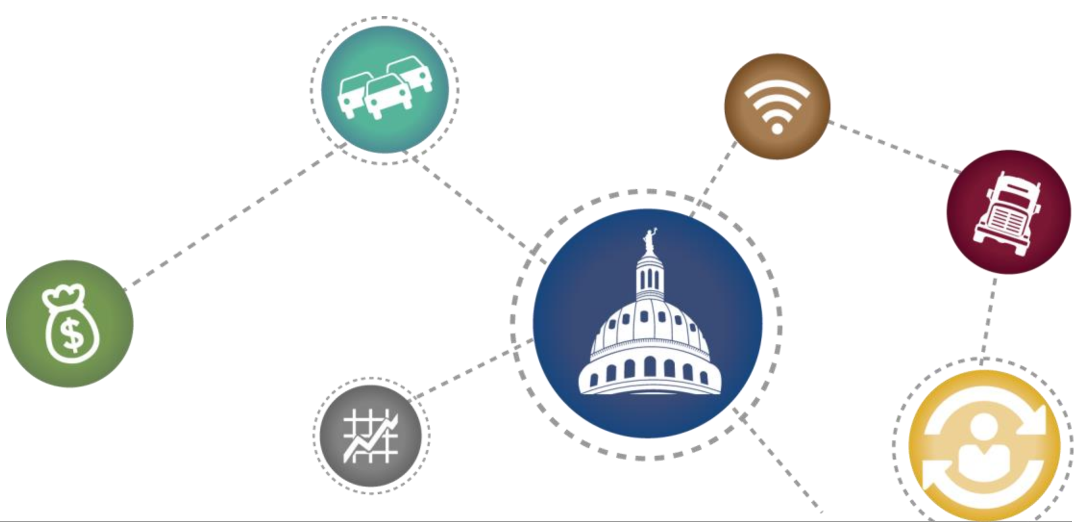
Texas A&M Transportation Institute

Incentives for Truck Use of SH 130

Final report

PRC 14-23F



TRANSPORTATION
Policy Research CENTER

Incentives for Truck Use of SH 130

Texas A&M Transportation Institute

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Introduction

Roads are a key element of any region's transportation infrastructure. Today's road system allows unprecedented levels of mobility, accessibility, and economic growth. Costs associated with inadequate road infrastructure can amount to billions of dollars. For example, it has been estimated that nationally, truck congestion costs were $27 billion in 2011 (*1*).

In the U.S., the largest revenue source for the funding of transportation infrastructure is the federal and state fuel taxes, which were conceived in the last century as a way to recover the costs of vehicle travel on the U.S. highway system. However, the tax has not kept up with the rate of inflation, and given increasing roadway maintenance and construction costs, and more fuel-efficient vehicles, the motor fuel tax is no longer sufficient. This inadequate funding from the traditional fuel tax, together with increased demand for transportation and increasing maintenance needs (resulting from an aging highway system), has thus resulted in significant debt and infrastructure shortfalls. Given these conditions and the challenges associated with preserving the existing infrastructure, governments are pressed to provide major capital investment projects.

To address this need, a number of state departments of transportation (DOTs), including Texas, have been actively pursuing tolling as a means to provide capacity.

In some cases, toll roads were in part motivated by the need for truck bypasses around congested urban areas. For example, SH 130 was envisioned as a potential bypass around the Austin downtown area for through truck trips. The literature, however, reveals a reluctance of the trucking industry to use tolled facilities. This report aims to increase the understanding and the behavioral responses of the trucking industry to tolls charged. In particular, this report looks at the current use of the tolled bypass road around Austin (i.e., SH 130) that was intended to serve as an alternative to IH 35, which goes through Austin. The report also examines past incentives to encourage truck traffic on SH 130.

This report answers three questions regarding truck use of tolled roads (specifically SH 130):

- What does the literature say?
- What do the traffic and transaction data say?
- What does industry say?

Ultimately, this study aims to inform short- and long-term mobility policy and planning strategies to move freight more efficiently in and through Texas. The positive implications of diverting truck traffic to uncongested toll roads are reduced traffic congestion, increased safety, and better air quality on the parallel facility.

Determining Optimal Toll Rates

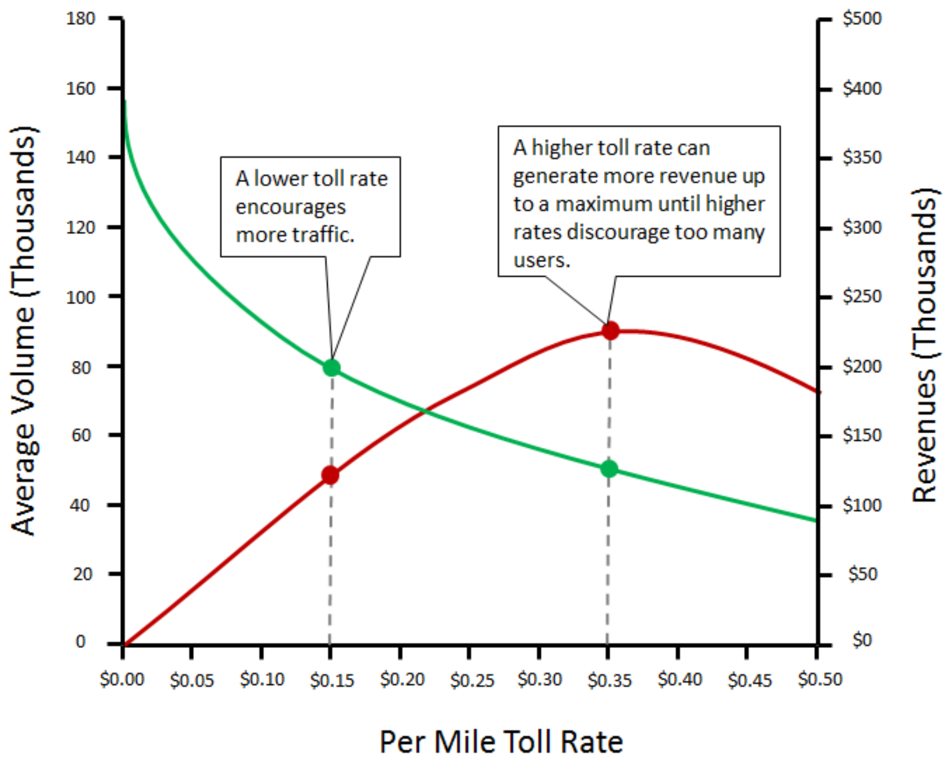
Balancing Revenue and Traffic Optimization

Tolls are a finance mechanism that can be used to pay for road infrastructure. Numerous projections are, however, made during the concept and planning stages of a toll road project to determine the project's operational and, ultimately, financial feasibility. These projections include predictions of:

- How many people will choose to use the toll road.
- The length of the period for drivers to become accustomed to the toll road.
- The annual rate of traffic growth.
- The base toll rate and the frequency and magnitude of toll rate increases.
- The percentage of toll transactions conducted with an electronic toll tag.
- The mix of vehicles (e.g., passenger cars versus trucks) that will use the toll road.

In the study entitled *Executive Report: Toll Roads, Toll Rates, and Driver Behavior*, Beaty et al. stated that the desire to maximize revenue versus traffic on a toll road can influence the ability of the toll road operator to adjust the toll rates for a specific market segment (*2*). These two operating strategies (revenue optimization versus traffic optimization) have different objectives and can have an inverse relationship. The financing of the toll road, and the bond covenants, will likely dictate the flexibility that the toll road operator has in lowering tolls to increase traffic on the road. Private toll road operators are likely to have limited flexibility to decrease toll rates, as that will decrease revenues and possibly impact their ability to pay the interest on the bonds. Government-financed toll roads may also have the same limitations if the toll road is funded through bonds that are to be repaid based on toll receipts.

Determining the optimal toll rate for a roadway depends on whether the tolling agency wants to maximize revenue (or at least what is needed for the coverage ratio of its debt) or maximize traffic volumes. A non-tolled road will attract the most traffic, while a toll road with unnecessarily high rates will go virtually unused. If revenue maximization is the goal, the toll rate will be set at the point where the toll rate multiplied by the number of users equals the highest maximum value. To generate maximum revenue, this rate must not go so high that it demotivates drivers to use the toll road. On the other hand, if maximizing traffic volumes on the toll road is preferred, then lowering toll rates is a viable option. Figure 1 illustrates the relationship between traffic on (i.e., toll road use) and revenue generated by a toll road.



Red Line = Toll Revenues ($'000)
Green Line = Average Traffic Volume (000)

Figure 1. The Impact of Toll Rates on Toll Road Traffic and Revenues.

Over-Estimating Toll Road Usage

Previous research has shown that the base traffic forecasts for new toll roads can be overly optimistic by 20 to 30 percent (*3*). This optimism bias is observed to be even higher when forecasting the percentage of trucks that will divert from a non-tolled route to the toll road (*4*). This over-estimating of toll road usage by trucks is significant for two primary reasons:

1. Because trucks pay toll rates that are often three to five times higher than the typical passenger car, toll revenues assumed from trucks can be significant. For example, in one analysis, trucks represented less than 10 percent of the toll road traffic, but they contributed over 25 percent of the revenues (3).
2. Trucks that use a toll road are assumed to be the trucks that are no longer on highly congested alternate routes. Having more trucks use a toll road is perceived to reduce traffic congestion and improve safety on alternate non-toll routes.

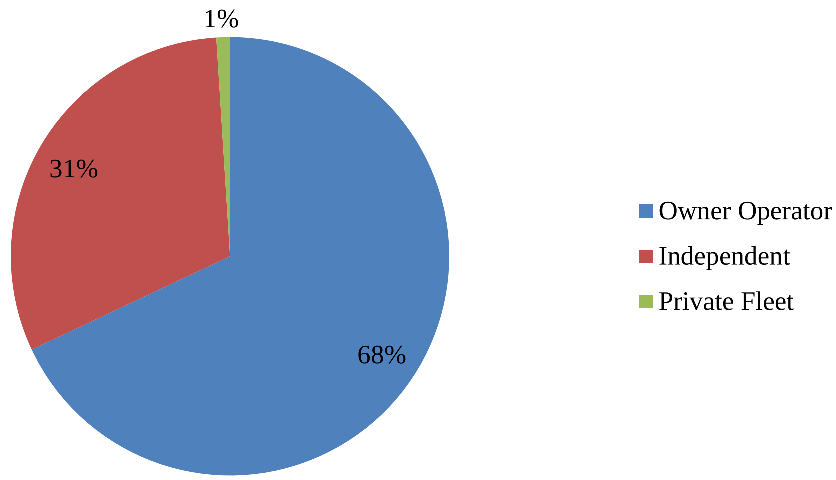
The Trucking Industry

It is important to acknowledge at the outset that the trucking industry is not homogenous. The many and varied elements of the trucking industry can be segmented in terms of:

- Service area (e.g., local, regional, national, and international [i.e., crossborder U.S.-Canada, U.S.-Mexico, and Canada-Mexico]).
- Trip type (e.g., intra-city, inter-city, and inter-state trips).
- Vehicle ownership (e.g., owner-operator and company truck).
- Vehicle operator (e.g., owner-operator, company employee driver).
- Fleet size (e.g., small [fewer than five trucks], medium, and large).
- For-hire or private trucking.
- Vehicle characteristics (e.g., light, medium, heavy, and specialized trucks).
- Trailer type (e.g., dry freight, refrigerated, flatbed, liquid tank, dry hopper, auto rack, household goods).
- Carrier/operation type (e.g., truckload, less than truckload, parcel/express, and specialized services).

Although these segments are not mutually exclusive, one must recognize the different segments when delineating the factors influencing a trucking company's decision to use or avoid a toll facility. This is largely because the cost structure and route choices of these segments are different. More information on the trucking industry, including operations and routing decisions that may influence an organization's decision to use a toll road, can be found in Appendix A: Interviews with the Trucking Industry.

Figure 2 shows what percentages of the trucking industry in Texas are owner-operators, independent drivers, and private fleet (*5*). Overall, 45 percent of Texas trucking companies are single-person operations (5). In addition, approximately 57 percent of Texas trucking companies provide interstate transport services, while 43 percent operate solely within Texas (5).

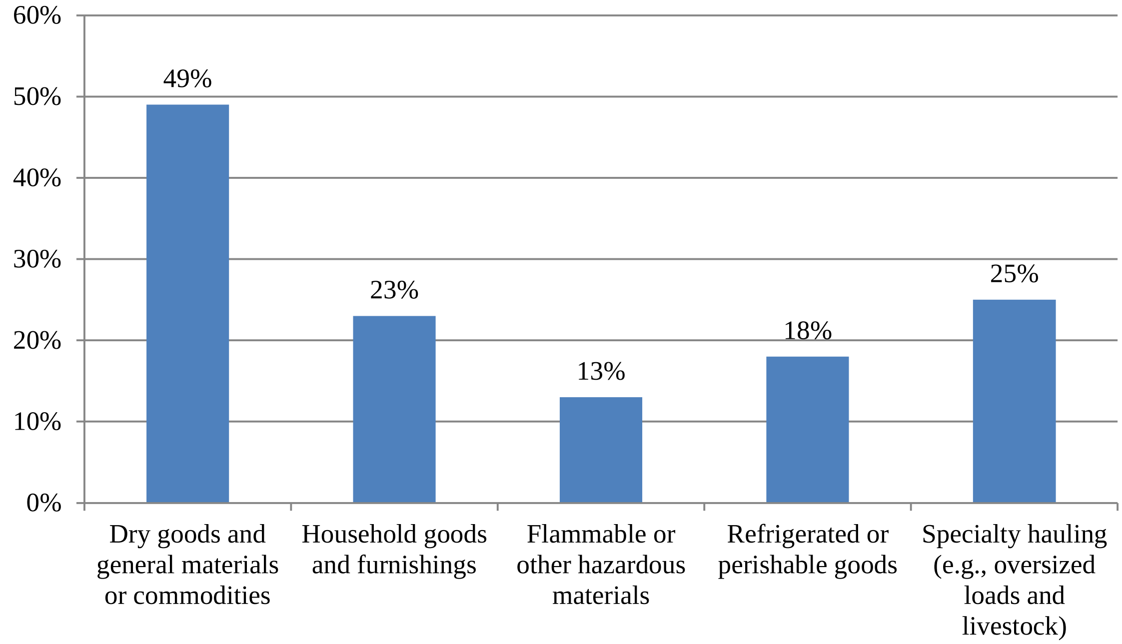


Source: Texas Trucking Alliance, 2012

Figure 2. Composition of the Texas Trucking Industry.

Figure 3 provides information about the many transportation services offered by Texas trucking companies (5), with some Texas companies offering more than one type of transportation service. The following are key points about the services:

- Almost half of the Texas trucking companies (49 percent) are in the business of moving dry goods and general materials or commodities.
- This is followed by specialty hauling (i.e., oversize/overweight loads and livestock), which is offered by 25 percent of Texas trucking companies.
- The transportation of household goods and furnishings is offered by 23 percent of Texas trucking carriers.
- Refrigerated or perishable goods transportation is offered by 18 percent of trucking companies in Texas.
- Finally, about 13 percent of Texas trucking companies transport flammable or other hazardous materials.



Source: Texas Trucking Alliance, 2012

Figure 3. Transportation Services Offered by Texas Truckers.

What Does the Literature Say?

The creation of the Central Texas Turnpike System (CTTS) in the greater Austin area, which opened to traffic in late 2007, brought attention to the topic of truck usage of toll roads, since SH 130 was viewed by many as a potential truck bypass.

With the general expansion of toll roads in Texas, understanding the benefits from a new toll road—specifically to the trucking sector—and industry's response to toll rates are of considerable interest to transportation agencies, legislators, investors, and the public. There have thus been numerous studies related to trucks and toll roads, many specifically examining toll roads in Texas. Table 1 lists the research most relevant to Texas, and the subsequent sections highlight the key findings of each of these studies.

Table 1. Relevant Toll Road Research.

Document Title	Year of Publication
Truck Use on Texas Toll Roads (*6*)	2013
Executive Report: Toll Roads, Toll Rates, and Driver Behavior (*2*)	2012
Truck Tolling: Understanding Industry Tradeoffs When Using or Avoiding Toll Facilities (*7*)	2011
Responses of Trucking Operations to Road Pricing in Central Texas (*8*)	2010
Characteristics of the Truck Users and Non-Users of Texas Toll Roads (*9*)	2009
Impact of Incentives on Toll Road Use by Trucks (*10*)	2009
Actual vs. Forecasted Toll Usage: A Case Study Review (*11*)	2008
Trucking Industry Response in a Changing World of Tolling and Rising Fuel Prices (*12*)	2007
Estimating Toll Road Demand and Revenue (*13*)	2006

Truck Use on Texas Toll Roads (*6*)

The 2013 study by Seedah, Muckelston, and Harrison entitled *Truck Use on Texas Toll Roads* investigates the challenges in diverting truck traffic from IH 35 to SH 130 (*6*). The researchers estimated the cost of using IH 35 and SH 130 under different modeling scenarios. For the scenario where a truck bypasses Austin by traveling on SH 45 Southeast and SH 130, Segments 1 to 4, versus IH 35 between SH 45 Southeast, and where SH 130 and IH 35 intersect north of Georgetown, the authors found that given 2011 conditions, it cost $27.84 more for truck drivers to use the SH 130 alternative. Based on this analysis, the authors noted that IH 35 was more economical in free flow conditions and when transporting goods that are not time sensitive. The same study also estimated the cost of using a segment of SH 130 and IH 35 in combination with SH 71 to reach Bastrop. The authors reported that SH 130 was the more economic choice only for southbound travel to Bastrop in congested conditions. For northbound travel, and all travel in free flow conditions, IH 35 was the more economic route. Finally, the authors estimated the cost of using a segment of IH 35 versus a segment of SH 130 to US 290E toward Houston. The authors reported that for northbound travel, IH 35 was the less expensive choice in both free flow and congested conditions. For southbound travel, SH 130 was the less expensive choice in both free flow and congested conditions.

Executive Report: Toll Roads, Toll Rates, and Driver Behavior (*2*)

In 2012, Beaty et al. conducted a study to compile information on views and opinions of truck toll road use, including SH 130 specifically, from industry stakeholders (2). This culminated in the publishing of a research report entitled *Executive Report: Toll Roads, Toll Rates, and Driver Behavior*. The study included a review of the findings of interviews and focus groups that were conducted as part of other research efforts. These revealed the following about the trucking industry and the use of SH 130 in the greater Austin area by truckers and trucking companies:

- The ideal travel speed for a truck is in the 62–64 miles per hour range considering performance and fuel efficiency. It is more expensive to drive faster; therefore, the higher speed limit on SH 130 provides practically no benefit to truckers. Additionally, with most companies, trucks are not allowed to operate above these speeds because of insurance requirements and safety concerns.
- Using SH 130 to get around Austin instead of using IH 35 to travel through Austin adds 11.6 miles to the trip. This increases fuel costs in addition to the toll charges.
- For trucks, tolls rates are usually three to six times higher than rates for passenger cars. For example, where a car would pay $9, a truck can pay up to $54 for the same length of toll road travel.
- Tolls are an out-of-pocket expense for independent truck drivers that cannot be passed on to their customers. For this segment of the trucking industry, this additional cost is a reason to avoid toll roads.
- Shipping schedules, which include routes and times, take the delays on IH 35 in and around Austin into account. For trucking companies to route trucks to SH 130, delays on IH 35 must be longer than two hours.
- Unless a truck is completely bypassing Austin, taking SH 130 for only part of the trip is very time consuming, as trucks will have to travel west back into Austin, stopping frequently on surface streets for lights and stop signs.

Additionally, the study emphasized the need for timely traveler information so that drivers can make knowledgeable routing decisions (2). Travel information is already being provided along IH 35 and Loop 1 at various locations, but typically only for that particular roadway (i.e., no comparable information is provided for the tolled alternatives). The cost to gather travel information has reduced dramatically in recent years with the use of Bluetooth® technology (*14*). Guidance for displaying travel and tolling information for better driver comprehension has also been examined in Texas (*15*).

Besides knowing the fundamentals of toll roads, such as where they are located and where to access and exit them, drivers repeatedly indicated wanting to know the travel time comparison between two points using a toll road versus a non-tolled alternative.

Another example is current travel speeds between alternate routes, such as SH 130 and IH 35. Travel information is only helpful if provided in a time frame where routing choices can be made prior to a decision point. For example, real-time information for the travel times on IH 35 and SH 130 must be presented prior to the IH 35/SH 130 diversion. Once a driver has chosen a route, he or she cannot easily switch to the other route past the point where they diverge. The study also pointed out that the total toll cost to travel that segment of SH 130 must be presented so that drivers are fully aware of direct costs in addition to time savings by traveling SH 130. Information on current travel information and toll costs allow the driver to determine how the price to save time compares to their perceived value of time (*2*).

Truck Tolling: Understanding Industry Tradeoffs When Using or Avoiding Toll Facilities (*7*)

State and federal research has examined the trucking industry's view of toll roads and has attempted to identify methods to make toll roads a more attractive option for truck drivers and trucking companies. At the national level, a research study commissioned by a joint committee of the National Cooperative Freight Research Program (NCFRP) and National Cooperative Highway Research Program (NCHRP) published a report in 2011 entitled *Truck Tolling: Understanding Industry Tradeoffs When Using or Avoiding Toll Facilities*. The study examined what kinds and levels of benefits must be obtained from a toll road for truckers and trucking companies to select toll roads over non-tolled alternatives. In terms of attitudes toward toll roads, this research showed that the trucking industry had an overwhelmingly negative view of toll roads. In fact, the study found that

> *there is not a single segment of the trucking industry which showed any positive attitude about toll roads or the benefits they might offer, either in congestion relief, time savings, or reduced shipping cost.* (*7*)

Broadly, this negativity is attributed to two items: (a) there is no financial gain in using toll roads, and (b) toll costs are difficult to pass on to end users. The same study did, however, find that truckers and dispatchers that were more familiar with toll roads (meaning they have the opportunity to use them more than 10 percent of the time) expressed some willingness to pay for the time savings offered by a toll road. The negative attitudes of truckers toward toll roads were thus attributed to the inability to monetize the benefits of toll roads (*7*).

Responses of Trucking Operations to Road Pricing in Central Texas (*8*)

A report by Rutzen, Prozzi, and Walton, *Responses of Trucking Operations to Road Pricing in Central Texas*, attempted to understand the variability in truck toll road use when considering location, industry sector, commodity type, and trip distance (*8*). The authors noted that because trucks pay a higher toll than passenger vehicles, overestimation of truck toll road use can lead to lower than expected total toll revenues. This study surveyed trucking companies and classified respondents as truck toll road users and truck toll road non-users in order to gain an understanding of their decision making process in road choice. Major findings included that congestion was negatively impacting most trucking companies and that time savings was considered to be a major benefit of using toll roads. However, high costs were a key reason that non-toll users gave for not using toll roads, and many non-toll users had negative sentiments toward toll roads regardless of incentives. A fuel tax refund for the number of miles traveled on a toll road was the incentive that was viewed most favorably.

Characteristics of the Truck Users and Non-Users of Texas Toll Roads (*9*)

A survey conducted by Prozzi et al., as documented in *Characteristics of the Truck Users and Non-Users of Texas Toll Roads* (9), found that:

- Truck toll road users were mostly private carriers.
- Truck toll road users thought that their business was impacted more greatly by congestion than non-users.
- Truck toll road users were more likely to have a set delivery time window than non-users.

As in the previous study (8), non-users indicated high cost to be a major deterrent for toll road use. The study reported that 43 percent of non-toll road truck users indicated that they will never use a toll road, or they will use a toll road only if there is no other alternative available (*9*).

Impact of Incentives on Toll Road Use by Trucks (*10*)

Zhou et al. reported in a paper entitled *Impact of Incentives on Toll Road Use by Trucks* that overall, reducing the cost of using a toll road has been found to be the most efficient incentive for use of a toll facility. Reducing the cost of using a toll road can be achieved through a toll discount, reduced fuel price, off-peak discount, or a free trip after a certain number of trips (*10*). The topic of specific incentives for trucks within Texas has been specifically examined in greater detail (2). Incentives that were either directly discussed with focus groups in previous research, or suggested by participants, include the following:

- For vehicle fleets (such as trucking companies): offer a <u>*frequent user program*</u> so that after a certain number of toll road trips, not necessarily individual transactions, within a defined period (e.g., a month) the company receives a certain number of free trips along the toll road. All fleet vehicles would require a TxTag; only transactions via a TxTag would be accrued, and rewards would be applied only against TxTag transactions.
- For certain users/vehicle types: offer a <u>*flat-rate program*</u> where a monthly fee could be paid for unlimited transactions during that same period. A TxTag would be required for a vehicle to participate in this type of program.
- For all patrons: offer <u>*free toll tags*</u> with no initial set-up fee for newly created TxTag accounts.
- For all patrons: offer a period (e.g., 30 days) of <u>*discounted tolls*</u> (e.g., 50 percent less) for newly created TxTag accounts.

Actual vs. Forecasted Toll Usage: A Case Study Review (*11*)

Prozzi et al., in a research study entitled *Actual vs. Forecasted Toll Usage: A Case Study Review*, sought to understand the reasons for underestimating truck toll road use in traffic and revenue (T&R) studies (*11*). The authors pointed out a variety of issues ranging from obtaining relevant data to a lack of transparency in the models used by T&R consultants when making forecasts. The authors presented a traffic risk index as a way of estimating the uncertainty of revenues and recommended complex risk analyses to be included in all T&R forecasts.

Trucking Industry Response in a Changing World of Tolling and Rising Fuel Prices (*12*)

Research by Gupta et al., entitled *Trucking Industry Response in a Changing World of Tolling and Rising Fuel Prices*, reinforced the idea that toll road users are a diverse group and that uniform assumptions about users will likely lead to forecast error (*12*). This study also pointed out that a variety of factors influence route choice, including fuel prices, cargo and haul characteristics, and whether or not a toll road previously existed in the area.

Estimating Toll Road Demand and Revenue (*13*)

Finally, a report by Kriger, Shiu, and Naylor entitled *Estimating Toll Road Demand and Revenue* sought to outline the practices behind creating demand forecasting models that are used to forecast toll road revenues (*13*). The tendency for revenue forecasts to be made by the financial sector, as opposed to the transportation sector, is pointed out as problematic. The authors also stated a need for more refined models that included time-of-day choice modeling and modeling for commercial and truck traffic. They also recommended incorporating risk and uncertainty.

What Do the Data Say?

SH 130 was conceived as a bypass for the worsening IH 35 traffic congestion through central Austin, and it was assumed that improved trip reliability, higher actual travel speeds, and lower traffic volumes on the toll road would be attractive to passenger cars and trucks not needing to stop in central Austin (i.e., through trips). It was further argued that the predicted diversion of trucks to SH 130 would also generate benefits to IH 35 in terms of incremental congestion relief and safety. However, evidence since 2007 indicates trucks are not using SH 130 to the degree predicted in the feasibility studies of the CTTS.

To encourage trucks to use SH 130 as an alternative to IH 35, the Texas Department of Transportation (TxDOT) implemented discounts for trucks on SH 130 on two occasions: the first from 2011–2012 and the second in 2013.

2011–2012 Discount Period

The first truck toll discount period for SH 130, Segments 1–4, occurred between December 21, 2011, and January 25, 2012. During the discount period, the tolls for trucks were reduced to the same rate as passenger cars—a 67 percent reduction in truck toll rates.

Analysis of the data from the discount period showed that truck toll transactions on SH 130 increased by 40 to 45 percent (*2*). A toll transaction is generated each time a vehicle passes a tolling point, and most vehicles pass more than one tolling point during their trip. Therefore, even though truck toll transactions increased, this does not indicate that the number of trucks on SH 130 increased by 40 to 45 percent.

At the end of the discount period, SH 130 truck traffic decreased, but stayed slightly higher than prior to the discount period. These results show that lowering truck toll rates increased toll road use by truckers. However, the higher truck volumes during the discount period came at a loss of toll revenues because of the discounted price (*2*). Also, the impact of the truck toll discounts on IH 35 is unclear because of a lack of data.

2013–2014 Discount Period

Originally, the Texas Transportation Commission issued a Minute Order for a truck toll discount for SH 130, Segments 1–6, from April 1, 2013, to March 31, 2014. A $5 million account was created with funds from a contractual payment to TxDOT by the SH 130 Concession Company to “reimburse” the toll road operators for any revenue lost as a result of the discount (*16*). The Minute Order specified that all vehicles using SH 130, Segments 1 to 4, and SH 45 Southeast be charged the two-axle rate. However, the initial $5 million indenture account was nearing depletion by November 2013, and the commission authorized TxDOT in November 2013 to allocate an additional $2 million from the SH 130 payments to continue subsidizing the truck toll discount (*17*). The second allocation was depleted in December 2013, which ended the discount period (*18*).

Volume Comparison on IH 35 and SH 130

Data were available for one month prior to the toll discount (March 2013), the nine months when the toll discount was in effect (April 2013 to December 2013), and for four months after the toll discount ended (January 2014 to April 2014). These data, provided by TxDOT, were for count stations on SH 130 and IH 35, and were used to investigate trends in total traffic and truck traffic. Specifically, traffic volumes were compared for the parallel segments of IH 35 and SH 130 at three cut lines: the Georgetown cut line, the Central Austin cut line, and the Seguin cut line from north to south. The cut lines are shown in Figure 4 with color-coded dots representing the count sites:

- Brown dots show short count sites.[1]
- Blue dots show permanent volume count sites.
- Green dots show permanent vehicle classification count sites.
- Purple dots show permanent weigh-in-motion sites (*19*).

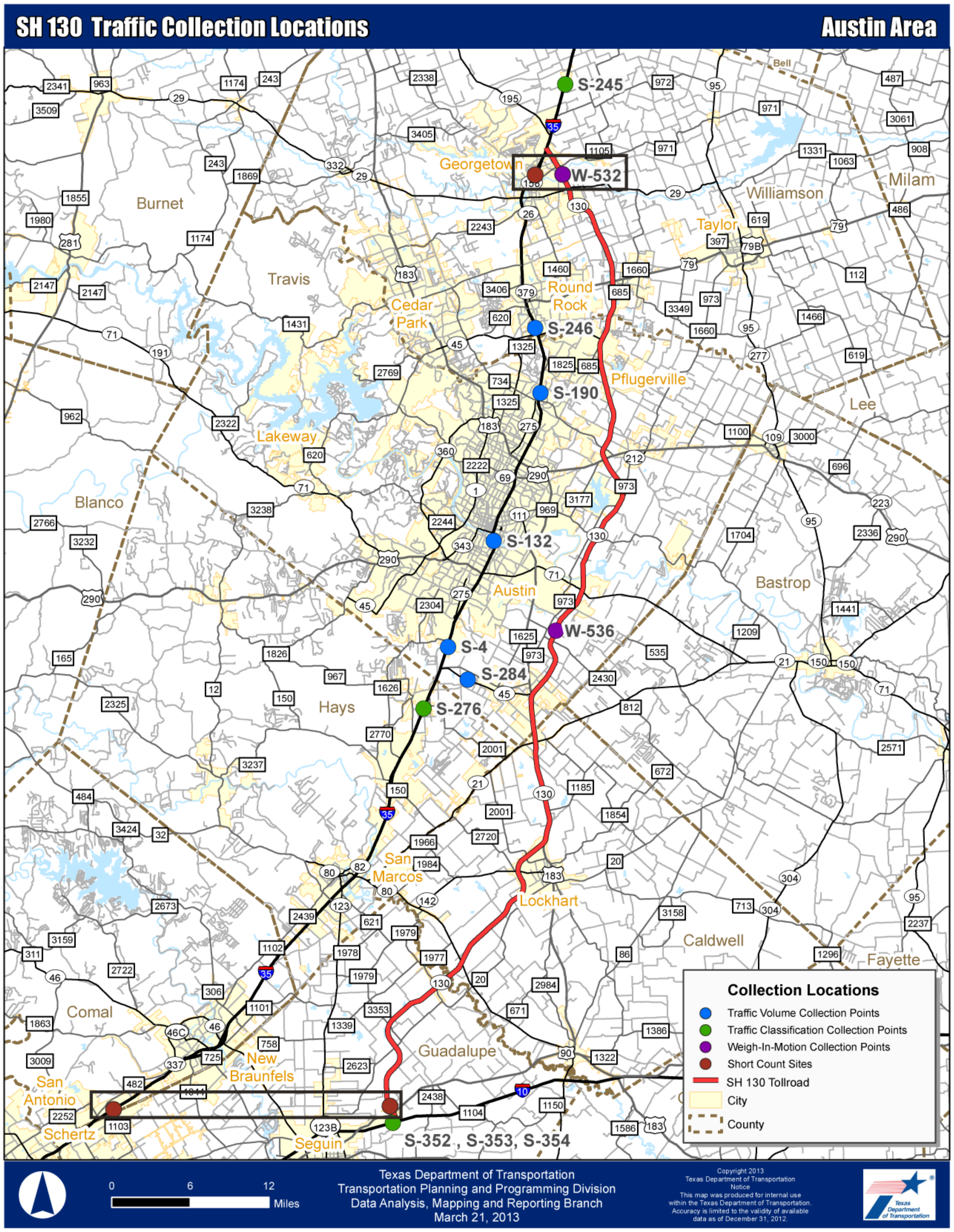
Figure 5 shows truck volume trends on SH 130 and IH 35, as well as SH 130's share of trucks relative to total trucks on both IH 35 and SH 130 from March 2013 to April 2014.[2] Details on methodology and truck volumes for the 2013 discount period can be found in Appendix B: Methodology and Traffic Volumes for 2013 SH 130 Discount Period.

Figure 5 shows the following:

- SH 130's share of trucks relative to IH 35's is comparatively low across all cut lines—around 16 percent at the two northern cut lines and 5 percent at the Seguin cut line.
- Truck throughput on SH 130 increased at all three cut lines after the implementation of the toll discount.
- SH 130's share of truck throughput decreased at all three cut lines immediately after the end of the toll discount program, but then increased slightly over time.
- At the central cut line the highest truck traffic volume was actually reached in the last month of data collection—several months after the discount period had ended (*19*).[3]

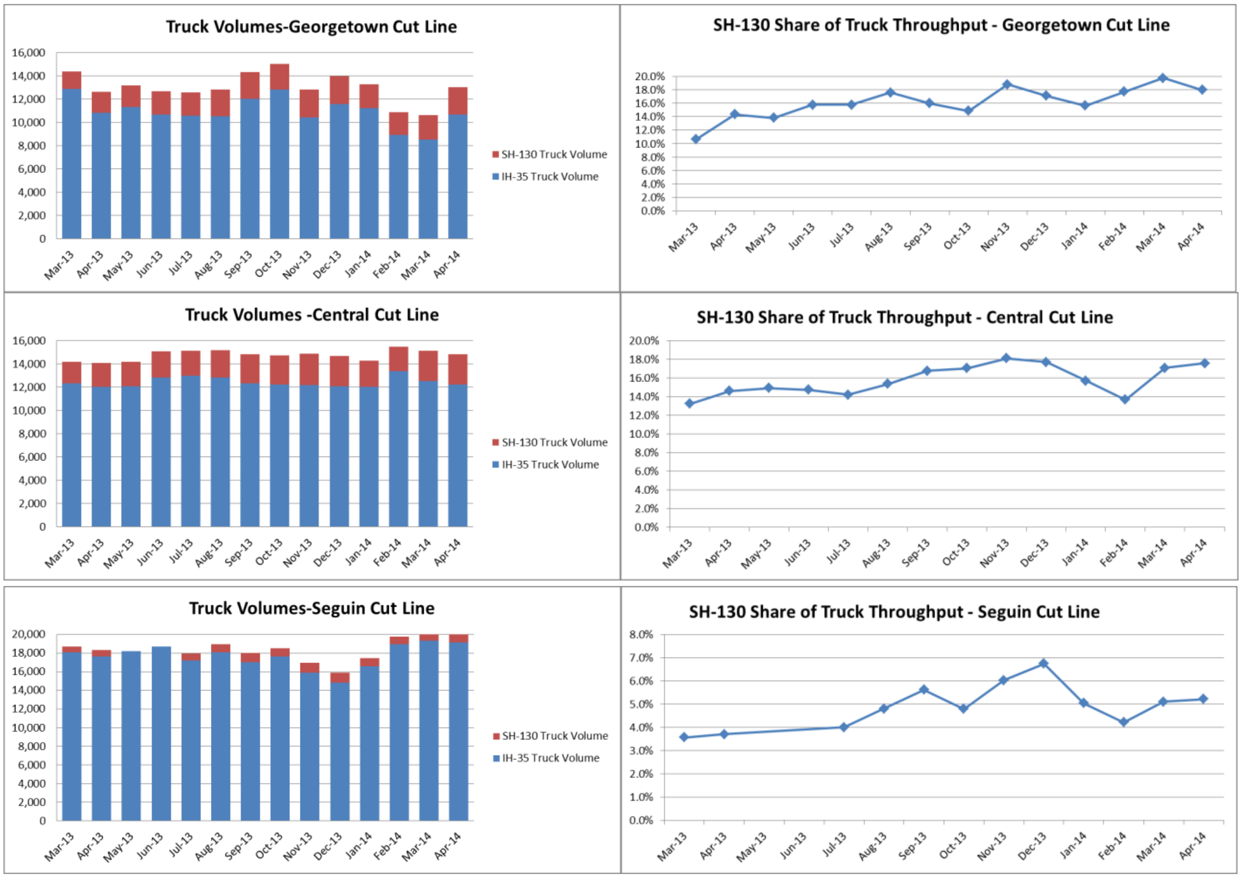
Given that the pre-toll incentive data are limited to one month and the post-toll incentive data are limited to four months, the data are not sufficient to conclude that the observed trends are not attributable to month-to-month fluctuations or other factors. The data are therefore insufficient to conclude that a permanent diversion of trucks occurred from IH 35 to SH 130 (*19*).

[1] Short count sites are sites where data (traffic count and vehicle classification) are collected for two consecutive days (a Tuesday and Wednesday) in a month.
[2] May 2013 and June 2013 truck volume data were not available for SH 130.
[3] IH 35 truck counts at the central Austin cut line are estimated based on T-Log data.



Source: TxDOT Transportation Planning and Programming Division

Figure 4. Count Stations Used for Volume Comparison on IH 35 and SH 130.



Note: May 2013 and June 2013 Truck Volume Data Not Available for SH 130

Source: Ramani and Alemazkoor, 2014

Figure 5. Volume Trends and SH 130's Share of Truck Throughput.

Visualizing Volume and Traffic Type Data for Commercial Vehicle Diversion to SH 130

In addition to the TxDOT data, the Texas A&M Transportation Institute (TTI), in coordination with Atkins Global and Gram Traffic Inc., collected data on IH 35 and SH 130 as part of a study entitled *IH 35/SH 30 Commercial Vehicle Diversion Study*. Specifically, the study team collected origin-destination (O/D) and traffic count data using Bluetooth® readers, automatic license plate recorders, and vehicle classification counters. The objectives of the study were to provide estimates of the following:

1. Traffic being diverted from IH 35 to SH 130.
2. Percentage through traffic on IH 35.
3. Percentage of traffic on SH 130 that travels from IH 35 near Georgetown to IH 10 near Seguin.

The data were collected over a three-day, 72-hour weekday period in October 2013 (8th–10th), during the truck toll discount period. Details on the methodology, data, and analysis can be found in Appendix C: IH 35/SH 130 Commercial Vehicle Diversion Study.

To visualize the volume and traffic type data that were collected on IH 35 and SH 130 in the Austin area, TTI developed a series of graphics (Figures 6 through 10) that illustrate the traffic profile of SH 130 and IH 35.

In Figure 6, traffic on IH 35 and SH 130 is divided by a thick gray line, with IH 35 on the left and SH 130 on the right. The x-axis of the graphic (labeled horizontally across the top as "traffic volume, in thousands per day") shows the volume increasing as it moves away from the middle thick gray line separating IH 35 and SH 130. Traffic is measured in thousands of vehicles per day and represents both north and southbound travel.

The y-axis of the graphic shows locations along both highways vertically, with the top location being the farthest north and the bottom location the farthest south. Through traffic is defined as vehicle trips that travel the entire length of the facility from Georgetown to Buda or vice versa within a 24-hour period. The remaining trips are considered local trips. Volumes are reported in 2–5 mile intervals in a stacked bar format, with the following separate colors representing the different types of vehicles traveling the corridors:

- Passenger vehicles—Light and dark green.
- Light trucks—Light and dark purple.
- Heavy trucks—Yellow and orange.

Figure 6 shows that the traffic volumes on IH 35 are much higher than on SH 130 and that local passenger vehicles (dark green), not heavy trucks, make up the highest proportion of all traffic in the area. Local volumes in Austin are the highest on IH 35 between US 183 and Braker, and on SH 130 roughly between downtown Austin and FM 1431.

It is noteworthy that heavy trucks passing through the Austin area, represented by the thin yellow line that is barely visible, are a small percentage of all traffic. Even heavy local trucks (in orange) make up a small proportion of total traffic. Overall, through trucks only constitute one percent of the total volume on IH 35 (for the highest volume segment), as opposed to through passenger vehicles at 12 percent of total volume. Therefore, it seems that targeting through trucks in an attempt to decrease congestion on IH 35 and increase traffic on SH 130 may be ineffective because through trucks represent a relatively small percentage of the traffic on IH 35. Given the comparatively higher percentage of through passenger vehicles on IH 35, targeting incentives at diverting through passenger vehicles may be a more effective strategy in reducing traffic congestion on IH 35.

Heavy trucks are, however, larger in size and have very different operational characteristics than passenger vehicles. These differences result in trucks consuming relatively more highway capacity than a passenger vehicle. The base unit for measuring highway capacity is a passenger car equivalent (PCE). The *Highway Capacity Manual* provides guidance for determining PCEs for trucks (*20*). Typically, PCEs are determined based on vehicle length and the grade of the road. For example, an average length truck and trailer combination on a highway traversing relatively flat terrain may have a PCE value between 1.5 and 2.5 depending on highway conditions and area (congested/uncongested and urban/rural).

Figure 7 provides the traffic profiles of IH 35 and SH 130 where the traffic volumes are expressed in PCEs.

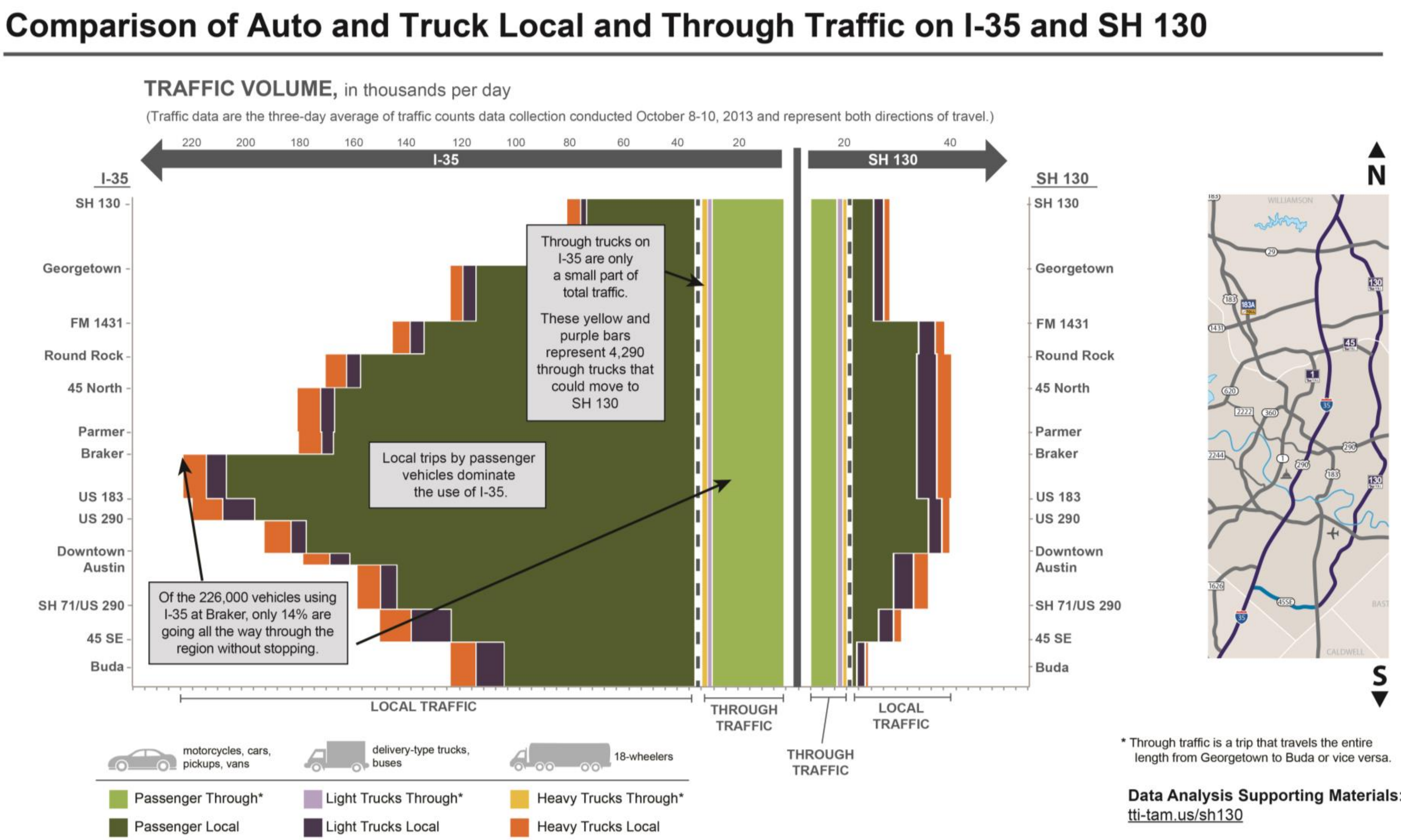


Figure 6. Traffic Profile of IH 35 and SH 130 (Truck Incentive in Effect).

Comparison of Auto and Truck Local and Through Traffic on I-35 and SH 130

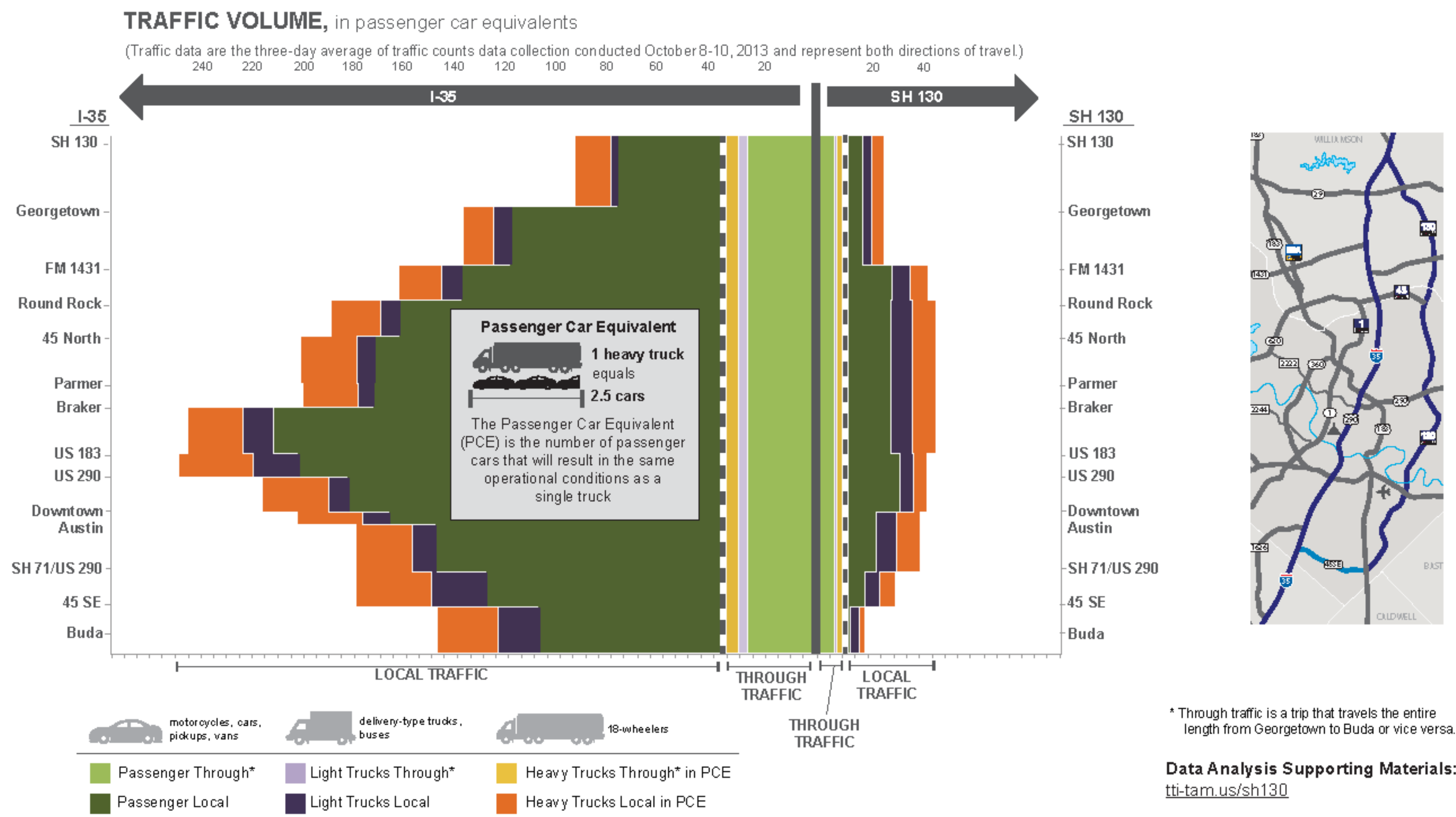


Figure 7. Traffic Profile of IH 35 and SH 130 in Passenger Car Equivalents (Truck Incentive in Effect).

Figure 8 shows the traffic volumes on IH 35 and SH 130 when the truck incentive program was in effect for the morning peak period (between 6:00 a.m. and 9:00 a.m.). Local volumes during the morning peak period in Austin are the highest on IH 35 between US 183 and US 290, and on SH 130 roughly between downtown Austin and Round Rock.

Figure 9 shows the traffic volumes for the evening peak period (between 4:00 p.m. and 7:00 p.m.).

- In the evening, traffic volumes are higher on IH 35 at all locations, except for between 45 SE and SH 71/US 290, which has more traffic during the morning peak period.
- The traffic on SH 130 is also generally higher during the evening peak and shows a slightly higher traffic volume between downtown Austin and US 183.
- Through traffic on IH 35 is higher during the evening peak period, but through traffic is similar on SH 130 during the morning and evening peak periods.
- On IH 35 and SH 130, truck volumes represent a small percentage of the total through traffic during both the morning and evening peak periods.
- Trucks account for 14 percent of all daily through traffic.
- In the morning and evening peak periods, trucks account for approximately 5 percent of total through traffic.

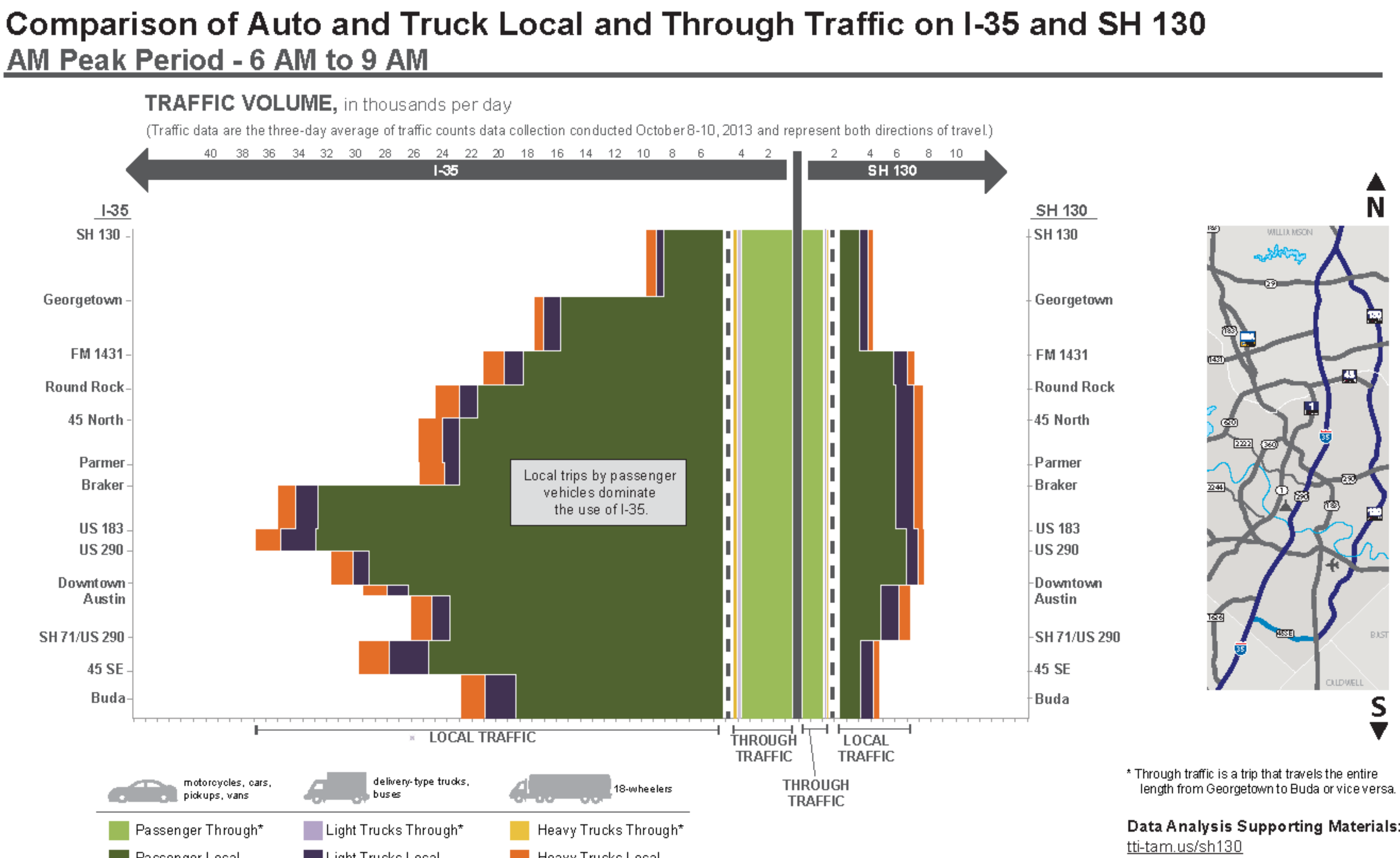


Figure 8. Traffic Profile of IH 35 and SH 130 during AM Peak Period (Truck Incentive in Effect).

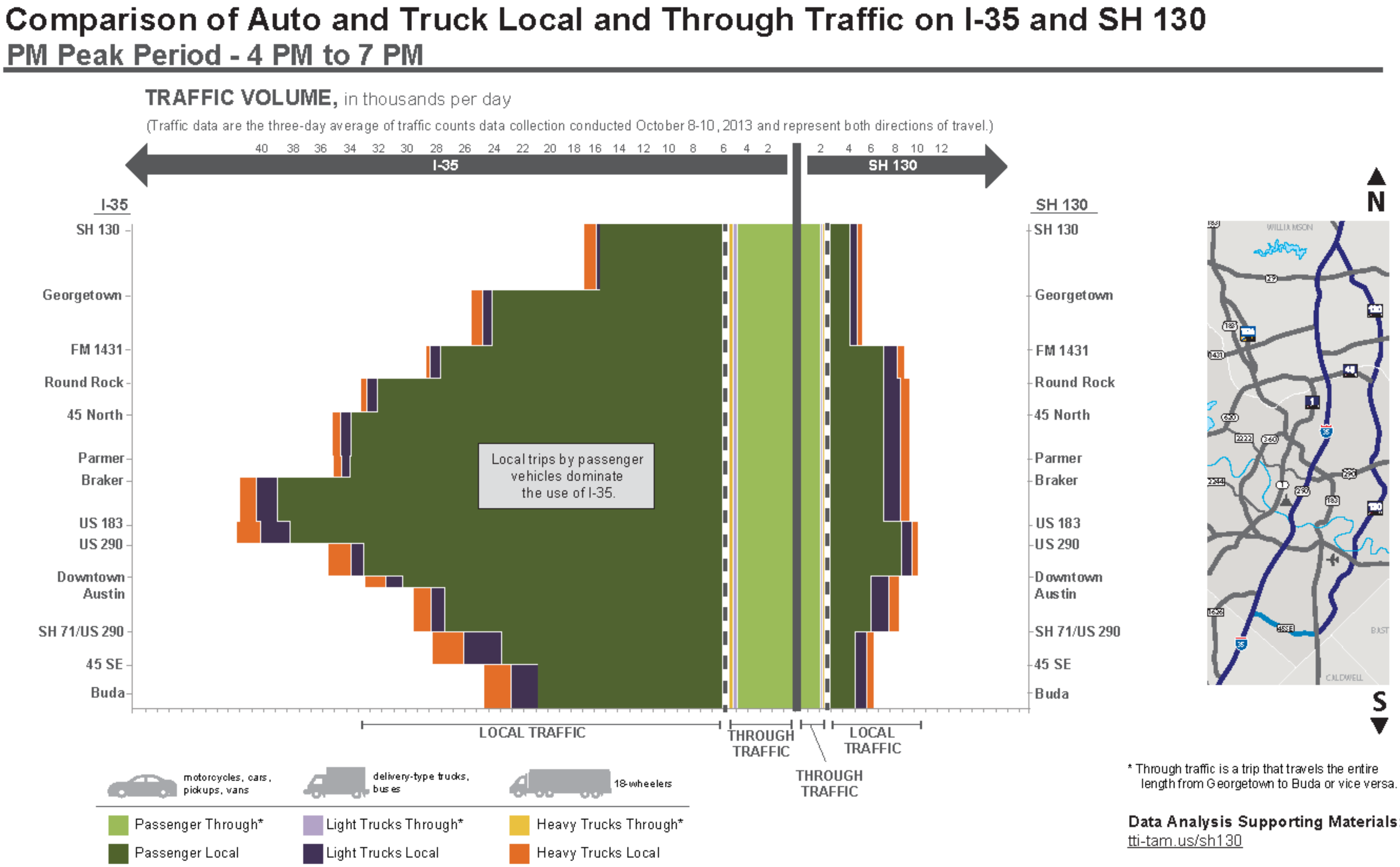


Figure 9. Traffic Profile of I-35 and SH 130 during PM Peak Period (Truck Incentive in Effect).

Figure 10 shows the traffic volumes on IH 35 and SH 130 when the truck incentive program was in effect for the overnight, off-peak period between 12:00 a.m. and 3:00 a.m.

- Traffic volumes on both IH 35 and SH 130 are significantly lower during the overnight period compared to the morning and evening peak periods.
- During the overnight period, the highest traffic volume on IH 35 is roughly between US 290 and Round Rock.
- During the overnight period, traffic on SH 130 is relatively low without any significant high volume locations. The reason may be that there is little incentive for vehicles to use SH 130 as an alternative to IH 35 when there is little to no congestion on IH 35 during this time.
- Through trucks on both IH 35 and SH 130 represent a small percentage of total traffic during the overnight period.

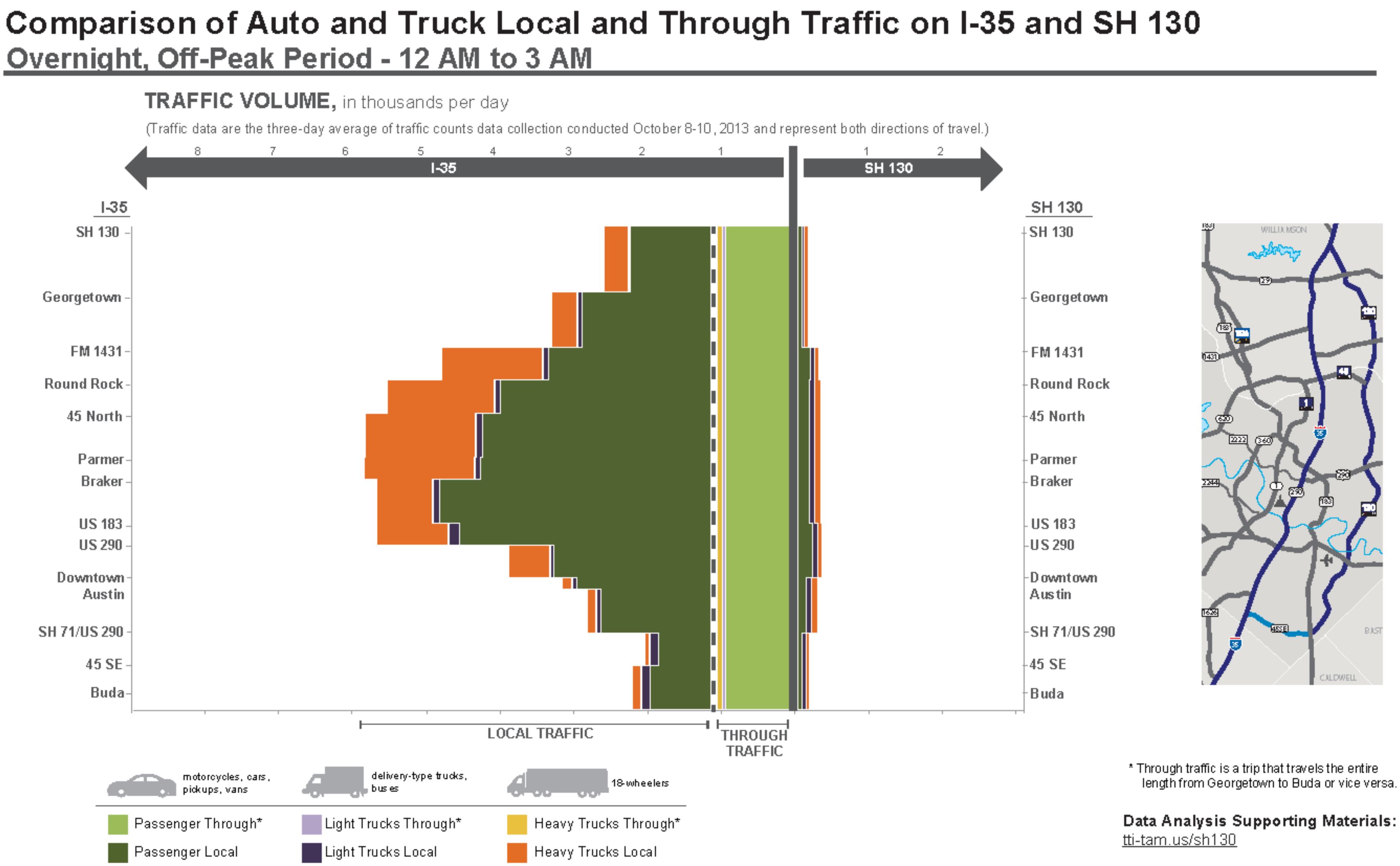


Figure 10. Traffic Profile of IH 35 and SH 130 during Off-Peak Period (Truck Incentive in Effect).

What Does the Industry Say?

In 2014, TTI researchers conducted interviews with representatives from the trucking industry. The companies and industry groups[4] represented three types of trucking companies: independent trucking companies, owner-operators, and private fleets. As mentioned above, the distinction between the types of trucking companies is important to consider when thinking about truck use on SH 130 and other toll roads, mainly because they all have different factors to consider in making their routing and logistics decisions due to differences in their underlying business models. However, company type is not the only determining factor in toll road usage. Another factor to consider is the time frame, distance, and delivery window for the deliveries being made. Long-haul and interstate shipments tend to have wider delivery windows relative to regional and local deliveries, which often have more narrowly defined delivery windows. Furthermore, shipments that occur on a routine basis, such as those that might be made between manufacturing centers and distribution or retail centers, are more predictable, meaning it is easier for shippers to plan routes and departure times such that using a toll facility to save time is not necessary.

Influencing Factors for Toll Road Use

Researchers asked interviewees about the different factors that influence logistics decisions and, specifically, about factors influencing the use or non-use of toll roads such as SH 130 in Central Texas. For example, factors explored included:

- Party responsible for trip routing.
- Toll reimbursement policies.
- Driver's and/or company's compensation system.

The research team also discussed with interviewees recent toll-rate discounts for commercial trucks on SH 130 and whether their operations had utilized the facility because of the discounts. The following are some of the major findings from this effort and insight into incentives that could encourage the use of toll roads. A more extensive summary of the trucking industry interviews can be found in Appendix A: Interviews with the Trucking Industry.

Major Findings

Numerous Factors Influence Routing Decisions, and Saving Time Is Generally Not the Most Important

Trucking companies do not necessarily make routing decisions, and thus decisions on toll road usage, based solely on what will save the most time. There are numerous factors that influence decision making, but most trucking firms seek to minimize their overall cost per trip. Tolls

[4] The companies and industry groups interviewed were CEVA Logistics, HEB, Wal-Mart, Wilson Art, the Texas Trucking Association (TxTA), and the Owner-Operator Independent Drivers Association (OOIDA).

accrued on area toll facilities increase costs, and so does distance. If a toll road represents a significant increase in distance relative to a non-tolled option, as is often the case with the SH 130 facility, then the cost for that trip will be increased due to the need to consume more fuel. Additional mileage also puts additional wear-and-tear on commercial vehicles, increasing the cost further. These cost factors tend to outweigh the benefits of saving time, particularly since most firms already account for time lost due to congestion in their routing and logistics systems.

Regional and Local Deliveries Stand to Benefit the Most from Toll Road Usage

In general, toll roads are most viable for trucking firms that make regional deliveries and might benefit from being able to make more deliveries within a given time frame due to usage of the toll road. Their pay structure is more likely to be load/delivery-based, meaning that if they can make more deliveries, it might offset the cost of the tolls relative to pay based on mileage or travel time. Long-haul truckers, on the other hand, cannot make additional deliveries using the toll road. These deliveries tend to have wider delivery windows, and using the toll road to bypass Austin congestion will not yield benefits that outweigh the cost of the toll.

Independent Owner-Operators Are Unlikely to Use the Facility

Usage of the SH 130 facility seems to be limited mostly to company-owned fleets and independent trucking firms. Company-owned fleets are better able to absorb the cost of the tolls, and independent trucking firms are in a better position to negotiate contracts with shippers that cover toll usage. Independent owner-operators, on the other hand, have less leverage in negotiating contracts with shippers, and are thus less likely to be able to absorb the cost of a toll. For these drivers, a toll represents money out of their pocket, and they already operate on thinner profit margins than the rest of the industry. Independent owner-operators make up the largest percentage, 68 percent, of operators in Texas, according to the Texas Trucking Alliance.

Some Firms Are Still Evaluating Whether Toll Roads Make Sense for Their Operation

Some of the firms interviewed for this effort stated that they do not use toll roads or do not specifically use the SH 130 facility. However, some companies stated that they still needed to analyze their own operations to determine if usage of the SH 130 facility makes sense for them. They noted that they had traditionally used non-tolled routes and that their drivers knew those routes well and could account for congestion in their delivery schedules. However, they stated that there may be instances where the toll road would allow them to make more deliveries or better meet their delivery windows, and that they would be assessing the utility of doing just that in the future.

Interview Conclusions

One of the most significant conclusions drawn from these interviews is that in a lot of cases, travel time savings is not the most important consideration in making routing decisions. Therefore, presenting toll roads as a time saving option to IH 35 will not necessarily encourage higher utilization by the trucking industry. Furthermore, trucking firms, both large and small, have access to a wide array of resources to help them plan trips. Many shippers and trucking companies therefore already take into account traffic congestion when determining when and where to drive for delivery of a particular shipment. As such, potential time savings and travel time reliability may not be enough of a benefit to offset the cost of a toll, given that shippers already have a good idea of how long it will take to make a shipment, even during congested periods of the day.

It is important to keep the type of company in mind when looking at potential toll road users. Toll facilities and SH 130 do offer potentially significant benefits to companies and drivers who generate revenue on a per delivery basis, if the facility allows them to make more deliveries in a day. Some of the firms that operate on this model and do not currently utilize a toll road indicated that they would be undertaking an assessment of whether using the toll road makes business sense for their operations. Thus, there are likely still a number of trucking firms that could decide to use the facility in the future. Company-owned fleets can absorb the cost of tolls somewhere else, such as in a retail setting. For these companies, the benefits of safety and efficiency in their operations may be a more pertinent benefit of using a toll road. Independent owner-operators tend to operate on a thinner profit margin relative to other trucking entities. They are much more likely to make routing decisions that will minimize the cost of a particular trip, which means they are less likely to incur additional costs through tolls.

Potential Incentives for Toll Road Usage

TTI researchers asked interviewees about their thoughts on potential incentives to get commercial vehicles to use the SH 130 facility to bypass Austin. Specifically, the researchers asked about the following:

- Higher speed limits on SH 130.
- No exceeding hours of service.
- The presence of nearby amenities and associated facilities.
- Providing speed and travel times for alternate routes.
- Use of long combination vehicles (LCVs).
- Toll discounts.

This section summarizes the interviewees' responses to the potential incentives to encourage the use of SH 130.

Higher Speed Limits

The high speed limits offered on toll facilities, and in particular on SH 130, are not an effective incentive for truckers to use the facility. Most companies govern vehicle speeds and would not allow drivers to travel 80 mph, even if they were not governed. In almost all cases, 80 mph is deemed too fast to safely operate a large commercial vehicle. Although drivers and trucking companies have indicated that some drivers may indeed operate that fast, it was made clear that these individuals do not represent the norm for the industry and are likely to face repercussions in the future for that behavior.

Speed tends to increase the cost of a trip in terms of fuel consumption. One industry representative estimated that driving 85 mph relative to the standard speed limit could increase costs by up to $0.09 per mile. Another company representative stated that, for their trucks, reducing their speed from 70 mph to 68 mph saves about one tenth of a gallon of fuel per mile.

Hours of Service

Truck drivers are limited in terms of the hours they can drive. They are required to keep log-books documenting their total time driving and rest time while on the road and can face penalties if they drive too long without resting. This is particularly critical for interstate truck drivers. Toll roads are often seen as an attractive time saving option for drivers who are in danger of going over their hours of service on a particular trip.

Trucking companies' that run the risk of putting drivers over their allowed hours of service address this in different ways—none of which appear to include route changes or the use of toll facilities. Some companies use a team of drivers to ensure that no one driver exceeds their hours of service. Other companies take rest periods into account in calculating delivery windows and departure times. Many private fleets and independent trucking companies use distribution facilities and define service territories to prevent drivers from going over their hours of service. For example, a long distance delivery might not be made by one driver in one vehicle. One driver may pick up the shipment and deliver it to another distribution facility, where it will be picked up by another driver for final delivery.

On-Facility Amenities

One industry representative noted that there is a lack of amenities (i.e., rest stops, parking and fueling stations) on SH 130. However, the interviewee noted that for it to be a true incentive, these amenities would have to "operate as a loss leader." Significant discounts on fuel or berthing fees would have to be offered for a significant number of truck drivers to use SH 130.

Travel Information

There is a possibility that truck drivers are not using SH 130 because they are unaware of the potential time savings offered by the facility relative to IH 35. As such, providing travel time information on digital message signs prior to SH 130 access points is seen as a possible mechanism for diverting truck traffic to the toll road. The interviews conducted, however, revealed that companies and drivers generally use an array of services and applications that show them travel times for alternative routes. Such services are provided by sophisticated back office systems or low-cost mobile-device-based applications. Providing travel time information near access points to SH 130 is unlikely to motivate companies or drivers to use the toll road.

Long Combination Vehicles

A potential incentive for the use of SH 130 is allowing LCVs, (e.g., a truck and trailer combination wherein the tractor pulls multiple trailers instead of just one). LCVs allow companies to transport more product on a particular trip, thereby offsetting some of the toll costs to operate on SH 130. One of the company-owned fleet operators stated he/she would indeed use LCVs if they were allowed on SH 130. Two other fleet operators also indicated they would use LCV combinations on Texas roads if they were allowed, but did not speculate as to whether it would be an additional incentive to use SH 130 if allowed there.

Toll Discounts

Most of the companies interviewed for this effort were aware of TxDOT's toll discount program. Those that were not aware of the discount program do not currently use SH 130. One company that currently uses SH 130 on a frequent basis was very pleased with the program and noted it had helped lower their transportation costs, but it did not result in them using the facility more than they had been. The owner-operator representatives indicated that they were not aware if the discounts resulted in any increased usage of SH 130 by their constituents. They noted that their organization is, in principle, opposed to toll roads and that that opposition generally extended to their constituents.

Summary of Findings

Given that the largest revenue sources for funding transportation infrastructure (i.e., the federal and state fuel taxes) have become largely inadequate, a number of state DOTs, including Texas, have pursued tolling as a means to provide much needed additional capacity. In some cases, these toll roads were in part motivated as truck bypasses around congested urban areas.

This report attempted to answer three questions regarding truck use of tolled roads (with an emphasis on the use of SH 130):

- What does the literature say?
- What does the traffic and transaction data say?
- What does industry say?

What Does the Literature Say?

In general, the literature reveals a reluctance of the trucking industry to use tolled facilities. Truckers are cost conscious and will only choose to pay a toll if it makes financial sense, in that the savings exceed the additional cost imposed by the toll. The literature also revealed that trucking companies use sophisticated routing and scheduling systems to avoid congestion or to minimize the impact of congestion on their operations. Recurring congestion is factored into the routing and scheduling algorithms. For some truckers, usage of toll roads is determined by the shipper's willingness to pay for the incremental cost of toll charges incurred. To understand how trucking companies (specifically, company fleets and owner-operators) recompense toll costs, a better understanding is required of the factors considered by goods movement businesses (e.g., shippers, receivers, and logistics companies) in their decisions to use toll facilities. The incentives most attractive to truckers generally involve cost reduction. However, a segment of the market (specifically, owner-operators) has negative sentiments toward toll roads regardless of incentives.

What Do the Traffic and Transaction Data Say?

An analysis of the traffic data from TxDOT and the data collected as part of the 2013 IH 35/SH 130 Commercial Vehicle Diversion Study showed that overall SH 130 carries very few trucks compared to IH 35—even when the truck incentive program was in effect in October 2013. The data showed that the traffic volumes on IH 35 are much higher than on SH 130 and that local passenger vehicles make up the highest proportion of all traffic in the area. The data also showed that heavy trucks passing through the Austin area are a very small percentage of all traffic. Even heavy local trucks make up a small proportion of total traffic. Overall, pass-through trucks only constitute 1 percent of the total traffic volume on IH 35 (for the highest volume segment), as opposed to through passenger vehicles at 12 percent of the total traffic volume. Even when accounting for the size and different operating characteristics of trucks (by expressing truck volumes in passenger car equivalents), trucks still represent a relatively small percentage of the traffic volume on IH 35 and SH 130.

What Does Industry Say?

Finally, TTI researchers conducted interviews with representatives from independent trucking companies, owner-operators, and private fleets. Researchers asked interviewees about the different factors that influence logistics decisions and, specifically, factors influencing the use or non-use of toll roads such as SH 130 in Central Texas. The following are some of the major findings:

- In many cases, travel time savings is not the most important consideration in making routing decisions. Therefore, presenting toll roads as a time saving option to IH 35 will not necessarily encourage higher utilization by the trucking industry.
- Trucking firms, both large and small, have access to a wide array of resources to help them plan trips. Many shippers and trucking companies already take into account traffic congestion when determining when and where to drive for delivery of a particular shipment. As such, potential time savings and travel time reliability may not be enough of a benefit to offset the cost of a toll.
- It is important to keep the type of company in mind when looking at potential toll road users. Toll facilities and SH 130 do offer potentially significant benefits to companies and drivers who generate revenue on a per delivery basis, if the facility allows them to make more deliveries in a day.
- Some of the firms interviewed that do not currently utilize a toll road indicated that they would be undertaking an assessment of whether using the toll road makes business sense for their operations. Thus, there are likely still a number of trucking firms that could decide to use the facility in the future.
- Company-owned fleets can absorb the cost of tolls somewhere else, such as in a retail setting. For these companies, the benefits of safety and efficiency in their operations may be more pertinent when using a toll road. Independent owner-operators tend to operate on a thinner profit margin relative to other trucking entities. They are much more likely to make routing decisions that will minimize the cost of a particular trip, which means they are less likely to incur additional costs through tolls.

Finally, TTI researchers asked interviewees about their thoughts on potential incentives to get commercial vehicles to use the SH 130 facility to bypass Austin. The following insights were obtained:

- The high speed limits offered on toll facilities, and in particular on SH 130, are not an effective incentive for truckers to use the facility. In almost all cases, 80 mph is deemed too expensive (in terms of fuel consumption) and too fast to safely operate a large commercial vehicle.

- Although toll roads are often seen as an attractive time saving option for drivers who are in danger of going over their hours of service on a particular trip, the researchers found that trucking companies address this issue in different ways—none of which appear to include route changes or the use of toll facilities.
- Although a lack of amenities (i.e., rest stops and fueling stations) were noted on SH 130, it was also noted that for it to be a true incentive, these amenities would have to offer significant discounts on fuel or berthing fees for a significant number of truck drivers to use SH 130.
- Providing travel time information near access points to SH 130 is unlikely to motivate companies or drivers to use the toll road because companies and drivers generally use an array of services and applications that show them travel times for alternative routes.
- It is unclear whether allowing LCVs (e.g., a truck and trailer combination wherein the tractor pulls multiple trailers instead of just one) will encourage a substantial number of companies to use SH 130.
- Most of the companies interviewed for this effort were aware of TxDOT's toll discount program. Those that were not aware of the discount program do not currently use SH 130. Toll discounts help lower transportation costs, but it is not clear whether it results in higher usage of the facility.

Appendix A: Interviews with the Trucking Industry

The decision by TxDOT in 2011 to initiate a pilot program offering discounted tolls to trucks using SH 130 was seen as a strategy to divert these vehicles off of the heavily trafficked IH 35 corridor in the Austin metropolitan area. It was hoped that the discounts, by reducing the cost of a trip on the facility, would induce enough trucks off of IH 35 that safety might be improved and that congestion on the interstate could potentially be reduced (*21*). Truck usage of the facility did increase over the course of the program.

However, it is unknown to what extent monetary incentives alone will accomplish the objective of moving trucks off IH 35 and onto SH 130, or, for that matter, increasing truck usage of toll roads in general. This is because the trucking industry is not homogenous in terms of how individual firms make routing and logistics decisions. Different types of companies have different business models. For example, some are for-hire, and some provide the type of services of a large company or private fleet. Even companies with similar business models have aspects unique to their company in terms of the products being hauled, driver employment/pay, and delivery windows that necessitate differences in how they operate and route their vehicles.

In the 2012 *Texas Trucking Industry Study*, the Texas Trucking Alliance (TTA) classified Texas trucking operations into three groups (*22*):

- **Independent trucking companies**—These are companies in which the "owners or principals are not personally driving a truck and the company serves a wide variety of customers." These are trucking companies that own vehicles and tractors, but are in the business of moving freight and goods for other companies that own and/or receive the products being shipped. These operations are not part of a larger entity that is responsible for manufacturing or selling the goods being moved. TTA estimates that almost a third (31 percent) of Texas trucking companies are independents, and about 80 percent of these employ fewer than 20 drivers.

- **Company-owned/private fleets**—These trucking entities are owned or affiliated with a company that is the "sole customer of the trucking company." These trucking operations are part of a larger entity that manufactures and/or sells the goods and products being shipped. Private fleets can be among the largest of trucking companies and may employ hundreds of drivers at a time, but TTA estimates that they comprise about 1 percent of all Texas trucking companies.

- **Owner-operators**—These are companies or individuals that own the vehicle and are "personally involved in driving a truck and transporting cargo for a variety of customers." Owner-operators own their own vehicle but move goods under contract with a shipper (the one who has goods to move) or a carrier (a third party that facilitates logistics for a shipper). Owner-operators may operate under contract to independent trucking companies or company-owned fleets, but because they own their vehicle, they are generally subject to different pay and incentive structures relative to drivers employed directly by independent trucking companies or company-owned fleets. TTA estimates that about two-thirds (68 percent) of Texas truckers are owner-operators.

For this research effort, researchers with the Texas A&M Transportation Institute interviewed companies and industry groups representing these three trucking company types. As this report shows, the distinction between the types of trucking organizations is important to consider when thinking about truck use of SH 130 and other toll roads, mainly because they all have different factors to consider in making their routing and logistics decisions due to differences in their underlying business models. Independent trucking companies and owner-operators generally operate under contract with their shippers, meaning they may have fewer options available to absorb the cost of a toll. Private fleets, as part of a larger commercial operation, have more opportunities to absorb the cost of tolls in other parts of the corporate structure, such as in the retail environment.

However, company type is not the only determining factor in toll road usage. Another factor to consider is the time frame, distance, and delivery window for the deliveries being made. Long-haul and interstate shipments tend to have wider delivery windows relative to regional and local deliveries, which often have more narrowly defined delivery windows. Furthermore, shipments that occur on a routine basis, such as those that might be made between manufacturing centers and distribution or retail centers, are more predictable, meaning it is easier for shippers to plan routes and departure times such that using a toll facility to save time is not necessary.

This appendix summarizes the findings of the trucking industry interviews conducted by TTI researchers.

General Factors Influencing Trucking Operations

There are numerous factors influencing trucking operations and specifically toll road usage. However, it does not appear that trucks are avoiding toll roads based on principled opposition. In general, the companies interviewed did not oppose toll roads in principle, with those that did not use them (or specifically SH 130) stating that it tended to not make sense from a business standpoint. According to representatives of one of the trucking organizations interviewed, there is not likely to be much organized opposition to toll roads from the trucking industry as long as toll roads are presented as an option. However, this organization mostly represents independent trucking firms and companies, and, according to the organization, their members are generally not owner-operators. On the other hand, representatives of the owner-operator group did indicate that they and their constituents were indeed opposed to tolling. Trucking groups and the industry representatives interviewed indicated that they prefer taxpayer funding of roadways through fuel taxes. A lack of toll road usage by the sector can generally be attributed to it simply not making business sense for a particular operation.

From a business perspective, the trucking industry tends to operate on very thin profit margins. Many factors influence routing decisions and add to the cost of operations. Fluctuating fuel prices can significantly alter shipping costs in a short period of time. One logistics manager interviewed indicated that he spent several hours a week looking at fuel prices in order to get the best bargain for the company. Furthermore, fleets and the vehicles comprising them require maintenance and must eventually be retired, which requires the purchase of replacement vehicles. Unforeseen traffic incidents involving company vehicles can further add unexpected costs to shipping and transportation.

Independent owner-operators operate on an even thinner margin and are less capable of absorbing increases in the costs of transportation and shipping. These owners/drivers tend to operate in niche markets, hauling flat-beds and reefers, and may be very sensitive to changes in the economy. Thus, owner-operators tend to be very cost conscious. Representatives of an owner-operator group indicated that Texas had the largest number of their members and that a lot of owner-operator activity in Texas is tied to energy development, particularly fracking operations.

Thin profit margins and fluctuating costs mean that trucking companies undertake numerous operational and administrative strategies in order to contain and predict cost. To get a better sense of some of the general factors considered in logistics operations, TTI researchers asked interviewees about responsibility for making routing decisions and how drivers are paid. Researchers also inquired about general company policies and practices on the utilization of toll roads.

Routing Responsibility

All of the companies interviewed utilize some form of routing or logistics software to determine shipping routes. There are a number of services and applications that can be utilized for logistics operations of all sizes and budgets. These systems allow logistics managers to account for congestion conditions and can allow for the gathering of more detailed vehicle data such as fuel consumption. This allows trucking operations to select the most cost efficient routes and departure times for a particular trip. However, there are differences in the flexibility offered to drivers in accepting shipments or altering the assigned route and departure time.

In general, drivers who are independent owner-operators (driving under contract to an independent trucking company or private fleet) have more leeway in accepting or rejecting a load. One independent trucking firm interviewed stated that its company does not have much recourse if its contractors decide to refuse to haul a load outside of simply not assigning them loads in the future and not renewing their contracts (independent drivers can be required to haul loads if it is spelled out in their contract). This company recommends routes to their drivers based on a software application that accounts for factors such as congestion time estimations, but drivers are generally free to choose their own route. Although the company noted that it is very strict on drivers meeting their delivery windows, it also noted that it does not have an established protocol for penalizing drivers when they do not meet their delivery windows.

Drivers employed by company-owned fleets have less leeway than independent drivers in accepting shipments and determining routes but are still offered some freedom. One company-owned fleet operator stated that the company provides drivers with a printed sheet containing their destination and a recommended route. This sheet serves only as a recommendation, as actual routing decisions are made by the logistics managers in consultation with drivers. While on the road, drivers have discretion on the routes they use and may change en route, if necessary. A similar operation indicated that it also provides its drivers with recommended routes but leaves the actual route determination to the drivers while they are on the road. Another company-owned fleet operator stated that the company uses a routing and logistics program that was developed in-house, and that its drivers are not allowed to deviate from the proscribed route.

In general, companies utilize a broad array of services and applications to aid them in their routing decisions to lower shipping costs. However, they are also cognizant that conditions en route can change, and that drivers may need to alter their trip en route. Logistics operations are thus predictable in certain aspects and dynamic in others.

Delivery Windows

A delivery window refers to the period of time within which a delivery must be made. Delivery windows can vary significantly, even for shipments made by company-owned fleets. Meeting delivery windows has different implications depending on the type of operation. An independent trucking firm or an independent owner-operator derives income from making its deliveries, and there is often a strong financial incentive for delivery windows to be met. Company-owned fleets tend to lose productivity and reduced operational efficiency if delivery windows are not met, so the money does affect the bottom line but not in the same direct manner as for an independent owner-operator.

Two of the company-owned operations interviewed noted that different commodities have different delivery windows, which are often determined by requirements for stocking at retail outlets. For example, the stocking of very small commodities, such as cosmetics, can be time consuming and might impede customers as they shop. Retailers insist that these items be stocked at times when there are fewer shoppers, such as late at night, to avoid disruption to the shopping experience. Another company-owned operation indicated that while its delivery windows are narrow, in that the shipment has to arrive at its destination at a certain time, the delivery window does not have to be met exactly (i.e., the driver can be early). This is due to the fact that the shipments made by this company do not require immediate stocking in a retail environment. Drivers are certified to operate forklifts and can unload the trucks themselves if they are early. In the case of the first company, it is critical to hit the delivery window as close as possible because staff is on hand waiting to stock the delivery. If the shipment is late, then stockers are not working. If it is early, the truck driver must wait for stockers.

While there are some instances where long-haul truckers have very narrow delivery windows, for the most part these operations have wide delivery windows such that saving an hour or two bypassing Austin is not going to help them much. On the other hand, companies that have narrow delivery windows will already account for traffic congestion in their routing decisions and are unlikely to travel through Austin during periods of congestion.

Driver Pay

Driver pay structure across the companies interviewed varied considerably. One trucking company that utilizes independent owner-operators for its operations stated that it pays its contractors based on mileage with an adjustment offered for the weight of the load. In general, heavier loads have a higher pay rate. However, this company noted that it often has shipments to one of its customers that are bulky in that they take up a lot of volume, but the goods are relatively light. These shipments constitute a full load, but they are not very heavy, so contractors are often reticent to accept these loads. In those cases, specialized rates may be offered to induce a driver to accept the load. This same company also makes residential deliveries for online retailers. For these shipments, drivers are paid based on the number of shipments they make as well as the weight being hauled.

The pay structure for drivers employed by private fleets tends to be mileage-based in combination with other factors. One private fleet operator pays its drivers based on mileage and per hour. Due to the fact that his company often requires drivers to make trips that would put them over their hours of service, the company covers their time while sleeping/resting when on the road. Another private fleet owner pays drivers by the mile and per trip, with adjustments made for the type of commodity being hauled. This entity does not send drivers on trips that would put them over their hours of service, and thus does not need to pay for driver rest periods. Mileage pay is calculated based on what is recorded in the route book for a particular trip, not actual mileage accrued. Another private fleet simply pays its drivers by the mile. This company utilizes teams of drivers to ensure that no one driver goes over his/her hours of service.

Toll Road Usage

Usage of toll roads by the companies interviewed varied. An independent trucking firm that utilizes independent owner-operators indicated that it had no policy on toll road usage and would not forbid drivers from using the toll road, but noted that the company would not cover the cost of the tolls unless there were extreme circumstances. These would include the possibility of a shipment missing its delivery window due to congestion. However, for tolls to be covered by the company, the late delivery would have to be due to an occurrence that was outside of the control of the driver. If the driver should have anticipated congestion in determining his/her route and/or departure time, then the tolls would not be covered by the company.

Two company-owned fleet operators stated that they use toll roads in other states, or in other areas such as Houston, but did not do so in Central Texas. They indicated that based on the location of their distribution centers, the destinations of their shipments, and their associated delivery windows, it simply did not make sense for them to use the SH 130 facility. In general, it was because either the facility is too far out of the way and time savings would not offset the increased cost of fuel and other trip costs or the facility simply did not serve them in reaching their destinations.

Another company-owned fleet operator indicated that they use toll roads and the SH 130 facility specifically. This company stated that safety is its number one priority, and getting its vehicles out of congestion increases safety. However, the company does not use the SH 130 for all trips, just during those times when there is significant congestion on IH 35 through the Austin metropolitan area.

Making Routing Decisions

One of the most important elements of these trucking industry interviews was finding out how companies make routing decisions and how these decision making processes factor into toll road utilization. Based on these discussions, three conclusions were reached:

- Most trucking companies are already utilizing data and some form of routing software application to inform their logistics decisions and, specifically, select routes.
- Most trucking companies are familiar with Austin area congestion and have already factored it into their decision making processes.
- Saving time is not among the most important factors considered in making routing decisions.

It has been repeatedly noted that trucking firms use routing assistance systems and applications, but as also noted, there is a dynamic aspect to these operations that requires a certain level of input from the driver and discretion in making changes while en route. Several trucking firms, but not all, indicated that they allow their drivers to have discretion in choosing the specific routes that they take for a delivery. The only requirement is that they make deliveries within the prescribed delivery windows. However, it was noted by trucking industry representatives that drivers tend to be habitual in the routes they take. Once they settle on a route and become familiar with it, they tend to stick with it. Owner-operators, in particular, tend to know an area very well and account for congestion in their departure times and routes. Factors such as preferred truck stops, rest areas, and fueling locations can also influence the preference for a particular route by long-haul drivers.

It was noted by the industry representatives that shipping firms, particularly if they want to retain a particular driver, will defer to their driver's wishes on routing in many cases. Even the companies interviewed for this effort who assign routes to their drivers noted that they do allow drivers to make changes to the route if circumstances arise. All of the companies interviewed indicated that they have high driver retention rates and that they prefer to have very experienced and seasoned drivers. Some of the firms stated that they only hire drivers with a minimum experience of 1 million miles. Another stated that they prefer to train their own drivers, moving them up from warehouse positions to operating warehouse and loading equipment to eventually driving the trucks. In all of the interviews conducted, interviewees emphasized the need to trust their drivers to make decisions on the road.

Routing and Logistics Processes

As noted in the previous section, all of the companies interviewed utilize some form of routing software to determine optimal routes and departure times for shipments leaving their facilities. Industry representatives also indicated that the use of mobile phone-based applications is growing in popularity for individual drivers. Independent owner-operators without access to the sophisticated systems used by larger operations thus have information available to them on traffic conditions that can help them plan their routes.

Larger trucking fleets, in particular, have a strong incentive to utilize available data to run their operations as efficiently as possible. This applies not just to routing. For example, one private fleet operator indicated that their company had undergone extensive data gathering operations to optimize their operations. The company collected (and still collects) information such as hours per driver, miles per driver, pay, commodities by volume, miles per gallon, fuel costs, tire costs, total labor per driver, etc. The company found that the biggest cost was “the inability to haul payload” (i.e., hauling empty) and that costs escalated when miles where accrued hauling empty. The company reduced overall miles first, meaning that it would utilize the shortest route, but more often it meant restructuring its logistics to simply haul more products. The company switched from its standard trailers (44 feet long by 96 inches wide) to larger trailers (20 feet long by 102 inches wide). These trailers also had a taller roof and allowed the company to increase its cubic volume hauled. However, at that volume, about 30 percent of loads “weighed out,” so the company worked to reduce the weight of their trucking rigs and equipment. Finally, the company improved upon how products were loaded.

The researchers documented several other examples of how companies use data. The collection of fuel data, in particular, is common among most major carriers, as fuel consumption is among the largest and most variable cost drivers. These examples are illustrative because it shows that trucking companies are highly cognizant of the factors that influence the cost of transportation and are willing to dedicate significant resources to improve efficiency. They are acutely aware of how changes in, for example, speed and distance can affect their bottom line.

Accounting for Congestion

With the use of logistics software applications and low-cost mobile applications, congestion becomes more predictable. This is important because a commonly cited benefit of toll roads is that they offer a more reliable and predictable trip, but that might not be as important to commercial companies given other factors that impact transportation costs.

Accounting for congestion is also an outgrowth of a firm’s experience in working an area. The companies interviewed, for example, already knew that they were likely to experience congestion in Austin, so they typically adjust their departure or arrival times. An independent company that utilizes private contractors (owner-operators) stated that they have daily deliveries going out in the morning and that their drivers know there is going to be traffic but are familiar with it. They know when they need to leave to make their delivery window and do not mind sitting in traffic as long as that window is made.

A representative of one company-owned fleet stated that deliveries from their plant go to several national distribution centers, and are thus very repetitive in nature. Thus, the company is able to make routing decisions and account for travel time well in advance of a particular shipment. The repetitive nature of their delivery schedules has given them the experience and data required to accurately account for how long a delivery will take, even if it is across the country. This particular company makes routine deliveries to distribution centers as far west as Los Angeles and Seattle and as far east as Florida and Massachusetts.

Time Savings Are Often Not That Critical in Routing Decisions

The researchers found that companies take a number of factors into account when deciding to utilize a toll facility, but routing decisions generally appear to be made based on what will minimize the cost of a particular trip on a per mile basis. In many cases, interviewees indicated that differences as low as a tenth of a cent per mile can be critical in choosing one route over another. One fleet-owned operator stated that their "run rate" (transportation cost) ranges between $2 to $3 per mile, and every extra mile driven adds cost regardless of whether that mile is traveled at a higher speed or in the absence of congestion.

The concern with toll roads is that they can significantly alter the per mile cost of a trip. And while they may offer safety advantages and travel time savings, saving time is not the number one factor affecting route choice. Trucking companies select routes that will allow them to hit their delivery windows and drive for as long as possible at the "sweet spot" speed that allows them to minimize fuel consumed per mile. Every extra mile added to a trip adds cost, regardless of time savings, and the SH 130 toll facility represents a longer route to get around Austin. When a truck uses the SH 130 bypass it must travel further, meaning it is using more fuel. The added cost of consuming more fuel is not worth the time savings in a lot of cases.

Reasons for Using Toll Roads

Truck usage of toll facilities is low relative to passenger vehicles, but there are trucking companies that use them. The main reason for using toll facilities in general, and specifically the SH 130 facility, included safety and the ability to make more deliveries in a day. As noted in the previous section, saving time was not listed by any of the companies using toll roads as a reason for using the facility. Avoiding congestion was mentioned within the context of safety.

Make More Deliveries

TTI researchers have found in past research efforts that a significant number of commercial users of the SH 130 facility were local and regional area independent trucking companies making deliveries in the Austin metropolitan or San Antonio metropolitan areas. Firms such as these, that aim to maximize their revenue by making as many deliveries as they can, are one particular segment of the industry that can benefit significantly from toll facilities.

One of the independent trucking companies interviewed indicated that it does not currently have a policy for its independent drivers using toll roads. However, the company has recently begun making residential deliveries in the Austin area, and the representative acknowledged that the facility might enable them to make more deliveries in a given day. The company representative stated that they would be doing analysis in the future to see if using the toll road makes more business sense.

Company-owned fleets are generally not concerned about making more deliveries within a given time period. This is because delivery schedules are controlled by and in service to the parent company. Company-owned fleet vehicles are generally making deliveries between company distribution centers and other company-owned properties, and the company is not deriving revenue from these deliveries. Operational efficiency might improve with the ability to make more deliveries, but the company will not see an increase in revenue from the additional trips. This does not apply to company-owned fleet vehicles that make service calls to residential and commercial consumers.

Safety

Researchers interviewed one company-owned fleet that utilizes toll roads extensively. That company indicated that its number one priority was safety, and that that focus necessitated the use of toll roads to bypass Austin. This company noted that the cost of even one collision involving its vehicles can be significant.

The company representative stated that the cost of using toll roads, and specifically SH 130, is generally not a factor in routing trucks onto the facility for deliveries, and that the number one factor was improved safety. The company feels that getting vehicles out of congestion minimizes the chance of an incident. However, the company did note that it is concerned with efficiency and that getting its trucks out of congestion was more efficient, particularly if it meant meeting a delivery window.

This company also stated that toll road usage is usually limited to daytime driving, when safety concerns due to congestion are higher. Vehicles are generally routed through Austin on IH 35 for night deliveries, as there is relatively little vehicle traffic to interact with. Furthermore, this focus on safety applies to routing decisions involving both loaded and empty trucks. A truck returning to the main distribution center empty at rush hour would therefore likely be routed onto a toll road to avoid congestion.

It is unknown to what extent this focus on safety is prevalent in other trucking companies. Based on the interviews conducted, it would appear that while safety is a concern for all trucking firms and the industry, IH 35 is not perceived as being so unsafe as to warrant taking a toll road. The interviewees did note that safety is a concern among their constituents, noting that drivers can be tried in criminal court and shippers can be held liable in civil court for safety-related incidents.

Potential Incentives for Toll Road Usage

TTI researchers asked interviewees about their thoughts on potential incentives to get commercial vehicles to use the SH 130 facility to bypass Austin. Specifically, the researchers asked about the following:

- Higher speed limits on SH 130.
- No exceeding hours of service.
- The presence of nearby amenities and associated facilities.
- Providing speed and travel times for alternate routes.
- Use of LCVs.
- Toll discounts.

As noted earlier, time savings is not the overriding factor in making routing decisions for most companies interviewed. Thus, it is unlikely that simply presenting toll facilities as a time savings option and educating the trucking community about that savings will be enough to increase truck usage of SH 130. Furthermore, in many cases these companies have already conducted an analysis of what routes and departure times are likely to minimize the cost of a particular trip, so additional education and outreach is unlikely to influence utilization.

Speed

The high speed limits offered on toll facilities, and in particular on SH 130, are not an effective incentive for truckers to use the facility. Most companies govern vehicle speeds and would not allow drivers to travel 80 mph, even if they were not governed. Researchers at TTI have yet to interview a logistics firm, trucking company, or driver who is capable of traveling that fast (due to speed governors) or is willing to if provided the opportunity. In almost all cases, 80 mph is deemed too fast to safely operate a large commercial vehicle. Although drivers and trucking companies have indicated that some drivers may indeed operate that fast, it was made clear that these individuals do not represent the norm for the industry and are likely to face repercussions in the future for that behavior.

Speed tends to increase the cost of a trip in terms of fuel consumption. Trucks have a sweet spot in terms of fuel efficiency relative to speed. Drivers and shippers are aware of this and will attempt to drive at that speed as long as possible. Speeds over this sweet spot increase fuel consumption per mile and thus increase the cost of a specific trip. One industry representative estimated that driving 85 mph relative to the standard speed limit could increase costs by up to $0.09 per mile. Another company representative stated that, for their trucks, reducing their speed from 70 mph to 68 mph saves about one-tenth of a gallon of fuel per mile.

Hours of Service

Truck drivers are limited in terms of the hours they can drive. They are required to keep log books documenting their total time driving and rest time while on the road, and can face penalties if they drive too long without resting. This is particularly critical for interstate truck drivers. Toll roads are often seen as an attractive time saving option for drivers who are in danger of going over their hours of service on a particular trip.

Trucking companies' shipments that run the risk of putting drivers over their allowed hours of service address this in different ways, none of which appear to include route changes or the use of toll facilities. Some companies use a team of drivers to ensure that no one driver exceeds his/her hours of service. Other companies take rest periods into account in calculating delivery windows and departure times. Furthermore, saving one or two hours of travel time by bypassing Austin is unlikely to impact the ability of a long-haul trucker to make a delivery without exceeding his/her hours of service, unless the delivery is destined for a location near Central Texas. In many cases, a driver will stop and wait out congestion to also get his/her required rest time in the cab.

Many private fleets and independent trucking companies use distribution facilities and define service territories to prevent drivers from going over their hours of service. For example, a long-distance delivery might not be made by one driver in one vehicle. One driver may pick up the shipment and deliver it to another distribution facility, where it will be picked up by another driver for final delivery.

One company-owned fleet operator indicated that they use independent contractors for deliveries that may have hours of service issues. The issue of how to make the delivery without exceeding hours of service then becomes an issue for the contractor to address.

On-Facility Amenities

One industry representative noted that there is a lack of amenities, i.e., rest stops and fueling stations, on SH 130. Furthermore, his constituents regularly express concern about the general lack of commercial vehicle facilities on Texas roads. The location of commercial vehicle amenities along SH 130 might encourage commercial usage of SH 130, given that there are not such amenities along IH 35 within Austin. However, the interviewee noted that for it to be a true incentive, these amenities would have to "operate as a loss leader." Significant discounts on fuel or berthing fees would have to be offered for a significant number of truck drivers to use SH 130.

Travel Information

There is also a possibility that truck drivers are not using SH 130 because they are unaware of the potential time savings offered by the facility relative to IH 35. As such, providing travel time information on digital message signs prior to SH 130 access points is seen as a possible mechanism for diverting truck traffic to the toll road. The interviews conducted, however, revealed that travel time savings are generally not the leading factor in determining whether or not to use a toll road. Furthermore, companies and drivers generally use an array of services and applications that show them travel times for alternative routes. Such services are provided by sophisticated back office systems or low-cost mobile device-based applications. As such, routing assistance services are available to most drivers, regardless of company size. Providing travel time information near access points to SH 130 is unlikely to motivate companies or drivers to use the toll road.

Long Combination Vehicles

A potential incentive for the use of SH 130 is allowing LCVs, (e.g., a truck and trailer combination wherein the tractor pulls multiple trailers instead of just one). LCVs allow companies to transport more product on a particular trip, thereby offsetting some of the toll costs to operate on SH 130.

One of the company-owned fleet operators stated that the federal government currently allows the use of LCVs in 17 U.S. states, and that the railroad industry is blocking efforts at expanding LCV use. This operator noted that he/she would indeed use LCVs if they were allowed on SH 130. It would allow them to deliver more to their distribution centers in fewer trips, thereby reducing mileage. The representative indicated that the use of LCVs to their distribution centers could potentially reduce their mileage by half, even though the fuel efficiency of the tractor pulling the load would reduce. The interviewee stated that 53 foot triple combinations are currently used in Canada, and their company has demonstrated in the past that they are capable of safely operating 53 foot double combinations. Two other fleets operators also indicated they would use LCV combinations on Texas roads if they were allowed, but did not speculate as to whether it would be an additional incentive to use SH 130 if allowed there.

Toll Discounts

Most of the companies interviewed for this effort were aware of TxDOT's toll discount program. Those that were not aware of the discount program do not currently use SH 130. One company that currently uses SH 130 on a frequent basis was very pleased with the program and noted it had helped lower their transportation costs, but it did not result in them using the facility more than they had been.

The representative of the owner-operator group indicated that its members were aware of the toll discounts, but the group was not aware if the discounts resulted in any increased usage of SH 130 by their constituents. The representative noted that the group is in principle opposed to toll roads and that that opposition generally extended to their constituents.

Which Segments of the Trucking Sector Are Most Likely to Use Toll Roads?

Independent Owner-Operators

Independent owner-operators operate on a very thin profit margin. They are unlikely to use toll facilities because they cannot absorb the cost of the tolls and still make money on a particular shipment. Independents often operate under contract to a carrier who in turn contracts with a shipper. In some cases, the independent driver may not be party to the contract negotiations between the shipper and carrier. Their payment is set, and they make routing decisions to minimize their trip cost. Independents tend to be keenly aware of how to adjust their departure time and route to minimize cost. It is unlikely an independent driver will use a toll road to save time (even in the presence of congestion) as long as he/she is able to meet his/her delivery window. Tolls add cost to the trip without providing an appreciable benefit. In most cases, an independent driver will only use a toll road if the penalty for missing a delivery window outweighs the cost of the toll. From the interviews, it did not appear that most shippers levy such penalties on a routine basis. Furthermore, owner-operators seem to have a lot of leeway in terms of accepting or declining a particular shipment. It was noted by one independent trucking company that they often have issues with their independent contractors declining loads that are not deemed profitable. In some cases, changes in compensation have to be made for a particular load to be picked up.

Independent owner-operators who make local and regional shipments and are paid per delivery could potentially benefit from using SH 130. Based on previous TTI research and these interviews, however, it does not appear that regional independent owner-operators are using SH 130.

Long-Haul Trucks

Long-haul and interstate trucking companies do not appear likely to use SH 130. These companies have already accounted for congestion in their scheduling, and saving an hour or two bypassing Austin is not going to benefit them when it comes to trips that can take several days to complete. For example, some companies make long-haul deliveries from plants located on the Texas-Mexico border to manufacturing centers in Detroit, Michigan. These trips may take several days, and saving an hour or even two to bypass congestion in Austin is not very important given the overall length and duration of the trip.

Furthermore, the value of time on a particular trip tends to increase the closer a long-haul trucker gets to his/her destination, particularly if he/she is in danger of running past his/her delivery window. The example of the company making deliveries from the Texas-Mexico border to Detroit is again illustrative. Austin is relatively close to the border with Mexico, and saving an hour or two is not very important at the beginning of the trip. This is particularly true given that time lost in congestion can possibly be made up on the more rural and open stretches of highway between Texas and Michigan. The long-haul trucker will be more inclined to use a toll facility to save time near Detroit. SH 130 may thus be attractive for long-haul truckers whose final destination is near Austin and they are running late.

Local/Regional Trucks

Local and regional haulers appear to be the most viable customer base for a toll facility, particularly companies/drivers that get paid per shipment or per trip. If the toll road allows them to make more shipments/trips (and thus get paid more), then they are more likely to use the toll road. Trucks hauling fracking sand to energy sites is one example of a freight-related activity that might utilize and benefit from the toll road. However, representatives of an independent owner-operator group indicated that it tends to be very difficult for their drivers to get shippers to cover tolls.

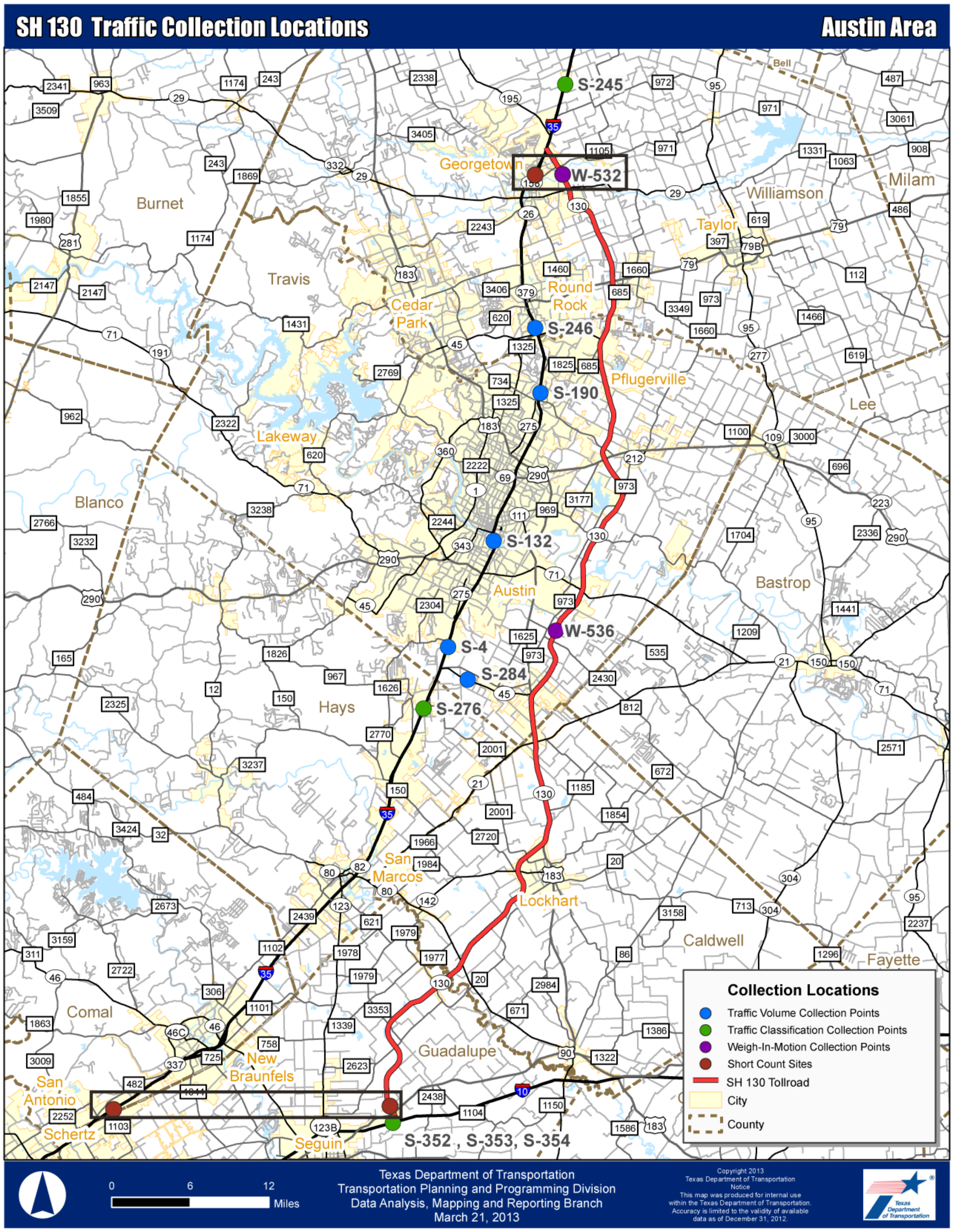
Appendix B: Methodology and Traffic Volumes for 2013 SH 130 Discount Period[5]

TxDOT collected traffic count information from a combination of permanent and short count duration stations located as shown in Figure 11. Short count duration data are for two consecutive days (a Tuesday and Wednesday) in a month. Therefore, the data analyzed from the permanent sites were for the same two days in each month. The average traffic for these two days was used as the representative of average daily volume for the month at each site.

Data from the short count duration sites included vehicle classification data. Some permanent sites did not include classification data (e.g., if the site was a volume-only collection site). Other types of permanent sites (traffic classification collection sites or weigh-in-motion collection sites) included traffic classification data. For those permanent sites where only traffic volume was available, the truck percentages were based on data from the TxDOT Transportation Planning and Programming Division's Traffic Log (T-log). Truck volumes were calculated as the sum of vehicles in Classes 7 through 13, which ranges from three axles and one trailer to seven or more axles and multiple trailers. In this analysis, unclassified vehicles (Class 14) were included in the total vehicle volume numbers, but not in the truck category.

Traffic volumes were compared for the parallel segments of IH 35 and SH 130 at three cut lines: the Georgetown cut line, the Central Austin cut line, and the Seguin cut line, respectively, from north to south (see Figure 11). In the figure, the brown dots show the short count sites. Blue dots show permanent volume count sites, green dots show permanent vehicle classification count sites, and purple dots show permanent weigh-in-motion sites.

5 The data and information in this appendix comes from a memorandum authored by Ramani and Alemazkoor (2014) for TxDOT's Transportation Planning and Programming Division.



Source: TxDOT Transportation Planning and Programming Division

Figure 11. Count Stations Used for Volume Comparison on IH 35 and SH 130.

Traffic Volumes

Table 2 shows the monthly traffic volumes, truck volumes, and SH 130's share of truck throughput (defined as percentage of trucks on SH 130 relative to total trucks on both highways at a cut line). [6]

[6] The dataset is limited as truck percentages were calculated from assumptions of T-Log for IH 35 Central Austin sites, and May and June 2013 data were unavailable for SH 130 for the Seguin cut line.

Table 2. 2013–2014 Daily Volume Comparison on IH 35/SH 130.*

Month	Statistic	Location					
		Georgetown Cut Line		Central Austin Cut Line		Seguin Cut Line	
		SH 130	IH 35	SH 130	IH 35	SH 130	IH 35
March-13	Total Vehicle	12,284	43,803	15,338	118,381	3,017	
	Total Trucks	1,525	12,858	1,881	*12,312*	670	18,075
	Share of Truck Throughput (%)	10.6%	89.4%	13.3%	86.7%	3.6%	96.4%
April-13	Total Vehicle	12,603	40,285	15,711	115,606	2,778	
	Total Trucks	1,811	10,818	2,061	*12,023*	681	17,671
	Share of Truck Throughput (%)	14.3%	85.7%	14.6%	85.4%	3.7%	96.3%
May-13	Total Vehicle	13,309	46,903	16,056	115,992	*Data not available*	
	Total Trucks	1,817	11,357	2,115	*12,063*		18,236
	Share of Truck Throughput (%)	13.8%	86.2%	14.9%	85.1%		N/A
June-13	Total Vehicle	14,505	45,900	16,934	123,468		
	Total Trucks	2,001	10,704	2,221	*12,841*		18,720
	Share of Truck Throughput (%)	15.7%	84.3%	14.7%	85.3%		N/A
July-13	Total Vehicle	13,830	46,754	16,500	124,648	3,320	
	Total Trucks	1,982	10,587	2,146	*12,963*	721	17,249
	Share of Truck Throughput (%)	15.8%	84.2%	14.2%	85.8%	4.0%	96.0%
August-13	Total Vehicle	14,215	45,566	16,672	123,466	3,321	
	Total Trucks	2,250	10,560	2,330	*12,840*	914	18,089
	Share of Truck Throughput (%)	17.6%	82.4%	15.4%	84.6%	4.8%	95.2%
September-13	Total Vehicle	13,579	38,542	16,182	118,786	3,271	
	Total Trucks	2,293	12,056	2,488	*12,354*	1,016	17,043
	Share of Truck Throughput (%)	16.0%	84.0%	16.8%	83.2%	5.6%	94.4%
October-13	Total Vehicle	13,146	40,853	15,987	117,416	3,282	
	Total Trucks	2,230	12,809	2,510	*12,211*	891	17,656
	Share of Truck Throughput (%)	14.8%	85.2%	17.1%	82.9%	4.8%	95.2%
November-13	Total Vehicle	13,822	40,180	17,005	117,255	3,172	
	Total Trucks	2,406	10,413	2,697	*12,195*	1,024	15,932
	Share of Truck Throughput (%)	18.8%	81.2%	18.1%	81.9%	6.0%	94.0%
December-13	Total Vehicle	13,242	41,080	16,199	115,979	3,290	
	Total Trucks	2,395	11,601	2,598	*12,062*	1,074	14,833
	Share of Truck Throughput (%)	17.1%	82.9%	17.7%	82.3%	6.8%	93.2%
January-14	Total Vehicle	12,866	40,711	15,527	115,709	2,896	
	Total Trucks	2,079	11,218	2,241	*12,034*	882	16,577
	Share of Truck Throughput (%)	15.6%	84.4%	15.7%	84.3%	5.1%	94.9%
February-14	Total Vehicle	11,999	36,974	15,047	128,494	3,251	
	Total Trucks	1,924	8,952	2,121	*13,363*	836	18,962
	Share of Truck Throughput (%)	17.7%	82.3%	13.7%	86.3%	4.2%	95.8%
March-14	Total Vehicle	13,350	43,463	17,802	120,652	4,302	
	Total Trucks	2,095	8,516	2,584	*12,548*	1,042	19,358
	Share of Truck Throughput (%)	19.7%	80.3%	17.1%	82.9%	5.1%	94.9%
April-14	Total Vehicle	14,896	48,867	18,339	117,639	3,870	
	Total Trucks	2,340	10,677	2,608	*12,234*	1,058	19,186
	Share of Truck Throughput (%)	18.0%	82.0%	17.6%	82.4%	5.2%	94.8%

**Italicized numbers were calculated by using truck percentages based on T-Log data.*

Source: Ramani and Alemazkoor, 2014

Appendix C: IH 35/SH 130 Commercial Vehicle Diversion Study

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Technical Memorandum

To: Charlie Hall, Texas Department of Transportation
Rene Garza, Atkins Global

From: Steve Farnsworth, Texas A&M Transportation Institute
Darrell Borchardt, Texas A&M Transportation Institute

Date: 18 March 2014

Subject: 2013 IH-35/SH 130 Commercial Vehicle Diversion Study

Study Background and Purpose

The Texas Transportation Commission authorized a one year truck toll reduction period on Toll Road SH 130 that began on April, 1 2013. The purpose of the toll reduction was to improve safety and reduce congestion on IH-35 through central Austin by diverting more (commercial) trucks from IH-35 over to SH 130. To measure the effectiveness of this strategy, the Texas Department of Transportation (TxDOT) commissioned the Texas A&M Transportation Institute (TTI) and Atkins Global to work together on a traffic study to provide estimates of the amount of commercial vehicle traffic being diverted from IH 35 to SH 130 with the truck toll reduction in place.

This memo serves as the Technical Memorandum documenting the analysis of data collected as part of this study. The study was performed in accordance with the methods and data collection plan set forth in the 'IH-35/SH 130 Commercial Vehicle Diversion Study' scope of work prepared by the Texas A&M Transportation Institute in coordination with Atkins Global and TxDOT. Under the scope, work performed on this project by TTI was funded through an Interagency Contract (IAC) with TxDOT, while worked performed by Atkins was funded through its General Engineering Contract (GEC) with TxDOT. Atkins Global subcontracted with Gram Traffic, Inc. to collect traffic data for the project using video capture equipment and vehicle classification counters.

Study Methodology

The scope of work specified that TTI and the GEC collect origin-destination (O-D) and traffic count data using Bluetooth (BT) readers, Automatic License Plate Recorders (ALPR), and vehicle classification counters (VCC) to provide estimates of traffic being diverted from IH-35 to SH 130. The study was also tasked with determining estimates of the percentage of traffic on IH-35 that is travelling through the Austin area as well as estimates of SH 130 traffic that travels between IH-10 near Seguin and IH-35 near Georgetown. The study primarily focused on commercial truck diversion, but it also collected data on non-commercial vehicles. The GEC performed the ALPR data collection and TTI performed the Bluetooth data collection. Both TTI and the GEC conducted VCC data collection. TTI was responsible for data analysis and for reporting the results to the GEC and TxDOT for their review and input. The GEC, TTI, and TxDOT coordinated on data collection equipment locations and the dates for the data collection effort. The data for this study were collected over a three day, 72-hour weekday period in October 2013 (8^{th} – 10^{th}) that was mutually determined by TxDOT, TTI, and the GEC.

The study included BT and VCC data collection at numerous locations along the IH-35 and SH 130 corridors between Buda and Seguin in the south to near Georgetown in the north. BT data was collected at 14 permanent BT sites on IH-35 and 12 permanent BT sites on SH 130. Table 1 and Table 2 list the locations of permanent BT sites on IH-35 and SH130, respectively. Those locations are also graphically illustrated in Figure 1 and Figure 2, respectively.

Table 1. Permanent BT Locations on IH-35.

Site No.	Approximate BT Location	Latitude	Longitude	Explanation
35P-01	SH 195, MM 266	30.704678	-97.651094	New solar cabinet just north of SH 195 exit ramp
35P-02	SH 29, MM 260	30.627010	-97.691108	New solar cabinet install on NB OSB
35P-03	FM 1431, MM 256	30.555834	-97.692258	New solar cabinet install on NB OSB
35P-04	US 79, MM 253	30.515921	-97.687421	New solar cabinet install on NB OSB
35P-05	SH 45, MM 250	30.476347	-97.672449	AC AWAM in existing NB IA (Loop) cabinet
35P-06	Parmer Ln, MM 246	30.413197	-97.673394	AC AWAM in existing NB CCTV cabinet
35P-07	Braker Ln, MM 243	30.382503	-97.673611	AC AWAM in existing NB IA (Loop) cabinet
35P-08	US 183/US 290, MM 240	30.334889	-97.703184	AC AWAM in existing SB IA (Loop) cabinet
35P-09	Airport Blvd, MM 238	30.305415	-97.713259	AC AWAM in existing SB cabinet
35P-10	5th St, MM 235	30.264312	-97.734939	New solar AWAM cabinet on NB OSB
35P-11	Riverside Dr., MM 234	30.252298	-97.736063	AC AWAM in existing TPP Loop cabinet NB between ML & FR
35P-12	Stassney Ln, MM 230	30.199360	-97.762919	AC AWAM in NB IA (Loop) cabinet
35P-13	Slaughter Ln, MM 227	30.162036	-97.788336	AC AWAM in IA (Loop) cabinet
35P-14	Buda, MM 222	30.099007	-97.812937	New Solar AWAM on outside leg of NB OSB

Table 2. Permanent BT Locations on SH 130.

Site No.	Approximate BT Location	Latitude	Longitude	Explanation
45P-01	SH 45 at Turnersville	30.100404	-97.777702	New solar cabinet before Turnersville exit WB
130P-02	SH 130 at US 183	30.091508	-97.679198	New solar cabinet at Maha Loop Rd overpass
130P-03	SH 130 at FM 812	30.141108	-97.664436	AC AWAM in existing CCTV cabinet at FM 812 overpass SB
130P-05	SH 130 at SH 71	30.189949	-97.625910	New solar cabinet at NB exit to SH 71 -- exit 449
130P-07	SH 130 at FM 969	30.263631	-97.598549	New solar cabinet at SB FM 969 exit -- exit 444
130P-08	SH 130 at US 290	30.330842	-97.585527	New solar cabinet 1/4 mile ahead exit sign for 290 -- exit 437
130P-09	SH 130 at Parmer	30.358317	-97.587927	New solar cabinet at Gilleland Creek north of Parmer overpass
130P-10	SH 130 at Cameron	30.409042	-97.583745	New solar cabinet NB past Cameron overpass
130P-11	SH 130 at SH 45h	30.464617	-97.594052	New solar cabinet NB south of exit to SH 45
130P-12	SH 130 at US 79	30.527759	-97.575583	New solar cabinet at NB exit to US 79
130P-14	SH 130 at Chandler	30.598696	-97.595779	New solar cabinet next to toll station for NB Chandler entry
130P-15	SH 130 at FM 971	30.662598	-97.640439	New solar cabinet at NB FM 971 exit

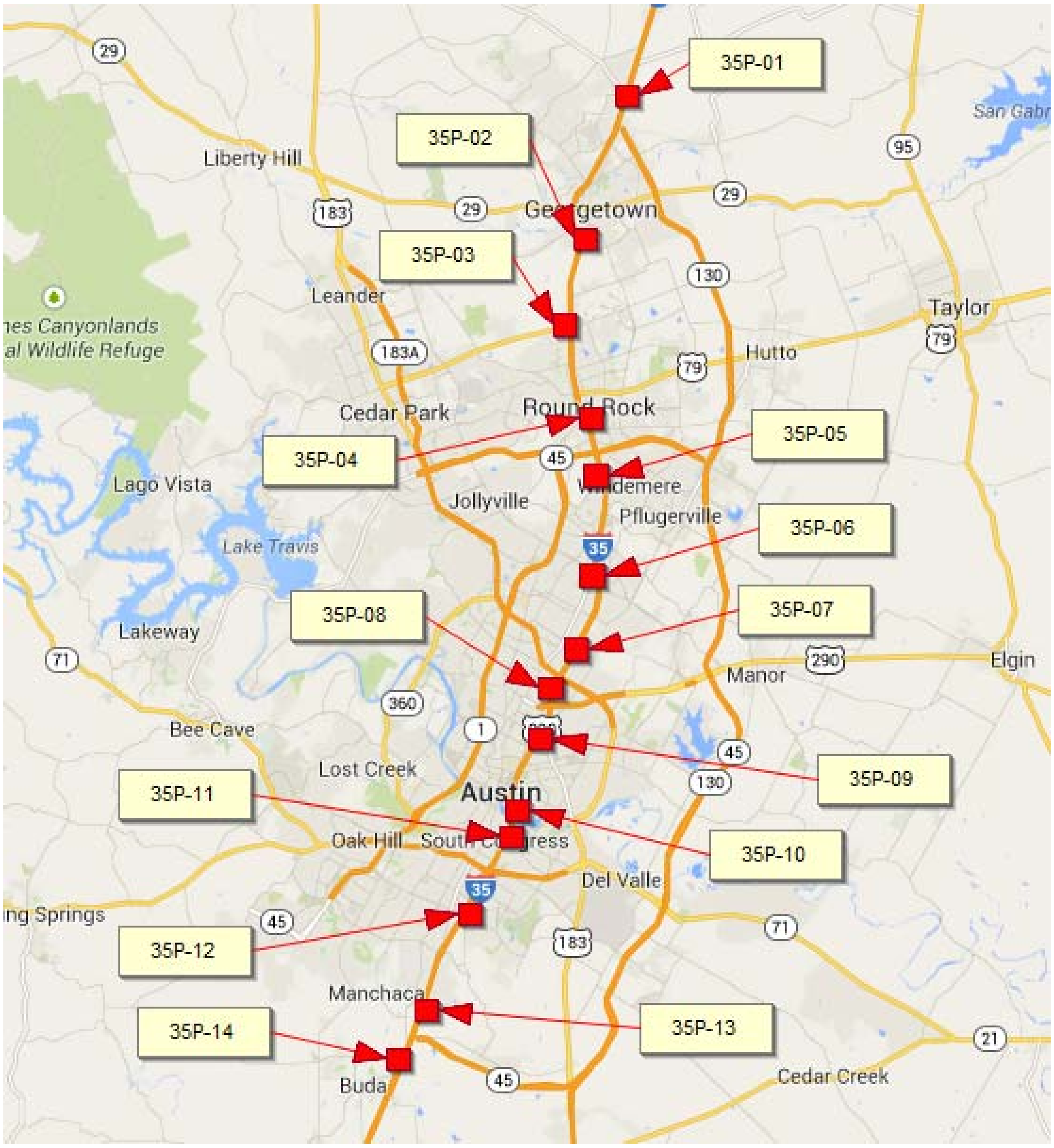

Figure 1. Permanent Bluetooth Reader Locations on IH-35.

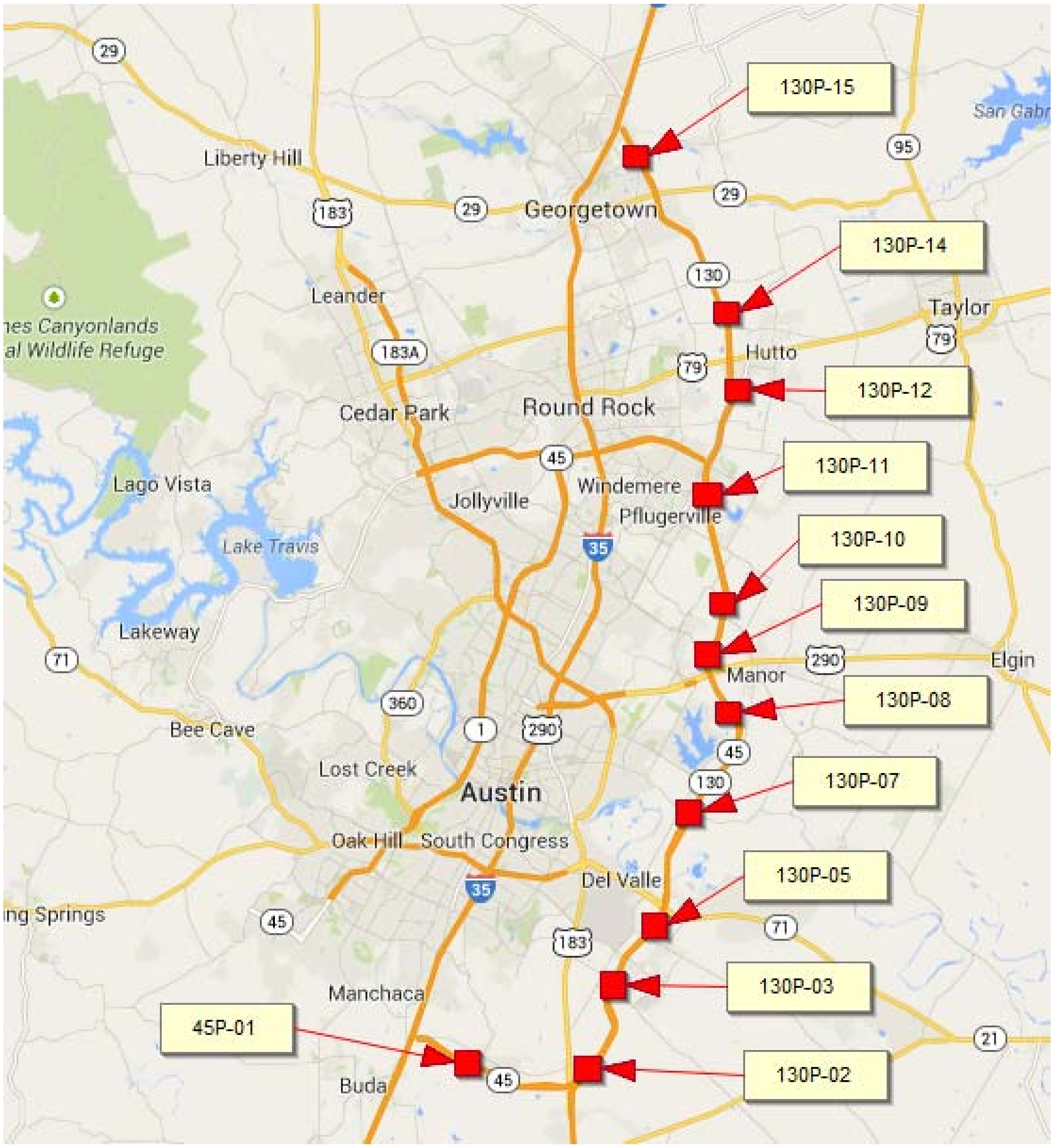

Figure 2. Permanent Bluetooth Reader Locations on SH 130.

BT data was also collected at eight additional sites using TTI mobile BT readers. Table 3 lists the approximate locations where TTI mobile BT readers were deployed. Additionally, Figure 3 graphically illustrates the portable Bluetooth reader locations. The final locations for mobile BT readers were determined as part of pre-fielding site visits that took place prior to the study commencing.

Table 3. Mobile BT Reader Locations.

Site No.	Approximate BT Location	Latitude	Longitude	Explanation
183M-01	US 183 north of SH 45/130	30.092113	-97.693790	US 183 north of SH45/SH 130 split
130M-01	US 183/SH 130 south of SH 45/130	30.069482	-97.692174	About 100 feet north of Margo Dr.
45M-01	SH 45/130 west of US 183	30.082160	-97.710263	SH 45 west of SH 130 and US 183
130M-02	SH 130S north of Lockhart	29.982206	-97.681201	At Gantry on SH 130S, between SH 21 and FM 1185
130M-03	SH 130S south of Lockhart	29.812199	-97.765128	At Gantry on SH130S, between SH 142 and SH 80
130M-04	SH130S near Seguin	29.615316	-97.876673	About midway between I-10 and US 90
35M-01	IH-35 north of Lakeway	30.680506	-97.660467	IH-35N between the Lakeway and SH 130 interchanges
35M-02	IH-35 north of SH45	30.128598	-97.800573	IH-35 north of IH-35/SH 45 interchange

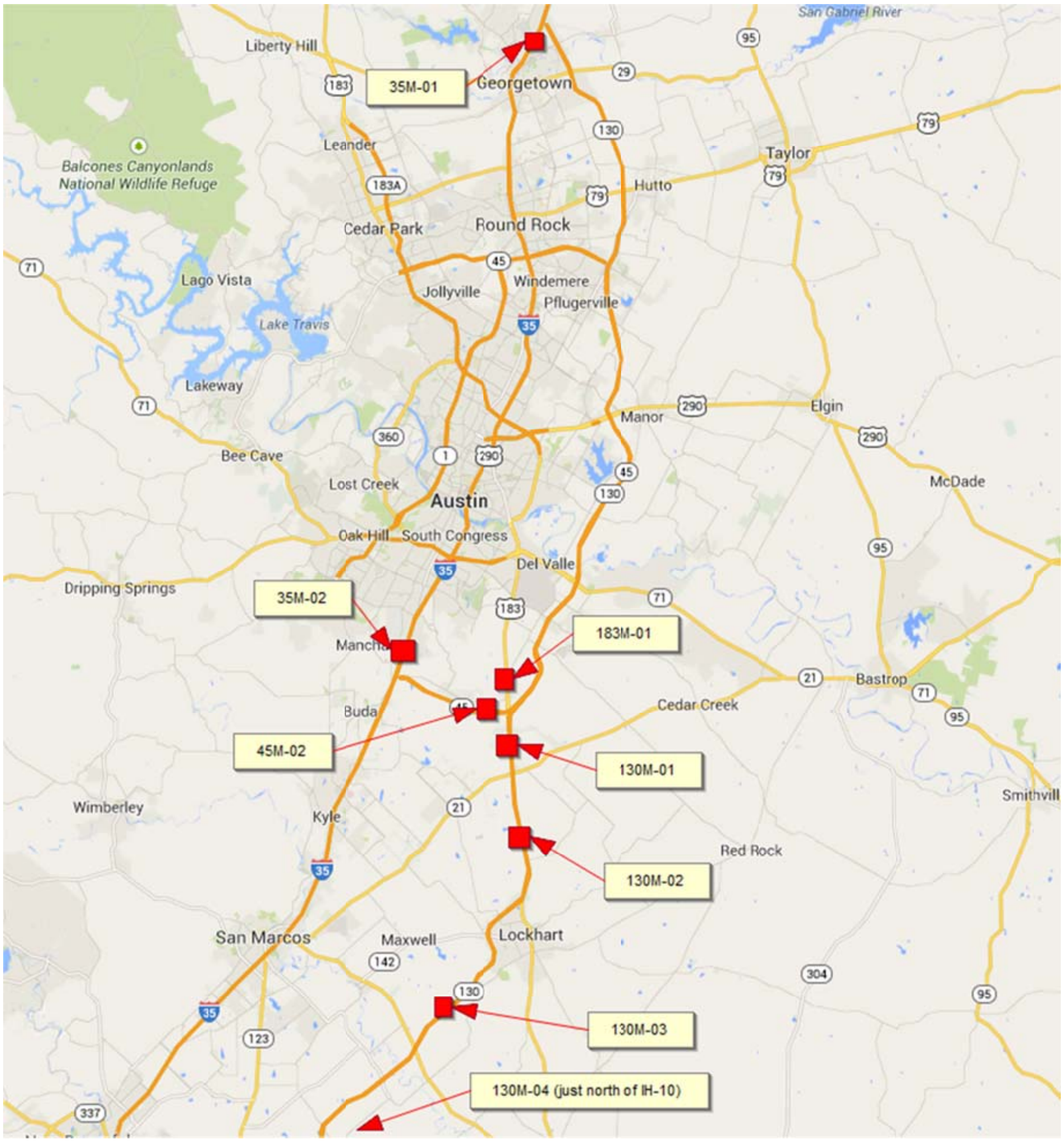

Figure 3. Mobile Bluetooth Reader Locations.

ALPR cameras were used to collect data on directional and through movements of vehicles at the IH-35/ SH 130 interchange near Georgetown and the IH-35 SH 45/130 interchange near Buda. The ALPR data was collected in order to provide a breakdown of non-commercial and commercial/truck vehicles for each videoed movement/direction. Table 4 lists the locations where ALPR cameras were deployed while Figure 4 shows those locations. ALPR data were collected for one 24-hour period on October 9, 2013.

After reviewing the ALPR data that were collected, it was determined that the camera placement did not allow for the capture of all commercial vehicle license plates. As a result, a second data collection effort was performed on October 30, 2013. The second ALPR data collection period coincided with a significant rain event in the area and the data collection had to be terminated after approximately 21 hours (around 9 p.m.)

Table 4. ALPR Locations.

	Site No.	Approximate ALPR Location	Lanes	Cameras Used	Explanation
IH-35N/SH 130 Interchange Area	35A-01	35N SB main lanes near SH 195	3	3	Total SB 35 traffic prior to SH 130 SB exit.
	35A-02	35N SB exit ramp to SH 130 SB	2	2	Total SB 35 traffic exiting on to SH 130
	35A-03	35N NB main lanes at Lakeway	3	3	Total NB 35 traffic just prior to SH 130 exit
	130A-01	130 NB main lanes south of Old Bishop Road	2	2	Total 130 NB traffic just prior to IH-35N interchange and just prior to last exit ramp to SH 130 feeder road
IH-35S/SH45/130 Interchange Area	35A-04	35S NB main lanes, prior to SH 45/130 NB exit	3	3	Total NB 35 traffic prior to SH 45/130 NB exit
	35A-06	35S NB exit ramp to SH 45/130 NB	2	1	Total 35S traffic exiting on to SH 45/130 NB
	130A-02	WB SH45/130 traffic to IH-35S	3	2	Total 45/130 WB traffic exiting to IH 35 (NB or SB)

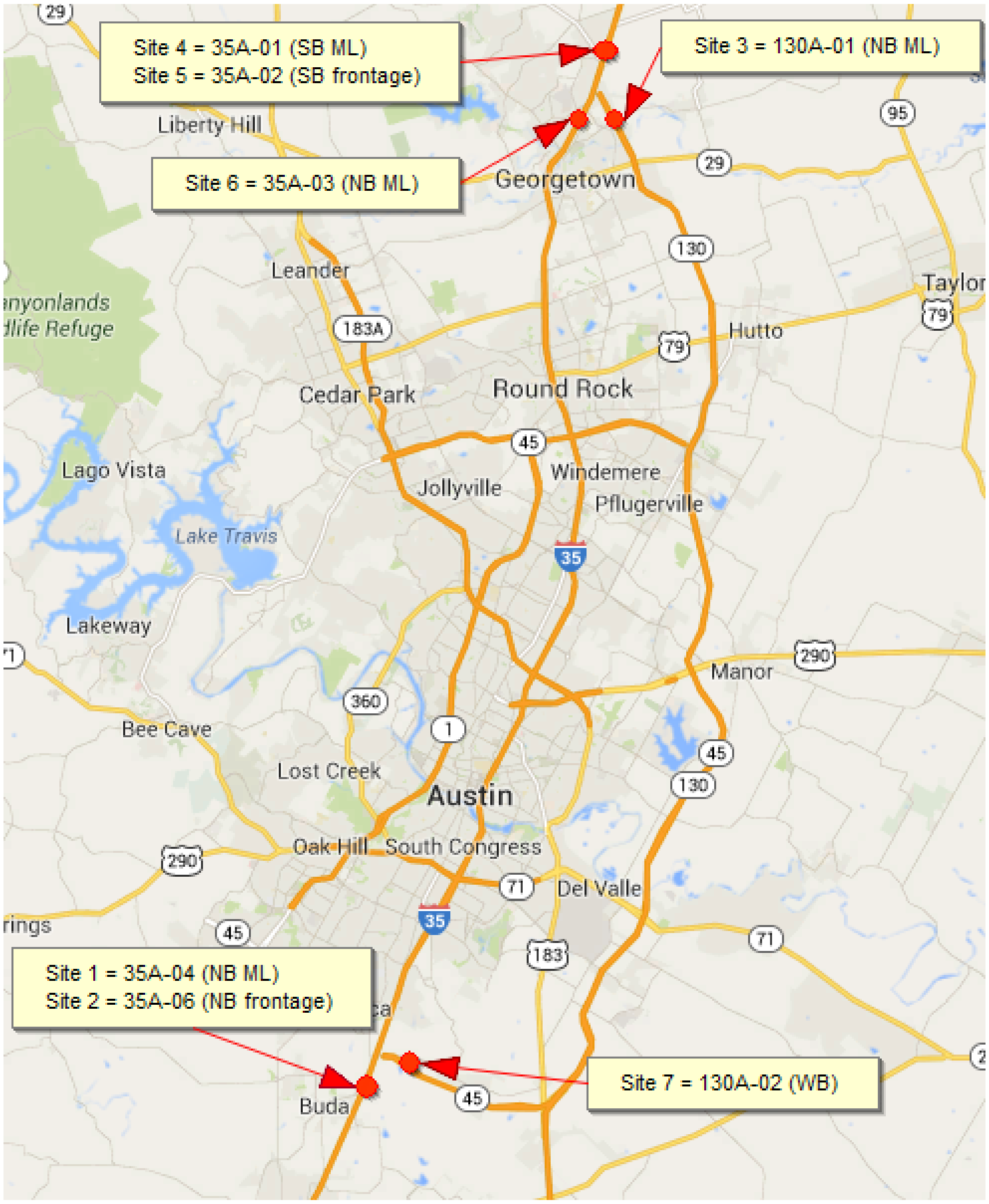

Figure 4. ALPR Data Collection Locations.

Vehicle Classification Count Summary

Vehicle classification counts (VCC) were conducted at each of the data collection locations for the same 3-day period that the BT data were collected. The counts were performed for both directions of travel and were aggregated into 15-minute increments. Since the Bluetooth results represents only a sample of traffic travelling through the area, the counts serve as a basis for expanding the Bluetooth data. The summarized results of the VCC data are provided in Tables 5-8. The results were aggregated into three primary groups, and those groups are:

- Non-commercial – classes 1-3
- Light Truck – classes 4-7
- Heavy Truck – classes 8-13

Additionally, the FHWA classification scheme that was utilized also has a 14th class that is for 'unclassified' vehicles. That is, those vehicles that could not be assigned to one of the 13 classification 'bins'. Due to some locations having a significant number of unclassed vehicles, it was determined to be necessary to account for the unclassified vehicles in the totals. Therefore, the unclassified vehicles were distributed proportionally (based on the percentage of daily vehicles in each of the three groups) and the subsequent results are shown in the 'Adjusted Daily Average' columns.

Table 5 provides a summary of the VCC results for those location along IH-35 where permanent BT readers have been deployed while Table 6 shows those locations along SH 130. Table 7 provides summary count results for mobile BT reader locations and Table 8 provides results for ALPR locations.

Table 5. VCC at Permanent BT Locations on IH-35.

Site	Direction	Daily Average				% NC	% Lt Trk	% Hvy Trk	Unclassed (3-day)	Daily Unclassed	Adjusted Daily Average*			
		NC	Lt Trk	Hvy Trk	Total						NC	Lt Trk	Hvy Trk	Total
35P-01	Northbound	31,889	1,270	1,708	34,867	91.46	3.64	4.90	1,081	360	32,218	1,283	1,726	35,227
	Southbound	29,222	1,588	881	31,691	92.21	5.01	2.78	389	130	29,341	1,594	885	31,820
35P-02	Northbound	34,338	2,694	2,703	39,735	86.42	6.78	6.80	721	240	34,546	2,710	2,719	39,975
	Southbound	34,019	1,389	5,085	40,493	84.01	3.43	12.56	525	175	34,166	1,395	5,107	40,668
35P-03	Northbound	53,638	4,252	4,286	62,177	86.27	6.84	6.89	1,185	395	53,979	4,279	4,313	62,572
	Southbound	56,433	2,802	2,549	61,783	91.34	4.53	4.13	959	320	56,725	2,816	2,562	62,103
35P-04	Northbound	63,762	4,397	6,271	74,431	85.67	5.91	8.43	1,245	415	64,118	4,422	6,306	74,846
	Southbound	65,771	3,271	2,637	71,679	91.76	4.56	3.68	1,119	373	66,114	3,288	2,651	72,052
35P-05	Northbound	75,018	3,949	6,238	85,205	88.04	4.63	7.32	978	326	75,305	3,964	6,262	85,531
	Southbound	79,138	3,579	3,759	86,477	91.51	4.14	4.35	1,061	354	79,462	3,594	3,774	86,830
35P-06	Northbound	79,500	3,798	6,343	89,641	88.69	4.24	7.08	1,022	341	79,802	3,813	6,367	89,981
	Southbound	84,463	3,636	4,548	92,646	91.17	3.92	4.91	1,071	357	84,788	3,650	4,565	93,003
35P-07	Northbound	79,286	3,605	6,520	89,410	88.68	4.03	7.29	852	284	79,538	3,616	6,540	89,694
	Southbound	85,044	3,099	4,410	92,552	91.89	3.35	4.76	945	315	85,333	3,109	4,425	92,867
35P-08	Northbound	104,297	6,433	5,319	116,049	89.87	5.54	4.58	6,201	2,067	106,154	6,548	5,413	118,116
	Southbound	99,059	3,554	5,292	107,906	91.80	3.29	4.90	1,106	369	99,398	3,566	5,310	108,275
35P-09	Northbound	93,806	10,999	7,394	112,198	83.61	9.80	6.59	2,232	744	94,428	11,072	7,443	112,942
	Southbound	100,014	3,406	6,380	109,800	91.09	3.10	5.81	1,221	407	100,385	3,419	6,403	110,207
35P-10	Northbound	79,779	4,554	8,901	93,234	85.57	4.88	9.55	7,494	2,498	81,916	4,676	9,140	95,732
	Southbound	93,005	3,196	3,339	99,540	93.43	3.21	3.35	825	275	93,262	3,205	3,348	99,815
35P-11	Northbound	72,527	6,096	8,135	86,758	83.60	7.03	9.38	7,252	2,417	74,548	6,266	8,361	89,175
	Southbound	83,998	3,185	4,318	91,502	91.80	3.48	4.72	797	266	84,242	3,195	4,331	91,767
35P-12	Northbound	63,923	6,033	6,998	76,955	83.07	7.84	9.09	6,422	2,141	65,701	6,201	7,193	79,095
	Southbound	74,772	2,332	3,868	80,972	92.34	2.88	4.78	741	247	75,000	2,339	3,880	81,219
35P-13	Northbound	57,516	5,872	7,030	70,418	81.68	8.34	9.98	6,133	2,044	59,186	6,042	7,234	72,462
	Southbound	58,745	10,645	6,692	76,082	77.21	13.99	8.80	9,146	3,049	61,099	11,071	6,960	79,130
35P-14	Northbound	47,537	4,868	5,765	58,171	81.72	8.37	9.91	5,065	1,688	48,917	5,009	5,933	59,859
	Southbound	49,900	8,005	5,772	63,677	78.36	12.57	9.06	3,806	1,269	50,894	8,164	5,887	64,945

Table 6. VCC at Permanent BT Locations on SH 130.

Site	Direction	Daily Average				% NC	% Lt Trk	% Hvy Trk	Unclassed (3day)	Daily Unclassed	Adjusted Daily Average*			
		NC	Lt Trk	Hvy Trk	Total						NC	Lt Trk	Hvy Trk	Total
45P-01	Eastbound	4,777	1,920	1,038	7,735	61.76	24.83	13.42	0	0	4,777	1,920	1,038	7,735
	Westbound	4,576	543	668	5,788	79.07	9.39	11.55	0	0	4,576	543	668	5,788
130P-02	Northbound	6,219	1,930	1,456	9,605	64.75	20.09	15.16	0	0	6,219	1,930	1,456	9,605
	Southbound	5,029	2,437	1,411	8,877	56.66	27.45	15.89	0	0	5,029	2,437	1,411	8,877
130P-03	Northbound	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	Southbound	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
130P-05	Northbound	7,702	3,081	2,083	12,866	59.86	23.95	16.19	0	0	7,702	3,081	2,083	12,866
	Southbound	7,794	2,813	2,032	12,639	61.67	22.26	16.07	0	0	7,794	2,813	2,032	12,639
130P-07	Northbound	12,792	1,981	654	15,427	82.92	12.84	4.24	0	0	12,792	1,981	654	15,427
	Southbound	11,975	2,123	1,897	15,996	74.87	13.27	11.86	0	0	11,975	2,123	1,897	15,996
130P-08	Northbound	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	Southbound	12,870	3,554	2,891	19,315	66.63	18.40	14.97	0	0	12,870	3,554	2,891	19,315
130P-09	Northbound	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	Southbound	11,928	2,365	1,583	15,876	75.13	14.89	9.97	0	0	11,928	2,365	1,583	15,876
130P-10	Northbound	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	Southbound	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
130P-11	Northbound	10,019	3,335	2,164	15,518	64.57	21.49	13.95	0	0	10,019	3,335	2,164	15,518
	Southbound	11,545	2,698	1,968	16,211	71.22	16.65	12.14	0	0	11,545	2,698	1,968	16,211
130P-12	Northbound	11,236	2,755	1,528	15,519	72.40	17.75	9.84	0	0	11,236	2,755	1,528	15,519
	Southbound	10,807	2,358	1,643	14,809	72.98	15.93	11.10	0	0	10,807	2,358	1,643	14,809
130P-14	Northbound	5,149	1,123	1,313	7,585	67.88	14.81	17.31	0	0	5,149	1,123	1,313	7,585
	Southbound	5,082	1,825	1,076	7,982	63.66	22.86	13.48	0	0	5,082	1,825	1,076	7,982
130P-15	Northbound	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	Southbound	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A

Table 7. VCC at Mobile BT Locations.

Site	Direction	Daily Average				% NC	% Lt Trk	% Hvy Trk	Unclassed (3day)	Daily Unclassed	Adjusted Daily Average*			
		NC	Lt Trk	Hvy Trk	Total						NC	Lt Trk	Hvy Trk	Total
183M-01	Northbound	5,771	1,431	409	7,611	75.83	18.80	5.37	0	0	5,771	1,431	409	7,611
	Southbound	6,177	933	334	7,444	82.98	12.54	4.49	0	0	6,177	933	334	7,444
130M-01	Northbound	2,181	1,669	467	4,317	50.53	38.65	10.82	0	0	2,181	1,669	467	4,317
	NB Frontage	3,619	2,769	775	7,163	50.53	38.65	10.82	0	0	3,619	2,769	775	7,163
	Total NB	5,800	4,437	1,242	11,479	50.53	38.65	10.82	0	0	5,800	4,437	1,242	11,479
	Southbound	3,352	992	884	5,229	64.11	18.98	16.91	0	0	3,352	992	884	5,229
	SB Frontage	4,834	1,431	1,275	7,540	64.11	18.98	16.91	0	0	4,834	1,431	1,275	7,540
	Total SB	8,186	2,424	2,160	12,769	64.11	18.98	16.91	0	0	8,186	2,424	2,160	12,769
45M-01	Eastbound	5,750	907	1,098	7,755	74.15	11.69	14.15	0	0	5,750	907	1,098	7,755
	Westbound	5,243	2,028	679	7,950	65.95	25.51	8.54	0	0	5,243	2,028	679	7,950
130M-02	Northbound	3,046	669	772	4,487	67.89	14.91	17.20	0	0	3,046	669	772	4,487
	Southbound	3,471	546	955	4,972	69.81	10.98	19.20	0	0	3,471	546	955	4,972
130M-03	Northbound	1,152	739	591	2,482	46.40	29.77	23.83	0	0	1,152	739	591	2,482
	Southbound	1,742	649	439	2,829	61.56	22.93	15.51	0	0	1,742	649	439	2,829
130M-04	Northbound	1,495	372	470	2,337	63.96	15.92	20.11	0	0	1,495	372	470	2,337
	Southbound	1,365	448	552	2,364	57.73	18.94	23.34	0	0	1,365	448	552	2,364
35M-01	Northbound	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	Southbound	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
35M-02	Northbound	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	Southbound	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A

Table 8. VCC at ALPR Locations.

Site	Direction	Daily Average				% NC	% Lt Trk	% Hvy Trk	Unclassed (3day)	Daily Unclassed	Adjusted Daily Average*			
		NC	Lt Trk	Hvy Trk	Total						NC	Lt Trk	Hvy Trk	Total
35A-01	SB ML	31,601	1,225	5,200	38,026	83.10	3.22	13.67	204	204	31,771	1,232	5,228	38,230
35A-02	SB Frontage	2,862	251	476	3,589	79.74	6.99	13.26	4	4	2,865	251	477	3,593
35A-03	NB ML	29,843	1,445	4,031	35,319	84.50	4.09	11.41	227	227	30,035	1,454	4,057	35,546
35A-04	NB ML	46,083	4,187	5,959	56,229	81.96	7.45	10.60	1,452	1,452	47,273	4,295	6,113	57,681
35A-06	NB Ramp	3,267	269	541	4,077	80.13	6.60	13.27	4	4	3,270	269	542	4,081
130A-01	NB ML	4,457	549	529	5,535	80.52	9.92	9.56	13	13	4,467	550	530	5,548
130A-02	WB Ramp	3,351	620	394	4,365	76.77	14.20	9.03	151	151	3,467	641	408	4,516

Bluetooth Summary

During the week of October 7, 2013 TTI utilized a combination of permanent and mobile Bluetooth readers along the IH-35, SH 130, and SH 45 corridors to gather information on travel patterns in the Austin area. The devices were configured to collect data for 72 consecutive hours during a Tuesday through Thursday time period (October 8-10, 2013). TTI personnel monitored all Bluetooth equipment and other data collection activities during this time period. The following is a summary of the Bluetooth data collection.

Table 9 provides the total number of observations per day for each of the Bluetooth data collection locations. Additionally, the 3-day total and daily average reads per location is provided. In order to assess the penetration of Bluetooth devices detected during the study, traffic count data was utilized to determine the percentage of vehicles that were detected with Bluetooth enabled equipment. Since the daily and total Bluetooth read data provided in Table 9 are not directionally specific, the count values provided in the table are for both directions of travel. The range of “% Reads” varies from three percent to 10 percent.

While deployed, the Bluetooth units transmitted data in real-time to TTI host software. TTI configured host software to determine the number of Bluetooth reads and the number of matches between each of the deployed stations such that a matrix of matches between each of the station deployments could be made. At the conclusion of the data collection process, the resulting matches were aggregated to determine the 3-day total number of matches and the number of daily average matches between all data collection locations.

Table 9. Bluetooth Observations by Location.

Site No.	Location Name	10/8/13	10/9/13	10/10/13	Total (3-day)	Avg (reads/day)	ADT (3-day avg)	% Reads
		Tue	Wed	Thu				
35P-01	IH-35 at Georgetown	6,619	6,821	7,325	20,765	6,922	67,047	10.3
35P-02	IH-35 at SH 29	6,061	5,931	5,751	17,743	5,914	80,643	7.3
35P-03	IH-35 at FM 1431	4,899	5,162	5,502	15,563	5,188	124,674	4.2
35P-04	IH-35 at US 79	10,182	10,245	10,544	30,971	10,324	146,898	7.0
35P-05	IH-35 at SH 45	8,041	8,686	8,379	25,106	8,369	172,361	4.9
35P-06	IH-35 at Parmer	8,119	8,613	9,032	25,764	8,588	182,985	4.7
35P-07	IH-35 at Braker	7,471	7,734	8,093	23,298	7,766	182,561	4.3
35P-08	IH-35 at US 183/US 290	9,881	9,959	10,019	29,859	9,953	226,390	4.4
35P-09	IH-35 at Airport Blvd	11,645	11,891	11,721	35,257	11,752	223,149	5.3
35P-10	IH-35 at 5th St	9,850	9,867	9,740	29,457	9,819	195,547	5.0
35P-11	IH-35 at Riverside	9,943	10,270	10,457	30,670	10,223	180,943	5.7
35P-12	IH-35 at Stassney	9,614	9,406	9,638	28,658	9,553	160,314	6.0
35P-13	IH-35 at Slaughter	7,244	7,477	8,395	23,116	7,705	151,592	5.1
35P-14	IH-35 at Buda	6,159	6,255	6,453	18,867	6,289	124,804	5.0
45P-01	SH45 at Turnersville	766	839	866	2,471	824	13,523	6.1
130P-02	SH 130 at SH 183	1,022	1,192	1,402	3,616	1,205	18,482	6.5
130P-03	SH 130 at FM 812	1,371	1,472	1,556	4,399	1,466	N/A	N/A
130P-05	SH 130 at SH 71	1,269	1,255	1,437	3,961	1,320	25,505	5.2
130P-07	SH 130 at FM 969	1,649	1,731	1,800	5,180	1,727	31,422	5.5
130P-08	SH 130 at US 290	1,715	1,776	1,884	5,375	1,792	N/A	N/A
130P-09	SH 130 at Parmer	1,619	1,681	1,804	5,104	1,701	N/A	N/A
130P-10	SH 130 at Cameron	1,912	2,088	2,176	6,176	2,059	N/A	N/A
130P-11	SH 130 at SH 45	1,879	1,954	2,026	5,859	1,953	31,279	6.2
130P-12	SH 130 at US 79	1,520	1,520	1,659	4,699	1,566	30,328	5.2
130P-14	SH 130 at Chandler	951	953	1,089	2,993	998	15,567	6.4
130P-15	SH 130 at FM 971	924	911	1,033	2,868	956	N/A	N/A
183M-01	US 183 N	564	433	433	1,430	477	15,055	3.2
130M-01	US 183 S	903	1,022	1,113	3,038	1,013	24,248	4.2
45M-01	SH 45 at US183	603	656	583	1,842	614	15,705	3.9
130M-02	SH 130 at Lockhart N	585	635	741	1,961	654	9,460	6.9
130M-03	SH 130 at Lockhart	281	302	328	911	304	5,311	5.7
130M-04	SH 130 at IH-10	323	341	363	1,027	342	4,701	7.3
35M-01	IH-35 at Lakeway	4,010	4,042	4,281	12,333	4,111	N/A	N/A
35M-02	IH-35 at SH 45	5,940	5,875	6,276	18,091	6,030	N/A	N/A
N/A	US 183 at Lockhart	635	630	678	1,943	648	N/A	N/A
Total		146,169	149,625	154,577	450,371	150,124		

Automatic License Plate Recognition Summary

A separate data collection method using Automatic License Plate Recognition (ALPR) equipment was employed by Gram Traffic. ALPR cameras were deployed at each of the seven locations listed in Table 4 and illustrated in Figure 4. The data collection plan called for the collection of data for all lanes of traffic in a pre-determined direction at each location for a 24-hour period.

The intent of the ALPR data collection was to utilize the processed results to compare against the Bluetooth results. However, due to issues with the ALPR data collection, the ability to compare data sets was compromised. On the initial data collection date (October 9, 2013) several of the camera set-up locations were on overpasses with the cameras positioned to capture the rear license plates of vehicles passing under the overpass. It was determined in reviewing the results that some commercial vehicle license plates were being missed due to the license plates not being 'flush' with the rear of the trailer (i.e., the plate was set back underneath the rear edge). Therefore, the total number of commercial vehicles was under-reported.

A determination was made to perform a second ALPR data collection. This took place three weeks after the initial data collection on the same day of the week (October 30, 2013). However, on this date there was a significant rain event in the region that caused the data collection to be suspended after 21-hours of data having been collected. Additionally, no classification counts were performed, which complicated matters by there not being any means to expand the collected data to a 24-hour period.

Despite these issues, after the data were collected it was processed and summarized by Gram Traffic. License plate results were anonymized by Gram Traffic prior to submitting to TTI for analysis. The data provided to TTI included the following information:

- License plate (randomized letters and numbers unique for each recorded plate)
- Time of day that the plate was recorded
- Site where plate was recorded
- State of plate
- Vehicle type

ALPR data can also provide an opportunity to assess the similarities and differences between the distributions obtained from the ALPR cameras and the vehicle classification counters. However, some noticeable disparities were evident when comparing data from the two methods. Based on the VCC results for the seven ALPR locations, the total number of vehicles counted (in the same direction that the cameras were facing) on October 9, 2013 was 149,195. The total number of plates recorded on October 9, 2013 was 95, 264 (approximately 64 percent of the VCC total). On October 30, 2013 the total number of plates recorded was 92,098 (or roughly 62 percent of the VCC total). Additionally, a review of the distribution of license plates observed on an hourly basis showed instances where the number of plates recorded exceeded the traffic count for that time period. Those results are provided in Figure 5. Each of the seven colored lines represents data from each of the seven ALPR sites. The lines represent the percentage of license plates captured (on an hourly basis) as compared to the traffic count for that same time period. The horizontal dashed red line was placed at 100% to illustrate what should be the expected maximum percentage. Site 4 was the only location where the 100% threshold was not exceeded during the course of the day.

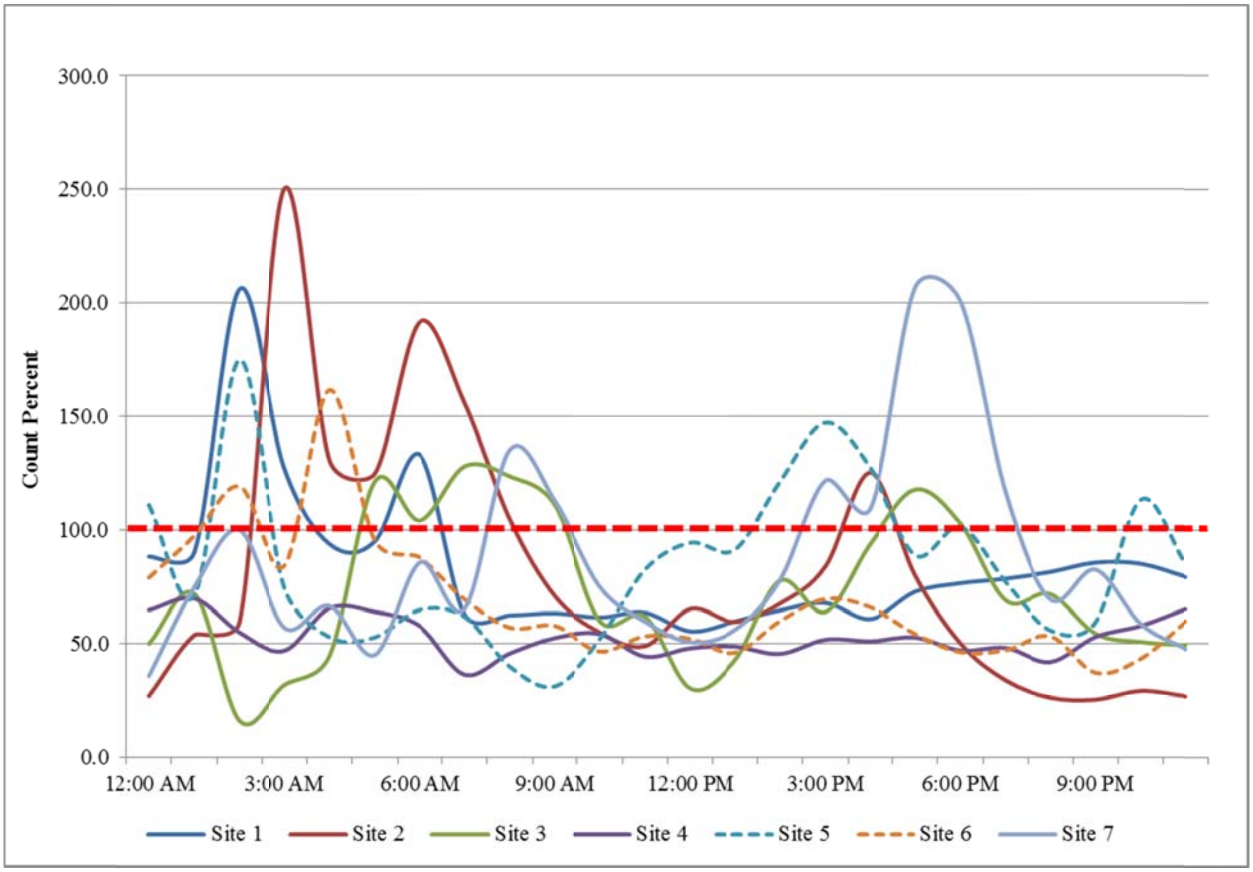

Figure 5. Percent of License Plates Recorded as Compared to Traffic Counts.

Furthermore, the ALPR data provides an opportunity to assess the distribution of vehicle types. Based on the results of the analysis, approximately 87 percent of the vehicles observed on October 30, 2013 were non-commercial vehicles (non-commercial and light trucks) and 13 percent were commercial vehicles (heavy trucks). For the data collection performed on October 9, 2013, the distribution of non-commercial vehicles was 90 percent and 10 percent were commercial. This discrepancy in the vehicle type distribution for the two dates is consistent with the purpose for performing the data collection a second time due to the cameras not capturing all of the commercial vehicles. These results are provided in Table 10.

Table 10. Vehicle Type Distribution per Site.

Number of Vehicles						
Site	October 9			October 30*		
	NC	COM	Total	NC	COM	Total
1	38,399	2,759	41,158	30,283	3,122	33,405
2	2,629	470	3,099	2,976	432	3,408
3	3,786	654	4,440	4,011	768	4,779
4	16,672	2,244	18,916	19,685	3,213	22,898
5	2,346	513	2,859	2,297	701	2,998
6	18,101	2,247	20,348	17,206	3,224	20,430
7	4,111	333	4,444	3,715	465	4,180
Total	86,044	9,220	95,264	80,173	11,925	92,098
Percent of Vehicles						
Site	October 9			October 30*		
	NC	COM	Total	NC	COM	Total
1	93.3	6.7	100.0	90.7	9.3	100.0
2	84.8	15.2	100.0	87.3	12.7	100.0
3	85.3	14.7	100.0	83.9	16.1	100.0
4	88.1	11.9	100.0	86.0	14.0	100.0
5	82.1	17.9	100.0	76.6	23.4	100.0
6	89.0	11.0	100.0	84.2	15.8	100.0
7	92.5	7.5	100.0	88.9	11.1	100.0
Total	90.3	9.7	100.0	87.1	12.9	100.0

*Approximately 21 hours of data were collected

A further analysis was conducted in order to ascertain how the vehicle type distribution percentages compared to the VCC results for the ALPR sites. As noted previously, the number of license plates recorded was significantly less than the total number of vehicles counted using the traditional classification method. For commercial vehicles, a total of 17,355 were counted at the seven ALPR locations on October 9, 2013. The ALPR results only recorded 9,220 commercial vehicles, or roughly 53 percent of the commercial vehicles identified via the VCC. On October 30, 2013 a total of 11,925 commercial plates were recorded. Since no counts were performed on the second ALPR data collection date, the actual percentage of plates recorded as compared to the VCC cannot be ascertained. If it were compared to the count on October 9, 2013 the percentage of plates recorded as compared to the VCC is 69 percent.

An overview of the commercial vehicle distribution is provided in Figure 6. The results are provided by site for each of the ALPR data collection dates as well as the VCC data collected on October 9, 2013. A review of the results shows no clear trends among the seven sites.

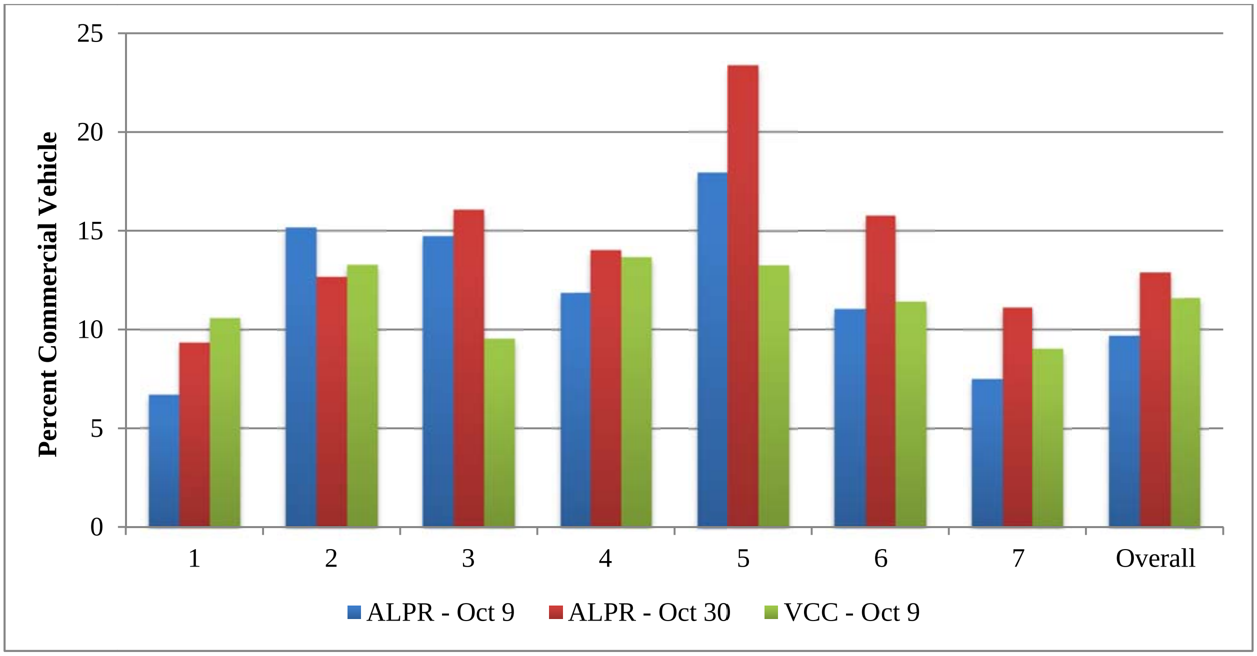

Figure 6. Distribution of Vehicle Types.

The ALPR data were processed by TTI to determine the number of license plate matches observed between specific data collection location. Since the cameras were deployed to capture data for specified directions, there were only three traffic movements that were evaluated. Those movements are as follows:

- Movement #1 – Northbound through traffic on IH-35 (site 1 to site 6)
- Movement #2 – Northbound through traffic diverted onto SH 130 (site 2 to site 3)
- Movement #3 – Southbound through traffic diverted onto SH 130 (site 5 to site 7)

The resulting matches were prepared in tabular format and are shown in Table 11. The table provides the results from both of the data collection dates. For the purpose of the analysis, those vehicles (primarily pick-up trucks) that were towing trailers were included in the non-commercial vehicle category. The results of the ALPR data analysis were intended to provide a means to compare the ALPR results against the Bluetooth results to provide the best O-D estimates possible. However, due to the issues involved with the ALPR data collection, the accuracy of the results is questionable.

Table 11. Summary of ALPR Matches by Movement.

10/9		Non-Commercial			Commercial			All Vehicles		
O	D	Plates @ Origin	Matches	% Matched	Plates @ Origin	Matches	% Matched	Plates @ Origin	Matches	% Matched
1	6	38,399	2,041	5.3	2,757	1,547	56.1	41,156	3,588	8.7
2	3	2,629	553	21.0	470	223	47.4	3,099	776	25.0
5	7	2,346	343	14.6	513	100	19.5	2,859	443	15.5
10/30		**Non-Commercial**			**Commercial**			**All Vehicles**		
O	D	Plates @ Origin	Matches	% Matched	Plates @ Origin	Matches	% Matched	Plates @ Origin	Matches	% Matched
1	6	30,283	939	3.1	3,122	648	20.8	33,405	1,587	4.8
2	3	2,976	603	20.3	432	243	56.3	3,408	846	24.8
5	7	2,297	334	14.5	701	156	22.3	2,998	490	16.3

Analysis of Bluetooth Data

The results of the Bluetooth data that were collected were analyzed in order to provide estimates of the amount of traffic that traveled through Austin on IH-35 as well diverted onto SH 130. The following sections provide results of those analyses.

Summary of Southbound Traffic on IH-35 and SH 130

The northern interchange of IH-35 and SH 130 falls between SH 195 and Lakeway Drive in the Georgetown area. Portable and permanent Bluetooth readers were utilized to determine the number of matched results observed at each data collection location. Furthermore, traffic count data was utilized to expand the matched results and to provide an estimate of the traffic that diverts onto SH 130 from IH-35 as well as whether or not that traffic continues through the greater Austin area.

There were a total of 5,433 Bluetooth matches between site 35P-01 and sites 35M-01 and 130P-15 (see Figure 7). Of those matches, 836 (15.4 percent) were between site 35P-01 and 130P-15. Using VCC data from site 35P-01, an estimate of the number and vehicle type of those vehicles that diverted onto SH 130 was developed. Those results are provided in Table 12.

Table 12. Estimate of Southbound Traffic Divergence.

Site	Description	Non-Com	Lt Truck	Hvy Truck	Total
35P-01	IH-35	29,341	1,594	885	31,820
35M-01	IH-35	24,823	1,348	749	26,920
130P-15	SH 130	4,519	246	136	4,900

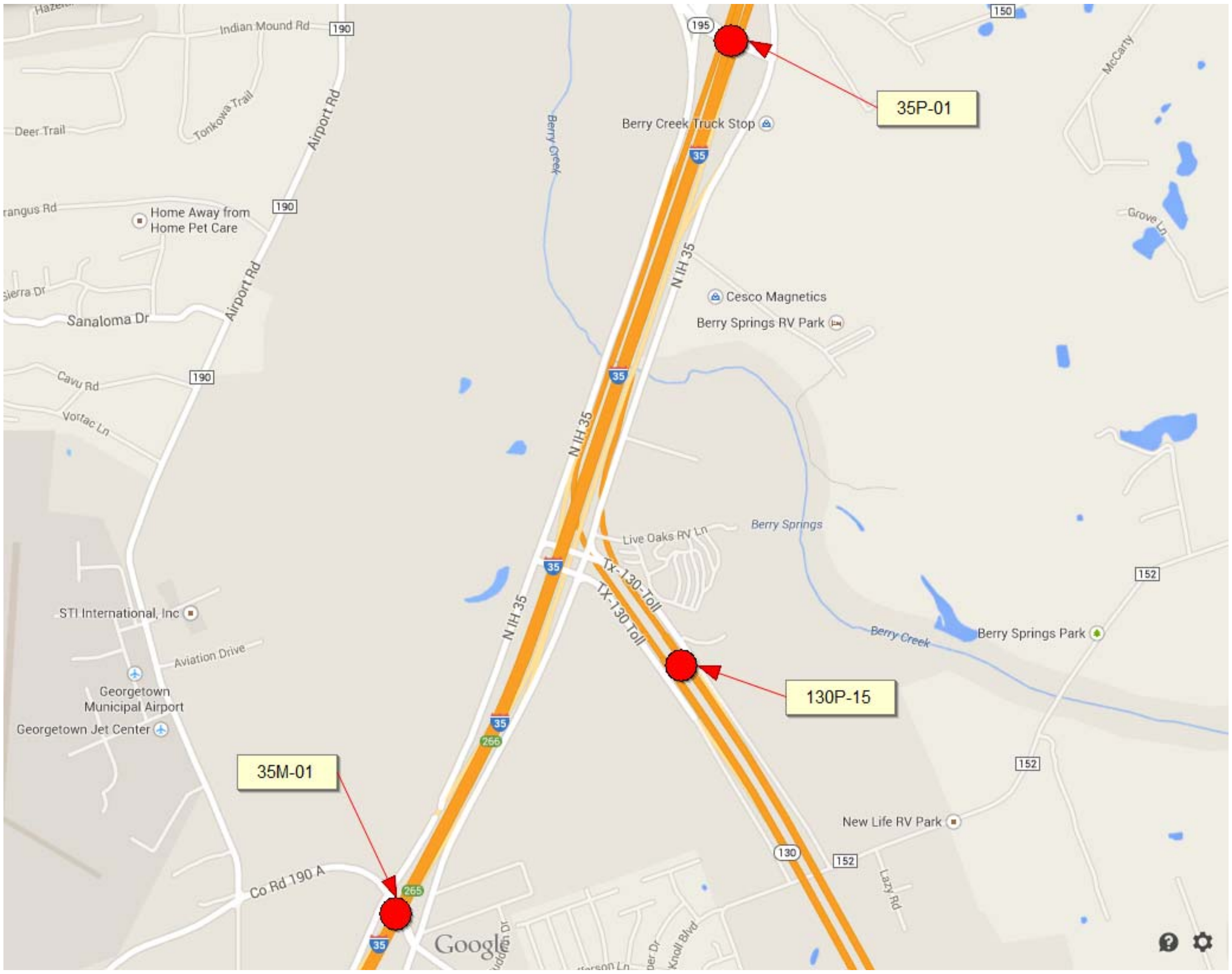

Figure 7. Northern IH-35/SH 130 Interchange.

Matches for those vehicles that diverted onto SH 130 were analyzed to provide an estimate of how many vehicles continued southbound along SH 130. Of those vehicles that diverted onto SH 130, approximately 37 percent continued on SH 130 until it merged back with IH-35 near Buda and 37 percent continued on SH 130 until it merged with IH-10 near Seguin. The results in terms of the vehicle types are shown in Table 13.

Table 13. Estimate of Vehicles Traveling to Buda and Seguin.

Site	Description	Non-Com	Lt Truck	Hvy Truck	Total
130P-15	SH 130 at FM 971	4,519	246	136	4,900
45P-01	SH 45 at IH-35 (Buda)	1,664	90	50	1,804
130M-04	SH 130 at IH-10 (Seguin)	1,669	91	50	1,810

The estimated number of vehicles at various points along the SH 130 corridor is provided in Table 14. The volumes provided for site 35P-01 are the actual VCC results for that location. The volumes for each following location are not the VCC for that respective location, but rather are the estimated number of vehicles (per aggregated vehicle type group) that diverted off of IH-35 onto SH 130 and continued on to each successive location along the corridor.

Table 14. Estimate of Southbound Vehicles on SH 130.

Site	Description	Non-Com	Lt Truck	Hvy Truck	Total
35P-01	IH-35 at Georgetown	29,341	1,594	885	31,820
130P-15	SH130 at FM 971	4,519	246	136	4,900
130P-14	SH130 at Chandler	4,847	263	146	5,257
130P-12	SH130 at US 79	4,914	267	148	5,329
130P-11	SH130 at SH 45	4,760	259	144	5,162
130P-10	SH130 at Cameron	4,899	266	148	5,312
130P-09	SH130 at Parmer	3,985	216	120	4,321
130P-08	SH130 at US 290	4,488	244	135	4,867
130P-07	SH130 at FM 969	5,140	279	155	5,574
130P-05	SH130 at SH 71	3,481	189	105	3,775
130P-03	SH130 at FM 812	4,349	236	131	4,717
130P-02	SH130 at US 183	2,701	147	81	2,929
45M-01	SH130 at US 183 W	1,581	86	48	1,715
45P-01	SH45 at Turnersville	1,664	90	50	1,804
130M-01	SH130 at US 183 S	2,270	123	68	2,461
130M-02	SH130 north of Lockhart	1,848	100	56	2,005
130M-03	SH130 south of Lockhart	1,350	73	41	1,465
130M-04	SH130 at IH-10	1,669	91	50	1,810

Approximately 85 percent of those vehicles traveling southbound on IH-35 did not divert onto SH 130. Of those vehicles, an estimated 54 percent continued on IH-35 through Austin and through site 35P-14 near Buda. A complete overview of the estimated number of vehicles at select locations along the IH-35 corridor is provided in Table 15. As with Table 14, the volumes provided for sites other than 35P-01 are not the traffic volumes for those sites, but rather are estimates of those vehicles that passed through 35P-01 and did not divert onto SH 130.

Table 15. Estimate of Southbound Vehicles on IH-35.

Site	Description	Non-Com	Lt Truck	Hvy Truck	Total
35P-01	IH-35 at Georgetown	29,341	1,594	885	31,820
35M-01	IH-35 at Lakeway Dr	24,823	1,349	749	26,920
35P-02	IH-35 at SH 29	24,228	1,316	731	26,276
35P-03	IH-35 at FM 1431	18,098	983	546	19,628
35P-04	IH-35 at US 79	24,906	1,353	751	27,010
35P-05	IH-35 at SH 45	20,439	1,110	616	22,166
35P-06	IH-35 at Parmer	19,600	1,065	591	21,256
35P-07	IH-35 at Braker	18,620	1,012	562	20,193
35P-08	IH-35 at US 183/US 290	21,038	1,143	635	22,816
35P-09	IH-35 at Airport Blvd	19,417	1,055	586	21,058
35P-10	IH-35 at 5th St	14,564	791	439	15,795
35P-11	IH-35 at Riverside	16,644	904	502	18,050
35P-12	IH-35 at Stassney	14,856	807	448	16,111
35P-13	IH-35 at Slaughter	14,820	805	447	16,072
35M-02	IH-35 at SH 45	16,670	906	503	18,079
35P-14	IH-35 at Buda	13,454	731	406	14,591

Summary of Northbound Traffic on IH-35 and SH 130

The southern interchange of IH-35 and SH 45/SH 130 falls between Onion Creek Parkway and Main Street in the Buda area. As with vehicles traveling in the southbound direction, portable and permanent Bluetooth readers were utilized to determine the number of matched results observed at each data collection location. Additionally, traffic count data was utilized to expand the matched results and to provide an estimate of the traffic that diverts onto SH 45/SH 130 from IH-35 as well as whether or not that traffic continues through the greater Austin area.

There were a total of 9,736 Bluetooth matches between site 35P-14 and sites 35M-02 and 45P-01 (see Figure 8). Of those matches, 1,059 (10.9 percent) were between site 35P-14 and 45P-01. Using VCC data from site 35P-14, an estimate of the number and vehicle type of those vehicles that diverted onto SH 45/SH 130 was developed. Those results are provided in Table 16.

Table 16. Estimate of Northbound Traffic Divergence.

Site	Description	Non-Com	Lt Truck	Hvy Truck	Total
35P-14	IH-35 at Buda	48,917	5,009	5,933	59,859
45P-01	SH 45	5,332	546	647	6,525
35M-02	IH-35 (north of SH 45)	43,585	4,463	5,286	53,334

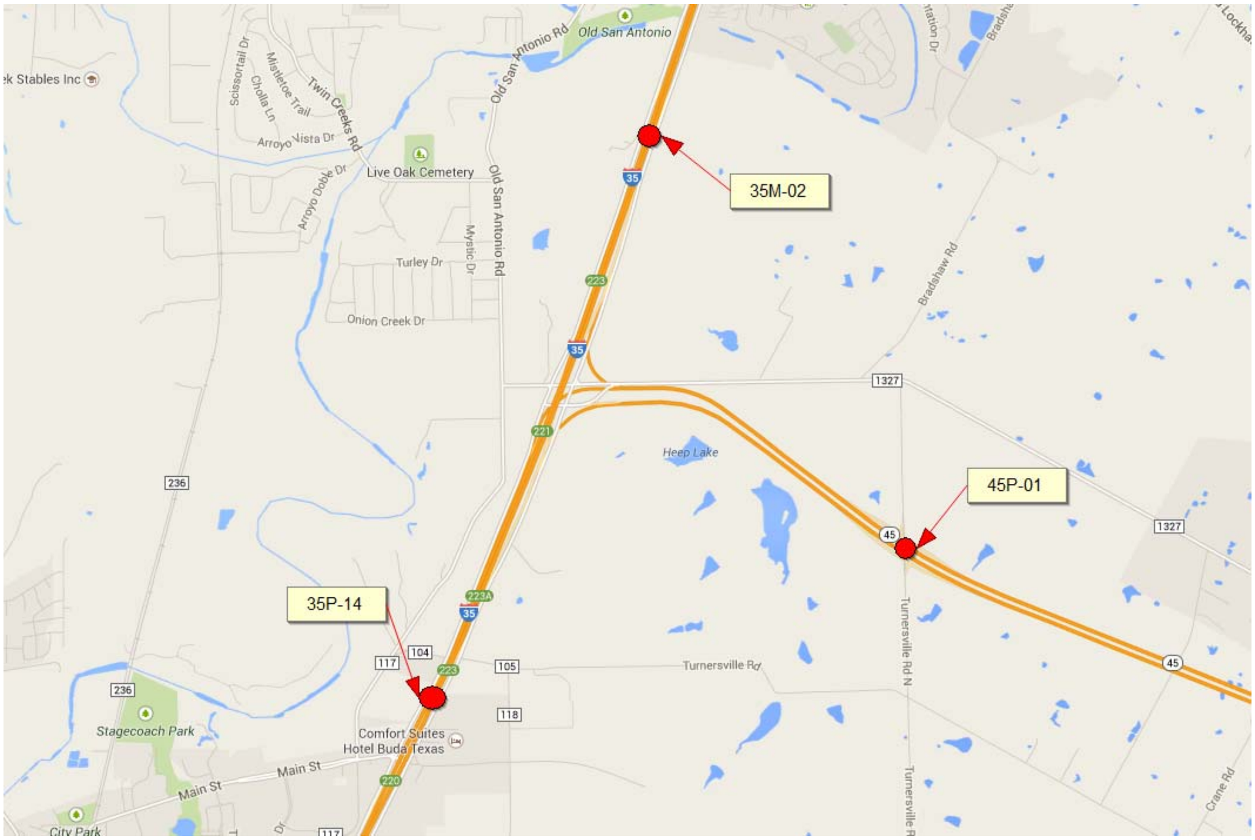

Figure 8. Southern IH-35/SH 45 Interchange.

Matches for those vehicles that diverted onto SH 45/SH 130 were analyzed to provide an estimate of how many vehicles continued northbound along SH 130. Of those vehicles that diverted onto SH 45/SH 130, approximately 50 percent continued on SH 130 until it merged back with IH-35 near Georgetown. The estimated number of vehicles at various points along the SH 130 corridor is provided in Table 17. As with previous tables, the traffic volume provided for 35P-14 is the true VCC for the data collection date. Each successive row represents the estimate of vehicles that passed through 35P-14 and traveled to/through that respective site.

Table 17. Estimate of Northbound Vehicles on SH 130.

Site	Description	Non-Com	Lt Truck	Hvy Truck	Total
35P-14	IH-35 at Buda	48,917	5,009	5,933	59,859
45P-01	SH45 at Turnersville	5,332	546	647	6,525
45M-01	SH130 at US 183 W	3,016	309	366	3,691
130P-02	SH130 at US 183	5,423	555	658	6,636
130P-03	SH130 at FM 812	3,519	360	427	4,307
130P-05	SH130 at SH 71	5,413	554	656	6,623
130P-07	SH130 at FM 969	3,650	374	443	4,467
130P-08	SH130 at US 290	4,738	485	575	5,798
130P-09	SH130 at Parmer	4,134	423	501	5,058
130P-10	SH130 at Cameron	4,219	432	512	5,163
130P-11	SH130 at SH 45	3,962	406	481	4,849
130P-12	SH130 at US 79	3,197	327	388	3,912
130P-14	SH130 at Chandler	2,623	269	318	3,210
130P-15	SH130 at FM 971	2,674	274	324	3,272

Approximately 89 percent of those vehicles traveling northbound on IH-35 did not divert onto SH 45/SH 130. Of those vehicles, an estimated 32 percent continued on IH-35 through Austin and through site 35M-01 just south of the northern IH-35/SH 130 interchange near Georgetown. A complete overview of the estimated number of vehicles at select locations along the IH-35 corridor is provided in Table 18. The traffic volume provided for 35P-14 is the true VCC for that site, and each successive row represents the estimate of vehicles that passed through 35P-14 and traveled to/through that respective site.

Table 18. Estimate of Northbound Vehicles on IH-35.

Site	Description	Non-Com	Lt Truck	Hvy Truck	Total
35P-14	IH-35 at Buda	48,917	5,009	5,933	59,859
35P-13	IH-35 at Slaughter	43,585	4,463	5,286	53,334
35P-12	IH-35 at Stassney	36,282	3,715	4,401	44,397
35P-11	IH-35 at Riverside	28,541	2,923	3,462	34,925
35P-10	IH-35 at 5th St	25,231	2,584	3,060	30,875
35P-09	IH-35 at Airport Blvd	22,478	2,302	2,726	27,506
35P-08	IH-35 at US 183/US 290	18,314	1,875	2,221	22,411
35P-07	IH-35 at Braker	17,716	1,814	2,149	21,679
35P-06	IH-35 at Parmer	18,460	1,890	2,239	22,589
35P-05	IH-35 at SH 45	16,581	1,698	2,011	20,290
35P-04	IH-35 at US 79	17,651	1,807	2,141	21,599
35P-03	IH-35 at FM 1431	13,798	1,413	1,674	16,885
35P-02	IH-35 at SH 29	14,014	1,435	1,700	17,149
35M-01	IH-35 at Lakeway	13,914	1,425	1,688	17,026

A final analysis examined those vehicles that entered onto SH 130 from IH-10 near Seguin. Of those vehicles that that entered onto SH 130 at Seguin, an estimated 67 percent traveled the entire length of SH 130 to the northern interchange with IH-35 near Georgetown. Using the traffic count obtained at site 130M-04, a distribution of vehicles at various points along the corridor is provided in Table 19. As with previous tables, the distribution of vehicles at locations other than site 130M-04 are not the VCC for the location but rather a distribution of those vehicles that passed through site 130M-04.

Table 19. Estimate of Northbound Vehicles on SH 130 Entering from IH-10.

Site	Description	Non-Com	Lt Truck	Hvy Truck	Total
130M-04	SH 130 at IH-10	1,495	372	470	2,337
130M-03	SH130 south of Lockhart	1,495	372	470	2,337
130M-02	SH130 north of Lockhart	1,565	389	492	2,446
130M-01	SH130 at US 183 S	1,481	369	466	2,315
130P-02	SH130 at US 183	1,370	341	431	2,141
130P-03	SH130 at FM 812	998	248	314	1,560
130P-05	SH130 at SH 71	1,342	334	422	2,097
130P-07	SH130 at FM 969	1,082	269	340	1,691
130P-08	SH130 at US 290	1,295	322	407	2,025
130P-09	SH130 at Parmer	1,216	303	382	1,902
130P-10	SH130 at Cameron	1,249	311	393	1,952
130P-11	SH130 at SH 45	1,189	296	374	1,858
130P-12	SH130 at US 79	1,147	285	361	1,793
130P-14	SH130 at Chandler	970	241	305	1,517
130P-15	SH130 at FM 971	1,003	250	315	1,568

Summary of Bluetooth Reader Detection

At first glance, a review of the Bluetooth matching results might not seem to follow an expected matching pattern. That is, the number of matches between the origin location and each successive location along a corridor was not always a linear decline. Table 20 provides the match percentage results for the IH-35 and SH 130 corridors in the southbound and northbound directions. For southbound IH-35, site 35P-03 shows a match percentage that appears low and site 35P-04 has a match percentage that is higher than expected. For southbound SH 130, sites 130P-14 through 130P-10 all have a match percentage over 100 percent.

It is important to remember that the results provided are ‘estimates’ of travel that occurred. An ideal situation would result in match percentages that decline in a linear manner. However, that would be predicated on the Bluetooth readers capturing 100 percent of the anonymous Bluetooth signals passing through the “read zone”. Causes for Bluetooth readers not capturing 100 percent of the signals can include reader placement, antenna positioning, or occlusion of the antenna. For site 35P-03 southbound, the match percentage does not fit a normal expected decline along the corridor. However, that same site in the northbound direction has a more reasonable result. Therefore, it can be deduced that the reader placement was such that it captured the northbound direction more accurately than the southbound direction. The review of the data for the entire study period indicated that this occurrence was consistent for each day of the study period.

Table 20. Match Percentages on IH-35 and SH 130.

Southbound					
IH-35			SH 130		
Site	**Description**	**Match %**	**Site**	**Description**	**Match %**
35M-01	IH-35 at Lakeway	100.0%	130P-15	SH 130 at FM 971	100.0%
35P-02	IH-35 at SH 29	97.6%	130P-14	SH 130 at Chandler	107.3%
35P-03	IH-35 at FM 1431	72.9%	130P-12	SH 130 at US 79	108.8%
35P-04	IH-35 at US 79	100.3%	130P-11	SH 130 at SH 45	105.3%
35P-05	IH-35 at SH 45	82.3%	130P-10	SH 130 at Cameron	108.4%
35P-06	IH-35 at Parmer	79.0%	130P-09	SH 130 at Parmer	88.2%
35P-07	IH-35 at Braker	75.0%	130P-08	SH 130 at US 290	99.3%
35P-08	IH-35 at US 183/US 290	84.8%	130P-07	SH 130 at FM 969	113.8%
35P-09	IH-35 at Airport Blvd	78.2%	130P-05	SH 130 at SH 71	77.0%
35P-10	IH-35 at 5th St	58.7%	130P-03	SH 130 at FM 812	96.3%
35P-11	IH-35 at Riverside	67.1%	130P-02	SH 130 at US 183	59.8%
35P-12	IH-35 at Stassney	59.8%	130M-01	SH 130 at US 183 S	50.2%
35P-13	IH-35 at Slaughter	59.7%	130M-02	SH 130 at Lockhart N	40.9%
35M-02	IH-35 at SH 45	67.2%	130M-03	SH 130 at Lockhart S	29.9%
35P-14	IH-35 at Buda	54.2%	130M-04	SH 130 at IH-10	36.9%
Northbound					
IH-35			**SH 130**		
Site	**Description**	**Match %**	**Site**	**Description**	**Match %**
35P-13	IH-35 at Slaughter	100.0%	45P-01	SH 45 at Turnersville	100.0%
35P-12	IH-35 at Stassney	83.2%	130P-02	SH 130 at US 183	101.7%
35P-11	IH-35 at Riverside	65.5%	130P-03	SH 130 at FM 812	66.0%
35P-10	IH-35 at 5th St	57.9%	130P-05	SH 130 at SH 71	101.5%
35P-09	IH-35 at Airport Blvd	51.6%	130P-07	SH 130 at FM 969	68.5%
35P-08	IH-35 at US 183/US 290	42.0%	130P-08	SH 130 at US 290	88.9%
35P-07	IH-35 at Braker	40.6%	130P-09	SH 130 at Parmer	77.5%
35P-06	IH-35 at Parmer	42.4%	130P-10	SH 130 at Cameron	79.1%
35P-05	IH-35 at SH 45	38.0%	130P-11	SH 130 at SH 45	74.3%
35P-04	IH-35 at US 79	40.5%	130P-12	SH 130 at US 79	60.0%
35P-03	IH-35 at FM 1431	31.7%	130P-14	SH 130 at Chandler	49.2%
35P-02	IH-35 at SH 29	32.2%	130P-15	SH 130 at FM 971	50.1%
35M-01	IH-35 at Lakeway	31.9%			

With regards to southbound SH 130, it is likely that the reader at site 130P-15 did not capture all of the Bluetooth signals and therefore the following match percentages (that were over 100 percent) are reflective of that. It is also worth noting that the number of observations along SH

130 were significantly less than on IH-35 so any ‘irregularities’ are magnified due to the smaller sample size. That is, there was an average of 293 daily matches between site 35P-01 (the starting detection point on IH-35) and site 130P-15 (the first detection point on SH 130). Additionally, there was an average of 315 daily matches between site 35P-01 and site 130P-14 (the second detection point on SH 130). So the second detection point (130P-14) only had an average of 22 more daily matches, but the resulting match percentage equates to 107 percent.

The majority of Bluetooth readers used for this study are permanent installations along IH-35 and SH 130 utilized for obtaining real-time travel time and speed information for traffic management. As a result, their locations might not have been ideal for an origin-destination study. However, using the permanent infrastructure did provide for adequate samples to obtain the data needed to provide a representation of the traffic patterns.

When looking at the match percentages along the corridors in terms of linear trends, the data exhibit the expected result of decline along the corridor. Figure 9 and Figure 10 provide a graphical illustration of the match percentages on IH-35 and SH 130, respectively. In addition to providing the match percentages, the figures provide a linear trend line (dashed line) for each data series. The match rates are generally higher in the southbound direction on both corridors. Additionally, the trajectory of the decline in match percentage is similar for each direction in the IH-35 corridor as well as both directions for the SH 130 corridor.

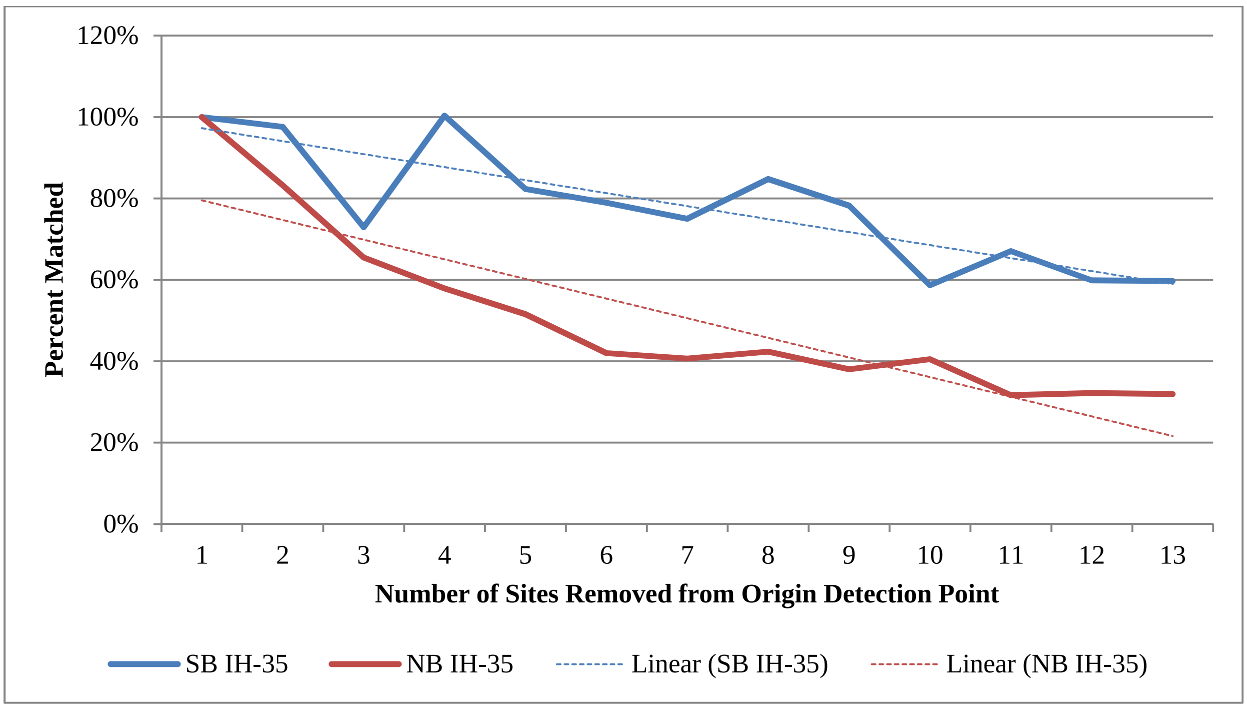

Figure 9. Match Percentages on IH-35.

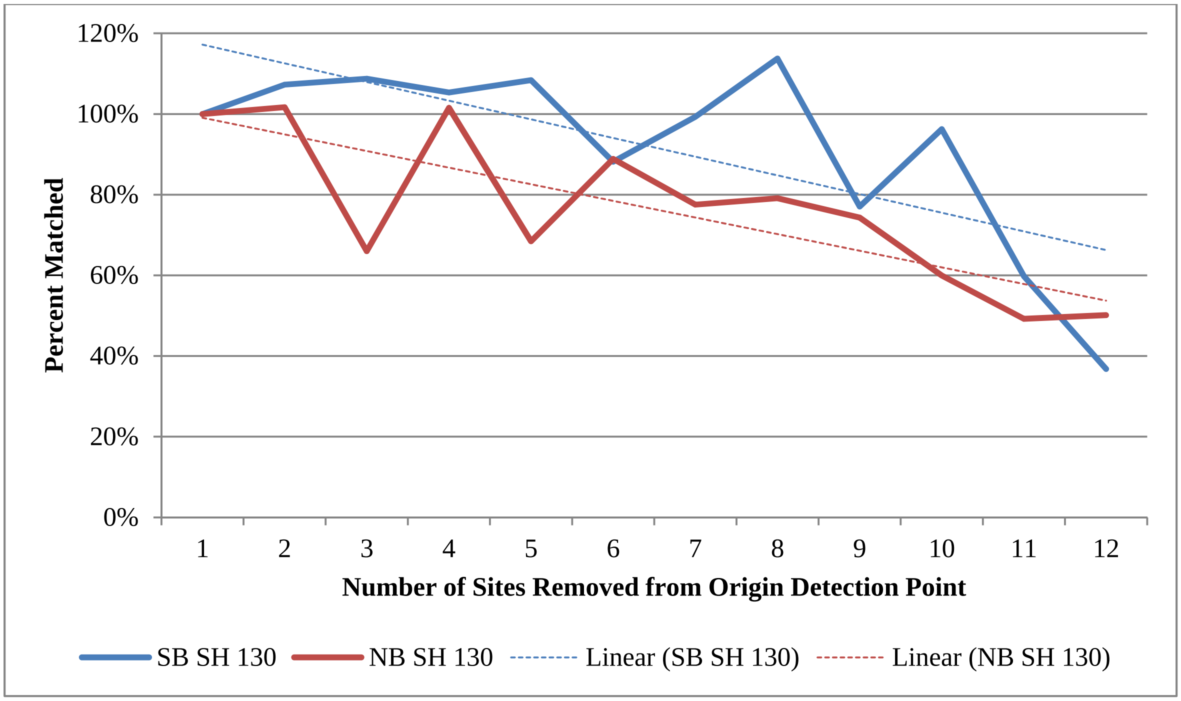

Figure 10. Match Percentages on SH 130.

Comparison of Bluetooth and ALPR Results

As noted in the review of the ALPR results, the problems encountered with the license plate data collection compromised the integrity of the results. Despite this, the results were compared against corresponding data collected via the Bluetooth methodology. The resulting percentage of estimated through trips for both data collection methodologies is provided in Table 21.

Table 21. Summary ALPR and Bluetooth Through Trip Results.

Origin	Destination	Facility/Direction	Percent Matched		
			ALPR - 10/9	ALPR - 10/30	Bluetooth
35A-04	35A-03	IH 35 NB	8.7	4.8	31.9
35A-06	130A-01	SH 130 NB	25.0	24.8	50.1
35A-02	130A-02	SH 130 SB	15.5	16.3	36.8

The ALPR and Bluetooth estimates of through trip percentages were also developed as an average of the two data collection methodologies. Figure 11 and Figure 12 provide a graphical representation of the percentage of through trips as determined by ALPR, Bluetooth, and an average of the two methods for ALPR data collected on October 9, 2013 and October 30, 2013, respectively.

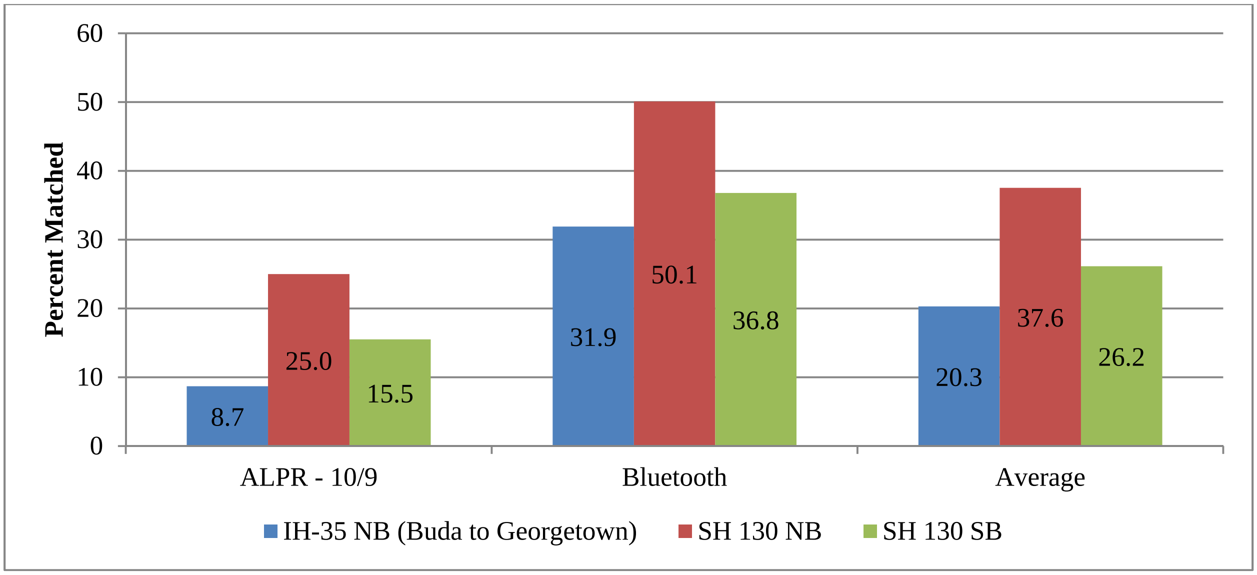

Figure 11. ALPR (10/9) and Bluetooth Through Trip Estimates.

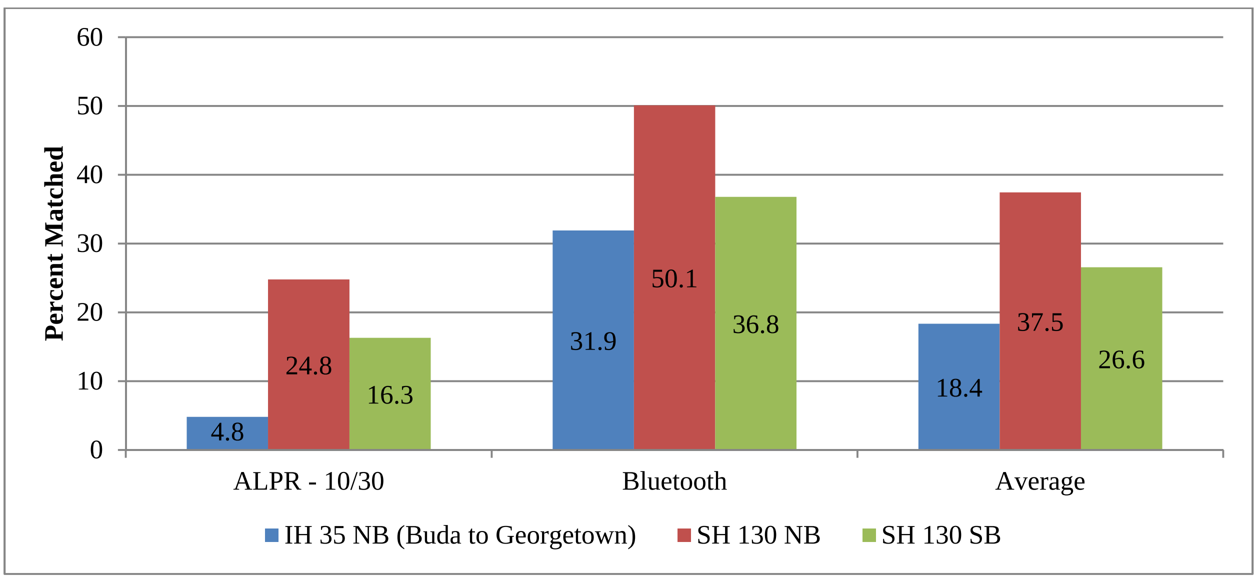

Figure 12. ALPR (10/30) and Bluetooth Through Trip Estimates.

Conclusions

The preceding sections provide details pertaining to the data collected as part of the 2013 IH-35/SH 130 Commercial Vehicle Diversion Study. Using methods previously employed in other areas as a means to estimate travel patterns within an area, these data can provide useful information for planning purposes. While the geographic scope was limited to two primary corridors, the impact that the corridors have on traffic in the region is significant.

The following provides a summary of the key findings as determined from the Bluetooth analyses provided previously.

Findings for Southbound (SB) Traffic on IH-35 Approaching from North of Austin

- Site 35P-01 (north of the SH 130 interchange) had a daily average of 31,820 vehicles traveling SB on IH-35. Of those vehicles, 15.4 percent (4,900 vehicles) diverted onto SH 130.
- Based on VCC data from Site 35P-01, an estimated 4,519 non-commercial vehicles, 246 light trucks, and 136 heavy trucks diverted off of IH-35 onto SH 130.
- Of those vehicles that diverted onto SH 130, roughly 37 percent remained on SH 130 until the IH-35/SH 45-130 interchange near Buda.
- Of the vehicles that diverted onto SH 130, almost 37 percent remained on SH 130 until the terminus at IH-10 near Seguin.
- For those vehicles that did not divert onto SH 130, over half (54 percent) passed through the data collection location in Buda.

Findings for Northbound (NB) Traffic on IH-35 Approaching from South of Austin

- Site 35P-14 (south of the SH 45/130 interchange) had a daily average of 59,859 vehicles traveling NB on IH-35. Of those vehicles, 10.9 percent (6,525 vehicles) diverted onto SH 45/130.
- Based on VCC data from Site 35P-14, an estimated 5,332 non-commercial vehicles, 546 light trucks, and 647 heavy trucks diverted off of IH-35 onto SH 45/130.
- Of those vehicles that diverted onto SH45/130, half (50 percent) traveled on SH 45/130 until the interchange with IH-35 near Georgetown.
- Of those vehicles that did not divert onto SH 45/130, roughly one-third (32 percent) traveled all the way through the Austin area on IH-35.

Findings for Northbound (NB) Traffic on SH 130 Entering Near Seguin

- Based on VCC data from Site 130M-04, an estimated 2,337 vehicles (1,495 non-commercial, 372 light truck, and 470 heavy truck) entered onto SH 130 via IH-10.
- For those vehicles that entered SH 130 from IH-10 (near Seguin), two-thirds (67 percent) travelled northbound through the region on SH 130 until the interchange with IH-35 near Georgetown.
- Of those vehicles that entered onto SH 130 at Seguin, an estimated 1,566 (1,002 non-commercial, 249 light truck, and 315 heavy truck) traveled the length of the toll road until the northern terminus at IH-35 near Georgetown.

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