Hwy 217 Re-engineering Plan: Increasing Vehicle Safety and Meeting Fire Department Response Times

Norvin Collins
Tualatin Valley Fire & Rescue
Aloha, OR

November 2010
Certification Statement

I hereby certify that this paper constitutes my own product, that where the language of others is set forth, quotation marks so indicate, and that appropriate credit is given where I have used the language, ideas, expressions, or writings of another.

Signed: ______________________________
Abstract
This paper intends to quantify and develop TVF&R’s position in regards to passenger vehicle safety and emergency response in the affected areas of Interstate highway 217 (OR I-217). The problem is that the public safety, specifically TVF&R, prospectus to the re-engineering of OR I-217 has not been identified. The purpose of this study is to identify the public safety, specifically TVF&R, prospectus of the re-engineering of OR I-217 to increase vehicle safety and effective fire department response times. Descriptive research methodology will be used to document the following research approach: (a) determine the available data for the affected areas of the interstate both from TVF&R responses and ODOT, (b) collection and analysis of this data to include all of the proposed highway improvement options, and (c) draw conclusions and synthesize information regarding TVF&R’s highway responses on OR I-217. The research will answer the following questions: (a) how will widening the road shoulders in specified portions of OR I-217 affect vehicle safety and/or fire district response times, (b) how will a ramp closure at Wilshire Avenue on OR I-217 affect vehicle safety and/or fire district response times, (c) how will a ramp closure at Walker Road on OR I-217 affect vehicle safety and/or fire district response times, (d) how will a ramp closure at Denney Boulevard on OR I-217 affect vehicle safety and/or fire district response times, (e) how will a ramp closure at Wilshire Avenue and Denney Boulevard on OR I-217 affect vehicle safety and/or fire district response times, and (f) how will a ramp closure at Wilshire Avenue Denney Boulevard, and Walker Road on OR I-217 affect vehicle safety and/or fire district response times? The results of the research provided a solid foundation for TVF&R to take a position on the re-engineering plan for ODOT.
# CONTENTS

Certification Statement .................................................................................................................... 2  
Abstract ............................................................................................................................................ 3  
Table of Figures ................................................................................................................................... 5  
HWY 217 Re-engineering Plan ....................................................................................................... 6  
  Introduction ..................................................................................................................................... 6  
  Background & Significance ............................................................................................................ 8  
    Organizational Impact .................................................................................................................. 10  
    Area of Impact, Current Issues, and Proposed Changes .......................................................... 12  
Literature Review .......................................................................................................................... 16  
Procedures ...................................................................................................................................... 22  
  Limitations and Assumptions ....................................................................................................... 23  
Results ........................................................................................................................................... 24  
  TVF&R Response Demographics .............................................................................................. 25  
  Section I: Shoulder Widening .................................................................................................... 27  
  Section II: Ramp Closures ........................................................................................................... 29  
Discussion/Implications .................................................................................................................. 33  
  Organizational Implications ......................................................................................................... 35  
  Recommendations ....................................................................................................................... 37  
References ....................................................................................................................................... 38  
Appendix A  I-217 Study Area Map .............................................................................................. 41  
Appendix B  Interviewees ............................................................................................................... 42  
Appendix C  Shoulder Widening Area Map .................................................................................. 43  
Appendix D  5-year Crash Data .................................................................................................... 44
Table of Figures

Figure 1. : TVFR Jurisdiction.........................................................................................................9

Figure 2. : Projected TVF&R Population Growth.........................................................................12

Figure 3. : Triple Bottom Line. .....................................................................................................14

Figure 4. : 10-year Incident History. .............................................................................................25

Figure 5. : 3-year Incidents by Station. .........................................................................................27

Figure 6. : Capacity loss secondary to incident. .............................................................................28

Figure 7. : Congestion Cost. $7,000 ..............................................................................................29

Figure 8. : Congestion and Incident Cost. $58,000 .......................................................................29

Figure 9. : Performance/Safety Relationship.................................................................................30

Figure 11: Ramp Closure vs. Surface Street. ..............................................................................31

Figure 12: Denney Traffic Flow................................................................................................32
HWY 217 Re-engineering Plan

Introduction

This paper seeks to quantify the level of support and necessary influence Tualatin Valley Fire and Rescue (TVF&R) should exert to the proposed changes for an interstate highway bisecting their jurisdiction; furthermore, this paper intends to develop TVF&R’s position in regards to passenger vehicle safety and emergency response in the affected highway areas.

The ability for emergency responders to efficiently and effectively respond to incidents is dependent upon well-maintained traffic systems. In addition to emergency responders, well-designed and maintained transportation systems create a safe driving environment for the citizens of the area or those passing through. These systems are not in the direct purview of any of the emergency service providers; even city departments are not responsible for the development, maintenance, or improvement of these systems. The influence emergency responders have over these changes is dependent on the relationship the organization has with the appropriate regulatory agency or agencies.

The Oregon Department of Transportation (ODOT) conducted an investigation into the practical upgrades to one of the major highways traversing TVF&R’s jurisdiction. It is obviously essential for emergency services to be able to respond in a timely manner to emergencies both on and off the freeway. An effective transportation system is paramount for effective movement and recovery of traffic flow. Traffic systems are designed to support the flow of vehicles through a myriad of roads; the roads that are considered the most efficient are those with limited ingress and egress such as highways. Any alterations to existing transportation systems or creation of new transportation systems must be watched by emergency
services for potential impact, both positive and negative; the affected jurisdictions should exert influence to support or oppose such proposed changes early in the development process.

The problem is that the public safety, specifically TVF&R’s, prospectus to the re-engineering of Interstate highway 217 (OR I-217) has not been identified.

The purpose of this study is to identify the public safety, specifically TVF&R’s, prospectus of the re-engineering of OR I-217 to increase vehicle safety and effective fire department response times.

Descriptive research methodology will be used to document the following research approach: (a) determine the available data for the affected areas of the interstate both from TVF&R responses and ODOT, (b) collection and analysis of this data to include all of the proposed highway improvement options, and (c) draw conclusions and synthesize information regarding TVF&R’s freeway responses on OR I-217.

To meet the purpose of this paper, descriptive research method answered the following questions: (a) how will widening the road shoulders in specified portions of OR I-217 affect vehicle safety and/or fire district response times, (b) how will a ramp closure at Wilshire Avenue on OR I-217 affect vehicle safety and/or fire district response times, (c) how will a ramp closure at Walker Road on OR I-217 affect vehicle safety and/or fire district response times, (d) how will a ramp closure at Denney Boulevard on OR I-217 affect vehicle safety and/or fire district response times, (e) how will a ramp closure at Wilshire Avenue and Denney Boulevard on OR I-217 affect vehicle safety and/or fire district response times, and (f) how will a ramp closure at Wilshire Avenue, Denney Boulevard, and Walker Road on OR I-217 affect vehicle safety and/or fire district response times?
Background & Significance

Tualatin Valley Fire & Rescue is the largest combination and fire district in the State of Oregon; it is the second largest overall fire department in the State behind Portland Fire & Rescue. TVF&R consists of approximately 500 operational (career and volunteer) and staff personnel protecting 210 square miles and 440,000 residents. TVF&R, being a special protection district, protects nine different cities (Beaverton, Durham, King City, Rivergrove, Sherwood, Tigard, Tualatin, West Linn, and Wilsonville) and portions of three counties (Clackamas, Multnomah, and Washington) responding to approximately 33,000 incidents in 2008 (Figure 1). These incidents are predominately medical (EMS) in nature; however, the District staffs a Technical Rescue Team, Water Rescue Team, and one of the State’s Regional HazMat Teams. The Operations Division administrative personnel support 22 stations staffing apparatus on a 3-shift, 24-hour rotation (A, B, C staffing model). All apparatus are advanced life support (ALS) units with a minimum of one paramedic staffing. These crews are led by a company officer (one Lieutenant per crew with one Captain overseeing each station), in three battalions, and one of the nine Battalion Chiefs on shift daily. TVF&R is located in the Pacific Northwest with its cities suburbs of Portland in Oregon (Peck, 2009).

In April 2010, ODOT was requested to re-evaluate their plan for re-engineering OR I-217. The original plan called for $1 billion improvements to the corridor and a $100 million capital project to address mobility and safety problems on the highway (Metro, 2005). This project included widening the entire study area to six (6) lanes, braiding ramps, and adding collector-distributor roadways. Given the existing and forecasted funding levels, it was decided by council that these projects were not likely to be funded in the foreseeable future; therefore,
Figure 1. TVFR Jurisdiction.
council requested that alternatives be identified that would be more cost effective yet meet the objectives of increasing reliability, mobility, and safety.

**Organizational Impact**

The entire proposed area of re-engineering is included in TVF&R’s jurisdictional area and is protected by five (5) different stations: Station 60, Station 65, Station 67, Station 51, and Station 53. In addition to these primary stations, there are an additional three (3) stations that use this highway for direct access to incidents in their neighboring first-due areas: Station 61, Station 66, and Station 50. The use of OR I-217 demonstrates an impact to approximately 1/3 of the responding units within the immediate area; this does not take into account the collateral use by other responders from other jurisdictions or further TVF&R units responding to greater alarm incidents. TVF&R strives to meet and maintain NFPA1710 response standards while maintaining CFAI accreditation (Morrow, 2010; Balfour, 2010). Responses within the affected area are within the urban and suburban zones with response reflex baseline time of 2 minutes 30 seconds for all incidents. The additional total response baseline goal is 10 minutes 20 seconds. While this is technically outside CFAI baselines and benchmarks, TVF&R has plans in place to meet these goals. One area of impact on meeting this response goal is travel time. The travel time, as demonstrated in the difference between 2:30 and 10:20, is of significant concern for any travel impacts.

TVF&R sets and reviews their strategic goals on a regular basis and updates them where necessary. These strategic goals guide how the organization responds to inside and outside requests. The response to the potential impact of the proposed re-engineering of OR I-217 is guided by the following strategic goals:

a) “Goal I: Reduce the number and severity of emergency incidents
• Arrive at 75% of emergency incidents within six minutes and forty seconds of being dispatched in Category A areas.

• Reduce the rate and severity of fires per 10,000 estimated population.

• Reduce the rate of EMS calls per 10,000 estimated population.

• Reduce severity of specific EMS calls with measurable outcomes.

• Reduce the percentage of calls where false alarms, inaccurate location or situations are present.

b) Goal VI: Promote craftsmanship, innovation, and excellence throughout the organization

• Maintain or improve CFA11 accredited agency status, CFOD2, the current ISO3 rating, the GFOA4 status, the State Fire Marshal’s Office “exempt jurisdiction” status, local fire code adoption including multi-family appendices, and compliance with DPSST5 and NIMS6.

• Improve overall performance based upon the processes, systems, and criteria established by Continuous Quality Improvement (CQI) programs.

• Increase the percentage of TVF&R employees who have initiated or achieved four-year and advanced degrees.

c) Goal VII: Leverage use of existing resources for the greatest community good

• Develop and maintain partnerships that create efficiencies.

• Maintain or improve the value of state, federal, and foundation grants that enhance TVF&R’s ability to better serve customers.

• Develop greater diversification of revenue sources.
• Increase the percentage of environmentally friendly practices for daily operations” (TVF&R, 2009)

Following the guidelines and principles set by the organization this research intends to evaluate the best outcome for response, citizen care, and impact to the community TVF&R serves while maintaining cooperation and partnerships with other government agencies.

**Area of Impact, Current Issues, and Proposed Changes**

While the initial proposal was to improve the entire length of OR I-217, as mentioned previously, the cost was prohibitive. Attachment A illustrates the study area that DKS Associates was requested to evaluate (2010, p. 2). The roads between Hwy26 to OR I-5 are some of the most highly travelled roads in TVF&R’s jurisdiction. Over the years, the populations of the cities and surrounding areas have grown, and the size of the transportation infrastructure has remained constant (Figure 2).

![Figure 2: Projected TVF&R Population Growth.](image)

This increase in population density is projected to maintain the growth rate of 0.80% to 1.57% for the foreseeable future (Rabin & Sharkova, 2010). Continued growth will increase demand on
all road systems and further impact the already congested OR I-217 during peak times. There are currently numerous safety and mobility problems on this stretch of road including bottlenecks, high crash rates, and unreliable travel times (DKS Associates, 2010). These issues are aggravated during peak travel times in the morning and evening as people go to and return from work or school. It is noted that several areas have ingress and egress ramps within ¼ mile of each other.

The increase in travel times and congestion on the freeway creates additional impact on vehicular safety and travel times on the road systems, including ingress and egress. There are upwards of 200 crashes annually along this stretch of road. Traffic engineers for ODOT were requested to evaluate alternatives to a complete widening of OR I-217 because of budgetary cutbacks; the cost of complete revamping of the system was projected at nearly $1 billion dollars. There are three main goals for the re-engineering: cost, reliability, and safety (Figure 3). The first phase of the project is in progress. This phase included system management projects to optimize existing infrastructure, ramp management projects associated with street improvements, surface street improvement projects, and highway interchange modernization. Phase I has negligible impact to the ability for TVF&R to respond to incidents. Phase II projects have recently been brought to key political stakeholders and key partners for consideration and comment; TVF&R is one of the key partners in the process.
Phase II is a refinement of the Best in Class strategies; these include three system management projects and four ramp management projects. The system management projects include traveler information, variable speed systems, and targeted shoulder widening. The four ramp management projects include potential, permanent ramp closures. The proposed ramps are Wilshire, Denney, and Walker; the ramp closures are being considered both individually and in combinations.

TVF&R has initial support for some of the concepts, but it has concern for some of the ramp closures. Phase I, as stated, has no impact to the operations of the District; therefore, support was given to ODOT for progress with the plan. Phase II, as discussed, has two portions; at first glance, the proposed system management projects appear to maintain or enhance the response reliability of the responders. This research is intended to refine the decision to support selected shoulder widening; there is a neutral position for the variable speed systems and the traveler information. The second portion, ramp management, has potential concern for response
reliability. This research is intended to provide enough information to take a position for or against the proposed ramp closures, either in part or completely.

The research conducted in this paper ties directly to the National Fire Academy’s *Executive Analysis of Community Risk Reduction* Course as part of the Executive Fire Officer’s Program. One of the main premises in the course was focusing on the impact of the fire service on the long-term safety of the citizens we serve; this is accomplished by finding partnerships to create ways to improve community safety while assuring efficiency is response (NFA, 2009). This research is intended to combine these concepts in the decision to support or not the proposed re-engineering project of OR I-217.

The primary mission of Tualatin Valley Fire & Rescue is to provide exceptional emergency prevention, preparedness and incident response services through cost effective innovation, data driven decision making, individual excellence and outstanding customer service (TVF&R, 2009, p. 2). This applied research paper will help to strengthen both TVF&R’s commitment to data driven decision making in regards to operational impacts to community safety and continued partnerships with other governmental agencies.

The research project supports operational objectives 1 (one) and 3 (three) as described in The United States Fire Administrations’ (USFA) Operational Policies (USFA, 2010). These operational objectives are as follows: “reduce risk at the local level through prevention and mitigation,” and “improve the fire and emergency services’ capability for response to and recovery from all hazards” (NFA, 2008, p. II-2; USFA, 2010). The relevance of the operational objective is based on the ability for TVF&R personnel to respond to emergency incidents in a timely manner while reducing community risk by supporting improvements to traffic systems increasing vehicle safety. This research paper intends to address both the objectives of the
USFA and the expectation previously mentioned from the NFA; furthermore, it will able to culminate in a position Tualatin Valley Fire & Rescue is able to articulate in regards to the re-engineering projects proposed by ODOT.

**Literature Review**

The ability for citizens to travel around a city in a safe manner is dependent on city transportation managers and designers. The plan for the layout of road systems in a city or town change over the years as the town grows. A small single, paved road with a single traffic light or stop sign does not have the same needs for transportation management as a large city like Los Angeles does. Many cities have grown so much over the years that roads that were designed to support the amount of traffic through the developing years have fallen short of current needs. Many traffic engineers plan road systems with the intent of having them support current and a 15-20 year growth projection. As cities grow faster than the projections or as the life expectancy of the roads begin to reach time, the roads begin to have increased travel issues. These issues include congestion during peak hours of the day, increase in motor vehicle crashes, ineffective recovery following crashes, and more wear and tear on the road. When these impacts begin to materialize, traffic engineers begin to make new plans to improve those roadways.

The First National Conference on City Planning occurred in Washington DC 100 years ago; this group of leaders looked to set vision for the planning of cities to include transportation (Brown, et.al., 2009). While the planners contemplated the needs of the future they considered, they were unable to foresee the development of the growth of suburbanization and the sophistication of transportation venues. Planning ahead is always a good idea and necessary for the continuation of harmony in a tight community like a metropolitan city. Effective and efficient road systems allow for people to get to and from work, getting groceries, and travelling
to friends and relatives for recreation. Cities have changed over time with the increased need of sophisticated transportation systems where there was initially the horse drawn carriage.

Cities originally planned transportation with the concept of stressing the harmony between transportation needs and land use; furthermore, while Americans are proactive in problem-solving and do not tolerate inconvenience, they have lost the initial focus and have become complacent with inefficient or poorly maintained roads (Brown, et. al., 2009; Samuel, 1999). Samuel’s (1999) work may be slightly dated; however, the concepts and challenges have not changed from the initial meeting in Washington DC a century to modern roads a decade ago. Space, density, cost, and politics played into the discussion then, as does so today. As the cost of developing and maintaining roads increases, the more politicians and citizens are willing to tolerate the decrepitating states of the roads.

Some solutions to these problems come in many shapes and sizes. Increasing the size of current roads is the best long range plan if possible because it does not destroy more land or impact other areas of the city. This plan, however, is the most costly option. Some other options to address these needs might include creating separate truckways to reduce the impact of heavy rigs on the roads. Toll roads for the recovery of costs of maintenance and creation of roads; these roads can be either for regular travel or, better yet, as an option for those who want to travel faster or with less congestion. Both of these concepts speak to the initial design as discussed originally as well as by Samuel (1999; Brown, et. al., 2009). Once these concepts are considered, construction or improvement of roadways must look to current capacity and future needs.

Effective management of traffic flow is the crux of the issue. This includes ingress, egress, and flow of traffic. All of these characteristics bring their own set of challenges of which
each must be addressed. Brown, et. al. (2009), and Samuel (1999) discuss the importance of planning and consideration for wider, better engineered roads; the reason behind this desire becomes clear when assessing the behaviors of drivers merging onto roadways (Ahammed, et. al., 2008). Canada and America experience similar incidents of crashes on their roads. While those travelling on freeways make up a 40% of the total vehicles on the road, the number of crashes is the lowest of all road systems (Brown, et. al., 2009, p. 174). It is interesting that the freeway speeds are faster which requires an increase in attention on the part of the drivers, the incidents of crashes is low. All freeways have ingress and egress ramps as part of the design. This design is essential to the smooth flow and higher allowed speeds because of that limited access. Continuing with design considerations for making transportation better that Samuel (1999) spoke and combining the findings of Brown, et. al. (2009), the effects of ingress and egress ramps should have the greatest frequency for motor vehicle crashes.

Remaining consistent with the concept that crashes are more likely to occur with slower speeds, Ahammed, et. al. (2008), studied the effects of ramp speeds and merging to the number of incidents of motor vehicle crashes. Their study evaluated 23 merging sites in Ottawa, Canada, to evaluate driver behavior in merging areas, both ramps and acceleration lanes. “…18% of all interstate crashes, 17% of the injury crashes, and 11% of the fatal crashes occurred at interchanges, although such locations constitute less than an estimated 5% of total freeway mileage” (Ahammed, et. al., 2008, p. 370). Understanding the areas of greatest crash occurrence allows for modeling to be developed and assessed for improving highway safety. Freeway design only impacts driver safety in certain situations. Driver behavior and attention has a greater impact on vehicle safety. Ahammed, et. al. (2008), found that the merge lane and acceleration lanes had the greatest number of crashes. This finding was consistent with crashes
when drivers were attempting to change lanes and reducing their speed. Studies have shown that the rate of vehicular speed compared to those around it has the largest impact on extent of a crash (Ahamed, et. al., 2008; Chassiakos, et. al., 2005). This data is consistent throughout the world; Greece experienced similar statistics in regards to speed, rate of crash, and injury severity on a 7 year period (Chassiakos, et. al., 2005, p. 371).

Safety is of paramount concern to traffic engineers, city planners, responders, and citizens. Creating and maintaining safe transportation systems assures a prosperous community. Freeways are a major part of many medium and large communities; understanding and acting, both proactively and reactively, to freeway data helps to create that safe environment and prosperity. Many researchers have developed traffic modeling to predict areas of concern for drivers and responders (Ahamed, et. al., 2008; Chassiakos, et. al., 2005; Kiattikomol, et. al., 2008). All of these models take into account any slope or curvature of the road or ramp, the average speed of acceleration, and the length of the acceleration lane. According to Ahamed, et. al. (2008), the length and attained speeds on the ingress ramp has the greatest impact on reducing freeway crashes; these were demonstrated with 5% significance. Like Ahamed, et. al. (2009), Kiattikomol, et. al., (2008) found the use of a predictor tool to be beneficial to planners for creating safer freeways. Driving on freeways has two predominate areas to evaluate when assessing for potential areas for improved, interchange and non-interchange. Adding to current, accepted studies, regression models looking at two specific variables, traffic volume and length of segment, were shown to provide reliable predictability to planners (Kiattikomol, et. al., 2008). These models allow traffic engineers to take the time and spend a smaller amount of money to design the safest freeways and evaluate proposed changes to current freeways.
Even with the best planning and design of freeway systems, motor vehicle crashes will continue to occur. Responding to those emergencies is generally the responsibility of the local emergency services; these services include police, fire, and emergency medical providers. These providers must be able to access and predict incident rates to best meet the needs of the public they serve. Many of the predictor models are effective at giving direction for planning for station locations and response needs and projections. Some transportation systems have advanced, real-time monitoring and intervention strategies in place to improve freeway safety. Unlike the previously mentioned predictor tools, Abdel-Aty, et. al. (2007) developed a real-time system for evaluation and reaction to freeway incidents. They demonstrated that low speed conditions were improved with ramp metering where high-to-moderate speed conditions were improved with variable speed zones. The ability to control the speeds on the freeway both enhances the response capabilities of emergency services, but it also creates safer travelling for citizens. Once crash occurs, the ability for responders to arrive is critical and the flow of traffic prior to and after the incident site is imperative.

The higher capacities that freeways offer create the greatest opportunity for crashes, with or without injury. As it has been demonstrated, slow speeds at ingress ramps and congestion present the highest danger; a driver’s study in which a person was presented in a simulator similar situations to those of high and low risk areas confirmed at these areas are the most probable for incidents to occur (Abdel-Aty, et. al., 2007; Ahammed, et. al., 2008; Sarvi, et. al., 2004). It has been established that freeway ramps and slow, congested speeds increase the potential for occurrences of crashes. Ramps are a fact of necessity for freeway design and use; therefore, it is necessary to control traffic on freeway crashes. Jha & Cuneo (1999) found that lengthening the marking zones around incidents helped drivers react better to the lane closures
and respond more appropriately to the crash creating a safer area for emergency responders and vehicle occupants. Creating flow that crash vehicles or other drivers can move to increases safety and vehicle occupant safety while reducing the probability of a secondary crash. Widening of existing freeways or inclusion of wide enough road shoulders may have a positive impact on crash scenes and travel recovery times following incidents.

All proposals for design or improvement of transportation systems cost the public significant amounts of money. This costing, especially during economically hard times, is met with negativity from the voters. This was prevalent in California in the 1960s; following this lack of support, freeway systems began to deteriorate (Taylor, 1995). Changing public perception for support of freeway creation and improvement is necessary for increasing safety for users of transportation systems. Reallocation of funding with well laid out plans drives that community support; additionally, having public safety partners support changes also helps in public support (Taylor, 1995).

In conclusion, it was established that freeway design and/or improvement is complex but manageable. There are many predictive tools planners can use for these challenges; furthermore, many of these designs improve freeway safety. They all come at varying costs and construction time. As emergency providers, the research illustrates two major areas that impact the primary mission: ingress/egress ramp control and management of incidents on freeways. Understanding the dynamics of freeway’s greatest areas of potential safety concerns and mitigation strategies helps protect the citizens emergency responders are sworn to protect. While this literature review confirmed many preconceived ideas, it also presented context in understanding what should be considered when making decisions about freeway safety and response that are different than previously assumed. The most important of those is the inherent danger to drivers
on ingress/egress ramps. This understanding must be balanced with emergency response data for appropriate decisions to be made in regards to traffic changes concerning freeways.

**Procedures**

Analysis of the re-engineering problem facing Tualatin Valley Fire & Rescue consisted of numerous evaluation tools. The outcome of this descriptive research intends to provide the District with direction for establishing a position on the re-engineering proposal presented by ODOT. The literature review included books, journals, and additional written material available from various sources including but not limited to local libraries, the LRC, Internet search drivers such as Bing.com or Google.com, and scholarly/professional search drivers such as Sage Psychology, Academic Search Premier, or PsycARTICLES. These reviews came in addition to jurisdictional and local demographic documents. The design of the research supported the research questions presented.

While the literature review set the foundation from the historical perspective in regards to freeway design and challenges associated with transportation systems, further perspectives form the fire district point of view was necessary. This perspective was obtained through personal interviews with key TVF&R staff, ODOT/Metro Staff, and the consulting company staff that ODOT has hired to conduct the project. Additional background was gained from historic data related to TVF&R relative to call volume and population within a 5 and 10 year perspective. This internal historic information was gained through documents and electronic media within various TVF&R databases and divisions, i.e. GIS, fire prevention, and operations. This review included a review of database information on call volumes (present and past), incident numbers including a breakdown between fire and EMS incidents, and growth statistics including future predictions.
Some of the most pertinent information was gathered from review of data obtained reports obtained from ODOT and the consultant hired to manage the proposal for the affected county. This information contained the position of the traffic engineers designing the improvements, the cost of the proposals, and the perceived impacts on the changes for the road systems. Interviews were conducted with critical personnel both internal and external to TVF&R (Appendix B).

The information compiled was interpreted by the author in coordination with subordinates assigned to the Traffic and Transportation program within TVF&R whose purpose is to interact with all issues surrounding traffic, transportation, and water supply issues from both the fire prevention/code enforcement and operational perspectives.

**Limitations and Assumptions**

The limitations and assumptions of this research are relative to the lack of literature and studies available for the fire service specifically. Until greater information is specific to the fire service, the uniqueness of the industry will allow for varied interpretation and application of data derived for traffic and transportation issues.

As with all research for a target issue, assumptions are made sometimes falsely. The ability to compare one city to another is difficult, even for the same demographics. Because there are limited articles arguing a change in philosophy for freeway design, current literature was difficult to find; therefore, the foundational literature was approximately 10 years old. This information is considered to be relevant today and used as foundational.

Another assumption is that all interviewees were honest and forthcoming with information that was with understanding and knowledge of their organization’s opinion or position on the topics asked. Assumptions are made to the reliability of the research and quality
of the research; thus, only peer-reviewed articles were used for the literature review. Results were assessed objectively from the perspective of the citizen’s response needs in regards to response time while keeping a balance of the regulatory agency’s financial needs which in turn affects the citizens in the form of taxes.

Results

As discussed previously, there are two sections to the proposed re-engineering of OR I-217; therefore, the results section will be broken-down similarly with the addition of TVF&R specific demographics. Section I contains system management projects. There is not discussion concerning traveller’s information or variable speed zones as those do not have direct operational impact to this District. Section II contains ramp management projects. These are of concern to the District and information necessary to evaluate support or not are presented in regards to single or multiple ramp closures.

The research questions used for this paper are: (a) how will widening the road shoulders in specified portions of OR I-217 affect vehicle safety and/or fire district response times, (b) how will a ramp closure at Wilshire Avenue on OR I-217 affect vehicle safety and/or fire district response times, (c) how will a ramp closure at Walker Road on OR I-217 affect vehicle safety and/or fire district response times, (d) how will a ramp closure at Denney Boulevard on OR I-217 affect vehicle safety and/or fire district response times, (e) how will a ramp closure at Wilshire Avenue and Denney Boulevard on OR I-217 affect vehicle safety and/or fire district response times, and (f) how will a ramp closure at Wilshire Avenue Denney Boulevard, and Walker Road on OR I-217 affect vehicle safety and/or fire district response times?
TVF&R Response Demographics

Response data revealed multiple opportunities for the re-engineering to be beneficial to both the District and the citizens. Review of the Standard of Cover document for TVF&R showed both historic data and sets expectations of responders and assures meeting the goals of continued accreditation (TVF&R, 2010).

TVF&R continues to demonstrate an upward trend in incident volume; this includes fires and EMS calls alike (Figure 4). Of these, there are approximately 87 incidents per day that crews respond. The 87 incidents daily are then further broken down to approximately 66 EMS

Figure 4. : 10-year Incident History.
incidents daily; these 66 incidents include responses to freeway incidents. Call reliability documents the ability of crews to respond within their area regardless of incident type; the following represents the District’s goals and current status for reliability.

- **Response Reliability (First-Due Company or Peak Activity Unit Dispatched):**
  - Baseline Standard = 90%
    - *Actual Performance (2006 – 2008) = 95.3%*
    - *Actual Performance (2008) = 95.5%*

- **Reflex Time at the 75th Percentile (minutes:seconds):**
  - Baseline Standard = 1:30
    - *Actual Performance (2008) = 1:37*

- **Response Performance (minutes:seconds):**
  - Baseline Standard, Category A = 6:40
    - *Actual Performance (2008) = 6:34*

The greatest call volumes are during working hours with increases during morning and evening travel times. There is a positive skew and with leptokurtic distributions toward rush hour travel times. This represents increase in call volume for those stations surrounding or responding through the OR I-217 corridor; the following represents the incidents responded to by those stations utilizing OR I-217 (Figure 5). Of the five stations that are listed, three (Station 51, Station 53, and Station 67) use the freeway more frequently than the others because it runs through all of their first-due areas. The layout of these first-due areas have the freeway running down the center necessitating their use on a more regular bases than just responses.
Figure 5: 3-year Incidents by Station.

With the exception of Station 64 and Station 35, Station 51, Station 53, and Station 67 are the busiest stations in the District. Improved or maintained ability to access incidents either on the freeway or within close proximity is essential to maintaining the District’s call reliability.

**Section I: Shoulder Widening**

Incidents on freeways cost travellers in relation to time and money. This loss is described as a loss of capacity in the flow of traffic (Figure 4). In addition to capacity loss, the dollar cost of congestion is also significant especially if an incident occurs simultaneously (Figure 5, Figure 6) (Platman, 2010). The cost to widen all the proposed areas on OR I-217 would be $22.8 million for all 6 sections; Appendix C shows the proposed areas. Discussions took place that the design of the shoulders would support the weight of a fire apparatus parking or driving on them. In addition to the cost of congestion and incidents, the quicker the recovery time is on the freeway, the quicker efficient flow can be restored.
Figure 6. Capacities loss secondary to incident.
Research question 1: how will widening the road shoulders in specified portions of OR I-217 affect vehicle safety and/or fire district response times, is supported by a combination of TVF&R data and that of the ODOT proposal.

The goals that the District desire to achieve and those of the different cities are the same. They both want safer freeways, better travel times, and any changes that need to occur to improve upon them must be cost effective (Doyle, 2010). The data presented is a more cost effective way to enhance the safety and travelling ease on this freeway currently and until a future time where more money becomes available for a total revamping of the system.

Section II: Ramp Closures

The impact of an ingress or egress ramp has a greater potential impact on travel for both emergency responders and travellers. OR I-217 connects many of the suburbs of Portland, Or. Because of this, the freeway is used frequently and has become antiquated in its design. The increased congestion during peak travel periods also increases the numbers of crashes (Appendix
D). The rate of speed is a factor involved in freeway crashes; however, there is a cross-over between speed and safety (Figure 9). There are a greater number of slower vehicles during ingress and egress to and from the freeway. Because of this, ODOT proposed selected ramp closures either partially or completely.

Research questions (b) – (f) are impacted by these proposals. ODOT proposes the following closures: Wilshire (Complete closure), Walker (Complete or partial (South bound ingress open)), Denney (Complete closure).
Wilshire Avenue is at the northern most portion of the freeway. There is little flow for this ramp as reported by ODOT traffic flow studies. There is heavy traffic flow at the Walker Road exchange for both emergency responders and citizens. This is the first southbound exit from OR I-217 when entering from OR HWY-26. Denney Boulevard has steady traffic flow; however, there are two additional exits with ½ or ¼ mile from it. This causes increased congestion and slows traffic, increasing the potential for a crash (DKS Associates, 2010).

Reducing the use of surface streets while maintaining high volumes on freeways creates a cost savings of between $1.9 to $4.9 million per closure. There is a balance between ramp closures and surface street use (Figure 10). With the close proximity of Denney Boulevard ingress being so close to Allen Boulevard, North, and Scholls Ferry Road, South, a greater reduction in flow capacity is achieved.

Review of the flow on Denney Boulevard on-ramp shows a significant reduction in flow...
compared to those around it and the others in the study. Denney Boulevard is the second most contentious proposed ramp closure behind Walker Road; therefore, there is more data available concerning this exchange.

The cost for construction of the Denney exchange is estimated at $11.2 million with a 20 year traveler benefit of $19.7 million.

The cost for construction of the Wilshire exchange is estimated at $0.4 million with a 20 year traveler benefit of $7.6 million.

The cost for construction for both Wilshire and Walker exchanges is estimated at $15.9 million with a 20 year traveler benefit of $18.8 million.

The cost for construction for Denney, Wilshire, and Walker exchanges is estimated at $29.6 million with a 20 year traveler benefit of $30.3 million.

Analysis of the research questions is as follows:

(a) How will widening the road shoulders in specified portions of OR I-217 affect vehicle safety and/or fire district response times? The data appears to support the inclusion for shoulder widening from both the cost and safety perspectives

\textit{Figure 12:} Denney Traffic Flow.
(b) How will a ramp closure at Wilshire Avenue on OR I-217 affect vehicle safety and/or fire district response times? The data appears to support the inclusion of a complete closure of Wilshire Avenue for a minimal cost saving but an increase in safety in the area.

(c) How will a ramp closure at Walker Road on OR I-217 affect vehicle safety and/or fire district response times? The data appears to show a cost savings for the closure, either complete or partial, for the Walker Road exchange; however, there are significant response and station location implications with this closure.

(d) How will a ramp closure at Denney Boulevard on OR I-217 affect vehicle safety and/or fire district response times? The data appears to support a complete closure of Denney Boulevard in regards to cost savings and safety. Additionally, it appears that with collateral ramps with \(\frac{1}{2}\) mile from each other, there will be minimal impact to emergency response.

(e) How will a ramp closure at Wilshire Avenue and Denney Boulevard on OR I-217 affect vehicle safety and/or fire district response times? The data appears to support the complete closures of both Wilshire Avenue and Denney Boulevard for the above reasons.

(f) How will a ramp closure at Wilshire Avenue, Denney Boulevard, and Walker Road on OR I-217 affect vehicle safety and/or fire district response times? The data appears to have minimal support for all three closures because of emergency responders’ concerns for the Walker Road exchange.

**Discussion/Implications**

It is clear from the literature review, personal interviews, and TVF&R data that there is the opportunity to improve the safety of the citizens while meeting their response expectations and maintaining or improving partnerships with other governmental agencies. TVF&R has committed to the citizens they serve to provide exceptional service and to support them through
partnerships and prevention activities (TVF&R, 2009). This commitment includes good stewardship of the money entrusted to them and to look for ways to support savings through those afore mentioned partnerships. The OR I-217 re-engineering project is a prime example of one such program that could strengthen the relationships between the District, partners, and the citizens.

The literature review demonstrated the complexity of designing transportation systems so they are effective and efficient for travelers while maintaining reasonable costs. As communities grow, the original vision of the city planners comes back into reality. These visions and understandings about human behavior impact the current and future planning of road systems. Brown, et.al. (2009) and Samuel (1999) showed that people become complacent about the roads they drive and figure it is a fact of life that roads do not work efficiently. This assumption is difficult to fathom for, as Americans, the citizens have very little tolerance for any creature discomfort. The one thing all people involved in traffic planning or road use have in common is vehicle and traveler safety.

Safety, being paramount to all, sets the foundation for road design and improvement. Recall freeway design for safety includes an understanding of cost, travel speeds, exchange distances from each other, and congestion (Ahammed, et.al., 2008; Brown, et. al., 2009; Chassiakos, et. al., 2005; Samuel, 1999). Evaluation of transportation systems and individual communities affords the safest, more cost effective designs. Taking design needs to the next step and comparing them to other agency’s data, especially emergency responder data, can exponentially improve the community. The goals of the politicians, financial restraints, emergency responders, and citizens are the same (Balfour, 2010; DKS Associates, 2010; Doyle, 2010; Morrow, 2010; Platman, 2010).
The citizens of TVF&R want to be able to travel throughout the suburbs with limited inconveniences. Because of difficult economic times, the original $1.1 billion improvement plan for OR I-217 became cost prohibitive (Metro, 2005). Traffic engineers in association with local partners developed an alternative plan that meets the same goals at a lower price tag. While this plan has limited longevity, it does provide a much needed change and improvement to current problems (Balfour, 2010; Doyle, 2010; Platman, 2010).

The safety implications presented in the literature review in regards to ramp issues are taken into account in the proposed plan. The concern TVF&R has with DKS Associates is they proceeded with Section II planning without gaining support from key stakeholders. This became clear following a community outcry for the continued use of some of the proposed ramp closures. Because of this outcry, the consultants took more time and began to review the proposal while gaining those key stakeholders support, TVF&R being one of them.

**Organizational Implications**

Re-engineering any of the transportation systems within TVF&R’s jurisdiction can have catastrophic implications. Meeting the goals set forth within the Strategic Plan and Standard of Cover is dependent on intact transportation systems and reliable traffic flow (TVF&R, 2009 & 2010). The research questions are based on the need for the District to have influence into the response routes used by responding companies throughout. There are different implications to TVF&R whether it is shoulder improvement or ramp closures.

All research and literature review combine to defend a strong commitment to widen shoulders on OR I-217. Not only will wider shoulders enhance response times, they provide for safer areas to work or drive during a crash. TVF&R’s partnership with ODOT created the opportunity for them to include weight needs for emergency apparatus, and this was included in
the proposal. The only open discussion is which side of the roadway to include the shoulders. There are equal arguments for both sides. In the end, both sides work well without major benefits either way.

The ramp closures, however, make sense after review of data and foundations from the literature review. The majority of crashes occur on the ramps or the right most lane because of speed and margining needs (Ahammed, et. al., 2008; Chassiakos, et. al., 2005; Jha & Cuneo, 1999; Kiattikomol, et. al., 2008; Sarvi, et. al., 2004). TVF&R’s data demonstrated that not all of the exchanges were used equally; therefore, flexibility can be used when taking a stance on which ones to close or not. Ramp implications in regards to responders are unique to the different ramps.

Wilshire Ramp: There is little to oppose the closure of this ramp from operational considerations or financial implications. The ramp is used little by TVF&R responders and citizens alike. Furthermore, the ramp has been closed during construction on the I-217 and HWY-26 freeway exchange and has not shown to be a challenge for responders or travelers.

Walker Ramp: This ramp is used by emergency responders on a regular basis. Additionally, many commuters use this ramp to travel to work in the high tech corridor or major Oregon companies, i.e. Intel and Nike. While the data shows a cost savings with the closure of this ramp and limited flow capacity improvement, the closure data does not contemplate the collateral impact the increased flow on surrounding surface streets. This closure will also increase response times to incidents surrounding the ramp and change response orders because station locations will no longer be in the best responding areas.

Denney Ramp: This ramp is used by both responders and the public. Many times while traveling the freeway, citizens experience increase congestion between Allen Boulevard and
Scholls Ferry Road because of the ramp at Denney Boulevard. These roads being \( \frac{1}{2} \) mile apart goes against efficient freeway design. Station location allows for access to the freeway be all three accesses with limited time differences between them. From the data presented, there will be limited surface street impact and a significant financial savings.

**Recommendations**

The purpose of this research paper was to provide data driven recommendations for the proposed re-engineering plan for OR I-217. Each of the research questions were designed to create information necessary for TVF&R to take a position for Section I and Section II proposals. Based on the research, the following recommendations are supported:

(a) Support should be given to the widening of shoulders in all the proposed areas on OR I-217.

(b) Support should be given to the complete closure of the ramp at Wilshire Avenue.

(c) No support and active opposition should be voiced to complete or partial closure of the ramp at Walker Road.

(d) Support should be given for the complete closure of the ramp at Denney Boulevard.

(e) Support should be given for the complete closures of the ramps at Wilshire Avenue and Denney Boulevard.

(f) No support and opposition should be voiced to the complete or partial closures of the three ramps at Wilshire Avenue, Denney Boulevard, and Walker Road.
References


Appendix A

I-217 Study Area Map
Appendix B

Interviewees

1. Internal TVF&R
   a. Dustin Morrow
      Deputy Chief, TVF&R
      dustin.morrow@tvfr.com
   b. Clark Balfour
      Vice President – Board of Directors TVF&R
      clark.balfour@tvfr.com

2. External from TVF&R
   a. Deena Platman
      Principal Planner – METRO
      deena.platman@oregonmetro.gov
   b. Denny Doyle
      Mayor for City of Beaverton, OR
      mayormail@ci.beaverton.or.us
Appendix C

Shoulder Widening Area Map
Appendix D

5-year Crash Data