Traffic Data Needs for National Parks

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2. INTRODUCTION

CLR Analytics has developed a traffic data collection system to count vehicles and estimate travel times along segments using vehicle re-identification. System components were pilot testing on George Washington Memorial Parkway (GWMP) in June 2015. In order to help guide further development of this system, this report summarizes traffic data needs for National Parks in General, then provides a more focused look at GWMP.

3. OTHER NATIONAL PARKS

This chapter summarizes common traffic challenges in national parks and how traffic data can be used to mitigate these challenges.

3.1. Common Traffic Issues

Most national parks have continued growth in visitation (Figure 1) with the primary travel mode being personal auto. The continued growth puts pressure on the transportation system causing congestion and delay in the transportation system.

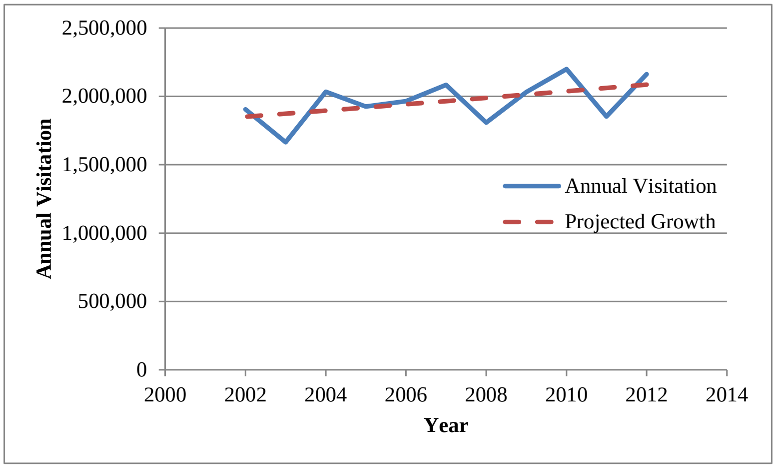

Figure 1: Example of Visitation Growth, Glacier National Park (Rutherford et al., 2014)

Visitation, and thus auto traffic, has a seasonal variation that typically peaks in the summer months. Some parks have a more extreme summer peak than others (Figure 2). In some cases, alleviating congestion (often costing millions of dollars) may not be worth it considering peak congestion may only occur two or three weekends a year.

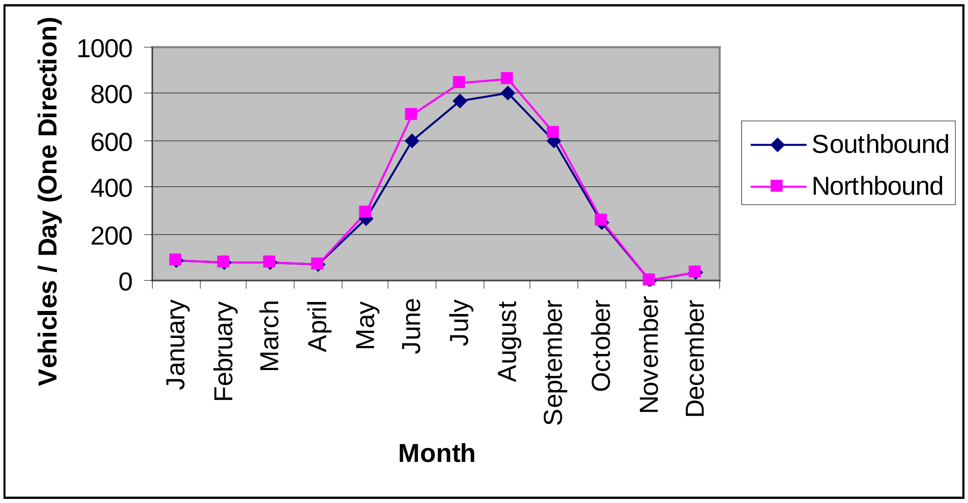

Figure 2: Example of Seasonal Variation in Traffic, Grand Teton National Park at the South Entrance (McGowen, 2007)

To provide a transportation system to handle the visitation, park units are often balancing natural resource protection, visitor experience and congestion. From the NPS mission:

"The National Park Service preserves unimpaired the natural and cultural resources and values of the National Park System for the enjoyment, education, and inspiration of this and future generations."

Providing a transportation system with little or no congestion and good access to park destinations may result in crowds of people at these destinations which can reduce the quality of the visitor experience and over-stress wildlife and other natural resources. In some cases solving a congestion problem can have negative effects on other park goals.

The major elements of the auto portion of a park transportation system typically include:

- Park entrance stations,
- Interior park road segment and intersections,
- Parking spaces, and
- Interactions with non-auto modes.

Unlike GWMP, most park units do not have as much of an issue on the interior park roadways, but the main concern is congestion at the park entrances stations and/or of overcapacity parking at destinations. Unlike GWMP, most parks sell (or check for) park passes, and provide information for all vehicles that enter the park. This bottle-neck at park entrances will often limit the traffic such that there is plenty of spare capacity on the interior park roadways (Figure 3).

Figure 3: Example of Congestion at Entrance to Yellowstone National Park

Parking congestion at major park destinations is one of the most common traffic congestion problems parks deal with (Figure 4). Full parking lots lead to frustrated visitors, risky driver behavior, and damage to resources (e.g., parking in non-designated areas destroying vegetation).

Figure 4: Full Parking Lot in Grand Teton National Park Leads to Parking on Main Highway

Park units can mitigate these challenges by implementing improvements through planning efforts. These planning efforts need historic traffic data to guide mitigations. Also, some mitigations require real-time traffic data.

3.2. Historic Traffic Data Needs

The National Park Service (NPS) requires park units to report daily visitation numbers. In some cases, receipts at entrance stations are used, but most commonly traffic counters are used in visitation estimates. In addition to these daily totals, hourly distributions and origin-destination data can help with planning.

Often congestion of transportation facilities is only a problem for certain hours of the day. Knowing when these peaks occur can help park units guide travel demand management efforts or other mitigations to deal with these peaks. Because parking lots at destinations are often the bottle-neck, a running total (total in minus total out) for destination points can be helpful.

A good example is Devil's Tower National Monument (Figure 5). This park has one entrance with a single main road to the base of the tower, which is the main destination. Simple observation made it clear that the current parking (140 spaces) at the tower base was full for most of the day, with some vehicles circling around looking for parking. They were considering a multi-million dollar project that would have added about 30 spaces. A simple count of cumulative vehicles indicated that currently there may be over 200 vehicles in the area that might park if spaces were available. Vehicles in the latent demand portion might currently be circling the parking lot looking for an empty space, or just driving through the area not stopping, but would if a space was available.

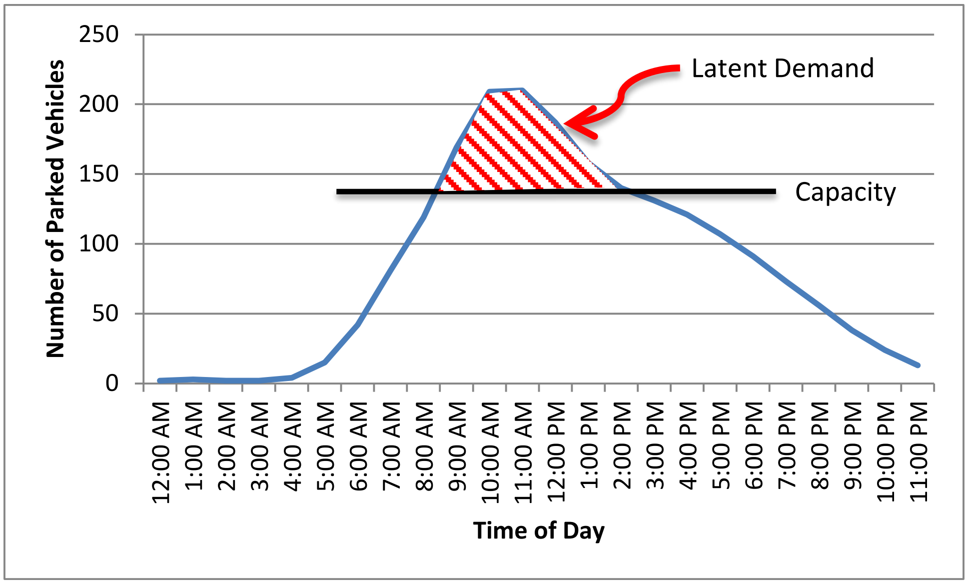

Figure 5: Using Hourly Traffic Flows to Estimate Parking Demand (DETO 2014)

Basic point traffic counts with hourly resolution would be useful. Vehicle classification is not typically a concern in national parks. Many park units (including GWMP) have restrictions on large trucks. Separating recreational vehicles (RVs), busses, and passenger cars may be of interest, otherwise vehicle classification is typically not needed.

Travel patterns are also of interest. Knowing common travel paths through a park can help in planning for transit systems. Considering a transit system in Grand Teton National Park, it was found that 40 percent of visitors ended their day at a different location than they started, making a park and ride transit system less feasible (Kack and Chaudhari, 2009).

3.3. Real Time Traffic Data Needs

Incident detection is a concern for national parks. Incidents can be similar to urban areas such as crashes or disabled vehicles that block lanes. Some incidents are unique to national parks. A common occurrence is what is referred to as an animal jam, where vehicles will stop on a highway if a rare animal is seen (e.g., grizzly bear), and people will get out of their vehicles turning the highway into a parking lot (Figure 6). Park staff want to send rangers out to these locations to not only manage traffic, but provide interpretive services and ensure wildlife and visitors have a safe interaction. Excessive travel times on segments will alert staff to potential incidents.

Figure 6: Animal Jam on Moose-Wilson Road, Grand Teton National Park

Providing real-time travel speeds to visitors may improve visitor experience. Some parks have primarily two-lane roadways leading to large platoons behind a slow moving RV during high traffic times. Considering the recreational nature of these roadways, minimizing the percent time spent following (PTSF) but adding passing lanes or other improvements may not be a concern. However, informing visitors of real-time travel times may lead to better planning and managing expectations of visitors so they know what travel speeds to expect.

Real time data on parking demand at major destinations can help with a number of congestion mitigation methods. Park units can dispatch a "parking ambassadors" to provide information on other less crowded destinations and limit illegal parking. Real time destination congestion information can be provided to travelers through 511 systems, variable message signs, and entrance station staff.

3.4. Related Challenges

In addition to traffic challenges, many national park units have complicating issues related to aesthetics, power access, communications, and staffing.

Traffic problems may be similar across multiple parks, the fact is, no two parks are the same in the types of challenges they deal with. Although this chapter tries to summarize common issues in order to guide the development of a common traffic data collection system, the traffic data needs of each individual park unit are at least somewhat unique. GWMP is an example of unique needs and is discussed in the next chapter.

4. GEORGE WASHINGTON MEMORIAL PARKWAY

GWMP includes a 25 mile highway that boarders the Potomac River. The Parkway includes the highway and several destinations that allow for short hikes, wildlife viewing and visiting of historic locations.

4.1. Current Traffic

Visitation to the park is separated as recreational and non-recreational. Recreation visitation to GWMP is an estimate of the number of people that visit the various destinations (e.g., parks, memorials and viewing areas). Non-recreational visitation is an estimate of the number of people that pass through the park on the highway, but do not stop at a destination. Although there is a bicycle pathway (part of Mount Vernon Trail), most of the visitation to GWMP is by personal auto.

Recreational visitation is estimated by multiplying various vehicle occupancy factors with traffic counts entering major destination locations (e.g., Belle Haven, Gravelly Point, Fort Hunt Park and others). Various bicycle counts and park activity attendance counts are also added to these traffic numbers. Recreational visitation is around seven million per year and has been increasing by about 0.6 percent per year (Figure 7).

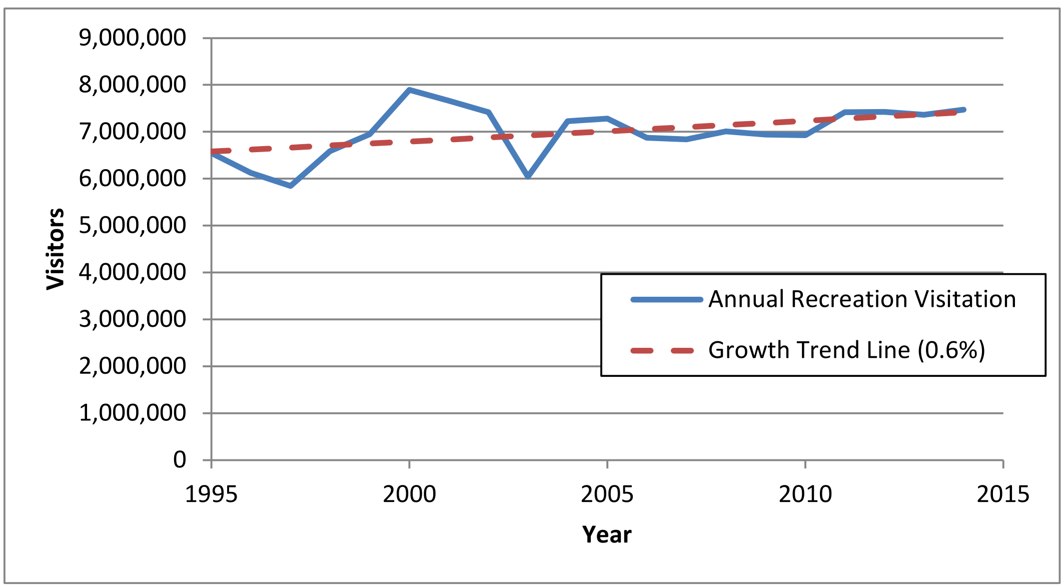

Figure 7: GWMP Annual Recreational Visitation (Data Source: NPS, 2015)

Non-recreation visitation (i.e., pass-through traffic) accounts for most of the traffic on GWMP. It is estimated by traffic counts on the mainline roadway multiplied by an estimated occupancy rate (1.2 people per car). This non-recreational visitation is approximately 30 million people per year and has been increasing an average of 0.4 percent per year (Figure 8).

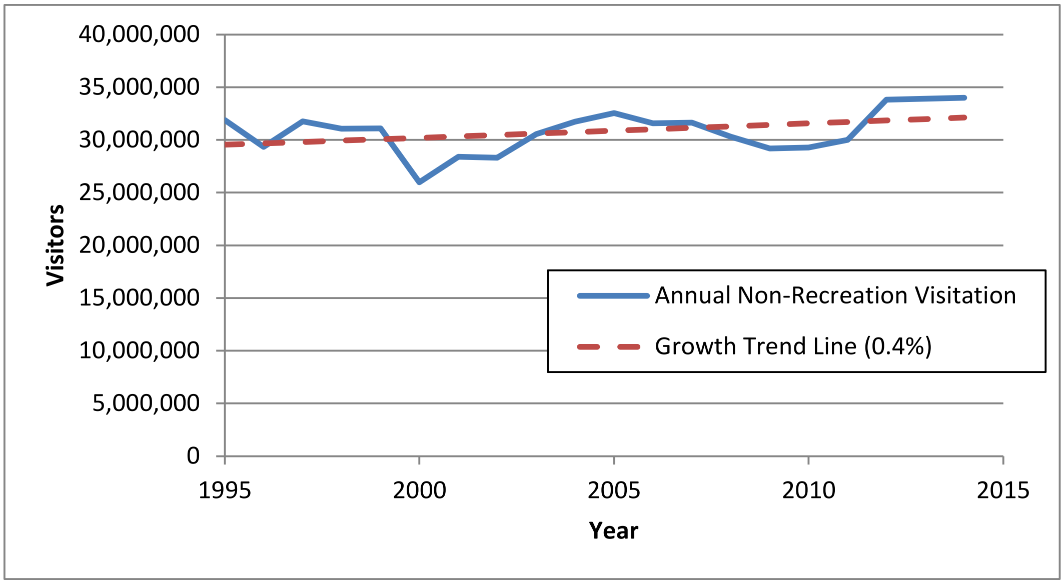

Figure 8: GWMP Annual Non-Recreational Visitation (Data Source: NPS, 2015)

The Parkway provides access to City of Alexandria and is one of the major commuting routes into Washington DC from Maryland and Virginia. Although the GWMP is focused on the Park destinations, managing this commuter through traffic is the main traffic concern.

Considering recreational visitation, GWMP has a seasonal distribution similar to other national parks where the traffic peaks in the summer months (Figure 9). The non-recreational traffic does not have as distinct a seasonal variation. Note that in Figure 9 the non-recreational travel total for August was removed as it was nearly twice the traffic as other months and this anomaly was not seen when looking at data from other years.

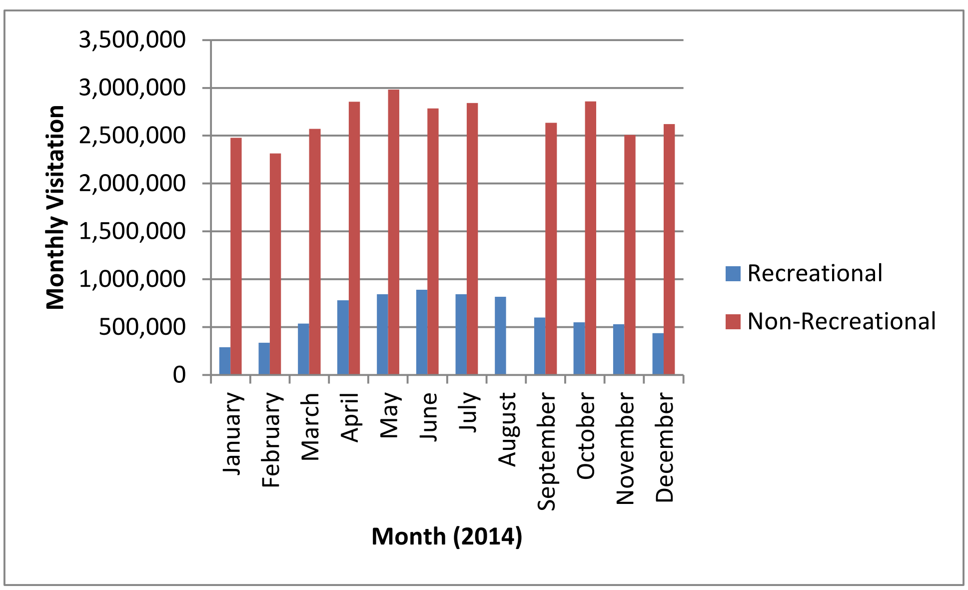

Figure 9: GWMP Seasonal Variation in Visitation (Data Source: NPS, 2015)

4.2. Traffic Data Needs

The primary need for this project is to detect real time traffic congestion in order to provide real-time data to park staff, VDOT and the traveling public. The system envisioned could have a dedicated webpage with real-time updates of travel times, with alerts sent to GWMP staff when certain thresholds were hit that might warrant immediate action. The primary traffic information dissemination tool for the traveling public is Virginia Department of Transportation (VDOT) 511 system discussed in the next chapter.

By providing real time traffic condition data to the travelling public, drivers may be more likely to take a less congested alternate route, relieving congestion on GWMP. If they choose not to take an alternate route, they may be less anxious due to the advanced knowledge of delay, resulting is less aggressive driving.

Real time traffic condition data also allows for incident detection. Detecting traffic incidents (such as crashes) sooner can result in faster clearing of the incident and a return to normal highway operations. Every extra minute a freeway lane is blocked results in an additional four minutes of delay after the incident is cleared due to traffic backing up (NTIMC, 2006). Additionally, secondary crashes are three percent more likely to occur for every additional minute the primary incident remains a hazard (Karlaftis, and Richards, 1999).

Other traffic data needs for GWMP are to collect historic data for planning purposes. This is already being accomplished by inductive loop counters with daily traffic counts.

There are a total of 9 mainline counting stations covering both directions of the parkway. These existing counting stations along the parkway only provide historic traffic count data, which may need to be upgraded to provide more types of data in real-time. More traffic data collection stations may be needed in order to count vehicles going to major on and off ramps and connecting freeways.

Implementation issues for any system include aesthetics, power and staffing. The upgrade of the existing counting stations is relatively easy because of the involvement of detection hardware only. The installation of new data collection stations will need to ensure the station is self-powered and its components are non-intrusive. The operation of these new stations may need minimum NPS staff’s time for maintenance.

5. DATA NEEDS FOR VIRGINIA DOT (511 SYSTEM)

The major freeways in Virginia have real time traffic data through VDOT's 511 program (Figure 10). Real time camera images can be viewed by clicking the camera icons. Real time congestion condition is indicated by color on the route. Congestion condition is measured as percent reduction in travel speed:

- Black for current travel speeds being less than less than 40 percent of free flow speed,
- Red for current travel speeds being 40 to 60 percent of free flow speeds,
- Yellow for current travel speeds being 60 to 80 percent of free flow speeds, and
- Green for current travel speeds being more than 80 percent of free flow speeds.

Real time data for GWMP is conspicuously absent from this system with neither real time camera images, nor congestion condition.

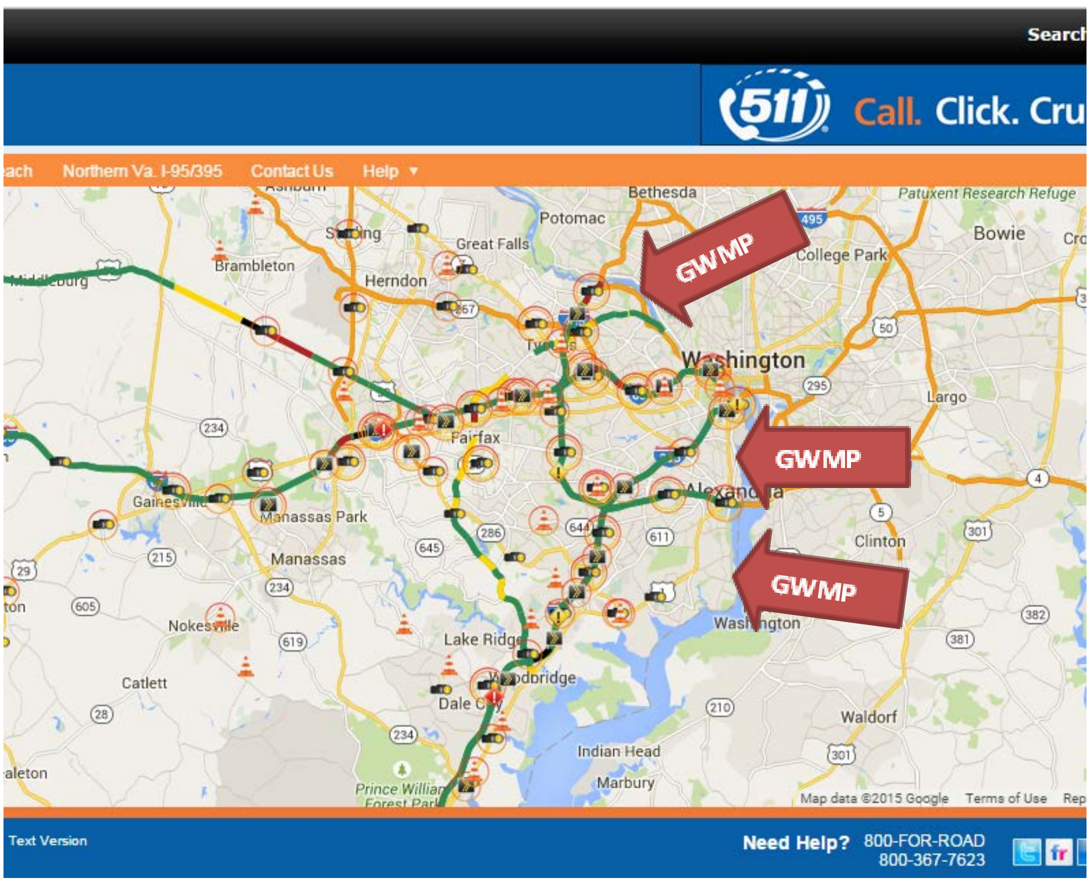

Figure 10: Screenshot of VDOT 511 System

Comparing a similar map showing the high traffic roadways, GWMP is essentially the only roadway that has high traffic (Figure 11), but has no real time traffic data (Figure 10).

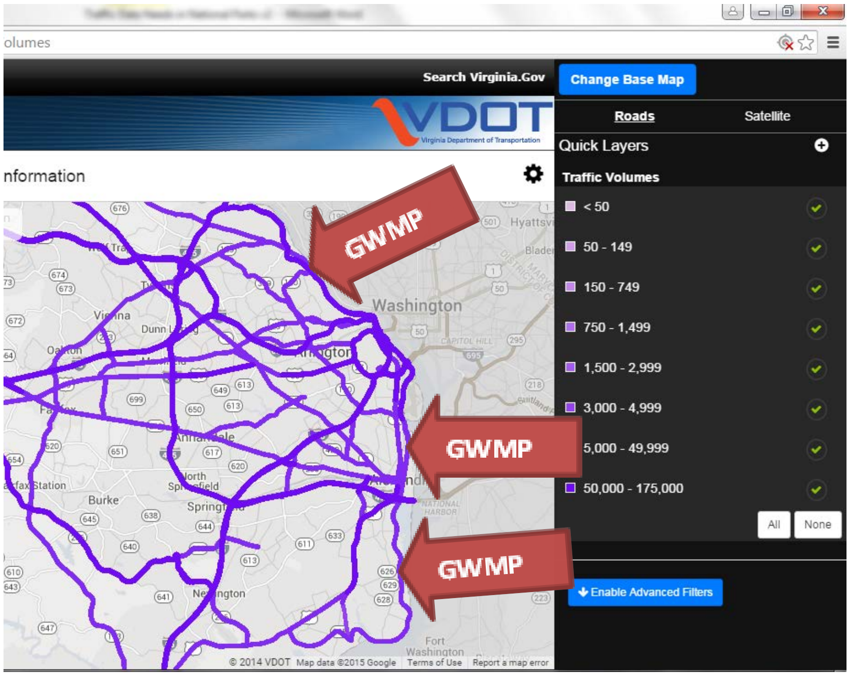

Figure 11: High Traffic Highways Near GWMP

Initial conversations have occurred with VDOT regarding how they might use data from this system. Real-time travel speeds will be available for VDOT to consider including in their 511 system, depending on business needs and resource availability (Earnest 2015).

In addition to the 511 system, VDOT desires historic traffic data for planning purposes. They would want 15 minute counts with classification according to the Federal Highway Administration (FHWA) Scheme F, which includes 13 vehicle classes identified by axle number and spacing. VDOT staff do not feel that inductive loops can achieve good results in classifying vehicles according to the FHWA classification scheme because axles are difficult to identify and using vehicle length as a surrogate is much less desirable (Bush, 2015). However, the expertise of the research team is to classify and re-identify vehicles using the inductive loop signature technology using existing loop infrastructure. The team could develop better classification accuracy for historical classification data with their system.

6. RECOMMENDATIONS

The system should be designed with a minimal visual and physical footprint in order to have a minimal impact on the natural aesthetics. It should be designed with flexibility for power options so that when power is not available the following can be balanced for the best option for an individual park unit:

- minimize staff labor needs (e.g. replacing batteries),
- minimize aforementioned aesthetic impact,
- minimize cost, and
- minimize system down time.

The primary need this system can supply is real-time travel speeds. Data should be accessible for use by a wide variety of traveler information systems.

The system should have as an option, updates to park staff for incident detection when real-time travel speeds fall below certain thresholds.

A consideration for expanding system capabilities is to estimate destination parking demand, or segments of the park where more vehicles may be stopped at destinations.

The system should also supplement historic traffic data with hourly vehicle counts. Vehicle classification is not a priority but it will be good to distinguish between passenger cars, busses and RVs.

If vehicle re-identification can be expanded beyond an individual segment, historic travel pattern data would be useful. Travel patterns tracked would include where the vehicle entered the park, which locations they visited (and for how long), and where the vehicle exited the park.

7. REFERENCES

Bush, R. (2015), Data and Statistics, Virginia Department of Transportation [Personal Communication].

Earnest, K. (2015) Assistant Division Administrator, Virginia Department of Transportation [Personal Communication]

Kack, D., and Chaudhari, J. (2009) Grand Teton National Park Transit Business Plan. Grand Teton National Park. October 2009.

Karlaftis, L. and Richards, S. (1999). "ITS Impacts on Safety and Traffic Management: An Investigation of Secondary Crash Causes," ITS Journal, 1999, Vol. 5, pp.39-52.

McGowen, P. (2007) Studying Travel Patterns in National Parks. ITE District 6 Annual Meeting Portland Oregon. July 2007.

National Park Service (NPS 2015). NPS Stats. Available online at https://irma.nps.gov/Stats/. Last accessed July 2015.

National Traffic Incident Management Coalition (NTIMC 2006): Benefits of Traffic Incident Management, available online: http://www.transportation.org/sites/ntimc/docs/Benefits11-07-06.pdf.

Rutherford, A., McGowen, P., McClure, M., Ament, R. and Grebenc, J. (2014). Highway Mitigation for Wildlife in Northwest Montana. National Fish and Wildlife Foundation October 2014.