intersections within the project boundary based on crash data from 2005-2015 and 2018-2019. The majority occurred in 2007; in February, April, September, November and December; on Thursday and Sunday; and between 9 AM-10 AM or 5 PM-6 PM (Table 43). However, of the crashes that did occur, there was a larger than anticipated likelihood of an injury crash for otherwise infrequently occurring crashes. It would have been useful to have had more details for the four crashes that provided little information. There seems to be a number of individuals leaving the road and hitting a tree/shrub, which can often result in severe crashes. Therefore, there is likely a need to reduce speeds or ensure that motorists remain on the roadway (as due to context sensitivity associated with the corridor, removing trees/shrubs is not a viable solution). There is a potential need for regular maintenance of pavement markings, particularly so that they are visible at night when there is no lighting in the corridor.

Table 43: The Parkway & Stratford Lane, Summary of Key Data Findings

Criteria	Count
Number of Crashes	12
Year (of greatest frequency)	2007
Month (of greatest frequency)	February, April, September, November & December
Day (of greatest frequency)	Thursday & Sunday
Percent from 12 AM to 12 PM	33%
Most Frequent 1 Hour Block	9 AM-10 AM & 5 PM-6 PM
Most Frequent Time Period (pre-AM PEAK; AM PEAK; mid-day; PM PEAK; post-PM PEAK)	PM Peak
Might lighting be an issue?	Maybe
Is weather a contributing factor?	No
Might the surface condition be a factor?	No
Most Typical Crash Type	Not Applicable & Angle
Most Typical Reported Cause	No Information (3 of 12)
Driving Under the Influence	Zero crashes (0 of 12)
Hit & Run	Zero crashes (0 of 12)
Percent of Injury & Fatal Crashes (measure of severity)	33% (4 of 12)
Total Number of People Injured in Crashes	8 people
Pedestrian/Bicycle Involved Crashes?	No; 0% (0 of 12)
Animal Involved Crashes?	No; 0% (0 of 12)

3.10 Summary of Intersections

This section provides a summary of some of the key aspects that were analyzed for each intersection, viewed from the lens of the corridor, and concluding with a summary highlighting potential concerns associated with each intersection.

Crash occurrence was analyzed to understand if crashes happened more often in the first half of the day (12 AM to 12 PM) or the second half of the day (12 PM to 12 AM). The majority of crashes appear to be occurring in the second half of the day (Figure 150).

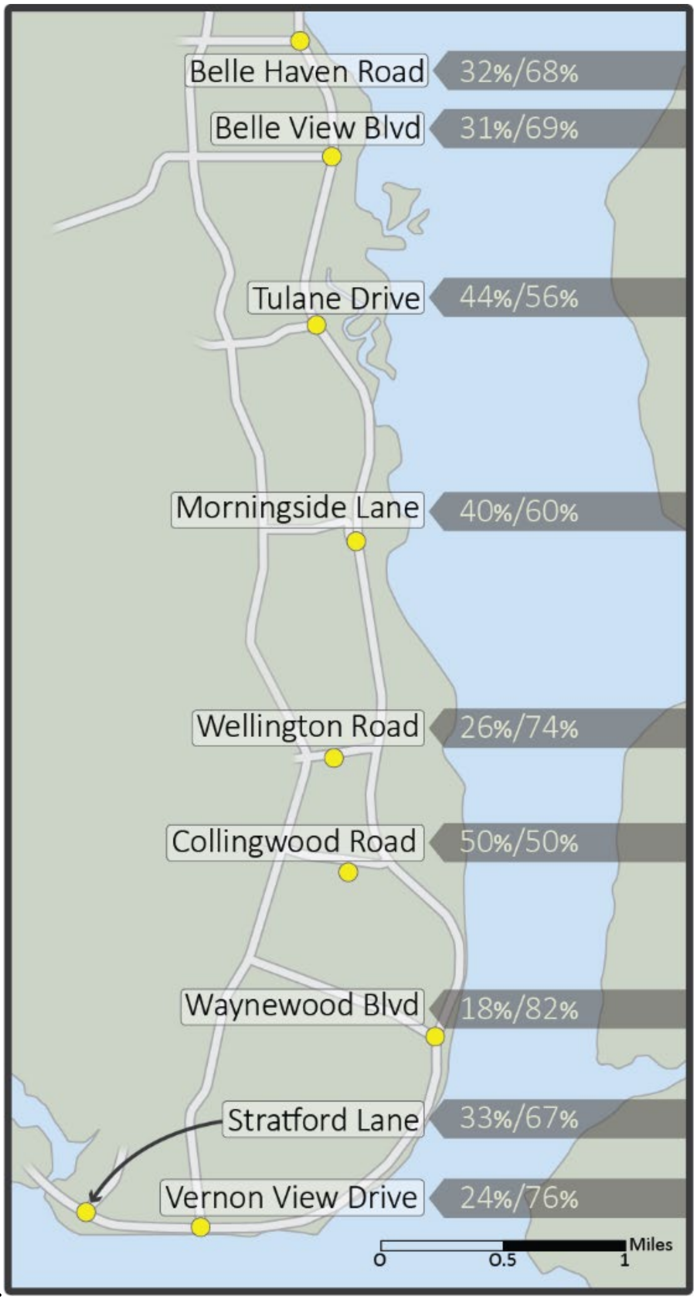

Figure 150: The South Parkway Corridor, Percent of Crashes in the AM/PM

However, while the second half of the day had the majority of crashes, the time period with the greatest number of crashes across all intersections was from 8 AM-9 AM (Belle Haven Road, Morningside Lane, and Collingwood Road) (Figure 151).

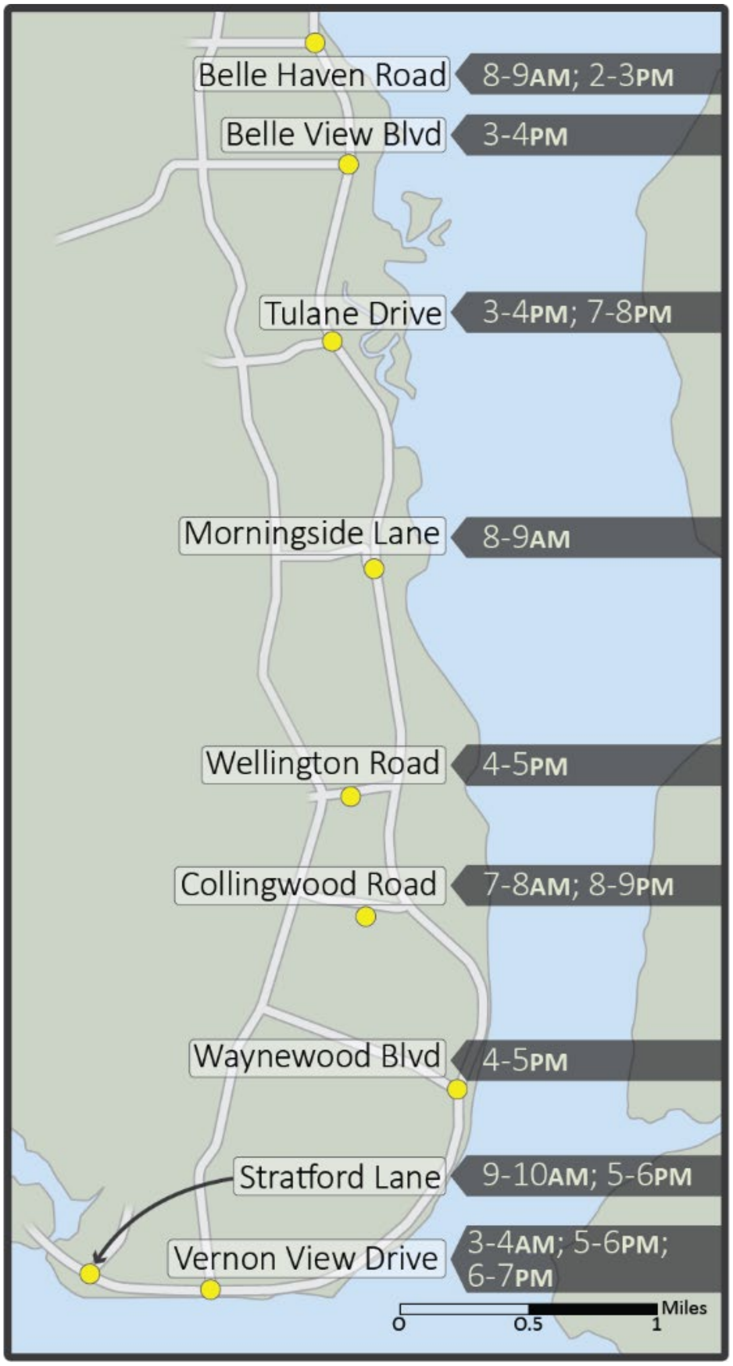

Figure 151: The South Parkway Corridor, Peak Crash Time Period

Therefore, overall, it appears that the AM peak and PM peak periods have the most frequent crashes.

The year with the most crashes at these intersections was 2011 (Figure 152). However, as suggested by the number of intersections without any observed crashes in 2015, the number of crashes seems to be underreported to the database.

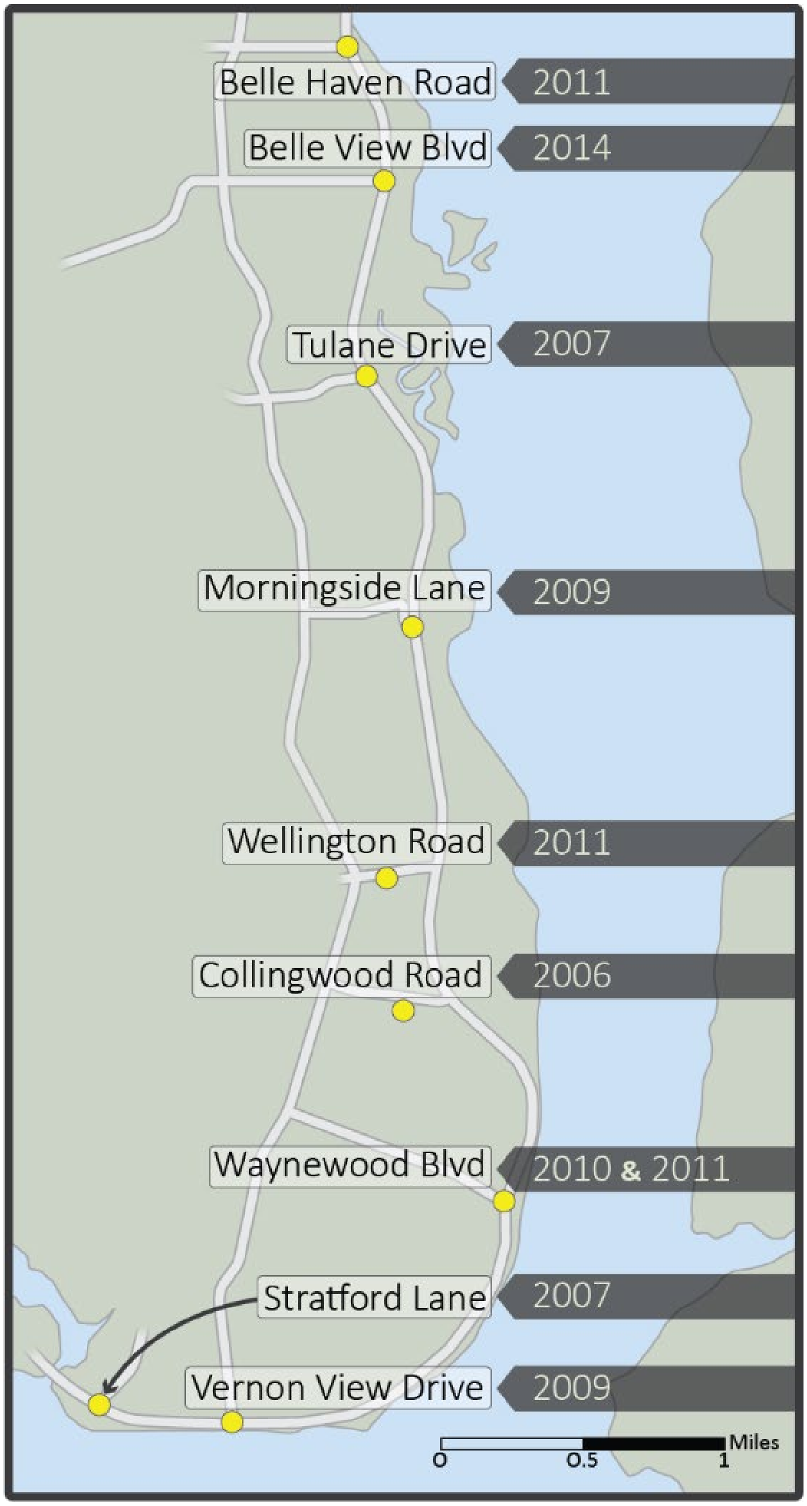

Figure 152: The South Parkway Corridor, Year of Most Frequent Crashes

April had the highest number of observed crashes at five of the intersections (Figure 153).

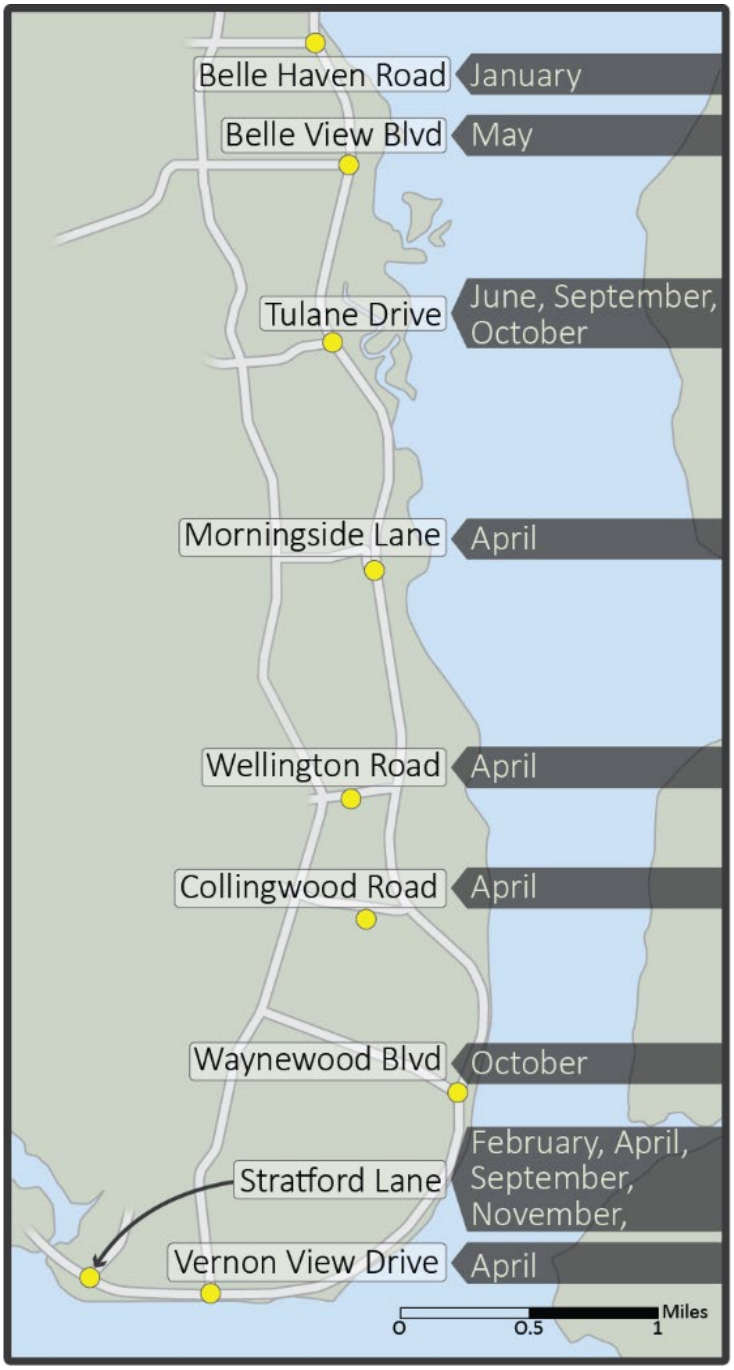

Figure 153: The South Parkway Corridor, Month of Most Frequent Crashes

Higher crash rates in April could potentially be attributed to an increase in the number of bicycles/pedestrians accessing MVT, a reduction in sight lines as a result of foliage returning, and an increase in the number of motorcycles. As an example of how the data supports some of these theories, Belle View Boulevard had a bicycle/pedestrian crash that occurred in April. This is also likely the time when foliage is coming into full bloom, so there is the potential that motorists may have become accustomed to slightly greater sight lines during winter. There is also the potential that motorcyclists may be riding again come April, and other motorists may have gotten out of the habit of looking for them. Searching through the 2018-2019 crash data, which provides information about vehicle type, there was at least one crash in April that was identified as involving a motorcycle.

At five intersections, crashes were most frequently observed on Friday (Figure 154).

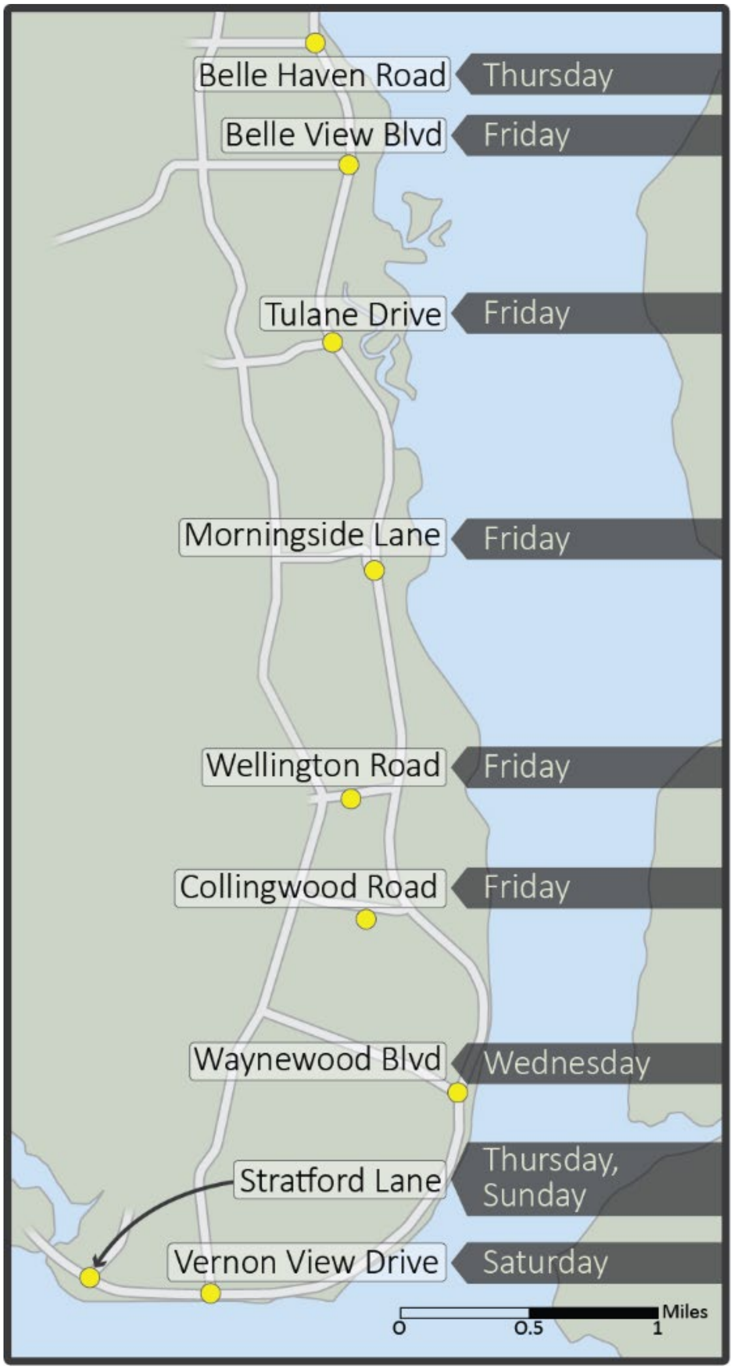

Figure 154: The South Parkway Corridor, Day of Most Frequent Crashes

Belle Haven Road, Belle View Boulevard, Morningside Lane, and Collingwood Road had the greatest number of crashes in the corridor (Figure 155).

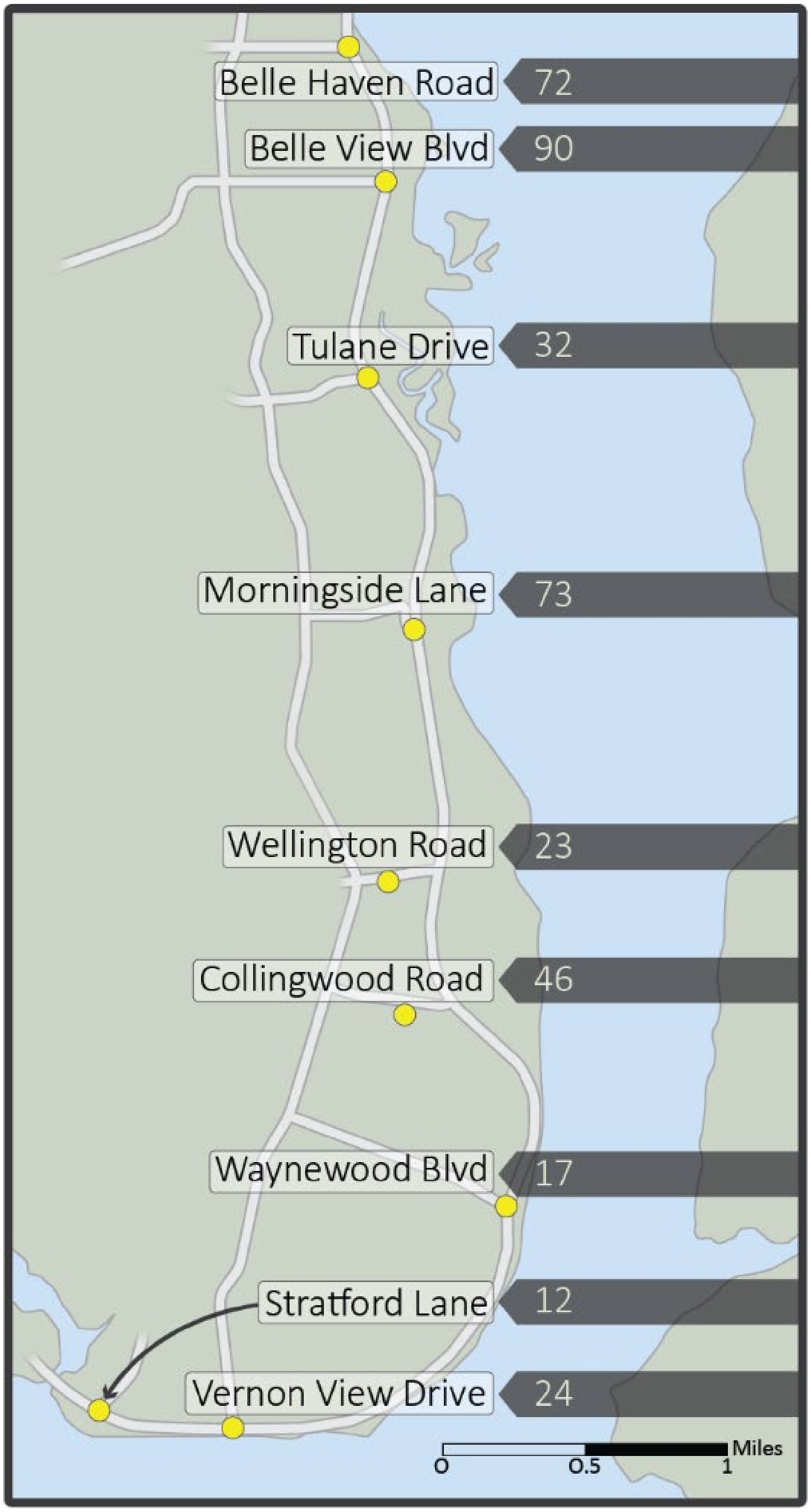

Figure 155: The South Parkway Corridor, Number of Crashes

The severity of crashes at these intersections is most notable (Figure 156). While Belle Haven Road and Belle View Boulevard have the greatest number of crashes, they have considerably lower crash severity when compared with intersections like Waynewood Boulevard and Vernon View Drive. Morningside Lane has both a high crash count and high crash severity.

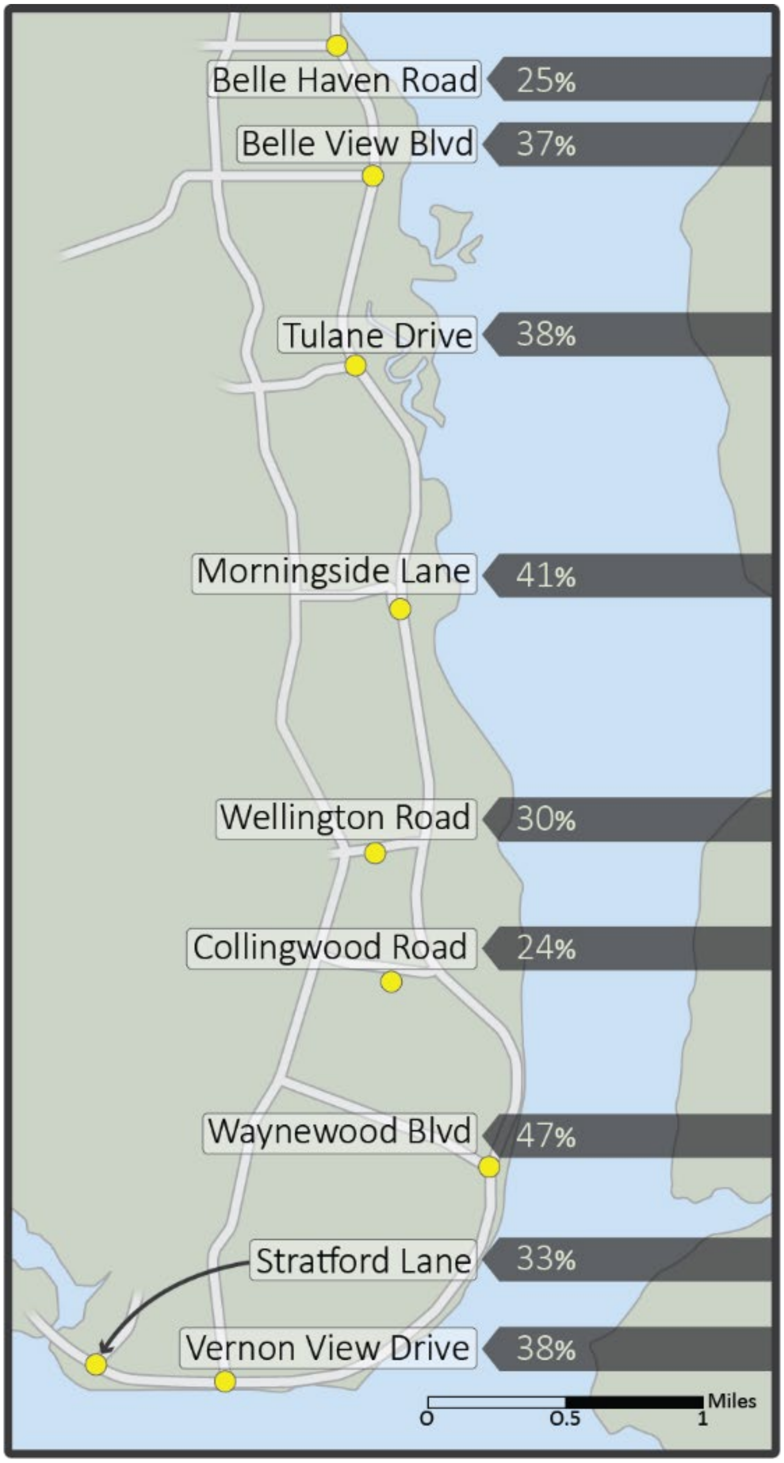

Figure 156: The South Parkway Corridor, Severity of Crashes

Bicycle and pedestrian crashes were reported at Belle Haven Road, Belle View Boulevard, Wellington Road, and Collingwood Road (Figure 157). Geometric modifications to support bicycles and pedestrians crossing the Parkway to access the MVT could, at a minimum, be addressed at these intersections.

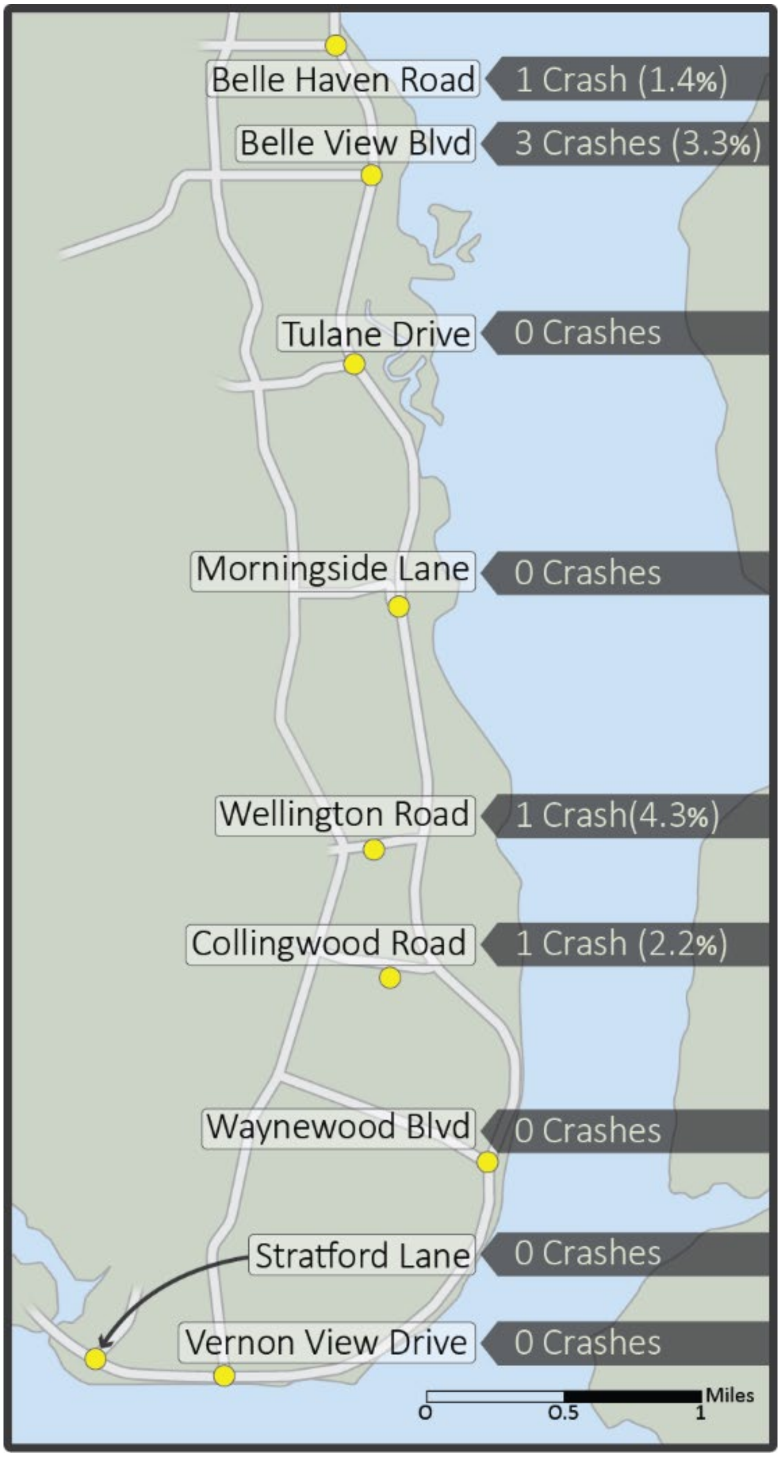

Figure 157: The South Parkway Corridor, Number and Percent of Bicycle/Pedestrian Crashes

Animal collisions, particularly for the northern intersections of the corridor, are causing crashes (Figure 158). Mitigation efforts for these types of crashes could be considered. However, there was no information in the 2005-2015 crash tabular data that identified the type of animal (e.g. deer) involved in the collision. One crash in the 2018-2019 indicated that the animal was a deer.

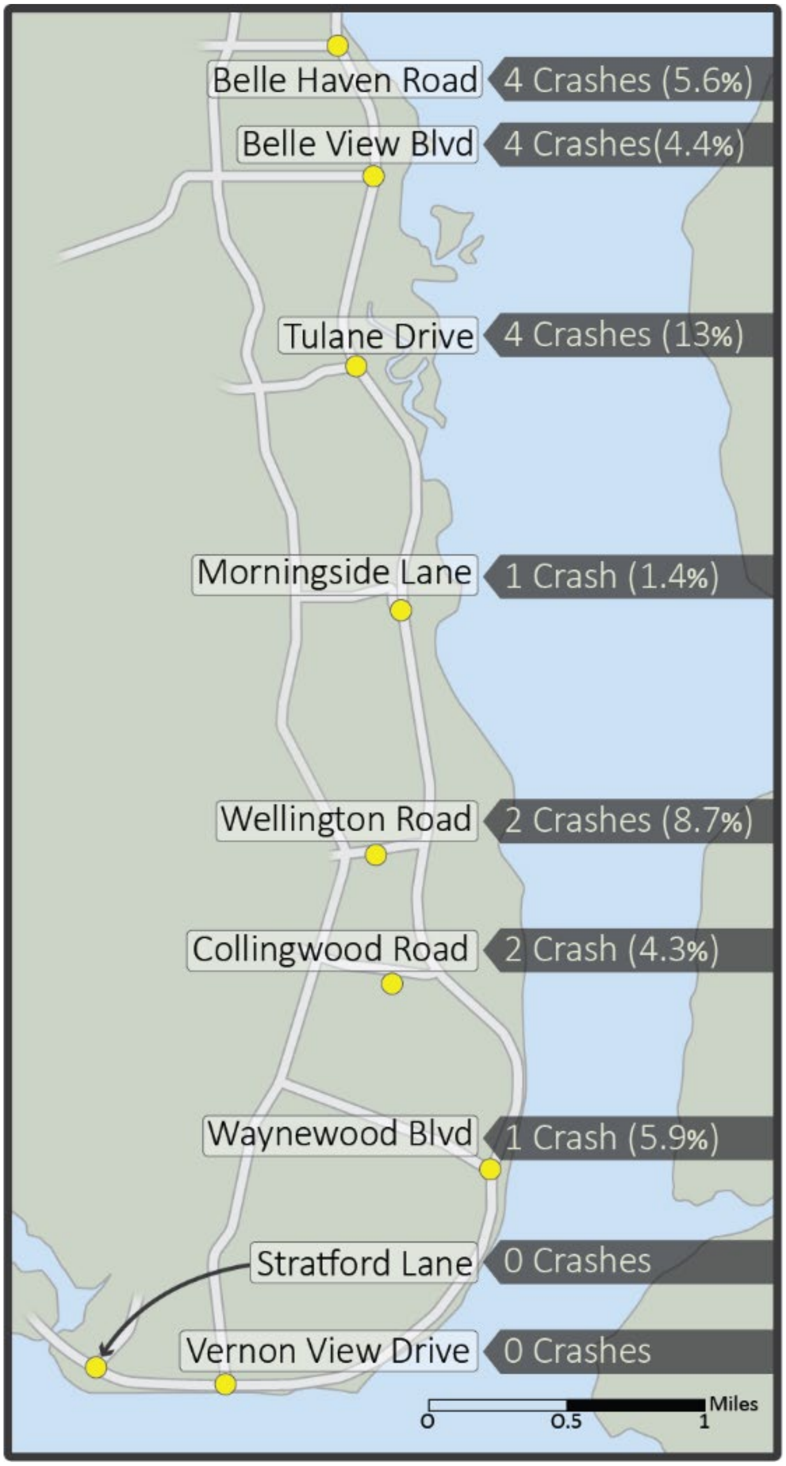

Figure 158: The South Parkway Corridor, Animal Crashes

Table 44 summarizes the details of the animal crashes.

Table 44: Summary of Crashes with Animals

Intersection	Date	Month	Time	Day of Week
Belle Haven Road	10/2/2007	October	05:35	Tuesday
	11/7/2009	November	20:46	Saturday
	1/5/2011	January	19:22	Wednesday
	10/20/2013	October	19:21	Sunday
Belle View Boulevard	3/16/2008	March	06:38	Saturday
	7/23/2008	July	15:30	Wednesday
	10/24/2011	October	06:39	Monday
Tulane Drive	11/24/2010	November	19:07	Wednesday
	10/12/2011	October	06:50	Wednesday
	3/29/2012	March	19:51	Thursday
	9/4/2019	September	11:59	Friday
Morningside Lane	11/11/11	November	04:40	Friday
Wellington Road	1/9/2008	January	23:05	Wednesday
	3/15/2014	March	23:15	Saturday
Collingwood Road	10/19/2009	October	17:34	Monday
	10/22/2009	October	08:59	Thursday
Waynewood Boulevard	4/22/2010	April	01:17	Thursday

Clearly, October has the largest number of crashes with animals, and could therefore be a large contributor to the occurrence of crashes in the fall. A possible solution would be to use dynamic message signs (DMS) to notify drivers entering the corridor during the month of October that they should drive slower due to the presence of animals. It is also clear that early morning or late evening hours seem to be contributing factors to these crashes, also likely because of the limited lighting in the corridor and potential migration patterns of wildlife. GWMP's Natural Resource Manager, Aaron LaRocca, has indicated that deer tend to be most active in October and November.

Lighting seems to be an issue for every intersection but Tulane Drive, Wellington Road and Vernon View Drive (Figure 159).

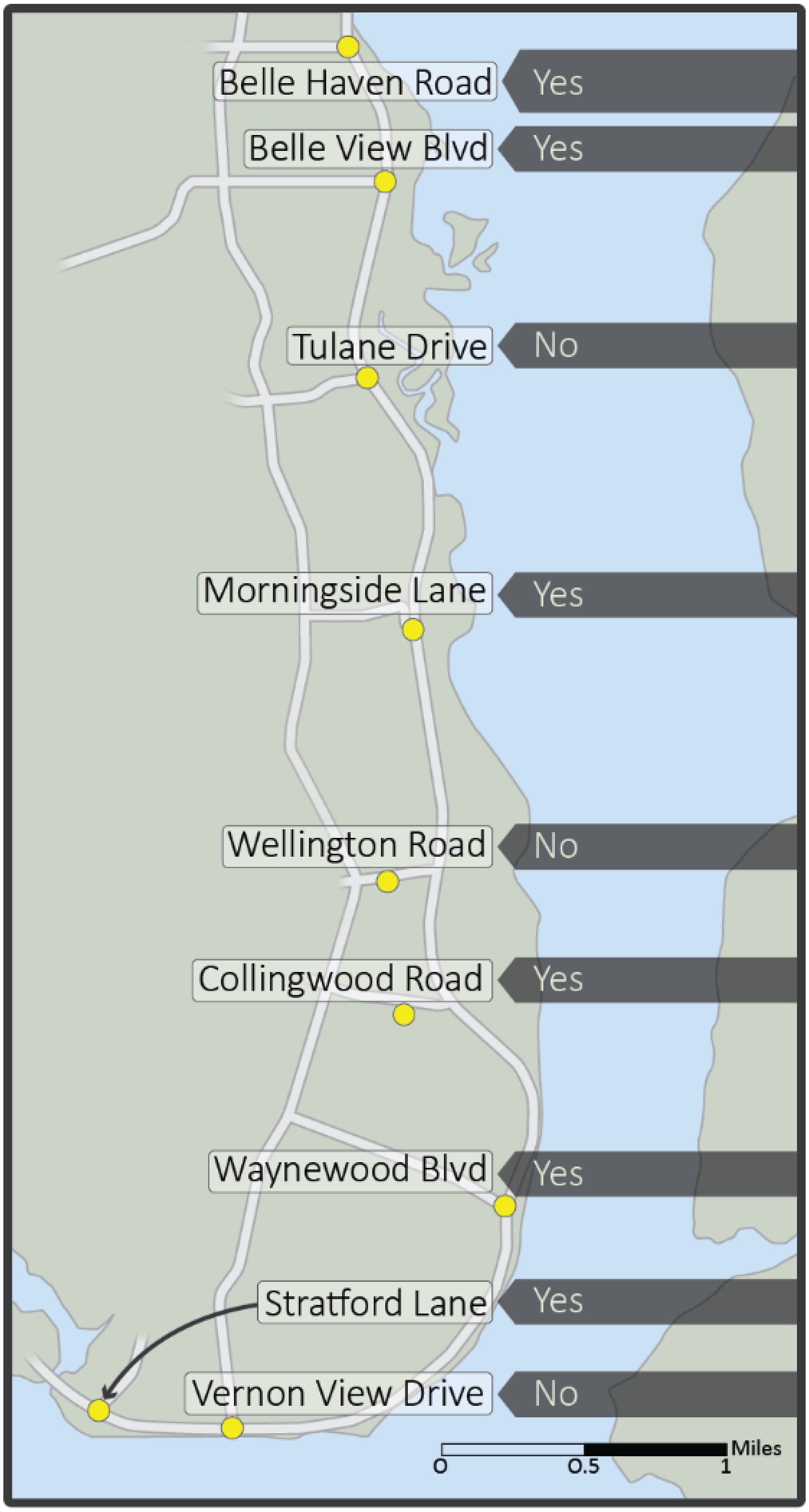

Figure 159: The South Parkway Corridor, Lighting

"Angle" and "Not Applicable" crashes are the most common reported crash types (Figure 160). Most angle crashes are between vehicles, whereas the latter are with trees/shrubs, animals, and other roadside objects (e.g. drainage structures, signs). Implementing measures that will keep vehicles on the roadway (e.g. slower speeds, more forgiving roadside) can help to mitigate these crashes.

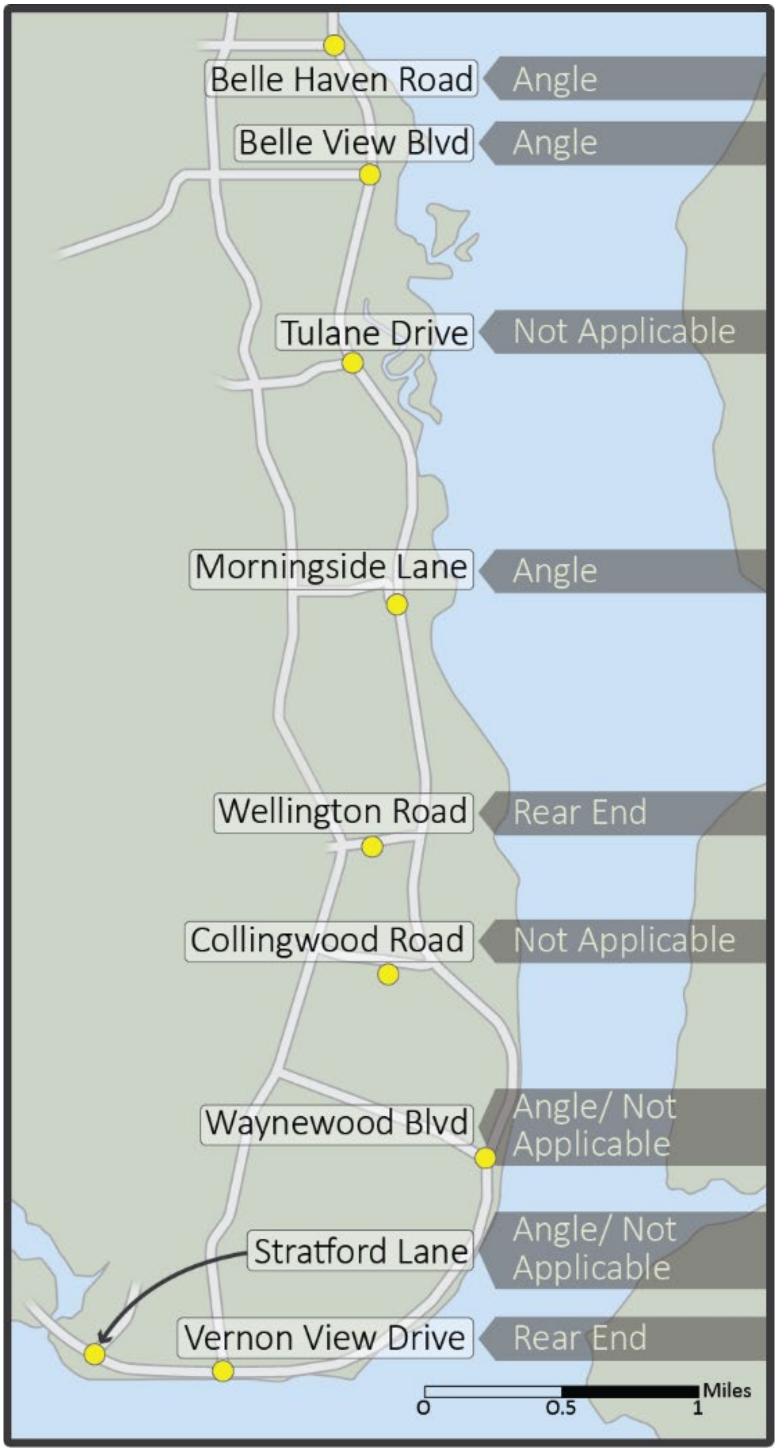

Figure 160: The South Parkway Corridor, Crash Type

Of 389 total crashes, 12 crashes (3.1%) involved driving under the influence (DUI). DUI is a problem, most notably, at Tulane Drive and at Collingwood Road (Figure 161).

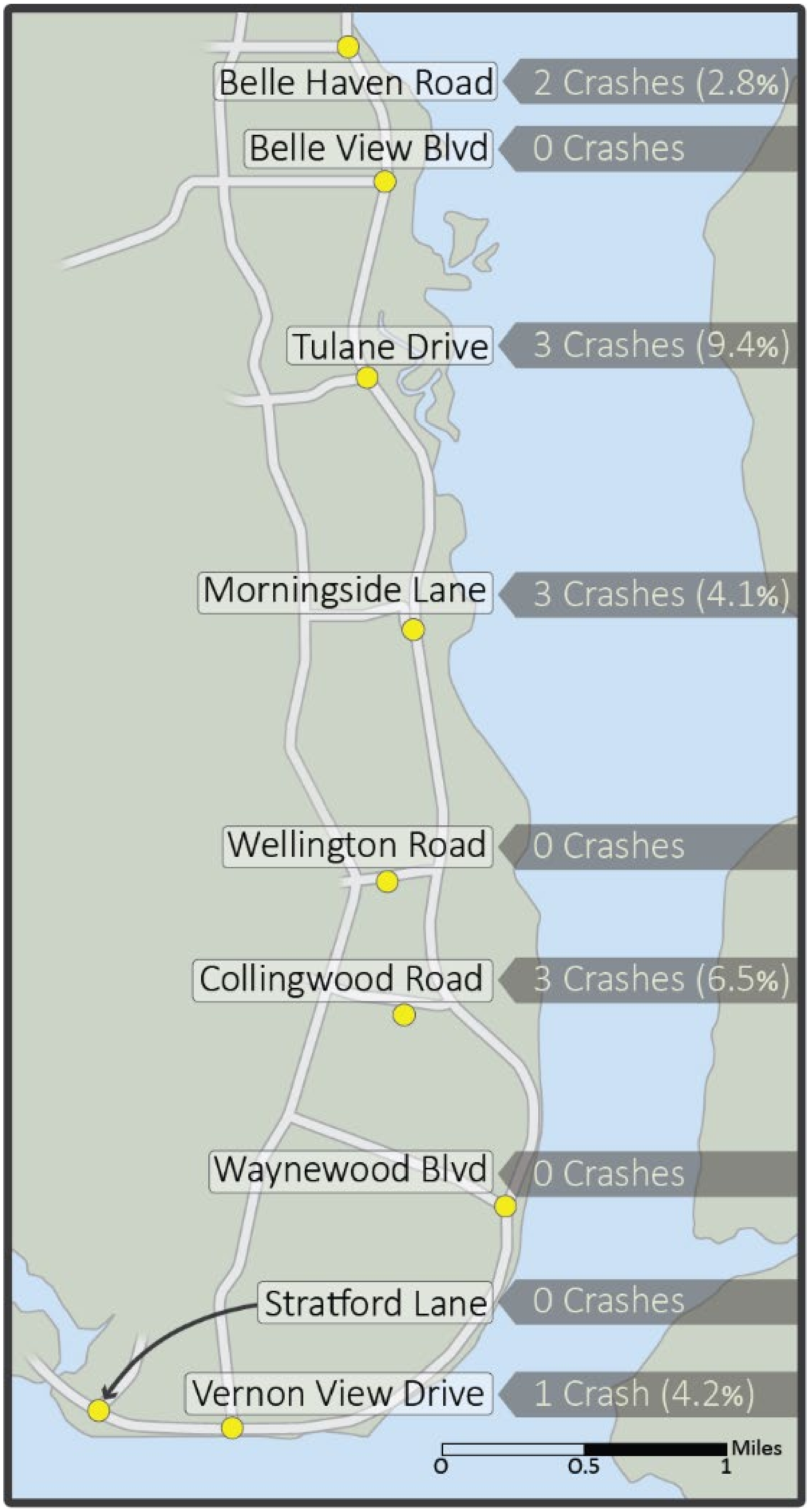

Figure 161: The South Parkway Corridor, Driving Under the Influence

Table 45 presents the date, month, time, day of week, crash type and severity of crashes involving DUI.

Table 45: Summary of Driving Under the Influence Crashes

Intersection	Date	Month	Time	Day of Week	Crash Type	Severity
Belle Haven Road	1/26/2006	January	18:13	Thursday	Head On	INJ
	1/13/2008	January	23:04	Sunday	With a Fixed Object	INJ
Tulane Drive	3/13/2005	March	23:18	Sunday	Hit a Rock/Stone Wall	INJ
	6/29/2009	June	6:03	Monday	Hit a Tree/Shrub	INJ
	12/11/2014	December	22:51	Thursday	Hit a Tree/Shrub	PDO
Morningside Lane	6/3/2005	June	15:22	Friday	Another Vehicle	FAT
	3/3/2007	March	2:41	Saturday	Hit a Ditch	PDO
	9/27/2009	September	0:52	Sunday	Hit a Tree/Shrub	PDO
Collingwood Road	9/4/2006	September	5:27	Monday	Hit a Tree/Shrub	INJ
	4/21/2008	April	13:26	Monday	Hit a Tree/Shrub	INJ
	8/8/2012	August	2:16	Wednesday	Hit a Tree/Shrub	INJ

The statistics are grim regarding DUI. All but one of the DUI crashes occurred between Thursday evening and Monday morning. These crashes have the highest level of severity and are clearly contributing to the high overall level of severity of crashes found in the corridor. From the data, it appears that DUI crashes (and drivers) are only identified if the car is immobilized from hitting another object, whether it is a tree, ditch, or another vehicle. Enforcement of those driving under the influence could be conducted in January, March, and June from Thursday evening through Monday morning. Furthermore, George Washington Memorial Parkway could work with entities in the area that are selling liquor to encourage use of transportation network companies (TNCs), cabs, or a designated driver. Two of the crashes (1/13/2008 (Martin Luther King Weekend) and 9/4/2006 (Labor Day Weekend)) appear to be on holiday weekends.

Notice that six of the crashes involve hitting a tree/shrub. In many cases, if the underlying aspects of the crashes are not investigated, the recommendation may be to remove a tree or shrub. However, if DUIs are identified, it is possible to address the cultural aspect of people drinking and driving, consequently hitting objects off the roadside. Another interesting find is that there were no DUI crashes reported from 2018-2019. However, there was missing data for some of these crashes, including that for the severity of the crash, so the incidence of DUI may be underreported.

Hit-and-run crashes are a problem across all intersections except Stratford Lane (however, it is also notable that there was no information for the majority of crashes at this intersection) (Figure 162).

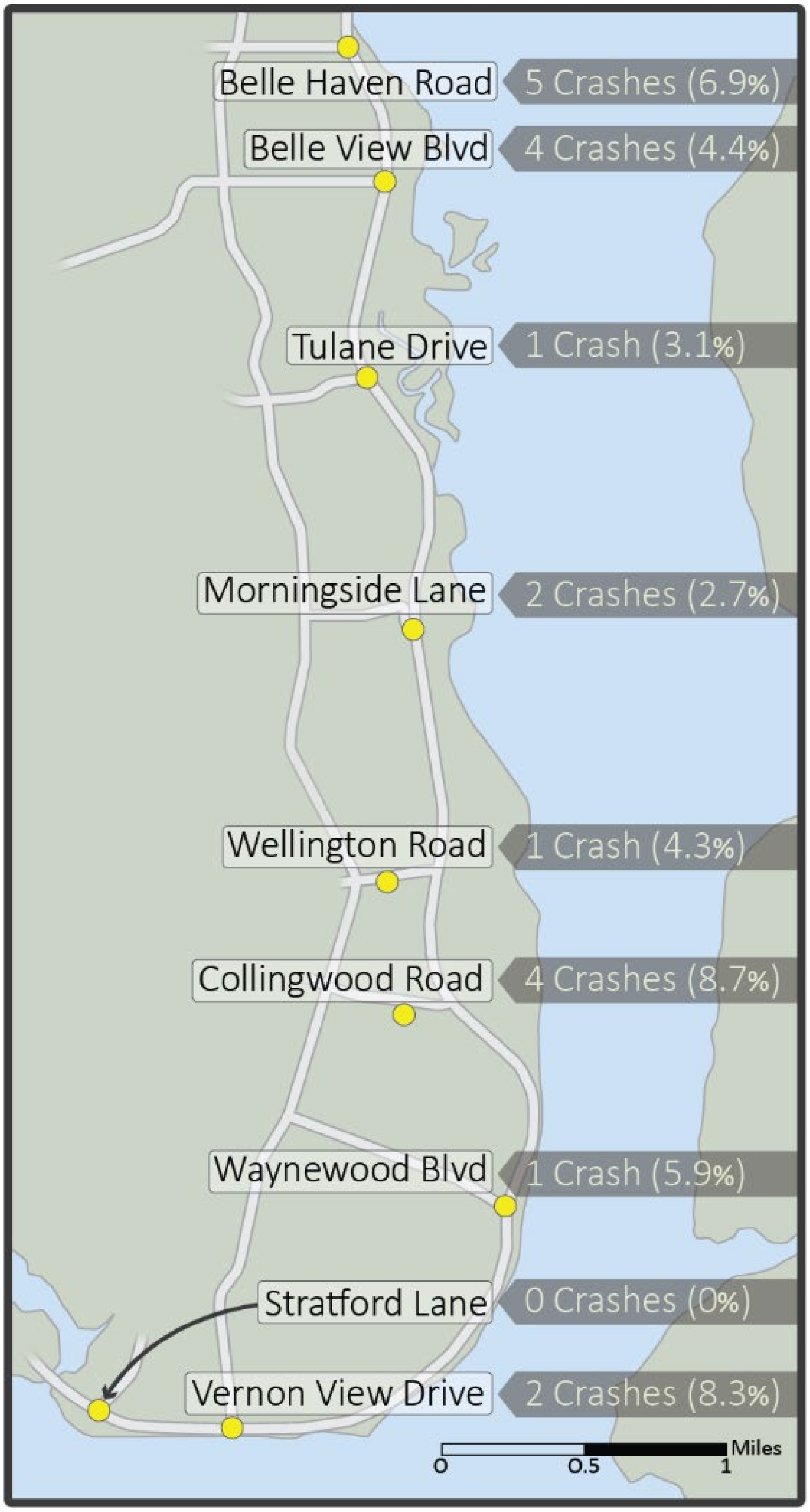

Figure 162: The South Parkway Corridor, Hit & Run Crashes

Table 46 presents the date, month, time, day of week, crash type and severity of hit and run crashes.

Table 46: Summary of Hit & Run Crashes

Intersection	Date	Month	Time	Day of Week	Crash Type	Severity
Belle Haven Road	11/10/2006	November	8:12	Friday	Sideswipe - Opposing	PDO
	3/1/2008	March	19:54	Saturday	Rear End	PDO
	2/14/2011	February	18:46	Monday	Angle	PDO
	6/1/2013	June	21:41	Saturday	Rear End	PDO
	6/20/2018	June	20:00	Wednesday	Unknown	PDO
Belle View Boulevard	6/4/2007	June	12:30	Monday	Sideswipe - Overtaking	PDO
	11/29/2011	November	7:24	Tuesday	Sideswipe – Overtaking	PDO
	6/22/2012	June	15:35	Friday	Sideswipe - Opposing	INJ
	5/26/2019	May	14:20	Tuesday	Other	PDO
Tulane Drive	9/27/2012	September	14:26	Thursday	Rear End	PDO
Morningside Lane	3/3/2005	March	18:34	Thursday	Angle	PDO
	6/24/2014	June	7:15	Tuesday	Sideswipe - Overtaking	PDO
Wellington Road	11/10/2011	November	18:55	Thursday	Unknown	PDO
Collingwood Road	5/19/2006	May	13:18	Friday	Sideswipe – Overtaking	PDO
	9/4/2006	September	5:27	Monday	Hit Tree/Shrub	INJ
	11/29/2010	November	15:41	Monday	Angle	INJ
	9/28/2011	September	6:30	Wednesday	Sideswipe - Overtaking	PDO
Waynewood Boulevard	2/13/2013	February	16:09	Wednesday	Hit Tree/Shrub	INJ
Vernon View Drive	3/12/2011	March	16:31	Saturday	Sideswipe – Opposing	PDO
	8/5/2011	August	20:54	Friday	Rear End	PDO

Overall, the primary cause listed most frequently in the corridor was "Failed to Yield ROW" (Figure 163). This suggests that either this is the primary cause chosen most frequently by those completing the crash reports, or there is a lack of clarity for drivers regarding ROW.

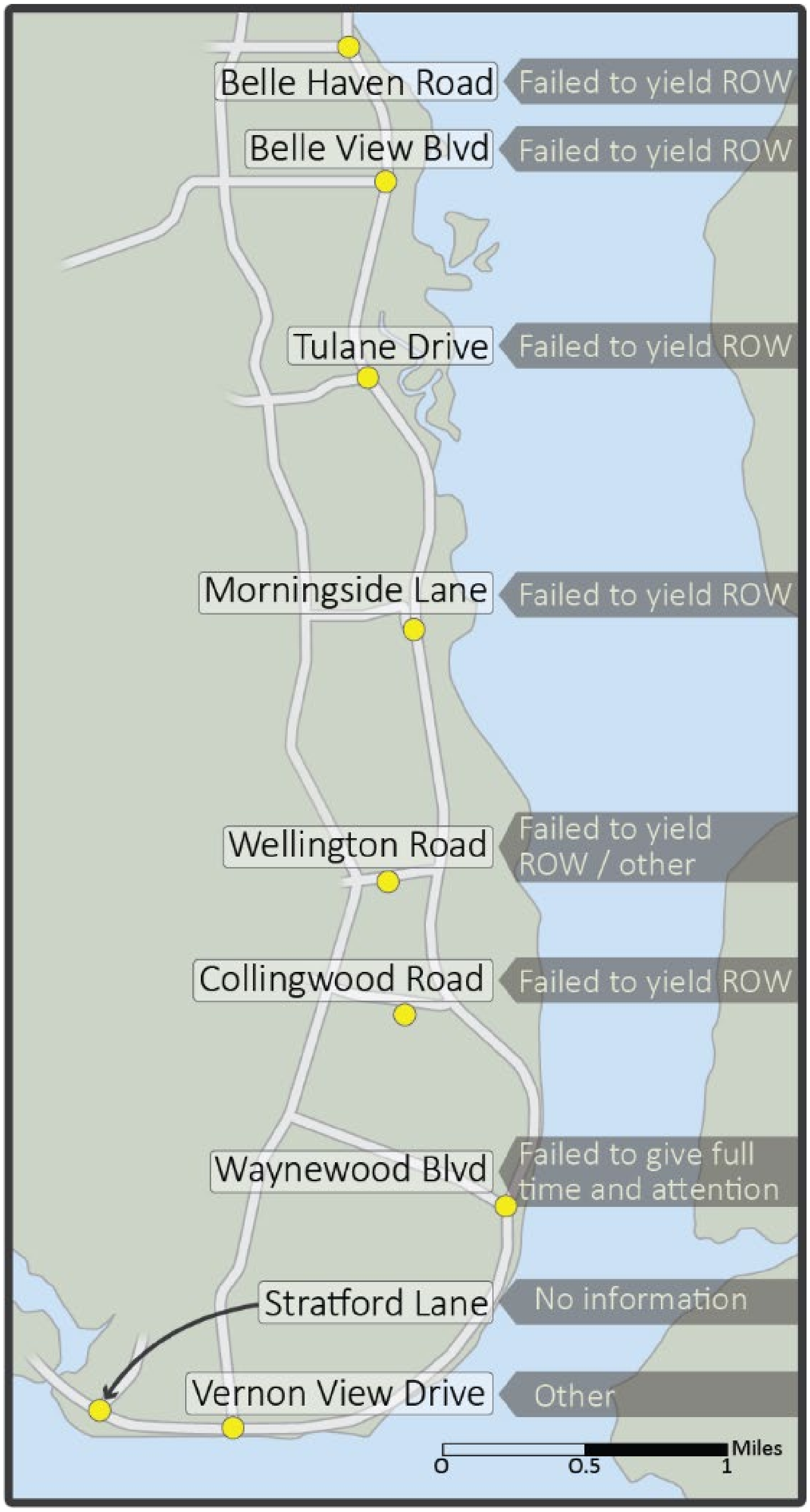

Figure 163: The South Parkway Corridor, Primary Cause

Weather only seems to be a factor for crashes at Waynewood Boulevard (Figure 164).

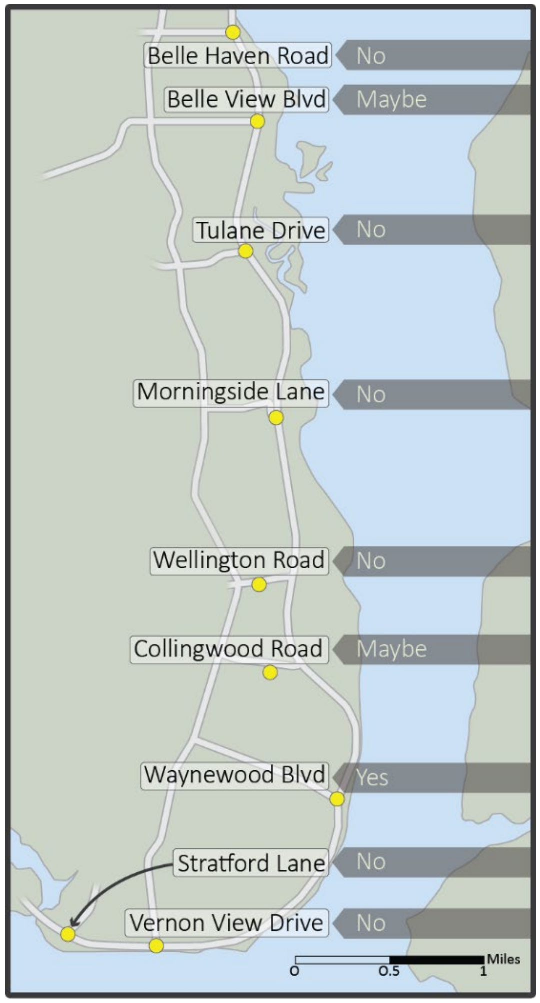

Figure 164: The South Parkway Corridor, Are Weather-Related Crashes a Factor?

Overall, the factors contributing to crashes at each intersection appear to be very different. To demonstrate this, Table 47 shows issues or concerns for each intersection in red. Green indicates that the factor is not contributing to crashes, and yellow indicates that there is a potential that the criteria may be contributing to crashes. Notice that no two lines have exactly the same color pattern. As an example, for Belle Haven Road, addressing the following factors could reduce the number and severity of the crashes at the intersection: providing lighting, addressing the underlying factors that are resulting in hit and run crashes (Note: Data was limited regarding why hit and runs may be occurring), finding a way to mitigate interactions between animals and vehicles, and providing safe crossing options for bicyclists and pedestrians. In contrast, for Waynewood Boulevard, it might be necessary to consider: providing lighting, investigating surfaces, investigating why weather may be having an impact (is more traction needed for vehicle tires; is water standing on the roadway when it rains), addressing hit and runs, mitigating animal crashes, and identifying if there are specific trees/shrubs that motorists are hitting.

Table 47: Summary of Intersection Crash Analysis

Intersection	Count	Severity	Lighting a Potential Factor	Weather a Potential Factor	Surface Condition a Potential Factor	Drugs/Alcohol a Potential Factor	Hit & Run a Potential Factor	Animal Crashes a Potential Factor	Trees/Shrubs a Potential Factor	Fatalities	Injuries	Pedestrian/ Bicycle Involved?
Belle Haven Road	72	25%	Yes	No	No	2 (2.8%)	5 (6.9%)	4 (5.6%)	3 (4.2%)	No	32	Yes
Belle View Boulevard	90	37%	Yes	Maybe	Maybe	0 (0%)	4 (4.4%)	4 (4.4%)	5 (5.6%)	Yes	47	Yes
Tulane Drive	32	38%	No	No	No	3 (9.4%)	1 (3.1%)	4 (13%)	5 (16%)	No	16	No
Morningside Lane	73	41%	Yes	No	No	3 (4.1%)	2 (2.7%)	1 (1.4%)	6 (8.2%)	Yes	40	No
Wellington Road	23	30%	No	No	No	0 (0%)	1 (4.3%)	2 (8.7%)	3 (13%)	Yes	11	Yes
Collingwood Road	46	24%	Yes	Maybe	No	3 (6.5%)	4 (8.7%)	2 (4.3%)	10 (22%)	No	12	Yes
Waynewood Boulevard	17	47%	Yes	Yes	Yes	0 (0%)	1 (5.9%)	1 (5.9%)	3 (18%)	Yes	9	No
Vernon View Drive	24	38%	No	No	No	1 (4.2%)	2 (8.3%)	0 (0%)	2 (8.3%)	No	15	No
Stratford Lane	12	33%	Yes	No	No	0 (0%)	0 (0%)	0 (0%)	4 (33%)	No	8	No

3.11 Intersection Sight Distance

Another factor that could be contributing to collisions is intersection sight distance. The WTI Team conducted field observations to collect data and conduct a sight distance analysis, as described in this section.

Figure 165 illustrates a clear sight triangle, which is the unobstructed view that a driver needs to avoid potential conflicts with approaching vehicles. Figure 166 shows the existing line of sight for making a right or left turn at each stop-controlled intersection in the study area.

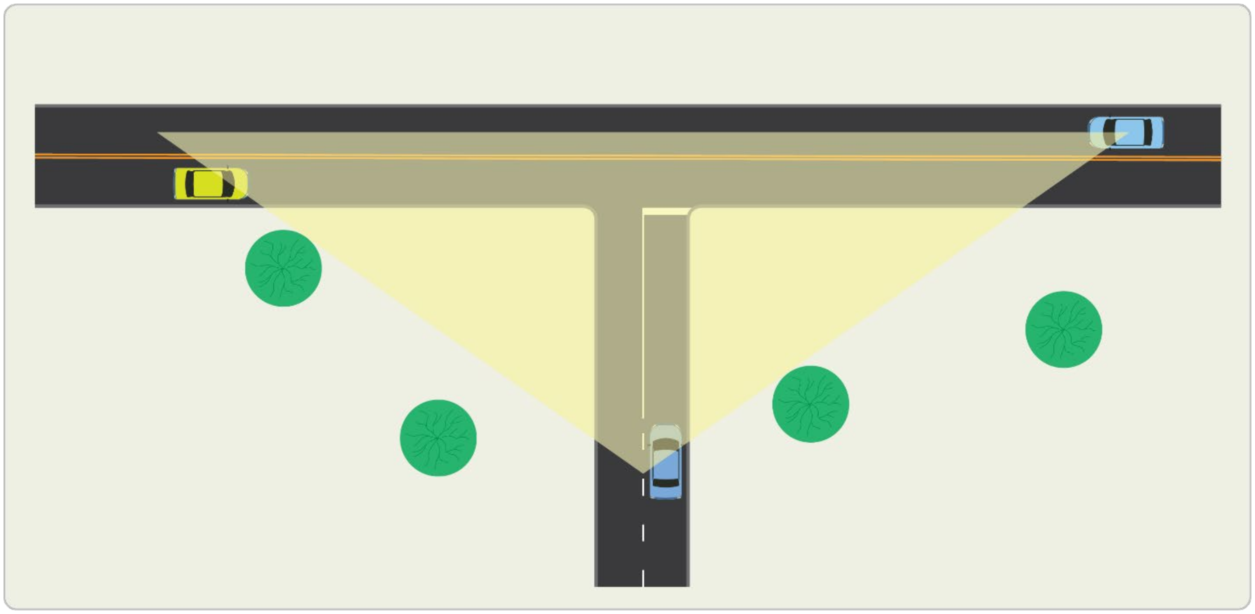

Figure 165: Sight Distance Triangles

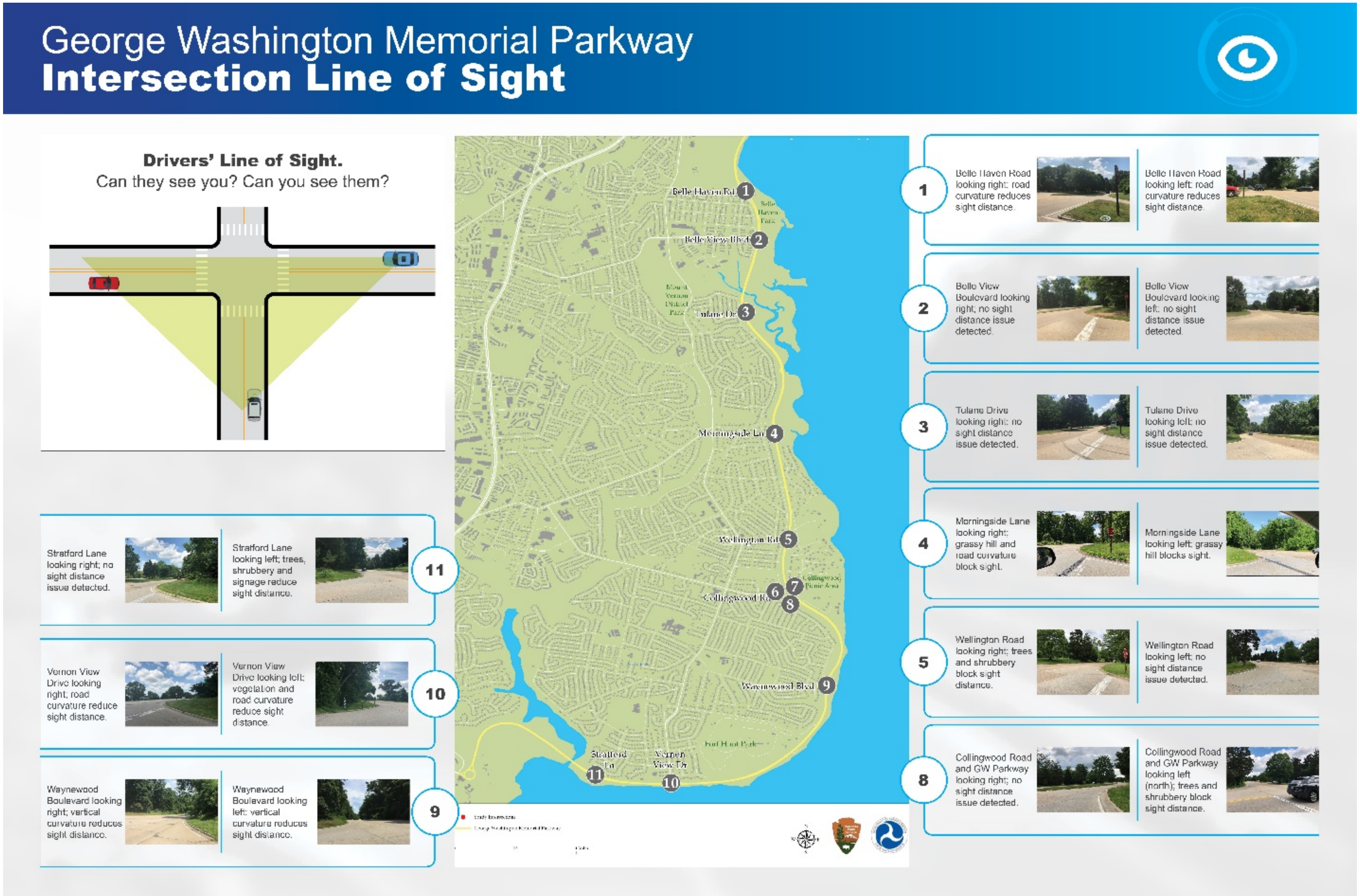

Figure 166: Driver's Line of Sight at Study Intersections

Table 48 summarizes field observations regarding sight distances. The results compare the available line of sight for stopping and for crossing maneuvers, based on the required stopping sight distance using the prevailing roadway speeds. For example, a vehicle traveling at 50 mph (prevailing speed) requires about 425 feet to stop on a level terrain. Making a left turn from a stop onto the Parkway when vehicles on the Parkway are traveling at 50 mph requires a minimum of 555 ft of sight distance, and 480 ft if making a right turn (AASHTO, 2018). For left-turns, for each lane that the turning vehicle has to traverse, an additional 0.5 seconds of delay must be added, resulting in 590 to 625 feet (less if they turn into the near lane, more if they turn into the far lane) needed to safely allow the turning vehicle to enter the Parkway. As can be seen from the table, drivers traveling along the Parkway have an adequate stopping sight distance when traveling at the prevailing speeds. At intersecting streets, road curvature and vegetation present sight obstructions for drivers turning left or right when merging onto the Parkway. Also, changes in slopes, skewed intersecting angles, and vegetation present sight obstructions at most of the intersections including: Belle Haven Road, Tulane Drive, Morningside Lane, Wellington Road, Collingwood Road, Waynewood Boulevard, Vernon View Drive, and Stratford Lane. Figure 167 includes photographs of obstructions for vehicles entering the Parkway from side streets.

Based on these findings, most intersecting roads do not provide adequate sight lines. Reducing vehicles speeds, as well as removing some obstructions such as vegetation, would improve intersection sight lines.

Table 48: Stopping Sight Distance and Design Intersection Sight Distance for Passenger Cars

Intersection	Approach	Adequate Stopping Sight Distance on the Parkway	Minor Street Adequate Intersection Sight Distance	Sight Obstruction
Belle Haven Road	Eastbound Right Turn	Yes	No	Road Curvature
	Eastbound Left Turn		No	Road Curvature
Belle View Boulevard	Eastbound Right Turn	Yes	Yes	None
	Eastbound Left Turn		Yes	None
Tulane Drive	Eastbound Right Turn	Yes	Yes	None
	Eastbound Left Turn		Yes	None
	Westbound Right Turn		No	Vegetation
	Westbound Left Turn		No	Vegetation

Intersection	Approach	Adequate Stopping Sight Distance on the Parkway	Minor Street Adequate Intersection Sight Distance	Sight Obstruction
Morningside Lane	Eastbound Right Turn	Yes	No	Vegetation/Road Curvature
	Eastbound Left Turn		No	Vegetation
Wellington Road	Eastbound Right Turn	Yes	No	Vegetation
	Eastbound Left Turn		Yes	None
Collingwood Road	Eastbound Right Turn	Yes	Yes	None
	Eastbound Left Turn		Yes	None
	Westbound Right Turn		Yes	None
	Westbound Left Turn		No	Vegetation
Waynewood Boulevard	Eastbound Right Turn	Yes	No	Vertical Curve
	Eastbound Left Turn		No	Vertical Curve
	Westbound Right Turn		No	Road Curvature/Vegetation
	Westbound Left Turn		No	Road Curvature/Vegetation
Vernon View Drive	Eastbound Right Turn	Yes	No	Road Curvature
	Eastbound Left Turn		No	Vegetation/Road Curvature
Stratford Lane	Eastbound Right Turn	Yes	Yes	None
	Eastbound Left Turn		No	Vegetation/Sign
	Westbound Right Turn		No	Vegetation
	Westbound Left Turn		No	Vegetation

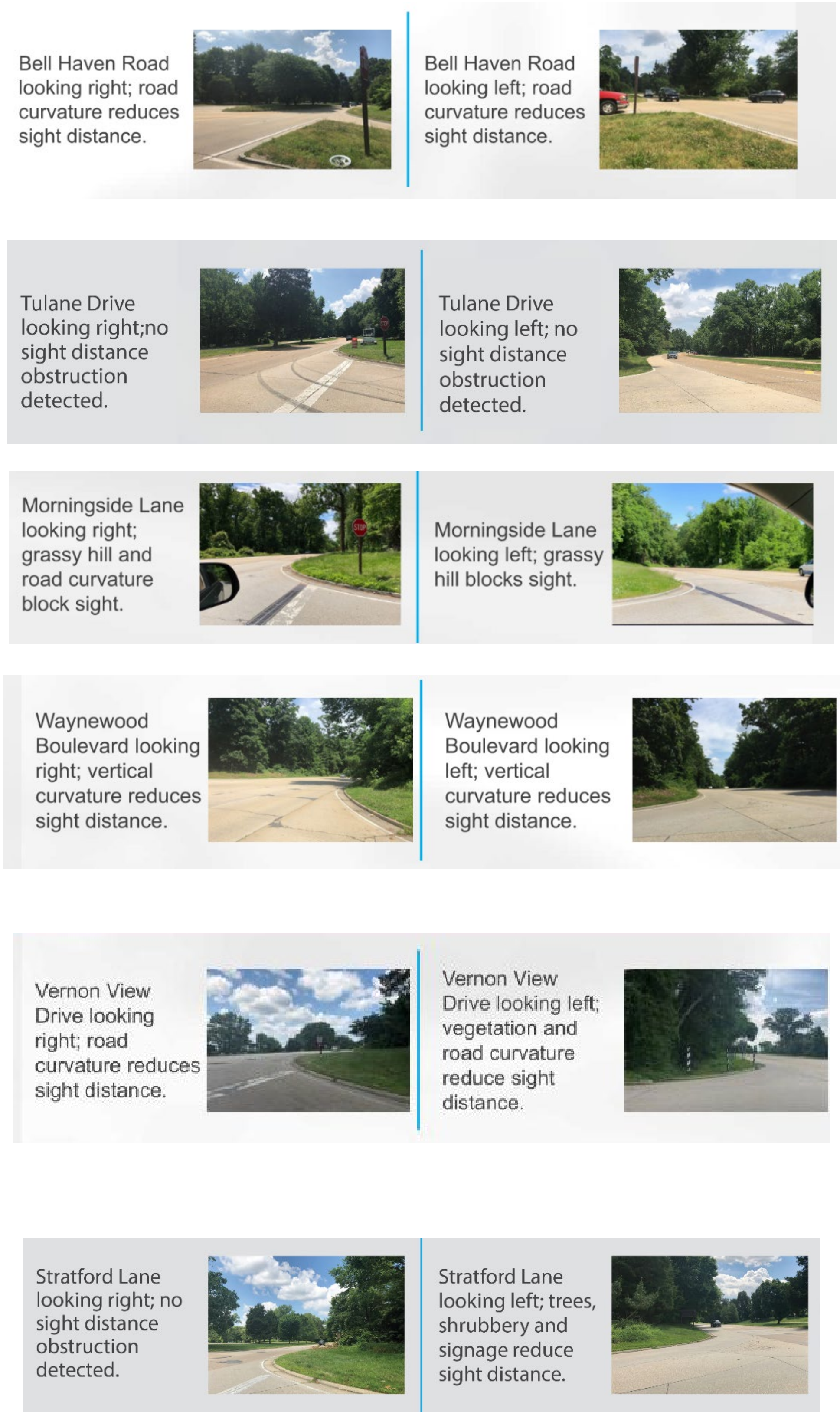

Figure 167: Intersections with Sight Obstructions

3.12 Traffic Safety Evaluation and Crash Experience Conclusions & Recommendations

Safety cannot often be improved with a single solution. There are many potential improvements that can be made to address the safety concerns that exist in this corridor. Speed is a primary contributing factor of crash severity and likely a primary cause of crashes. It was recommended USPP and GWMP apply for a grant through the Governor's Highway Association to pilot speed management. Unfortunately, they have not been successful due to the state selecting non-federal applicants. Meanwhile, coordinated efforts between GWMP and the USPP regarding expanded enforcement efforts are encouraged. The majority of public feedback expressed support for more enforcement.

Overall, while there is some variation across intersections, crashes seem to be overrepresented in April (Morningside Lane; Wellington Road; Collingwood Road; Vernon View Drive; and Stratford Lane) and on Fridays (Belle View Boulevard; Tulane Drive; Morningside Lane; Wellington Road; and Collingwood Road). Therefore, in addition to the proposed geometric and traffic operation modifications that may assist with clarifying right-of-way (at some intersections) and reducing speeds at other locations, the GWMP in cooperation with the USPP could consider a traffic enforcement blitz during the month of April and on Fridays. This, in cooperation with education (e.g. look for pedestrians in the month of April), can assist with improving safety in the corridor.

There seems to be missing data, which limited the depth and comprehensiveness of analysis. Some is the result of the transition from one database to the other, where it seems that most of the 2015 crash data was lost. However, for some of the more recent crash data (2018-2019), there was not information about crash severity, whether or not the driver was tested for driving under the influence, or whether or not the crash was a result of a hit-and-run.

Detailed crash data can help pinpoint contributing circumstances to crashes. The results and analysis contained herein are done to the best of the ability of the available data. The WTI Team recommends that training be conducted with the individuals collecting the data and creating the crash reports to emphasize the importance of thorough, accurate data. As an example, through training, the impacts of erroneous data (e.g. Dark – Lighted vs. Dark – Not Lighted) can be discussed and emphasized. Furthermore, it was conveyed to the WTI Team that as compared with providing more detailed crash data, some agencies are moving towards providing crash reports only in the case of a fatality. This is not recommended. Crash reports, particularly narratives, can provide insight into what is not captured in tabular data. As an example, they can record insights from those involved or observers of the crash that could better explain the underlying crash mechanism. In addition, there was also a suggestion that fatal crashes were not reported to the Fatality Analysis Reporting System (FARS). Federal land management agencies are increasingly making the case for funding and need accurate data to justify funding requests. By not reporting the data, they are limiting availability and access to data, which will in turn hamper their ability to address critical safety concerns like those identified in this project.

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4. Stakeholder & Public Engagement Process

Two sets of meetings were held to inform and engage elected officials, stakeholders, and the public. The first set occurred in July 2019, and the second in December 2019.

4.1 Outreach Meeting (Set 1), July 2019

In July 2019, the project team conducted outreach meetings with elected officials, stakeholders, and the public.

4.1.1 Stakeholder Meeting #1

The Stakeholder Meeting was held on Monday July 8, 2019 at the Mount Vernon District Station-Fairfax County Police Department in Alexandria, Virginia. This meeting provided a briefing on the safety study and a preview of the information that the WTI Team would be sharing during the public meeting on July 11, 2019. The attendees included representatives from:

- National Park Service, George Washington Memorial Parkway
- Federal Highway Administration, Eastern Federal Lands Highway Division
- Fairfax County Department of Transportation
- Western Transportation Institute at Montana State University
- Mead & Hunt

During the meeting, stakeholders discussed the purpose of and need for the study, emphasizing the traffic safety and access concerns that the community had expressed to their local governments, which resulted in the first study conducted by EFL (Ocel, 2019). The stakeholders recognized that understanding the public input is crucial in identifying themes, important issues, or location-specific concerns when providing temporary and long-term safety solutions for the study corridor within the Parkway. Stakeholders mentioned previous studies conducted in 2017 at Morningside Lane, which were expanded to include crash data, corridor recommendations, and other strategies to improve the parkway. This meeting provided a review of how people are using the parkway based on traffic volumes collected, actual travel speeds, gaps and delays at intersecting arterials, crash frequency, and an inventory of transit and parking. Stakeholders identified the following traffic and safety concerns based on the data collected on delays, queueing, gaps, crashes, and turning movements:

- High volumes of commuters use the parkway to bypass congestion and traffic signals on Route 1, and then must cut through neighborhoods to reach Route 1 and the beltway. This creates few gaps for residents to turn from side streets onto the parkway and causes higher traffic volumes on residential side streets.
- The parkway was designed for slower travel speeds based on lower capacity.
- There are four locations out of the eleven study intersections on the corridor with a large number of crashes.
- The lack of gaps for residents to turn off their streets is causing people to misjudge gaps and make aggressive turns, resulting in crashes. The lack of gaps also causes queues.

- There are also problems that arise from trees and bushes that need to be trimmed back; encroaching vegetation reduces sight distance for stopping and turning.
- There is unbalanced traffic flow in the corridor. The parkway and neighboring roads are a system, and changes to the parkway will affect traffic on those roads.
- Pedestrian access is important and is a best practice to be considered.

Additionally, stakeholders discussed budget, temporary countermeasures, and maintenance issues. Key points are summarized below:

- Traffic calming and other projects have been proposed for Fairfax County Department of Transportation roads. There is currently no dedicated funding for any projects near the Parkway.
- The NPS has a small budget for transportation infrastructure, and the project would need funding help from a larger organization.
- VDOT has a program that will provide 50% of the funding on certain projects if other agencies will fund the other 50%.

Some of the temporary solutions that can be applied to the parkway to improve safety are both low-cost and high impact. For example:

- Preliminary mitigation methods that are being investigated include speed management and enforcement, restriping of the corridor, and trimming vegetation along the roadway.
- Turn restrictions are also on the table (which will redirect traffic back to Route 1). Turn restrictions will be considered where other mitigations will not be effective in improving safety.

At the end of the meeting, stakeholders mentioned that the public will have certain questions and expectations, and it will be the responsibility of the experts to help them understand the goal of the project and which problems will be addressed.

4.1.2 Elected Officials Meeting #1

The meeting with elected officials was conducted on the morning of Thursday, July 11, 2019, at the Mount Vernon District Station of the Fairfax County Police Department in Alexandria, Virginia, prior to the public meeting scheduled later on the same day. The purpose of the meeting was to preview public meeting materials, provide a summary of constituent concerns, and describe strategies to encourage citizen and visitor feedback on context sensitive solutions. The attendee list included representatives from:

- Office of Representative Don Beyer (VA)
- Mount Vernon Board of Supervisors (MVBOS)
- Mount Vernon District, Fairfax County Board of Supervisors
- National Park Service, George Washington Memorial Parkway
- National Park Service, Region 1, National Capital Region (NCR)

- Federal Highway Administration, Eastern Federal Lands Highway Division
- 44th District, Virginia House of Delegates
- Virginia State Senate
- Fairfax County Police Department
- Mead & Hunt

The project team presented an overview of the poster boards to the elected officials and representatives that attended the meeting, and introduced the stakeholders involved in the traffic safety study project, including FHWA working in cooperation with the NPS, WTI, and SAI. Team members presented the existing operational, geometric and safety conditions at the eleven selected intersections located in the southern segment of the Parkway between the City of Alexandria and Mount Vernon. In addition, the WTI Team provided a description of the materials to be presented during the public meeting, the logistics for delivering information, and the proposed methods to capture public input.

4.1.3 Public Open House Meeting #1

The first public meeting was conducted on Thursday July 11, 2019 at Walt Whitman Middle School in Alexandria, Virginia from 6:00 PM to 8:00 PM. This meeting facilitated discussions between stakeholders and the public on concerns and suggested safety improvements. There were approximately 124 participants from the public.

Figure 168. First Public Outreach Meeting held July 11, 2019

As shown in Figure 168, more than 12 posters were distributed along the nine stations in the meeting room. Members of the public were encouraged to visit each station to discuss traffic and safety concerns and share their experience using the parkway. Each station focused on one of the following topics:

- Station 1 - Sign-in sheet, project overview flyer, comment card collection box
- Station 2 - Project Purpose and Goals
- Station 3 - Project Schedule
- Station 4a - What is a Parkway?
- Station 4b - Current Projects
- Station 5 - Existing Typical Roadway Sections
- Station 6a - Existing Pedestrian and Bicycle Network
- Station 6b - Existing Transit Stops and Parking
- Station 7a - Traffic Volumes
- Station 7b - Traffic Operations
- Station 8a - Crash Data
- Station 8b- Sight Distance
- Station 9 - Roll Plan Base Map and Comments

4.1.4 Comments from First Outreach Meetings

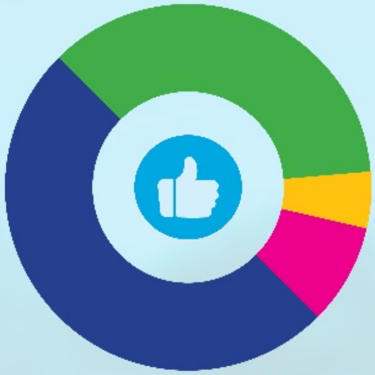
The project team collected comments from the public and elected officials in-person during the outreach meeting through comment cards. Members of the public also had the option to post notes on maps to identify areas of major safety concerns. The period to submit comments was extended through August 21, 2019, allowing the public to submit comments using other venues such as mail, e-mail, and the NPS Planning, Environment and Public Comment (PEP-C) webpage.

A total of 704 comments were collected after the first public meeting. About half of the comments were received at the public meeting with 144 comment cards and 201 comments posted on the maps. In addition, the GWMP project manager at NPS Headquarters (HQ) received 66 mailed letters and 40 emails, and 253 comments were posted in the PEP-C portal.

As can be seen in Figure 169, people expressed a high level of concern about pedestrian safety and limited access for non-motorists also using the Parkway.

George Washington Memorial Parkway
What We Heard - Over 700 Comments from the Public

What We Heard



- Over 345 Comments During the Last Public Meeting
- Over 60 Comments by Mail
- Over 250 Comments through the PEPC Portal
- Over 35 Comments by E-Mail

Major Concerns Identified by the Public

Item	Concern	Count	Percentage
1	Pedestrian Safety and Access (to trail, bus stops)	71	10%
2	Need for Speed Enforcement	65	9%
3	Difficult Intersection Geometric Design	63	9%
4	High Rate of Vehicle Speeds	56	8%
5	High # of Conflicts Making Left-Turns (in/ out of neighborhood streets)	48	7%
6	Limited Intersection Sight Lines	35	5%
7	Bicycle Safety and Access (to trail)	34	5%
8	Illegal Use of the Parkway by Trucks	30	4%
9	Lack of Appropriate Intersection Traffic Controls	30	4%
10	Faded or Lack of Roadway Markings	19	3%
11	Other	253	36%
	Total	704	

Comments by Intersection

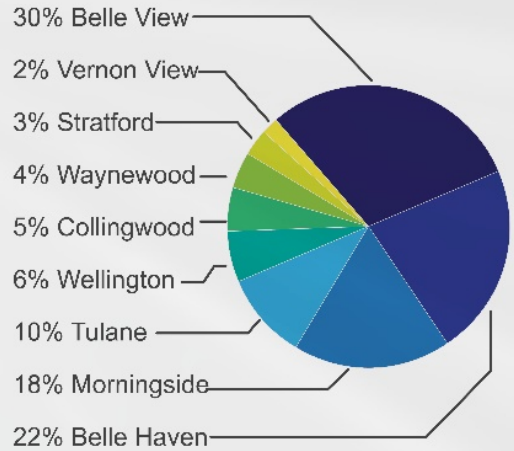


Figure 169. Feedback received from the first Public Outreach Meeting held on July 11th, 2019

Other specific concerns are related to speed enforcement, complex geometric designs, high rates of vehicle speeding on the parkway, and sight distance issues. The intersections at Belle View Boulevard, Belle Haven Road and Morningside Lane received the most comments. These intersections are adjacent to each other and located in the upper segment of the Parkway.

The cards received at the public meeting described speeding concerns, poor pedestrian/bike access and the lack of speed enforcement. On the maps, people identified locations for pedestrian access improvements and sight distance concerns. Public feedback submitted through email, mail and the PEP-C website also showed a high level of concern for speeding, and suggested speed enforcement strategies, as well as geometric modifications to improve safety.

4.2 Outreach Meeting 2, December 2019

The second set of outreach meetings were held in December 2019. Outreach was again conducted with the stakeholders, elected officials, and the public.

4.2.1 Stakeholder Meeting #2

The Stakeholder Meeting was held on Tuesday, December 3, 2019 at the Mount Vernon District Station of the Fairfax County Police Department in Alexandria, Virginia. This meeting provided a briefing on the safety study and a preview of the information that the WTI Team would be sharing during the public meeting that evening. Attendees included various representatives from:

- National Park Service, George Washington Memorial Parkway
- National Park Service, Region 1, National Capital Area
- National Park Service, Legislative Affairs
- Federal Highway Administration – Eastern Federal Lands Highway Division
- Fairfax County Board of Supervisors
- U.S. Representative Don Beyer (VA)
- U.S. Senator Tim Kaine
- Mount Vernon
- Virginia Department of Transportation
- Fairfax County Department of Transportation
- 44th District, Virginia House of Delegates
- Western Transportation Institute at Montana State University
- Mead & Hunt

During the meeting (Figure 170), stakeholders discussed feedback from the first round of meetings, discussed the screening process, received feedback, and discussed next steps. They also had the opportunity to preview materials for the public meeting.

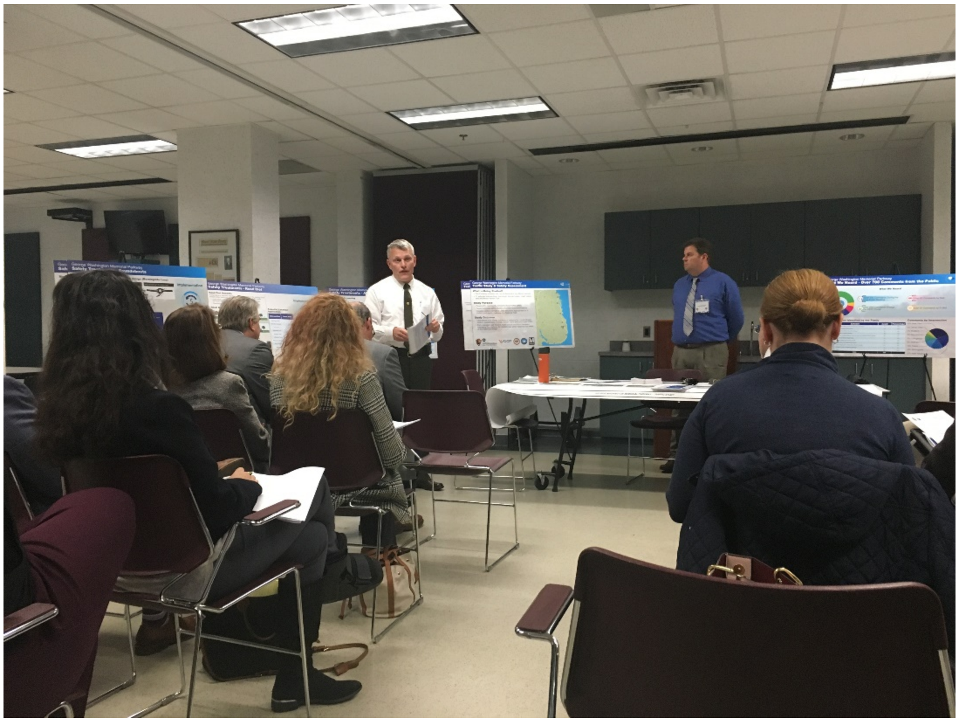


Figure 170. Second Stakeholder Meeting; December 3, 2019

In particular, the WTI Team identified that the top three intersections for which public comments were submitted were Belle Haven Road, Belle View Boulevard, and Morningside Lane. The WTI Team also indicated that based on the data collected, the Parkway can carry the current traffic that uses it. The suspected underlying issue that is contributing to the high severity of the crashes is speeding. It was noted that while GWMP could lower speeds, as reduced speeds are needed to install pedestrian crossings, this is not expected to result in lower speeds by the traveling public.

The stakeholders emphasized the need to continually view the solutions as a three-legged stool, where the legs were made up of the NPS, elected officials and the community. They reported that they had heard that automated speed enforcement (speed cameras) were of particular interest to the public. They also emphasized the need to select actionable solutions. The stakeholders had questions about funding. They also wanted to understand why the traffic circle at Mount Vernon was not included in the study. George Washington Memorial Parkway staff committed to reviewing other park studies such as the Memorial Circle Environmental Assessments and National Register Nomination to determine if operational changes can be made to improve the safety of Mount Vernon Circle.

4.2.2 Elected Officials Meeting #2

The meeting with elected officials was conducted in the afternoon of Monday, December 2, 2019, at the Mount Vernon District Station of the Fairfax County Police Department in Alexandria, Virginia. The purpose of the meeting was to discuss the screening process for whittling down the list of preferred alternatives, preview public meeting materials, provide a summary of proposed solutions, and describe strategies to encourage citizen and visitor feedback on context sensitive solutions. Attendees included representatives from:

- Mount Vernon District, Fairfax County Board of Supervisors
- Virginia State Senate
- National Park Service, George Washington Memorial Parkway
- Mt. Vernon District Police Station
- Western Transportation Institute at Montana State University
- Mead & Hunt

The project team presented an overview of the presentation and poster boards to the elected officials and representatives that attended the meeting. Finally, the WTI Team provided a description of the materials to be presented during the public meeting, the logistics for delivering information, and the proposed methods to capture public input.

4.2.3 Public Open House Meeting #2

The second public meeting was conducted on Tuesday, December 3, 2019 at Walt Whitman Middle School in Alexandria, Virginia from 6:00 PM to 8:00 PM. This meeting facilitated discussions between stakeholders and the public regarding potential solutions to the traffic safety concerns. There were approximately 83 participants from the public (Figure 171).

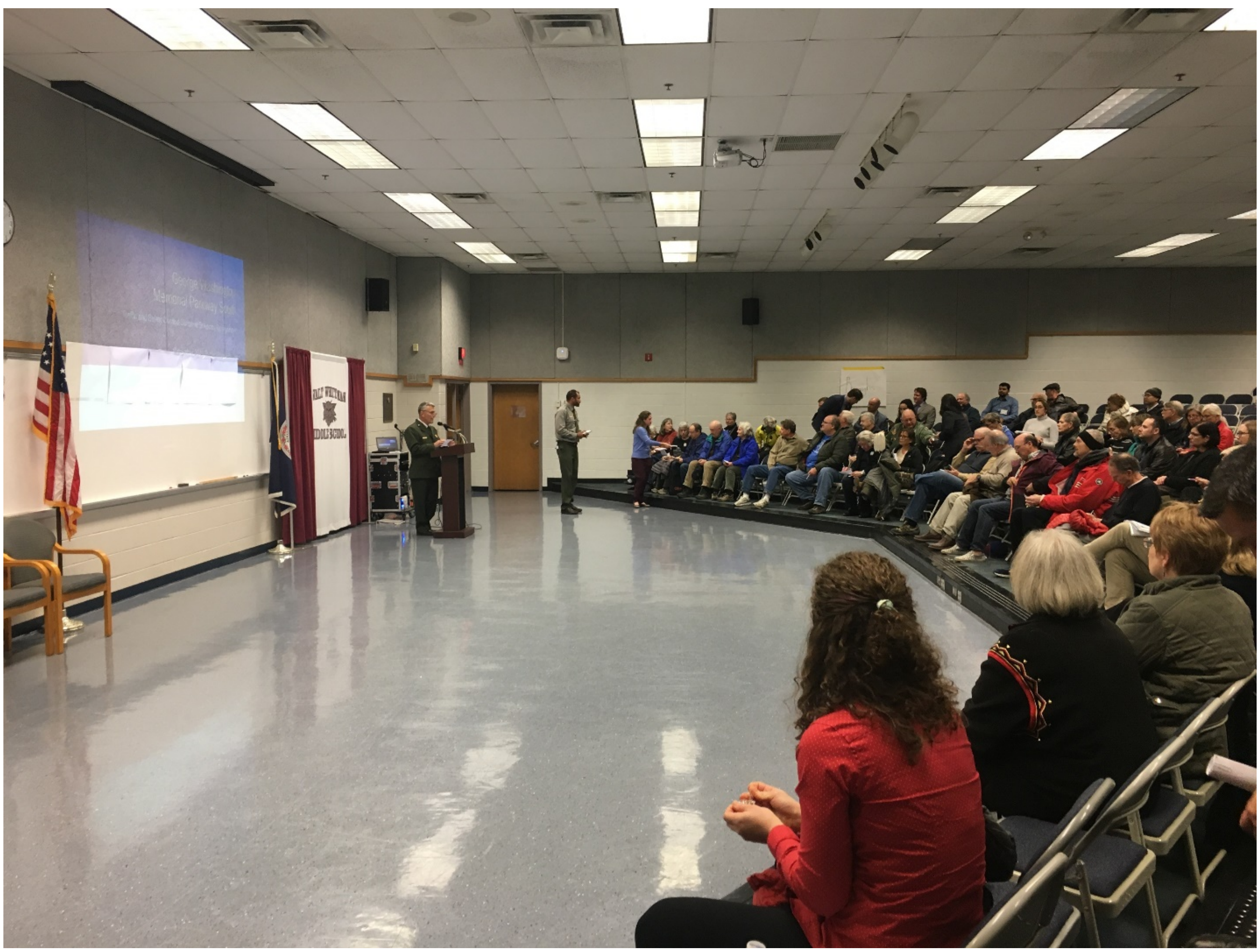


Figure 171. Second Public Outreach Meeting held on December 3, 2019

Sixteen posters were distributed in the meeting room. Members of the public were encouraged to visit each station to discuss the conceptual solutions (e.g. road diets, roundabouts, j-turns) and share their experience regarding how the proposed solutions may or may not be preferred. The following list summarizes the poster topics:

- Poster 1 – Study Schedule
- Poster 2 – What We Heard
- Poster 3 – What is a National Parkway?
- Poster 4 – Context Sensitive
- Poster 5 – Signing, Marking & Maintenance
- Poster 6 – Operational Changes
- Poster 7 – Road Diet
- Poster 8 – Road Diet Rendering
- Poster 9 – Roundabouts
- Poster 10 – Roundabouts vs. Traffic Circles
- Poster 11 – Roundabout Rendering
- Poster 12 – Pedestrian Crosswalks
- Poster 13 – Education
- Poster 14 – Enforcement
- Poster 15 – Alternative Screening
- Poster 16 – Roadway Departure

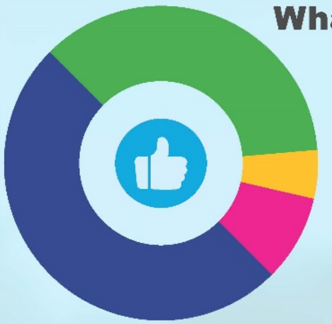
4.2.4 Comments from Second Outreach Meetings

The project team collected comments from the public and elected officials in-person during the outreach meeting through comment cards. The period to submit comments was extended through January 15, 2020, allowing the public to submit comments using other venues such as mail, e-mail, phone, and the NPS webpage (PEP-C).

A total of 156 comments were collected after the second public meeting. About half of the comments (seventy-one) were received at the public meeting via comment cards. In addition, the GWMP project manager at NPS HQ received 11 mailed letters, phone calls or emails. Seventy-four comments were also posted in the PEP-C portal (Figure 172). As can be seen in Figure 172, feedback suggested that safety, enforcement, and pedestrian considerations were the main focuses. The proposed solution that had the most comments was related to turn restrictions. Morningside Lane was the most frequently mentioned intersection within the comments.

George Washington Memorial Parkway Second Public Meeting
What We Heard - Over 156 Comments from the Public

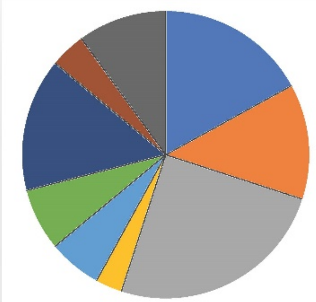
What We Heard



- 71 Comments During the Last Public Meeting
- 74 Comments through the PEPC Portal
- 11 Comments by Phone, Mail & E-Mail
- Comments by E-Mail

Comments by Proposed Solutions

17% Roundabouts
13% Road Diet
25% Turn Restrictions
3% Centerline Buffer
6% Lighting
7% Pavement Markings
15% Bike/Ped Crossings
4% Education
10% Maintenance



Major Concerns Identified by the Public

Item	Topic Area	Count	Percentage
1	Safety	30	
2	Police	28	
3	Pedestrian	28	
4	Signage	25	
5	Bicycle	15	
6	Traffic Lights	13	
7	Commercial Vehicles	8	
8	Sight Distance	8	
9	Flooding	8	
10	Tour Buses	8	
11	Bus	7	
12	Trees	7	
13	History	7	
14	Pot Holes	6	
15	Traffic Circle	3	
16	Ft. Belvoir 9, Stone Arch Bridge 8, East Blvd Dr. 5, Mt. Vernon 3, MVT 4		
	Total		

Comments by Intersection

20% Belle View
5% Vernon View
1% Stratford
2% Waynewood
13% Collingwood
8% Wellington
5% Tulane
30% Morningside
16% Belle Haven

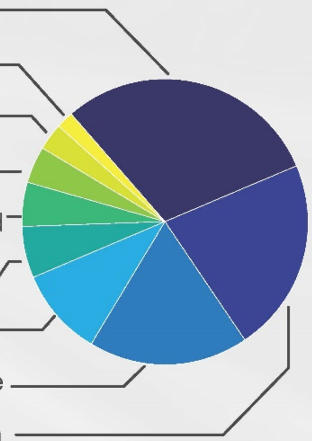


Figure 172. Feedback received from the second Public Outreach Meeting held on December 3, 2019

5. Alternatives Development

This section details the process used to move from baseline input data (crash; traffic; and stakeholder, elected official and public input) informing potential safety and traffic solutions to a narrowed list of final retained candidate solutions. As no one single solution will solve all traffic safety issues at each intersection, several alternatives remained after the screening process. The first section in this chapter discusses the context sensitivity of the Parkway, as it has significant weight in the solutions considered. The subsequent sections identify the categories of alternatives, criteria used to evaluate alternatives, and top potential solutions.

5.1 Context Sensitivity

Two factors strongly influenced the potential alternatives that could be retained as solutions to the safety and traffic concerns along the Parkway: 1) the intention behind a National Park, and 2) the founding purpose of the Parkway (National Park Service, 1946).

The following are parkway design and characteristics:

- They are owned and maintained by the NPS to provide scenic, recreational driving experiences.
- Parkways were built for "recreational driving," a popular activity during the time period when vehicles were becoming more accessible to many Americans. Many parkways were built in the 1930s when the maximum speeds that vehicles could travel was capped at 30 to 40 mph.
- NPS roadways are not intended to efficiently move traffic from origin to destination; rather, they are designed for slower speeds than highways, thereby respecting the natural areas and preserving the unique visitor experience which is better seen by traveling at slower speeds.

Of note, the speed limit on the portion of the Parkway considered for this study is 35 mph with sections increasing only to 45 mph. As shown in the data section, many users of the Parkway are vastly exceeding these speed limits, traveling at speeds beyond the design standards for the corridor.

Specific characteristics of the Parkway:

- It was opened in 1932, when the automobile was becoming more common.
- It is a memorial to America's First President, George Washington, and was designed to provide a safe and scenic transportation experience. It was not intended to serve commuters, as this was not a consideration at the time of founding.
- The landscape within the Parkway along the Potomac River to the Mount Vernon Estate defines this unique roadway.
- It is listed in the National Register of Historic Places, and the scenic vistas throughout the Parkway provide a unique visitor experience. This special status was given to the Parkway to protect unique places and cultural resources of national heritage and limits the amount and type of physical changes that can be made. Unlike most other roadways maintained by state and local governments, proposed changes to the Parkway require

formal Section 106 of the National Historic Preservation Act review before any construction, repair, and ground/ visual disturbances

- It provides habitat for local wildlife including many rare, threatened, and endangered plant and animal species.

As mentioned in the crash data section, there are many animal/vehicle collisions. .

Key themes of the context sensitivity associated with the Parkway:

- Honor the legacy of George Washington
- Provide recreational opportunities
- Maintain ceremonial entrance
- Provide transportation
- Preserve views and vistas
- Connect historic sites, scenic overlooks, memorials, monuments, stories, and people.

From a roadway design perspective, the implications of the context sensitivity suggest that:

- There should be a limited number of intersections (a.k.a. access points),
- There are vegetative transitions between the parkway and woodlands,
- The roadway should follow the natural contours of the landscape,
- The rural feel of the Parkway, even though it is located in a very urbanized area, should be retained,
- The road should remain concrete,
- The curb is mountable,
- The guardrails shall remain rustic (but they have been safety tested by the FHWA),
- The treatments of headwalls and swales shall remain stone,
- Tree plantings and groves contribute to memorialization,
- There exist frequent pull-offs, and
- There is limited sign clutter (e.g. of roadway signs, billboards, and business notifications).

The tie between key Parkway themes and roadway design features is better shown in Figure 173. A motorist, whether using the Parkway for tourism or commuter purposes, can feel and see all of these features that make the Parkway a national treasure.

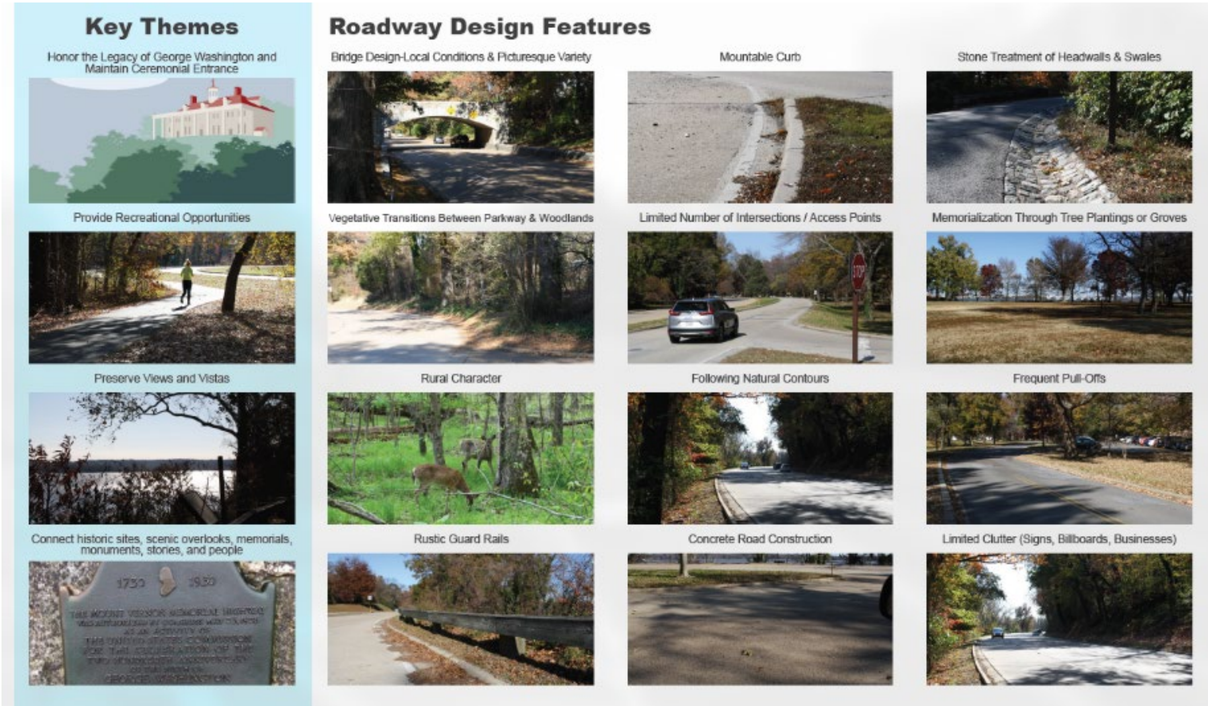


Figure 173: Roadway Features Tied to Key Parkway Themes

5.2 Alternatives Screening Process

The research team collected data on daily traffic volumes and peak hour intersection traffic movements (e.g. left turns) for the focus intersections identified previously. Team members also analyzed crash data and conducted several field visits of the corridor. All of this data, along with input from the elected officials, stakeholders, and the public, identified **eighty-nine** potential alternatives (found in Appendix G: Alternatives) that could be applied to the intersections in the corridor to address safety and traffic concerns. These alternatives were divided into nine categories:

1) Driver Behavior (A)
2) Signs & Markings (B)
3) Operational Changes (C)
4) Multi-Modal Improvements (D)
5) Geometric Modifications (E)
6) Roadway Departure Countermeasures (F)
7) Maintenance (G)
8) Environmental (H)
9) Fort Belvoir (I)

To funnel down the alternatives into manageable possibilities, several filters were applied. During the first pre-screening, potential solutions related to aspects outside of the scope of the project (e.g. large vehicles hitting the stone arch bridge; recommendations related to locations beyond the study limits/study intersections) were filtered out. Next, the context sensitivity factors described previously were considered. Potential solutions (e.g. traffic signals) that were not consistent with the context sensitivity considerations of this nationally significant asset were also screened out.

For the final screening, GWMP identified criteria to evaluate the alternatives. They included:

- Traffic Safety Benefit
- Law, Policy, & Regulatory Compatibility
- Implementation Timeline
- Traffic Operational Benefits
- Supporting Analysis
- Construction Cost
- Responsible Agency for Implementation
- Right-of-Way (ROW)
- Community Support

Points were assigned to each of these criteria. As safety was the driving force behind the current study, it was identified as a priority and assigned the highest number of potential points in the evaluation process. This process is summarized in Figure 174.

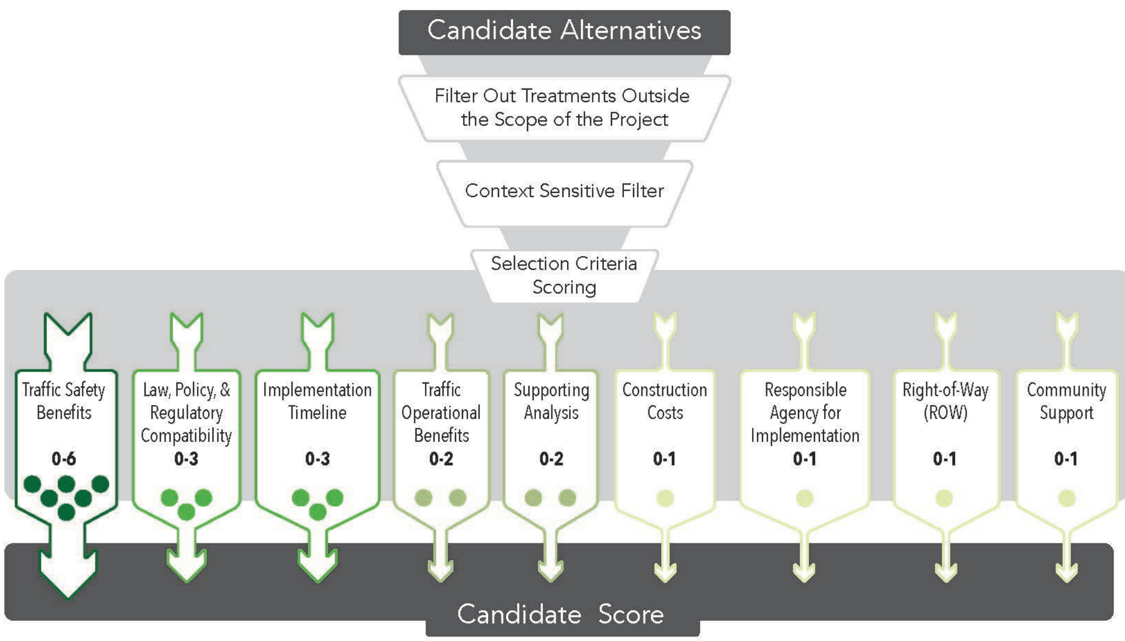


Figure 174: Alternatives Screening Process

Values were assigned to each treatment in whole number increments. Within each category, treatments were given an estimated value based on how well the proposed treatment was expected to meet the desired outcome.

For **Traffic Safety Benefit (0 to 6)**, if the proposed treatment is known to have a highly correlated impact on traffic safety, it was given a larger value, like 6. If there was no known or little expected impact, it was given a 0. If the results were expected to be variable, a 2, 3, or 4 was assigned to the alternative.

For **Law, Policy, and Regulatory Compatibility (0 to 3)**, if the alternative was in conflict with an existing law, policy, or regulation, it was given a 0. If it fit within or did not require changes to standing law, policy, or regulation, it was given a 3. If there was some flexibility or ambiguity, it received a 1 or 2. GWMP provided input regarding the assigned value.

For **Implementation Timeline (0 to 2)**, those alternatives that were anticipated to require further engineering studies or design, or would need extensive permitting, long construction durations, and so forth were given 0s. Alternatives that were anticipated to be more readily implemented in the short-term, based on the urgency of the solutions needed, were given 2s. This criterion reflected GWMP's desire to provide some solutions in the immediate future to address the public's concern.

For **Traffic Operational Benefits (0 to 2)**, if an alternative was expected to make the traffic operate more efficiently, it was given a 2. If it was anticipated to negatively impact the traffic movement, it was given a 0.

For **Supporting Analysis (0 to 2)**, for those alternatives that were anticipated to need a significant level of additional analysis, a 0 was given. If some analysis was needed, but it was not estimated to take a significant amount of time, the study was given a 1. If there was little to no additional analysis needed, it was given a 2.

For **Construction Costs (0 to 1)**, for an alternative that was anticipated to be costly to construct from a qualitative perspective, a 0 was given. Otherwise, a 1 was given.

For **Responsible Agency for Implementation (0 to 1)**, if GWMP could easily implement the alternative and could drive the result, a 1 was given. If cooperation and buy-in were needed from another entity (e.g. retiming a traffic signal owned by another entity), a 0 was given, as sometimes coordination efforts or acceptance of efforts can be challenging. Where GWMP could lead the implementation but would require a significant amount of time either for the implementation or for staff overtime, a 0 was given, as it is anticipated that due to already limited staff, this would be an unlikely solution.

For **Right-of-Way (ROW) (0 to 1)**, if an alternative might need additional ROW, it was given a 0. If an alternative could be implemented within the existing ROW, a 1 was given.

For **Community Support (0 to 1)**, if the public provided a "yes," "likely," or "some" positive responses (without negative responses) to the alternative during the first outreach meeting (July 2019), then the alternative was given a 1. If the comments provided by the public indicated a lack of support, it was given a 0.

Overall, the top five alternatives (with three tied for third place) retained after the screening process are:

1) Manual on Uniform Traffic Control Devices (MUTCD) Compliant Warning Signs (18 pts) [B]
2) Improved Delineation (17 pts) [B]
3) Commercial Vehicle/Educational Campaign (16 pts) [A]

4) Speed Public Awareness Campaign (16 pts) [A]
5) Distracted Driving Campaign (16 pts) [A]
6) Pedestrian Safety Public Awareness Campaign (16) pts) [A]

Looking at the results by category, the following alternatives represent the top three in each category (note, for those categories with less than three identified, the other potential alternatives were removed by filters during the preliminary screening; the Driver Behavior category has a four way tie for the top three):

5.2.1 Driver Behavior (A)

1. Commercial Vehicle/Educational Campaign (16 pts)
2. Speed Public Awareness Campaign (16 pts)
3. Distracted Driving Campaign (16 pts)
4. Pedestrian Safety Public Awareness Campaign (16 pts)

5.2.2 Signs & Markings (B)

1. MUTCD Compliant Warning Signs (18 pts)
2. Improved Delineation (17 pts)
3. Add Pavement Crosshatch Markings and Signs to Not Block Intersections (14 pts)

5.2.3 Operational Changes (C)

1. Reduced Speed Limits (14 pts)
2. Turn Prohibition (13 pts)
3. Corridor (Access) Management (10 pts)

5.2.3 Multi-Modal Improvements (D)

1. Pedestrian Crosswalks (12 pts)
2. Pedestrian Crossing with rectangular rapid flash beacon (RRFB) (10 pts)
3. Pedestrian Warning Application (App) (10 pts)

5.2.4 Geometric Modifications (E)

1. Remove Intersection (11 pts)
2. Roundabouts (9 pts)
3. Road Diet (e.g. Imbalanced Typical Section w/2 Lanes in One Direction and 1 Lane in the Other) (9 pts)
4. Spot Widen/Add Splitter Islands (9 pts)
5. Channelize Right-Turns with ‘Pork Chop’ Island (9 pts)

5.2.5 Roadway Departure Countermeasures (F)

1. Install Lighting (14 pts)
2. Centerline Buffer Area (10 pts)
3. Roadside Design Improvements at Curves (9 pts)
4. Longitudinal Rumble/Mumble Strips (9 pts)

5.2.6 Maintenance (G)

1. Update Existing Striping (16 pts)
2. Fix the Current Road Surface (15 pts)

3. Trim Trees/Shrubs/Grass/Edging (12 pts)

5.2.7 Environmental (H)

1. Drainage Study (6 pts)
2. Arborist Study (5 pts)

5.2.8 Fort Belvoir (I)

1. Educational Event at Fort Belvoir

5.3 Top Alternatives

Solutions reflected in the overall top five alternatives were drawn from the categories of Driver Behavior (A) and Signs & Markings (B). However, as suggested by the "3E model" (Enforcement, Education, and Engineering), safety requires a multi-faceted effort. Therefore, the "3E Model," which is a preferred approach to addressing traffic safety among many practitioners, particularly because it includes bicyclist and pedestrian use (Brookshire, Sandt, Sundstrom, Thomas, & Blomberg, 2016), was used. Using the 3E categories, the top alternatives are:

5.3.1 Enforcement

1) Commercial Vehicle Enforcement/Educational Campaign (16) [A7]
2) Law Enforcement Push on Speed, Driving Under the Influence, and Distracted Driving (15) [A5]
3) Automated Speed Enforcement (Speed Cameras) (9) [A8]
4) Crowdsource/Citizen Reporting Application (5) [A11]

5.3.2 Education

5) Speed Public Awareness Campaign (16) [A1]
6) Pedestrian Safety Public Awareness Campaign (16) [A4]
7) Distracted Driving Public Awareness Campaign (16) [A3]
8) Dynamic Message Signs (DMS) (13) [A10]
9) Infographic on Time vs. Speed (11) [A12]
10) Neighborhood Educational Event (10) [A6]
11) Parkway vs. Road Public Awareness Campaign (8) [A2]
12) Website for Public Comments/Concerns (8) [A14]
13) Speed Management Plan (8) [A13]
14) Educational Event at Fort Belvoir (7) [I1]

5.3.3 Engineering

5.3.3.1 Signing & Markings

15) MUTCD Compliant Warning Signs (18) [B1]
16) Improved Delineation (17) [B4]
17) Upgrade Existing Striping (16) [G3]
18) Add Pavement Crosshatch Markings and Signs to Not Block Intersections (14) [B5]
19) Turn Lane Pavement Arrows (13) [B2]
20) Speed Activated Feedback Sign (11) [B8]
21) Centerline Buffer Area (10) [F7]

5.3.3.2 Multi-Modal

22) Pedestrian Crosswalks (12) [D2]
23) Pedestrian Warning Application (App) (10) [D7]
24) Pedestrian Crossing with a RRFB (10) [D1]
25) Pedestrian Medians/Crossing Islands (8) [D4]
26) Add Capital Bikeshare Locations (8) [D11]
27) Transit Study (8) [D5]

5.3.3.3 Maintenance & Environment

28) Fix the Current Road Surface (15) [G2]
29) Trim Trees/Shrubs/Grass/Edging (12) [G1]
30) Drainage Study (5) [H2]
31) Arborist Study (5) [H1]

5.3.3.4 Operational Changes

32) Reduced Speed Limits (14) [C3]
33) Turn Prohibition (13) [C6]
34) Adjust Signal Timing on Route 1 (6) [C7]

5.3.3.5 Roadside Design Improvements

35) Install Lighting (14) [F4]
36) Roadside Design Improvement at Curves (9) [F1]

5.3.3.6 Geometric Modifications

37) Remove Intersection (11) [E15]
38) Corridor (Access) Management (10) [C5]
39) Roundabout (9) [E2]
40) Road Diet (e.g. imbalanced typical section with two-lanes in one direction and one lane in the other) (9) [E4]
41) Spot Widen/Add Splitter Islands (9) [E8]
42) Channelize Right-Turns with 'Pork Chop' Island (9) [E11]
43) Longitudinal Rumble/Mumble Strips (9) [F2]
44) Spot Left-Turn Lane Installation (8) [E6]
45) Reduced Left-Turn Conflict Intersections (8) [E10]
46) Right-Turn Lanes (7) [E9]
47) Speed Hump or Speed Table (6) [C11]
48) Two-Way Left-Turn Lane Installation (5) [E5]

5.4 Alternatives Summary

Forty-eight of the original eighty-nine potential alternatives came to the forefront as potential solutions using the 3E model approach (engineering, education, and enforcement). There is no one solution that will solve all of the safety and traffic issues at the intersections under consideration within this corridor. Rather, safety and traffic issues will be improved by looking at each intersection, considering the refined menu of options, and treating the conditions identified based on the data collected.

The next chapter will provide a closer look at several of the engineering safety countermeasures to help assess their applicability, safety and traffic benefit, geometric feasibility, and optimal placement in the corridor. The measures focus on geometric changes, operational changes, and multi-modal accommodations that would be more intensive changes than signing, marking, roadside departure or maintenance measures require.

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6. Engineering, Education, and Enforcement

This chapter discusses and provides details about the major engineering measures utilized for addressing the study intersections along the Parkway corridor. It should be noted that these are *conceptual designs*. The process of developing and evaluating the concept designs was intended to further whittle down the viable alternatives for final recommendations, so not all concepts presented were found to be viable. Topics covered include:

- Access Management
- Road Diets
- Roundabouts, and
- Refuge Islands for Pedestrian Safety

These concepts and their applications offer design flexibility and address safety while maintaining traffic operations. The following sections describe the benefits of the concepts and how these attributes can assist in providing context sensitive solutions within the study area. Any concept advanced into final design may be subject to full National Environmental Policy Act (NEPA) Section 106 compliance and documentation of all resource impacts.

6.1 Access Management

6.1.1 Description

Access Management countermeasures are effective and strategic applications for controlling traffic operations at the entry and exit points along a roadway. Access management techniques include numerous methods such as (USDOT, 2017):

- Driveway closure, consolidation, or relocation.
- Limited-movement designs for side streets or driveways (such as right-in/right-out only).
- Raised medians that preclude across-roadway movements.
- Intersection designs such as roundabouts or those with reduced left-turn conflicts (such as J-turns, median U-turns, etc.).
- Turn lanes (i.e., left-only, right-only, or interior two-way left).
- Lower speed one-way or two-way off-arterial circulation/ frontage roads.

Maneuvers at intersections can be controlled, restricted, and redirected by access management operations through geometric design and/or traffic control device assignments.

Access management measures are proven measures in restricting high-crash maneuvers along an arterial or limited access roadway. This is especially noteworthy regarding left-turns into the northbound or southbound Parkway travel-way, as well as in leaving the Parkway via a left turn and crossing against oncoming, opposite flow Parkway traffic. Potential locations for these applications are listed in Table 49.

Table 49: Potential Access Management Location Applications

Intersecting Roadway	Lefts to the Parkway, Northbound	Lefts from the Parkway, Northbound	Lefts from the Parkway, Southbound
Belle Haven Road	√	√	
Belle View Boulevard	√	√	
Tulane Drive	√	√	
Morningside Lane	√	√	
Wellington Road	√	√	
Collingwood Road	√	√	√
Waynewood Boulevard	√	√	
Vernon View Drive	√	√	
Stratford Lane	√	√	√

Access management options can be used to eliminate/restrict these left turns or reduce the areas of conflict. *Examples* of such measures are illustrated in Figure 175 through Figure 178 for the following intersections: Morningside Lane (right-in/ right-out channelization), Collingwood Road (Z-median), Belle Haven Road (channelization), and Belle View Boulevard (median U-turn). Please note, these treatments are shown on some intersections where they may not be the best solution (e.g. the Z-median on Collingwood Road); the intent of the following is to demonstrate conceptually what such a treatment would look like. While signing can be used to restrict motorists from turning left, it is often necessary to use channelized, raised barriers or bollards to prevent the disregard of traffic control guidance measures. For right-in and right-out or Z-median applications, the restricted movement would be re-routed to a designated downstream U-turn location with supplemental U-turn signage for motorist guidance.

6.1.2 Expected Safety Benefits

The anticipated safety benefit would be an elimination of all left-turn crashes at locations where the respective movement is restricted.

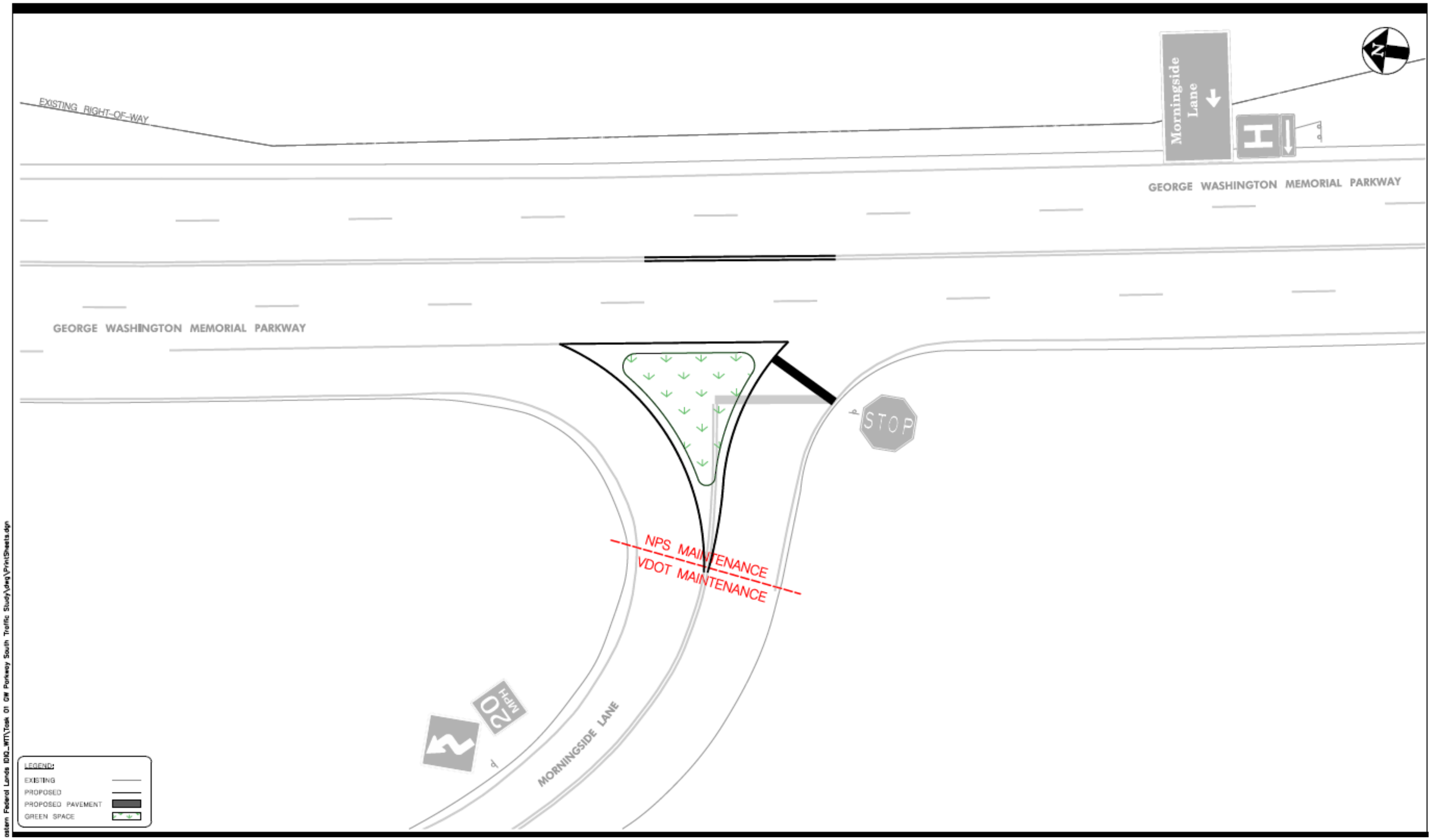

Figure 175: Morningside Lane Right-In and Right-Out Access Management

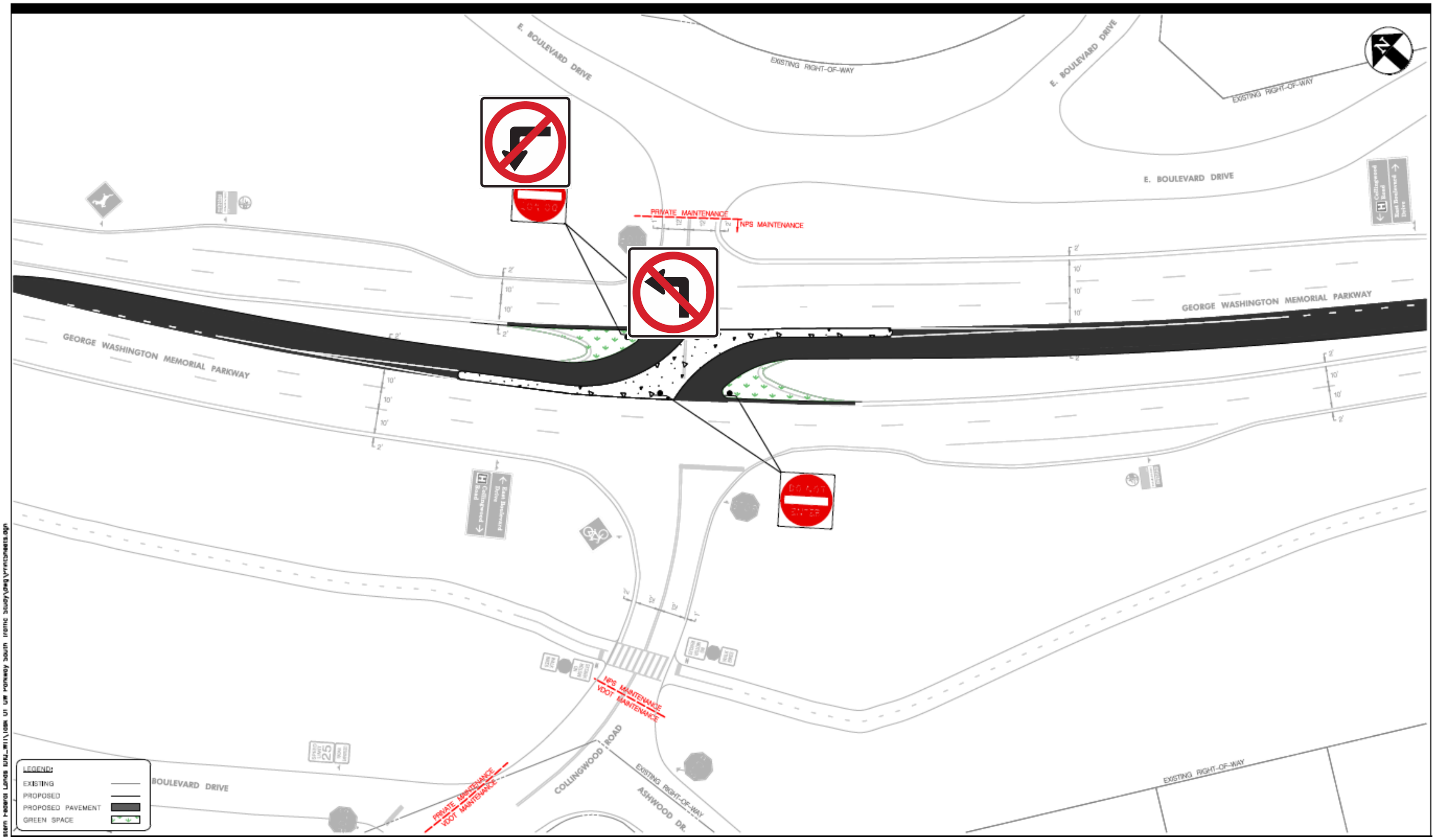

Figure 176: Example Z-Median Access Management at Collingwood Road

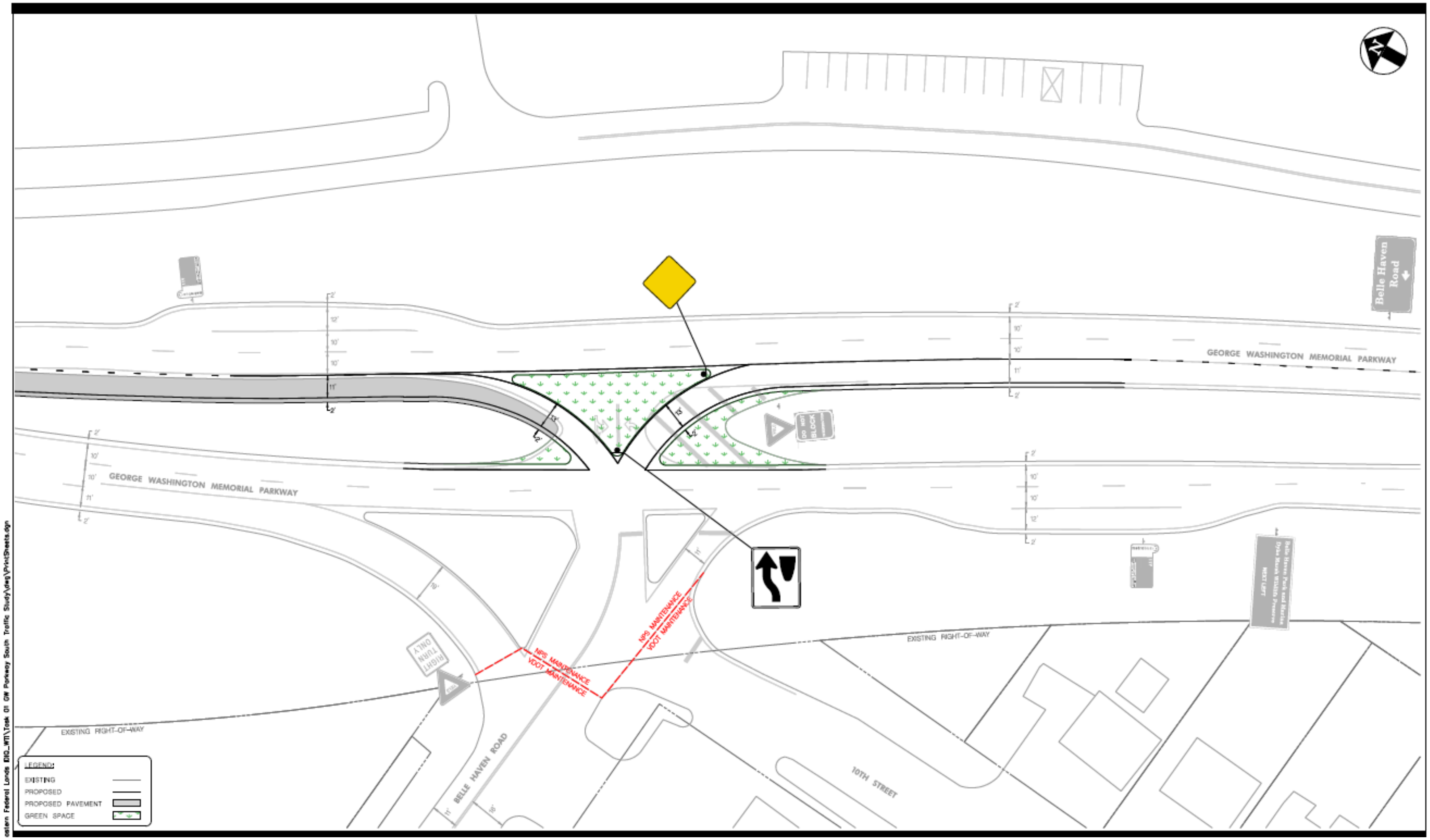

Figure 177: Belle Haven Road Channelization

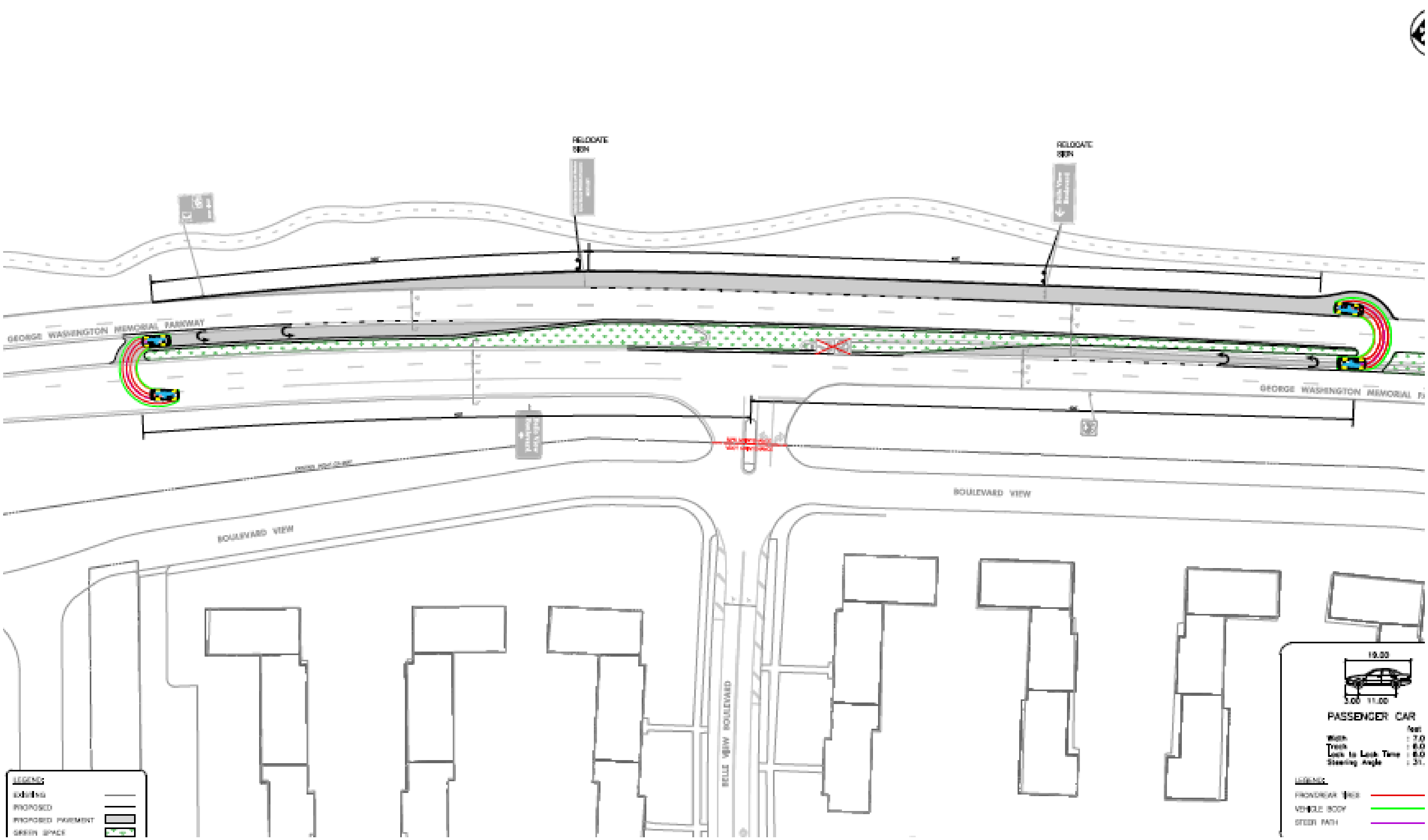

Figure 178: Belle View Boulevard Median U-Turn

6.2 Potential Access Management Applications

One variation of the access management concept is to utilize existing adjacent intersections along the Parkway for U-turn movements in locations where there is insufficient spacing to provide a separate U-turn movement on the Parkway itself. The WTI Team also prepared conceptual designs for these alternatives. A potential application would be to allow eastbound left-turns from Belle Haven Road for drivers heading northbound on the Parkway, using the Belle Haven Marina access intersection, shown in Figure 179. To further assess the feasibility of this movement, the turning templates for buses and passenger vehicles were examined to determine the footprint required for the U-turn maneuver, shown in Figure 180 and Figure 181. Buses would need to be restricted from this maneuver, and passenger cars would need a northbound acceleration lane to complete the maneuver.

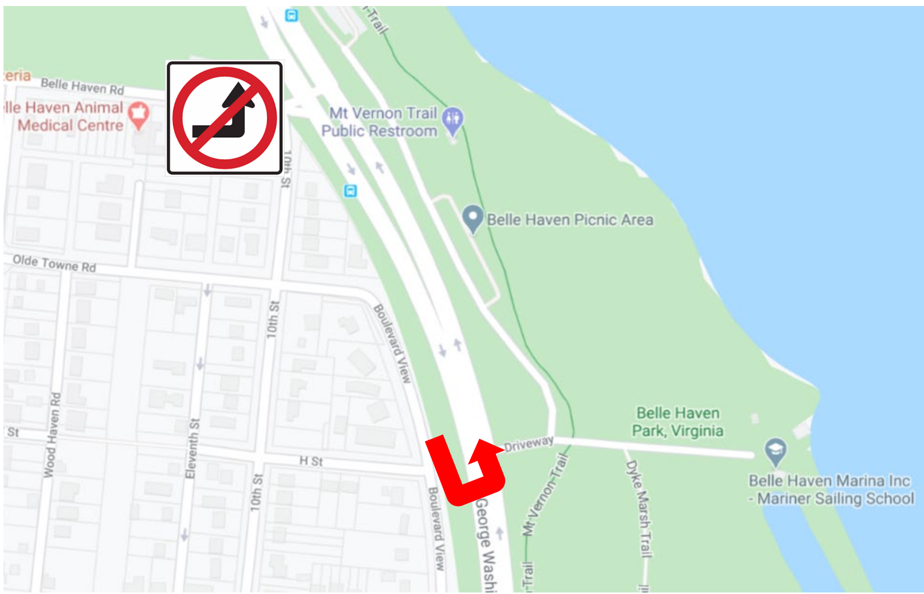

Figure 179: Potential Belle View Boulevard Eastbound Left-Turn Rerouting

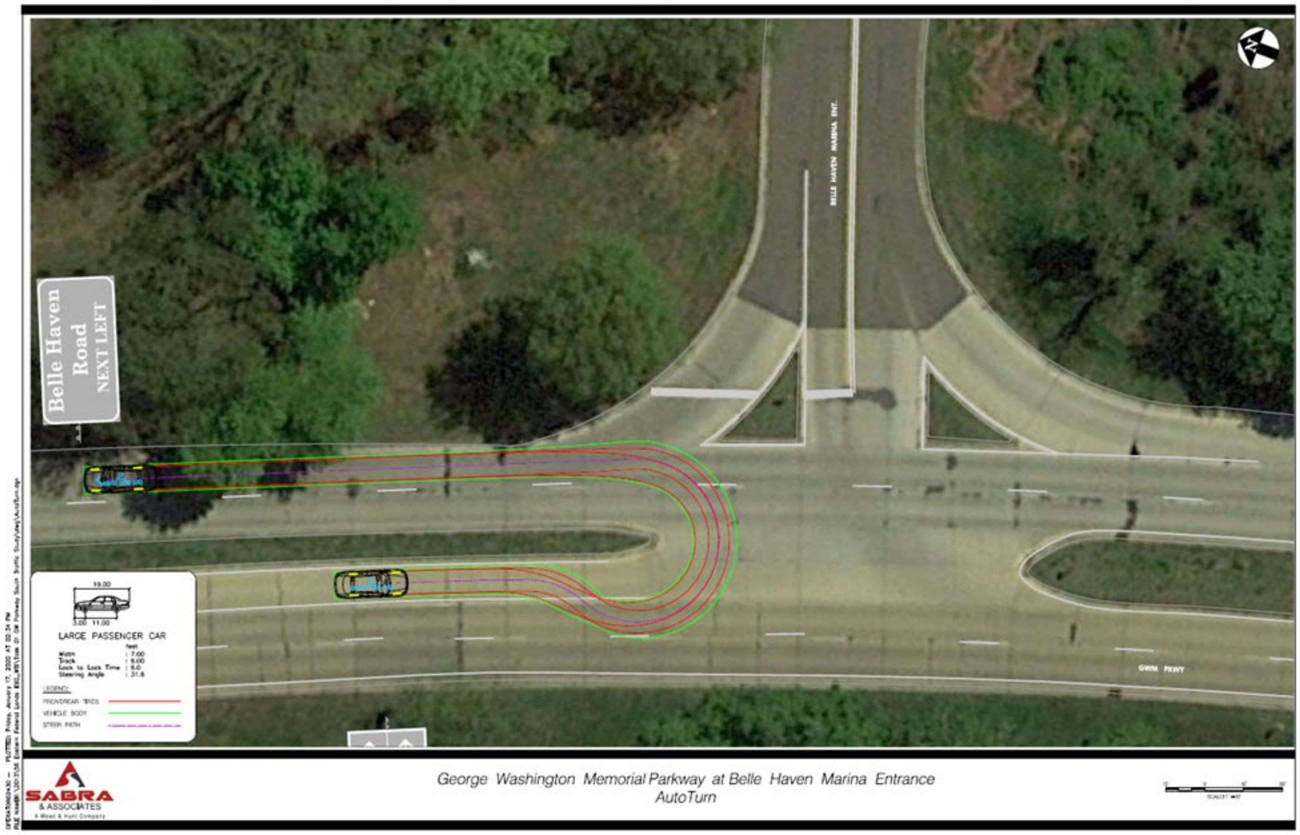

Figure 180: Passenger Vehicle Southbound U-Turn Radius at Belle Haven Marina

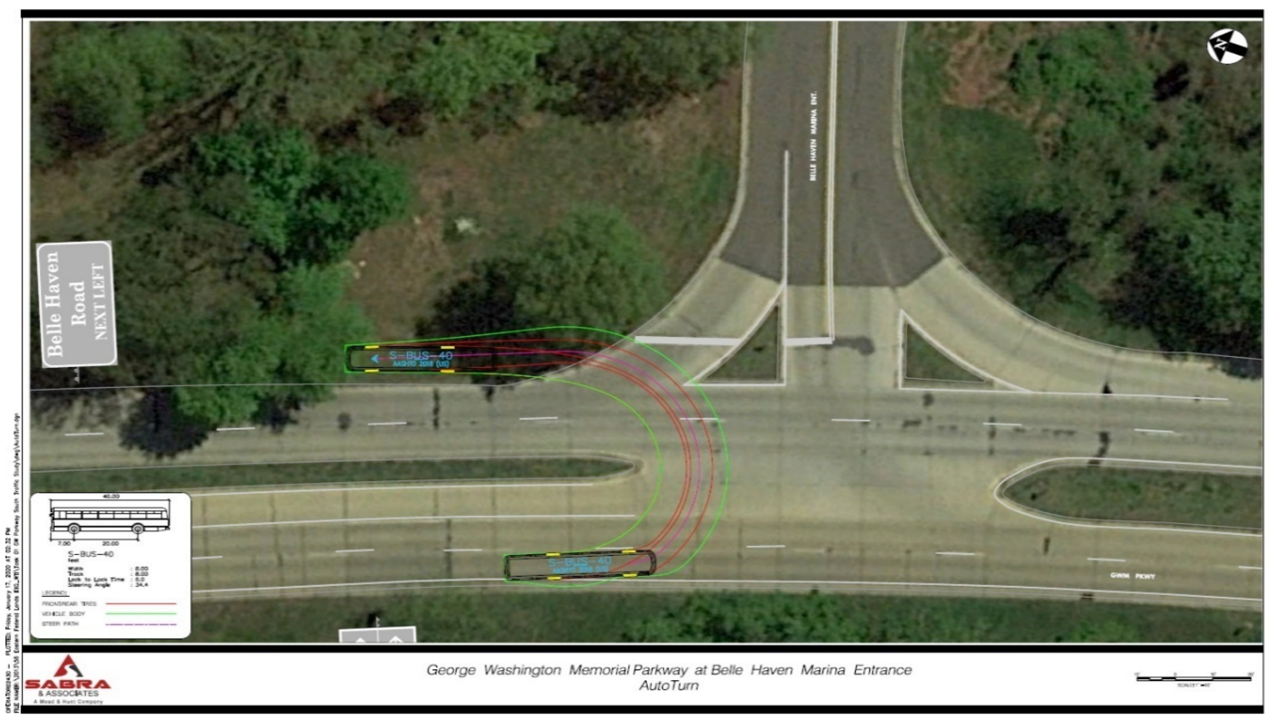

Figure 181: Bus U-Turn Radius at Belle Haven Marina

Figure 182 and Figure 183 illustrate the conceptual design of an acceleration lane to allow for the U-turn maneuver at Belle Haven Marina. A layout is shown for two design speeds – 35 MPH and 45 MPH. A higher design speed would require a longer acceleration lane, thus increasing the amount of impervious surface. Drainage would have to be installed. Some trees would have to be removed. The determination of acceleration lane length and full limits of disturbance need for retaining walls or other minor structures will be made based on a final determination of design and operating speeds for this segment of the parkway.

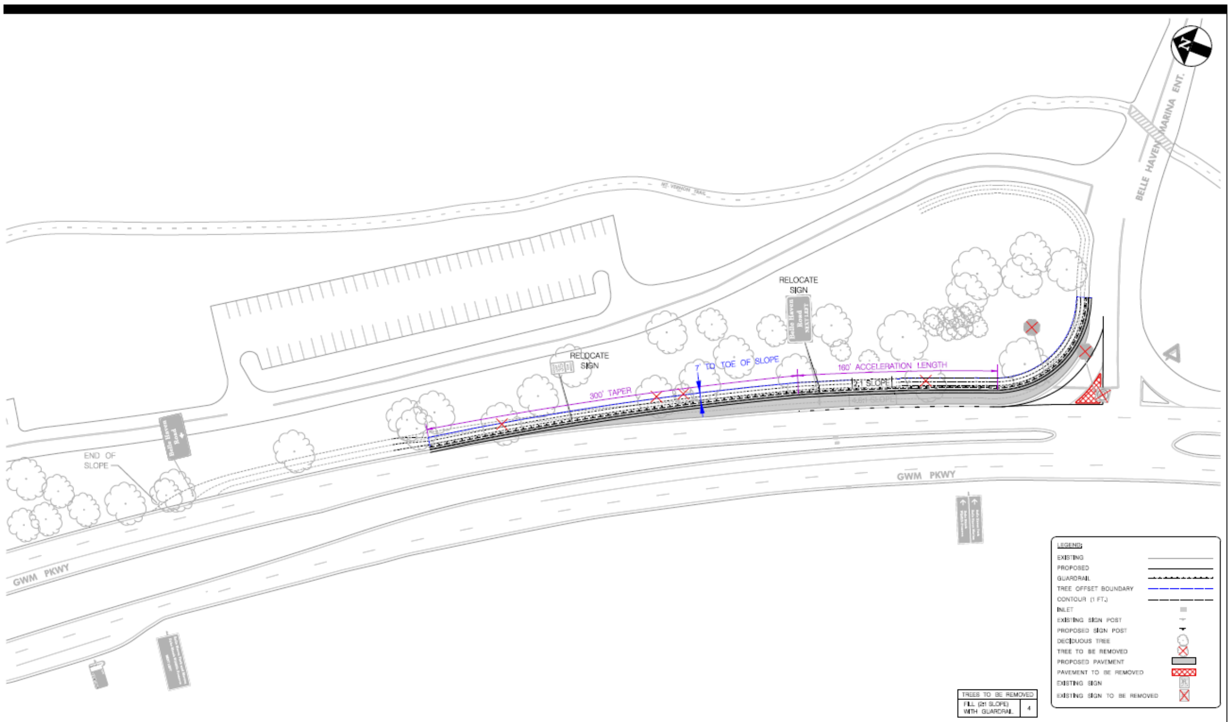

Figure 182: Belle Haven Marina U-Turn Acceleration Lane with 35 MPH Design Speed

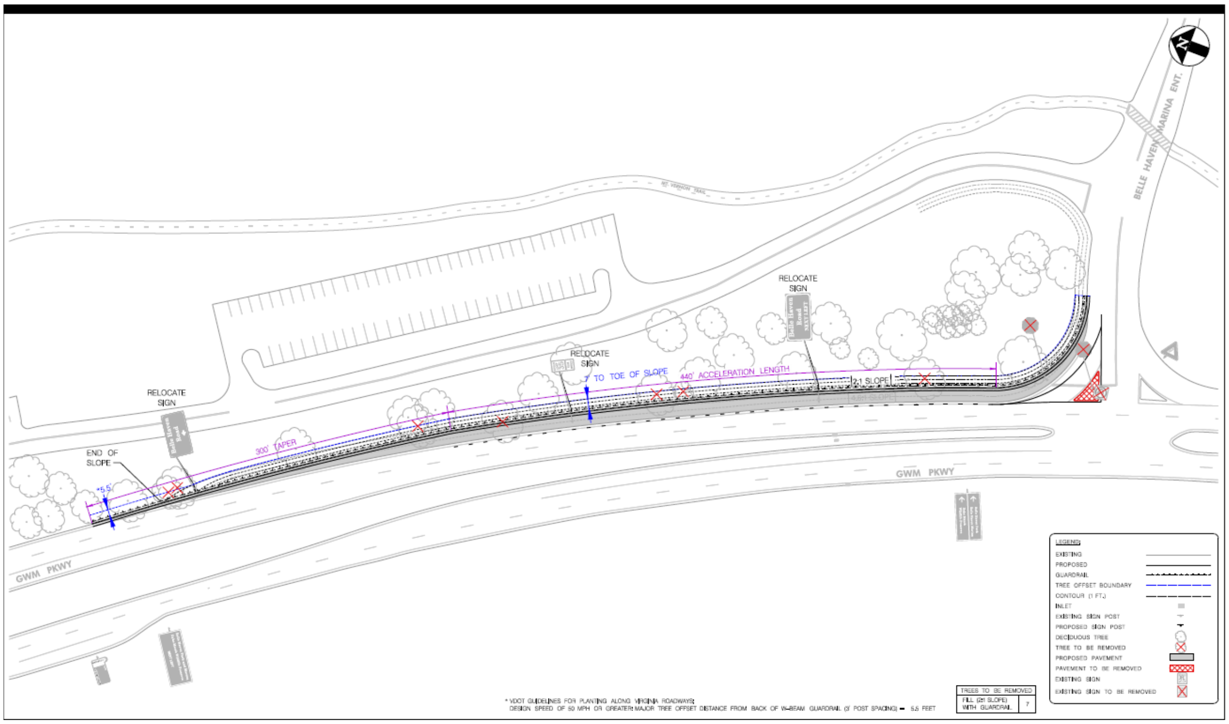

Figure 183: Belle Haven Marina U-Turn Acceleration Lane with 45 MPH Design Speed

To assess traffic operations impact of the diverted left-turn movement, a capacity analysis was performed at the intersections of Belle View Boulevard and Belle Haven Marina Entrance to evaluate delay, level of service and volume-to-capacity ratios for all movements (Table 50). The results indicate that the diverted left-turn movement could be accommodated as a U-turn at Belle Haven Marina without excessive delays, as shown by the mostly green level of service results. A field review was also performed, and adequate sight distance is available for all movements at the Belle Haven Marina Entrance.

Table 50: Capacity Summary Based on Left Turn Restrictions at Belle Haven Road and SB U-Turns at Marina Entrance (Build Condition)

Node	Intersection	Approach	Movement	U-Turn Build Conditions		
				AM (PM)		
				Delay	LOS	V/C
1	The Parkway & Belle Haven Road	Eastbound	Overall	12.4 (30.3)	B (D)	0.38 (0.64)
			right	12.4 (30.3)	B (D)	0.38 (0.64)
		Northbound	Overall	1.6 (14.0)	A (B)	0.55 (0.87)
			left	11.1 (75.3)	B (F)	0.35 (0.87)
			through	0.0 (0.0)	A (A)	0.00 (0.00)
		Southbound	Overall	0.0 (0.0)	A (A)	0.20 (0.65)
			through	0.0 (0.0)	A (A)	0.00 (0.00)
			right	0.0 (0.0)	A (A)	0.00 (0.00)
1.A	The Parkway & the Marina Entrance	Westbound	Overall	69.6 (46.6)	F (E)	0.07 (0.05)
			left	144.0 (98.6)	F (F)	0.07 (0.05)
			right	19.9 (11.9)	C (B)	0.01 (0.01)
		Northbound	Overall	0.0 (0.0)	A (A)	0.58 (0.29)
			through	0.0 (0.0)	A (A)	0.58 (0.29)
			right	0.0 (0.0)	A (A)	0.00 (0.00)
		Southbound	Overall	0.1 (0.0)	A (A)	0.24 (0.69)
			left	17.7 (10.2)	C (B)	0.01 (0.00)
			through	0.0 (0.0)	A (B)	0.24 (0.69)

6.3 Road Diets

6.3.1 Description

A road diet is a removal, reduction or repurposing of existing travel lanes on a roadway segment to another use. Road diets are low-cost options that can yield substantial benefits, including enhanced safety, improved mobility, and the reclaiming of space for a reallocation of other uses, such as turn lanes, pedestrian refuge islands and increased shoulder widths. Road diet roadway reconfigurations have been used for more than three decades across the US. The traditional road diet is the conversion of a four-lane undivided road to a three-lane undivided road made up of two through lanes and a center two-way-left turn-lane (FHWA, 2014). However, there are other road diet roadway options, such as reconfigurations from 4 lane to 5 lane with a center turning lane by reducing lane widths within the same right of way, or unbalanced cross-sections such as two through lanes in one direction, a center turning lane and a single through lane in the opposite direction.

Figure 184 shows a graphical comparison of the only three practical configurations that would allow removing a travel lane and repurposing it as a turn lane. They can be implemented on the Parkway where there is not currently a median.

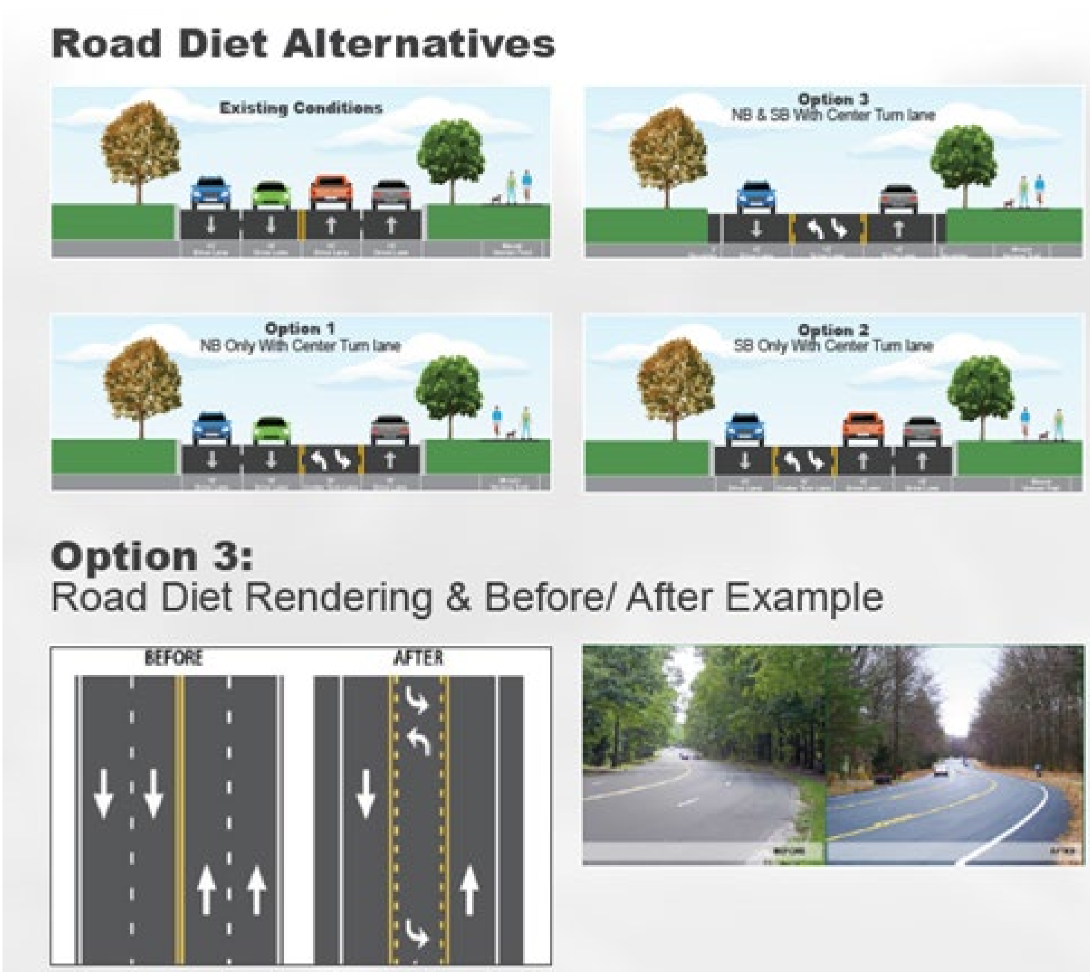

Figure 184: Road Diet Alternatives

A rendering of a road diet treatment for Option 2 at Morningside Lane is shown in Figure 185.

6.3.2 Expected Safety Benefits

Road diets provide crash reductions of 25 to 47% (four-lane to three-lane with center turn lane) (USDOT, 2017). FHWA has deemed Road Diets and other roadway reconfigurations as "Proven Safety Countermeasures" and promoted them as a safety-focused alternative cross section to a four-lane undivided roadway (U.S. Department of Transportation, Federal Highway Administration, 2017). They have been demonstrated to reduce all crashes from 19 to 47 percent. Crashes they can assist with reducing include rear-end and left-turns that benefit from the left-turn lane. In addition, as a result of the two-stage crossing, angle crashes can be reduced for the side street. For pedestrians, there is a benefit in that the number of lanes they have to cross is reduced. It would also provide space for a pedestrian refuge island. Because of the reduction in the number of lanes, traffic is calmed and speeds become more consistent. Overall, the implementation of a road diet creates "a more community-focused, 'Complete Streets' environment that better accommodates the needs of all road users" (USDOT, 2017).

Figure 185: Rendering of Option 2 Road Diet at Morningside Lane

6.3.3 Potential Road Diet Location Applications:

The potential locations for road diet applications are focused on the segments of the corridor where the roadway is undivided (e.g. no median exists). As shown in Table 51, road diets can be considered at several intersections along the corridor, including Morningside Lane, Wellington Road, Waynewood Boulevard, and Vernon View Drive.

Table 51: Road Diet Application Locations

Intersecting Roadway	Road Diet
Belle Haven Road	
Belle View Boulevard	
Tulane Drive	
Morningside Lane	√
Wellington Road	√
Collingwood Road	
Waynewood Boulevard	√
Vernon View Drive	√
Stratford Lane	

To assess the traffic impact of a potential road diet, a capacity analysis was performed at each intersection for each road diet configuration. The results, including the LOS and V/C, are summarized in Table 52. They indicate that the unbalanced road diet (Option 2 - southbound lane reduction) performs the best, improving delays for vehicles on the entering side streets over existing conditions due to the ability to execute a left-turn movement in two stages using the center turn lane.

Table 52: Capacity Summary Based on a Road Diet Along the Parkway (HCM 2000)

Node	Intersection	Approach	Option 1 – NB Direction Road Diet			Option 2 – SB Direction Road Diet			Option 3 – Road Diet Both Directions		
			AM (PM)			AM (PM)			AM (PM)		
			Delay	LOS	V/C	Delay	LOS	V/C	Delay	LOS	V/C
4	The Parkway & Morningside Lane	Eastbound	102.0 (23.7)	F (C)	0.94 (0.33)	20.2 (22.6)	C (C)	0.42 (0.32)	65.0 (21.4)	F (C)	0.79 (0.30)
		Northbound	0.0 (0.1)	A (A)	0.91 (0.37)	0.0 (0.1)	A (A)	0.46 (0.19)	0.0 (0.1)	A (A)	0.91 (0.37)
		Southbound	0.0 (0.0)	A (A)	0.14 (0.32)	0.0 (0.0)	A (A)	0.28 (0.65)	0.0 (0.0)	A (A)	0.28 (0.65)
5	The Parkway & Wellington Road	Eastbound	44.7 (17.9)	E (C)	0.65 (0.15)	18.1 (19.4)	C (C)	0.36 (0.16)	35.0 (18.2)	D (C)	0.57 (0.15)
		Northbound	0.0 (0.1)	A (A)	0.72 (0.32)	0.0 (0.1)	A (A)	0.36 (0.16)	0.0 (0.1)	A (A)	0.72 (0.32)
		Southbound	0.0 (0.0)	A (A)	0.14 (0.28)	0.0 (0.0)	A (A)	0.27 (0.57)	0.0 (0.0)	A (A)	0.27 (0.57)
9	The Parkway & Waynewood Boulevard	Eastbound	21.3 (10.9)	C (B)	0.44 (0.07)	15.8 (11.5)	C (B)	0.34 (0.08)	19.9 (11.0)	C (B)	0.41 (0.08)
		Northbound	0.1 (0.2)	A (A)	0.42 (0.34)	0.1 (0.2)	A (A)	0.21 (0.17)	0.1 (0.2)	A (A)	0.42 (0.34)
		Southbound	0.0 (0.0)	A (A)	0.13 (0.23)	0.0 (0.0)	A (A)	0.25 (0.45)	0.0 (0.0)	A (A)	0.25 (0.45)
10	The Parkway & Vernon View Drive	Northbound	1.6 (1.9)	A (A)	0.36 (0.34)	1.6 (1.9)	A (A)	0.18 (0.17)	1.6 (1.9)	A (A)	0.36 (0.34)
		Southbound	0.0 (0.0)	A (A)	0.13 (0.21)	0.0 (0.0)	A (A)	0.27 (0.42)	0.0 (0.0)	A (A)	0.27 (0.42)
		Eastbound	9.9 (10.7)	A (B)	0.20 (0.18)	10.2 (12.8)	B (B)	0.21 (0.23)	9.7 (11.6)	A (B)	0.19 (0.20)

A conceptual Option 2 road diet signing and marking design is shown in Figure 186 for the segment between Morningside Lane and Wellington Road, including a lane shift to avoid buses in the right southbound lane underneath the Alexandria Avenue bridge.

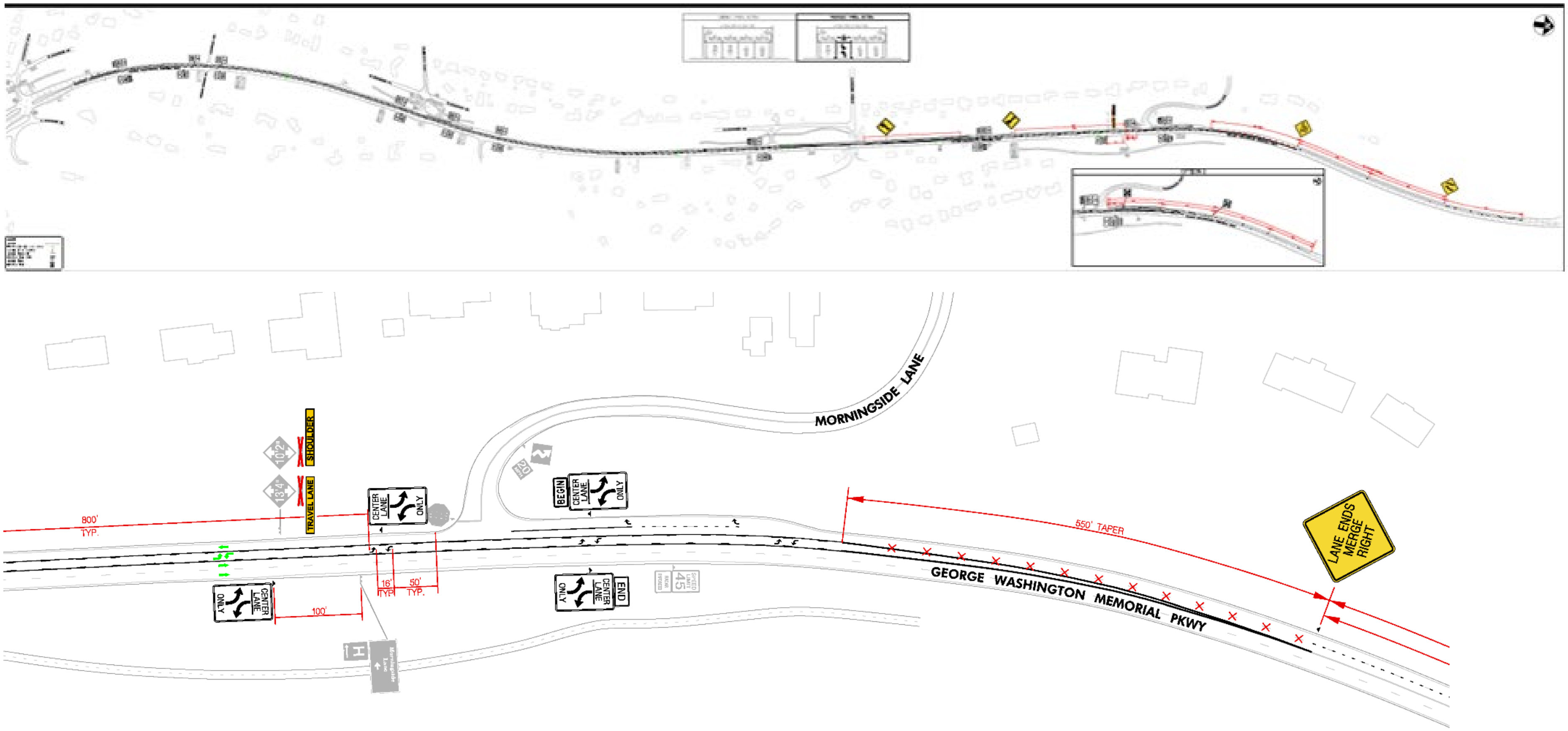

Figure 186: Road Diet Concept Plan

6.4 Roundabouts

6.4.1 Description

Roundabouts have been popular internationally but have only in the past two decades become popular in the U.S. and specifically Virginia. Modern roundabouts have evolved from the larger category of 'traffic circles' by promoting entering traffic to 'give way' or 'yield to' circulating traffic in the intersection. This policy allows for continuous movement and fewer points of conflict between vehicles. Mount Vernon Circle is a traffic circle and GWMP could investigate if a modern roundabout is appropriate for this intersection. Table 53 highlights differences between a modern roundabout and traffic circle (a.k.a. rotary).

Table 53: Roundabout vs. Traffic Circle

	Traditional Traffic Circle/Rotary
• Entering traffic must always yield to ALL traffic in the roundabout, regardless of which lane they are in, similar to crossing a one-way road. A roundabout is a series of "crossing intersections" where traffic entering the roundabout must yield the right-of-way to all traffic from the left. Entry is always controlled by yield signs for maximum efficiency. • Drivers choose a lane before entering, similar to a standard intersection. • No lane changes occur within a roundabout, except for vehicles that are turning right. Entering a roundabout is a crossing movement. • A roundabout's smaller diameter forces drivers to deflect their trajectory and reduce speeds upon approach, entry, and exit. • Roundabouts are able to handle heavy traffic and are used for efficiency and safety. Roundabouts were developed in the 1960s.	• It is typical to enter a rotary alongside traffic that is circulating in the inside lanes, like a freeway cloverleaf loop entrance. • No intersections occur in a rotary, only adding and dropping of lanes. • The right lane usually does not need to yield but must find a gap to change lanes. The left entry lane must merge or yield before entering. • The circle is usually not striped, though multiple vehicles may travel side by side. Lane changes occur after you have entered the circle. • A rotary is typically large, with entry speeds of 40mph or higher. • Entering drivers who wish to circulate must change lanes while circulating and weave with vehicles trying to exit. • Rotaries work well at low volumes but very poorly under heavy traffic conditions. Most were designed in the 1940s or earlier. • Entry may be controlled by yield signs, merge signs, or no signs at all.

Figure 187 shows contrasting characteristics of the Modern Roundabout versus the more traditional Traffic Circle/Rotary.

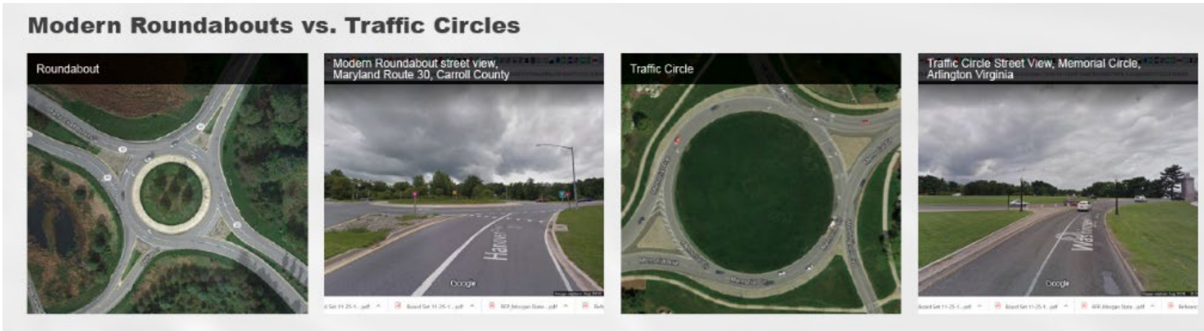

Figure 187: Modern Roundabout Versus Traffic Circles

Figure 188 shows example images and design features of existing modern roundabouts in federal land settings.

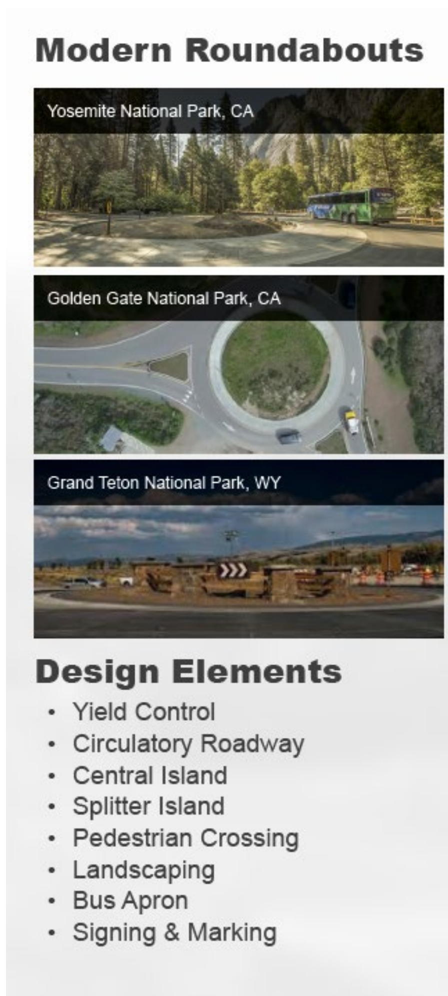

Figure 188: Images of Modern Roundabouts & Design Elements

6.4.2 Expected Safety Benefits

Modern roundabouts provide many benefits over traditional intersection designs. Roundabouts have been found to be safer than other traditional, signalized, stop-controlled intersections and larger traffic circles (or rotaries), as they provide slower speeds that create more gaps for entering traffic and reduce the number of possible conflicts. They also mitigate the severity of crashes by converting the left-turn and angle crashes to sideswipe crashes. According to the FHWA Crash Modification Factors (CMF) Clearinghouse, "Conversion of intersection into multi-lane roundabout" (U.S. Department of Transportation, Federal Highway Administration, 2020), while total crashes for a multi-lane roundabout increase by about six percent, severe crashes (injury and fatal crashes) decrease by about sixty-three percent.

In addition to traffic safety and operational benefits, other advantages include lower maintenance costs, less environmental impact, enhanced aesthetics such as landscaping opportunities, less noise pollution, and better accommodation of pedestrians and bicycles. Furthermore, within the Parkway corridor, this treatment is context sensitive. A significant drawback, however, is that a typical roundabout costs $1.5 to $2.5 million to install.

According to the FHWA Roundabouts: An Informational Guide (Robinson, et al., 2000), intersections that are likely to benefit from roundabout control have the following characteristics:

- High crash location (left turn or right-angle accidents)
- Capacity/ delay problem
- Intersection where signal is requested but not warranted.
- Restricted sight distance
- Equal distribution of volumes on all approach legs.

Several intersections along the Parkway exhibit high levels of left-turn crashes, excessive delays on the minor street, and restricted sight distance. However, the majority of traffic is on the Parkway, so there is not an equal distribution of traffic volume on all approach legs.

Roundabouts provide significant improvements to intersection performance with generally free-flowing travel, slower speeds, and the ability for the motorist to find gaps. The project team conducted an examination of the major intersections along the corridor to determine whether possible roundabout applications would exhibit reasonable LOS performance. All intersections were found to exhibit reasonable LOS performance, except for Belle Haven Road and Belle View Boulevard where delays and queues would be problematic under roundabout control. Table 54 summarizes the estimated operational performance of the roundabout concept at all study intersections:

Table 54: Capacity Summary Based on Roundabouts (HCM2000)

Intersection		Approach	Build (Roundabout)					
			Delay (sec/veh)		v/c Ratio		Level of Service	
			AM	PM	AM	PM	AM	PM
1	The Parkway and Belle Haven Road	**Overall**	**18.5**	**78.1**	**-**	**-**	**C**	**F**
		Eastbound	9.7	163.4	0.39	1.17	A	F
		Northbound	22.1	6.9	0.85	0.42	D	A
		Southbound	7.8	108.4	0.38	1.19	A	**F**
2	The Parkway and Belle View Boulevard	**Overall**	**13.3**	**22.3**	**-**	**-**	**B**	**C**
		Eastbound	7.5	38	0.24	0.68	A	**E**
		Northbound	16.1	0.42	0.77	0.40	C	A
		Southbound	5.5	0.93	0.30	0.88	A	D
3	The Parkway and Tulane Drive	**Overall**	**14.2**	**11.6**	**-**	**-**	**B**	**B**
		Eastbound	10.3	20.9	0.38	0.38	B	C
		Westbound	10.3	0	0.38	0.02	B	A
		Northbound	19.6	6.3	0.81	0.37	C	A
		Southbound	5.1	14.1	0.27	0.76	A	B
4	The Parkway and Morningside Lane	**Overall**	**9.8**	**7.7**	**-**	**-**	**A**	**A**
		Eastbound	5.7	9.1	0.19	0.18	A	A
		Northbound	12.6	0.25	0.19	0.26	B	A
		Southbound	4.5	8.9	0.21	0.58	A	A
5	The Parkway and Wellington Road	**Overall**	**7.3**	**5.9**	**-**	**-**	**A**	**A**
		Eastbound	5.4	0.08	0.16	0.08	A	A
		Northbound	8.8	4.6	0.53	0.22	A	A
		Southbound	4.2	6.6	0.18	0.42	A	A
7	The Parkway and Collingwood Road	**Overall**	**7.6**	**5.7**	**-**	**-**	**A**	**A**
		Eastbound	7.2	6.4	0.37	0.13	A	A
		Westbound	7.2	4.3	0.37	0.01	A	A
		Northbound	9.5	4.7	0.46	0.21	A	A
		Southbound	3.8	6.2	0.13	0.38	A	A
9	The Parkway and Waynewood Boulevard	**Overall**	**5.2**	**5.1**	**-**	**-**	**A**	**A**
		Eastbound	5.5	5.7	0.18	0.07	A	A
		Northbound	5.8	4.6	0.29	0.23	A	A
		Southbound	4.1	5.5	0.16	0.33	A	A
10	The Parkway and Vernon View Drive	**Overall**	**5.1**	**5.5**	**-**	**-**	**A**	**A**
		Northbound	5.3	5	0.28	0.27	A	A
		Southbound	4.7	5.9	0.19	0.32	A	A
		Eastbound	5.7	6.8	0.19	0.18	A	A

Intersection		Approach	Build (Roundabout)					
			Delay (sec/veh)		v/c Ratio		Level of Service	
			AM	PM	AM	PM	AM	PM
11	The Parkway and Stratford Lane	**Overall**	**7.8**	**5.6**	**-**	**-**	**A**	**A**
		Eastbound	8.7	5.2	0.55	0.30	A	A
		Westbound	7.0	5.9	0.44	0.34	A	A
		Northbound	6.0	5.2	0.01	0.03	A	A
		Southbound	6.9	6.3	0.18	0.11	A	A

6.4.3 Potential Roundabout Location Applications

While many of these intersections could be modified into roundabouts, other options may be more viable, appropriate, or inexpensive when considering potential environmental and right-of-way impacts. Based on environmental and ROW impacts to existing natural landscapes and private property or frontage roadways, roundabouts would be considered a viable option at only a few of the intersections along the Parkway (Table 55).

Table 55: Potential Roundabout Location Applications

Intersecting Roadway	Roundabout
Belle Haven Road	
Belle View Boulevard	
Tulane Drive	√
Morningside Lane	√
Wellington Road	√
Collingwood Road	
Waynewood Boulevard	
Vernon View Drive	
Stratford Lane	

Schematic conceptual drawings of roundabouts at Tulane Drive and Belle View Boulevard are shown below in Figure 189 and Figure 190**.**

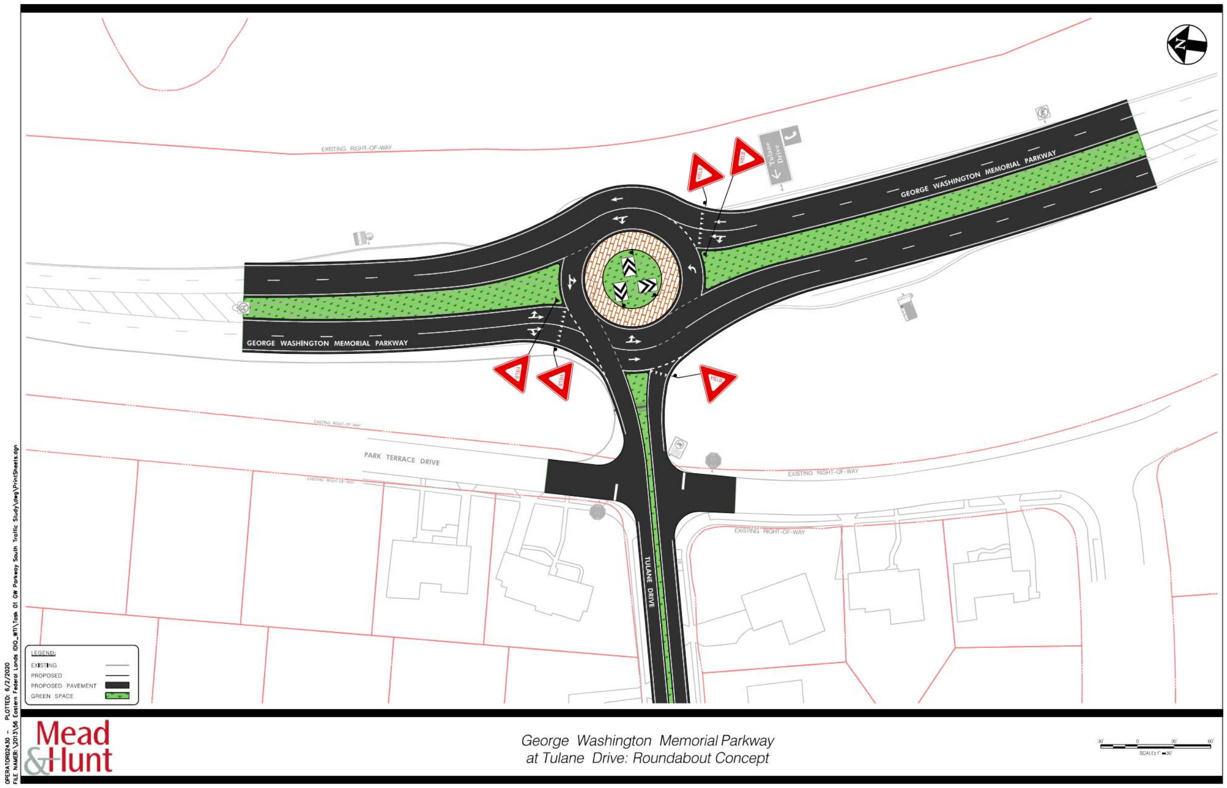

Figure 189: Roundabout Concept Design at Tulane Drive

The roundabout footprint at Belle View Boulevard (and likely at Belle Haven Road and Collingwood Road) would impact the frontage road potentially requiring restricted access to and from those roads. It would also impact the MVT. As a result, Figure 190 shows that geometrically, a roundabout at Belle View Boulevard does not fit. This combined with the imbalanced traffic volumes resulting in poor function of a roundabout is why a roundabout is ultimately not recommended at Belle View Boulevard. Similar findings exist for Belle Haven Road.

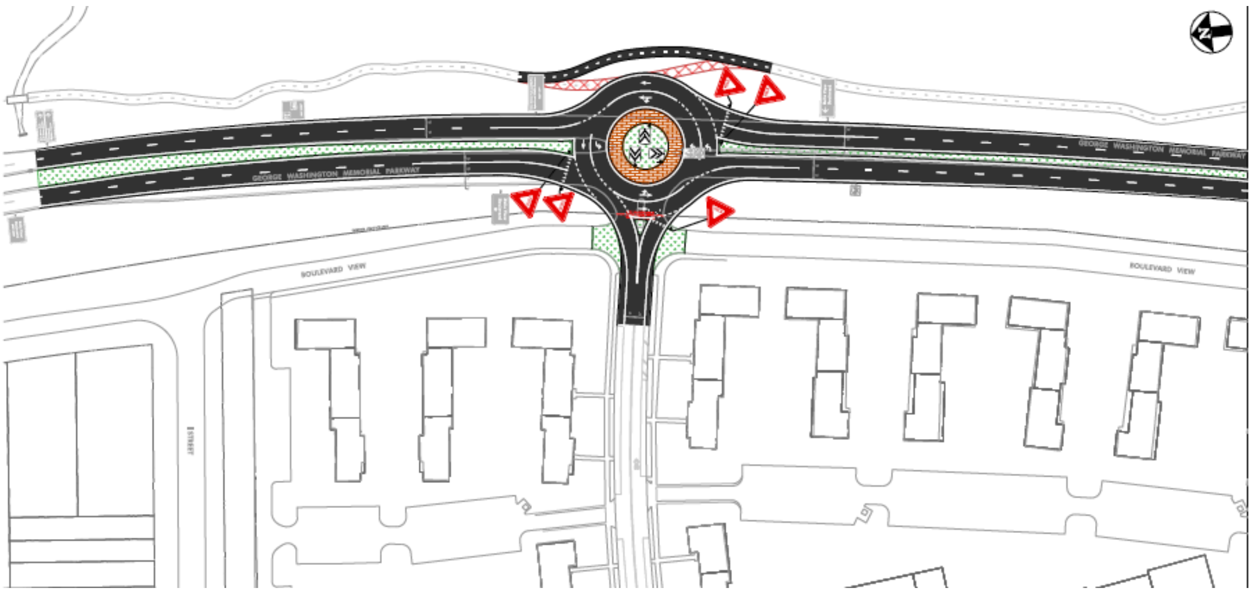

Figure 190: Roundabout Concept Design at Belle View Boulevard

A rendering of the roundabout at Morningside Lane is shown in Figure 191.

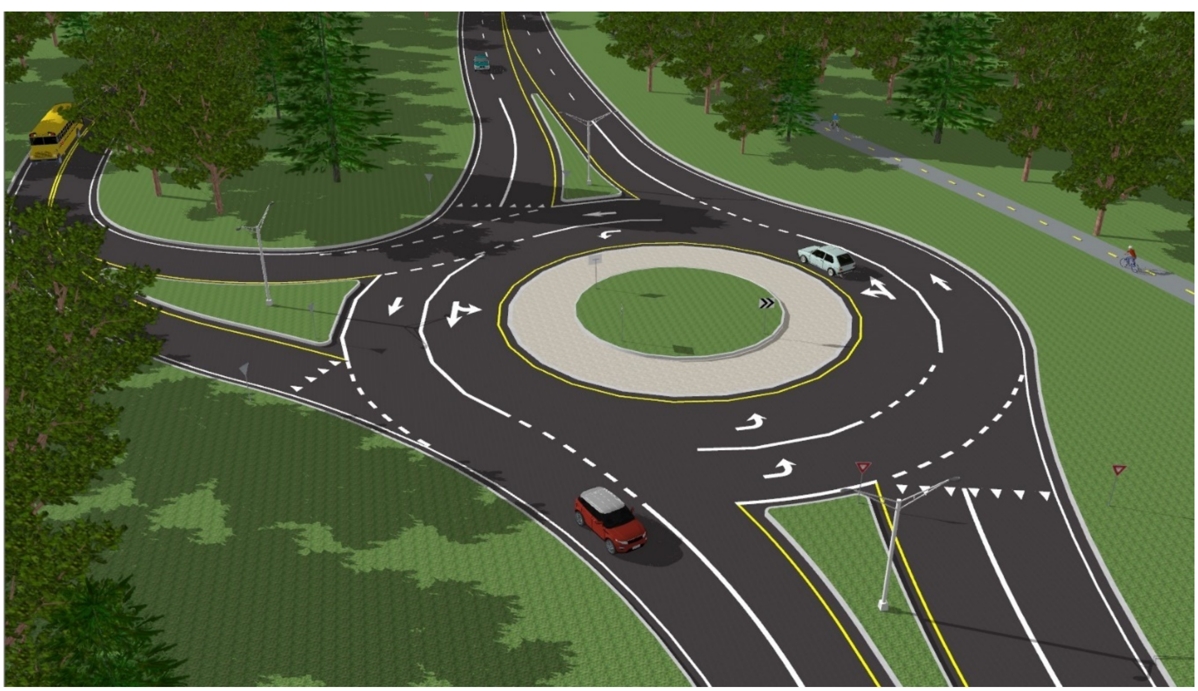

Figure 191: Roundabout Rendering at Morningside Lane

6.5 Refuge Island

6.5.1 Description

Refuge Islands (also known as Pedestrian Refuge Islands, Center Islands, or Crossing Islands) offer a protected location for pedestrians to avoid vehicular traffic and wait until it is safe to cross travel lanes, as shown in Figure 192. These islands are placed in the center or median of the roadway in a raised position. They allow the pedestrian to walk across one direction of traffic at a time. This type of facility has demonstrated reduced pedestrian casualties and vehicle conflicts.

Refuge islands can be combined with road diets to enhance pedestrian crossings of 4 lane undivided roadway crossings. They can be installed with lane reconfigurations at mid-block locations or in combination with a left turn lane if enough width is available.

The refuge island is particularly helpful to pedestrians crossing multilane roads by breaking up the walking distance and allowing a respite from a quick walk across both directions of traffic. Crossing islands also alert drivers to the pedestrian refuge and encourage motorists to reduce speed. For Refuge Islands to be effective, their implementation on the parkway would need to have complementary speed reduction countermeasures.

Figure 192: Enhanced Pedestrian Crosswalks (Street views from Google Maps)

6.5.2 Expected Safety Benefits

Refuge Islands have been shown to reduce pedestrian crashes by up to 30% according to the FHWA CMF Clearinghouse (U.S. Department of Transportation, Federal Highway Administration, 2020). Supplemental treatments such as high visibility crosswalk markings, yield lines, in-pavement marking text, upgraded signs, and pedestrian activated beacons (also known as RRFB) further enhance driver awareness of pedestrian activity and motorist compliance with yielding to pedestrians (or bicyclists) in the crosswalk. Due to the potential for pedestrians facing multiple threats (e.g. a driver in one lane stops so the pedestrian enters the crosswalk, while the driver in the adjacent lane does not see the pedestrian or stop), it is recommended that the refuge islands be used in combination with lane or speed reduction engineering treatments such as road diets and roundabouts.

6.5.3 Refuge Island Potential Location Applications

Refuge islands and accompanying pedestrian crosswalks can be incorporated throughout the Parkway at many locations. It is recommended that these treatments be implemented with Road Diets or Roundabouts at the intersection locations listed in Table 56.

Table 56: Potential Location Applications for Refuge Islands

Intersecting Roadway	Road Diet	Roundabouts
Belle Haven Road		
Belle View Boulevard		
Tulane Drive		√
Morningside Lane	√	√
Wellington Road	√	√
Collingwood Road		
Waynewood Boulevard	√	
Vernon View Drive	√	
Stratford Lane		

An example of combining the refuge island with a road diet is shown for the Wellington Road intersection in Figure 193, and a rendering is shown in Figure 194.

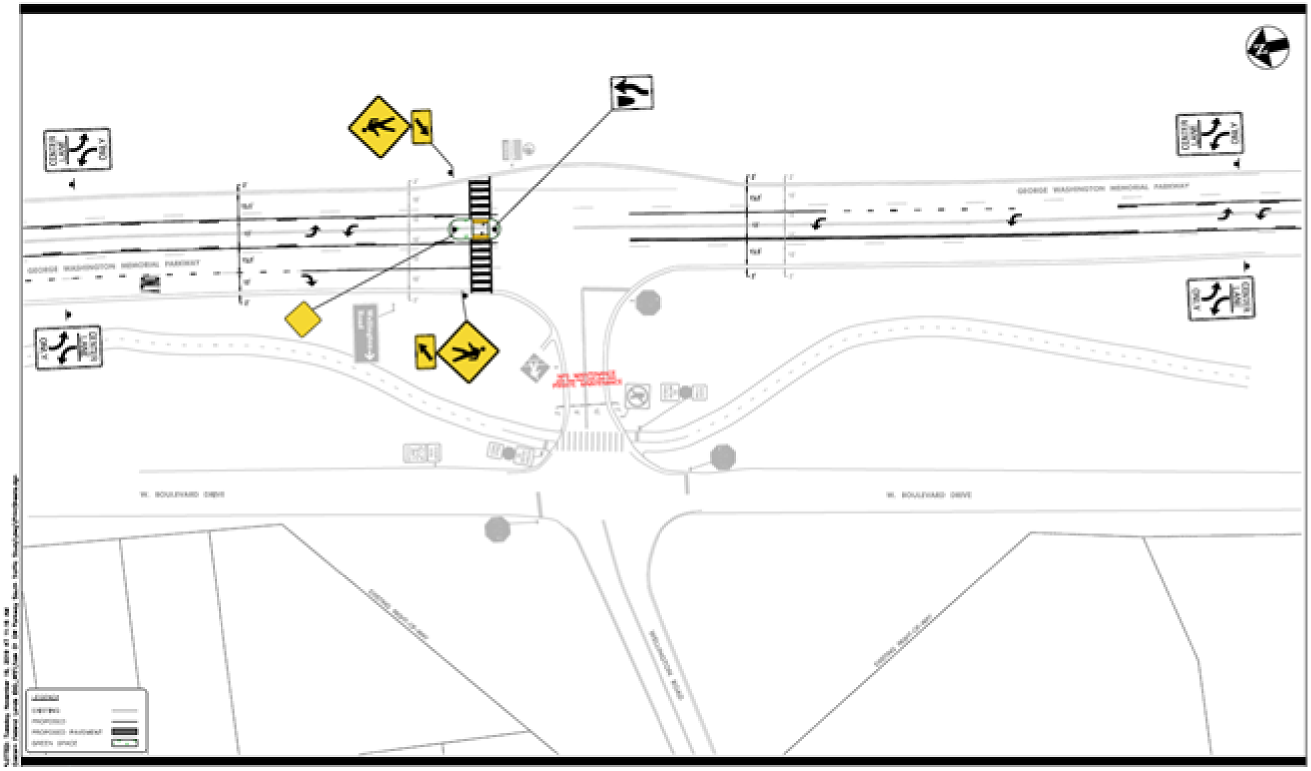

Figure 193: Pedestrian Refuge Island and Road Diet Concept Design at Wellington Road

Figure 194: Rendering of a Pedestrian Refuge Island and Road Diet at Wellington Road

6.6 Minor Engineering Measures

6.6.1 Upgraded Signing and Pavement Markings

6.6.1.1 Description

Upgraded signing and pavement markings are key to providing guidance to motorists at decision points along the Parkway such as intersections, MVT (bicycle/pedestrian) crossings and entering and exiting auxiliary lanes (Figure 195). Ensuring that signing is updated with current MUTCD standards such as W1-2 intersection warning signs, W11-15 (U.S. Department of Transportation (USDOT), 2017) trail crossing signs and advisory speed subplates will provide additional positive guidance to all motorists, especially park visitors.

Figure 195: Examples of Pavement Symbols for Dedicated Turn Lanes & Pedestrian Crosswalks (Street views from Google Maps)

Pavement markings similarly could be refreshed routinely and enhanced for visibility using high retro-reflectivity grade tape and contrast tape to maximum conspicuity. Supplemental markings for auxiliary lanes including left and right turn lane arrows and 'only' text could be included to inform drivers of auxiliary lane usage.

6.6.1.2 Expected Safety Benefits

Updating signing and pavement markings have been documented to reduce crash rates by 15% to 35% according to "Enhance Pavement Marking Retroreflectivity" and "Install Advance Intersection Warning Signs," as found in the FHWA CMF Clearinghouse (U.S. Department of Transportation, Federal Highway Administration, 2020).

6.6.1.3 Potential Location Applications

Signing and marking upgrades are recommended at all intersections along the Parkway.

6.6.2 Intersection Lighting

6.6.2.1 Description

Intersection lighting refers to devices that illuminate the intersections at night. It does not include traffic signals. Pole-mounted intersection lighting provides appropriate illumination levels during dark hours for all conflict points within an isolated intersection to enhance visibility for motorists, pedestrians and bicyclists (Figure 196).

Figure 196: Intersection Lighting, At Night & with Solar Power (Street views from Google Maps)

6.6.2.2 Expected Safety Benefits

Installing intersection lighting has been documented to reduce crash rates by 31% for all crashes up to 38% for nighttime injury and fatal crashes and 59% for vehicle/pedestrian crashes according to "Provide Intersection Illumination," as found in the FHWA CMF Clearinghouse (U.S. Department of Transportation, Federal Highway Administration, 2020).

6.6.2.3 Potential Location Applications

The study recognizes the potential benefit of lighting at intersections within the corridor (Cottrell & Lim, 2018). In particular, six intersections (Belle Haven Road, Belle View Boulevard, Morningside Lane, Collingwood Road, Waynewood Boulevard, and Stratford Lane) had a crash experience that suggests lighting would help improve visibility. Per the systemic method, it is recommended to install lighting across all intersections in the corridor. This approach is based on the assumption that the "absence of crashes does not equate to no risk" (Minnesota Department of Transportation, 2011).

6.6.3 Roadway / Travel Lane Departure Warning

6.6.3.1 Description

Rumble strips, or a variation with reduced noise impacts known as mumble strips, are a series of indented pavement grooves across (e.g. transverse rumble strips) or along a roadway or travel lane edge, changing the noise a vehicle's tires make on the surface and so warning drivers of speed restrictions or of the edge of the road, and provide positive guidance to avoid lane departures. Rumble strips can also be used in the center of the roadway in coordination with a double yellow centerline to make drivers aware if they start encroaching in the opposite direction of travel. Mumblestrips are still a relatively new treatment, as they have evolved from rumblestrips with the intent of retaining the safety benefits while reducing the noise impacts. Figure 197 shows mumblestrips on asphalt.

Figure 197: Centerline Buffer Area (Street views from Google Maps)

6.6.3.2 Expected Safety Benefits

Rumble/ mumble strips have been documented to reduce run off road, single vehicle crashes by 10 to 16% according to "Install continuous milled-in shoulder rumble strips" found in the FHWA CMF Clearinghouse (U.S. Department of Transportation, Federal Highway Administration, 2020).

6.6.3.3 Potential Location Applications

Mumble strips are recommended along the full length of the Parkway for the right travel lane. As there are numerous residences along the roadway, the mumblestrips could bring safety benefits but provide consideration for these residences.

6.6.4 Roadway Maintenance

Roadway maintenance plays a key role in improving traffic safety. Important measures for improving traffic safety on the Parkway (Figure 198) include providing:

- routine maintenance of vegetation to maintain intersection sight lines,
- clearing of storm drain inlets from debris to maintain storm water runoff and reduce standing water,
- repairing roadway surfaces such as potholes, and
- refreshing faded pavement markings.

Figure 198: Roadway Maintenance Examples (Street views from Google Maps)

Specifically, maintenance activities could provide a sight distance of at least 590 feet, which corresponds to vehicles traveling at 50 mph to accommodate intersection sight distance for prevailing vehicle speeds. (Note: This can be reduced as engineering and enforcement solutions are implemented to assist with traffic calming (e.g. speed reduction).)

6.7 Education

During outreach efforts, some members of the public indicated that they understood the context sensitivity associated with the Parkway. However, not all drivers or residents appear to understand how the Parkway's designation on the National Register of Historic Places (National Park Service (NPS)) limits or requires careful consideration regarding changes to the asset. Therefore, there is a need to create educational materials on this topic. While some exist, most are in traditional printed formats, and are not easily disseminated through other widely used methods of sharing information. Therefore, it is recommended that the Parkway develop a short video discussing context sensitivity and the associated implications. A short video implies five minutes or less, although a video that is closer to two minutes may be even more effective. Currently, succinct clips are generally preferred for conveying important information to an audience.

The speed data collected for this project demonstrated that vehicles were traveling well above the speed limits (35 mph or 45 mph) in the corridor. Excessive speeding is likely associated with much of the crash severity and is particularly concerning for vulnerable users (e.g. bicyclists and pedestrians) that need to cross the Parkway to access the MVT. A graphic could be developed to demonstrate the difference in time when traveling at two different speeds through the corridor (35 mph vs. 45 mph). It could also try to visually demonstrate the difference in how an object appears at the various speeds, showing how objects or people are less detailed or even "blurry" at higher speeds, or showing the likelihood of missing a pedestrian/bicyclist at a higher speed.

Numerous animal collisions were identified at multiple intersections in the corridor, particularly those in the northern part of the parkway being studied. More recent data suggests that animals involved in the collisions are deer. These crashes tended to be in the fall and at night. The researchers are aware of portable dynamic message signs (DMS) (a.k.a. variable message boards) placed along US24, a rural, U.S. highway, to warn motorists of the presence of wildlife.

The Colorado Department of Transportation (CDOT) noted that these signs were placed "temporarily/seasonally so that motorists do not become habituated and tolerant of signs" (Lawler, 2020), as these animals are not present in proximity to the roadway in the summer. It was also noted that the portable DMS "garner more attention than standard fixed ground signs" (Lawler, 2020).

The VDOT evaluated the effectiveness of deer advisory messages on DMS along I-64 between Waynesboro and Charlottesville, Virginia in October of 2015 (Donaldson & Kweon, 2018). The DMS were used in October and November between 5 PM and 9 AM. The results showed a statistically significant reduction in the removal of deer carcasses as a result of the signs. They also showed, at four of the five stations used to evaluate speeds, a reduction of up to 2.8 mph. Therefore, the authors of that study concluded that DMS messages, seasonally used, were effective in reducing deer/vehicles crashes.

6.8 Enforcement

The NPS and USPP coordinated with law enforcement across the state of Maryland to support the "Drive Sober or Get Pulled Over!" safety campaign (National Park Service (NPS), 2017). It was noted that: 1) speeding, 2) aggressive driving, 3) distracted driving, and 4) impaired driving are some of the most "unsafe and illegal behaviors" observed within the Baltimore-Washington Parkway corridor, which was the impetus behind the partnership among NPS, USPP, and Maryland law enforcement agencies.

Data collected as a part of this project identified that motorists are traveling at speeds above and beyond those posted. One of the recommendations was to develop a speed management program, and several of the specific actions (e.g. road diet, roundabout) have resulted in speed reductions. The following resources can assist with developing a speed management program:

- Institute of Transportation Engineer's Technical Resources for Speed Management for Safety: https://www.ite.org/technical-resources/topics/speed-management-for-safety/
- Webinar, Multi-Disciplinary Speed Management: https://ruralsafetycenter.org/resources/list/multi-disciplinary-speed-management/
- Speed Management Program Plan (NHTSA, 2014)
- Reducing Speed-Related Crashes Involving Passenger Vehicles (National Transportation Safety Board, 2017)
- Speed Management: A Manual for Local Rural Road Owners (Bagdade, Nabors, McGee, Miller, & Retting, 2012)
- Taming Speed for Safety: A Defining Approach and Leadership from Portland, Oregon (Vision Zero Network)

A best management practice is continuous evaluation of implemented solutions to assist with the objective of managing speed. GWMP and the USPP would benefit from incorporating this best practice on a quarterly or semi-annual schedule.

7. Summary & Conclusions

Having provided a detailed analysis of the intersections subject to the study, the summary and conclusions presented here are also a place for reorientation. A treatment or change is not only to be considered for a specific intersection but also examined for its cumulative effects on the park. As the park implements the various recommendations within the study, adaptations need to be context sensitive. In doing so, park management is mindful of and dutiful to make decisions, such that the National Capital Park & Planning Commissions admonishment that the park needs to be careful that the overlapping of functions does not extend too far. There can then be assurance that the Parkway character and visitor experience remains and the NPS has fulfilled its stewardship responsibilities.

No single solution will solve all of the crash occurrence at a single intersection or throughout the corridor. A myriad of solutions is needed to address the crash occurrence. Similarly, different solutions regarding traffic operations may lend better to one intersection as compared with another. All of these solutions will need to be context sensitive. Furthermore, some solutions can be more readily implemented, whereas others will take some time to implement. What follows are recommendations at the corridor level followed by more intersection-specific recommendations.

From the crash analysis, it would appear that running-off-the-road and animal crashes are occurring at numerous intersections across the corridor. Some global treatments that could assist with mitigation of these crashes are:

- Implementing lighting at the intersections throughout the corridor
- Trim trees and shrubs; ensure this is a reoccurring program throughout the period of the year when foliage is present and grows
- Reduction of excessive speed through Education and Enforcement Measures
    - Speed Management Action Plan
    - Public Awareness Campaign of the National Parkway Context
    - Manual and Automated Speed Enforcement
- Reapplication of pavement markings (on a recurring basis)
- Installation of mumblestrips to keep vehicles on the roadway
- Enforcement of driving under the influence (DUI) offenses
- Utilize dynamic message signs to alert drivers to the presence of wildlife along the corridor from Belle Haven Road to Waynewood Boulevard
- Develop a public awareness education campaign starting at the end of March to remind motorists about the increasing presence of pedestrians, bicyclists, and motorcyclists who are also using the corridor

Global treatments for enforcement of DUIs, reducing animal crashes, and bicycle/pedestrian crossings of the Parkway are detailed in the following paragraphs. Table 57 provides an overview of identified safety treatments by intersection followed by detailed summaries of each intersections.

For enforcement of DUI offenses, it would appear that enforcement blitzes performed between the hours of 6 PM to 6 AM, Thursday through Monday in January, June and September would be good candidates. These recommendations are made based on the historic crash tabular data.

To reduce animal crashes, dynamic message signs could be provided along the corridor from Belle Haven Road through Waynewood Boulevard from mid-October through the end of November, notifying people of the presence of animal crossings. Based on historic crash tabular data, most crashes occur between 5:30 PM and 9 AM, so it would be best if the signs were active between these periods and dark (no message on the signs) otherwise.

There is a need to provide or improve safe bicycle/pedestrian crossings. As discussed in Chapter 3 (Traffic Safety Evaluation & Crash Experience), as speeds increase, the likelihood of death when a bicycle/pedestrian is struck by a vehicle, exponentially increases. Most notably, when vehicles are traveling at over 40mph, the likelihood of mortality is almost certain.

The crash history between bicycles/pedestrians and motor vehicles at Belle Haven Road and Belle View Boulevard needs to be addressed. The complexity of these intersections would significantly benefit from proposed solutions to bring clarity to right-of-way and result in traffic calming. Belle View Boulevard also has an existing social trail. Furthermore, regular and consistent enforcement must be done to ensure the safety of these vulnerable road users. Bicycle and pedestrian crashes were also present at Wellington Road and Collingwood Road.

An overview of the safety recommendations for each intersection is provided in Table 57, followed by summaries of each intersection, including cost estimates and implementation timelines. Detailed itemized cost estimates for the engineering measures presented herein are included in Appendix I: Cost Estimates and final concept plans and/ or typical details for all intersections are incuded in Appendix H: HCM Reports 25-142.

Table 57: Safety Treatments by Intersection

Intersecting Roadway	Treatment	Issue Addressed
Belle Haven Road	• Channelization (e.g. acceleration lane) • Upgraded signing and marking • Intersection lighting • Tree trimming	• Angle crashes • ROW conflict • Animal crashes • Hit & Run (H&R) crashes
Belle View Boulevard	• Median U-Turn • Upgraded signing and marking • Intersection lighting • Tree trimming	• Angle crashes • Animal crashes • H&R crashes • Weather-related crashes • Roadway surface condition crashes
Tulane Drive	• Roundabout • Upgraded signing and marking • Intersection lighting	• Animal crashes • Run-off-the-road crashes • DUI crashes

Intersecting Roadway	Treatment	Issue Addressed
	• Tree trimming	• H&R crashes • Tree/shrub crashes
Morningside Lane	• Road diet • Upgraded signing and marking • Intersection lighting • Tree trimming	• Angle crashes • Animal crashes • H&R crashes • Tree/Shrub crashes
Wellington Road	• Road diet • Bicycle/pedestrian refuge island • Rectangular Rapid Flash Beacon • Upgraded signing and marking, including trail crossing on Wellington Road • Intersection lighting • Tree trimming	• Rear end crashes • Bicycle/pedestrian crashes • Animal crashes • H&R crashes • Tree/shrub crashes
Collingwood Road	• Upgraded signing and marking, including trail crossing on Collingwood Road • Intersection lighting • Tree trimming	• Animal crashes • Run-off-the-road crashes • DUI crashes • H&R crashes • Weather-related crashes • Tree/shrub crashes
Waynewood Boulevard	• Road diet • Upgraded signing and marking, including trail crossing on Waynewood Boulevard • Intersection lighting • Tree trimming	• Angle crashes • Animal crashes • H&R crashes • Weather-related crashes • Roadway surface condition crashes • Tree/shrub crashes
Vernon View Drive	• Road diet • Upgraded signing and marking • Intersection lighting • Tree trimming	• Rear end crashes • H&R crashes • Tree/shrub crashes
Stratford Lane	• Upgraded signing and marking • Intersection lighting • Tree trimming	• Angle crashes • Run-off-the-road crashes • Tree/shrub crashes

7.1 Belle Haven Road

All of the following recommendations are short-term, except for the channelization which is mid-term. Short-term costs are $300,000 and mid-term costs are $350,000.

7.1.1 Construct channelization

Constructing channelization in the median will reduce conflicts with northbound left-turns and eastbound left-turns and provide an acceleration lane for eastbound left-turns.

7.1.2 Install intersection lighting

Intersection lighting will enhance visibility of conflict points, trees/shrubs, and wildlife crossings during dark hours (Note: Intersection lighting refers to devices that illuminate the intersections at night. It does not include traffic signals.)

7.1.3 Upgrade Signing and Pavement Markings

- Typical detail of proposed new/upgraded signs to emphasize cross street warning (W2-1) and trail crossing warning (W11-15) is included in Figure 199 (U.S. Department of Transportation (USDOT), 2017).
- Install retroreflective pavement markings using black contrast tape for enhanced conspicuity.
- Install right turn and left turn pavement marking arrows and ‘only’ text to provide positive guidance to Parkway motorists on auxiliary lane usage.

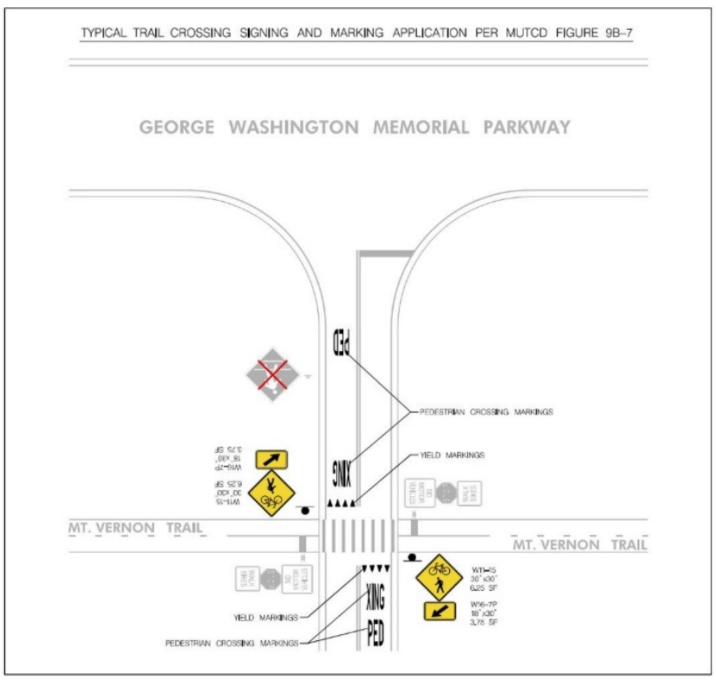

Figure 199: Example of Typical Trail Crossing Signing and Marking Application

7.1.4 Perform Sight Line Improvements

Provide a sight distance of at least 590 feet, which corresponds to vehicles traveling at 50 mph to accommodate intersection sight distance for prevailing vehicle speeds. (Note: This can be reduced as engineering and enforcement solutions are implemented to assist with traffic calming (e.g. speed reduction).) A regular maintenance program could be developed to maintain the desired sight distance during the spring and summer months.

7.2 Belle View Boulevard

The following recommendations are short-term, except for the median U-turn which is mid-term. Short-term costs are $300,000 and mid-term costs are $350,000.

7.2.1 Construct Median U-turn

Constructing median U-turn will reduce conflicts with northbound left-turns and eastbound left-turns.

7.2.2 Install Intersection Lighting

Installing intersection lighting will enhance visibility of conflict points during dark hours.

7.2.3 Upgrade Signing and Pavement Markings

- Typical detail of proposed new/upgraded signs to emphasize cross street warning (W2-1) and trail crossing warning (W11-15) is provided in Figure 199 (U.S. Department of Transportation (USDOT), 2017).
- Install retroreflective pavement markings using black contrast tape for enhanced conspicuity.
- Install right turn and left turn pavement marking arrows and 'only' text to provide positive guidance to Parkway motorists on auxiliary lane usage.

7.2.4 Perform Sight Line Improvements

Provide a sight distance of at least 590 feet, which corresponds to vehicles traveling at 50 mph to accommodate intersection sight distance for prevailing vehicle speeds. (Note: This can be reduced as engineering and enforcement solutions are implemented to assist with traffic calming (e.g. speed reduction).) A regular maintenance program could be developed to maintain the desired sight distance during the spring and summer months.

7.3 Tulane Drive

The following recommendations are short-term, except for the roundabout which is mid-term. Short-term costs are $300,000 and mid-term costs are $1,700,000.

7.3.1 Construct Multi-lane Roundabout

The multi-lane roundabout will reduce vehicle speeds, reduce conflicts with northbound left-turns and eastbound left-turns, and should be designed to address the need to accommodate bicycle/pedestrian crossings.

7.3.2 Install Intersection Lighting

Installing intersection lighting will enhance visibility of conflict points during dark hours.

7.3.3 Upgrade Signing and Pavement Markings

- Typical detail of proposed new/upgraded signs to emphasize cross street warning (W2-1) and trail crossing warning (W11-15) is provided in Figure 199 (U.S. Department of Transportation (USDOT), 2017).

- Install retroreflective pavement markings using black contrast tape for enhanced conspicuity.
- Install right turn and left turn pavement marking arrows and 'only' text to provide positive guidance to Parkway motorists on auxiliary lane usage.

7.3.4 Perform Sight Line Improvements

Provide a sight distance of at least 590 feet, which corresponds to vehicles traveling at 50 mph to accommodate intersection sight distance for prevailing vehicle speeds. (Note: This can be reduced as geometric solutions are implemented to assist with traffic calming (e.g. speed reduction).) A regular maintenance program could be developed to maintain the desired sight distance during the spring and summer months.

7.4 Morningside Lane

The following recommendations are short-term; short-term costs are $400,000.

7.4.1 Implement Road Diet

Implement road diet extending from Morningside Lane to Wellington Road, to reduce traffic speeds and provide a center two-way turn lane/ painted median:

- Merge outside southbound travel lane to end north of Morningside Lane.
- Restripe to provide two 10' northbound lanes and one southbound 10' lane.
- Provide center turn lane for side street vehicles to perform a dual-stage left turn similar to that provided at other intersections.
- Sign and mark gradual lane shift underneath Alexandria Avenue bridge to avoid buses in curbside lane.
- Continue road diet south of Wellington Road.

7.4.2 Install intersection lighting

Installing intersection lighting will enhance visibility of conflict points during dark hours.

7.4.3 Upgrade Signing and Pavement Markings

- Install retroreflective pavement markings using black contrast tape for enhanced conspicuity.
- Install right turn pavement marking arrows and 'only' text to provide positive guidance to Parkway motorists on auxiliary lane usage.

7.4.4 Perform Sight Line Improvements

Provide a sight distance of at least 590 feet, which corresponds to vehicles traveling at 50 mph to accommodate intersection sight distance for prevailing vehicle speeds. (Note: This can be reduced as engineering and enforcement solutions are implemented to assist with traffic calming (e.g. speed reduction)). A regular maintenance program could be developed to maintain the desired sight distance during the spring and summer months.

7.5 Wellington Road

The following recommendations are short-term; short-term costs are $400,000.

7.5.1 Implement Road Diet

Implement road diet extending from Morningside Lane to Wellington Road, to reduce traffic speeds and provide a center two-way turn lane/ painted median:

- Merge outside southbound travel lane to end north of Morningside Lane.
- Restripe to provide two 10' northbound lanes and one southbound 10' lane.
- Provide center turn lane for side street vehicles to perform a dual-stage left turn similar to that provided at other intersections.
- Sign and mark gradual lane shift underneath Alexandria Avenue bridge to avoid buses in curbside lane.
- Continue road diet south of Wellington Road to Chadwick Avenue.

7.5.2 Install Intersection Lighting

Install intersection lighting to enhance visibility of conflict points during dark hours.

7.5.3 Install Bicycle/Pedestrian Refuge Island

Install Bicycle/Pedestrian Refuge Island to reduce bicycle/pedestrian crossing distance. Pilot the installation of a bicycle/pedestrian-activated and solar powered rapid rectangular flash beacon to enhance driver awareness of bicycle/pedestrian activity.

7.5.4 Upgrade Signing and Pavement Markings

- Typical detail of proposed new/upgraded signs to emphasize cross street warning (W2-1) and trail crossing warning (W11-15) is provided in Figure 199 (U.S. Department of Transportation (USDOT), 2017).
- Install retroreflective pavement markings using black contrast tape for enhanced conspicuity and yield lines at trail crossing on Wellington Road.
- Install right turn pavement marking arrows and 'only' text to provide positive guidance to Parkway motorists on auxiliary lane usage.

7.5.5 Perform Sight Line Improvements

Provide a sight distance of at least 590 feet, which corresponds to vehicles traveling at 50 mph to accommodate intersection sight distance for prevailing vehicle speeds. (Note: This can be reduced as engineering and enforcement solutions are implemented to assist with traffic calming (e.g. speed reduction)). A regular maintenance program could be developed to maintain the desired sight distance during the spring and summer months.

7.6 Collingwood Road

The following recommendations are short-term; short-term costs are $300,000.

7.6.1 Install Intersection Lighting

Install intersection lighting to enhance visibility of conflict points during dark hours.

7.6.2 Upgrade Signing and Pavement Markings

- Typical detail of proposed new/upgraded signs to emphasize cross street warning (W2-1) and trail crossing warning (W11-15) is provided in Figure 199 (U.S. Department of Transportation (USDOT), 2017).
- Install retroreflective pavement markings using black contrast tape for enhanced conspicuity and yield lines at trail crossing on Collingwood Road.
- Install right turn and left turn pavement marking arrows and 'only' text to provide positive guidance to Parkway motorists on auxiliary lane usage.
- Install center line and stop line in median area to provide guidance for motorists staging in median.

7.6.3 Perform Sight Line Improvements

Provide a sight distance of at least 590 feet, which corresponds to vehicles traveling at 50 mph to accommodate intersection sight distance for prevailing vehicle speeds. (Note: This can be reduced as engineering and enforcement solutions are implemented to assist with traffic calming (e.g. speed reduction)). A regular maintenance program could be developed to maintain the desired sight distance during the spring and summer months.

7.7 Waynewood Boulevard

The following recommendations are short-term; short-term costs are $400,000.

7.7.1 Implement Road Diet

Implement Road Diet to reduce traffic speeds and provide a center two-way turn lane/painted median:

- Merge outside southbound travel lane to end north of Waynewood Boulevard and reopen north of Fox Hunt Road.
- Restripe to provide two 10' northbound lanes and one southbound 10' lane.
- Provide center turn lane for side street vehicles to perform a dual-stage left turn similar to that provided at other intersections.

7.7.2 Install intersection lighting

Installing intersection lighting will enhance visibility of conflict points during dark hours.

7.7.3 Upgrade Signing and Pavement Markings

- Typical detail of proposed new/upgraded signs to emphasize cross street warning (W2-1) and trail crossing warning (W11-15) is provided in Figure 199 (U.S. Department of Transportation (USDOT), 2017).
- Install retroreflective pavement markings using black contrast tape for enhanced conspicuity and yield lines at trail crossing on Waynewood Boulevard.
- Install right turn and left turn pavement marking arrows and 'only' text to provide positive guidance to Parkway motorists on auxiliary lane usage.

7.7.4 Perform Sight Line Improvements

Provide a sight distance of at least 590 feet, which corresponds to vehicles traveling at 50 mph to accommodate intersection sight distance for prevailing vehicle speeds. (Note: This can be reduced as engineering and enforcement solutions are implemented to assist with traffic calming (e.g. speed reduction).) A regular maintenance program could be developed to maintain the desired sight distance during the spring and summer months.

7.8 Vernon View Drive

The following recommendations are short-term; short-term costs are $400,000.

7.8.1 Implement Road Diet

Implement road diet to reduce traffic speeds, address rear-end crashes occurring at the intersection, and provide a center two-way turn lane/ painted median.

- Merge outside southbound travel lane to end north of River Farm Lane and reopen south of Lucia Lane.
- Restripe to provide two 10' northbound lanes and one southbound 10' lane.
- Provide center turn lane for side street vehicles to perform a dual-stage left turn similar to that provided at other intersections.

7.8.2 Install intersection lighting

Install intersection lighting to enhance visibility of conflict points during dark hours.

7.8.3 Upgrade Signing and Pavement Markings

- Typical detail of proposed new/upgraded signs to emphasize cross street warning (W2-1) and trail crossing warning (W11-15) is provided in Figure 199 (U.S. Department of Transportation (USDOT), 2017).
- Install retroreflective pavement markings using black contrast tape for enhanced conspicuity and yield lines at trail crossing on Vernon View Drive.
- Install right turn and left turn pavement marking arrows and 'only' text to provide positive guidance to Parkway motorists on auxiliary lane usage.

7.8.4 Perform Sight Line Improvements

Provide a sight distance of at least 590 feet, which corresponds to vehicles traveling at 50 mph to accommodate intersection sight distance for prevailing vehicle speeds. (Note: This can be reduced as engineering and enforcement solutions are implemented to assist with traffic calming (e.g. speed reduction)). A regular maintenance program could be developed to maintain the desired sight distance during the spring and summer months.

7.9 Stratford Lane

All recommendations are short-term; short-term costs are $300,000.

7.9.1 Install intersection lighting

Install intersection lighting to enhance visibility of conflict points during dark hours.

7.9.2 Upgrade Signing and Pavement Markings

- Typical detail of proposed new/upgraded signs to emphasize cross street warning (W2-1) and trail crossing warning (W11-15) is provided in Figure 199 (U.S. Department of Transportation (USDOT), 2017).

- Install retroreflective pavement markings using black contrast tape for enhanced conspicuity and yield lines at trail crossing on Stratford Lane.
- Install right turn and left turn pavement marking arrows and 'only' text to provide positive guidance to Parkway motorists on auxiliary lane usage.

7.9.3 Perform Sight Line Improvements

Provide a sight distance of at least 590 feet, which corresponds to vehicles traveling at 50 mph to accommodate intersection sight distance for prevailing vehicle speeds. (Note: This can be reduced as engineering and enforcement solutions are implemented to assist with traffic calming (e.g. speed reduction)). A regular maintenance program could be developed to maintain the desired sight distance during the spring and summer months.

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Appendix A: Intersection Existing Conditions Mapping

See Appendices in separate volume.

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Appendix B: Peak Hour Traffic Volumes

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Appendix C: Intersection Traffic Counts

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Appendix D: Average Daily Traffic Counts

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Appendix E: HCM Reports 1-24

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Appendix F: Traffic Safety

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Appendix G: Alternatives

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Appendix H: HCM Reports 25-142

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Appendix I: Cost Estimates

See Appendices in separate volume.

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