West Virginia Turnpike
2018 Revenue Bond Study

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Prepared for

West Virginia
Parkways Authority

CDM Smith

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Executive Summary

The West Virginia Parkways Authority (WVPA) is studying the effects of potential changes in toll policy on traffic and toll revenue on the West Virginia Turnpike (Turnpike). The changes under consideration include increases in toll rates as well as the introduction of a revised flat fee program offered to customers driving passenger cars, available through the West Virginia electronic toll collection program (WV E-ZPass). WVPA seeks to provide for continued funding for Turnpike capital projects and operations & maintenance costs, as well as additional bonding capacity for other roadway projects in the state to improve access to the Turnpike and other major highways that ultimately connect to the Turnpike for business, individuals, and commercial transportation providers alike.

As used in this report, the terms "flat fee program" and/or "flat fee" refer to the single fee discount program authorized under Chapter 17, Article 16A of the West Virginia Code, 1931, as amended (the "Authority Act") for Class 1 vehicle customers. Under this program, a Class 1 customer can obtain unlimited travel on the Turnpike for an annual fee plus a one-time issuance fee for the vehicle transponder. CDM Smith also analyzed a limited (one-time) early enrollment option that will allow Class 1 customers to participate in the flat fee program for calendar years 2019, 2020, and 2021 at a lower price if such customers opted, prior to December 31, 2018, to participate in the flat fee program and paid the lower price (and any issuance fee) covering all three years. As used in this report, this option is generally referred to as the "early enrollment option". The full terms and conditions of any toll increases, the flat fee program, the early enrollment option, issuance fee, and any related temporary price adjustments are subject to applicable law and further action of WVPA.

As part of this study, CDM Smith collected and analyzed background data on the Turnpike, detailed traffic and revenue (T&R) data covering the last twenty-five years of operation, and customer frequency of use data. By examining prior Turnpike performance, historic local and regional economics, and economic forecasts, a Baseline forecast without toll policy changes was established. A stated preference (SP) survey was conducted to determine the likely reaction of existing customers to a variety of toll policy changes. T&R models were developed to be sensitive to potential toll policy changes and several alternatives were examined. WVPA staff and advisors identified one of these alternatives as best balancing the relevant considerations and variables (the "Prospective Scenario") in calendar years 2018-2050. Finally, CDM Smith conducted sensitivity tests on key assumptions.

ES.1 Study Objectives and Approach

The objective of this study is to understand current travel on the Turnpike, future baseline conditions, future likely conditions based on revised toll policies, and generate an investment grade T&R forecast suitable for supporting toll revenue bonds. The study approach is summarized below by task.

Task 1 – Data Collection and Analysis

- Review relevant studies and reports
- Examine and analyze detailed historical data including toll class and payment type shares by plaza, as well as E-ZPass based frequency data
- Evaluate historical traffic data for nearby roadways
- Establish and analyze frequency of use patterns from Location-Based Services (LBS) data

Task 2 – Stated Preference Survey

- Develop on-line survey instrument to cover range of possible tolling policies
- Distribute information on survey through handouts to customers at plazas, emails to WV and Non-WV E-ZPass customers, and general information posters
- Consolidate survey results and develop statistical payment choice models for Class 1

Task 3 – Econometric Model

- Assemble historical data and forecasts of socioeconomic conditions in the region and nearby areas that contribute traffic to the Turnpike
- Perform econometric modeling against Turnpike data compiled in Task 1
- Prepare a base case forecast of normal traffic growth for the Turnpike under a scenario with no toll policy change
- Prepare baseline, low, and high forecasts of future annual T&R

Task 4 – Traffic and Toll Revenue Estimates

- Assess the impact of transportation improvement projects that would likely affect the usage of the Turnpike in the future
- Analyze impacts of the prior toll rate increase to estimate the toll elasticity of the Turnpike
- Develop a spreadsheet model which applies market shares from Task 3, baseline forecasts from Task 4, and toll policies to develop T&R streams
- Analyze scenarios, as identified by WVPA, producing estimates of annual T&R

Task 5 – Documentation

- Develop a comprehensive report documenting data, analysis, and findings suitable for use in an Official Statement

Task 6 – Meetings

- Present draft results to WVPA staff, finance working group, board subcommittees, and WVPA board as needed
- Attend WVPA public meetings on proposed toll rate increases
- Attend and present at bond rating agency meetings

ES.2 Background

Construction on the Turnpike began in 1952 and the first segment was opened in 1954. A series of upgrades in the 1970s and 80s resulted in the entire Turnpike being brought up to Interstate standards by 1987. The Turnpike is 88 miles in length with four travel lanes (two in each direction) between Charleston and Princeton. The Turnpike is designated as Interstate 77 along its entire length, but also carries the Interstate 64 designation from Charleston to just south of Beckley.

The Turnpike is an important north-south Interstate travel corridor linking eastern Ohio and western Pennsylvania in the north to eastern Kentucky, Virginia, North Carolina, and other states in the southeastern U.S. The Turnpike extends through mountainous terrain over much of its length; these mountains are a barrier to travel as shown on the regional location map (**Figure ES-1**). Posted speed limits are up to 70 miles per hour, reflecting the high design standards of the facility. The Turnpike

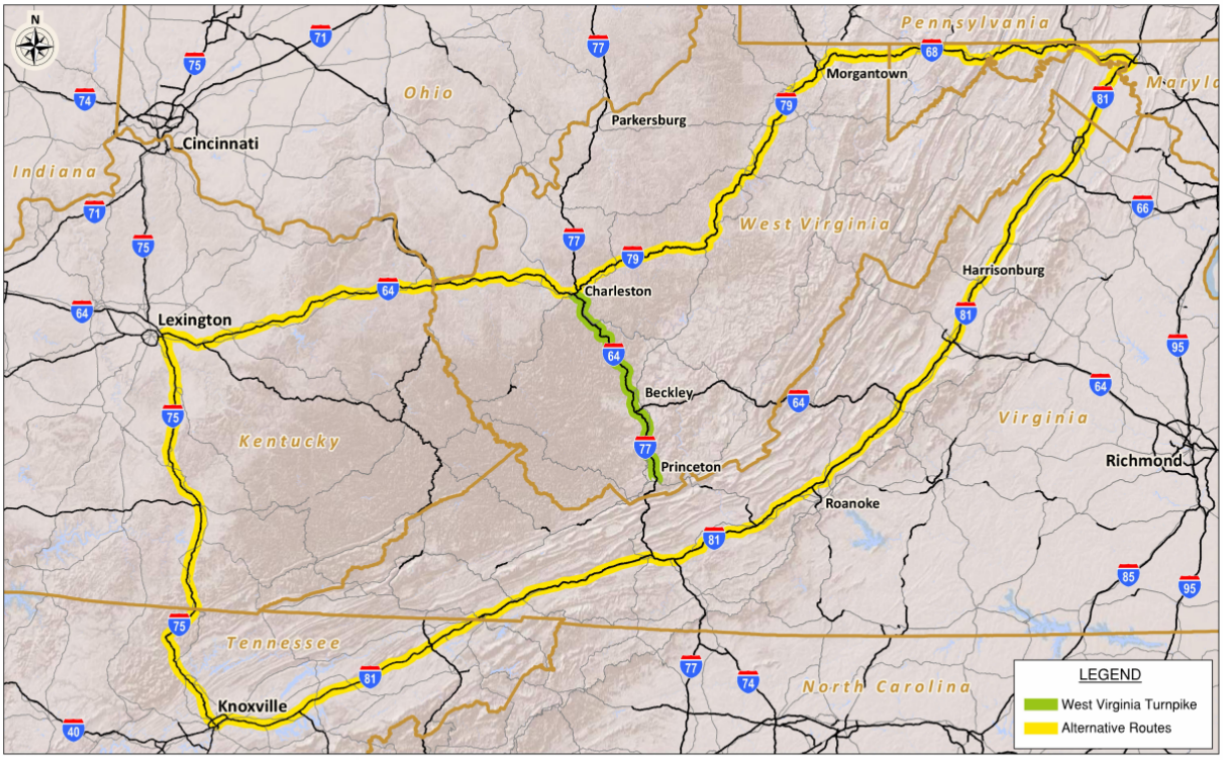
serves as a "land bridge" across these mountains. The alternative routes are I-75 in the west and I-68 in the east. For many trips these are not very strong competitors to the Turnpike.

CDM Smith has provided T&R forecasting services for the Turnpike for several decades. The most recent major studies include:

- A comprehensive T&R forecast conducted in 2005
- A Traffic and Toll Revenue Study conducted in 2009 to determine the effect of permanent toll increases and E-ZPass based discounts on transactions and toll revenue

After the 2009 study, WVPA established a toll increase as well as discounts for all WV E-ZPass customers and Non-WV E-ZPass commercial vehicle customers. Those toll rates remain in place today.

Figure ES-1 West Virginia Regional Location Map



ES.3 Existing Conditions

There are three mainline toll plazas along the Turnpike, at Ghent (Toll Plaza A) located at milepost 30, Pax (Toll Plaza B) at milepost 56, and Chelyan (Toll Plaza C) at milepost 83. There is also one ramp toll plaza located on Route 19, the North Beckley Exit at milepost 48. Tolls are collected in both directions at the mainline plazas and to and from the south at the North Beckley Plaza.

The Turnpike passes through the West Virginia counties of Kanawha, Fayette, Raleigh, and Mercer, serving cities including Charleston, Beckley, and Princeton. In addition to these cities, smaller communities with more localized trip origins and destinations are served. A large proportion of travel on the Turnpike consists of long-distance interstate trips.

A summary of the toll rate schedule currently in place on the Turnpike is presented in **Table ES-1**.

Currently, a Personal Discount Plan #1 provides unlimited usage of any number of plazas for an annual flat fee. The program is restricted to passenger cars and trucks without a trailer and having a gross vehicle weight of less than 8,000 pounds that are not being used for commercial or business purposes. Subscribers can choose any combination of the three mainline plazas for a flat fee of $25 per plaza per quarter of the year. A $5 discount per mainline toll plaza is offered for an annual plan. Customers can obtain unlimited usage of the entire length of the Turnpike for an annual cost of $285. Included with any of the mainline plazas is the North Beckley ramp, which costs $5 annually if purchased separately. Subscribers are issued an E-ZPass transponder which provides unlimited access to the selected plazas, while also processing regular pay-per-use transactions at other plazas.

Table ES-1 Current West Virginia Parkways Toll Rates – Aug. 1, 2009 to Present

Toll Class	Vehicle Type	No. of Axles	Barriers A, B & C			North Beckley		
			Cash	WV E-ZPass	Non-WV E-ZPass	Cash	WV E-ZPass	Non-WV E-ZPass
1	Passenger cars/pickup trucks (under 7' 6")	2	$2.00	$1.30	$2.00	$0.40	$0.26	$0.40
2	All Class 1 vehicles with a trailer (under 7' 6")	3+	$2.50	$1.63	$2.50	$0.80	$0.52	$0.80
3	Motorhomes only (over 7' 6")	2-3	$2.50	$1.63	$2.50	$0.80	$0.52	$0.80
4	Class 3 vehicles with a trailer (over 7' 6")	3+	$3.25	$2.11	$3.25	$1.20	$0.78	$1.20
5	2-axle trucks	2	$3.25	$2.60	$2.83	$0.80	$0.64	$0.70
6	3-axle trucks	3	$4.50	$3.60	$3.92	$1.20	$0.96	$1.04
7	4-axle trucks	4	$6.50	$5.20	$5.66	$1.60	$1.28	$1.39
8	5-axle trucks	5	$6.75	$5.40	$5.87	$1.60	$1.28	$1.39
9	6 or more-axle trucks	6+	$9.50	$7.60	$8.27	$2.40	$1.92	$2.09
10	Oversize trucks		$12.00	$9.60	$10.44	$7.20	$5.76	$6.26

Source: WVPA
Note: Class 1 refers to 2-axle vehicles with a gross vehicle weight less than 8,000 lbs. not being used for commercial purposes. Passenger Cars (PC) refers to Classes 1-4. Commercial Vehicles (CV) refers to Classes 5-10.

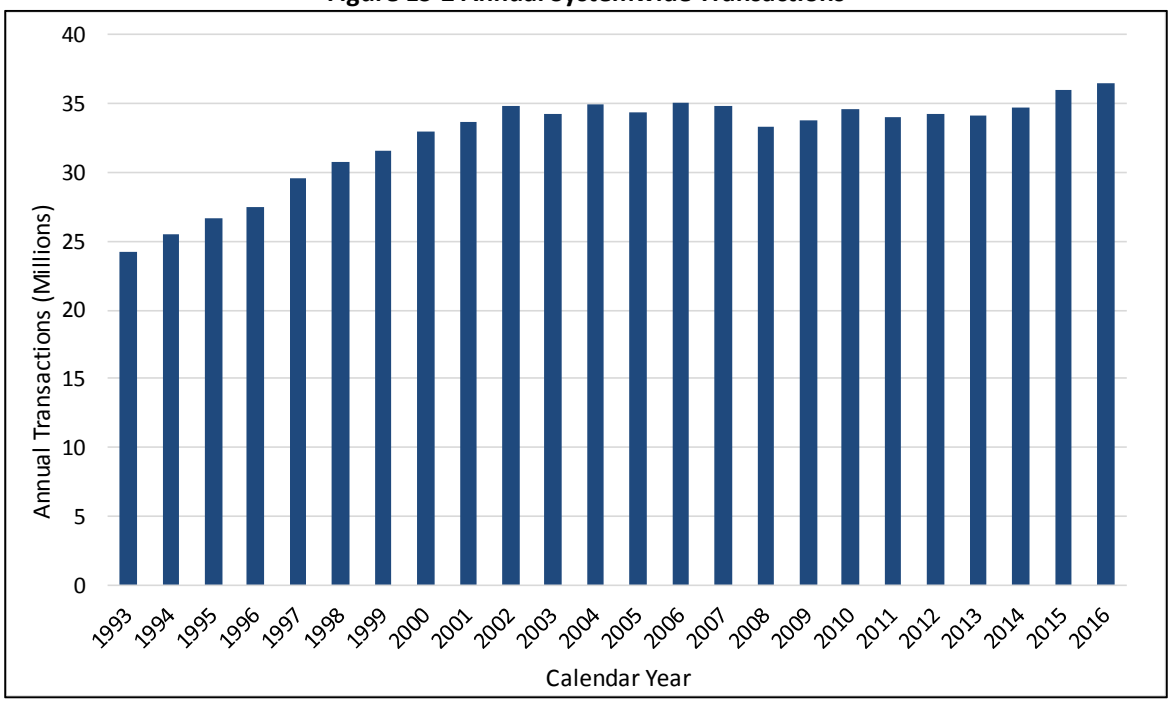
A Personal Discount Plan #2 currently provides a 35% discount from the cash toll rates for passenger cars and motor homes (Classes 1 through 4) as shown in Table ES-1.

A Commercial Discount Plan #3 currently provides a 20% discount from the cash toll rates for large vehicles (Classes 5 through 10) using a WV E-ZPass account as shown in Table ES-1.

Commercial Discount Plan #4 currently provides a 13% discount from the cash toll rates for large vehicles (Classes 5 through 10) using an account opened and managed by E-ZPass issued by an agency other than the Turnpike as shown in Table ES-1.

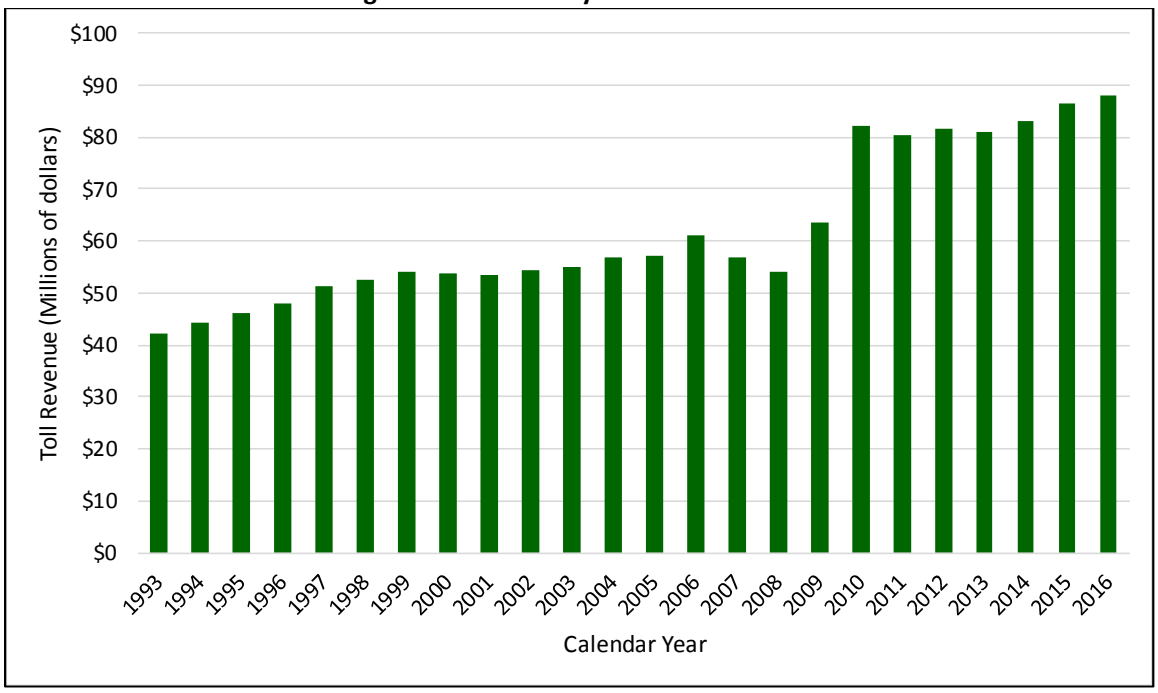
Figures ES-2 and **ES-3** provide historic systemwide information on Turnpike usage. Travel on the Turnpike has been steady for several decades. The roadway serves as an important conduit for local residents as well as a vital connection between the Midwest and the southeastern United States. Economic activity levels appear to have had only a minor effect on traffic in the 2006-2008 timeframe. The large toll increase of approximately 60% in August 2009 did not have a significant impact on transactions. In fact, annual transactions grew in the two-year period from 2008 to 2010. Annual toll revenue increased by approximately 52% from 2008 to 2010.

Figure ES-2 Annual Systemwide Transactions



Source: WVPA

Figure ES-3 Annual Systemwide Revenue



Source: WVPA

Passenger car traffic volumes on the Turnpike peak during the summer season whereas commercial traffic volumes are steady most of the year. The three mainline plazas have roughly equal numbers of transactions per year (approximately 10 million in 2016) whereas North Beckley has about half that amount (approximately 5.5 million in 2016). Many of the trips on the Turnpike travel the full length, based on available E-ZPass data.

Two-axle passenger car customers (Class 1) dominate transactions on the Turnpike at 76% while 5-axle trucks (Class 8) make up another 18% of transactions. Passenger car customers (Classes 1 to 4) make up about 51% of total revenue and commercial vehicle customers (Classes 5 to 10) make up about 49% of total revenue. As a share of transactions, payment by passenger car customers is about 72% cash, 18% WV E-ZPass, and 10% Non-WV E-ZPass. Payment by commercial vehicles is about 25% cash, 16% WV E-ZPass, and 59% Non-WV E-ZPass.

CDM Smith developed a frequency of use profile of existing E-ZPass customers from detailed transactions records. Frequency of use is very low, particularly for passenger car customers. About half of the passenger car customers using WV E-ZPass have 10 or fewer transactions in a year. Roughly 95% of all passenger car customers using Non-WV E-ZPass have 10 or fewer transactions a year.

The majority of WV E-ZPass commercial vehicle customers also travel on the Turnpike infrequently. Among WV E-ZPass commercial vehicle customers, the proportion of travelers using the Turnpike less than 50 times a year in 2016 was found to be approximately 82%. The level of frequency is even lower among Non-WV E-ZPass commercial vehicle customers, with the proportion of travelers using the Turnpike less than 10 times a year reaching about 91%.

CDM Smith obtained travel pattern information from StreetLight Data, Inc. This data represented a sample of the customers passing through each of the four tolling plazas during the year-long period July 2016 through June 2017 and established the number of times each device was observed at each location over the year, presented as the number of occurrences per year. Unfortunately, it was not possible to separate customer payment method, vehicle classification, or state of residence. The data included personal devices using Location Based Services (LBS) and did not include corporate fleet information. It was found that most customers were very infrequent users, with nearly 80% making only one one-way trip per year. About 96% of customers make less than 4 one-way trips per year. The frequency distribution was found to be very similar at all toll plazas.

Knowing the frequency of use of all customers both from the StreetLight data and E-ZPass data (and the size of each market), it was possible to deduce the frequency of use for cash customers. All data received was generic so individual privacy was protected.

Governor Jim Justice's ***Roads to Prosperity*** program contains hundreds of transportation improvement projects worth over $2.6 billion. This program will have a significant beneficial impact on the state economy. The program includes a widening project on the Turnpike. None of the projects included in the program will provide major improvements to roadways that compete with the Turnpike. As a result, the ***Roads to Prosperity*** program is expected to have relatively-small, positive impacts on the competitive advantages of the Turnpike.

ES.4 Stated Preference Survey

The primary objective of the SP survey was to understand how payment method and travel behavior will likely change if the revised annual flat fee WV E-ZPass is offered. The SP survey presented hypothetical scenarios within the context of the respondent's actual travel, and asked respondents to choose from a set of possible options: joining the flat fee program, paying the higher toll at each plaza, or stop making trips on the Turnpike. Resource Systems Group (RSG) with help from CDM Smith and input from WVPA, designed the survey, administered it to current customers, and evaluated the results.

The survey included questions on qualification of the respondent to take the survey such as making sure they are Class 1 customers; general travel questions such as segments of the turnpike used, frequency, and payment type; trip characteristics for a specific one-way "reference" trip; SP experiments with varying toll rates, flat fee rates, and other parameters; debriefing questions which help explain any unusual responses; and demographic questions to expand the survey to the general population.

A total of 6,438 valid surveys were completed representing nearly 43,000 SP experiments. For the purpose of asking the survey questions, frequent users were defined as those who made six or more trips per month on the Turnpike, while infrequent users were defined as individuals who made five or fewer monthly trips on the Turnpike. (As noted later, when the survey results were analyzed, "frequent" and "infrequent" were redefined due to the resulting behavioral differences at very low frequency of use.) Overall, frequent users were much more likely to travel for work-related purposes, while most infrequent users drove on the Turnpike for social or recreational trip purposes. WV E-ZPass customers had the highest average and median number of trips, while Non-WV E-ZPass customers tended to make the least. The median number of annual trips for all respondents was 8 trips, and the average was 51 trips.

In the SP experiments, as the per plaza toll rates increased, respondents increasingly chose to either stop making trips or to join the flat fee program. As the annual flat fee increased, respondents increasingly chose to pay per plaza or to a lesser extent, stop making trips on the Turnpike.

Statistical analysis and discrete choice model estimation were conducted using the SP survey data. The statistical estimation and specification testing were completed using a conventional maximum likelihood procedure that estimated coefficients for a set of multinomial logit (MNL) models. Payment choice models were constructed for each of the original payment methods (cash, WV E-ZPass. and Non-WV E-ZPass). Frequency of use appeared as an important determinant of customer choice, leading to separate formulations for infrequent and frequent users with the WV and Non-WV E-ZPass. The model estimation showed distinction between those who make three or more trips per year and those who make two or less and the definition of frequent and infrequent were refined. Frequency of use is also an independent variable in the models for frequent users. These market share models support revenue projections under the proposed new payment policies. Separate regression models were also estimated to forecast trip suppression and induction rates. The suppression/induction models were fitted with a total of 3,056 observations to support estimates of overall trip reductions based on proposed per plaza toll increases. Overall, the statistical fit and explanatory power of the discrete choice and suppression models was good.

The results from the models were incorporated into an Excel-based market share simulation tool. The equations behind the market share simulator were incorporated into tolling models used to estimate reaction to tolling policy.

ES.5 Economic Growth Analysis

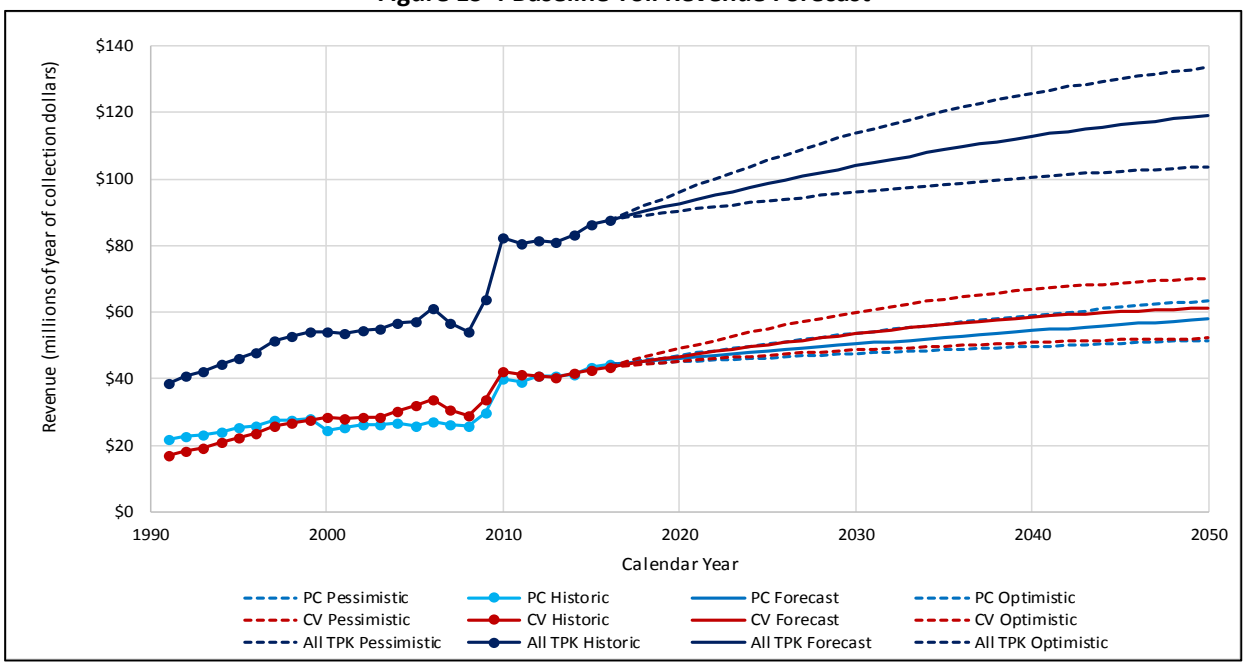
CDM Smith developed a series of econometric models to gauge trends in long-term travel demand on the Turnpike, with no change in toll policies. These models review trends in independent variables such as population and employment against historic transaction trends. Multiple regression equations were tested and evaluated for each plaza-vehicle category to account for the numerous possible combinations of relevant geographies (county and/or state clusters) for each socioeconomic variable, and inclusion of effective toll rates. A final equation for each combination of PC and CV at each plaza was selected based on multiple criteria, including overall equation robustness (adjusted R^2), independent variable robustness (t-statistics and p-values), logic and reasonableness of equation coefficients, logic and reasonableness of geographic catchment area, and the credibility of the independent variable(s) and source(s).

Geographic combinations of counties are the most-logical and statistically-valid catchment areas for PC transactions for all four plazas. CV transactions at the mainline plazas are related to the socioeconomics of a cluster of states, which include West Virginia, Virginia, Ohio, and Kentucky. However, the geographic catchment for commercial vehicles for North Beckley (NB) is more-closely related to a county cluster. PC transactions along the mainline plazas are related to real GRP, whereas for North Beckley (NB) PC and all CV transactions for all plazas, the socioeconomic variable is employment. Average effective annual toll rates are statistically significant for North Beckley (NB) PC transactions and Pax (B) and Chelyan (C) CV transactions. Adjusted R^2 (overall statistical robustness) is between 87.8% and 96.0%, indicating very good relationships throughout the eight equations (PC and CV for each of the four plazas).

With the final regression equations, forecasts of the regional socioeconomic variables were applied to the regression coefficients to estimate future long-term travel demand. Socioeconomic forecasts compiled from Woods & Poole Economics, Inc. (W&P) were compared with historical patterns; and were observed as generally more aggressive than the long-term historical patterns (1990 to 2016) and certainly more aggressive than more-recent timeframes (2000 to 2016). As such, the socioeconomic forecasts from W&P were designated as the optimistic scenario. A linear extrapolation of the long-term historical trends of the socioeconomics variables from 1990 to 2016 was designated the baseline scenario. A linear extrapolation of the socioeconomics from 2000 to 2016 was designated the pessimistic scenario. Once established, dampening or deceleration of the long-term growth rates was added to the forecasts to account for unknown factors including economic changes, travel pattern changes, and travel characteristics. Annual transaction streams were developed and existing revenue per transaction was applied to generate annual revenue streams. Existing class and payment shares were assumed to remain stable in the baseline forecast.

Generally, the Turnpike exhibited 3.6% average annual toll transaction growth in the 1990s, followed by a notable deceleration around the millennium, resulting in a 0.8% average growth between 2000 and 2016. Over the entire historical timeframe available from 1990 to 2016, the average annual toll transaction growth amounted to 1.9% annually. Over the future horizon through 2050, Turnpike toll transactions are projected to increase by 0.8% per year on average, annually. In the pessimistic alternative, the average future growth is 0.4% per year, and for the optimistic, 1.1% per year. Commercial vehicles are projected to grow faster than passenger vehicles for all plazas, at 1.0% versus the 0.8% average annual toll transaction growth for passenger cars. **Figure ES-4** provides a graphical view of historic and forecast baseline toll revenues along with pessimistic and optimistic ranges if current toll policies were to be extended.

Figure ES-4 Baseline Toll Revenue Forecast



Note: PC = Classes 1-4, CV = Classes 5-10
Source: CDM Smith Analysis

ES.6 Toll Modeling Approach

CDM Smith applied the existing conditions analysis, SP survey results, and economic baseline growth as well as decades of experience and industry accepted techniques to develop a spreadsheet-based toll modeling tool. The overall approach is shown in **Figure ES-5.**

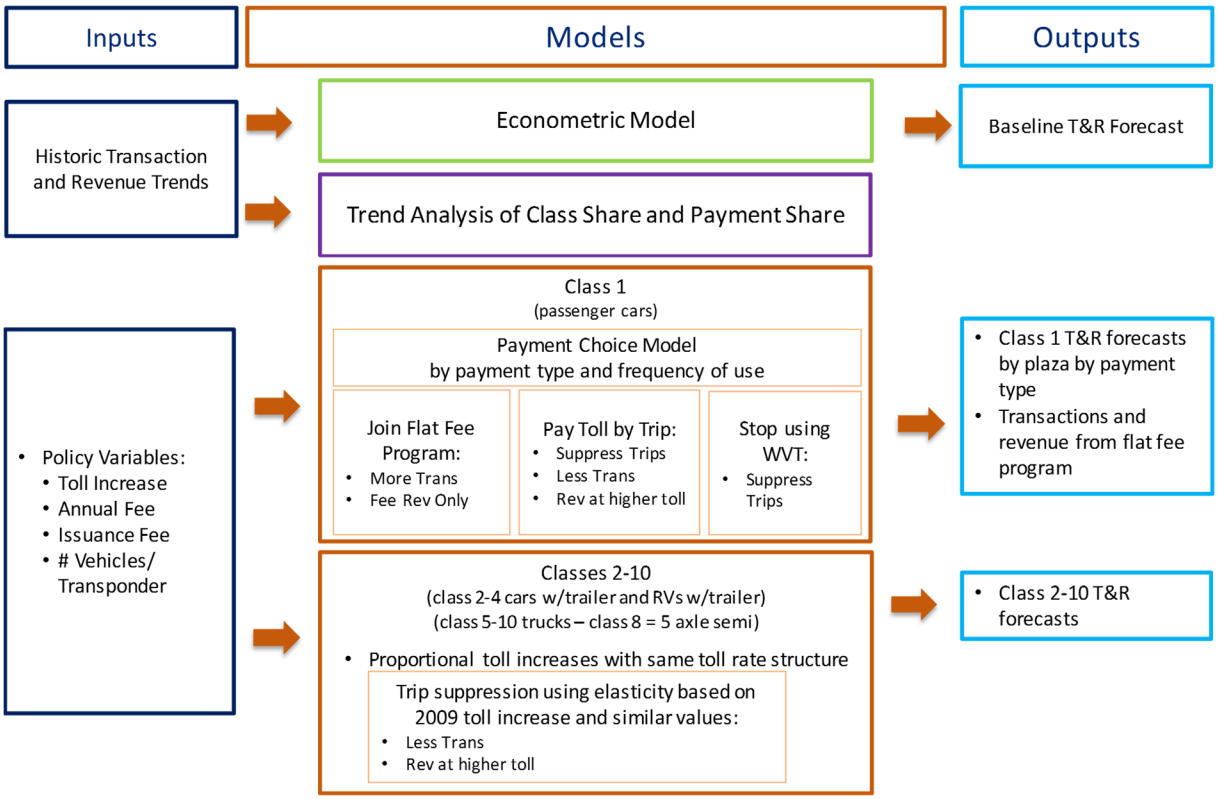
As noted earlier, the baseline T&R forecast was developed from econometric analysis of historic transactions trends for PCs and CVs against socioeconomic variables and forecasts of socioeconomic variables. To test proposed toll policies, modeling was divided into two main modules, one for Class 1 and the other for Classes 2-10. Model years included 2018, 2019, 2020, 2021, 2022, 2030, 2040, and 2050. Interim years were derived by interpolation at each class and payment type level.

The Class 1 module uses the baseline forecast and trend analysis of class and payment shares as primary inputs. It also uses the frequency of use data derived from E-ZPass transactions and StreetLight data described earlier. The Class 1 module handles customers by annual frequency "bins" to better explain infrequent and frequent traveler behavior. The existing proportion of customers in current frequency bins by payment type is factored up such that when multiplied by the frequency in each bin, they meet future baseline transaction forecasts. Then the Payment Choice Model derived from the SP survey is applied by each original payment type plaza (cash, WV E-ZPass, and Non-WV E-ZPass) and frequency to determine future payment shares including joining the flat fee program, paying per plaza (cash, WV E-ZPass, and Non-WV E-ZPass), or stop using the Turnpike all together. The results are then summarized for further use.

For Classes 2-10, a more traditional approach is applied since traditional toll rate increases are contemplated for these customers and flat fee tolling is not being studied. The traditional approach looks at the baseline forecast, applies class and payment share trend forecasts, and then applies tolling

elasticity factors to determine reductions in transactions as toll rates are increased. The elasticity applied was derived from analysis of the 2009 toll increase as well as through CDM Smith's extensive experience in toll road forecasting and results analysis. The results are then summarized for further use.

Figure ES-5 Toll Modeling Approach



ES.7 Traffic and Revenue Forecast

WVPA's goal has been to support the improvements to the Turnpike and to access roads connecting to the Turnpike, as identified in Governor Justice's ***Roads to Prosperity*** program. The intent of WVPA staff has been to maximize the amount of toll revenue bonds that can be sold, while maintaining the benefits of the flat fee program and retaining reasonable toll rates. Of course, WVPA will continue to keep the Turnpike in a good state of repair and operating efficiently.

Of the many potential tolling policies considered, WVPA staff and advisors identified a prospective scenario for further evaluation. The prospective scenario includes a revised flat fee program with an early enrollment option, a large toll rate increase in 2019, and modest long-term escalation of toll rates and flat fee program costs.

At the introduction of this prospective scenario, Class 1 customers will have the opportunity to choose an early enrollment option which covers tolls for a three-year period at a discounted cost of $24 (plus a $13 issuance fee if not already part of the WV E-ZPass program). To participate in this early enrollment option, customers will need to enroll in the flat fee program and pay the flat fee by December 31, 2018. Customers in this program will enjoy unlimited, toll-free use of the Turnpike from time of joining through December 31, 2021. For all other customers:

- The CY 2018 toll rates will remain the same as CY 2017
- In CY 2019, the annual cost of the Class 1 flat fee program will be $25 and cover CY 2019 only; and toll rates for all other customers paying tolls (Classes 1-10) will double
- The toll policies in CY 2020 and 2021 are the same as CY 2019
- Starting in CY 2022 and beyond, the $25 flat fee program and all toll rates will increase nominally at 1.6% annually (including CY 2022) subject to rounding

The T&R forecast for the prospective scenario is presented in **Table ES-2**, **Figures ES-6** and **ES-7**. Annual transactions increase from about 37 million in 2017 to about 40 million in 2018 due to regular background growth and induced transactions from the early enrollment adopters. From 2018 to 2019, transactions decrease to about 35 million due to the toll rate increase. There is a noticeable transaction decrease in 2022 due to the end of the early enrollment program coverage. Transactions increase slowly to about 35 million by 2031, but then begin to decrease as toll rates escalate and overall growth tapers off, shrinking to about 32 million by 2050.

Annual revenue ranges from about $93 million in 2018 to $180 million in 2050. The 2018 total revenue of about $93 million is higher than 2017 due mostly to the early enrollment option fees collected. During the period 2019-2021, total revenue increases due to the toll rate increase in 2019, but is moderated by the early enrollment option adopters. In 2022, a noticeable jump accompanies the end of the early enrollment program coverage and revenue increases over time due to gradually escalating toll rates. Total revenue is anticipated to increase about 22% in 2019 primarily due to the toll increase, about 1.5% in 2020 and 2021, and by about 18% in 2022 due to the end of the early enrollment option coverage. From 2022 to 2030, total revenue is expected to grow about 1.7% annually, decreasing to about 1.0% growth annually through 2040, and decreasing to about 0.3% growth through 2050.

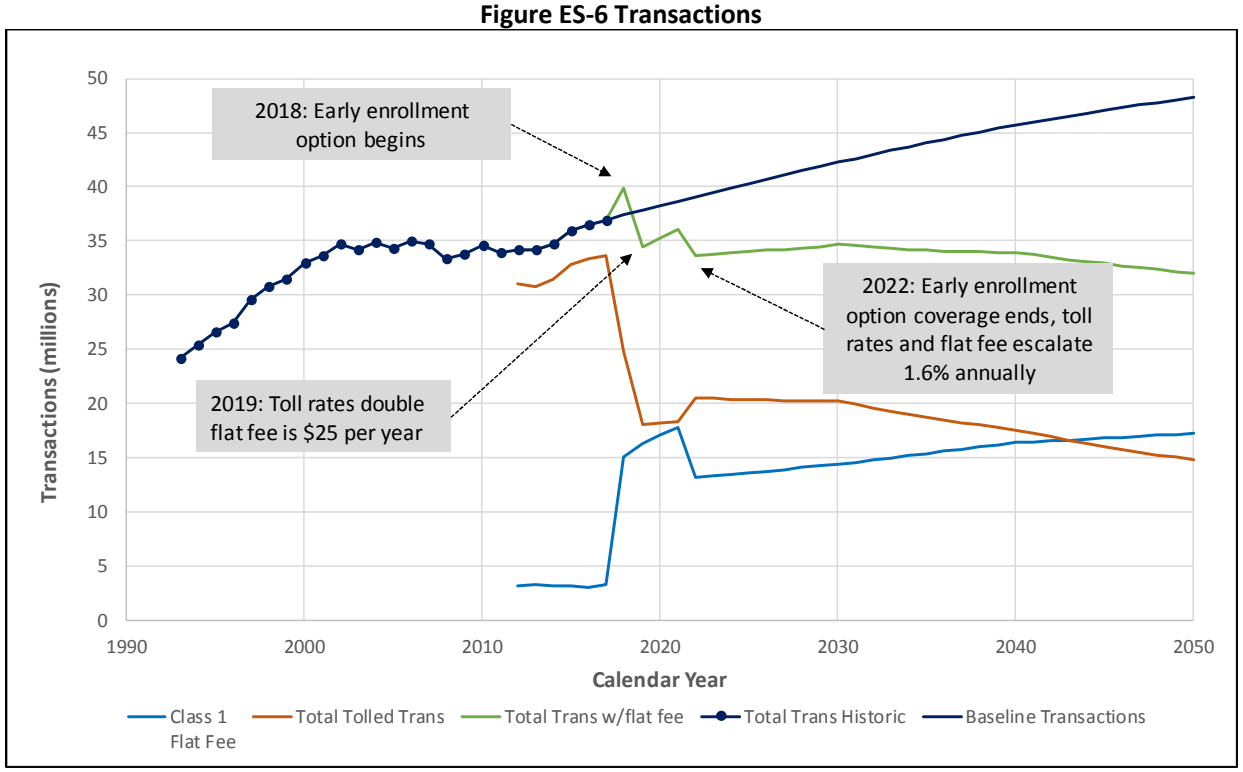
Note that for forecasting and modeling purposes, CDM Smith assumed the flat fee program started on January 1, 2018 and that all Class 1 customers decide on the method of payment at the beginning of each year and use that method for the entire year. WVPA will investigate and may implement ways for customers to join the flat fee program throughout the year. Also, since the toll rate setting process will extend into 2018, the effective date will be later and the forecast for 2018 will be adjusted in the final analysis.

Table ES-2 Annual Toll Transactions and Revenue Forecast

Calendar Year	Toll Transactions (millions)					Revenue (millions year of collection dollars)				
	Class 1 Flat Fee	Class 1 Tolled	Class 2-4 Tolled	Class 5-10 (CV) Tolled	Total Trans w/flat fee	Class 1 Flat Fee	Class 1 Tolled	Class 2-4 Tolled	Class 5-10 (CV) Tolled	Total Revenue w/flat fee
2012 (1)	3.16	22.86	0.78	7.40	**34.20**	$ 1.18	$ 39.02	$ 1.83	$ 40.67	**$ 82.70**
2013 (1)	3.30	22.63	0.79	7.40	**34.12**	$ 1.17	$ 38.79	$ 1.83	$ 40.41	**$ 82.20**
2014 (1)	3.23	22.99	0.80	7.64	**34.66**	$ 1.06	$ 39.51	$ 1.87	$ 41.79	**$ 84.23**
2015 (1)	3.13	24.11	0.87	7.84	**35.95**	$ 1.23	$ 41.53	$ 2.03	$ 42.81	**$ 87.60**
2016 (1)	3.09	24.50	0.92	7.98	**36.49**	$ 1.15	$ 42.24	$ 2.14	$ 43.46	**$ 88.99**
2017 (2)	3.31	24.55	0.93	8.11	**36.90**	$ 1.13	$ 42.37	$ 2.18	$ 44.33	**$ 90.01**
2018 (3)	15.03	15.64	0.95	8.26	**39.88**	$ 19.81	$ 25.82	$ 2.21	$ 45.33	**$ 93.17**
2019 (4)	16.38	10.61	0.77	6.75	**34.51**	$ 1.47	$ 34.15	$ 3.60	$ 74.06	**$ 113.28**
2020	17.10	10.57	0.78	6.86	**35.31**	$ 2.20	$ 34.00	$ 3.63	$ 75.18	**$ 115.01**
2021	17.82	10.53	0.78	6.97	**36.10**	$ 2.94	$ 33.87	$ 3.67	$ 76.30	**$ 116.78**
2022 (5)	13.14	12.75	0.79	7.02	**33.70**	$ 14.77	$ 41.61	$ 3.71	$ 78.04	**$ 138.13**
2023	13.29	12.66	0.79	7.05	**33.79**	$ 15.15	$ 41.86	$ 3.79	$ 79.54	**$ 140.34**
2024	13.45	12.57	0.80	7.08	**33.90**	$ 15.54	$ 42.12	$ 3.86	$ 81.09	**$ 142.61**
2025	13.61	12.48	0.80	7.11	**34.00**	$ 15.95	$ 42.41	$ 3.94	$ 82.67	**$ 144.97**
2026	13.77	12.41	0.80	7.14	**34.12**	$ 16.36	$ 42.71	$ 4.03	$ 84.31	**$ 147.41**
2027	13.93	12.33	0.80	7.17	**34.23**	$ 16.78	$ 43.03	$ 4.11	$ 85.98	**$ 149.90**
2028	14.10	12.26	0.81	7.20	**34.37**	$ 17.22	$ 43.37	$ 4.20	$ 87.71	**$ 152.50**
2029	14.26	12.20	0.81	7.23	**34.50**	$ 17.67	$ 43.73	$ 4.28	$ 89.48	**$ 155.16**
2030	14.43	12.14	0.81	7.27	**34.65**	$ 18.13	$ 44.11	$ 4.37	$ 91.30	**$ 157.91**
2031	14.62	11.86	0.81	7.25	**34.54**	$ 18.72	$ 43.68	$ 4.43	$ 92.54	**$ 159.37**
2032	14.80	11.58	0.81	7.24	**34.43**	$ 19.34	$ 43.25	$ 4.49	$ 93.80	**$ 160.88**
2033	14.99	11.31	0.80	7.22	**34.32**	$ 19.98	$ 42.84	$ 4.54	$ 95.08	**$ 162.44**
2034	15.18	11.05	0.80	7.20	**34.23**	$ 20.64	$ 42.43	$ 4.60	$ 96.39	**$ 164.06**
2035	15.38	10.80	0.80	7.19	**34.17**	$ 21.32	$ 42.03	$ 4.66	$ 97.71	**$ 165.72**
2036	15.58	10.55	0.80	7.17	**34.10**	$ 22.03	$ 41.64	$ 4.72	$ 99.05	**$ 167.44**
2037	15.78	10.32	0.79	7.16	**34.05**	$ 22.75	$ 41.26	$ 4.78	$ 100.42	**$ 169.21**
2038	15.98	10.09	0.79	7.14	**34.00**	$ 23.51	$ 40.88	$ 4.84	$ 101.81	**$ 171.04**
2039	16.18	9.87	0.79	7.12	**33.96**	$ 24.29	$ 40.52	$ 4.90	$ 103.22	**$ 172.93**
2040	16.39	9.66	0.78	7.11	**33.94**	$ 25.09	$ 40.16	$ 4.96	$ 104.66	**$ 174.87**
2041	16.48	9.43	0.78	7.03	**33.72**	$ 25.48	$ 39.61	$ 5.00	$ 105.18	**$ 175.27**
2042	16.56	9.21	0.77	6.96	**33.50**	$ 25.88	$ 39.07	$ 5.04	$ 105.71	**$ 175.70**
2043	16.65	9.00	0.76	6.88	**33.29**	$ 26.29	$ 38.54	$ 5.07	$ 106.25	**$ 176.15**
2044	16.73	8.80	0.75	6.81	**33.09**	$ 26.70	$ 38.03	$ 5.11	$ 106.80	**$ 176.64**
2045	16.82	8.60	0.75	6.74	**32.91**	$ 27.12	$ 37.53	$ 5.15	$ 107.36	**$ 177.16**
2046	16.91	8.40	0.74	6.67	**32.72**	$ 27.54	$ 37.04	$ 5.19	$ 107.93	**$ 177.70**
2047	16.99	8.22	0.73	6.60	**32.54**	$ 27.98	$ 36.57	$ 5.23	$ 108.50	**$ 178.28**
2048	17.08	8.04	0.73	6.53	**32.38**	$ 28.42	$ 36.11	$ 5.27	$ 109.09	**$ 178.89**
2049	17.17	7.86	0.72	6.46	**32.21**	$ 28.86	$ 35.66	$ 5.31	$ 109.68	**$ 179.51**
2050	17.26	7.69	0.71	6.40	**32.06**	$ 29.31	$ 35.22	$ 5.35	$ 110.28	**$ 180.16**

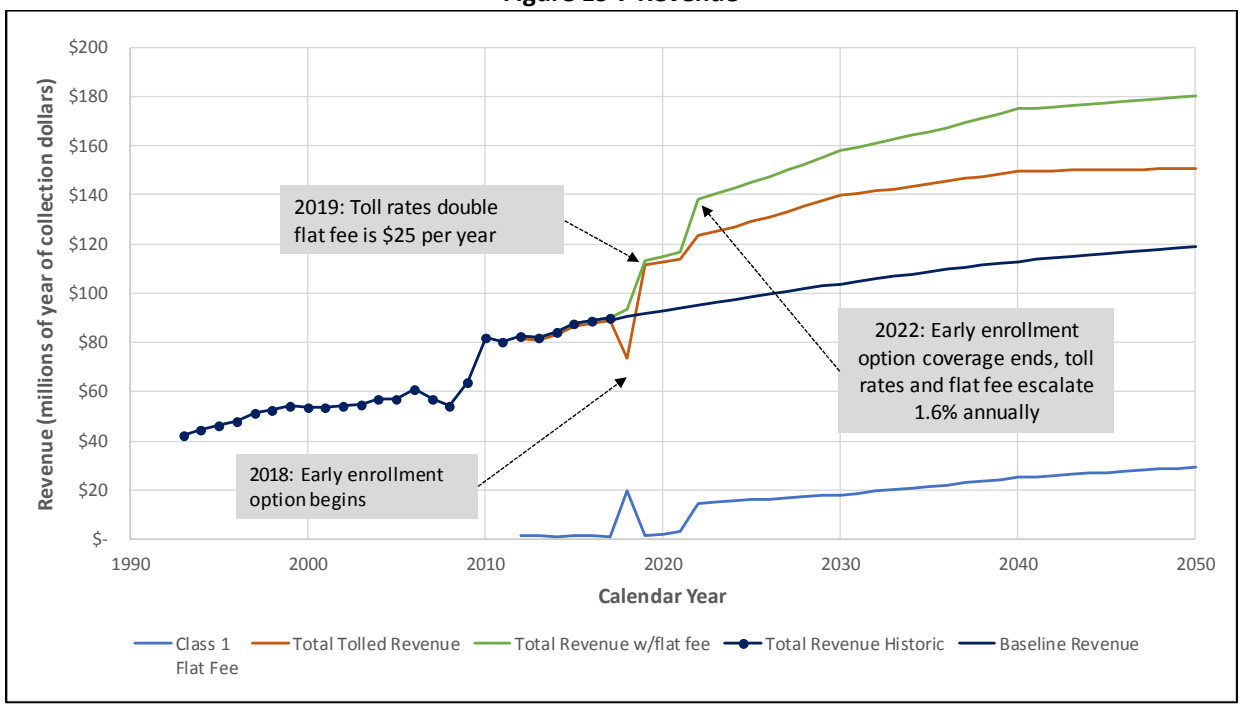
(1) 2012-2016: Actual values
(2) 2017: Estimated values subject to change
(3) 2018: Early enrollment option begins
(4) 2019: Toll rates double, flat fee is $25 per year
(5) 2022: Early enrollment option coverage ends 12/31/2021, toll rates and flat fee escalate 1.6% annually
Source: CDM Smith Analysis

Figure ES-6 Transactions



Source: CDM Smith Analysis

Figure ES-7 Revenue



Source: CDM Smith Analysis

ES.8 Sensitivity Tests

Due to the number of assumptions made in the T&R modeling, it is important to test assumptions which might have a major impact on the T&R forecasts. As described in CDM Smith's Disclaimer, the T&R estimates are forecasts of an uncertain future. The assumptions chosen for the tests are those that present risks and have a potential impact on the estimates. The purpose of the sensitivity tests is to help identify the sources of risk. All sensitivity tests were conducted for year 2030, and results were compared to the prospective scenario identified by WVPA staff and advisors for further evaluation.

Sensitivity to regional growth assumptions was tested in terms of their impact on overall T&R estimates for all vehicle classes. For 2030, under the downside regional growth scenario, total transactions and revenue are expected to be reduced by approximately 7.0% and 7.8%, respectively.

Sensitivity to toll rates was tested to see where revenue maximizing points were and how close selected toll rates are to those points. Class 1 and Classes 2-10 were tested separately and then jointly. The Class 1 toll rates were varied from $3.50 to $5.50 in $0.50 increment. The Class 1 revenue maximizing toll is $4.50 which is the selected toll rate for 2030. To test Classes 2-10, the Class 8 (5 axle semi) toll rate was varied from $3.50 to $25.25 and results showed the selected toll rate of $15.50 is well below the revenue maximizing rate of $20.25. Finally, in the joint test where all the toll rates were varied proportionally, the corresponding revenue maximizing rate of $5.50 for Class 1 cash payment was higher than the selected rate of $4.50 for Class 1.

Toll rate elasticity was tested for both Class 1 and Classes 2-10. For Class 1, the elasticity only applies to those who continue to pay with cash since the other payment options are determined through the payment choice model. The test showed when Class 1 cash elasticity is decreased from -0.18 to -0.30, total toll revenue decreases by -1.1%. For Classes 2-10, baseline elasticity was assumed to be -0.196. Lower elasticity of -0.231 resulted in a -3.7% decrease in overall revenue and lower elasticity of -0.266 resulted in a -7.4% decrease overall revenue.

For Class 1, initial cash share for each year is an input to the Class 1 model. The prospective scenario shares were derived from existing historic trends on the Turnpike as well as the overall trend in less cash payments for all types of transactions. Lowering the initial cash share by 10% of all Class 1 transactions results in -3.1% overall less revenue. For the Classes 2-10 payment share sensitivity test, two tests were performed. The first test involved lowering the initial cash share by 10% and distributing the remainder proportionally to WV E-ZPass and Non-WV E-ZPass. The result was a reduction of -0.9% in overall total revenue. The second test consisted of keeping the initial cash share unchanged, but lowering the Non-WV E-ZPass share by 10% and increasing the WV E-ZPass share to compensate. The result was a reduction of -0.5% in overall total revenue.

For Class 1 only, the distribution of existing frequency of use is an important input. Actual frequency data obtained was fitted to a Pareto curve statistical distribution. The Pareto distributions at each plaza and model year were then adjusted so that the number of overall trips in the 30+ trips per year bin prior to implementation of the flat fee program exceeded the number of E-ZPass trips in that bin by 10%. The total trips met the baseline transactions forecast for the year being modeled. The sensitivity test held the number of WV E-ZPass trips constant but increased the cash exceedance to 15%, resulting in more high frequency trips than the original assumption. This test resulted in a -0.6% reduction in overall revenue.

The Class 1 annual flat fee is another important factor for the overall revenue forecast. In 2030, the T&R forecasts are based on the assumption of a $28.84 flat fee annual cost. The sensitivity test showed a decrease to $25 is estimated to lower the overall total revenue by -1.4% and an increase to $30 would likely increase the overall revenue by +0.4%.

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Chapter 1
Introduction

The West Virginia Parkways Authority (WVPA) is studying the effects of potential changes in toll policy on traffic and toll revenue on the West Virginia Turnpike (Turnpike). The changes include increases in toll rates as well as the introduction of a revised flat fee program offered to customers driving a passenger car (Class 1) available through the West Virginia electronic toll collection program (WV E-ZPass). WVPA requires updated traffic and revenue (T&R) forecasts for the Turnpike. WVPA will use the forecasts to plan for continued Turnpike capital projects and operations & maintenance funding, as well as additional bonding capacity for other roadway projects in the state to improve access to the Turnpike and other major highways that ultimately connect to the Turnpike for business, individuals, and commercial transportation providers alike.

As used in this report, the terms "flat fee program" and/or "flat fee" refer to the single fee discount program authorized under Chapter 17, Article 16A of the West Virginia Code, 1931, as amended (the "Authority Act") for Class 1 vehicle customers. Under this program, a Class 1 customer can obtain unlimited travel on the Turnpike for an annual fee plus a one-time issuance fee for the vehicle transponder. CDM Smith also analyzed a limited (one-time) early enrollment option that would allow Class 1 customers to participate in the flat fee program for calendar years 2019, 2020, and 2021 at a lower price if such customers opted, prior to December 31, 2018, to participate in the flat fee program and paid the lower price (and any issuance fee) covering all three years. As used in this report, this option is generally referred to as the "early enrollment option". The full terms and conditions of any toll increases, the flat fee program, the early enrollment option, issuance fee, and any related temporary price adjustments are subject to applicable law and further action of WVPA.

As part of this study, CDM Smith collected and analyzed background data on the Turnpike, detailed traffic and revenue (T&R) data covering the last twenty-five years of operation, and customer frequency of use data. By examining prior Turnpike performance, historic local and regional economics, and economic forecasts, a Baseline forecast without toll policy changes was established. A stated preference (SP) survey was conducted to determine the likely reaction of existing customers to a variety of toll policy changes. T&R models were developed to be sensitive to potential toll policy changes and several alternatives were examined. WVPA staff and advisors identified one of these alternatives as best balance of the relevant considerations and variables (the "Prospective Scenario") in calendar years 2018-2050. Finally, CDM Smith conducted sensitivity tests on key assumptions.

1.1 Facility Description

Construction on the Turnpike began in 1952 and the first segment was opened in 1954. A series of upgrades in the 1970s and 80s resulted in the entire Turnpike being brought up to Interstate standards by 1987. The Turnpike totals 88 miles in length and is comprised of four travel lanes (two in each direction) between Charleston and Princeton. The Turnpike is designated as Interstate 77 along its entire length, but also carries the Interstate 64 designation from Charleston to just south of Beckley.

The Turnpike is an important north-south Interstate travel corridor linking eastern Ohio and western Pennsylvania in the north to western Kentucky, Virginia, North Carolina, and other states in the southeastern U.S. The Turnpike extends through mountainous terrain over much of its length; these

mountains are a barrier to travel as shown on the regional location map (**Figure 1-1**). Posted speed limits are up to 70 miles per hour, reflecting the high design standards of the facility. The Turnpike serves as a "land bridge" across these mountains. The alternative routes are I-75 in the west and I-68 in the east. For many trips these are not very strong competitors to the Turnpike.

1.2 Traffic and Revenue Forecasting History

CDM Smith has provided traffic and revenue forecasting services for the Turnpike for several decades. The most recent major studies include:

- A comprehensive traffic and revenue forecast conducted in 2005
- A Traffic and Toll Revenue Study conducted in 2009 to determine the effect of permanent toll increases and E-ZPass based discounts on transactions and toll revenue

At the conclusion of the 2009 study, WVPA established a toll increase as well as discounts for all WV E-ZPass users and Non-WV E-ZPass commercial vehicle users. Those toll rates remain in place today.

CDM Smith is under contract to conduct this 2018 Revenue Bond Study. The purpose of this report is to explain the data and methods used in the analysis and to present the T&R forecast for a prospective scenario. The scope of the study includes:

Task 1 – Data Collection and Analysis

- Review of relevant studies and reports
- Assemble detailed historical data including toll class and payment type shares by plaza, as well as E-ZPass based frequency data
- Collect historical traffic data for nearby roadways
- Obtain frequency of use patterns on customer usage from Location-Based Services (LBS)

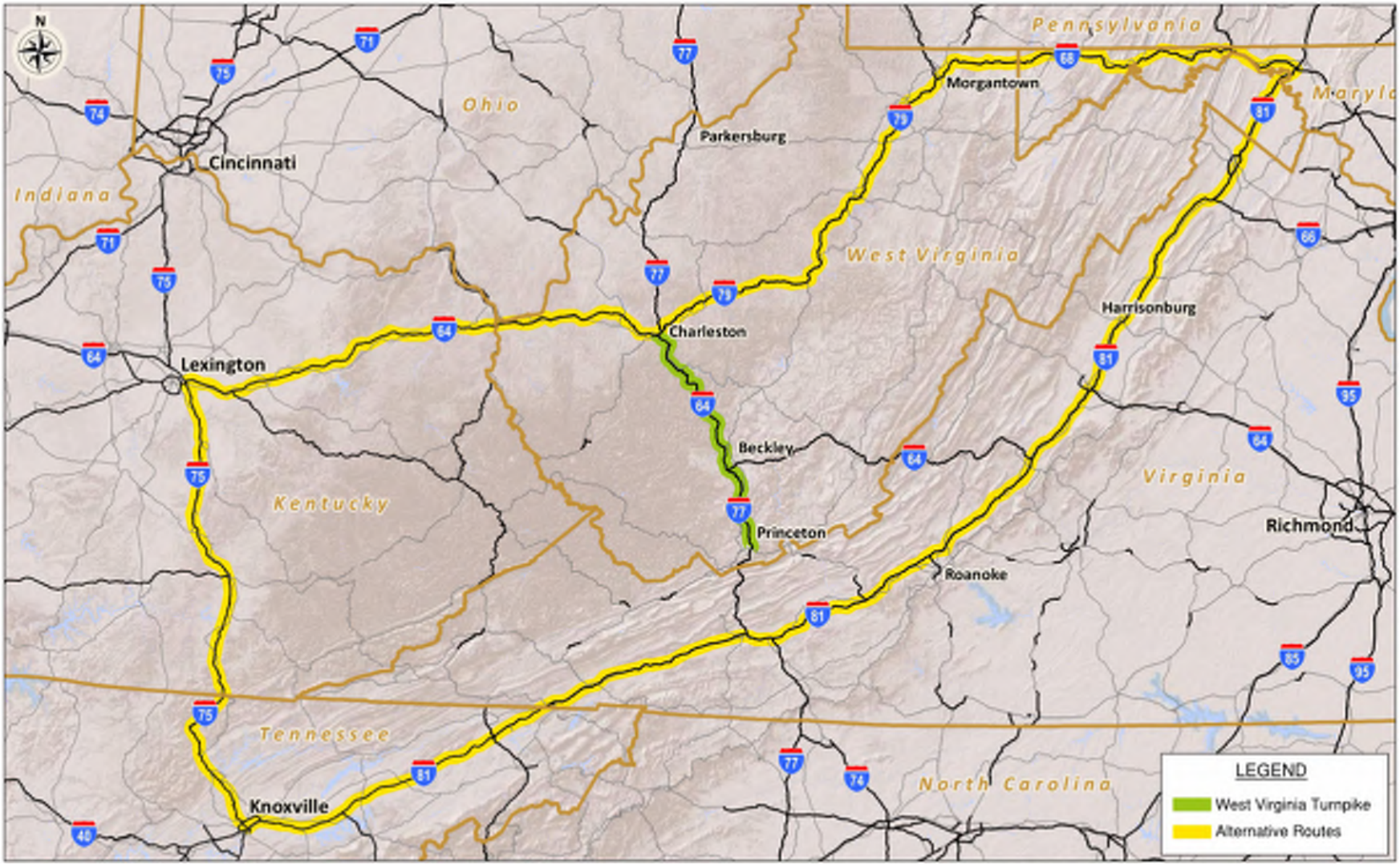
Task 2 – Stated Preference Survey

- Develop survey instrument to cover range of possible tolling policies
- Develop on-line survey
- Distribute information on survey through handouts to customers at plazas, emails to WV and Non-WV E-ZPass customers, and general information posters
- Consolidate survey results and develop statistical payment choice models for Class 1

Task 3 – Econometric Model

- Assemble historical data and forecasts of socioeconomic conditions (such as population, employment, income, and gross regional product) in the region and nearby areas that contribute traffic to the Turnpike
- Perform econometric (statistical) modeling with historic socioeconomic data and Turnpike data compiled in Task 1

Figure 1-1 West Virginia Regional Location Map



- Prepare a baseline forecast of normal traffic growth for the Turnpike under a scenario with no toll policy change
- Prepare low and high forecasts of traffic growth based on statistical variables

Task 4 – Traffic and Toll Revenue Estimates

- Assess the impact of transportation improvement projects that would likely affect the usage of the Turnpike in the future
- Analyze the impacts of the past toll increase to estimate the toll elasticity of the Turnpike, recalibrating and updating prior toll sensitivity analysis based on these findings
- Develop spreadsheet model which applies market shares from Task 3 and toll rates and programs to develop traffic and revenue streams
- Develop baseline T&R annual stream
- Analyze up to eight alternative scenarios, as identified by WVPA, producing estimates of annual traffic and revenue

Task 5 – Documentation

- Develop comprehensive reporting documenting data, analysis, and findings suitable for use in an Official Statement
- Develop presentation slides for use by WVPA in policy discussions and rating agency presentations

Task 6 – Meetings

- Project planning meeting
- Draft results presentations to WVPA staff, finance working group, board subcommittees, and WVPA board as needed
- Attend WVPA public meetings on proposed toll rate increases
- Attend and present at bond rating agency meetings

Task 7 – Project Management

- Project planning
- Project management including management of subconsultants and vendors
- Progress reports and invoices
- Comprehensive Quality Assurance and Quality Control to meet investment grade standards

Following is a list of the main data sources used for this study:

- Prior T&R studies by CDM Smith (2005 and 2009)

- Historical toll transactions and revenues provided by WVPA
- Comprehensive Annual Financial Reports (CAFRs)
- Annual Consulting Engineer's Reports
- Key transportation planning documents on regional and WV transportation plans, such as the latest WV Turnpike Capital Improvement Program (CIP)
- Data on frequency of usage provided by StreetLight Data, Inc.
- Transaction database (2010-2017) communicated by TransCore on behalf of WVPA

1.3 Order of Presentation

Following this introductory chapter, the remainder of this report is organized as follows.

- Chapter 2 has a summary of existing and historical traffic conditions as well as a review of current toll locations, toll schedules, and discount plans. This chapter also contains information about frequency of use.
- Chapter 3 contains a summary of the SP survey approach and results for existing customers of the Turnpike.
- Chapter 4 includes a detailed explanation of the econometric analysis that was conducted to estimate long-term travel demand for each plaza on the Turnpike.
- Chapter 5 presents the traffic and revenue forecasting approach. It includes an overview of the tolling analysis model, a description of the forecasting process, and major forecasting assumptions as well as example scenarios used to test model behavior.
- Chapter 6 includes the results of traffic and gross revenue analysis in the form of estimated annual transactions and toll revenue for the prospective scenario for the period from FY 2018 through FY 2050.
- Chapter 7 contains the results of sensitivity testing of key model parameters and assumptions.

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Chapter 2
Existing Conditions

This chapter contains a summary of existing conditions starting with a description of the physical characteristics of the Turnpike and the current toll schedule. The chapter also includes a review of trends in traffic and revenue, information about frequency of use, and an overview of the capital investment programs.

2.1 Description of the West Virginia Turnpike

Figure 2-1 shows the Turnpike and the location of the four toll plazas. There are three mainline toll plazas at Ghent (Toll Plaza A) at milepost 30, Pax (Toll Plaza B) at milepost 56, and Chelyan (Toll Plaza C) at milepost 83. There is also one ramp toll plaza located on Route 19 at the North Beckley Exit (Exit 48). Tolls are collected in both directions at the mainline plazas and to and from the south at the North Beckley Plaza.

The Turnpike passes through the West Virginia counties of Kanawha, Fayette, Raleigh, and Mercer, serving cities including Charleston, Beckley, and Princeton. In addition to these cities, smaller communities with more localized trip origins and destinations are served. A large proportion of long-distance interstate trips are served by the Turnpike.

Figure 2-1 also shows several parallel roadways that offer alternatives to various sections of the Turnpike. These roads include:

- U.S. Route 19 between Princeton and North Beckley
- U.S. Route 60 / U.S Route 19 between North Beckley and Charleston
- S.R. 3/S.R. 94 between Beckley and Marmet
- S.R. 61 between Chelyan and Kanawha City

These routes do not offer the higher speeds and convenience provided by the Turnpike. Many of the alternative roads pass directly through local communities, are narrow, and have lower standards of vertical and horizontal geometry in comparison to the Turnpike, which may be of concern due to the mountainous terrain through which the Turnpike corridor runs. Because of the numerous curves and grade changes, the actual average travel speeds on these facilities are significantly lower than those that can be achieved on the Turnpike, resulting in overall longer travel times, especially for longer distance trips.

Also shown on Figures 1-1 and 2-1 are some additional key feeder routes connected to the Turnpike, such as:

- I-81 west of Fort Chiswell in Virginia
- I-77 in the south end of the state near Virginia
- U.S. Route 460 east of I-77 and west of I-77
- I-64 east of Beckley

Figure 2-1 Toll Plaza Location Map

- U.S. Route 19 at North Beckley
- U.S. Route 60 east of Chelyan
- I-77 north of Charleston
- I-79 north of Charleston
- U.S. Route 119 west of Charleston
- I-64 west of Charleston and U.S. 35

2.2 Toll Schedule and Discount Plans

A summary of the toll rate schedule currently in place on the Turnpike is presented in **Table 2-1**. The current toll rates and discount plans became effective on August 1, 2009. (The previous toll rate increase had occurred in 1981.)

The current toll rate schedule consists of toll rates for ten vehicle classifications based on the number of axles, vehicle height, and vehicle characteristics. Under the current toll schedule, passenger car drivers pay $2.00 in cash at each mainline toll plaza and $0.40 at the North Beckley ramp plaza. Cash tolls for five-axle trucks are $6.75 at each mainline toll plaza and $1.60 at North Beckley.

Table 2-1 Current West Virginia Parkways Toll Rates – Aug. 1, 2009 to Present

Toll Class	Vehicle Type	No. of Axles	Barriers A, B & C			North Beckley		
			Cash	WV E-ZPass	Non-WV E-ZPass	Cash	WV E-ZPass	Non-WV E-ZPass
1	Passenger cars/pickup trucks (under 7' 6")	2	$2.00	$1.30	$2.00	$0.40	$0.26	$0.40
2	All Class 1 vehicles with a trailer (under 7' 6")	3+	$2.50	$1.63	$2.50	$0.80	$0.52	$0.80
3	Motorhomes only (over 7' 6")	2-3	$2.50	$1.63	$2.50	$0.80	$0.52	$0.80
4	Class 3 vehicles with a trailer (over 7' 6")	3+	$3.25	$2.11	$3.25	$1.20	$0.78	$1.20
5	2-axle trucks	2	$3.25	$2.60	$2.83	$0.80	$0.64	$0.70
6	3-axle trucks	3	$4.50	$3.60	$3.92	$1.20	$0.96	$1.04
7	4-axle trucks	4	$6.50	$5.20	$5.66	$1.60	$1.28	$1.39
8	5-axle trucks	5	$6.75	$5.40	$5.87	$1.60	$1.28	$1.39
9	6 or more-axle trucks	6+	$9.50	$7.60	$8.27	$2.40	$1.92	$2.09
10	Oversize trucks		$12.00	$9.60	$10.44	$7.20	$5.76	$6.26

Source: WVPA
Note: Class 1 refers to 2-axle vehicles with a gross vehicle weight less than 8,000 lbs. not being used for commercial purposes. Passenger Cars (PC) refers to Classes 1-4. Commercial Vehicles (CV) refers to Classes 5-10.

Electronic toll collection was introduced on the Turnpike in 2000 through the E-ZPass system and is available in all toll plaza lanes. A significant benefit of the E-ZPass system is that motorists are not required to come to a full stop at toll plazas to pay cash for tolls. Instead E-ZPass customers have an electronic transponder in their vehicles, and all transaction information is passed electronically between the vehicle and the toll plaza.

Several discount plans are available to customers through E-ZPass, as described below.

2.2.1 Personal Discount Plan #1

A discount plan intended for high frequency users of the Turnpike has been in place since 2000 (North Beckley since 1989) with no increase in fees since then. The program is restricted to Class 1 vehicles defined as passenger cars and trucks with a gross vehicle weight of less than 8,000 pounds that are not being used for commercial or business purposes.

This existing flat fee program entitles eligible customers to unlimited travel through each plaza for which they purchase the flat fee plan. Rates are shown on **Table 2-2**. Subscribers can choose any combination of the three mainline plazas for a quarterly flat fee of $25 per plaza. A $5 discount per mainline toll plaza is offered for an annual plan, for a total cost of $285 for all three mainline toll plazas. This equates to a 5% discount per mainline plaza over the quarterly flat fee. Included with any of the mainline plazas is the North Beckley ramp, which costs $5 annually if purchased separately. Subscribers are issued a WV E-ZPass transponder which provides unlimited access to the selected plazas, while also processing regular pay-per-use transactions at other plazas at the Plan #2 rates provided prepaid funds are added to the account.

Table 2-2 Personal Discount Plan #1 Rates

Plaza	Yearly Rate	Quarterly Rate
Plaza A	$95.00	$25.00
Plaza B	$95.00	$25.00
Plaza C	$95.00	$25.00
Plaza A & B	$190.00	$50.00
Plaza A & C	$190.00	$50.00
Plaza B & C	$190.00	$50.00
Plaza A, B, & C	$285.00	$75.00
North Beckley Ramp	$5.00	NA

Source: WVPA

2.2.2 Personal Discount Plan #2

A discount program for less frequent travelers than Personal Discount Plan #1, covering all Passenger Cars (PC - Classes 1 through 4), was introduced in 2009. Customers can sign up for a WV E-ZPass at a cost of $5.00 per year, then pre-pay funds via credit card into their account ($20.00 minimum account balance). Personal Discount Plan #2 provides a 35% discount from the cash toll rates. The discounted toll is automatically deducted from the prepaid account as they drive through the toll plazas. The WV E-ZPass is available to anyone, regardless of state or country of residence. Rates are shown in Table 2-1 under the column “WV E-ZPass”. (Note that no discount is offered to PCs paying with a Non-WV E-ZPass.)

2.2.3 Commercial Discount Plan #3

Commercial Discount Plan #3 provides a 20% discount from the cash toll rates for Commercial Vehicles (CV - Classes 5 through 10). This requires an E-ZPass account with the Turnpike, created through a $25.00 charge for the transponder and the creation of a prepaid account using a credit/debit card or bank account. Rates are shown in Table 2-1 under the column “WV E-ZPass”.

2.2.4 Commercial Discount Plan #4

Commercial Discount Plan #4 provides a 13% discount from the cash toll rates for CVs. This requires an account opened and managed by E-ZPass issued by an agency other than WV Turnpike. There is no

additional paperwork, account maintenance fee, or charge for the transponder. Rates are shown in Table 2-1 under the column "Non-WV E-ZPass".

2.3 Traffic and Transactions

Historical transaction trends on the Turnpike were reviewed and are presented in this section. Also described here are recent trends in traffic volumes, transactions by month, plaza, vehicle type, payment type, and place of residence. This data helps to develop an operating profile of Turnpike usage.

2.3.1 Average Daily Traffic

Counts of average daily traffic (ADT) on the Turnpike, which are derived from the West Virginia Division of Highways FY 2015 traffic counts, are listed by location in **Table 2-3**. Locations are shown by mile marker, from south to north. **Table 2-4** presents ADT for key connecting or competing routes.

Table 2-3 Average Daily Traffic on the Turnpike

Mile Marker	Location	ADT
9-28	Princeton to Ghent	32,400
28-40	Ghent to I-64	27,000
40-42	I-64 to Mabscott	38,800
42-44	Mabscott to Harper Rd	42,300
44-48	Harper Rd to N. Beckley	46,800
48-60	N. Beckley to Mossy	29,900
60-74	Mossy to Standard	29,600
74-78	Standard to Sharon	29,800
78-85	Sharon to Chelyan	29,400
85-90	Chelyan to Marmet	35,200
90-95	Marmet to Kanawha City	36,000
95-96	Kanawha City to Belle	53,800

Source: West Virginia Division of Highways FY 2015

Table 2-4 Average Daily Traffic on Other Routes

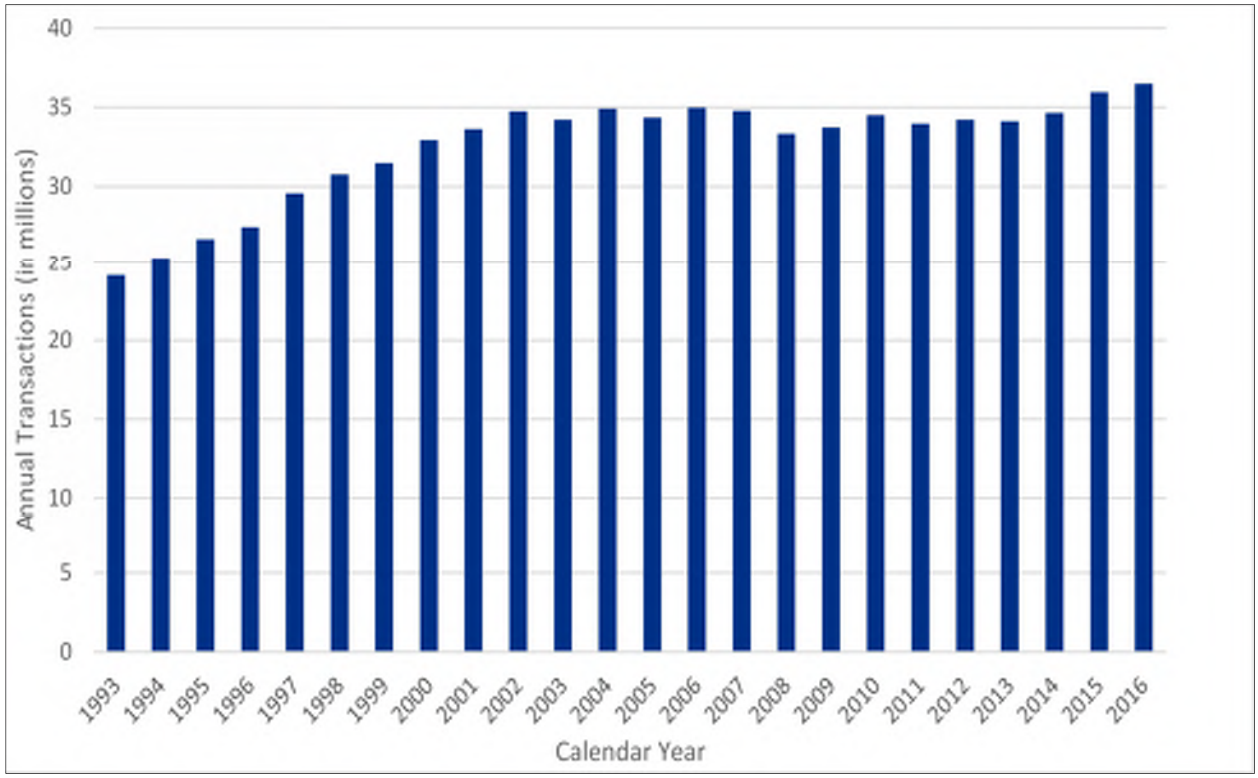
Facility	Location	Count Year	ADT
I-81	West of Fort Chiswell, VA	2015	52,000
I-77	VA state line	2015	28,000
U.S. 460	East of I-77	2015	14,400
U.S. 460	West of I-77	2015	14,300
I-64	East of Beckley	2014	24,600
U.S. 19	North of Beckley	2015	25,500
U.S. 60	East of Chelyan	2013	12,200
I-77	North of Charleston	2016	28,800
I-79	North of Charleston	2012	30,200
U.S. 119	West of Charleston	2016	34,100
I-64	West of Charleston	2015	79,800

Sources: WVDOT and VDOT

2.3.2 Historical Annual Transactions

Figure 2-2 contains total annual CY transactions on the Turnpike between 1993 and 2016. Over the entire period, systemwide toll transactions increased from 24.2 million in 1993 to 36.5 million in 2016, representing a compound annual growth rate (CAGR) of 1.8%. The Turnpike experienced strong growth in transactions from 1993 to 2002, with a CAGR of 4.1%. Between 2002 and 2013, transactions remained stable or declined. The decline of transactions in 2008 was influenced by the Great Recession. The toll rate increase of August 1, 2009 appears to have had little to no effect on overall transaction trends. In recent years, the Turnpike has experienced an upward trend with an annual average increase of 2.3% between 2013 and 2016. Variations in transactions are largely the result of the national macroeconomic climate affecting demographics and travel patterns.

Figure 2-2 Annual Systemwide Transactions

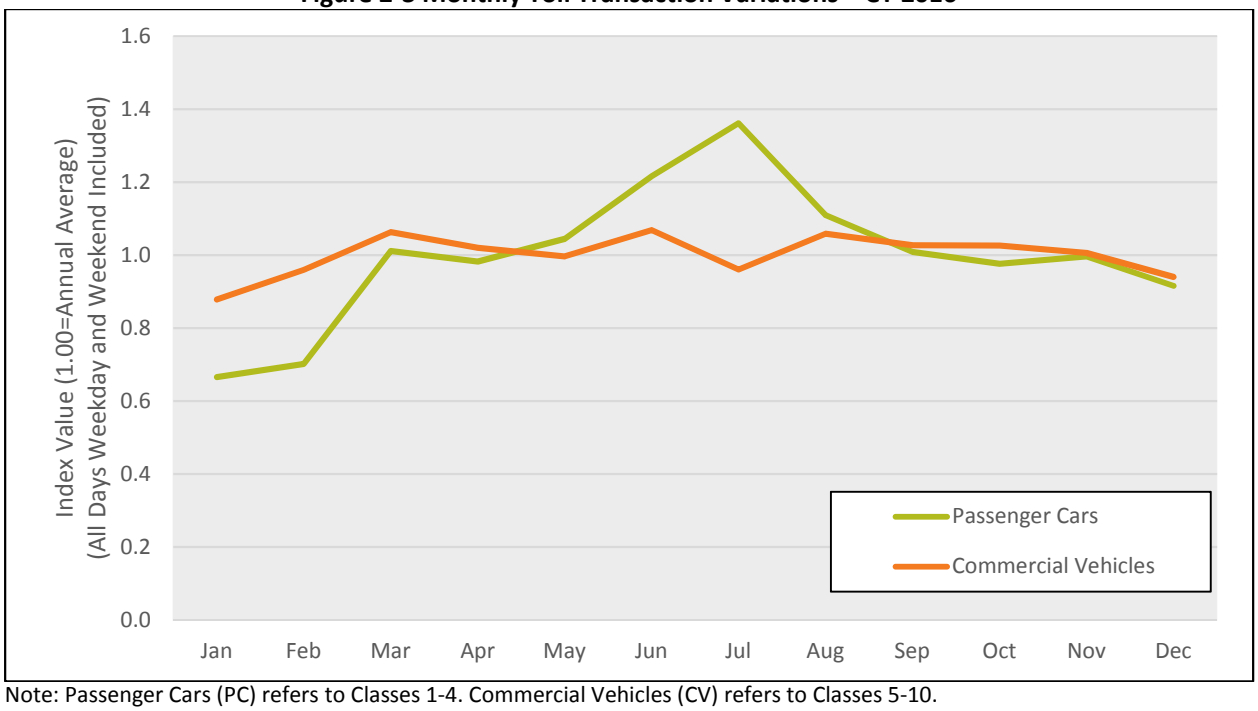


Source: WVPA

2.3.3 Seasonal Variations

Figure 2-3 provides a visual summary of the CY 2016 distribution of Turnpike transactions by month, between PCs (Classes 1-4) and CVs (Classes 5-10). PCs exhibit a distinct peaking pattern with significantly higher transactions in June through August (respectively 22%, 36%, and 11% higher than the annual average) due to the additional travel of summer tourists. Monthly total PC transactions in the peak summer month of July is approximately double that of the lowest months, January and February. Among CVs, there is considerably less variation and monthly transactions are generally stable throughout the year.

Figure 2-3 Monthly Toll Transaction Variations – CY 2016



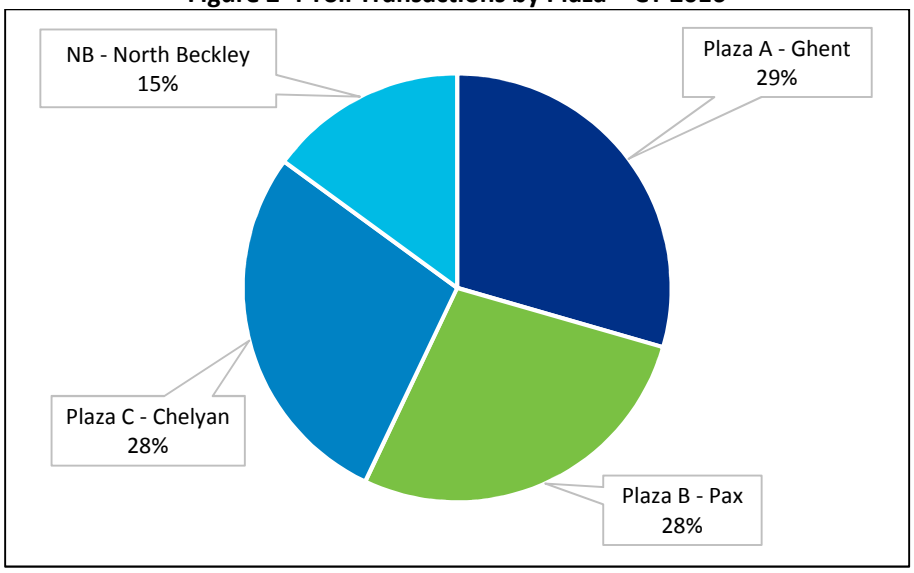
Note: Passenger Cars (PC) refers to Classes 1-4. Commercial Vehicles (CV) refers to Classes 5-10.

Source: WVPA (TransCore database) and CDM Smith Analysis

2.3.4 Transactions by Plaza

Figure 2-4 shows the relative contribution of each toll location to the Turnpike's total transactions in CY 2016. The three mainline plazas accounted for roughly the same share of overall transactions (about 28%) while the North Beckley ramp plaza represented about 15% of the total. The share of transactions by plaza has remained very stable over the last decade. For instance, in 2008, North Beckley had about 17% of all transactions and each mainline plaza had about 28%.

Figure 2-4 Toll Transactions by Plaza – CY 2016



Source: WVPA (TransCore database) and CDM Smith Analysis

2.3.5 Vehicle Classification

In CY 2016, PCs accounted for 78% of transactions and CVs accounted for almost 22% of transactions. The detailed breakout of 2016 transactions by class is shown in **Table 2-5**.

The share of CV transactions as a proportion of all transactions was the same in 2012 (22%). In 2016, all mainline plazas had a similar share of CV transactions, about 22% at Plaza A-Ghent, 25% at Plaza B-Pax, and 24% at Plaza C-Chelyan. However, the North Beckley ramp plaza had much fewer CVs at less than 10% of total transactions.

Table 2-5 Transactions by Class – CY 2016

Toll Class	Vehicle Type	Axles	Transactions	% Trans
1	Passenger cars/pickup trucks (under 7' 6")	2	27,588,560	75.6%
2	All Class 1 vehicles with a trailer (under 7' 6")	3+	795,590	2.2%
3	Motorhomes only (over 7' 6")	2-3	63,854	0.2%
4	Class 3 vehicles with a trailer (over 7' 6")	3+	58,277	0.2%
	Passenger Cars (PC) Sub Total		**28,506,282**	**78.1%**
5	2-axle trucks	2	544,502	1.5%
6	3-axle trucks	3	341,945	0.9%
7	4-axle trucks	4	129,246	0.4%
8	5-axle trucks	5	6,675,330	18.3%
9	6 or more-axle trucks	6+	174,140	0.5%
10	Oversize trucks		33,779	0.1%
	Commercial Vehicles (CV) Sub Total		**7,898,943**	**21.6%**
	Unclassified		80,661	0.2%
	Total		**36,485,886**	**100.0%**

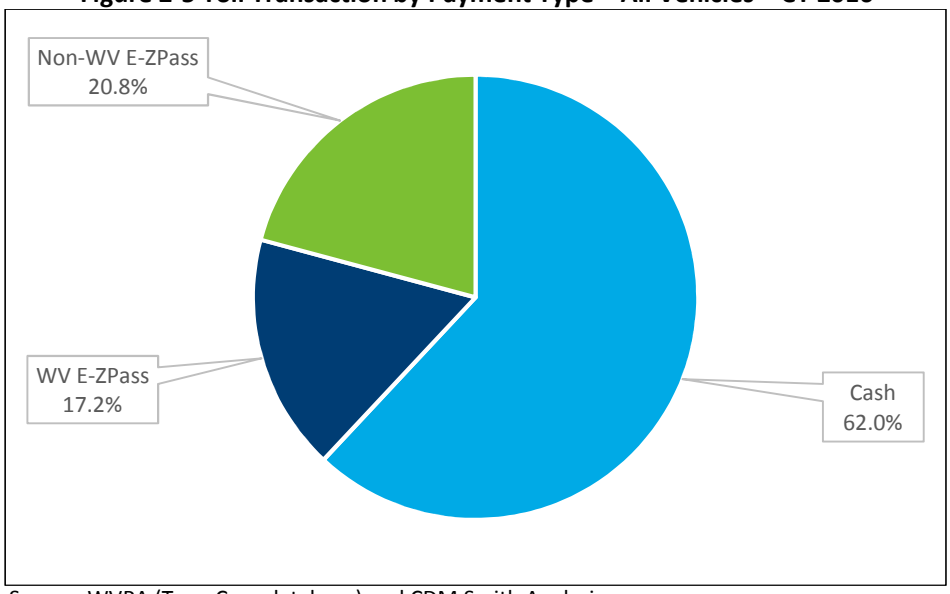
Source: WVPA (TransCore database) and CDM Smith Analysis
Note: About 80,700 transactions were not linked to a specific toll class and are shown as "Unclassified." However, nearly all of these occur at the North Beckley Automatic Coin Machines which mostly serve Class 1 vehicles. Transactions from the current flat fee Discount Program 1 are approximately 3.2 million annually and are included in the Class 1 results above.

2.3.6 Method of Payment

Only cash and E-ZPass can be used to pay tolls on the Turnpike. No debit/credit cards are accepted at toll plazas. **Figure 2-5** presents the breakout of CY 2016 annual toll transactions by payment category (cash, WV E-ZPass, and Non-WV E-ZPass).

The WVPA is a full member agency of the E-ZPass Group along with multiple other toll agencies equipped with the E-ZPass system. This allows any vehicle equipped with a transponder to travel seamlessly without stopping throughout 16 eastern states, including 27 public toll agencies where the E-ZPass standard is accepted. These states range from Illinois to the west, North Carolina in the south, and up to Maine in the north. The program overall includes over 20 million accounts with over 34 million transponders in circulation and the collection of over $9 billion in electronic toll revenues in CY 2016.

Figure 2-5 Toll Transaction by Payment Type – All Vehicles – CY 2016



Source: WVPA (TransCore database) and CDM Smith Analysis

All toll plaza lanes accept E-ZPass. In addition to staffed and E-ZPass capability, the North Beckley Toll Plaza includes two lanes in each direction that provide the option to pay by coin via automatic coin machines when operated unstaffed with "EXACT CHANGE" signs displayed. The use of these lanes provides additional options for patrons and operational efficiencies for WVPA. Advance E-ZPass signage is presented along the roadways approaching the toll plazas to further communicate that all lanes are available for E-ZPass customers. Temporary tandem toll booths continue to be available as a tool to relieve congestion during holiday periods as necessary at the Ghent, Pax, and Chelyan toll plazas.

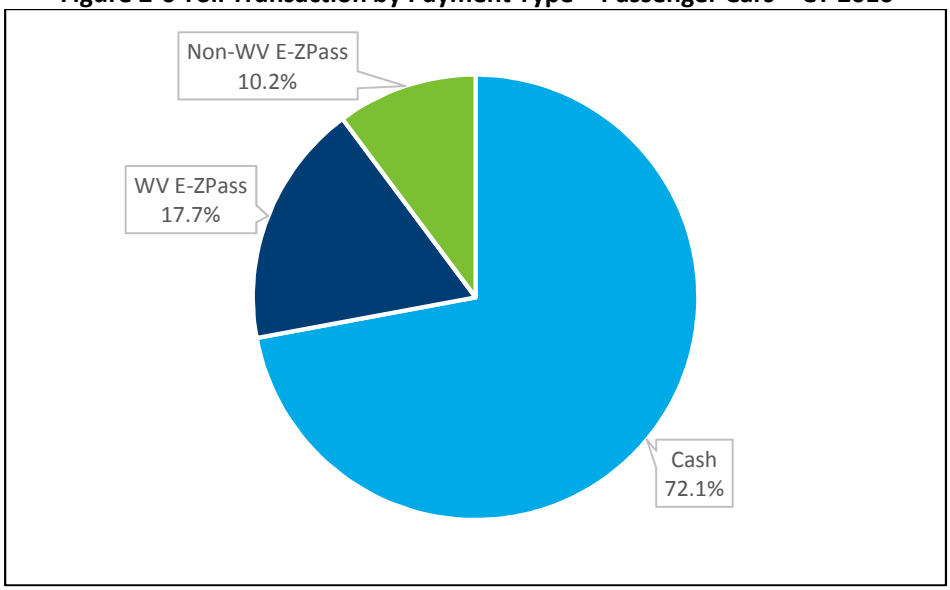
As shown in Figure 2-5, about 62% of CY 2016 transactions were paid by cash, 17% were WV E-ZPass transactions, and the remaining 21% were Non-WV E-ZPass transactions. In 2016, payment via automated coin machines at the North Beckley ramp plaza accounted for about 6% of all systemwide transactions (included in the cash total).

The method of payment varies significantly between passenger cars and commercial vehicles, as illustrated in **Figures 2-6** and **2-7**. Among PC transactions, cash is by far the method of payment used most often, representing 72% of all transactions. WV E-ZPass transactions represent 18% of PC transactions and 10% are Non-WV E-ZPass transactions.

Among CV transactions, E-ZPass is by far the most common method of payment at 75% total. Non-WV E-ZPass transactions represent 59% of CV transactions, WV E-ZPass are 16%, and the remaining 25% are cash transactions.

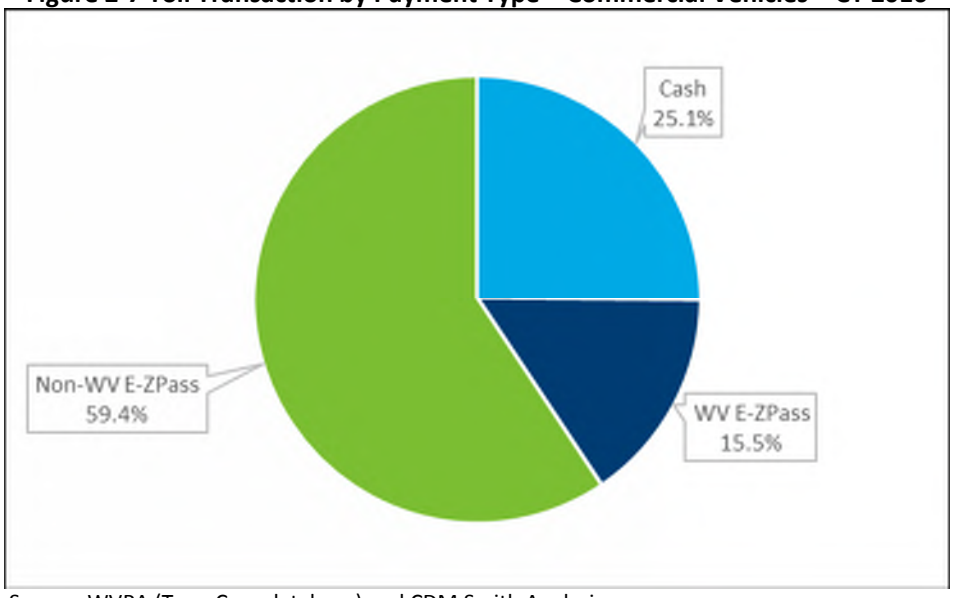
All three mainline plazas have a similar E-ZPass market (about 37%), while at the North Beckley ramp plaza, the share of E-ZPass transactions reached 43% in 2016.

Figure 2-6 Toll Transaction by Payment Type – Passenger Cars – CY 2016



Source: WVPA (TransCore database) and CDM Smith Analysis

Figure 2-7 Toll Transaction by Payment Type – Commercial Vehicles – CY 2016



Source: WVPA (TransCore database) and CDM Smith Analysis

As of 2017, the WV E-ZPass system has approximately 46,000 accounts. The WV E-ZPass system currently permits several vehicles to be associated with an individual E-ZPass account, however most of the accounts (87%) have just one vehicle registered. Two-vehicle accounts represent about 11%, and three-vehicle accounts about 2% of all WV E-ZPass accounts. The number of vehicles per account is shown in **Table 2-6**.

Table 2-6 Number of Vehicles per WV E-ZPass Account

# of Vehicles	# of Accounts	Share (%)
1	39,836	87%
2	4,972	11%
3	858	2%
4	177	0%
5	48	0%
Total	**45,891**	**100%**

Source: WVPA, as of September 2017

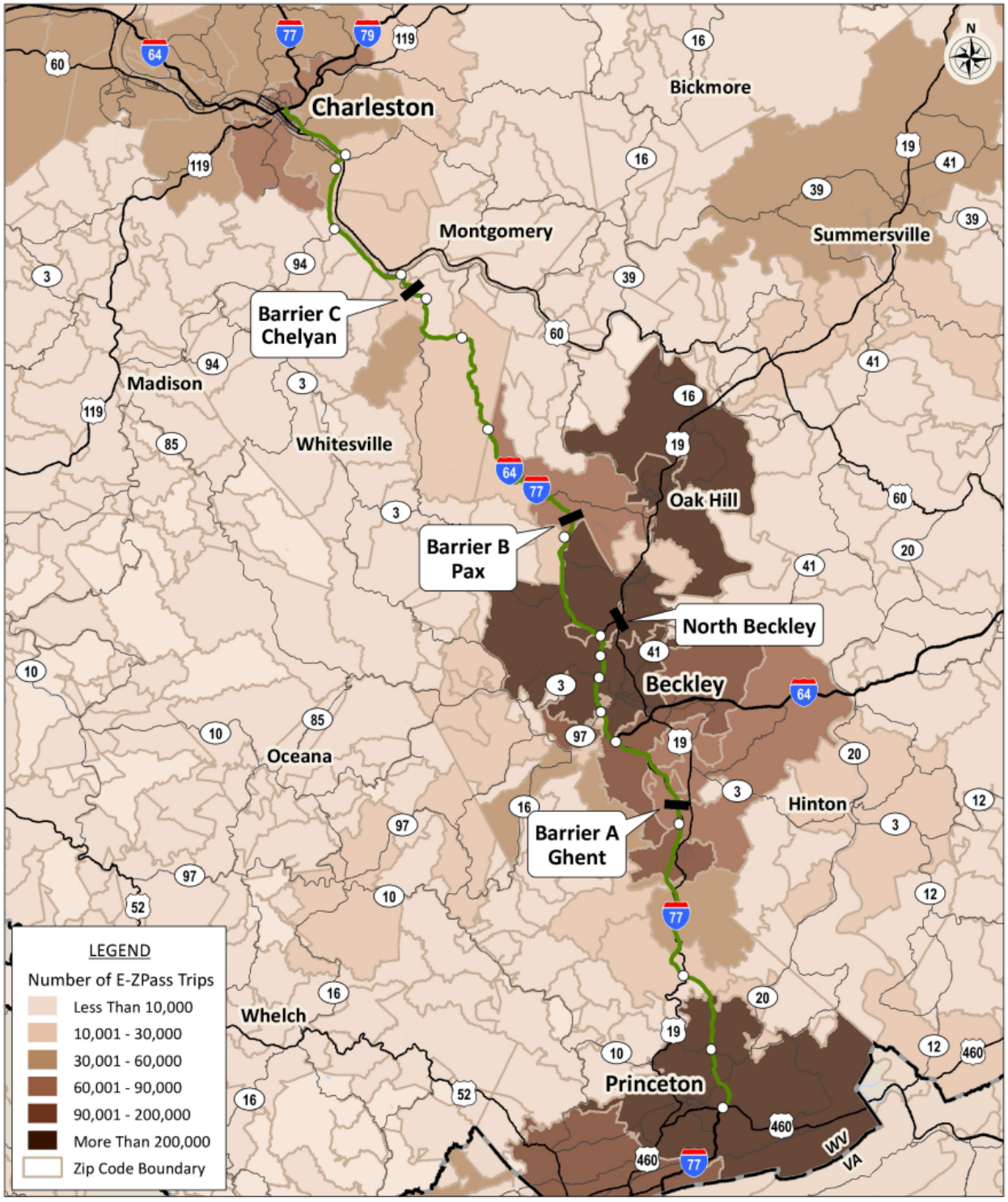
2.3.7 E-ZPass Trips by Zip Code

Figure 2-8 illustrates the number of CY 2016 E-ZPass trips by zip code. The zip codes are based upon the location of E-ZPass account registration. The share of E-ZPass trips with in-state accounts is 45%. The county with the highest share of E-ZPass trips is Raleigh County that includes Beckley and represents about 16% of all E-ZPass trips. More generally, a high share of E-ZPass trips are associated with Beckley and the surrounding areas. Other locations with high densities of E-ZPass trips include Princeton and Charleston.

2.3.8 E-ZPass End-to-End Trips

The CY 2016 E-ZPass transactions were analyzed to estimate the share of trips traveling end-to-end on the facility i.e., between Ghent and Chelyan. It was found that end-to-end trips represent about 31% of the WV E-ZPass trips and about 70% of the Non-WV E-ZPass trips. These percentages are based on total trips at Ghent and Chelyan.

Figure 2-8 Number of E-ZPass Trips by Zip Code (CY 2016)



Source: TransCore data and CDM Smith Analysis

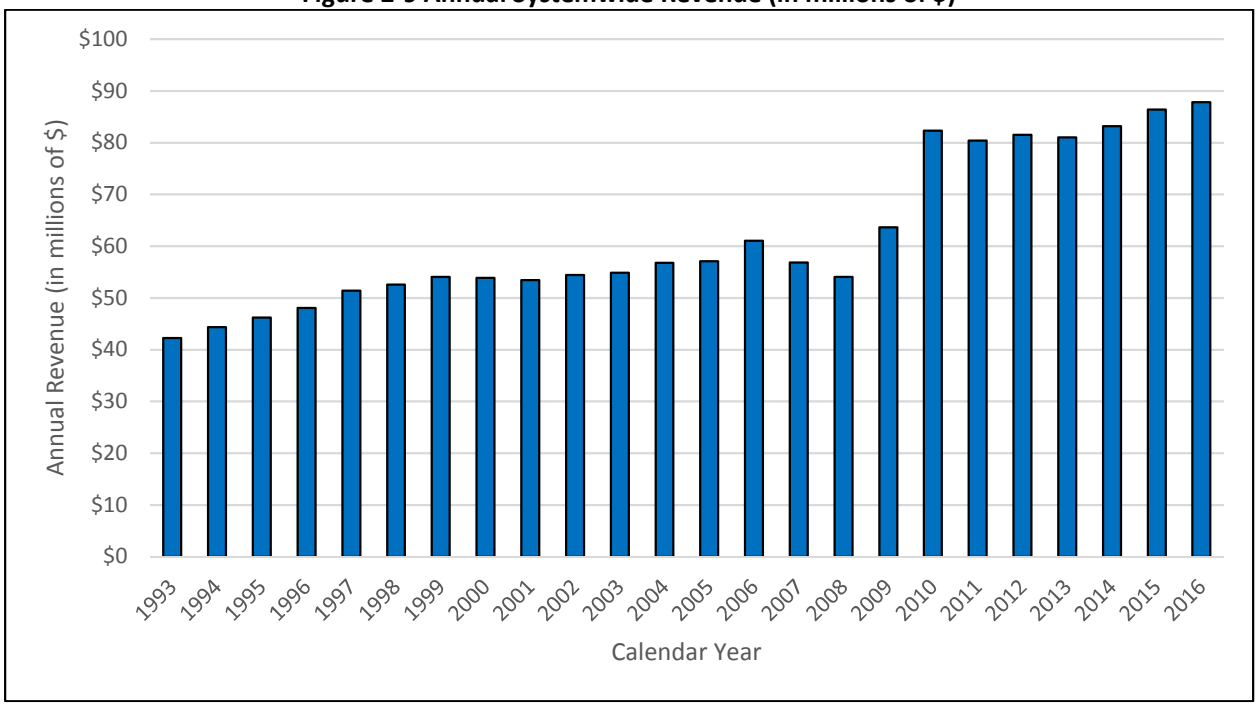
2.4 Annual Toll Revenue

Historical revenue trends on the Turnpike were reviewed and are presented in this section. Also described here are recent trends in revenue by plaza, vehicle class, and payment type.

2.4.1 Historical Annual Revenue

Figure 2-9 presents total CY annual revenue on the Turnpike between 1993 and 2016. Over the entire period, systemwide toll revenue increased from $42.3 million in 1993 to $87.8 million in 2016, representing a CAGR of 3.2%. Variations in revenue are largely the result of the national macroeconomic climate, toll rate adjustments made by WVPA, and increases in utilization of the E-ZPass discount programs. In general, the revenue trend followed the transaction pattern previously described, including a drop in 2007/2008 due to the Great Recession. The effects of the toll rate increase on August 1, 2009 were seen during the first five months of 2009 and the first seven months of 2010. For the twelve-month period beginning August 1, 2009, toll transactions increased 2.5% and toll revenues increased 56.3%. Stated another way, the approximately 60% toll rate increase for cash customers, but discounted for E-ZPass customers, contributed to an approximately 52% increase in revenue over the period 2008 to 2010.

Figure 2-9 Annual Systemwide Revenue (in millions of $)



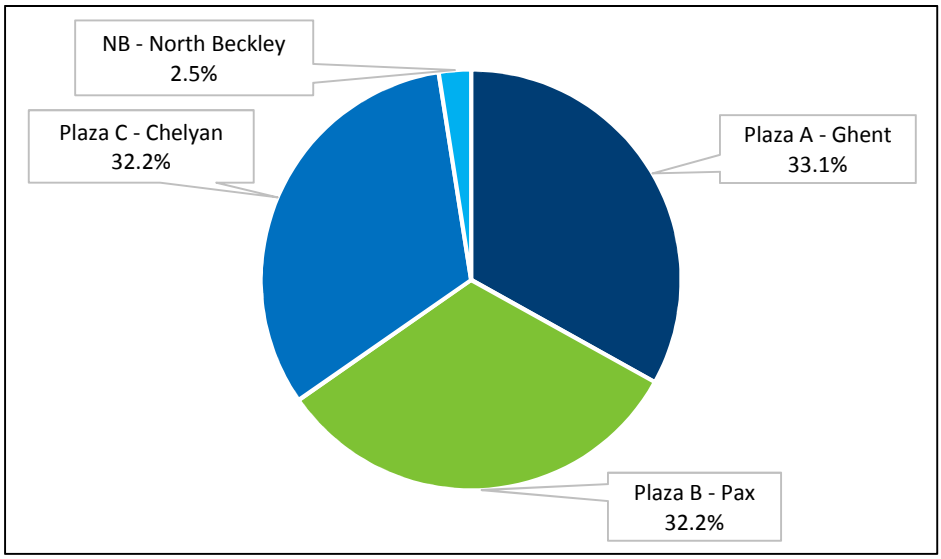
Source: WVPA

Note: Revenue from the current flat fee Discount Program 1 is tracked separately and is not included in the revenue summary results. For years 2012-2017, the average revenue from this program was $1.2M annually.

2.4.2 Revenue by Plaza

As shown on **Figure 2-10**, the three mainline plazas accounted for roughly the same share of overall revenue in CY 2016 (about 32% each) while the North Beckley ramp plaza represented only about 2% of the total. This reflects lower toll rates and fewer transactions at the North Beckley plaza. As a comparison, the share of revenue generated by North Beckley was 3% in 2000.

Figure 2-10 Revenue by Plaza



Source: WVPA (TransCore database) and CDM Smith Analysis

2.4.3 Revenue by Vehicle Classification

Commercial Vehicle (CV) toll rates are higher than passenger car toll rates, therefore the share of CVs in overall revenue is higher than the share of CVs in transactions. In CY 2016, CVs accounted for 49% of revenue. As a comparison, the share of revenue generated by CVs was 50% in 2012.

The breakdown by class is shown in **Table 2-7**. The vast majority (95%) of passenger car revenue comes from Class 1 vehicles. For commercial vehicles, Class 8 vehicles generate 88% of commercial vehicle revenue.

Table 2-7 Revenue by Class – CY 2016

Toll Class	Vehicle Type	Axles	Revenue	% Rev
1	Passenger cars/pickup trucks (under 7' 6")	2	$ 42,216,596	48.1%
2	All Class 1 vehicles with a trailer (under 7' 6")	3+	$ 1,818,479	2.1%
3	Motorhomes only (over 7' 6")	2-3	$ 147,597	0.2%
4	Class 3 vehicles with a trailer (over 7' 6")	3+	$ 176,632	0.2%
	Passenger Cars Sub Total		**$ 44,359,304**	**50.5%**
5	2-axle trucks	2	$ 1,447,737	1.6%
6	3-axle trucks	3	$ 1,232,604	1.4%
7	4-axle trucks	4	$ 706,495	0.8%
8	5-axle trucks	5	$ 38,327,692	43.6%
9	6 or more-axle trucks	6+	$ 1,383,802	1.6%
10	Oversize trucks		$ 360,194	0.4%
	Commercial Vehicles Sub Total		**$ 43,458,524**	**49.5%**
	Unclassified		$ 22,650	0.0%
	Total		**$ 87,840,478**	**100.0%**

Source: WVPA (TransCore database) and CDM Smith Analysis
Note: About $22,650 in revenues were not linked to a specific toll class and are shown as "Unclassified." However, nearly all of these occur at the North Beckley Automatic Coin Machines which mostly service Class 1 vehicles. Revenue from the current flat fee Discount Program 1 is tracked separately and is not included in the revenue summary results. For years 2012-2017, the average revenue from this program was $1.2M annually.

2.4.4 Revenue by Payment Type

In 2016, about 55% of the revenue was generated by cash payment, while the remaining 45% came from E-ZPass payment. Note that the share of E-ZPass in overall revenue is higher than the share of E-ZPass in transactions. This is because almost 73% of the E-ZPass revenue is generated by trucks.

Table 2-8 shows that 83% of the passenger car revenue comes from cash payment, while only 27% of the commercial vehicle revenue comes from cash. The highest share of the commercial vehicle revenue comes from Non-WV E-ZPass payment, with over 60%.

These results also show that a large portion (36%) of Turnpike revenue comes from Non-WV E-ZPass. Additional indication from cash users of the Turnpike who took the SP survey (see Chapter 3) indicates approximately 70% of the Class 1 cash users are out of state contributing 29% of the total revenue, bringing the out of state revenue proportion to approximately 65%, not including Non-WV cash Classes 2-10 revenue. A travel survey conducted by CDM Smith in 2005 as part of a previous revenue study indicated about 76% of all revenue comes from vehicles registered out of state.

Table 2-8 Revenue by Payment Type and Vehicle Class – CY 2016

Vehicle Type	Revenue			Share of Revenue		
	Passenger Cars	Commercial Vehicles	Total	Passenger Cars	Commercial Vehicles	Total
Cash	$ 36,929,460	$ 11,780,456	$ 48,709,916	83.2%	27.1%	55.5%
WV E-ZPass	$ 2,312,703	$ 5,533,495	$ 7,846,198	5.2%	12.7%	8.9%
Non-WV E-ZPass	$ 5,139,790	$ 26,144,573	$ 31,284,363	11.6%	60.2%	35.6%
Total	**$ 44,381,954**	**$ 43,458,524**	**$ 87,840,478**	**100.0%**	**100.0%**	**100.0%**

Source: WVPA (TransCore database) and CDM Smith Analysis

2.5 Frequency of Use

Frequency of use is a major factor to consider when studying the effects of the proposed changes in toll policy, particularly when revising the Class 1 flat fee program on the Turnpike. The frequency of use is defined as the number of trips each customer made through a given plaza during a year.

To estimate the existing frequency of use, CDM Smith had access to two various sources of data:

- A detailed record of E-ZPass transactions provided by WVPA
- A dataset provided by StreetLight Data, Inc. to understand the frequency of trips by mobile devices for the period July 2016 through June 2017

For these two data sources, the section below provides an overview of the approach and summary of findings.

2.5.1 E-ZPass Customers

The E-ZPass transaction records provided by WVPA were analyzed by CDM Smith to develop a frequency of use profile of E-ZPass customers in CY 2016.

The frequency of use, defined as the number of times a transponder passed through a given plaza in the year, was derived by vehicle class (PC and CV), and E-ZPass agency (WV and Non-WV). The frequency

data shows the proportion of customers that used the Turnpike 1 to 10 times per year, 10 to 20 times per year, 20 to 30 times per year, etc.

Figures 2-11 and **2-12** show the frequency distribution and cumulative frequency distribution for WV E-ZPass and Non-WV E-ZPass passenger car customers.

The majority of E-ZPass PC customers travel on the Turnpike infrequently. Among WV E-ZPass PC customers, the proportion of travelers using the Turnpike less than 50 times a year in 2016 was found to be 86% at the Ghent and Pax plazas, 85% at Chelyan, and 76% at North Beckley. North Beckley had a higher proportion of frequent users.

The level of frequency is even lower among Non-WV E-ZPass PC customers, with the proportion of travelers using the Turnpike less than 10 times a year reaching 98% at all four plazas.

Figures 2-13 and **2-14** show the frequency distribution and cumulative frequency distribution for WV E-ZPass and Non-WV E-ZPass CV customers.

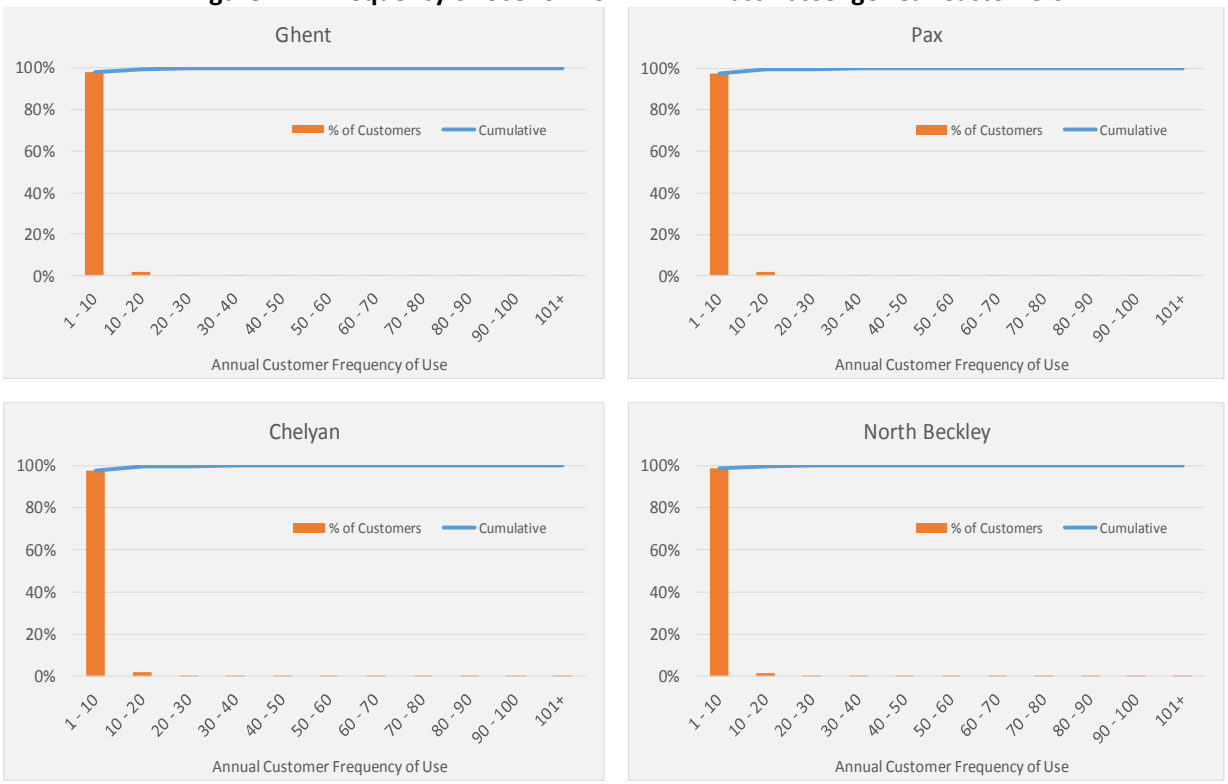
The majority of E-ZPass CV customers also travel on the Turnpike infrequently. Among WV E-ZPass CV customers, the proportion of travelers using the Turnpike less than 50 times a year in 2016 was found to be 80% at the Ghent plaza, 81% at Pax, 82% at Chelyan, and 90% at North Beckley.

The level of frequency is even lower among Non-WV E-ZPass CV customers, with the proportion of travelers using the Turnpike less than 10 times a year reaching about 90% at the mainline plazas, and 95% at North Beckley.

Figure 2-11 Frequency of Use for WV E-ZPass Passenger Car Customers

Source: WVPA (TransCore database) and CDM Smith analysis

Figure 2-12 Frequency of Use for Non-WV E-ZPass Passenger Car Customers

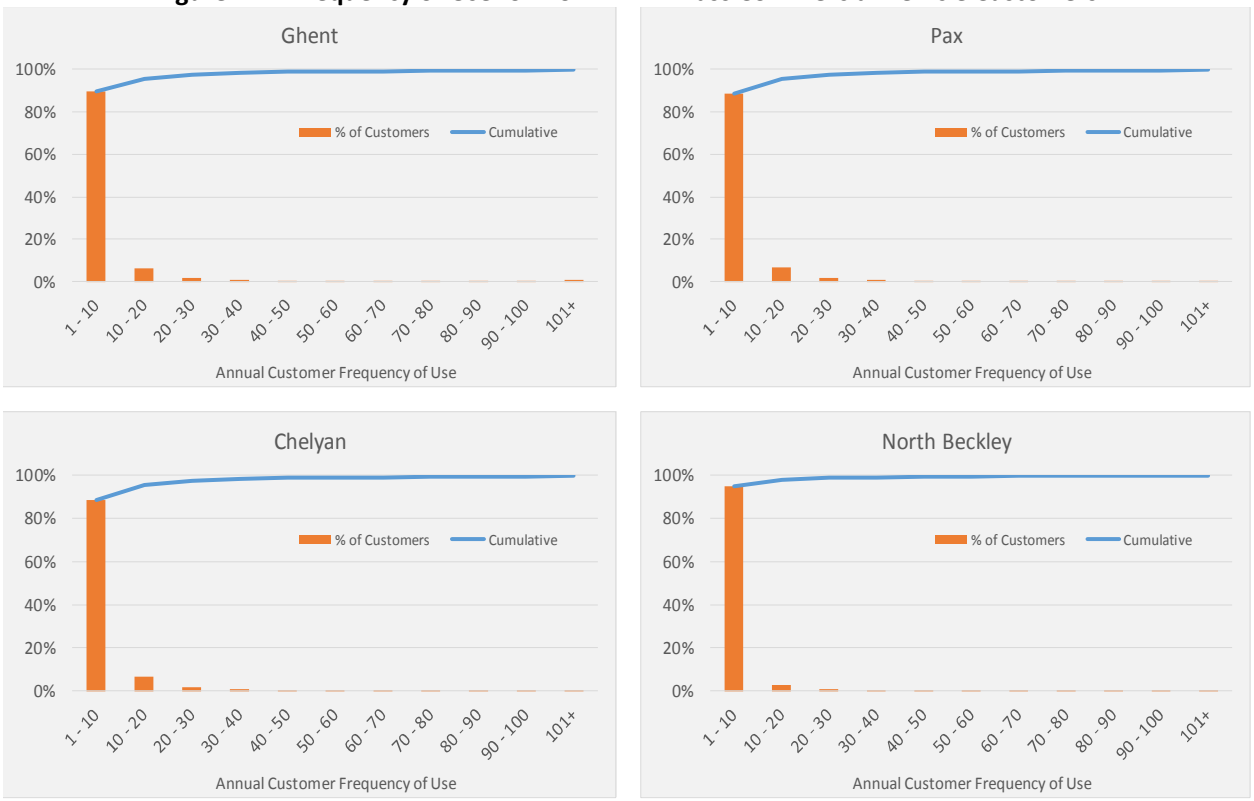


Source: WVPA (TransCore database) and CDM Smith analysis

Figure 2-13 Frequency of Use for WV E-ZPass Commercial Vehicle Customers

Source: WVPA (TransCore database) and CDM Smith analysis

Figure 2-14 Frequency of Use for Non-WV E-ZPass Commercial Vehicle Customers



Source: WVPA (TransCore database) and CDM Smith analysis

2.5.2 StreetLight Data

CDM Smith obtained Turnpike traveler frequency data from StreetLight Data, Inc. The data is LBS data developed from all available carriers and a variety of various sources (GPC, WIFI proximity, GPS, Bluetooth proximity, and cellular triangulation). LBS data are derived from smart phones with applications that use Location-Based Services, such as weather, retail shopping, or navigation applications, all of which provide services to their users that are fundamentally linked to those users' locations. While cellular data was considered for general traveler frequency data, the main advantages of LBS data are:

- Spatial precision: On average, StreetLight's LBS data has 25-meter spatial precision or better. In contrast, cellular data tends to have 100-300-meter spatial precision.
- Ping rate: Devices using LBS generally send "pings" when the device changes location. In contrast, cellular tower "pings" are irregular.
- Privacy protection: Device users must proactively opt-in and enable LBS before they can use them. In contrast, cellular providers do not require proactive opt-in.

The data from StreetLight is considered to be a representative sample of the customers passing through each of the four tolling plaza locations from July 2016 to June 2017. Toll plaza geographic capture zones were established to filter the data to the Turnpike roadway immediately before and after each toll plaza and excluding nearby local roadways and over/under passes. **Figure 2-15** through **2-18** illustrate the zones.

Figure 2-15 Ghent Toll Plaza A StreetLight Data Zone

Figure 2-16 Pax Toll Plaza B StreetLight Data Zone

Figure 2-17 Chelyan Toll Plaza C StreetLight Data Zone

Figure 2-18 North Beckley Toll Plaza StreetLight Data Zone

The data review established the number of times the device was observed at each toll plaza zone over the year, presented as the number of occurrences per year. The data describes the frequency of use by all types of Turnpike customers within the dataset. Unfortunately, it was not possible to separate customer payment method, vehicle classification, or state of residence. However, data was only obtained from personal devices and thus does not include commercial services and commercial fleet information.

The data was filtered to retain only the most reliable device makes. Some makes of smartphones are less reliable for a variety of reasons: less frequent locations when an application is in the background, interpolated locations, incorrect geolocations, and miscellaneous other effects. Devices were also screened to those that are seen throughout the 12 months of observations, typically showing a ping somewhere on the country-wide system nearly 300 days per year.

Each plaza was studied separately. **Table 2-9** shows how many devices were captured at each plaza as well as the number of trips. Note, due to the configuration of the nearby interchanges, the North Beckley zone was smaller (2.4 km) in length compared to the other study area zones (4.7 km or longer) which, in addition to the plaza having lower traffic volumes, likely resulted in a smaller sample size. Due to its shorter study area and proximity to other activity generators, North Beckley is expected to have less accurate results than the other three toll plazas.

Table 2-9 Sample Size from StreetLight

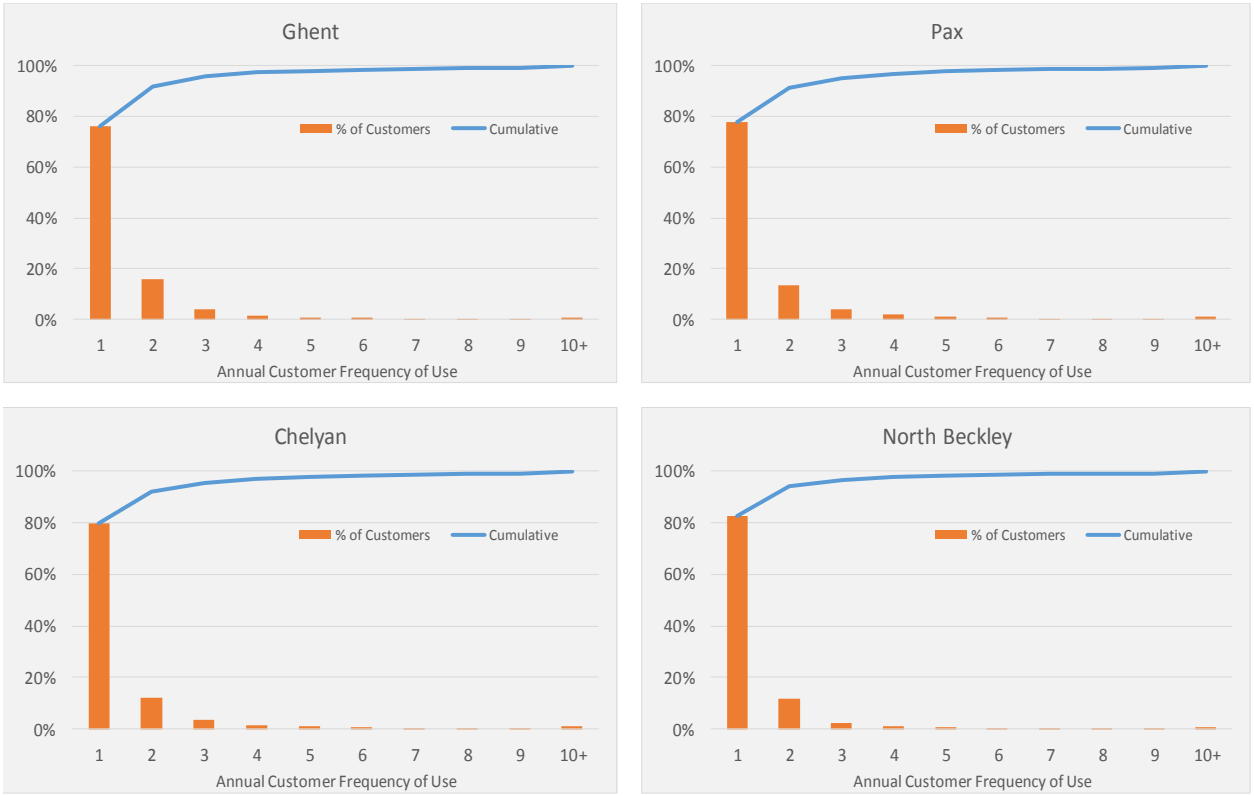
Plaza	Number of Devices	Number of Trips
Plaza A – Ghent	13,589	21,462
Plaza B – Pax	5,617	8,680
Plaza C – Chelyan	5,218	7,740
North Beckley	1,810	2,553
Total	**26,234**	**40,435**

Source: StreetLight Data

Figure 2-19 displays the frequency distribution profiles derived from the StreetLight dataset. It was found that most travelers were very infrequent users, with nearly 80% of customers making only one trip per year. About 96% of travelers make less than 4 trips per year. The frequency distribution was found to be very similar at all tolling plazas.

Also note, as a secondary check, the data used for the sample was expanded to include less reliable devices which increased the sample size to over 200,000 observations for each mainline plaza and over 62,000 for North Beckley. The frequency of use was very similar to the dataset constrained to the highly reliable devices.

Figure 2-19 Frequency of Use from StreetLight Sample



Source: StreetLight Data and CDM Smith analysis

2.6 Major Capital Improvement Projects

Governor Jim Justice's ***Roads to Prosperity*** program contains hundreds of transportation improvement projects across the entire state, worth over $2.6 billion. This program will have a significant beneficial impact on the state economy. While the program includes an important widening project on the Turnpike at Beckley and improvements to other roads that lead to the Turnpike, there are no major improvement projects on directly competing roadways. As a result, the ***Roads to Prosperity*** program is expected to have a relatively-small, positive impact on the competitive advantages of the Turnpike.

The ***Roads to Prosperity*** program and the 2010 state transportation plan identify the following projects on routes that have the potential to positively affect traffic on the Turnpike:

- East Beckley Bypass between CR 8 and Corridor L: construct a new 4.5 miles four-lane road
- I-64 Widening from Barboursville to the West Virginia / Kentucky State Line: construct 18 miles of additional lane in both directions
- WV 10 upgrades
- MacCorkle Avenue Improvements
- U.S. 60 upgrades from Chelyan to Montgomery
- I-77 upgrades from Tunnel to milepost 9

2.7 Conclusion

Travel on the Turnpike has been steady for several decades. The roadway serves as an important direct interstate connection between the Midwest and the southeastern United States as well as an important conduit for nearby residents. The Great Recession appears to have had minimal effect on traffic in the 2008-2010 timeframe. A large toll increase of approximately 50-60% in 2009 did not have a significant impact on transactions but a noticeable increase in revenue. The toll classification system uses multiple criteria (axles, height, and vehicle type) while the payment options offer significant discounts for customers using E-ZPass.

Passenger car travel on the Turnpike transactions peak during the summer travel season whereas commercial traffic is steady most of the year. The three mainline plazas have roughly equal numbers of transactions per year (approximately 10 million in 2016) whereas North Beckley has about half that amount (approximately 5.5 million in 2016). Many of the trips on the Turnpike travel the full length, based on available E-ZPass data.

Class 1 customers (2-axle passenger cars) dominate transactions on the Turnpike at 75% while Class 8 customers (5-axle trucks or 18 wheelers) make up another 18% of transactions. PC customers (Classes 1-4) make up about 51% of total revenue and CV customers (Classes 5-10) make up about 49% of total revenue. Payment by PC customers is about 72% cash, 18% WV E-ZPass, and 10% Non-WV E-ZPass. Payment by CV customers is about 25% cash, 16% WV E-ZPass, and 59% Non-WV E-ZPass.

Frequency of use is very low, particularly for PC customers. About half of WV E-ZPass PC customers have 10 or fewer transactions in a year. Roughly 95% of all Non-WV E-ZPass PC customers have 10 or fewer transactions a year. Smart phone and other location device data indicate that about 96% of all customers pass through individual plazas less than four times per year.

Approximately 80% of revenue collected via transponder comes from Non-WV E-ZPass customers. A large portion of this revenue comes from CV transactions. The state of residence of cash customers is not known, however it is reasonable to assume that most cash customers are from out of state as indicated by SP survey responses.

While the major capital improvement program, ***Roads to Prosperity***, is expected to have a large impact on the state economy, improve the condition of the state's infrastructure and relieve congestion, there are no major increases in capacity planned on competing roadways that would adversely influence the competitive advantages of the Turnpike.

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Chapter 3

Stated Preference Survey

3.1 Introduction

CDM Smith contracted Resource Systems Group, Inc. (RSG) to conduct a stated preference (SP) survey of existing Turnpike customers. SP surveys provide the ability to estimate demand models to predict how travelers are likely to utilize the Turnpike under different pricing scenarios, which is difficult to assess through conventional survey techniques or existing travel patterns alone. In this case, the SP survey presented hypothetical scenarios within the context of the respondent's actual travel, and asked respondents to choose from a set of possible options. RSG with help from CDM Smith and input from WVPA, designed the survey, administered it to current customers, and evaluated the results.

Potential changes in Turnpike policy include increasing toll rates and providing a revised Class 1 flat fee program. The primary objective of the SP survey was to understand how toll payment and travel behavior will likely change if the revised flat fee program is offered. A detailed report covering the SP survey was generated. This chapter contains a summary of that report.

3.2 Survey Approach

The questionnaires collected data on respondents' general and most recent travel behaviors (also referred to as "revealed preferences"), presented respondents with information about the proposed changes to payment amounts and options on the Turnpike, and used SP experiments to evaluate behavioral response for the potential new payment options on the Turnpike.

The survey instrument was a computer-assisted self-interview technique developed using RSG's proprietary software. The customized survey software adapted to respondents' previous answers by modifying question wording and SP tradeoff values. These dynamic survey features provide an accurate and efficient means of data collection and allow the presentation of realistic future conditions that correspond with the respondents' reported experiences. The software was customized for online administration to targeted audiences in the study region. Respondents were recruited to take the survey through the following methods:

- Invitation card distributed to drivers at selected toll gantries on the Turnpike
- WVPA customer and public outreach
- Out-of-state E-ZPass customer and public outreach

3.3 Survey Questionnaire

The survey was designed to collect information about a recent trip that a respondent made on the Turnpike and to find out how travelers might alter their behavior given the proposed changes to the Turnpike toll payment structure and costs. The questionnaire contained questions grouped into six main sections:

- Qualification Questions
- General Travel Questions
- Trip Characteristic Questions
- Stated Preference Questions
- Debrief and Opinion Questions
- Demographic Questions

A complete set of survey questions as they appeared to respondents is included in a detailed report on the survey.

3.3.1 Qualification Questions

Initially, survey candidates were asked several questions, including if they had made a trip on the Turnpike within the past 12 months, to determine if they were eligible to participate in the survey. To qualify, the candidates must have also traveled on any part of the Turnpike between Charleston and Princeton. Only customers traveling in a personal vehicle (Class 1) qualified. Respondents who reported no recent trips that met the above criteria were disqualified from the survey.

3.3.2 General Travel Questions

Qualified respondents were asked a series of questions about their travel behavior on the Turnpike, including whether they had made more than five trips per month in the past year to determine if subsequent survey questions should be asked using a monthly (frequent users) or annual (infrequent users) timeframe. (As noted later, when the survey results were analyzed, "frequent" and "infrequent" were redefined due to the resulting behavioral differences at very low frequency of use.) Respondents were then asked about the types of trips they made on the Turnpike to determine how many trips of each trip purpose they had made in the past month or year.

Next, respondents were asked a series of questions about their use of a transponder for electronic toll collection (ETC) which included if they owned a WV E-ZPass, a transponder from a state other than West Virginia, or did not own any transponders. Respondents who did not own a transponder then indicated their reasons for not having one in their car. Respondents who owned a WV E-ZPass were asked whether they paid an annual or quarterly flat fee for unlimited use of at least one toll plaza on the Turnpike under Personal Discount Plan 1; paid their tolls on a trip-by-trip basis either by cash, WV E-ZPass, or Non-WV E-ZPass; or were unsure of their payment for tolls on the Turnpike. Those who paid a flat fee were shown a map of all toll plazas on the Turnpike and asked to indicate which plazas they paid tolls for with this flat fee program. To conclude this section on electronic tolling, all respondents who owned a transponder were asked how many vehicles were associated with it.

3.3.3 Trip Characteristic Questions

Qualified respondents were then asked questions related to their most recent trip that used any part of the Turnpike. They were asked to think of the trip as their "reference trip" and were instructed to think of the one-way portion of that trip rather than the entire round trip. They were asked a series of questions regarding the specific details of their reference trip, including:

- Trip purpose
- Trip origin or destination outside of West Virginia (if appropriate)
- Highway entrance and exit interchanges
- Tolls paid (in addition to those paid with a flat fee plan, if applicable)
- Reason for not paying tolls, if none were paid
- Toll payment method and amount paid

3.3.4 Stated Preference Questions

After completion of the trip characteristics section of the questionnaire, a subset of respondents were provided with details about the proposed new payment options on the Turnpike and asked to answer a series of SP questions.

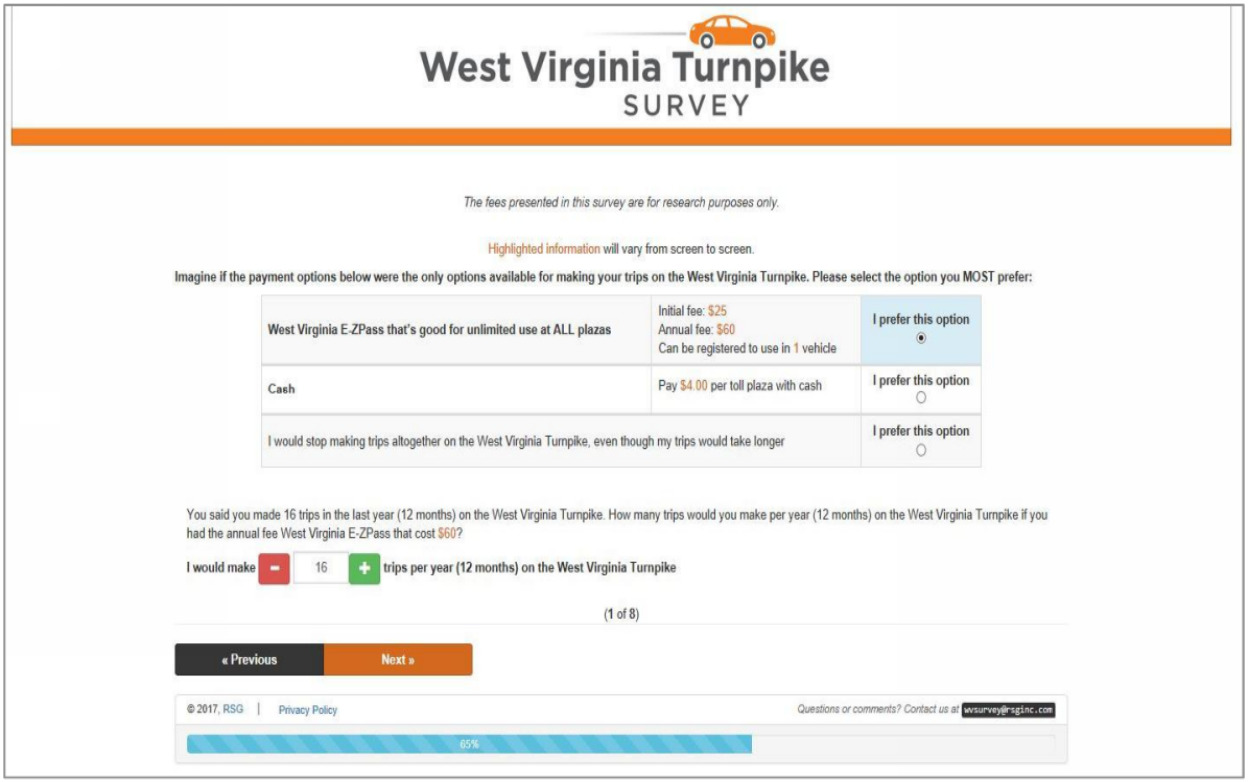
Respondents who already participated in the existing Class 1 flat fee program were not shown the SP questions since the proposed revised program would resemble their current payment schedule at a reduced price. Instead, these respondents were shown one hypothetical scenario of the revised flat fee program in which the annual cost for unlimited use of all three primary toll plazas on the Turnpike was a random price ranging from $8 to $75. Because respondents might change their trip rates under the revised flat fee program, they were shown the number of trips they had made on the Turnpike within the past year or month and prompted to adjust that number to report how many trips they would make within that timeframe if the revised flat fee program were available.

All respondents not currently enrolled in the existing flat fee program were shown instructions for the SP exercises. Respondents were shown a set of eight SP scenarios that included three travel alternatives for making their reference trip in the future. These alternatives were described by attributes such as initial issuance fee, annual flat fee, number of vehicles allowed under one transponder registration, and per plaza trip-by-trip toll rates. The values of the attributes varied across the eight questions, and respondents were asked to select the alternative they preferred most under the conditions that were presented. Respondents were presented with the following alternatives for their trips in the future:

- **Alternative 1 WV E-ZPass Flat Fee:** Respondent could use the revised flat fee program providing unlimited use at all Turnpike toll plazas. This alternative contained attributes for an initial issuance fee, annual flat fee, and number of vehicles that could be registered with the account.
- **Alternative 2 Cash Per Plaza:** Respondent could pay a given amount per toll plaza using cash, or a transponder from another state if the respondent indicated they owned one.
- **Alternative 3 Stop Making Turnpike Trips:** Respondent could stop making trips on the Turnpike altogether.

For the first two SP scenarios, respondents who chose Alternative 1 or Alternative 2 were shown a follow-up question about how their trip frequency on the Turnpike could change under the conditions presented. These respondents were shown the number of trips they had made on the Turnpike in the past year or month and prompted to adjust that number as needed to report how many trips they would make in that same timeframe. The remaining six SP scenarios did not include this trip suppression/induction question. An example screen shot of the survey is shown in **Figure 3-1**.

Figure 3-1 Sample Survey Screen



Source: WV Turnpike SP Survey

The attribute values presented in each scenario varied according to an experimental design. Respondents were presented with different payment structures and costs and could demonstrate their travel preferences across several scenarios.

3.3.5 Debrief and Opinion Questions

After completing the eight SP scenarios (or the single hypothetical scenario for those already participating in the existing Class 1 flat fee program), all respondents answered a series of questions to assess the underlying rationale for their choices and to identify any potential strategic bias in their responses. Respondents who were shown the SP questions and never chose the revised flat fee program alternative were asked to select their primary reason for this, while those who chose this option in at least one scenario were prompted to select their primary reason for choosing it. Next, all respondents indicated their opinion of the proposed changes to the payment options on the Turnpike. Those who indicated that they were "strongly" or "somewhat" in favor of the changes were then asked to indicate the primary reason for their support, while those who were "strongly" or "somewhat" opposed were asked to indicate the primary reason for their opposition.

3.3.6 Demographic Questions

In the final section of the survey, demographic information was collected to classify respondents, identify possible behavioral differences among demographic characteristics, and to confirm that that sample contained a diverse cross section of drivers that travel in the study region. Demographic information collected included zip code, gender, age, employment status, household size, vehicle ownership, and 2016 pre-tax household income. Finally, respondents were given the opportunity to win one of 20 $100 gift cards for their participation and provide their comments about the survey or proposed project.

3.4 Survey Administration

The focus of the survey administration plan was to produce a generally representative sample of a diverse cross section of Turnpike customers in West Virginia and surrounding states. The sampling plan was designed to include a sufficient range of customers from different trip purposes, household incomes, and geographies to accurately reflect any behavioral differences in the resulting discrete choice models. Three methods were used to recruit potential respondents to the survey website:

- Invitation card distribution to customers at selected toll gantries on the Turnpike
- WVPA customer and public outreach effort to distribute a link to the survey via e-mail to customers, on their website, and through poster boards displayed at rest stops along the corridor
- Out-of-state E-ZPass customer and public outreach

Survey administration began on September 19, 2017 and concluded on October 20, 2017. A total of 6,846 customers completed the SP survey during this time. The administration methods and number of complete surveys by survey type are presented in **Table 3-1**.

Table 3-1 Responses by Recruitment Source

Data Source	Completed Surveys
Invitation Card Distribution	1,750
WVPA Customer and Public Outreach	3,288
Out-of-state E-ZPass and Public Outreach	1,808
Total	**6,846**

Source: WV Turnpike SP Survey

3.4.1 Invitation Card

The consultant team worked closely with the WVPA to distribute approximately 50,000 invitation cards at three of the four toll collection points along the Turnpike. The invitations were distributed to cash-paying customers by Turnpike toll collection staff. The toll collection staff were instructed to distribute the invitations to personal vehicles (Class 1) only, and to distribute one card to each driver before they collected payment.

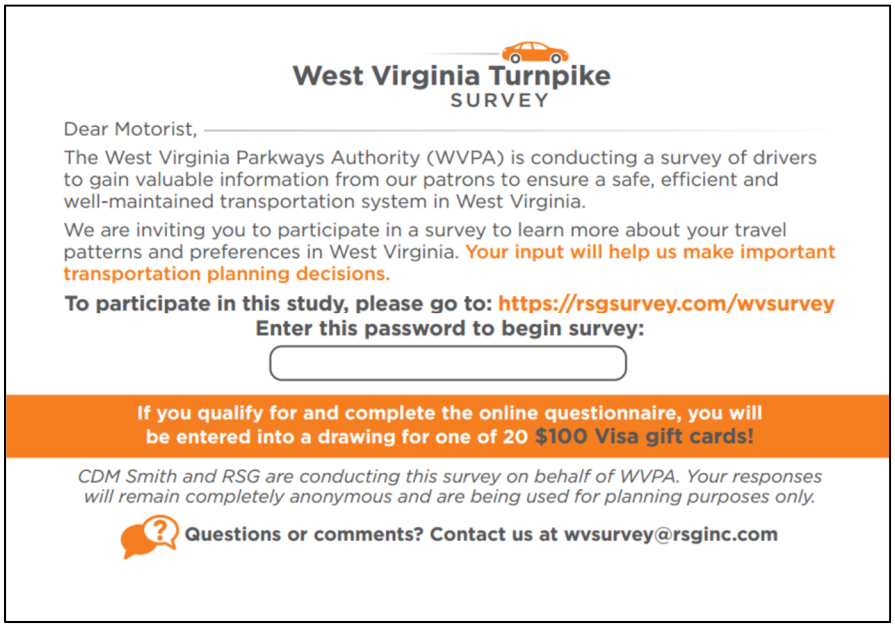
To minimize the number of customers who might have otherwise received more than one invitation card, distribution of the cards was limited to the northbound lanes at Ghent Plaza, the southbound lanes at Chelyan Plaza, and the North Beckley entrance-ramp. The invitations were handed out in measured

blocks over a period of four days (two weekdays and one weekend) to obtain a roughly proportional sample of weekday and weekend traffic from each of the sampled toll collection points.

The invitation cards included information about the study, a link and password to access the survey, information about the incentive, and an email address so respondents could obtain assistance or additional information about the research. **Figure 3-2** shows a sample of the front and back of the invitation cards.

Figure 3-2 Invitation Card Sample

Source: WV Turnpike SP Survey



Source: WV Turnpike SP Survey

Table 3-2 shows the number of invitations distributed, the number of completes received, and the overall response rate from each of the sampled plazas. Because of a compressed administration schedule, the distribution plan was adjusted after the cards had been printed, and a single batch of invitations originally designed for Pax Plaza was divided on-site for distribution between Ghent and Chelyan plazas as noted in the table.

Table 3-2 Invitation Card Distribution and Completes by Toll Plaza

Plaza/Ramp	No. of Invitations	Completed	Response Rate
Ghent Plaza - Northbound Lanes	22,002	902	4.1%
Chelyan Plaza - Southbound Lanes	20,875	653	3.1%
North Beckley On Ramp	1,959	57	2.9%
Ghent or Chelyan Plaza	5,163	138	2.7%
Total	**49,999**	**1,750**	**3.5%**

Source: WV Turnpike SP Survey

3.4.2 WVPA Customer and Public Outreach

A customized weblink was included in three outreach efforts to recruit WV E-ZPass customers and other customers to participate in the survey. The weblink was distributed and shared using the following outreach methods.

- **WV E-ZPass Email Outreach:** The WVPA distributed invitations via email to over 31,000 WV E-ZPass account holders. The email invitations contained a brief description of the research and prize drawing incentive, a weblink to access the survey, and an email address where recipients could contact the consultant team with any questions about the study.
- **WVPA Website:** The WVPA posted the weblink along with basic information about the survey on their website where visitors could participate in the survey.
- **Poster Boards:** Ten poster boards were placed at travel plazas, a rest area, and at the Tamarack arts and crafts retail outlet along the Turnpike. The poster boards contained information about the survey, a survey weblink, and a QR code respondents could scan with their smartphones to access the survey.

A total of 3,288 completed surveys were collected from the WVPA outreach efforts. Because the same web link was used for all three methods, it is not possible to provide an exact number of completed surveys by each method; however, it was clear that the e-mail outreach facilitated most of these completes.

3.4.3 Out-of-State and Public Outreach

With assistance from the WVPA, the consultant team worked alongside external departments of transportation and turnpike operations from states surrounding West Virginia. In all, three external organizations assisted with administering the survey.

- **Virginia E-ZPass Email Outreach:** The Virginia Department of Transportation distributed email invitations to a subset of Virginia E-ZPass customer accounts where a transaction had been made on WV Turnpike within the previous 30 days. The email invitations contained a brief description

of the research and prize drawing incentive, a weblink to access the survey, and an email address where recipients could contact the consultant team with any questions about the study. The invitations were sent to 10,500 customer accounts, which yielded 1,522 completed surveys – a response rate of 14.4%.

- **Pennsylvania Turnpike Website:** The Pennsylvania Turnpike posted a custom weblink and basic information about the survey on their website for visitors. This method yielded 116 completed surveys.
- **Ohio Turnpike Newsletter:** The Ohio Turnpike included a link and description of the survey in their September e-newsletter that was sent to Ohio E-ZPass customers. This method yielded 170 completed surveys.

3.5 Data Analysis

This section contains summary tabulations and statistics for select survey questions. An appendix to the SP survey report contains a complete set of survey tabulations for each question. The data were screened for outliers before final survey analysis and model estimation was completed.

3.5.1 Outliers

A total of 6,846 customers completed the SP survey. The number of records was reduced to 6,438 after completing logic checks and outlier analysis during the model estimation work. The following conditions were applied to determine which respondents to exclude from the final analysis; the categories listed are not mutually exclusive, so a respondent's data could have been disqualified for more than one of these reasons. A total of 408 respondents were excluded from the dataset based on these criteria.

- Respondents who do not own a WV E-ZPass and indicated in the SP questions they would no longer make any trips on the Turnpike when the per-plaza toll cost shown was the current rate ($2.00) or less (214 respondents).
- Respondents who indicated they would pay a specific toll to use the Turnpike but suppressed 100% of their trips in the embedded follow-up trip suppression question (38 respondents).
- Respondents who indicated they made 720 or more trips per year on the Turnpike, representing the top 2% of annual trip frequencies (142 respondents).
- Respondents who indicated in the suppression/ induction questions that they would make at least 400% or more trips per year than they currently make on the Turnpike (25 respondents).

Note that since these exclusion categories are not mutually exclusive, the number of exclusions will add up to more than the number of respondents excluded.

3.5.2 Survey Results

The descriptive analysis of the survey data presented in this section is based on the final dataset of 6,438 responses and is divided into five sections: 1) general travel behavior; 2) recent trip characteristic analysis; 3) SP analysis; 4) debrief and opinion analysis; and 5) demographic analysis.

General Travel Behavior

Respondents were classified into frequent or infrequent users of the Turnpike at the outset of the questionnaire. This permitted subsequent questions about general travel behavior to be assigned a monthly (past 30 days) or annual (past 12 months) reference time frame. Frequent users were defined as those who made six or more trips per month on the Turnpike, while infrequent users were defined as individuals who made five or fewer monthly trips on the Turnpike. (As noted later, when the survey results were analyzed, "frequent" and "infrequent" were redefined due to the resulting behavioral differences at very low frequency of use.) Twenty percent of respondents were classified as frequent users (n=1,265) and 80% were classified as infrequent users of the Turnpike (n=5,173).

All respondents were then asked to indicate all the types of trips they made on the Turnpike over the past 30 days or 12 months, depending on their assigned time frame. **Table 3-3** shows the types of trips frequent and infrequent users made on the Turnpike. Overall, frequent users were much more likely to travel for work-related purposes, while most infrequent users drove on the Turnpike for social or recreational trip purposes. Since respondents could choose more than one trip purpose during the survey, percentage totals exceed 100%.

Table 3-3 Trip Purposes on Study Corridor by Frequency of Use

Purpose	Frequent Users		Infrequent Users		Total	
	Count	Percent	Count	Percent	Count	Percent
Go to/from work	517	41%	194	4%	711	11%
Business-related travel	521	41%	1,157	22%	1,678	26%
Go to/from school	115	9%	314	6%	429	7%
Go to/from the airport	122	10%	149	3%	271	4%
Shopping	465	37%	584	11%	1,049	16%
Social or recreational	692	55%	4,061	79%	4,753	74%
Other personal business	589	47%	1,186	23%	1,775	28%
Total	**1,265**	-	**5,173**	-	**6,438**	-

Source: WV Turnpike SP Survey
Note: Percentage totals exceed 100% due to respondents being able to choose more than one trip purpose during survey.

Primary market segmentation was defined by electronic toll collection (ETC) device ownership. A plurality of respondents (45%) indicated they have a WV E-ZPass to pay for tolls on the Turnpike. Of these customers, 38% (n=1,090) pay an annual or monthly flat fee at one or more toll plazas. Twenty-nine percent of all respondents do not have any device and pay their tolls with cash, and 26% possess an ETC device from another state. Approximately 1% of the sample (n=72) owns a WV E-ZPass and an ETC device from another state and are considered WV E-ZPass customers for the purposes of this analysis. The proportion of respondents by market (payment method) varies from the proportion of all customers using the Turnpike, because of the differential success in recruiting. However, sample size was large enough to produce reliable models of payment choice for each segment.

Table 3-4 shows the purpose of trips made on the Turnpike by market segment. Nearly three-quarters of respondents had made a social or recreational trip on the Turnpike in the past month or year. WV E-ZPass customers were most likely to make a trip to or from work.

Table 3-4 Trip Purpose by Market Segment

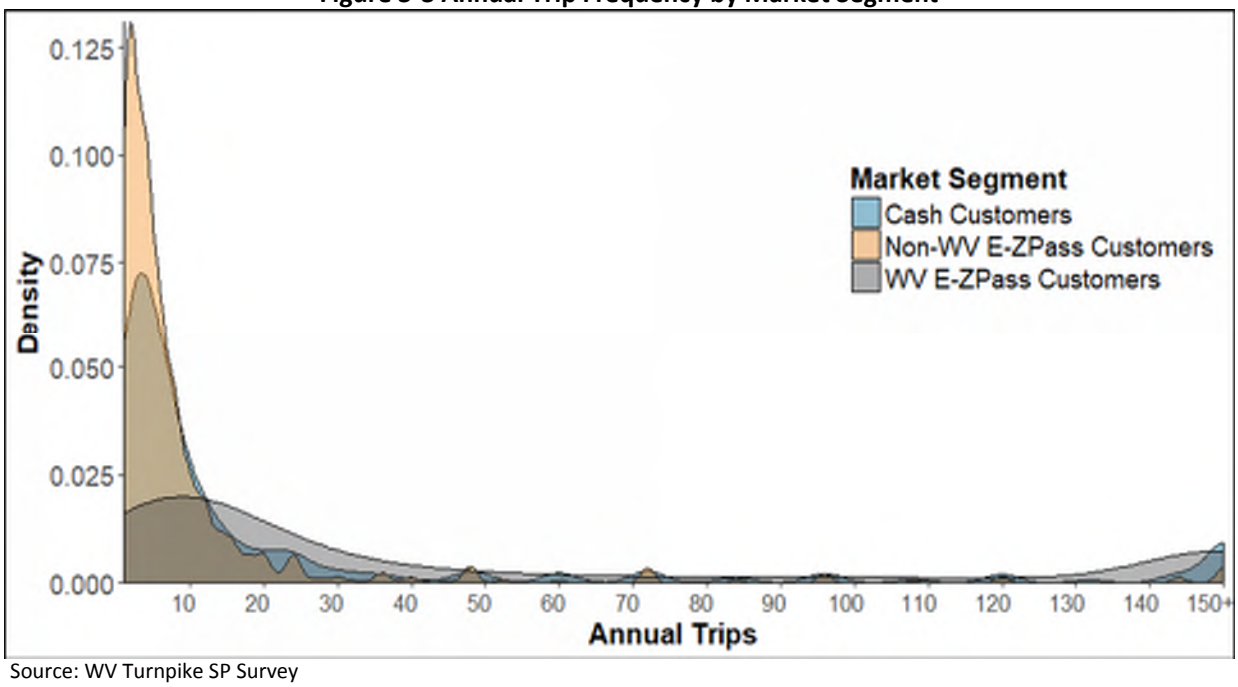
Purpose	Cash Customers		Non-WV E-ZPass Customers		WV E-ZPass Customers		Total	
	Count	Percent	Count	Percent	Count	Percent	Count	Percent
Go to/from work	127	7%	55	3%	529	18%	711	11%
Business-related travel	387	21%	376	22%	915	32%	1,678	26%
Go to/from school	141	8%	88	5%	200	7%	429	7%
Go to/from the airport	51	3%	16	1%	204	7%	271	4%
Shopping	254	14%	50	3%	745	26%	1,049	16%
Social or recreational	1,426	76%	1,268	75%	2,059	72%	4,753	74%
Other personal business	437	23%	253	15%	1,085	38%	1,775	28%
Total	**1,877**	**-**	**1,692**	**-**	**2,869**	-	**6,438**	-

Source: WV Turnpike SP Survey
Note: Percentage totals exceed 100% due to respondents being able to choose more than one trip purpose during survey.

For each trip purpose selected, respondents were asked to indicate the number of trips they had made on the Turnpike within their assigned time frame. Trip totals for each purpose were summed and expanded into an annual number of trips on the Turnpike for each respondent. **Figure 3-3** shows Annual Trip Frequency by Market Segment distribution.

WV E-ZPass customers had the highest average and median number of trips, while Non-WV E-ZPass customers tended to make the least. The median number of annual trips for all respondents was 8 trips, and the average was 51 trips.

Figure 3-3 Annual Trip Frequency by Market Segment



Source: WV Turnpike SP Survey

Recent Trip Characteristics

Respondents were next asked a short series of questions about their most recent trip on the Turnpike. Approximately 58% of respondents reported their most recent trip was made for social or recreational purposes. The second highest trip purpose of 15% was for other personal business. Only one percent of respondents reported their most recent trip was made for travel to/from the airport.

Respondents selected the Turnpike entrance (ingress) and exit (egress) ramps they used during their most recent trip. Most respondents exited and entered the Turnpike north of Exit 96. The next most frequently used ramps were at I-64 and South of Exit 9.

The total number of trips that passed through each toll plaza was inferred by respondents' reported entrance and exit ramps. Approximately three-quarters of respondents made a trip that passed through Chelyan and Pax Plaza, while 58% passed through Ghent Plaza. Only 4% of respondents passed through the gantries at North Beckley.

The total number of plazas that a respondent passed through on a single one-way trip cannot be greater than three. Fifty-eight percent of cash-paying customers passed through three plazas, while only 41% of WV E-ZPass customers did the same. Six percent of all respondents did not pass through any plazas during their most recent trip on the Turnpike.

All respondents, including the 1,090 respondents who paid an annual or quarterly flat fee, were asked if they paid any per-plaza tolls on the Turnpike during their most recent trip. Overall, 86% of respondents said they paid a toll on their most recent trip. This percentage does not match the total percentage of respondents whose trips passed through at least one plaza according to individual entrance and exit ramp selection. The discrepancy is likely due to respondents who have less familiarity with the road and may have estimated their entrance and exit ramp locations.

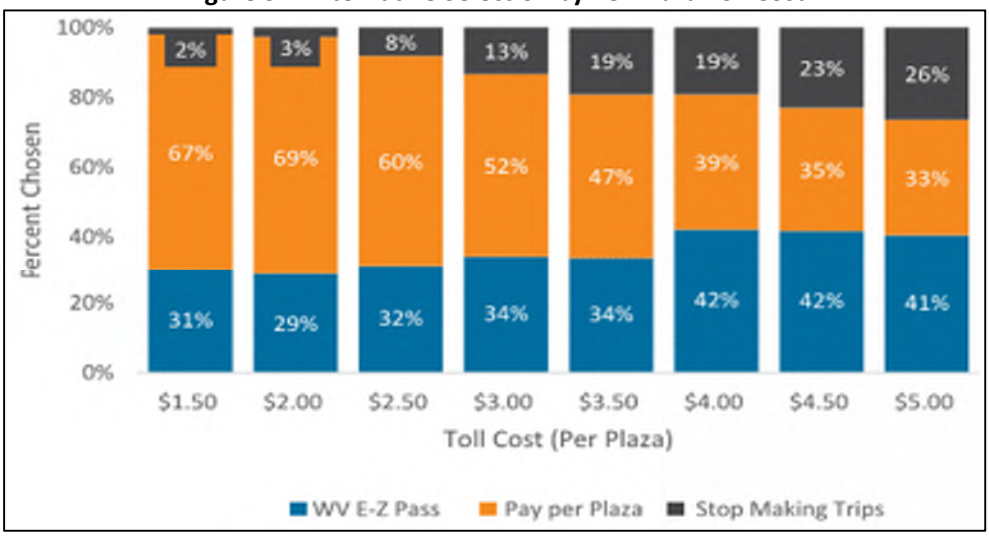
Stated Preference Results

The SP section of the survey was used to ascertain responses to different travel alternatives. In each SP scenario, respondents were presented alternatives for making a future trip. The 5,348 respondents not enrolled in the current flat fee program were shown eight SP trade-off experiments, each containing three alternatives. Out of a total of 42,784 experiments shown, 15,180 chose to enter the revised flat fee program; 21,523 selected to pay per plaza using cash, WV E-ZPass, or Non-WV E-ZPass; and 6,081 selected to stop making trips.

Across the eight SP experiments shown to each respondent, the attributes of each alternative (such as the per-plaza toll cost and annual flat fee) varied from one experiment to the next to assess the attributes' effects on respondents' payment preferences. **Figure 3-4** shows how respondents' choices of alternatives changed as the per-plaza toll cost increased. In general, as the toll amount increased, respondents became less likely to select pay per plaza and would either choose the flat fee program or stop making trips on the Turnpike. For instance, when the per-plaza toll cost was $1.50, 67% of respondents selected pay per plaza, while at $5.00, only 33% of respondents chose to pay per plaza.

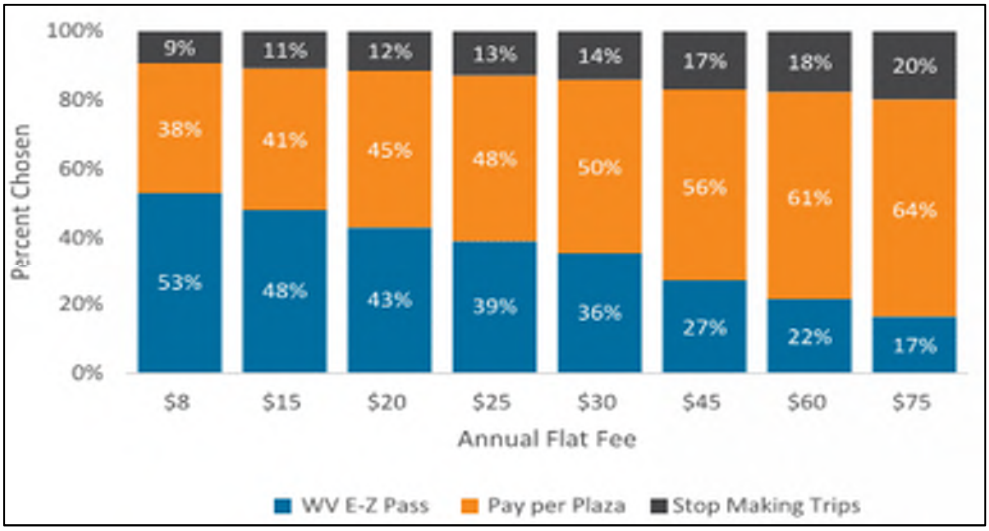
Similarly, **Figure 3-5** shows that as the cost of the annual flat fee increased, respondents became less likely to select the flat fee program and likelier to select pay per plaza. Overall, Figure 3-4 and Figure 3-5 show that respondents behaved in an intuitive and rational manner during the SP exercises.

Figure 3-4 Alternative Selection by Per-Plaza Toll Cost



Source: WV Turnpike SP Survey

Figure 3-5 Alternative Selection by Annual Flat Fee



Source: WV Turnpike SP Survey

Debrief and Opinion Analysis

After completing the SP scenarios, respondents were asked to answer a series of debrief and opinion questions to understand the underlying reasons for their choices in the eight SP questions. The 60% of respondents who selected the revised flat fee program at least once in the SP scenarios (n=3,214) were asked to indicate their primary reason for doing so. Approximately 48% did so because of the "lower cost than paying with cash," and 19% did so because they agreed with the statement "I travel on toll roads in West Virginia enough that it makes sense." Only eight percent of respondents did so because it is a "lower cost than paying with my out-of-state transponder."

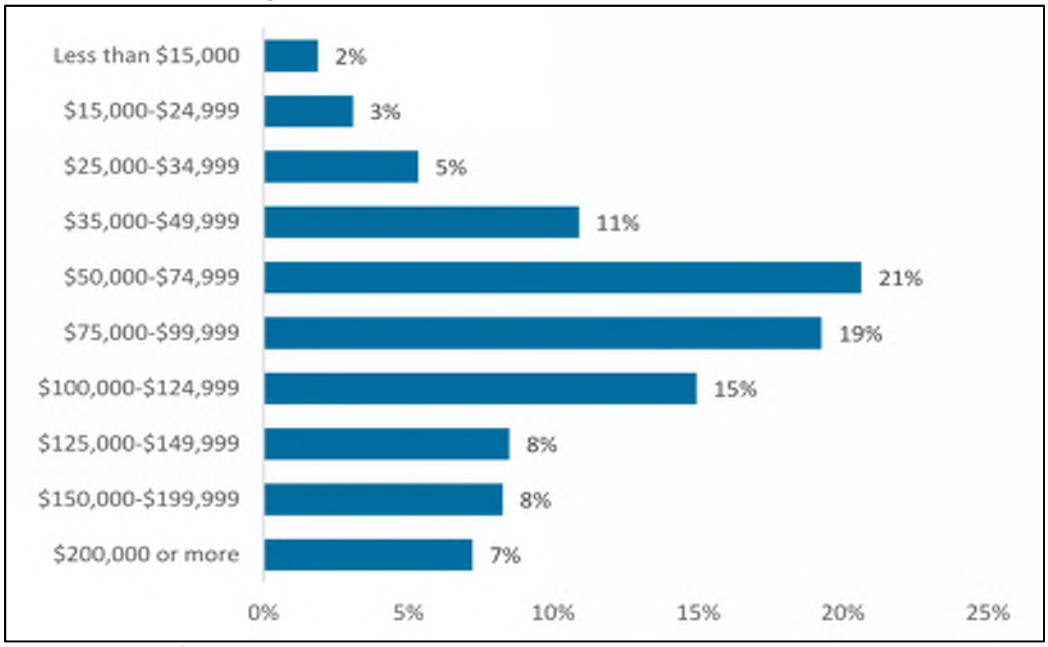
The 40% (n=2,134) of respondents who never selected the revised flat fee program in the SP scenarios were asked to indicate their primary reason for not doing so. Approximately 61% of these respondents did so because they "don't travel on toll roads in West Virginia often enough," and 17% because they "don't want to have two transponders."

Demographic Analysis

Demographic information was collected to ensure a diverse sample of drivers. Respondents provided their home ZIP Code, which was used to determine state of residence. A plurality (43%) of respondents were West Virginia residents and 22% were Virginia residents. The smallest number of respondents were from South Carolina, Kentucky, and Pennsylvania with only two percent each.

Of the 6,438 respondents, 59% were male. Forty-six percent lived in a household with two vehicles and 25% lived in household with three vehicles. Forty-nine percent were employed full time and 32% were retired. **Figure 3-6** shows the income group distribution for the 82% of the sample who reported their income. The median 2016 household income category before taxes was $75,000-$99,999.

Figure 3-6 2016 Household Income Before Taxes



Source: WV Turnpike SP Survey

3.6 Model Estimation

The primary objective of the SP survey was to estimate market shares for proposed new payment options on the Turnpike, as well as changes in trip rates that may occur because of the new payment options. These market share estimates support revenue projections under the proposed new payment policies. The eight choice observations for each respondent were compiled into a dataset with 42,784 observations to support the market share estimations.

Separate regression models were estimated to forecast trip suppression rates. The trip suppression models were fitted with data from 2,099 respondents who selected the pay tolls per trip/plaza - using cash, WV E-ZPass, or Non-WV E-ZPass in the first or second SP scenario. The suppression models were fitted with a total of 3,056 observations to support estimates of overall trip reductions based on proposed per plaza toll increases.

3.6.1 Discrete Choice Model

Statistical analysis and discrete choice model estimation were conducted using the SP survey data. The statistical estimation and specification testing were completed using a conventional maximum likelihood procedure that estimated coefficients for a set of multinomial logit (MNL) models. The MNL models were used to identify systematic differences in preference heterogeneity—for example, the difference in travel behavior at different annual trip frequencies. The model coefficients provide information about the respondents' sensitivities to the attributes that were tested in the trade-off scenarios and can be used to calculate market shares for travelers in the study corridor.

Specification and Segmentation

Respondents were presented with three alternatives in the SP scenarios. WV E-ZPass customers who currently pay a flat fee for unlimited use of at least one plaza on the Turnpike were not shown the SP scenarios. All other travelers were presented with the following alternatives:

- Join the revised flat fee program for unlimited trips on the WV Turnpike
- Continue to pay tolls per trip with the respondent's current payment method (cash, WV E-ZPass, or Non-WV E-ZPass)
- Stop making trips on the Turnpike altogether

The MNL model estimates a choice probability for each alternative presented in the SP trade-off exercises. The alternatives are represented in the model by observed utility equations of the form:

$$\cup 1=\beta 1\ X1+\beta 2\ X2\ldots+\beta n\ Xn$$

Where each X represents a variable specified by the researcher and each β is a coefficient estimated by the model that represents the sensitivity of the respondents in the sample to the corresponding variable.

To achieve the best model outcomes, several utility equation structures were tested using different variables from the collected data. In addition to costs presented in the SP experiments, tested variables included trip frequency, current payment method, opinion of the changes to payment options on the WV Turnpike, and income. These variables were introduced sequentially to test potential interactions with cost coefficients and to determine whether respondents' trip or personal characteristics significantly influenced their choices in the SP scenarios.

After reviewing the significance of each variable, the final model specification was chosen based on model fit, the intuitiveness and reasonableness of the model coefficients, and the expected application of the model results.

The final model specification includes variables for the annual flat fee, issuance fee, number of vehicles that can be registered with an annual pass, and per plaza toll cost, with segmentation based on trip frequency and current payment method (cash, WV E-ZPass, or Non-WV E-ZPass). The model specification showed distinction between those who make three or more trips per year and those who make two or less and the definition of frequent and infrequent were refined. **Table 3-5** presents the segments used in the final model specification.

Table 3-5 Model Segmentation

Segment Name	Payment Method	Annual Trip Frequency	Residence	Count	Percent
Non-WV E-ZPass ETC - Infrequent	Non-WV E-ZPass	1 or 2 Trips	Not WV	524	10%
Non-WV E-ZPass - Frequent	Non-WV E-ZPass	3+ Trips	Not WV	1,168	22%
Cash - Infrequent	Cash	1 or 2 Trips	Any State	425	8%
WV Residents Cash - Frequent	Cash	3+ Trips	WV	597	11%
Non-WV Resident Cash - Frequent	Cash	3+ Trips	Not WV	855	16%
WV E-ZPass	WV E-ZPass	Any	Any	1,779	33%
Total	-	-	-	**5,348**	**100%**

Source: WV Turnpike SP Survey

In the frequent market segments, the toll cost coefficient was interacted with annual trip frequency to identify the relationship between frequency of use on the Turnpike and toll cost sensitivity. For cash and Non-WV E-ZPass customers, separate models were estimated for frequent and infrequent users of the Turnpike, where frequent users are defined as making at least three trips on the Turnpike annually. In the models estimated for frequent users and WV E-ZPass customers, multiplying toll cost by the annual trip frequency raised to a power of lambda, a parameter estimated by the model, was found to provide the greatest improvement in model fit, and indicates that sensitivity to toll prices increases as trip frequency increases, though the rate is less than linear. An alternative specific constant is included on the pay tolls per trip and stop making trips altogether alternatives to capture the utility (or disutility) for the alternatives that cannot be attributed to any other variables in the model.

Coefficient Estimates

The results of the final MNL models are presented for each segment in **Table 3-6** through **Table 3-11** below. These tables contain coefficient values, robust standard errors, robust t-statistics, and general fit statistics for the models.

Table 3-6 MNL Model Results: Non-WV E-ZPass – Infrequent Users

Coefficient	Alternatives			Coefficient Values			
	WV E-ZPass	Toll Per Plaza	Stop Making Trips	Value	Robust Std. Error	Robust T-Test	Robust P-Value
Annual Fee	X			-0.0515	0.0108	-4.78	0
Issuance Fee	X			-0.0422	0.00936	-4.51	0
Vehicles	X			0.116	0.0597	1.94	0.05
Toll per Plaza		X		-0.935	0.0474	-19.7	0
Alternative Specific Constant - Toll per Plaza		X		5.33	0.2840	18.72	0
Alternative Specific Constant - Stop Making Trips			X	-0.0873	0.2460	-0.35	0.72

Model Statistics	
Number of Estimated Parameters	6
Number of Observations	4,192
Number of Individuals	524
Null Log-likelihood	-4,605.383
Final Log-likelihood	-1,738.625
Adjusted Rho-square	0.621

Source: WV Turnpike SP Survey

Table 3-7 MNL Model Results: Non-WV E-ZPass – Frequent Users

Coefficient	Alternatives			Coefficient Values			
	WV E-ZPass	Toll Per Plaza	Stop Making Trips	Value	Robust Std. Error	Robust T-Test	Robust P-Value
Annual Fee	X			-0.0352	0.00234	-15.05	0
Issuance Fee	X			-0.0272	0.00258	-10.54	0
Vehicles	X			0.1	0.0167	6.01	0
Toll per Plaza		X		-0.546	0.0315	-17.3	0
Alternative Specific Constant - Toll per Plaza		X		3.39	0.13	26.13	0
Alternative Specific Constant - Stop Making Trips			X	-1.03	0.101	-10.21	0
Lambda - Annual Number of Trips		X		0.173	0.0182	9.5	0

Model Statistics	
Number of Estimated Parameters	7
Number of Observations	9,344
Number of Individuals	1,168
Null Log-likelihood	-10,265.433
Final Log-likelihood	-6,189.413
Adjusted Rho-square	0.396

Source: WV Turnpike SP Survey

Table 3-8 MNL Model Results: Cash – Infrequent Users

Coefficient	Alternatives			Coefficient Values			
	WV E-ZPass	Toll Per Plaza	Stop Making Trips	Value	Robust Std. Error	Robust T-Test	Robust P-Value
Annual Fee	X			-0.0468	0.00579	-8.09	0
Issuance Fee	X			-0.0424	0.00576	-7.37	0
Vehicles	X			0.104	0.0348	2.98	0
Toll per Plaza		X		-0.761	0.0437	-17.41	0
Alternative Specific Constant - Toll per Plaza		X		3.26	0.237	13.74	0
Alternative Specific Constant - Stop Making Trips			X	-1.07	0.196	-5.46	0

Model Statistics	
Number of Estimated Parameters	6
Number of Observations	3,400
Number of Individuals	425
Null Log-likelihood	-3,735.282
Final Log-likelihood	-2,091.135
Adjusted Rho-square	0.439

Source: WV Turnpike SP Survey

Table 3-9 MNL Model Results: WV Residents Cash – Frequent Users

Coefficient	Alternatives			Coefficient Values			
	WV E-ZPass	Toll Per Plaza	Stop Making Trips	Value	Robust Std. Error	Robust T-Test	Robust P-Value
Annual Fee	X			-0.0372	0.00184	-20.18	0
Issuance Fee	X			-0.0294	0.00259	-11.34	0
Vehicles	X			0.077	0.0154	5.02	0
Toll per Plaza		X		-0.471	0.0401	-11.75	0
Alternative Specific Constant - Toll per Plaza		X		0.575	0.129	4.46	0
Alternative Specific Constant - Stop Making Trips			X	-2.75	0.119	-23.06	0
Lambda - Annual Number of Trips		X		0.148	0.0207	7.16	0

Model Statistics	
Number of Estimated Parameters	7
Number of Observations	4,776
Number of Individuals	597
Null Log-likelihood	-5,246.972
Final Log-likelihood	-4,047.093
Adjusted Rho-square	0.227

Source: WV Turnpike SP Survey

Table 3-10 MNL Model Results: Non-WV Resident Cash – Frequent Users

Coefficient	Alternatives			Coefficient Values			
	WV E-ZPass	Toll Per Plaza	Stop Making Trips	Value	Robust Std. Error	Robust T-Test	Robust P-Value
Annual Fee	X			-0.041	0.00197	-20.81	0
Issuance Fee	X			-0.0344	0.00243	-14.17	0
Vehicles	X			0.101	0.0146	6.89	0
Toll per Plaza		X		-0.54	0.0317	-17.06	0
Alternative Specific Constant - Toll per Plaza		X		1.83	0.115	15.9	0
Alternative Specific Constant - Stop Making Trips			X	-2.13	0.102	-20.91	0
Lambda - Annual Number of Trips		X		0.163	0.0207	7.88	0

Model Statistics	
Number of Estimated Parameters	7
Number of Observations	6,840
Number of Individuals	855
Null Log-likelihood	-7,514.508
Final Log-likelihood	-5,524.077
Adjusted Rho-square	0.264

Source: WV Turnpike SP Survey

Table 3-11 MNL Model Results: WV E-ZPass

Coefficient	Alternatives			Coefficient Values			
	WV E-ZPass	Toll Per Plaza	Stop Making Trips	Value	Robust Std. Error	Robust T-Test	Robust P-Value
Annual Fee	X			-0.0434	0.00103	-42.03	0
Issuance Fee	X			-0.0335	0.00155	-21.55	0
Vehicles	X			0.0799	0.0096	8.33	0
Toll per Plaza		X		-0.343	0.0198	-17.31	0
Alternative Specific Constant - Toll per Plaza		X		-0.933	0.0851	-10.97	0
Alternative Specific Constant - Stop Making Trips			X	-3.41	0.0827	-41.22	0
Lambda - Annual Number of Trips		X		0.282	0.0177	15.93	0

Model Statistics	
Number of Estimated Parameters	7
Number of Observations	14,232
Number of Individuals	1,779
Null Log-likelihood	-15,635.45
Final Log-likelihood	-10,358.342
Adjusted Rho-square	0.337

Source: WV Turnpike SP Survey

The coefficient values are the values estimated by the choice models that represent the relative importance of each of the variables. These values are unit-specific, and the units must be accounted for when comparing coefficients. The sign of the coefficient indicates a positive or negative relationship between utility and the associated variable. For example, a negative toll cost coefficient implies that utility for a given travel alternative will decrease as the toll cost associated with that alternative increases.

The standard error is a measure of error around the mean coefficient estimate. The t-statistic is the coefficient estimate divided by the standard error, which can be used to evaluate statistical significance. A t-statistic greater/less than ±1.96 indicates that the coefficient is statistically significantly different from zero (unless otherwise reported) at the 95% level.

The model fit statistics presented for each set of results include the number of estimated parameters (i.e., coefficients), the number of choice observations, the number of individuals, the initial log-likelihood, the log-likelihood at convergence, and adjusted rho-squared. The log-likelihood is a model fit measure that indicates how well the model predicts the choices observed in the data, where values closer to zero indicate higher predictive accuracy. The null log-likelihood is the measure of the predictive accuracy with coefficient values of zero. The final log-likelihood is the measure of predictive accuracy with the final coefficient values at model convergence (i.e., the coefficient estimates in the final models).

The log-likelihood cannot be evaluated independently, as it is a function of the number of observations, the number of alternatives, and the number of parameters in the choice model. The rho-square model fit measure accounts for this to some degree by evaluating the difference between the null log-likelihood and the final log-likelihood at convergence, and can take on values between 0 and 1. A rho-square of 0 indicates that the model cannot explain any variation in choice behavior, and a rho-square value of 1 indicates that the model explains 100% of the choice behavior in the SP exercises. The adjusted rho-square value considers the number of parameters estimated in the model. In the MNL models presented above, the adjusted rho-square values range from 0.227 to 0.621. In other words, the models above explain between 22.7% and 62.1% of the variation in choice behavior in the SP exercises.

3.6.2 Trip Suppression

In addition to the MNL models, linear regression models were estimated to forecast trip reduction rates in response to proposed increases in per-plaza toll rates. The suppression models were fitted with data from respondents who selected the second alternative (pay per plaza per trip) in the first or second SP scenario. Respondents who would stop making trips altogether on the Turnpike are not included in the estimated suppression rates presented in this section. They are instead accounted for separately in the forecast modeling.

Respondents who reported that they would continue to pay tolls per plaza if the toll cost increased were asked a follow-up question of how many trips they would make under the hypothetical conditions presented in the SP experiment.

4,878 suppression observations were collected from 3,039 respondents. Additional data cleaning was performed prior to estimating the suppression models to ensure practical model results. Respondents who met any of the following conditions were excluded from the suppression models:

- Made less than three trips annually on the Turnpike (1,127 observations)

- Were shown a toll cost of $1.50 in the SP experiment (816 observations)
- Indicated that they would suppress trips when the toll rate shown was equal to the current toll rate ($2.00) and were Non-WV E-ZPass customers (114 observations)

Removing these observations resulted in a suppression dataset of 3,056 suppression observations from 2,099 respondents. Suppression models were estimated for the four segments presented in **Table 3-12**.

Table 3-12 Suppression Model Segments

Segment	Respondents	Suppression Observations
Non-WV E-ZPass customers	940	1,495
West Virginia resident cash customers	255	347
Non-WV resident cash customers	546	785
West Virginia E-ZPass customers	358	429
Total	**2,099**	**3,056**

Source: WV Turnpike SP Survey

The dependent variable in the suppression model was the percentage of trips reduced because of increased toll rates, while the independent variable was the per-plaza toll rate shown in the experiment:

$$\Delta Tr = m * \Delta t$$

Where:

- ΔTr is the percentage difference in the number of trips.
- m is the regression coefficient.
- Δt is the toll rate shown in the experiment.

The results of the five suppression models are shown in **Table 3-13**. The coefficient is interpreted as the percent reduction in total trips for each $1.00 dollar increase in toll costs. The standard error is a measure of the statistical precision of the coefficient. The t-statistic for a coefficient estimate is the coefficient estimate divided by its standard error, and is used to evaluate statistical significance. A t-statistic greater/less than ±1.96 indicates that the coefficient is statistically significantly different from zero at the 5% significance level. The adjusted R^2 measures the overall fit of the model to the data and can be interpreted as the proportion of variation in the response variable that is explained by the model. For example, for the West Virginia E-ZPass segment, the model explains 19.42% of the variation in trip suppression.

Table 3-13 Trip Suppression Model Parameters

Model Segment	Coefficient	Standard Error	T-Stat	P-Value	Adjusted R
Non-WV E-ZPass	0.03961	0.00463	8.56	<0.001	0.0461
West Virginia resident cash	0.06935	0.00937	7.41	<0.001	0.1343
Non-WV resident cash	0.04626	0.01458	3.17	0.002	0.0114
West Virginia E-ZPass	0.07647	0.00748	10.22	<0.001	0.1942

Source: WV Turnpike SP Survey

The regression coefficients were used to calculate trip suppression rates for toll rates shown to respondents. **Table 3-14** shows trip suppression rates at incremental toll rates for each model segment.

The regression shows that as toll costs increase, trip reduction rates increase, particularly WV E-ZPass customers not in the flat fee program.

Table 3-14 Suppression Model Results

Toll Rate	Percent Trip Reduction by Market Segment			
	Non-WV E-ZPass	Cash, WV Resident	Cash, Non-WV Resident	WV E-ZPass
$2.00	0.0%	0.0%	0.0%	5.4%
$2.50	2.0%	3.5%	2.3%	9.2%
$3.00	4.0%	6.9%	4.6%	13.0%
$3.50	5.9%	10.4%	6.9%	16.8%
$4.00	7.9%	13.9%	9.3%	20.6%
$4.50	9.9%	17.3%	11.6%	24.5%
$5.00	11.9%	20.8%	13.9%	28.3%

Source: WV Turnpike SP Survey

3.6.3 Market Share Simulation

The coefficients of the MNL models can be used to calculate market shares for different payment alternatives. The results from the fully segmented models were incorporated into an Excel-based market share simulation tool. An example screen shot of the simulation tool's interface is shown in **Figure 3-7**. The tool converts estimates of preference into market shares for each of the three alternatives. The simulation model allows the consultant team to test "what-if" changes to payment options and costs and provides estimates of what percentage of the qualifying traveling population would join the revised flat fee program under specific scenarios.

Trip suppression and induction results were integrated into the simulator. Average trip induction rates by market segment among respondents who chose to join the revised flat fee program are shown next to the market share estimates for Option 1. The percent trip reduction estimates resulting from the regression models described above are presented next to the market share estimates for Option 2.

The equations behind the market share simulator were incorporated into tolling models used to estimate reaction to tolling policy. (See Chapter 5 for more information).

Figure 3-7 Market Share Simulator Example

West Virginia Turnpike Payment Choice Stated Preference Survey - Market Share Simulator

Inputs

Option 1 Join Revised Flat Fee Program		Option 2 Pay Tolls per Plaza		Option 3 Stop Making Trips on the West Virginia Turnpike
Annual Fee:	$8	Toll Cost per Plaza:	$4.00	
Issuance Cost:	$13			
Vehicles per Transponder:	1			

Market Shares

Market Segment	Average Number of Trips	Option 1 Join Revised Flat Fee Program Market Share	Option 1 % Trip Induction	Option 2 Pay Tolls per Plaza Market Share	Option 2 % Trip Reduction	Option 3 Stop Making Trips on the West Virginia Turnpike Market Share	Average Number of Suppressed Trips (per driver)
Non-WV E-ZPass - Infrequent Users	--	7%	39%	78%	--	15%	--
Non-WV E-ZPass - Frequent Users	16.0	32%	6%	48%	8%	20%	3.8
Cash - Infrequent Users	--	22%	42%	61%	--	17%	--
Cash - Frequent Users - WV Residents	73.2	83%	15%	8%	14%	10%	7.8
Cash - Frequent Users - Non WV Residents	18.4	62%	8%	24%	9%	14%	3.1
WV E-ZPass (not on a discount plan)	38.6	92%	10%	2%	21%	6%	2.5

Source: WV Turnpike SP Survey

3.7 Customer Comments

Approximately 1,300 survey respondents provided unstructured comments after taking the SP survey. Individually summarizing and classifying such a large group of comments would take a large amount of time. Instead, CDM Smith sorted the comments into one or more of eleven categories intended to clarify the nature of the comments, firstly by sorting them into categories with the appearance of certain key words in the comments as criteria and secondly through visually scanning comments. The categories used are described below.

- **Positive Hedonic** – These comments were positive about aspects of the Turnpike and/or the SP survey in a general sense. These comments included positive comments on the survey, the quality of the highway, the scenery surrounding the highway, the efficiency of toll collection and the politeness of toll collectors, and other information.
- **Negative Hedonic** – These comments dealt with the same subjects as the Positive Hedonic comments but described them negatively.

- **Positive Convenience** – These comments were positive about aspects of the Turnpike that were related to convenience and ease of travel.
- **Negative Convenience** – These comments dealt with the same subjects as the Positive Convenience comments but described them negatively.
- **Positive Cost** – These comments were positive about aspects of the Turnpike that are related to the cost of traveling the Turnpike and the cost of building and maintaining the highway and tolling system.
- **Negative Cost** – These comments dealt with the same subjects as the Positive Cost comments but described them negatively.
- **Positive Safety** – These comments were positive about aspects of the Turnpike that were related to the safety of traveling the Turnpike.
- **Negative Safety** – These comments dealt with the same subjects as the Positive Safety comments but described them negatively.
- **Trip Purpose** – These comments dealt with the reasons travelers used the Turnpike, as well as the frequency to some degree.
- **Geographic Content** – These comments mentioned certain geographic locations.
- **Low Content** – These comments had little to no content, either because they were short or nonsensical.

Table 3-15 contains the counts of responses in each of these categories. A large portion of the comments were generally positive about the Turnpike and the survey. There were some negative comments on both convenience and cost. Not all comments fit into the categories and some comments might fit into multiple categories.

Table 3-15 Categories of Response

Category of Response	Count
Positive Hedonic	481
Negative Hedonic	91
Positive Convenience Content	177
Negative Convenience Content	209
Positive Cost Content	22
Negative Cost Content	238
Positive Safety Comment	18
Negative Safety Comment	60
Trip Purpose Content	112
Geographic Content	439
Low Content	22
Sum	**1,869**
Total Number of Responses	**1,304**

Source: CDM Smith analysis of survey respondent comments

The following includes a summary of the main points that were derived from the various customer comments:

- E-ZPass was viewed by customers as a highly effective and convenient payment option, especially since the toll plazas do not currently accept payment by credit or debit card and coming up with exact change for payment purposes is considered difficult by many customers. Frequent customers were the happiest with E-ZPass, as well as customers from other states who enjoy the convenience of flexible payments. However, several respondents indicated they felt there should be a discount for Non-WV E-ZPass customers.
- Many respondents wrote that there should be additional E-ZPass only lanes in tolling plazas to reduce booth congestion. It was pointed out that customers making cash payments slowed down trips and caused delays by taking time to come up with exact change for tolls that would be avoided if the E-ZPass were used. Customers were divided about tolls collected in manned lanes. Some see manned lanes as outdated and inefficient but others stated that their travel experience on the Turnpike was improved by professional and friendly toll collectors and expressed concern about automation taking jobs out of an area with few employment opportunities.
- Generally, respondents expressed tentative support for increases in tolls if the tolls were spent directly on improving the quality and efficiency of the system. There were many comments expressing resentment over the fact that the Turnpike is the only tolled road in West Virginia and that the northern half of the state does not pay its fair share.
- Most respondents who commented on their origins, destinations, and reasons for traveling used the Turnpike for irregular or semi-regular trips such as family visits and vacations. These respondents were also usually out of state customers driving between the Midwest and South. Those respondents were more tolerant of fare increases than those living nearby and traveling on the Turnpike for commute purposes, errands, or medical reasons.

3.8 Conclusions

A stated preference survey questionnaire was successfully developed and implemented that gathered 6,438 valid responses from Turnpike customers. The questionnaire collected data on general and current travel behaviors on the Turnpike, presented respondents with information about the proposed changes to payment structures to use the facility, and engaged the travelers in a series of SP scenarios and trip suppression/induction questions.

The SP survey data was used to develop choice models to understand travelers' behavioral responses to the proposed payment option changes. The magnitude and signs of the coefficient estimates are reasonable and intuitively correct. The results of the choice models were used to create an excel-based simulation tool for the consultant team to test "what-if" changes to payment options and fee levels and provides estimates of what percentage of the qualifying traveling population would join a revised flat fee program, pay their tolls on a per plaza basis, or discontinue making their trips on the Turnpike all together. This tool can be used as a point of comparison to evaluate how different pricing arrangements for the proposed payment structures might affect revenue.

A separate set of regression models were developed to test how the proposed payment structure with increased per plaza toll cost might negatively affect total travel trips on the Turnpike. The regressions showed that as toll costs increase, trip reduction rates increase, particularly for WV residents.

A detailed report covering the SP survey development, fielding, results and modeling was completed.

Chapter 4

Economic and Baseline Forecast

4.1 Introduction

An econometric analysis was conducted to estimate long-term travel demand for each plaza on the Turnpike: Ghent (A), Pax (B), Chelyan (C), and North Beckley (NB). Historical passenger car and commercial vehicle demand for each plaza was econometrically estimated via regression equations, applying regional socioeconomics as explanatory variables. With such regression equations, once model parameters have been estimated, regional socioeconomic forecasts were applied to the equation coefficients to estimate annual future demand. In total, eight equations were derived for the combinations of four plazas and two vehicle categories (PCs and CVs). For each equation, a baseline forecast was developed along with a pessimistic and optimistic sensitivity test. Once the regression baseline was established, consideration was given to other factors which may influence the long-range forecasts.

In future stages, econometrically-derived baseline and alternative travel demand forecasts for each plaza-vehicle combination were incorporated into the tolling model that considered a range of future toll policies and rate structures.

4.2 Econometric Modeling

Multivariate regression analysis establishes a mathematical equation for a dependent variable (e.g., annual transactions) as a function of other independent variables (e.g., annual socioeconomic data), with associated statistics explaining the equation robustness. Generally, a regression equation is expressed as follows:

$$y_t=\alpha+\beta_1*x_{(1,t)}+\beta_2*x_{(2,t)}+\cdots+\varepsilon$$

Where:

- y_t is the dependent variable in timeframe t
- $x_{(1,t)}$ and $x_{(2,t)}$ etc. are the independent variables in timeframe t
- α is the intercept coefficient
- β_1 and β_2 etc. are the slope coefficients for the respective independent variables
- ε is the residual error

In each regression equation, an analysis of variation (ANOVA) table is created that explains the statistical parameters, such as adjusted R^2 (coefficient of determination) and t-statistics for each independent variable, which indicate overall equation and independent variable robustness, respectively. ANOVA results determine the statistical defensibility of the equation.

A regression equation can be leveraged for forecasting the dependent variable if ANOVA metrics are statistically significant, the equation's relationships are conceptually valid, and forecasts of independent variables are credibly available.

4.2.1 Regression Testing and Data

Individual highway travel occurs for myriad reasons, such as recreation, commuting, and trade. Travel is influenced by factors such as fuel prices, other travel costs, weather, trip urgency, and economics. Aggregated highway travel typically trends closely with regional socioeconomic variables. As such, conceptually-relevant socioeconomic data were hypothesized, compiled, and regression-tested for explaining annual travel demand. These include population, employment, and real gross regional product, compiled at various geographic levels. Additionally, the effective average annual toll rates were calculated and tested in combination with the socioeconomics.

Multiple regression equations were tested and evaluated for each plaza-vehicle category to account for the numerous possible combinations of relevant geographies (county and/or state clusters) for each socioeconomic variable, and inclusion of effective toll rates. A final equation was selected based on multiple criteria, including but not limited to: overall equation robustness (adjusted R^2), independent variable robustness (t-statistics and p-values), logic and reasonableness of equation coefficients, logic and reasonableness of geographic catchment area, and the credibility of the independent variable(s) and source(s).

Data compiled for regression testing included:

- WVPA – historical transactions and revenues
- United States Census Bureau – historical population
- United States Bureau of Economic Analysis (BEA) – historical employment
- Woods & Poole Economics, Inc. (W&P) – historical and forecast population, employment, and real gross regional product (GRP)

4.2.2 Regression Caveats

Econometrically-derived long-term demand forecasts served as basis for further modeling of annual transaction and toll revenues. The regression growth forecasts do not explicitly consider route choice assumptions, the existing roadway network and planned improvements, existing and anticipated roadway capacities, origin-destination pairing, peak and directional factors, traffic diversions, or future toll pricing changes.

As this regression analysis attempts to estimate aggregate travel demand, the equations cannot account for all potentially influencing factors, especially any small-scale, qualitative/difficult-to-quantify, and/or irregularly occurring factors. Also, a regression analysis is incapable of forecasting unprecedented factors (positive or negative influence) such as catastrophic climate change, health epidemics, terrorism, natural disasters, or any other significantly destabilizing factors. Forecasts are estimates, limited by the availability and robustness of input data, both historical and projected. Data unavailability, discrepancies, aberrations, and inaccuracies can hinder the robustness and results of econometric forecasting. Consequently, the long-range growth rates were dampened to account for these other unknown factors.

4.2.3 Regression Equations and Forecasting

A final regression equation was estimated for each plaza-vehicle combination, relating historical annual demand (plaza transactions) with a regional socioeconomic variable, and in some instances, average effective toll rates, over a 27-year horizon (1990 to 2016, inclusively). **Table 4-1** identifies the general regression characteristics, including the explanatory socioeconomic variable and corresponding geographic scale of the socioeconomic catchment area, as well as whether the average effective toll rates are included in the equation, and the adjusted R^2 statistics.

Geographic combinations of counties are the most-logical and statistically-valid catchment areas for PC transactions for all four plazas. While the combinations of each catchment area vary slightly between the plazas, the areas of statistical influence include counties between the city of Charleston and the Monongahela, Washington, and Jefferson National Forests along the Appalachian Mountains (southeastern West Virginia and northwest Virginia).

CV transactions at the mainline plazas are related to the socioeconomics with a cluster of states, which include: West Virginia, Virginia, Ohio, and Kentucky; however, the geographic catchment for North Beckley (NB) is more-closely related to a county cluster like the passenger-related catchment. The catchment areas are identified in the regression equations summarized at the end of the chapter.[1]

PC transactions along the mainline plazas are related to real GRP, whereas for North Beckley (NB) PC and all CV transactions for all plazas, the socioeconomic variable is employment. Average effective annual toll rates are statistically significant for North Beckley (NB) PC transactions and Pax (B) and Chelyan (C) CV transactions. Adjusted R^2 (overall statistical robustness) is between 87.8% and 96.0%, indicating very good relationships.

Table 4-1 Regression Equation Summary

Plaza	Vehicle Type	Catchment	Variable	Toll Rate	Adj. R^2
Ghent (A)	PC	Counties	GRP	Irrelevant	96.0%
Pax (B)	PC	Counties	GRP	Irrelevant	92.9%
Chelyan (C)	PC	Counties	GRP	Irrelevant	90.9%
North Beckley (NB)	PC	Counties	Employment	Relevant	94.3%
Ghent (A)	CV	States	Employment	Irrelevant	95.2%
Pax (B)	CV	States	Employment	Relevant	94.7%
Chelyan (C)	CV	States	Employment	Relevant	95.6%
North Beckley (NB)	CV	Counties	Employment	Irrelevant	87.8%

Note: PC = Classes 1-4, CV = Classes 5-10
Source: CDM Smith Analysis

With the final regression equations, forecasts of the regional socioeconomic variables were applied to the regression coefficients to estimate future long-term travel demand. Socioeconomic forecasts compiled from W&P were compared with historical patterns; and were observed as generally more aggressive than the long-term historical patterns (1990 to 2016) and certainly more aggressive than more-recent timeframes (2000 to 2016). As such, the socioeconomic forecasts from W&P were

[1] Catchment areas aggregate a regionalize socioeconomic variable as related to travel demand; however, it does not imply that travel demand is *only* from those geographies, but rather that the catchment is a logical, statistically-valid representation for the aggregate demand.

designated as the optimistic scenario. A linear extrapolation of the long-term historical trends of the socioeconomics variables from 1990 to 2016 was designated the baseline scenario; and, a linear extrapolation of the socioeconomics from 2000 to 2016 was designated the pessimistic scenario.

4.3 Econometric Growth Forecasts

Econometrically-derived travel demand forecasts for the Turnpike were based on regression equations with regional socioeconomic explanatory variables, forecasted from either W&P or extrapolating historical trends. Applying socioeconomic forecasts into the equations yielded long-term toll transaction trend estimates for each plaza including baseline, pessimistic, and optimistic ranges. Once established, dampening or deceleration of the long-term growth rates was added to the forecasts to account for unknown factors including economic changes, travel pattern changes, and travel characteristics. A summary of the compound average growth rates (CAGR) for the plazas is provided in **Table 4-2**, depicting the average toll transaction growth from 1990 to 2000, 2000 to 2016, and for the entire 1990 to 2016 history, and the 2016 to 2050 average for each of the three alternatives.

Generally, the Turnpike exhibited 3.6% average toll transaction growth in the 1990s, followed by a notable deceleration around the millennium, resulting in a 0.8% average growth between 2000 and 2016. Over the entire historical timeframe available from 1990 to 2016, the average toll transaction growth amounted to 1.9% annually.

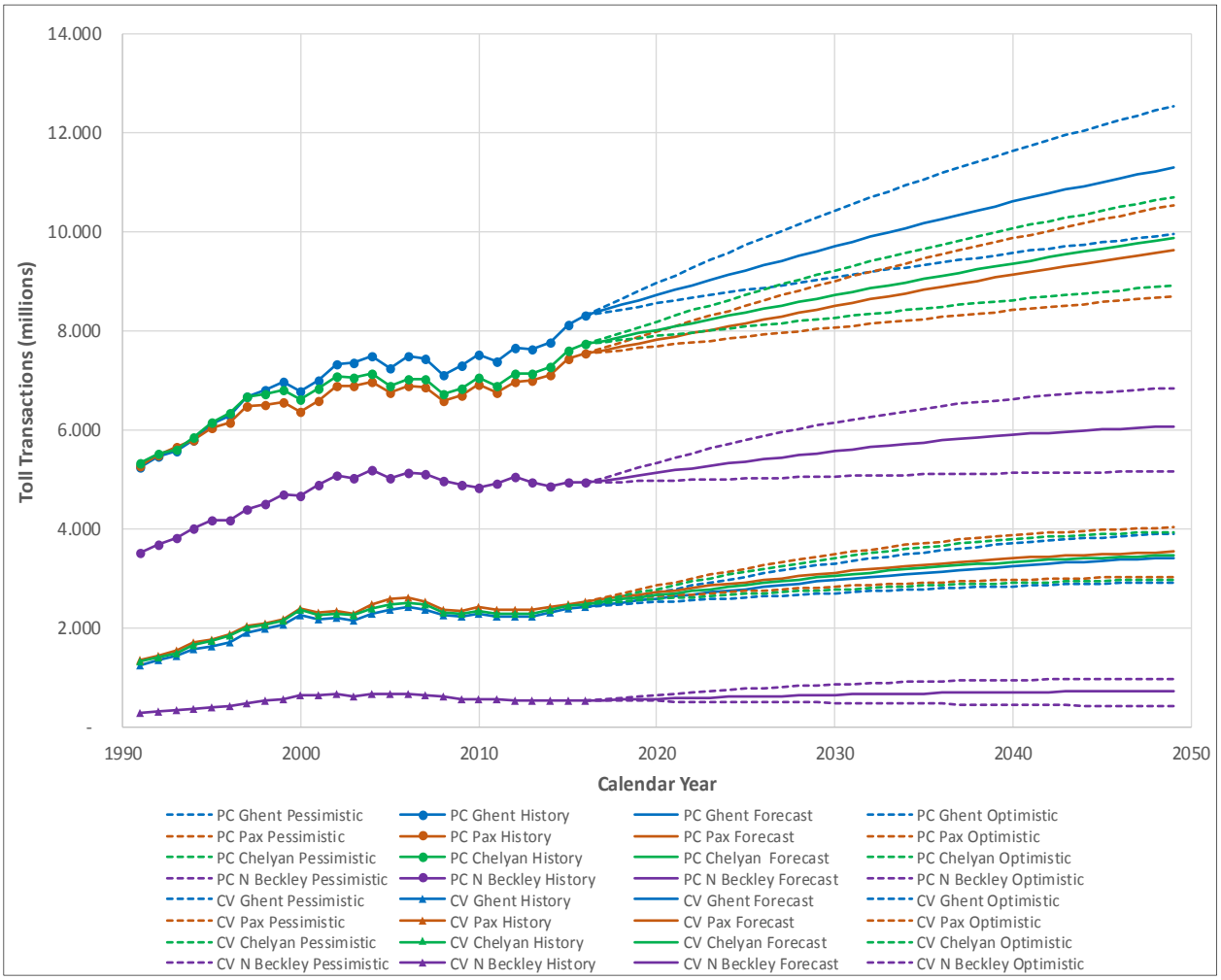
Over the future horizon through 2050, Turnpike toll transactions are projected to increase by 0.8% on average, annually. In the pessimistic alternative, the average future growth is 0.4%, and for the optimistic, 1.1%. CV transactions are projected to grow faster than PC transactions for all plazas, at 1.0% versus 0.8% average annual PC toll transaction growth. A visual summary of the transaction history and alternative forecasts for each plaza-vehicle combination is provided below in **Figure 4-1**; the primary/center line is the baseline, and lighter dashed lines enveloping the baseline are the optimistic and pessimistic alternatives. In **Figure 4-2**, the total transactions for the baseline forecast along with the optimistic and pessimistic forecasts are summarized by class and for the entire Turnpike.

Table 4-2 Transaction Growth Summary

Plaza	Vehicle Type	Historical CAGR			Forecast CAGR (2016-'50)		
		1990-'00	2000-'16	1990-'16	Pessimistic	Baseline	Optimistic
Ghent (A)	PC	3.2%	1.3%	2.0%	0.5%	0.9%	1.2%
Pax (B)	PC	2.4%	1.0%	1.6%	0.4%	0.7%	1.0%
Chelyan (C)	PC	2.6%	1.0%	1.6%	0.4%	0.7%	1.0%
North Beckley (NB)	PC	3.4%	0.4%	1.5%	0.1%	0.6%	1.0%
Ghent (A)	CV	6.1%	0.5%	2.6%	0.5%	1.0%	1.4%
Pax (B)	CV	5.9%	0.4%	2.5%	0.5%	1.0%	1.4%
Chelyan (C)	CV	6.0%	0.3%	2.5%	0.5%	1.0%	1.4%
North Beckley (NB)	CV	8.9%	-1.2%	2.6%	-0.8%	0.9%	1.8%
Total PC		2.9%	1.0%	1.7%	0.4%	0.8%	1.1%
Total CV		6.2%	0.3%	2.5%	0.5%	1.0%	1.4%
Total PC + CV		3.6%	0.8%	1.9%	0.4%	0.8%	1.1%

Note: PC = Classes 1-4, CV = Classes 5-10
Source: CDM Smith Analysis

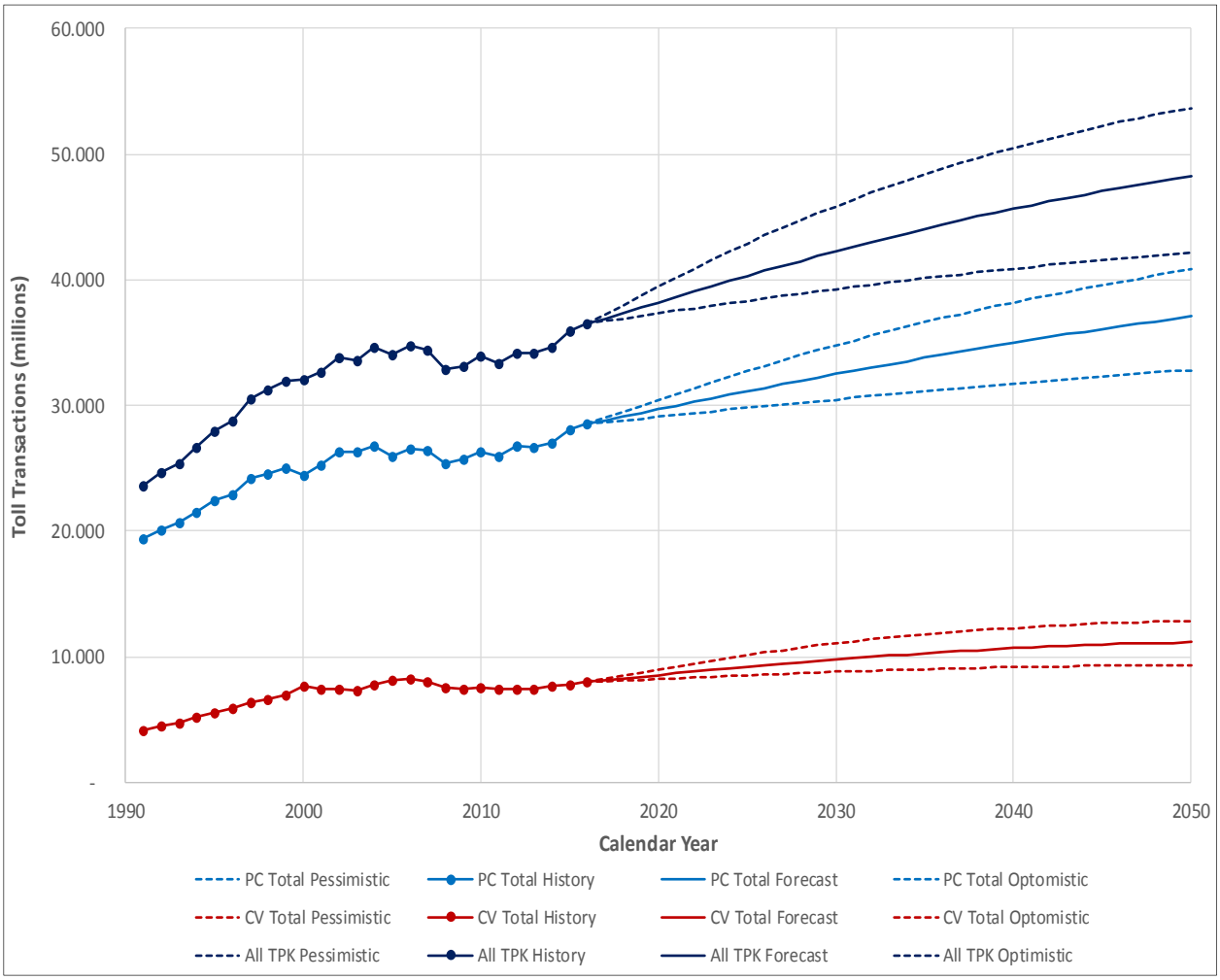
Figure 4-1 Transactions Summary by Plaza



Note: Passenger = Classes 1-4, Commercial = Classes 5-10

Source: CDM Smith Analysis

Figure 4-2 Transactions Summary by Class



Note: Passenger = Classes 1-4, Commercial = Classes 5-10

Source: CDM Smith Analysis

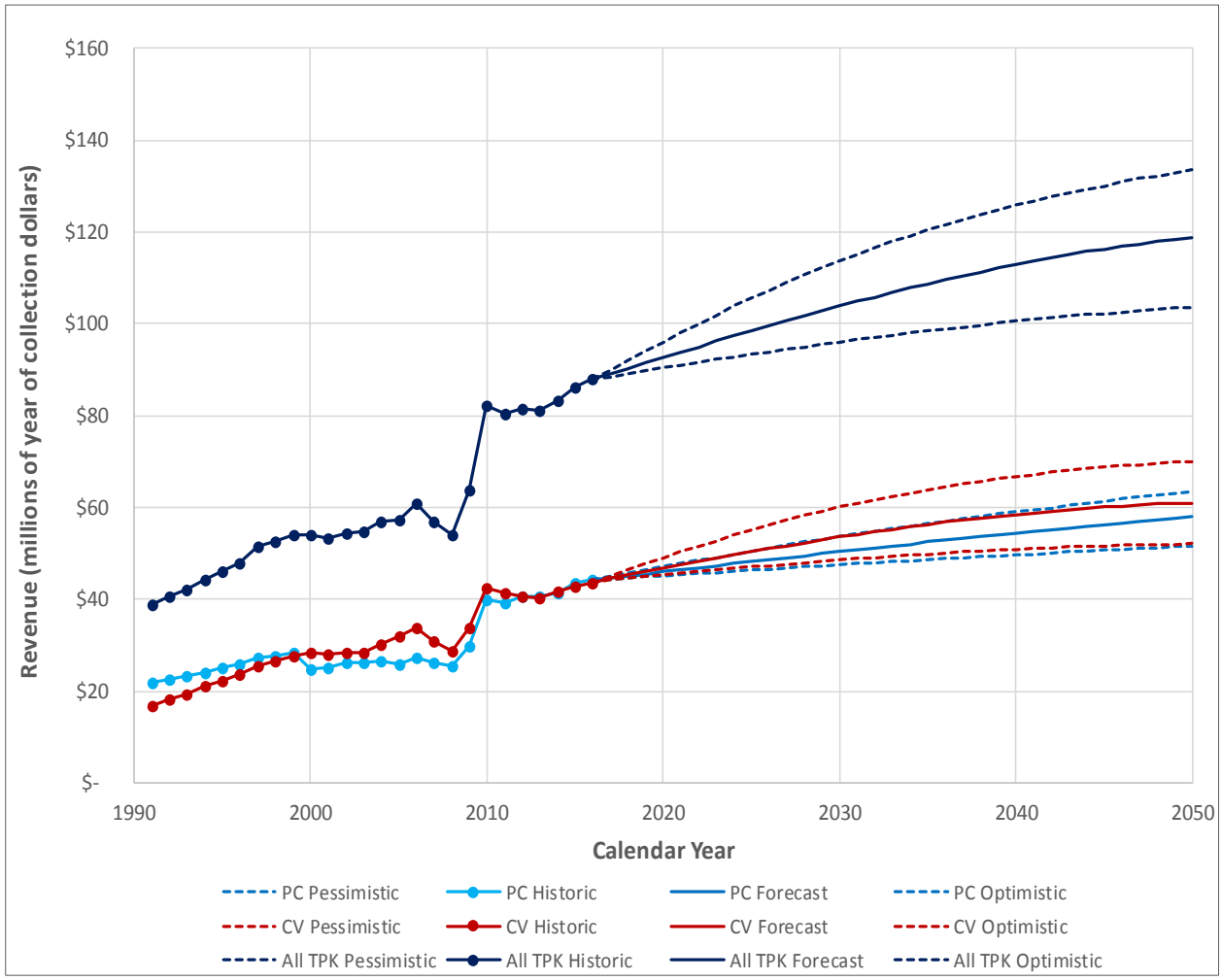
While the WVPA is considering toll policy changes as part of the current study, a baseline toll revenue forecast was developed from the toll transactions forecast. By assuming existing (2012-2016) revenue per transaction by plaza and the mix of passenger cars and commercial vehicles continue throughout the forecast horizon, **Table 4-3** shows the expected total toll traffic and revenue for the Turnpike as well as the pessimistic and optimistic revenue sensitivity tests. **Figure 4-3** illustrates the total historic and projected baseline revenue along with optimistic and pessimistic boundary scenarios.

Table 4-3 Baseline Toll Traffic and Revenue Forecast

Calendar Year	Toll Transactions (millions)			Revenue (millions year of collection dollars)			Revenue Sensitivity Test	
	Passenger Cars	Commercial Vehicles	Total	Passenger Cars	Commercial Vehicles	Total	Pessimistic	Optimistic
2017	28.80	8.12	36.92	$ 44.58	$ 44.49	$ 89.07	$ 88.48	$ 89.92
2018	29.10	8.26	37.36	$ 45.03	$ 45.25	$ 90.28	$ 89.12	$ 91.99
2019	29.39	8.40	37.79	$ 45.49	$ 46.00	$ 91.49	$ 89.75	$ 94.04
2020	29.68	8.53	38.21	$ 45.95	$ 46.75	$ 92.70	$ 90.38	$ 96.06
2021	29.97	8.67	38.64	$ 46.40	$ 47.48	$ 93.88	$ 90.99	$ 98.04
2022	30.26	8.80	39.06	$ 46.85	$ 48.21	$ 95.06	$ 91.59	$ 99.99
2023	30.55	8.93	39.48	$ 47.30	$ 48.92	$ 96.22	$ 92.18	$ 101.89
2024	30.83	9.06	39.89	$ 47.74	$ 49.62	$ 97.36	$ 92.77	$ 103.75
2025	31.11	9.18	40.29	$ 48.18	$ 50.31	$ 98.49	$ 93.34	$ 105.56
2026	31.39	9.31	40.70	$ 48.62	$ 50.98	$ 99.60	$ 93.90	$ 107.31
2027	31.67	9.43	41.10	$ 49.06	$ 51.64	$ 100.70	$ 94.46	$ 109.00
2028	31.94	9.54	41.48	$ 49.49	$ 52.28	$ 101.77	$ 95.00	$ 110.63
2029	32.21	9.66	41.87	$ 49.92	$ 52.91	$ 102.83	$ 95.53	$ 112.19
2030	32.48	9.77	42.25	$ 50.35	$ 53.51	$ 103.86	$ 96.04	$ 113.67
2031	32.75	9.88	42.63	$ 50.77	$ 54.11	$ 104.88	$ 96.55	$ 115.11
2032	33.01	9.98	42.99	$ 51.19	$ 54.68	$ 105.87	$ 97.04	$ 116.51
2033	33.27	10.08	43.35	$ 51.60	$ 55.23	$ 106.83	$ 97.53	$ 117.86
2034	33.52	10.18	43.70	$ 52.01	$ 55.76	$ 107.77	$ 98.00	$ 119.16
2035	33.77	10.27	44.04	$ 52.42	$ 56.28	$ 108.70	$ 98.45	$ 120.41
2036	34.02	10.36	44.38	$ 52.82	$ 56.77	$ 109.59	$ 98.90	$ 121.61
2037	34.27	10.45	44.72	$ 53.21	$ 57.23	$ 110.44	$ 99.33	$ 122.75
2038	34.51	10.53	45.04	$ 53.60	$ 57.68	$ 111.28	$ 99.75	$ 123.83
2039	34.74	10.60	45.34	$ 53.99	$ 58.10	$ 112.09	$ 100.15	$ 124.85
2040	34.97	10.67	45.64	$ 54.37	$ 58.50	$ 112.87	$ 100.54	$ 125.82
2041	35.20	10.74	45.94	$ 54.75	$ 58.87	$ 113.62	$ 100.92	$ 126.75
2042	35.43	10.80	46.23	$ 55.12	$ 59.22	$ 114.34	$ 101.28	$ 127.64
2043	35.65	10.86	46.51	$ 55.48	$ 59.54	$ 115.02	$ 101.63	$ 128.50
2044	35.86	10.92	46.78	$ 55.84	$ 59.84	$ 115.68	$ 101.96	$ 129.33
2045	36.07	10.96	47.03	$ 56.19	$ 60.11	$ 116.30	$ 102.28	$ 130.12
2046	36.28	11.01	47.29	$ 56.54	$ 60.35	$ 116.89	$ 102.59	$ 130.87
2047	36.48	11.05	47.53	$ 56.88	$ 60.57	$ 117.45	$ 102.88	$ 131.58
2048	36.68	11.08	47.76	$ 57.22	$ 60.76	$ 117.98	$ 103.15	$ 132.26
2049	36.87	11.11	47.98	$ 57.55	$ 60.92	$ 118.47	$ 103.41	$ 132.90
2050	37.06	11.13	48.19	$ 57.87	$ 61.05	$ 118.92	$ 103.66	$ 133.50

Source: CDM Smith Analysis

Figure 4-3 Baseline Toll Revenue Forecast



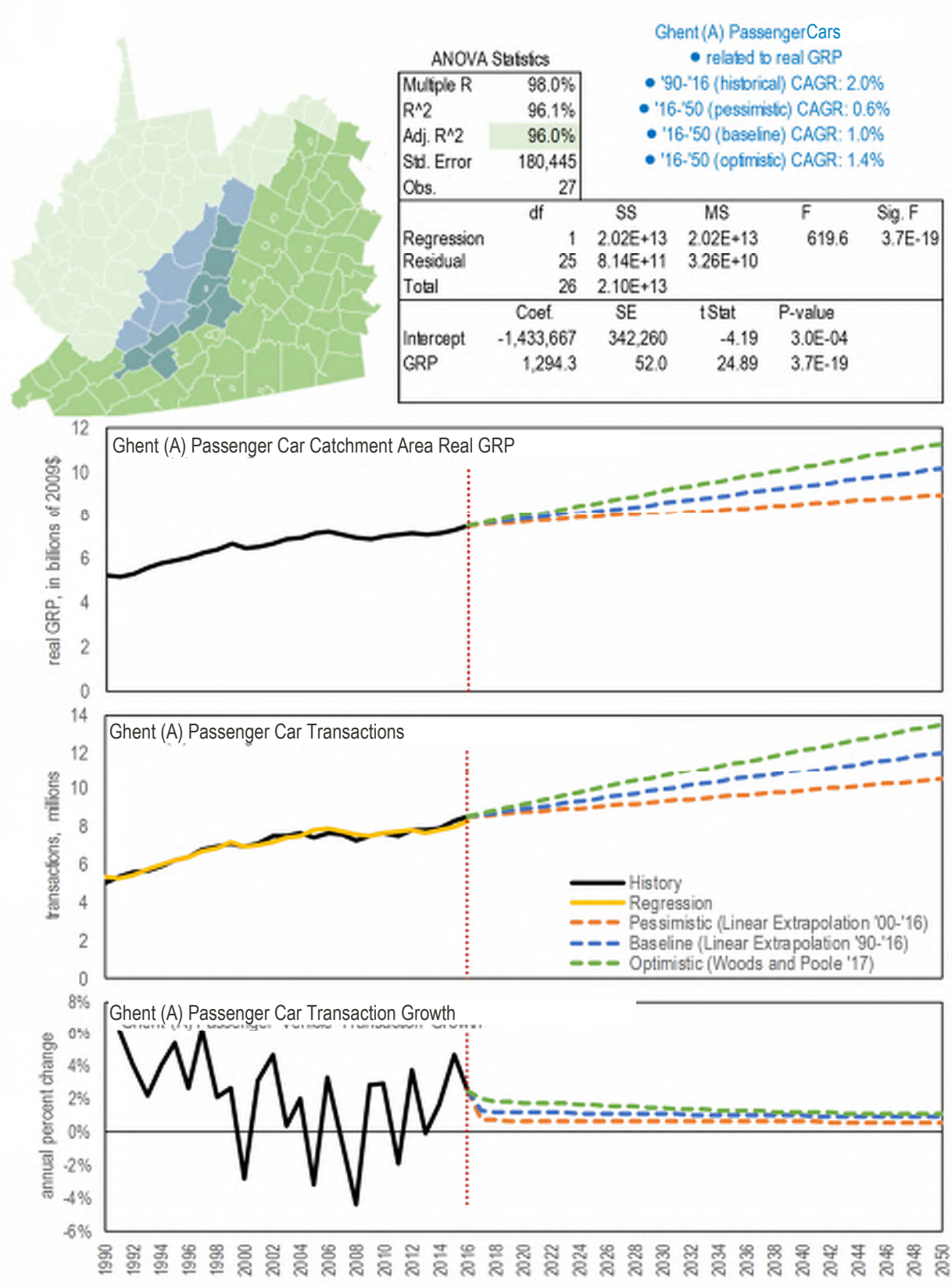
Note: Passenger = Classes 1-4, Commercial = Classes 5-10

Source: CDM Smith Analysis

4.4 Summary

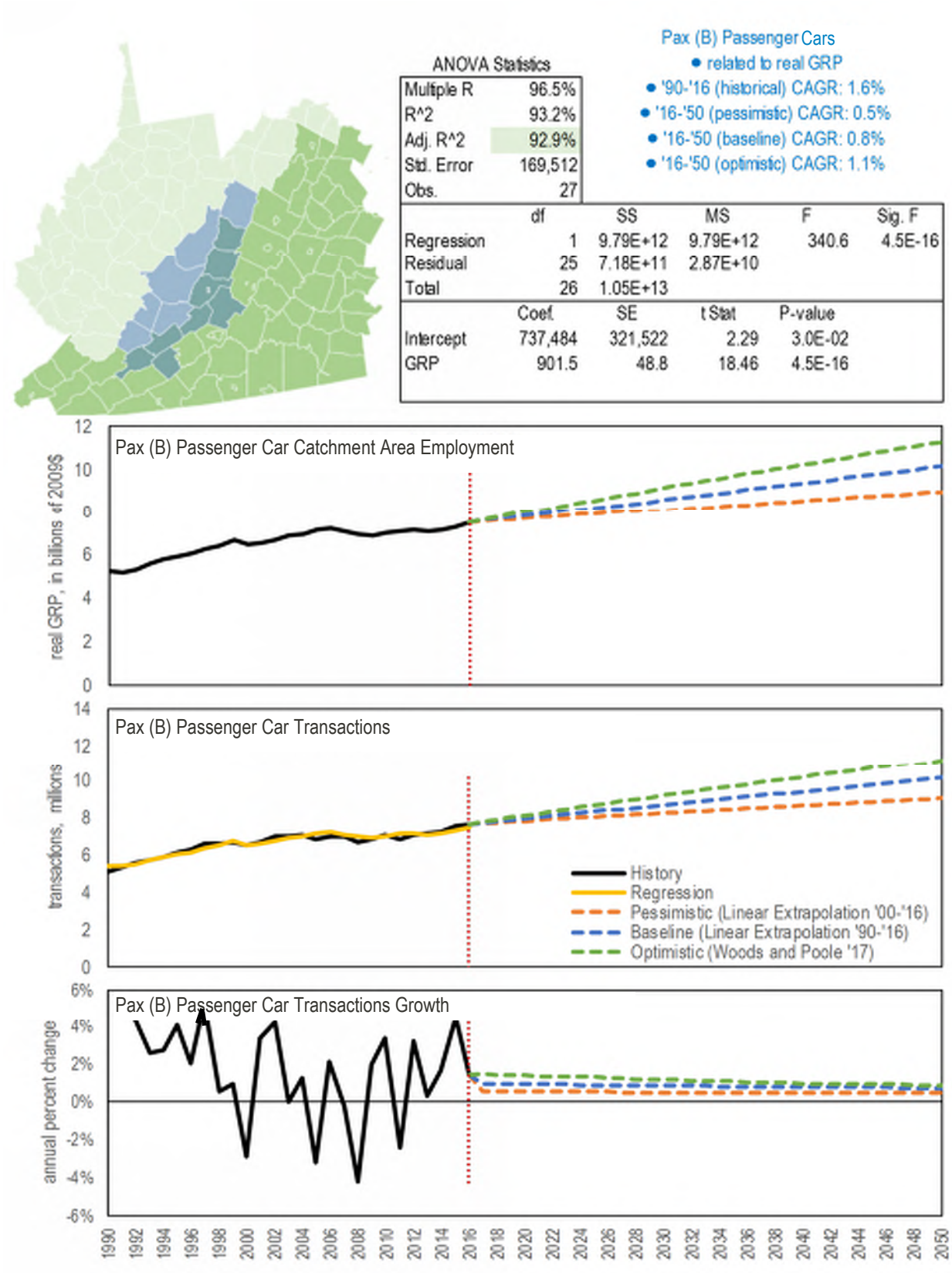
Transaction and revenue growth on the Turnpike has shown periods of growth in the early 1990s, steady traffic with fluctuations in the early 2000s, and more recently has been showing additional growth. The forecasts from econometric analysis indicate modest but steady growth for the forecast horizon. The econometric snapshots are shown in **Figure 4-4** through **Figure 4-11**.

Figure 4-4 Ghent (A) Passenger Cars – Econometric Snapshot



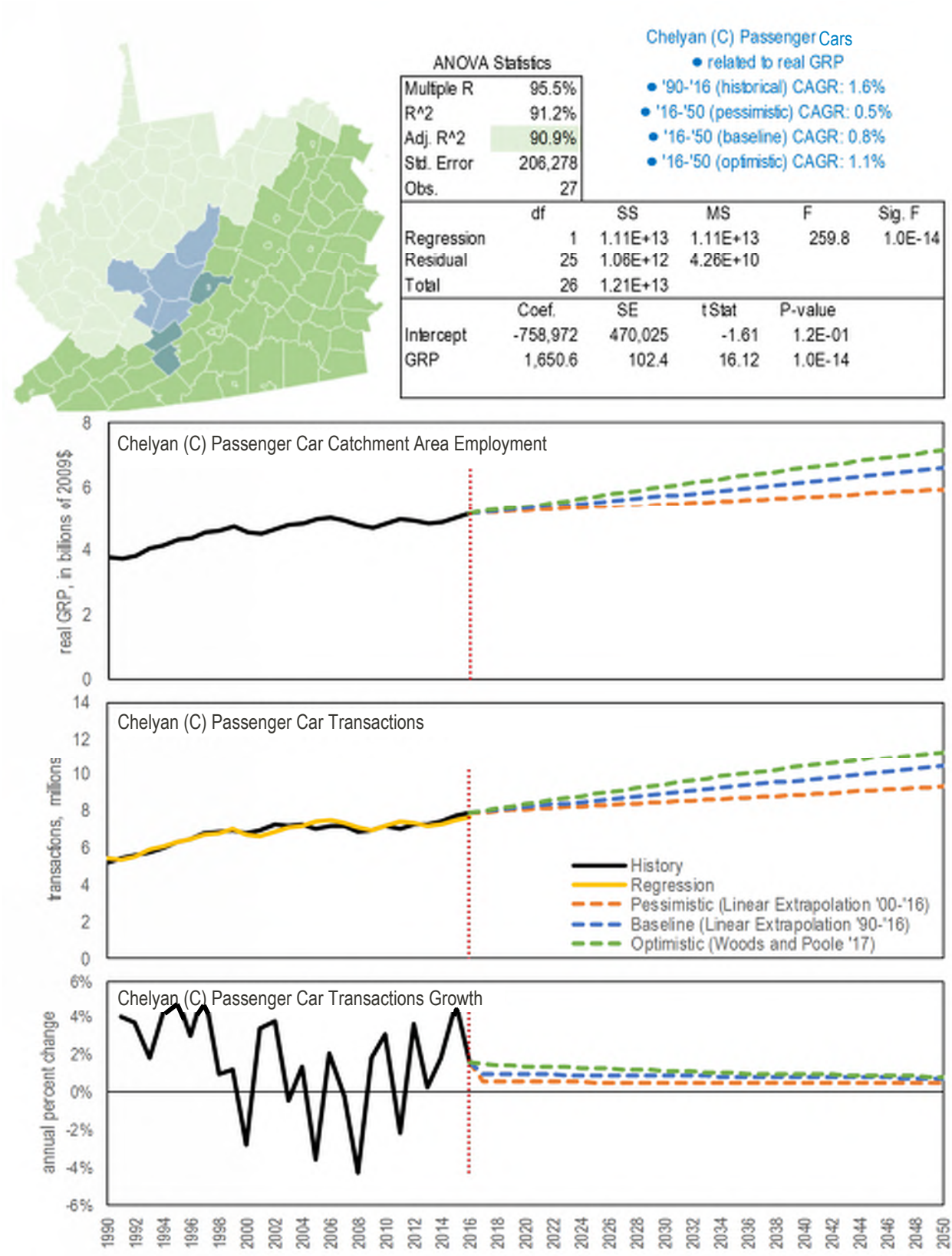
Source: CDM Smith Analysis

Figure 4-5 Pax (B) Passenger Cars – Econometric Snapshot



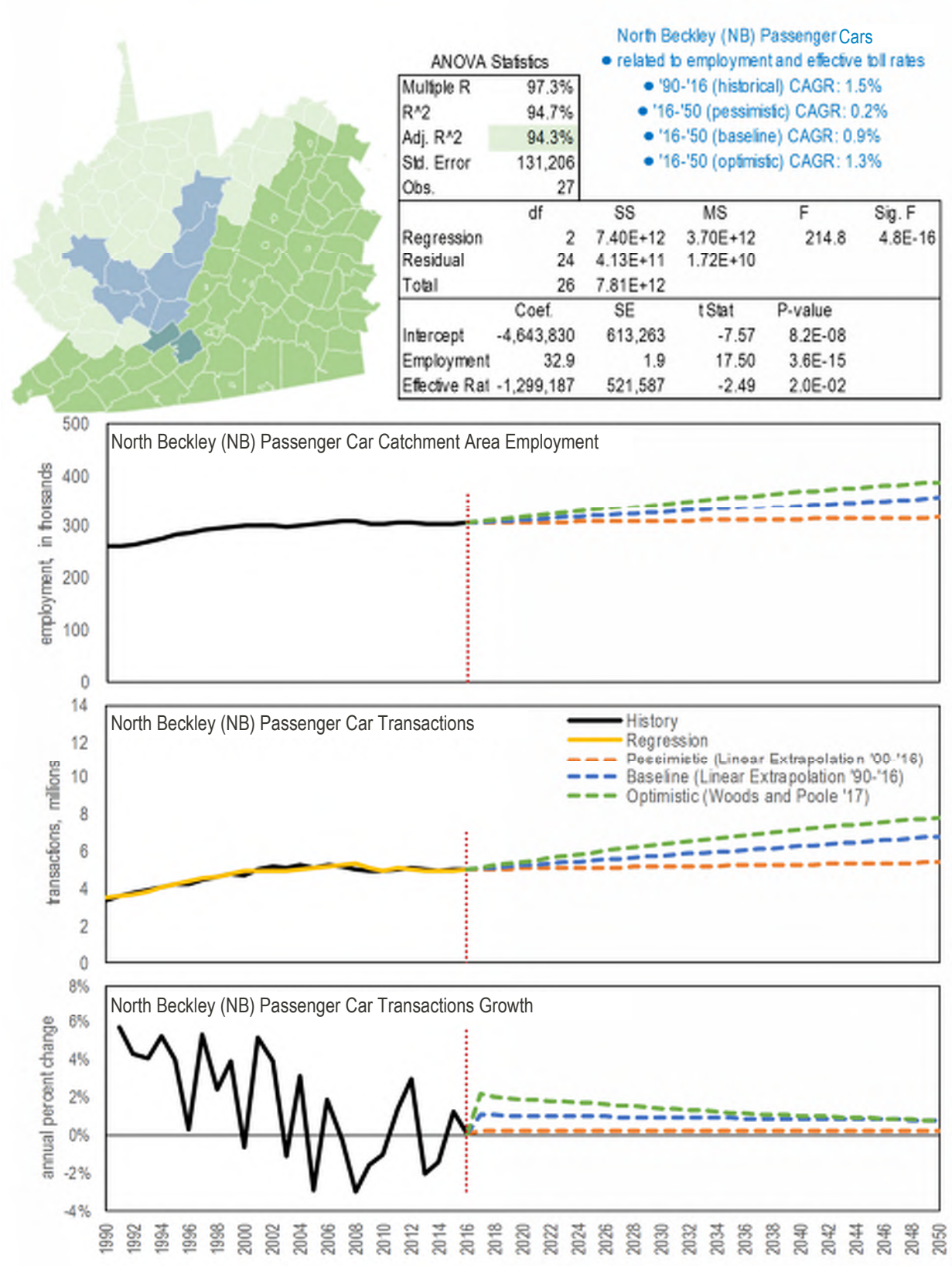
Source: CDM Smith Analysis

Figure 4-6 Chelyan (C) Passenger Cars – Econometric Snapshot



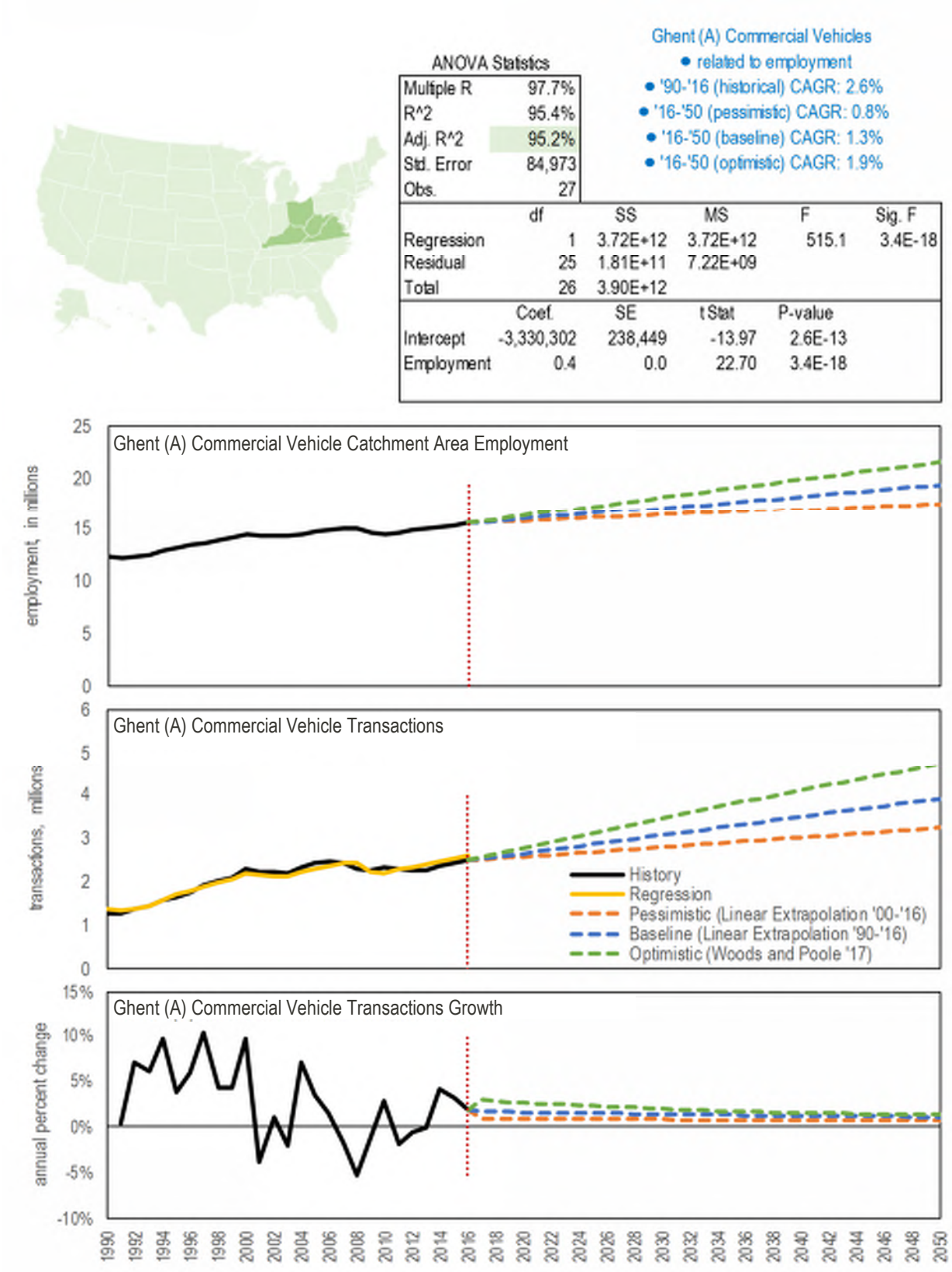
Source: CDM Smith Analysis

Figure 4-7 North Beckley (NB) Passenger Cars – Econometric Snapshot



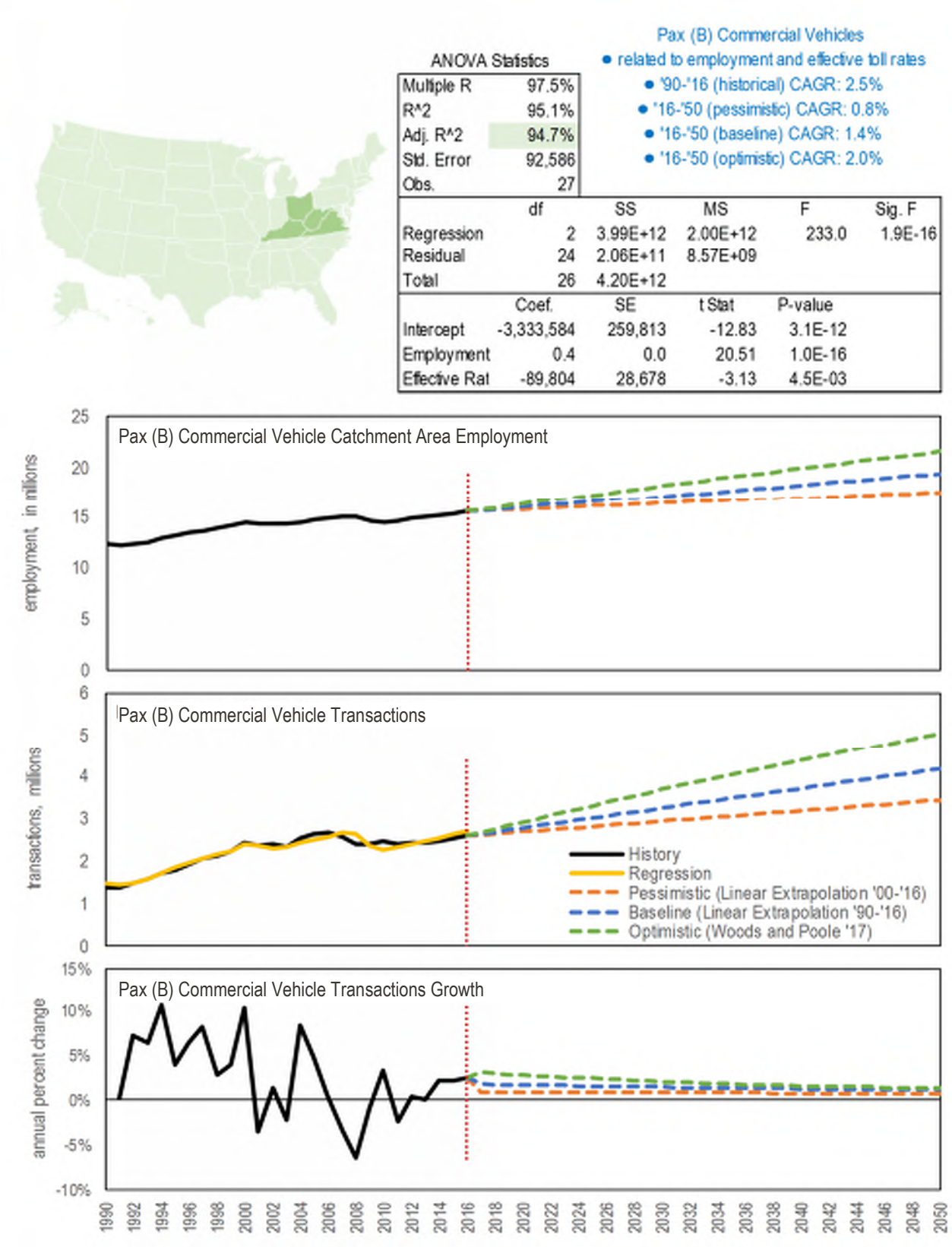
Source: CDM Smith Analysis

Figure 4-8 Ghent (A) Commercial Vehicles – Econometric Snapshot



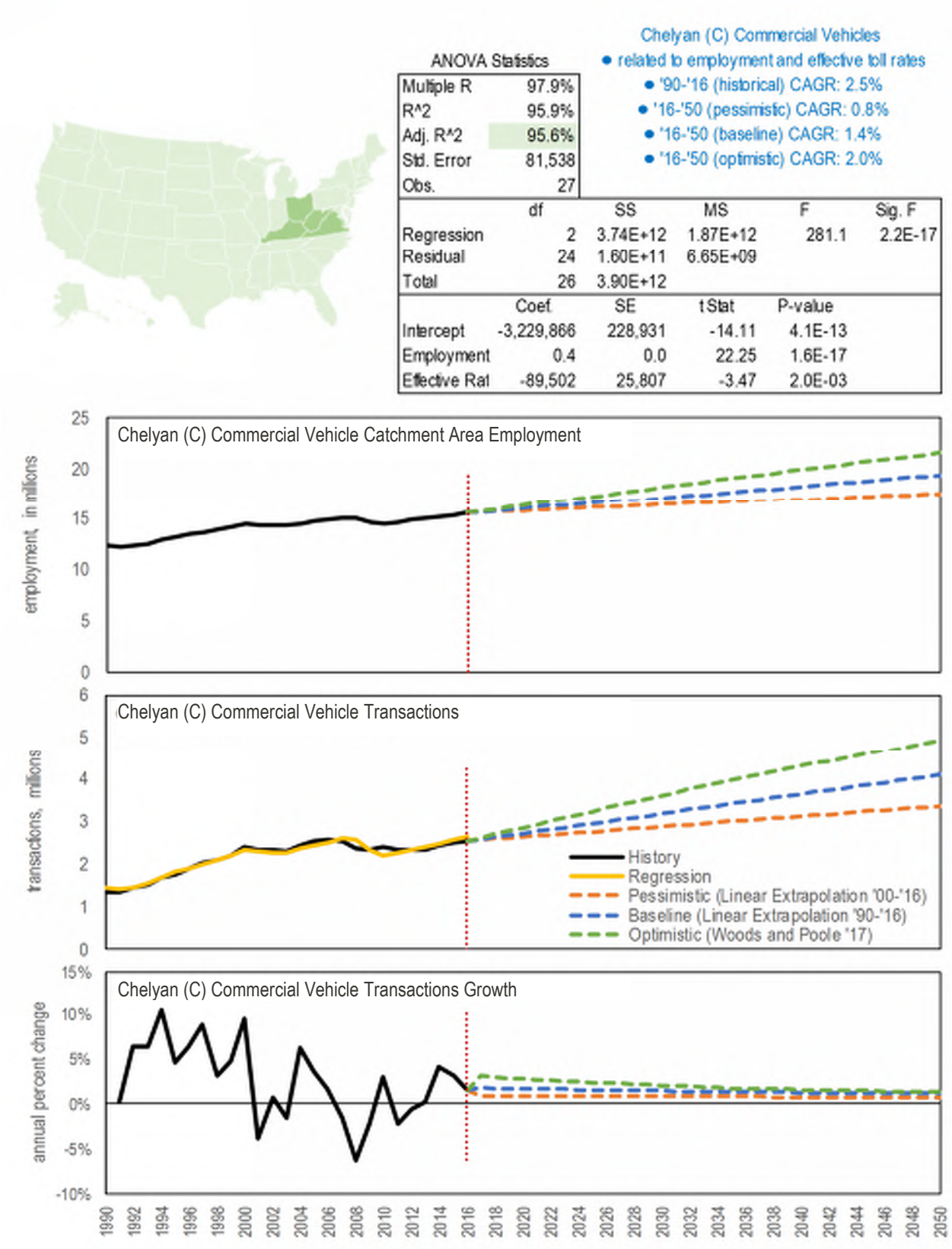
Source: CDM Smith Analysis

Figure 4-9 Pax (B) Commercial Vehicles – Econometric Snapshot



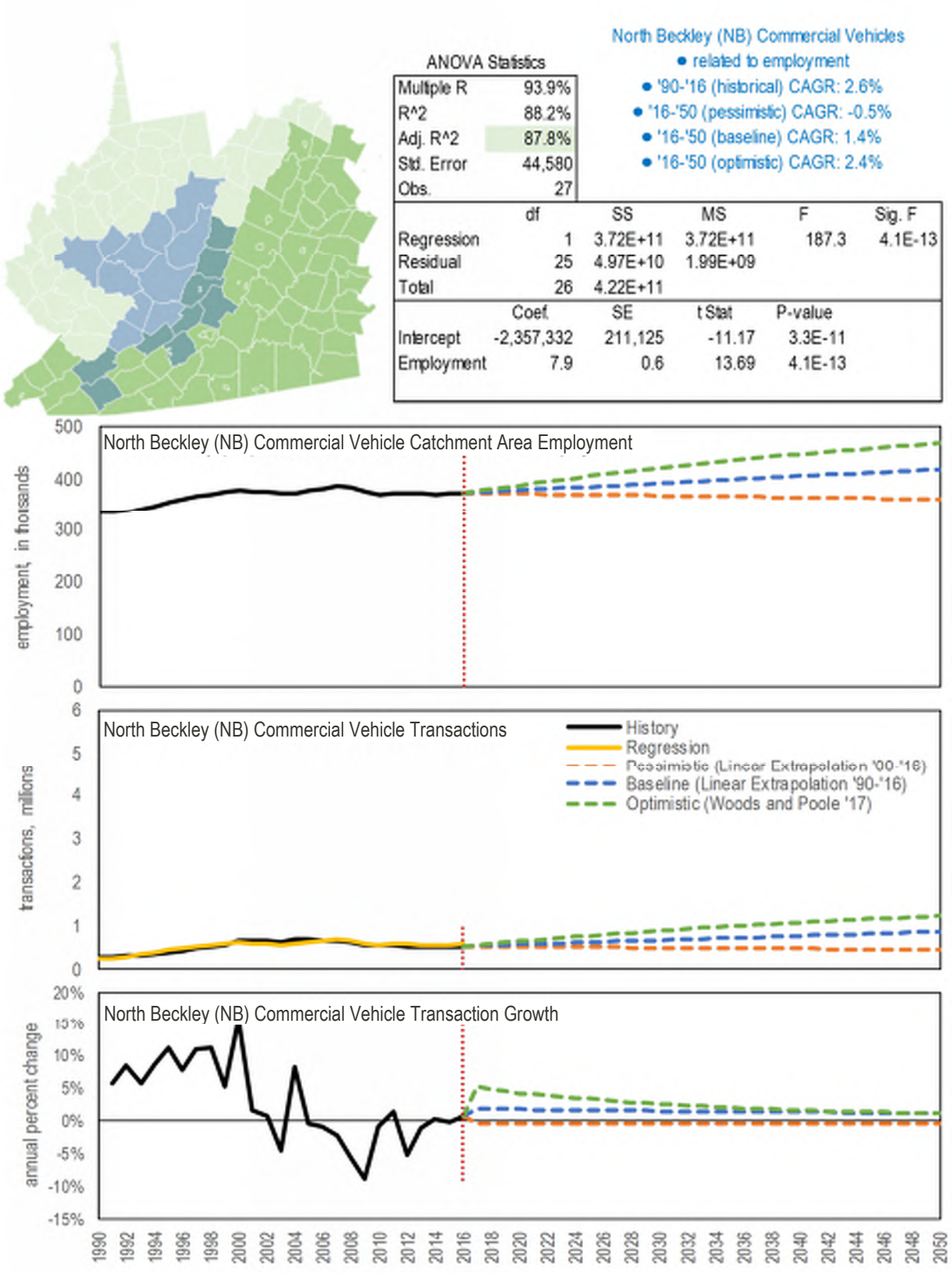
Source: CDM Smith Analysis

Figure 4-10 Chelyan (C) Commercial Vehicles – Econometric Snapshot



Source: CDM Smith Analysis

Figure 4-11 North Beckley (NB) Commercial Vehicles – Econometric Snapshot



Source: CDM Smith Analysis

Chapter 5

Traffic and Revenue Forecast Approach

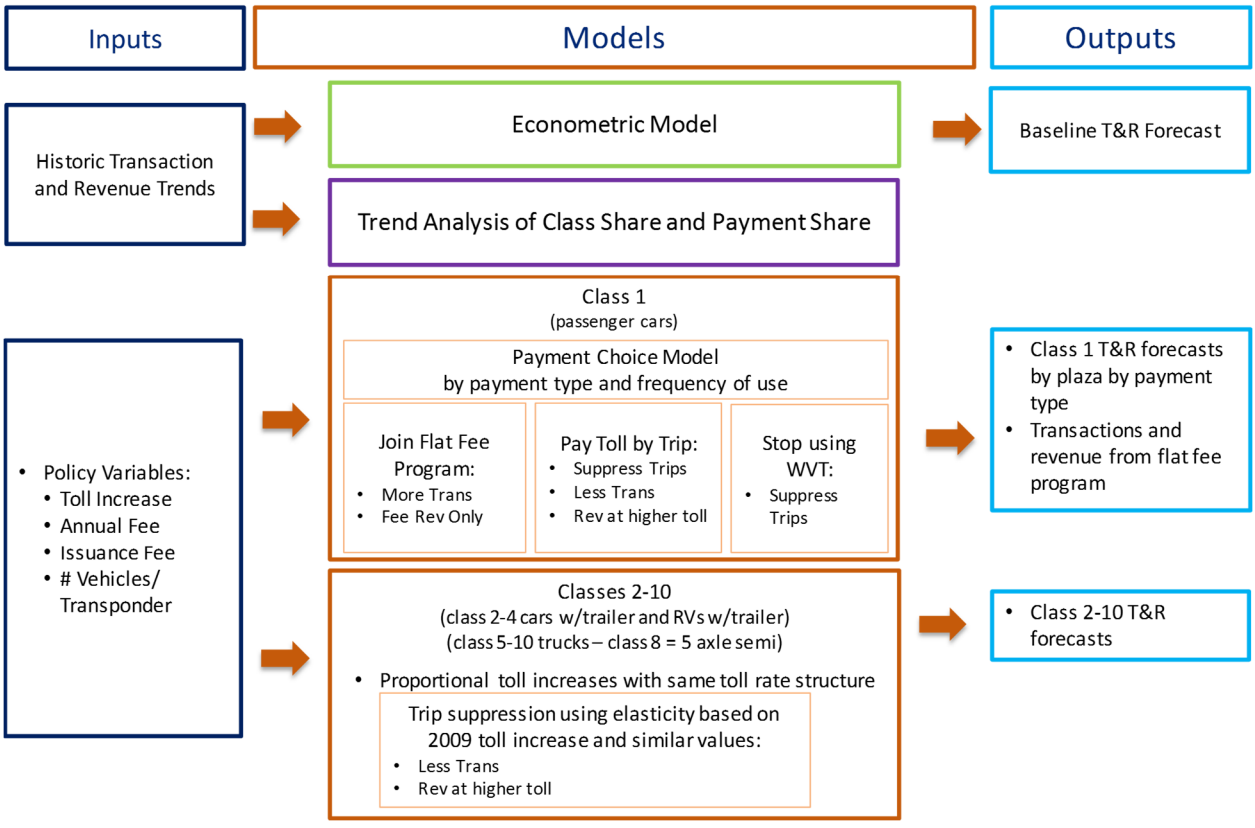
5.1 Introduction

This chapter starts with an overview of the modeling approach developed by CDM Smith for this study. It then describes in more detail the methodology used to develop T&R estimates for Class 1 vehicles (those eligible to enter the revised flat fee program or pay tolls per trip) and for Classes 2-10 vehicles (not subject to the revised flat fee program and facing higher toll rates). Example scenarios are then introduced to describe the expected customer behavior and resulting annual T&R streams based on toll policy parameters. Finally, from among many potential alternatives, a prospective scenario identified by WVPA staff and advisors is described and details are provided in Chapter 6.

5.2 Overall Forecasting Approach

The overall forecasting approach is illustrated on **Figure 5-1**.

Figure 5-1 Overview of T&R Modeling Approach



The first two modeling components – econometric model and class/payment share – are independent of the proposed changes in toll policies. They are intended to produce a forecast of T&R based on the current toll rate schedule, assuming no changes in toll rate policies during the forecast horizon. This is referred to as the "Baseline" forecast.

The process applied to develop the Baseline forecast as well as the optimistic and pessimistic forecasts is documented in Chapter 4. As explained in that chapter, the econometric analysis resulted in modest but steady growth in T&R over the forecast period.

The review of historical transactions on the Turnpike provided detailed information about trends regarding vehicle class and payment method at each plaza. As reported in Chapter 2, CDM Smith analyzed a comprehensive database of E-ZPass transactions covering calendar years 2012 through the first half of 2017. Using historic Turnpike data related to transaction share by vehicle class (Classes 1 through 10) and transaction share by payment method (cash, WV E-ZPass, and Non-WV E-ZPass), as well as general industry trends, CDM Smith prepared projections of anticipated class and payment shares at each plaza for the forecast horizon.

Alternative toll policies contemplated by WVPA involve the introduction of a revised flat fee program available only to Class 1 vehicles using a WV E-ZPass, and toll rate increases for other customers including Class 1 customers not in the revised flat fee program and all Classes 2-10 customers. To evaluate customer responses to these changes, separate models were developed to forecast annual T&R for Class 1 and Classes 2 through 10. The next section of this chapter is focused on the Class 1 forecasting approach, and explains how the payment choice model derived from the SP survey was used to describe the way Class 1 customers would choose between entering the flat fee program, paying higher tolls, or stop using the Turnpike. For the purposes of analysis and this discussion, CDM Smith has assumed that all customers using Class 1 vehicles will choose a payment method at the beginning of the year and use that payment method throughout that year. WVPA will investigate and may implement ways for customers to join the flat fee program throughout the year. This chapter also contains a description of the forecasting approach for Classes 2-10, that includes customers' response to higher toll rates.

At the end of the process, annual forecasts by plaza for Class 1 and Classes 2-10 are combined to produce systemwide T&R estimates, covered in Chapter 6 of this report. Sensitivity tests on important variables are presented in Chapter 7.

5.3 Class 1 Forecasting Approach

The Class 1 forecasting approach is illustrated in more detail on **Figure 5-2**.

5.3.1 Class 1 Model Inputs

Primary inputs to the Class 1 model are below.

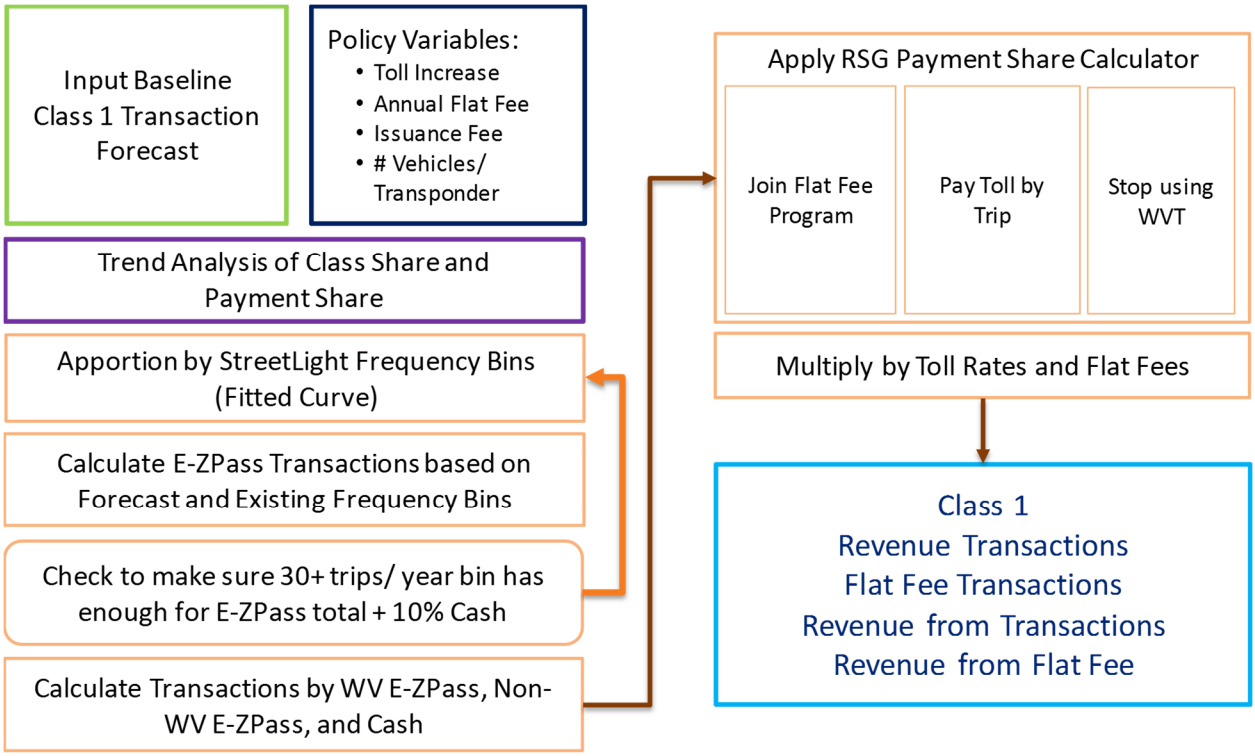
Policy variables include the cost of the annual flat fee providing unlimited use of the Turnpike through a WV E-ZPass; WV E-ZPass transponder issuance cost; number of vehicles that could be registered per transponder; and toll rate increase for Class 1 vehicles paying at toll plazas.

Baseline Class 1 (PC) transaction forecast includes estimates of future annual transactions derived from the econometric analysis, assuming no change in current toll policies.

Future toll class and pay share proportions include projections of future shares of Class 1 vehicles among PC transactions, and methods of payment (cash, WV, and Non-WV E-ZPass) for Class 1 vehicles assuming no change in current toll policies.

Frequency of use includes data related to frequency of use under current toll policies derived from the E-ZPass database and from the StreetLight Data sample for overall customers. Assumptions were made to derive the frequency of use for cash customers since this information was not directly available from the collected data.

Figure 5-2 Class 1 Forecasting Approach



Payment choice model by payment type and frequency of use was based on responses to the SP survey. The payment choice model describes the customer decision-making as they will either join the revised flat fee program, choose to pay higher tolls, or stop making trips on the Turnpike. The payment choice model also provides estimates of the additional trips made by customers that entered the flat fee program (trip induction or more travel due to the lower cost) and the reduced number of trips for customers that are facing higher toll rates per plaza (trip suppression less travel).

5.3.2 Class 1 Model Logic

The Class 1 forecasting model is a spreadsheet-based tool used to estimate annual T&R for each plaza, and for the various payment methods that will be available to Class 1 customers. The same process is repeated at each of the four plazas for all model years, before the results are combined into systemwide estimates. The process starts with Baseline conditions before applying the payment choice results representing customer responses to the change in toll policies. The model separates all transactions and customers by payment type (cash, WV, and Non-WV E-ZPass) and frequency of use. The frequency of use is organized by "bins" according to the number of trips per year (1, 2, 3…, 9, 10-19, 20-29, and 30+).

Within a given frequency bin and payment type, all customers are assumed to make similar decisions in terms of payment choice and level of trip inducement or suppression. More frequent customers are more likely to take advantage of the flat fee program than are customers who rarely use the Turnpike. Customers who already have a transponder are more likely to participate in the flat fee program. These theories were tested, verified and quantified through the SP survey. The results are embedded in the Multinomial Logit (MNL) models used in the payment share calculator.

For both WV and Non-WV E-ZPass customers, distributing trips and customers among the frequency bins was done by directly using the distribution derived from the 2016 transaction database. It was assumed that the frequency distribution for WV and Non-WV E-ZPass customers would remain unchanged throughout the forecast horizon although the overall number of customers and transactions can increase. For cash customers, such frequency distribution was not directly available from any available data sources. Data from StreetLight Data, Inc. provided information about frequency distribution for the overall customer population, including all payment types (refer to Chapter 2 for more details on the StreetLight data and results). The number of cash customers within each frequency bin was derived by subtracting the WV E-ZPass and Non-WV E-ZPass customers from the overall customer population distributions.

This overall process is repeated for each model year. First, the baseline transactions forecast and the forecast of class share and payment share shifts for each model year are combined with the E-ZPass frequency shares to determine overall number of customers by each payment type prior to applying the payment choice model. The payment choice model is then applied based on the scenario characteristics and resulting customer behavior and transactions are estimated.

The main results for Class 1 customers are system-wide estimates of annual toll transactions and revenue by payment type and the annual amount of flat fee transactions and revenue. The model is applied separately to each toll plaza. However, a relatively large portion of customers travel through more than one plaza on a single one-way trip and are almost certain to use the same payment method for the entire one-way trip. The total number of transactions and toll revenue under modeled conditions is the sum of the results from all four plazas. Since payment choice is modeled at each plaza, these results represent average payment choice by plaza, not by individual customer. However, customers in the flat fee program will only pay the fee once and consequently, the total amount of flat fee revenue is the sum of results from all four plazas divide by the average number of plazas used by customers who choose the flat fee program. The estimates are prepared with the assumption that on average customers travel through three plazas during a one-way trip. This approach was validated by comparing the number of E-ZPass customers observed at each plaza with the overall number of WV E-ZPass registered accounts.

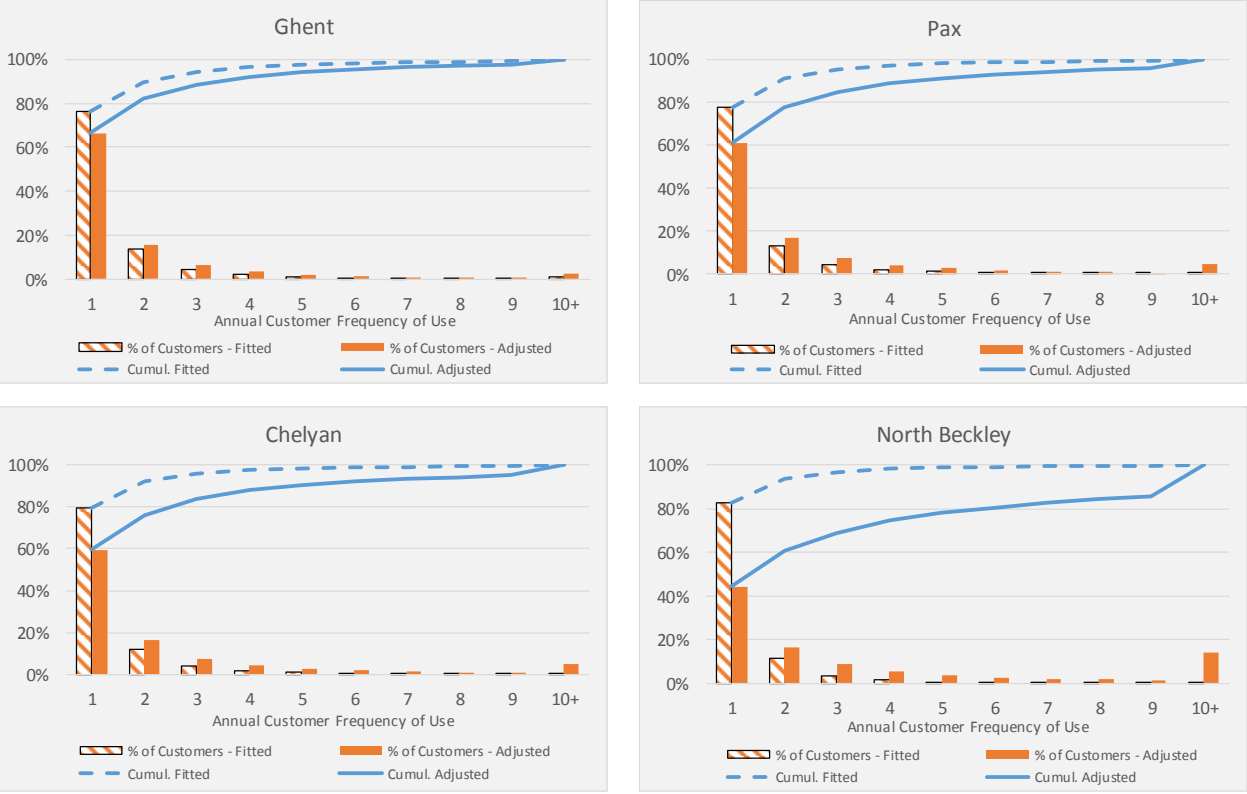
5.3.3 Frequency Distribution Curve Fit and Adjustment

In general, the previously described approach worked well and produced a realistic number of customers and trips for all frequency bins. However, it was recognized that the original StreetLight data was “lumpy,” meaning that there were some gaps at higher frequencies and some irregularities in the frequency distributions. For these reasons, using regression analysis, Pareto functions were fit to the frequency distribution for each plaza. The Pareto function is a probability distribution used to describe socio-economic phenomena that are unequally distributed, such as wealth among individuals or city size. At each of the four plazas, the Pareto functions fit the StreetLight data on frequency of use very well, with R squared statistics exceeding 0.9985. When the results were reviewed, the 30+ frequency bin of all customers did not have enough transactions to cover the estimated E-ZPass transactions. The

Pareto distributions at each plaza and model year were then adjusted so that the number of overall transactions in the 30+ trips per year bin exceeded the number of E-ZPass transactions in that bin by 10%. In other words, it was assumed there would always be some cash transactions in the 30+ frequency bin.

Figure 5-3 illustrates this two-step fit and adjustment process. The horizontal axis represents the number of annual trips through a given toll plaza in a year. The vertical axis represents the share of plaza customers within each frequency bin for all methods of payment. The hatched bars correspond to the distribution that best fit the StreetLight data. The solid orange bars correspond to the distribution adjusted to increase the number of high frequency customers and trips. The adjusted distribution decreases the share of customers making one trip a year, and increases the share of customers in all other frequency categories. The dashed and solid lines represent cumulative frequency distributions of the fitted and adjusted frequency distributions.

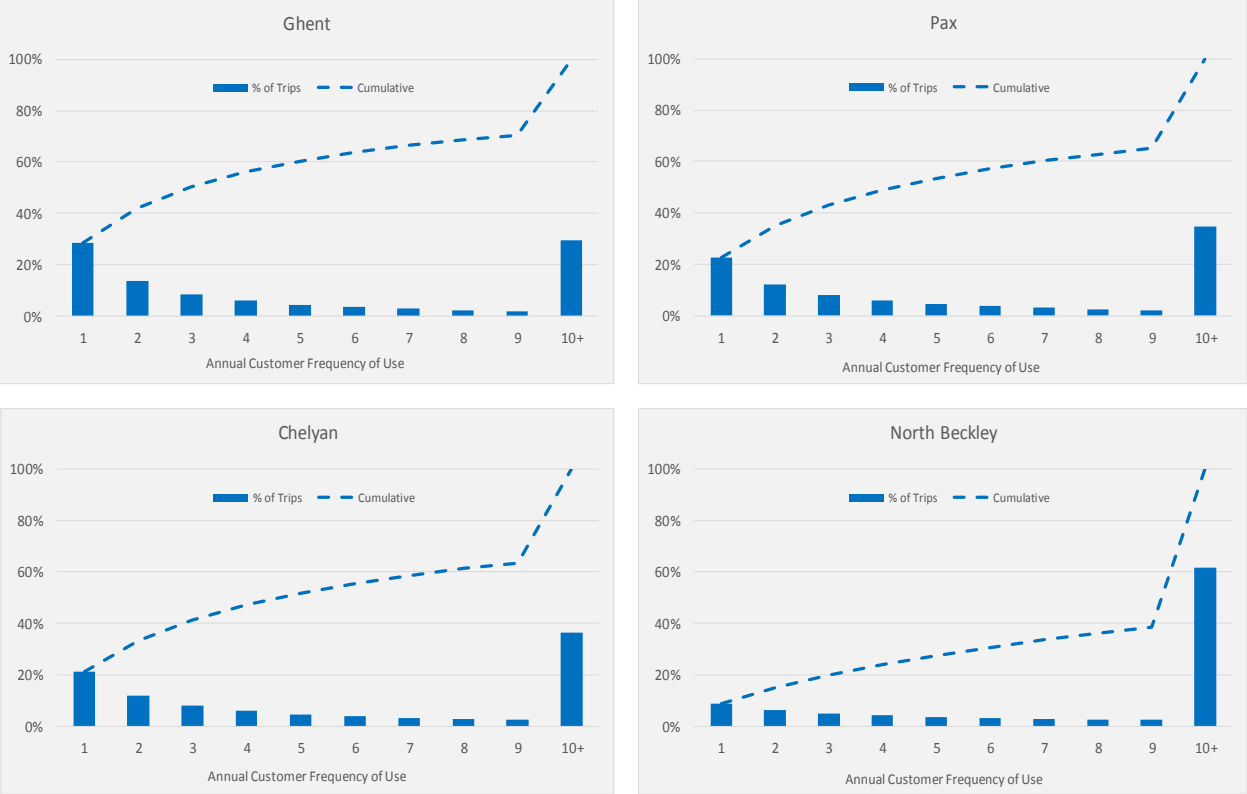
Figure 5-3 Annual Frequency of Use for All Payment Method Class 1 Customers



Source: StreetLight Data and CDM Smith Analysis

Figure 5-4 contains similar information for the number of transactions made by customers in each bin. So, while the number of customers in the ten or more trips per year bin is relatively low, they represent a much larger proportion of all transactions on the Turnpike, since they make more trips. Conversely, the proportion of customers in the one trip per year bin is very high, but together they pay a relatively smaller proportion of the toll transactions.

Figure 5-4 Annual Frequency of Use for All Payment Method Class 1 Transactions



Source: StreetLight Data and CDM Smith Analysis

5.3.4 Class 1 Proportion and Payment Shares

In addition to the Class 1 frequency of use modeling, changes in the share of Class 1 vehicles among Classes 1-4 needed to be determined since the Baseline forecast only breaks out to PCs (Classes 1-4) and CVs (Classes 5-10). It is expected that the proportion of transactions from each vehicle class on the Turnpike will slowly change due to changes in overall demand and vehicle fleet. However, based on 2012-2016 trends, changes in future year class shares are expected to be small. The proportion of Class 1 transactions among all passenger car transactions (Classes 1-4), which is currently around 97% to 98%, is assumed to decrease slightly over the forecast period. These levels are a basic input to the Class 1 model.

Payment shares by vehicle class are also expected to change over the forecast horizon as more customers use electronic toll collection. For the Baseline forecast (without toll policy changes) at the mainline plazas, the transaction cash share for Class 1 is assumed to decline from about 75% to 55%, while WV E-ZPass share is assumed to increase from about 15% to 20% and Non-WV E-ZPass is assumed to increase from about 10% to 25%. At North Beckley, Class 1 transaction cash share is assumed to drop from about 60% to 37%, WV E-ZPass share is assumed to increase from about 30% to 47%, and the share of Non-WV E-ZPass transactions is assumed to increase from 10% to 16%. These baseline levels are an input to the Class 1 model.

The proposed revised flat fee program will affect the Class 1 payment shares since, based on the SP survey and choice modeling results, participants in the program will draw from each payment type, but not proportionally. The payment choice model describes the way that customers will choose amongst the new set of payment options (flat fee program, cash, WV E-ZPass and Non-WV E-ZPass). The number of customers before and after the choice is the same. The number of trips is likewise conserved, except that there are some additions and other subtractions. Some customers will stop using the Turnpike; another set of customers will decide to join the revised flat fee program and make more trips because of the lower cost (toll induction); and a third set of customers will choose to continue paying toll but make fewer trips on the Turnpike because of the higher toll rate (toll suppression). The payment choice model describes customer behavior differently based on the original payment method and the frequency of use as described in Chapter 3. In general, customers who are more frequent users of the Turnpike across all payment methods are more likely to join the revised flat fee program. Customers who have a Non-WV E-ZPass are less likely to participate in the revised flat fee program.

Example scenarios are covered in the next section and describe the change in payment shares under these scenarios in more detail.

5.3.5 Class 1 Model Outputs

Class 1 forecasts were first computed by plaza, and then combined into systemwide results. Results were assembled for calendar years 2018, 2019, 2020, 2021, 2022, 2030, 2040 and 2050, and then interpolated to derive an annual stream of revenue from 2018 through 2050.

Model outputs include transactions broken down by payment type:

- Flat fee program transactions (no toll payment)
- Cash transactions
- WV E-ZPass transactions (not part of the revised flat fee program)
- Non-WV E-ZPass transactions

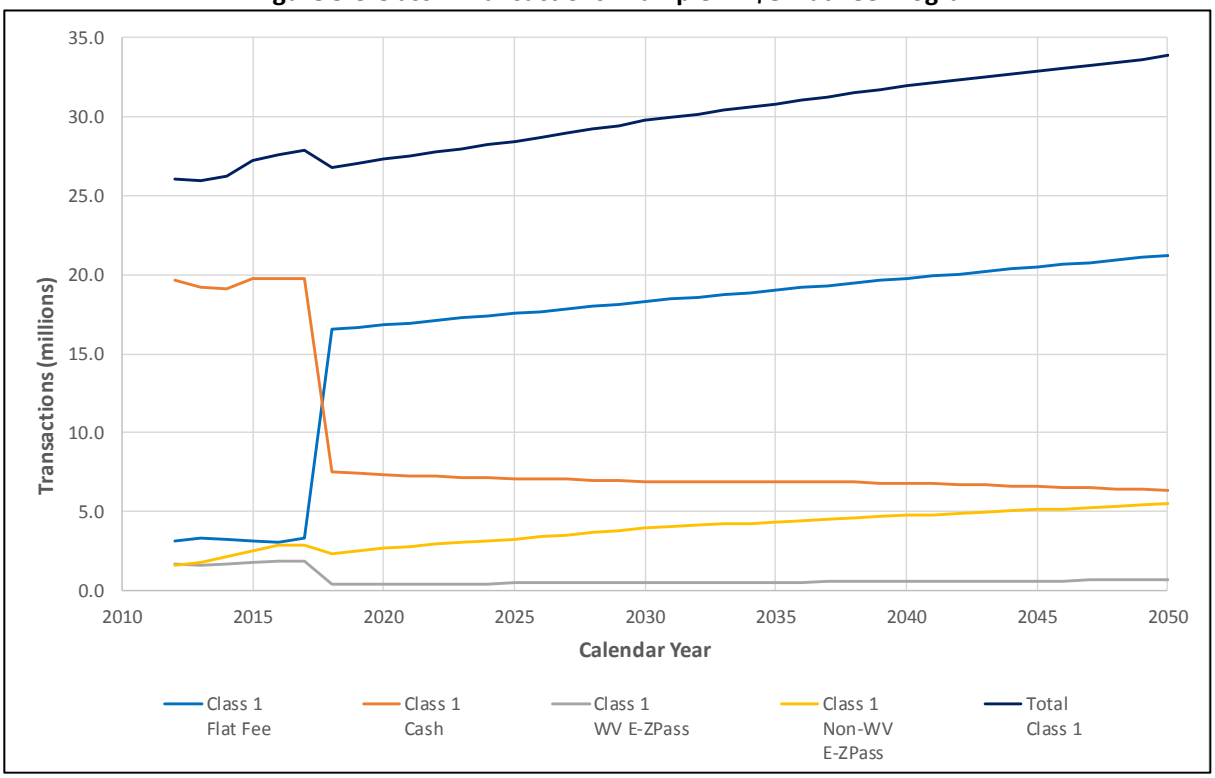
Similarly, revenue is broken down by flat fee program fees, and toll revenue by each payment type (cash, WV E-ZPass, and Non-WV E-ZPass).

To test the Class 1 model, two examples were set-up:

- Example 1: $8 flat fee program beginning in 2018
- Example 2: $25 flat fee program beginning in 2018

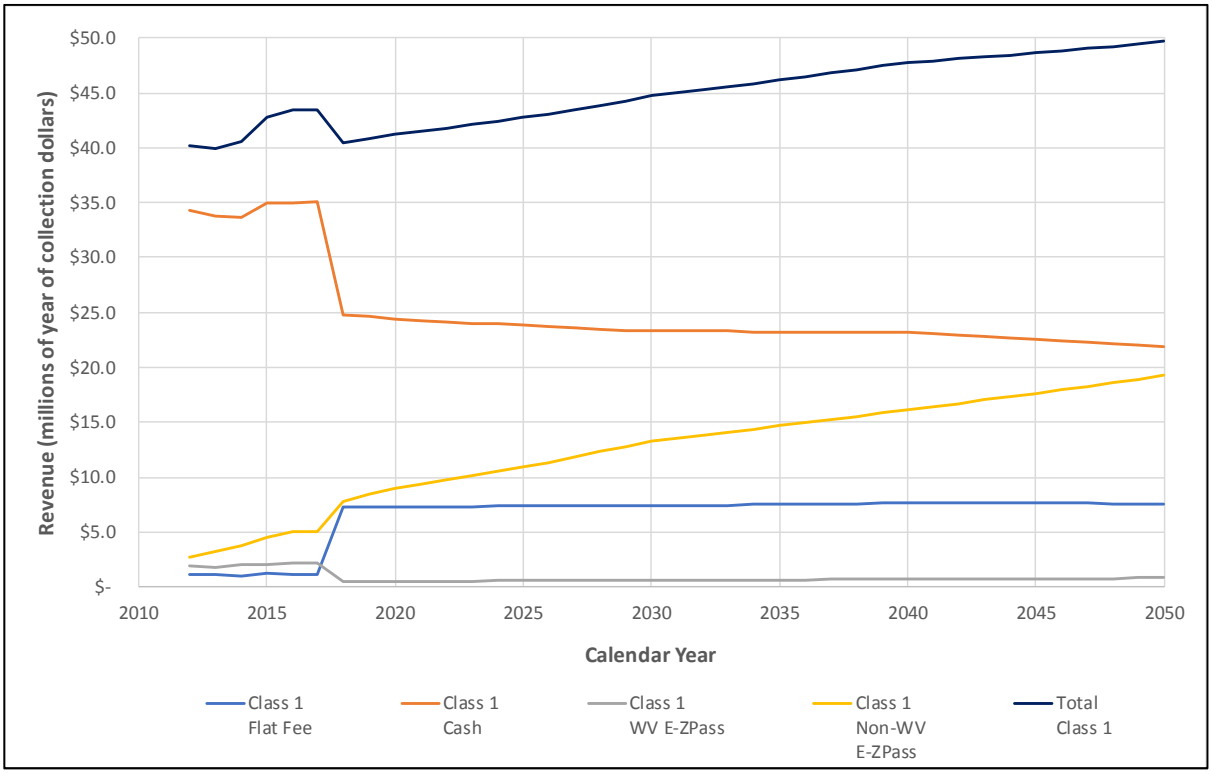
Common assumptions include the doubling of the existing Class 1 toll rate to $4.00 at mainline plazas and to $0.80 at North Beckley plaza for all customers not participating in flat fee program, a $13 issuance fee per WV E-ZPass transponder, and one vehicle per transponder in the revised flat fee program. **Figures 5-5** and **5-6** illustrate the Example 1 results.

Figure 5-5 Class 1 Transactions Example 1 - $8 Flat Fee Program



Source: CDM Smith Analysis

Figure 5-6 Class 1 Revenue Example 1 - $8 Flat Fee Program



Source: CDM Smith Analysis

Example 1 helps explain the behavior of Class 1 customers. Prior to the toll increase and revised flat fee program, cash transactions make up the major share of Class 1 transactions, and the other three payment types are much smaller shares. Flat-fee transactions prior to 2018 refer to those participating in the existing flat fee program (Personal Discount Plan 1 described earlier). After the toll policy changes, flat fee program participation is expected to rise dramatically as shown in Figure 5-5, while cash payments drop dramatically. Under the revised program, the flat-fee transactions travel without paying toll. However, the flat fee program also affects WV E-ZPass and Non-WV E-ZPass customers, with both decreasing. Over the long term, most of the growth in transactions is concentrated in the flat fee program and some growth in the Non-WV E-ZPass transactions.

In terms of revenue, current flat fee program revenue is roughly $1.2M per year and the revised flat fee program revenue is expected to be about $7.4M per year. The change is not as dramatic as it is in transactions since the flat fee program allows participants unlimited travel for a relatively low annual fee. A reduction in WV E-ZPass revenue is seen due to most of them entering the flat fee program. Non-WV E-ZPass revenue rises due to the large toll increase, despite the decrease in transactions for this group. Over time, flat fee revenue does not change much. However, Non-WV E-ZPass revenue increases through natural growth. It is interesting to note that initially the estimates indicate a reduction in both Class 1 transactions and revenue.

5.3.6 Class 1 Details for Example 1

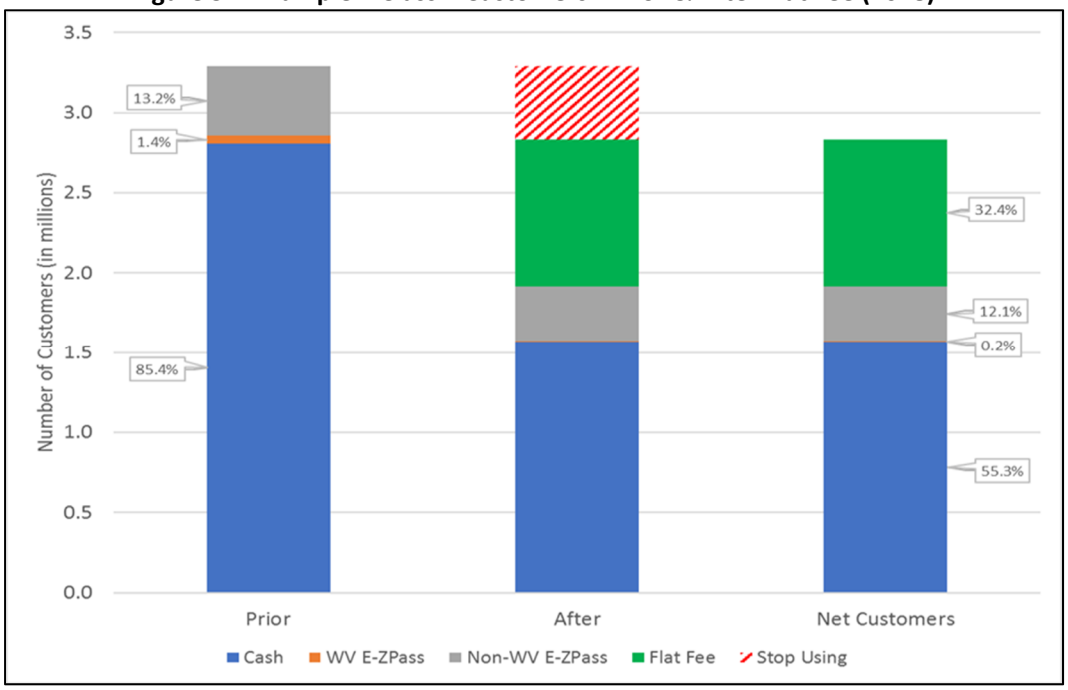
This section provides additional details about transaction and revenue estimates for calendar year 2018, focusing on customer choices following the implementation of the revised flat fee program. All the information presented in this section is related to Example 1, but illustrates how the payment choice model describes Class 1 customer behavior under the new proposed toll policies.

Prior and After Flat Fee Program

Figures 5-7 and **5-8** illustrate the resulting payment choices, in terms of the number of customers and transactions. In both figures, "prior" and "after" describe conditions without and with the proposed flat fee program. The statistics for the "prior" condition come from the Baseline forecast and the statistics from the "after" condition come from the Class 1 model.

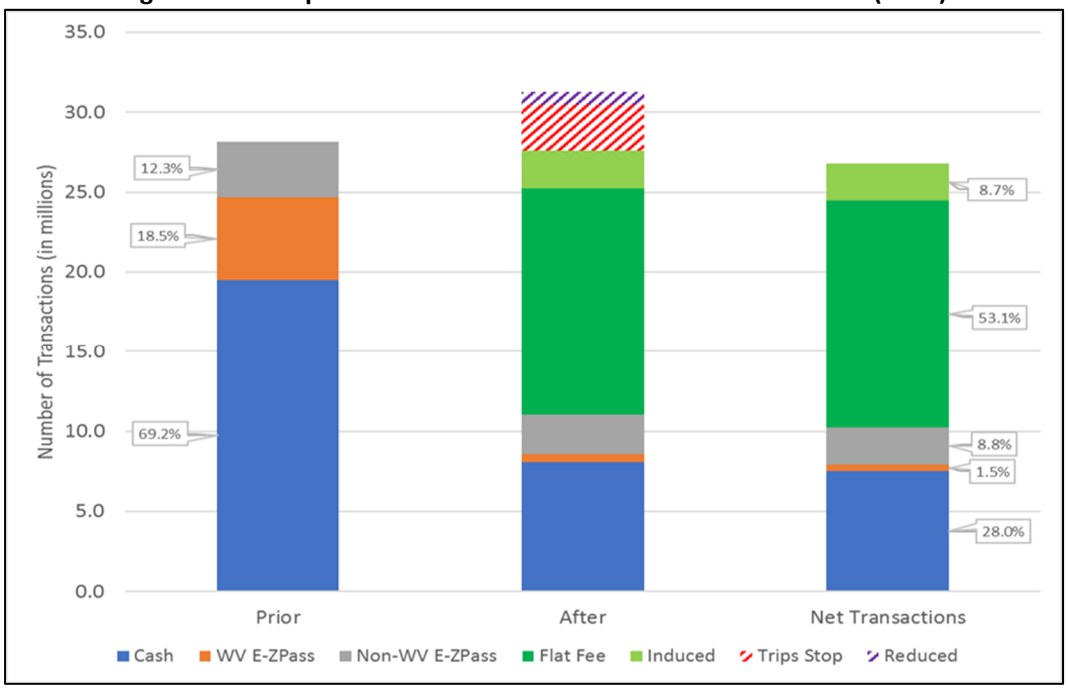
Figure 5-7 shows that under "prior" conditions, most Class 1 customers opt for paying cash (about 85%), 13% use Non-WV E-ZPass, and about 1% use WV E-ZPass transponders. After the introduction of the flat fee program, about 32% of the remaining customers join the flat fee program (in green), and the rest pay higher tolls. About 55% of the customers pay cash (blue), and 12% are Non-WV E-ZPass customers (gray). These are typically infrequent users and out-of-state customers. The WV E-ZPass toll-paying customers almost disappear since they are extremely likely to enter the flat fee program. Some customers are forecasted to stop using the Turnpike due to the higher tolls implemented for all methods of payments that are not the flat fee program, resulting in a 14% decrease in the net number of customers (in hatched red). Including those customers who stop using the Turnpike, the number of customers "prior" and "after" are identical at each plaza.

Figure 5-7 Example 1 Class 1 Customers - Prior & After Flat Fee (2018)



Source: CDM Smith Analysis

Figure 5-8 Example 1 Class 1 Transactions - Prior & After Flat Fee (2018)



Source: CDM Smith Analysis

Figure 5-8 contains similar information in terms of number of transactions. Prior to the implementation of the flat fee program, 69% of Class 1 transactions are paid by cash, 19% are WV E-ZPass and 12% are Non-WV E-ZPass. Customers paying with cash are relatively infrequent travelers. Customers using the WV E-ZPass to pay tolls are typically more frequent users of the Turnpike.

The bar representing the "After" flat fee condition includes transactions that no longer occur either due to customers eliminating their use of the Turnpike (in hatched red) or reducing their number of trips (in hatched purple). All transactions shown in green are made within the flat fee program; the induced trips corresponding to increased trip-making because there is no incremental cost after paying the flat fee, are shown in lighter green. Transactions made by customers in the flat fee program have the annual fee per customer but no toll revenue.

After the revised flat fee program is implemented, there is a 5% net decrease in total number of transactions. The flat fee transactions account for the highest share (62% including induced trips) of Class 1 transactions. These transactions do not pay a toll, as these customers have already paid the flat fee. Cash represents 28% of the transactions. About 1% of the trips are paid using WV E-ZPass and 9% are paid using Non-WV E-ZPass.

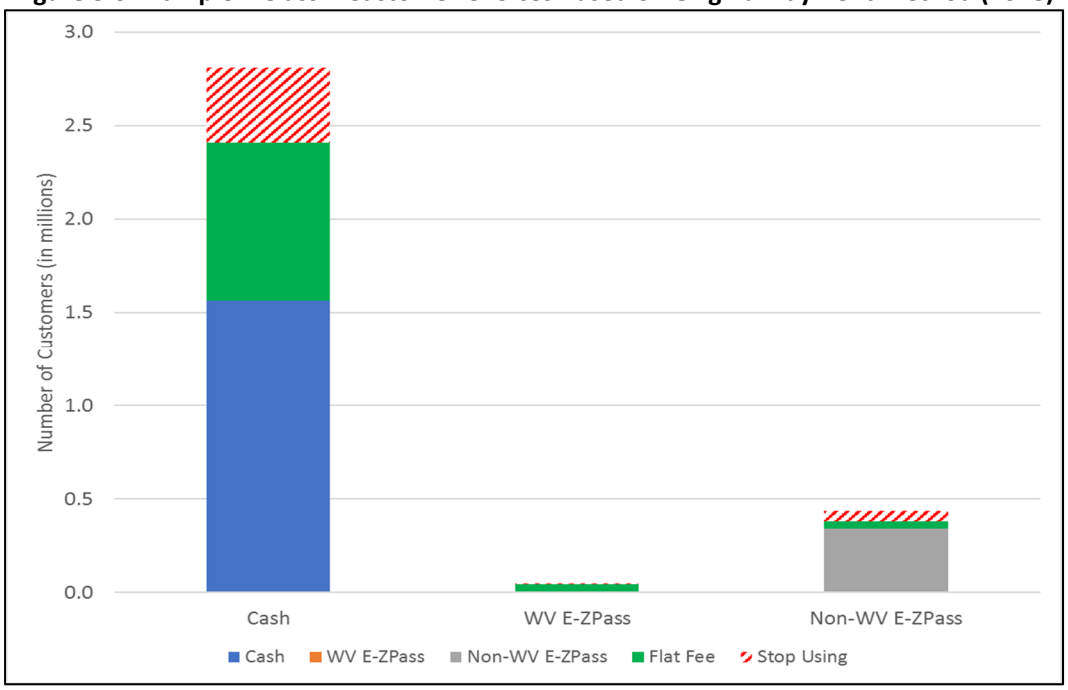
Choices Based on Original Payment Method

Figures 5-9 and **5-10** further depict results regarding payment choices, in terms of the number of customers and the number of transactions respectively. In both figures, customers or transactions are organized based on their original payment methods, i.e. prior to application of the revised flat fee program. These are cash, WV E-ZPass, and Non-WV E-ZPass.

Figure 5-9 illustrates customer choices of payment method "after" the revised flat fee program is introduced based on their original payment choice. It shows that among customers that originally paid cash, most customers continue to pay cash (56% shown in blue), a significant portion opt for the flat fee program (30% in green), and a significant number of customers stop using the Turnpike after the introduction of doubled toll rates (14% in hatched red). Among WV E-ZPass customers, a relatively small number to start, most opt for the revised flat fee program (83%), a significant portion continue to pay toll using WV E-ZPass (12%), and some customers stop using the Turnpike (5%). Among Non-WV E-ZPass customers, a relatively small portion opt for the revised flat fee program (9%), but the majority continue to pay tolls with their Non-WV E-ZPass (79%), and a sizable portion of customers stop using the Turnpike altogether (12%). These results make sense because customers using WV E-ZPass tend to be relatively frequent users and customers using Non-WV E-ZPass are generally infrequent users of the Turnpike.

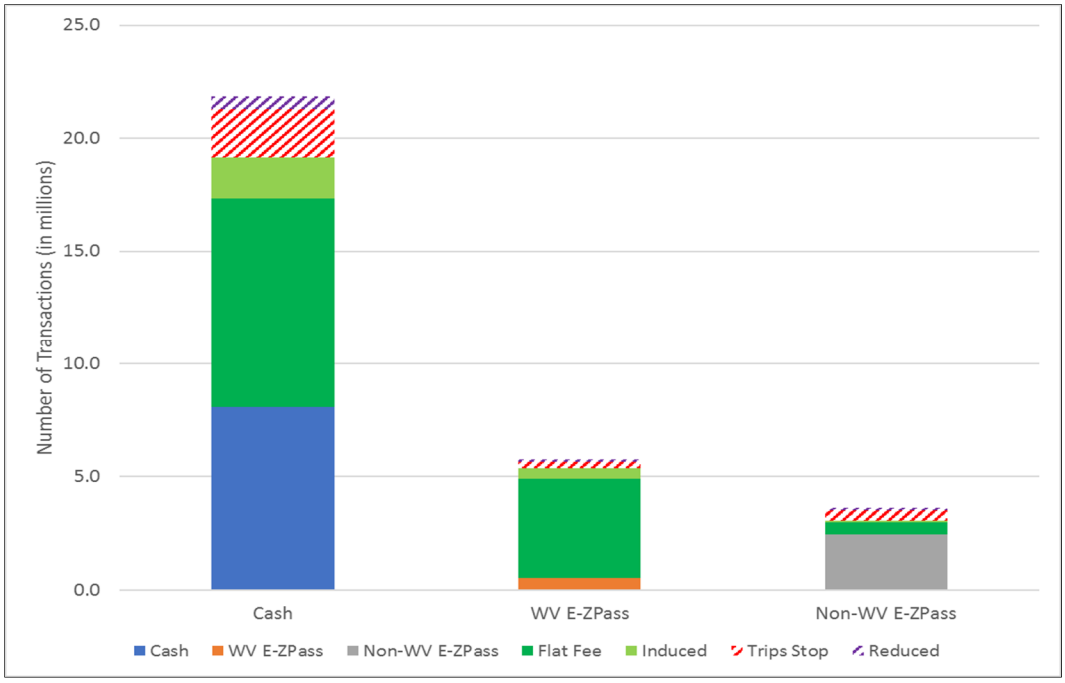
Figure 5-10 presents similar information in terms of number of transactions. Among transactions that would have been paid in cash before the revised flat fee program is applied, there would be about 9% additional trips induced due to customers switching to the flat fee program. The toll increase causes other customers to stop using the Turnpike reducing transactions by 11%. In addition, those who continue to pay tolls reduce their total number of trips by another 3%. The net effect is a reduction of about 5% of the original cash paying trips. Of the remaining original cash trips, about 40% are paid with cash and 60% are paid with the flat fee program.

Figure 5-9 Example 1 Class 1 Customer Choices Based on Original Payment Method (2018)



Source: CDM Smith Analysis

Figure 5-10 Example 1 Class 1 Transactions - By Original Payment Method (2018)



Source: CDM Smith Analysis

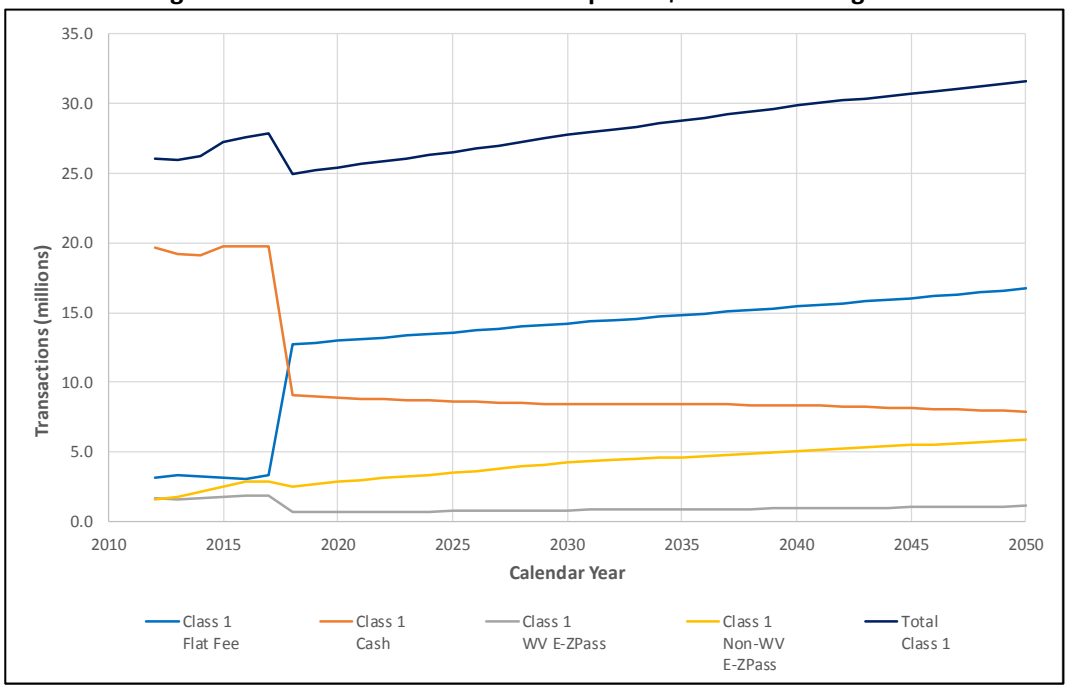
Among transactions that would have been paid by WV E-ZPass before the revised flat fee program, there would be induced trips due to customers switching to the flat fee program of about 8% additional transactions. The toll increase causes other customers to stop using the Turnpike reducing transactions by 6%. In addition, those who continue to pay tolls reduce their total number of trips by another 2%. The net effect is just about no change in transactions from WV E-ZPass. Of the remaining original WV E-ZPass trips, about 8% are paid with WV E-ZPass and 92% are paid with the flat fee program. Once again, customers paying tolls with a WV E-ZPass are generally frequent users of the Turnpike.

Finally, among transactions that would originally be paid by Non-WV E-ZPass before offering the revised flat fee program, there would be induced trips due to customers switching to the flat fee program of about 2% additional transactions. The toll increase causes other customers to stop using the Turnpike reducing transactions by 14%. In addition, those who continue to pay tolls reduce their total number of trips by another 3%. The net effect is a reduction of about 15% in transactions from Non-WV E-ZPass. Of the remaining original Non-WV E-ZPass trips, about 79% are paid with Non-WV E-ZPass and 21% actually shift to the flat fee program. Most customers paying tolls with a Non-WV E-ZPass are infrequent users of the Turnpike.

Example 2 has similar results to Example 1, but since the annual fee is higher (at $25) fewer customers choose the flat fee program. **Figures 5-11** and **5-12** illustrate the expected effect on transactions and revenue.

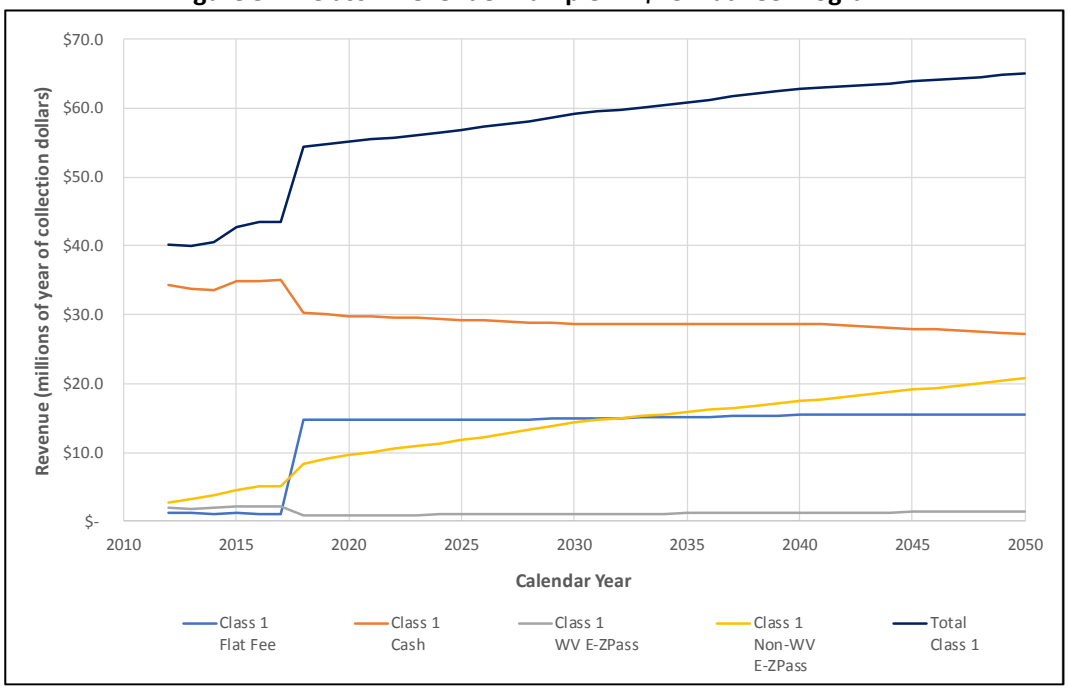
Figure 5-11 shows the conversion to the flat fee program is still strong, but not as strong as Example 1. Because of the higher annual fee, more customers continue to pay with Cash, WV E-ZPass, and Non-WV E-ZPass in Example 2. Overall transactions are somewhat lower. However, the flat fee revenue as shown in Figure 5-12 is nearly double what it is in Example 1 due to the much higher flat fee. Also, revenue from the other three payment types is higher since fewer people enter the flat fee program and they pay the higher tolls.

Figure 5-11 Class 1 Transactions Example 2 - $25 Flat Fee Program



Source: CDM Smith Analysis

Figure 5-12 Class 1 Revenue Example 2 - $25 Flat Fee Program

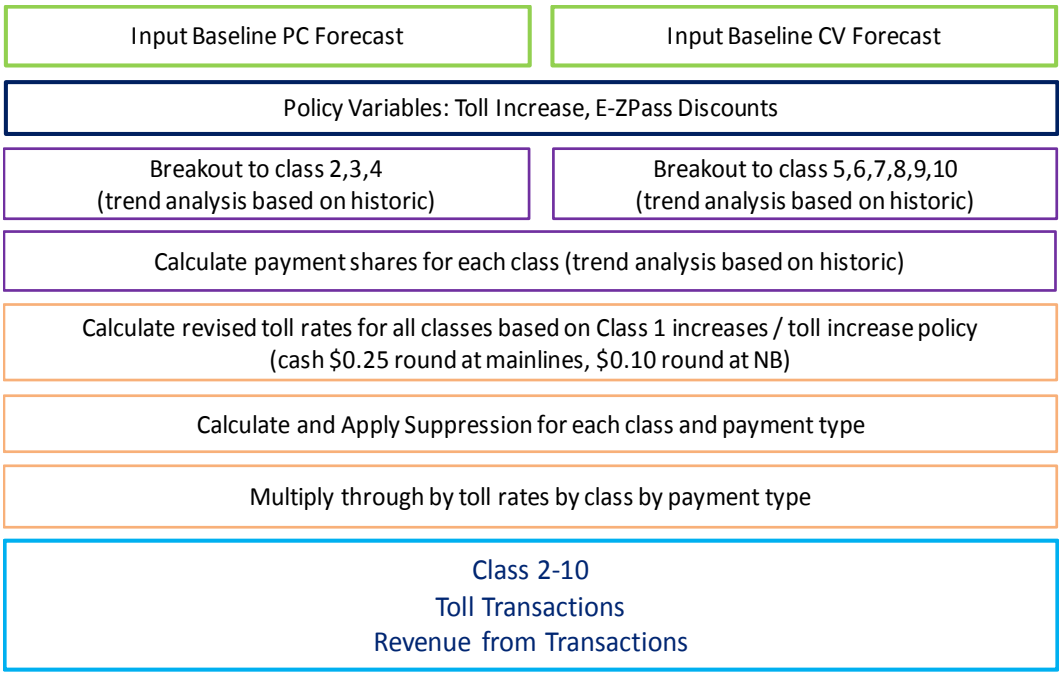


Source: CDM Smith Analysis

5.4 Classes 2-10 Forecasting Approach

The Classes 2-10 forecasting approach is illustrated on **Figure 5-13**.

Figure 5-13 Classes 2-10 Forecasting Approach



The econometric model provided the Baseline forecast for PCs (Classes 1-4) and CVs (Classes 5-10), assuming no changes in current toll rate policies. The review of historical transactions on the Turnpike provided details about trends regarding vehicle class and payment method at each plaza. These historic trends on the Turnpike, combined with general industry trends, were used to prepare projections of anticipated class and payment shares at each plaza for the forecast horizon.

As noted earlier, the share of Class 1 transactions as a proportion of Classes 1-4 transactions is expected to change very little, and thus the share of Classes 2-4 is assumed to change very little over time. The proportion of Class 8 transactions (5 axle semi-trailer truck) among CV transactions which is currently around 85%, is assumed to decline by 2% to 3% at the mainline plazas over the forecast horizon. At North Beckley, this share is assumed to increase from about 75% today to 80% in the outer years of the forecast.

In terms of payment shares, Classes 2-4 customers paying with cash is assumed to drop from about 90% to 85%, while WV E-ZPass share remains at 4% throughout, and the Non-WV E-ZPass share is expected to increase from 6% to 11%. The cash share of CV transactions is assumed to drop from about 25% to 12%, while WV E-ZPass share is assumed to drop from about 15% to 12%, and Non-WV E-ZPass is assumed to increase from 60% to 76%.

For Classes 2-10, a toll rate elasticity was used to estimate customer response to higher toll rates, resulting in fewer transactions. The elasticity estimate for the Class 2-10 model was based, in part, on a review of historical Turnpike transaction trends following the last toll rate increase. Current toll rates and discount plans became effective on August 1, 2009. The Class 1 tolls at mainline plazas increased from $1.25 to $2.00 for cash customers (a 60% increase). Rates for all classes of commercial vehicles also increased by approximately 60%. With the introduction of the commercial discount programs, WV E-ZPass commercial account holders received a 20% relative savings, and Non-WV E-ZPass holders received a 13% relative savings from the new toll rate. Because the new rate became effective in the middle of the year, results of this increase appeared in two fiscal years (2009 and 2010). The increases in annual toll revenue were pronounced. Annual transactions, however, actually increased in each of these two years. (See Chapter 2 for additional detail.)

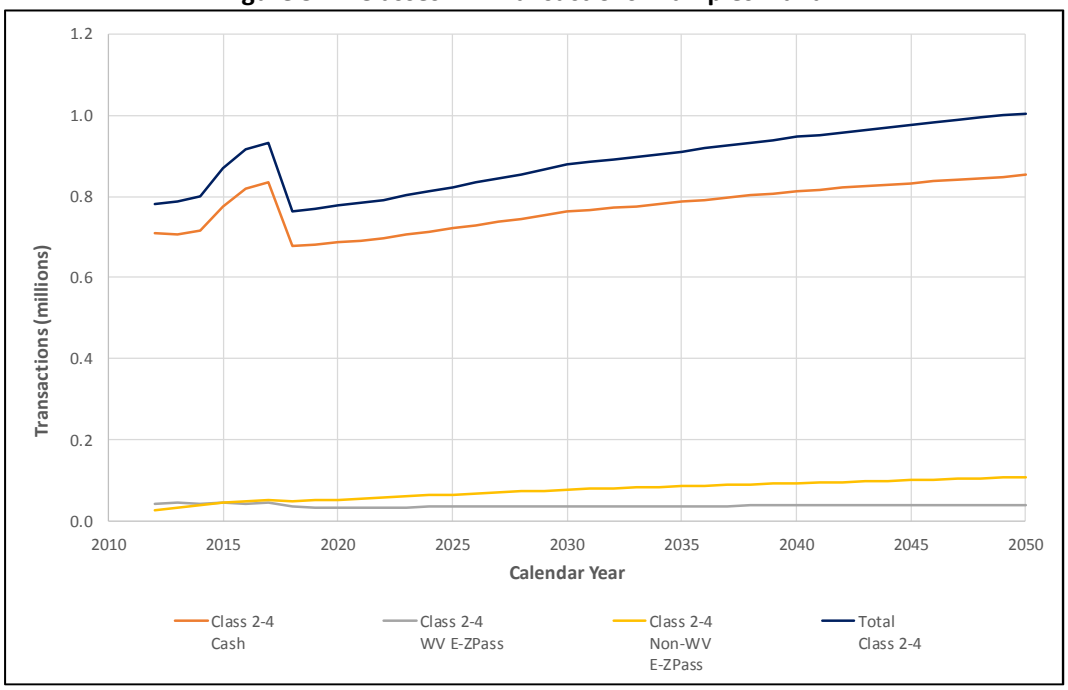
The econometric analysis was used (with effective toll rates as an explanatory variable) to help estimate the effect of toll changes on historical transactions. While only statistically significant for commercial vehicles at two of the mainline plazas, a toll elasticity could be approximately determined from the historical toll rate and transaction patterns. Based on model coefficients, the historical commercial vehicle toll rate elasticity was estimated to be -0.156 for the 2009 increase.

The toll rate increase to be tested for this forecast was expected to be higher than the increase in 2009, and likely near 100%, i.e., a doubling of toll rate. It was thus assumed a higher elasticity than that proxied by the econometric model for the historical increases should be applied. The toll rate elasticity was adjusted to account for the difference, with an assumed elasticity of -0.196 applied in forecasting.

Note that when testing alternative toll rates, cash rates at mainline plazas were always rounded to the $0.25, while North Beckley cash rates were rounded to $0.10. E-ZPass toll rates are rounded to the $0.01.

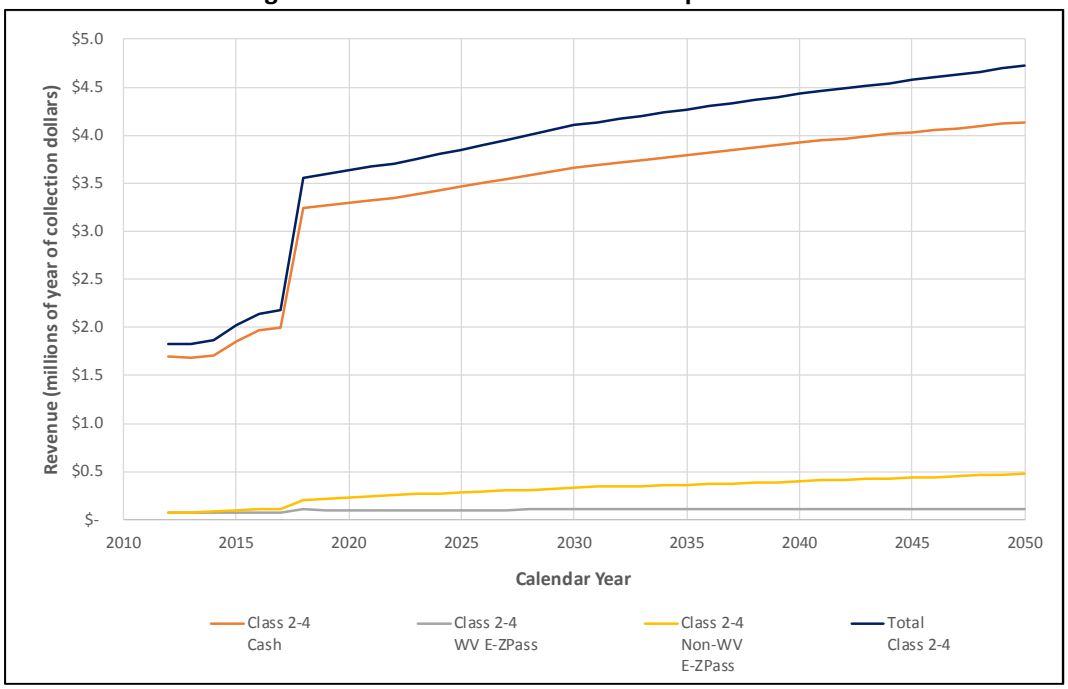
For the two examples described earlier in this chapter, Classes 2-10 toll rates are the same for Example 1 and 2, essentially representing a doubling of the toll rates from current policy. **Figures 5-14** and **5-15** represent the results for Classes 2-4 total transactions and revenue respectively.

Figure 5-14 Classes 2-4 Transactions Examples 1 and 2



Source: CDM Smith Analysis

Figure 5-15 Classes 2-4 Revenue Examples 1 and 2

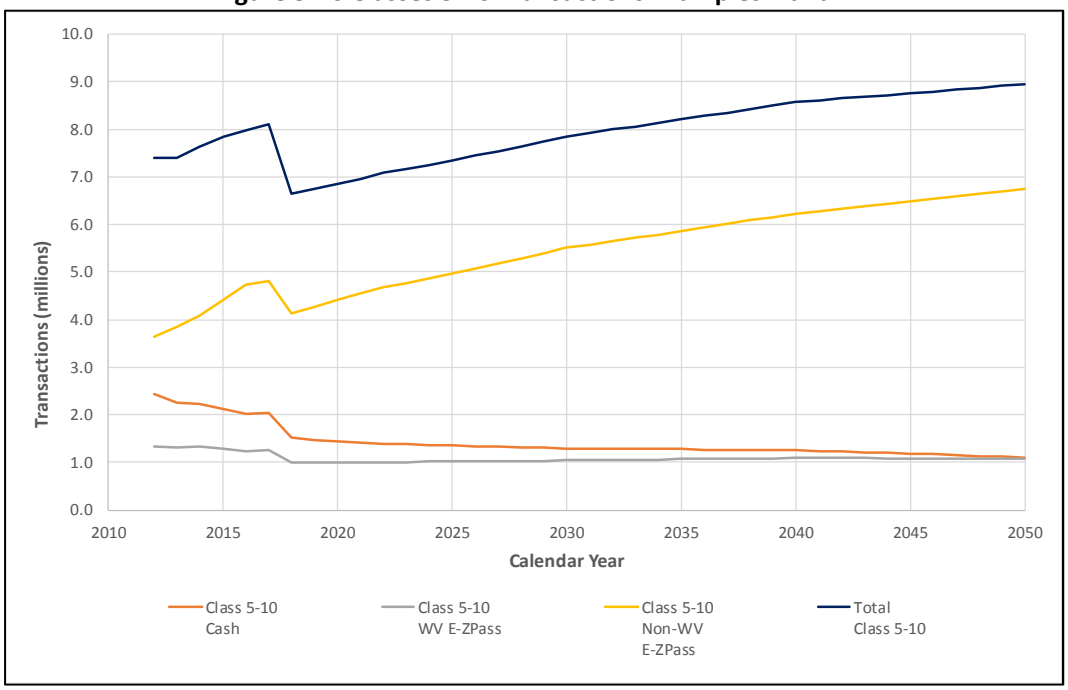


Source: CDM Smith Analysis

In both Examples 1 and 2, the Classes 2-4 transactions decrease significantly after the toll increase, but continue to grow over time eventually exceeding the levels prior to the toll rate increase. Revenue increases significantly due to the toll increase and grows over time.

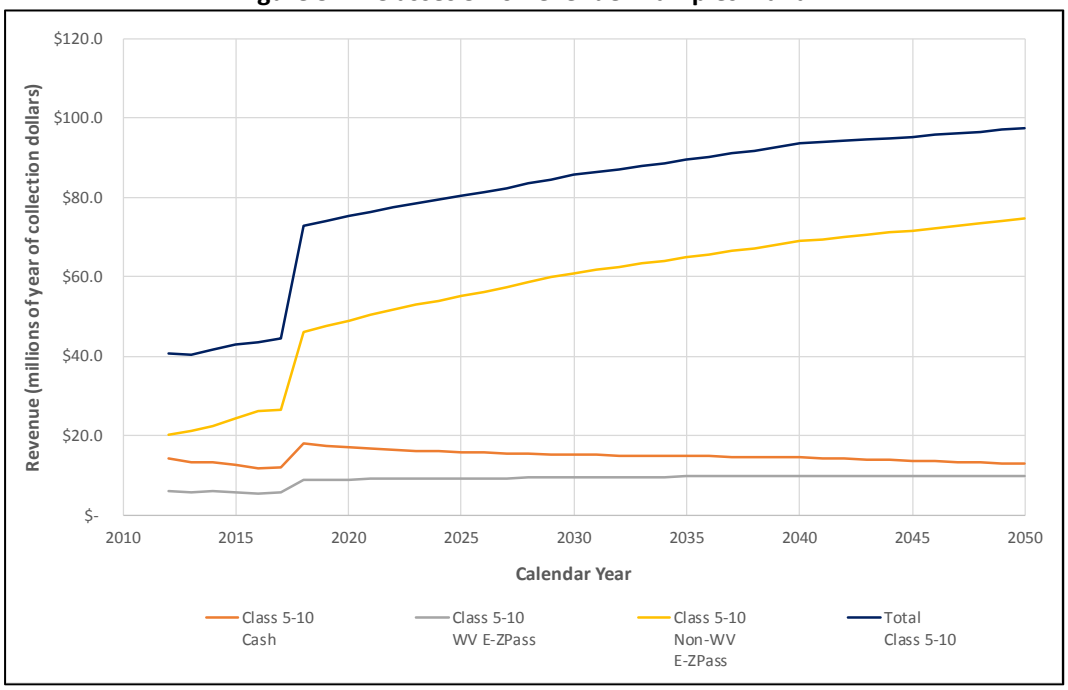
The results for Classes 5-10 are shown in **Figures 5-16** and **5-17**. The trends are similar in that the large toll increase in 2018 causes a significant drop in transactions which eventually recovers and grows above the levels prior to the toll rate increase. Annual revenue has an initial step up followed by slow but continuous growth over time. It is interesting to note that both cash transactions and revenue slowly decrease over time, due to the forecasted shift away from cash towards electronic toll collection, especially to Non-WV E-ZPass.

Figure 5-16 Classes 5-10 Transactions Examples 1 and 2



Source: CDM Smith Analysis

Figure 5-17 Classes 5-10 Revenue Examples 1 and 2



Source: CDM Smith Analysis

5.5 T&R Forecasts for Examples 1 and 2

Combining the results from Class 1 and Classes 2-10 models, results for Examples 1 and 2 were compiled to understand overall implications of the toll policies.

As noted above, several policy variables remain unchanged across the examples. The one-time issuance cost to enter the revised flat fee program (cost to issue the WV E-ZPass transponder) was set to $13 and the amount collected was assumed to exactly offset the issuance costs and is not included in the revenue. Only one vehicle can be registered with each E-ZPass account in the revised flat fee program for all alternatives. The flat fee program was assumed to start on January 1, 2018 for Examples 1 and 2.

The policy variables that differ across alternatives is the flat fee program annual amount:

Example 1 assumes an $8 Class 1 revised flat fee program.

Example 2 assumes a $25 Class 1 revised flat fee program.

The toll rates for Class 1 customers not choosing the flat fee program and all other customers would double. **Tables 5-1** and **5-2** provide the results of the two examples.

Existing conditions indicated about 76% of all transactions are Class 1 vehicles. Classes 2-4 vehicles make up about 2%, and Classes 5-10 the remaining 22%. Under Example 1, Class 1 transactions increase to about 78% of all transactions, and Classes 5-10 drop back to about 20% of all transactions. Existing revenue is about 49% from Class 1 transactions, 2% from Classes 2-4 transactions, and 49% from Classes 5-10 transactions.

Table 5-1 Example 1 ($8 flat fee program, 100% toll increase) Results

Calendar Year	Toll Transactions (millions)					Revenue (millions year of collection dollars)				
	Class 1 Flat Fee	Class 1 Tolled	Class 2-4 Tolled	Class 5-10 (CV) Tolled	Total Trans w/flat fee	Class 1 Flat Fee	Class 1 Tolled	Class 2-4 Tolled	Class 5-10 (CV) Tolled	Total Revenue w/flat fee
2012 (1)	3.16	22.86	0.78	7.40	**34.20**	$ 1.18	$ 39.02	$ 1.83	$ 40.67	**$ 82.70**
2013 (1)	3.30	22.63	0.79	7.40	**34.12**	$ 1.17	$ 38.79	$ 1.83	$ 40.41	**$ 82.20**
2014 (1)	3.23	22.99	0.80	7.64	**34.66**	$ 1.06	$ 39.51	$ 1.87	$ 41.79	**$ 84.23**
2015 (1)	3.13	24.11	0.87	7.84	**35.95**	$ 1.23	$ 41.53	$ 2.03	$ 42.81	**$ 87.60**
2016 (1)	3.09	24.50	0.92	7.98	**36.49**	$ 1.15	$ 42.24	$ 2.14	$ 43.46	**$ 88.99**
2017 (2)	3.31	24.55	0.93	8.11	**36.90**	$ 1.13	$ 42.37	$ 2.18	$ 44.33	**$ 90.01**
2018 (3)	16.54	10.26	0.76	6.64	**34.20**	$ 7.35	$ 33.13	$ 3.56	$ 72.91	**$ 116.95**
2019	16.68	10.37	0.77	6.75	**34.57**	$ 7.34	$ 33.53	$ 3.60	$ 74.06	**$ 118.53**
2020	16.82	10.48	0.78	6.86	**34.94**	$ 7.33	$ 33.91	$ 3.63	$ 75.18	**$ 120.05**
2021	16.96	10.55	0.78	6.97	**35.26**	$ 7.34	$ 34.17	$ 3.67	$ 76.30	**$ 121.48**
2022	17.11	10.63	0.79	7.08	**35.61**	$ 7.35	$ 34.44	$ 3.71	$ 77.42	**$ 122.92**
2023	17.25	10.71	0.80	7.16	**35.92**	$ 7.35	$ 34.74	$ 3.75	$ 78.36	**$ 124.20**
2024	17.40	10.80	0.81	7.26	**36.27**	$ 7.36	$ 35.04	$ 3.80	$ 79.31	**$ 125.51**
2025	17.55	10.89	0.82	7.35	**36.61**	$ 7.37	$ 35.37	$ 3.85	$ 80.30	**$ 126.89**
2026	17.70	10.98	0.83	7.45	**36.96**	$ 7.38	$ 35.71	$ 3.90	$ 81.30	**$ 128.29**
2027	17.85	11.09	0.84	7.54	**37.32**	$ 7.39	$ 36.08	$ 3.95	$ 82.34	**$ 129.76**
2028	18.00	11.19	0.85	7.64	**37.68**	$ 7.40	$ 36.46	$ 4.00	$ 83.39	**$ 131.25**
2029	18.16	11.31	0.87	7.75	**38.09**	$ 7.40	$ 36.86	$ 4.05	$ 84.48	**$ 132.79**
2030	18.31	11.43	0.88	7.85	**38.47**	$ 7.41	$ 37.28	$ 4.10	$ 85.59	**$ 134.38**
2031	18.45	11.50	0.88	7.92	**38.75**	$ 7.44	$ 37.54	$ 4.13	$ 86.33	**$ 135.44**
2032	18.60	11.57	0.89	7.99	**39.05**	$ 7.46	$ 37.80	$ 4.17	$ 87.08	**$ 136.51**
2033	18.74	11.64	0.90	8.06	**39.34**	$ 7.48	$ 38.07	$ 4.20	$ 87.84	**$ 137.59**
2034	18.89	11.72	0.90	8.13	**39.64**	$ 7.51	$ 38.35	$ 4.23	$ 88.62	**$ 138.71**
2035	19.04	11.79	0.91	8.21	**39.95**	$ 7.53	$ 38.63	$ 4.26	$ 89.40	**$ 139.82**
2036	19.18	11.87	0.92	8.28	**40.25**	$ 7.55	$ 38.91	$ 4.30	$ 90.19	**$ 140.95**
2037	19.33	11.95	0.92	8.35	**40.55**	$ 7.58	$ 39.20	$ 4.33	$ 90.99	**$ 142.10**
2038	19.48	12.03	0.93	8.43	**40.87**	$ 7.60	$ 39.50	$ 4.37	$ 91.80	**$ 143.27**
2039	19.64	12.11	0.94	8.50	**41.19**	$ 7.62	$ 39.80	$ 4.40	$ 92.63	**$ 144.45**
2040	19.79	12.19	0.95	8.58	**41.51**	$ 7.65	$ 40.11	$ 4.43	$ 93.46	**$ 145.65**
2041	19.93	12.23	0.95	8.62	**41.73**	$ 7.64	$ 40.28	$ 4.46	$ 93.82	**$ 146.20**
2042	20.07	12.26	0.96	8.65	**41.94**	$ 7.64	$ 40.45	$ 4.49	$ 94.19	**$ 146.77**
2043	20.21	12.30	0.96	8.68	**42.15**	$ 7.63	$ 40.62	$ 4.52	$ 94.56	**$ 147.33**
2044	20.36	12.34	0.97	8.72	**42.39**	$ 7.63	$ 40.81	$ 4.55	$ 94.94	**$ 147.93**
2045	20.50	12.38	0.97	8.76	**42.61**	$ 7.63	$ 41.00	$ 4.57	$ 95.33	**$ 148.53**
2046	20.65	12.42	0.98	8.79	**42.84**	$ 7.62	$ 41.20	$ 4.60	$ 95.72	**$ 149.14**
2047	20.80	12.47	0.99	8.83	**43.09**	$ 7.62	$ 41.40	$ 4.63	$ 96.12	**$ 149.77**
2048	20.94	12.51	0.99	8.87	**43.31**	$ 7.61	$ 41.62	$ 4.66	$ 96.53	**$ 150.42**
2049	21.09	12.56	1.00	8.91	**43.56**	$ 7.61	$ 41.83	$ 4.69	$ 96.94	**$ 151.07**
2050	21.24	12.61	1.00	8.95	**43.80**	$ 7.61	$ 42.06	$ 4.72	$ 97.36	**$ 151.75**

(1) 2012-2016: Actual values
(2) 2017: Estimated values subject to change
(3) 2019: Toll rates double, flat fee is $8 per year
Source: CDM Smith Aanalysis

Table 5-2 Example 2 ($25 flat fee program, 100% toll increase) Results

Calendar Year	Toll Transactions (millions)					Revenue (millions year of collection dollars)				
	Class 1 Flat Fee	Class 1 Tolled	Class 2-4 Tolled	Class 5-10 (CV) Tolled	Total Trans w/flat fee	Class 1 Flat Fee	Class 1 Tolled	Class 2-4 Tolled	Class 5-10 (CV) Tolled	Total Revenue w/flat fee
2012 (1)	3.16	22.86	0.78	7.40	**34.20**	$ 1.18	$ 39.02	$ 1.83	$ 40.67	**$ 82.70**
2013 (1)	3.30	22.63	0.79	7.40	**34.12**	$ 1.17	$ 38.79	$ 1.83	$ 40.41	**$ 82.20**
2014 (1)	3.23	22.99	0.80	7.64	**34.66**	$ 1.06	$ 39.51	$ 1.87	$ 41.79	**$ 84.23**
2015 (1)	3.13	24.11	0.87	7.84	**35.95**	$ 1.23	$ 41.53	$ 2.03	$ 42.81	**$ 87.60**
2016 (1)	3.09	24.50	0.92	7.98	**36.49**	$ 1.15	$ 42.24	$ 2.14	$ 43.46	**$ 88.99**
2017 (2)	3.31	24.55	0.93	8.11	**36.90**	$ 1.13	$ 42.37	$ 2.18	$ 44.33	**$ 90.01**
2018 (3)	12.74	12.22	0.76	6.64	**32.36**	$ 14.71	$ 39.63	$ 3.56	$ 72.91	**$ 130.81**
2019	12.86	12.35	0.77	6.75	**32.73**	$ 14.69	$ 40.06	$ 3.60	$ 74.06	**$ 132.41**
2020	12.98	12.47	0.78	6.86	**33.09**	$ 14.68	$ 40.47	$ 3.63	$ 75.18	**$ 133.96**
2021	13.10	12.55	0.78	6.97	**33.40**	$ 14.71	$ 40.76	$ 3.67	$ 76.30	**$ 135.44**
2022	13.22	12.64	0.79	7.08	**33.73**	$ 14.73	$ 41.06	$ 3.71	$ 77.42	**$ 136.92**
2023	13.34	12.73	0.80	7.16	**34.03**	$ 14.75	$ 41.39	$ 3.75	$ 78.36	**$ 138.25**
2024	13.46	12.83	0.81	7.26	**34.36**	$ 14.77	$ 41.73	$ 3.80	$ 79.31	**$ 139.61**
2025	13.59	12.93	0.82	7.35	**34.69**	$ 14.79	$ 42.09	$ 3.85	$ 80.30	**$ 141.03**
2026	13.71	13.04	0.83	7.45	**35.03**	$ 14.82	$ 42.47	$ 3.90	$ 81.30	**$ 142.49**
2027	13.84	13.15	0.84	7.54	**35.37**	$ 14.84	$ 42.87	$ 3.95	$ 82.34	**$ 144.00**
2028	13.97	13.28	0.85	7.64	**35.74**	$ 14.86	$ 43.29	$ 4.00	$ 83.39	**$ 145.54**
2029	14.10	13.40	0.87	7.75	**36.12**	$ 14.88	$ 43.73	$ 4.05	$ 84.48	**$ 147.14**
2030	14.23	13.54	0.88	7.85	**36.50**	$ 14.91	$ 44.20	$ 4.10	$ 85.59	**$ 148.80**
2031	14.34	13.62	0.88	7.92	**36.76**	$ 14.96	$ 44.49	$ 4.13	$ 86.33	**$ 149.91**
2032	14.46	13.70	0.89	7.99	**37.04**	$ 15.01	$ 44.79	$ 4.17	$ 87.08	**$ 151.05**
2033	14.58	13.79	0.90	8.06	**37.33**	$ 15.06	$ 45.10	$ 4.20	$ 87.84	**$ 152.20**
2034	14.70	13.87	0.90	8.13	**37.60**	$ 15.11	$ 45.41	$ 4.23	$ 88.62	**$ 153.37**
2035	14.82	13.96	0.91	8.21	**37.90**	$ 15.16	$ 45.73	$ 4.26	$ 89.40	**$ 154.55**
2036	14.94	14.05	0.92	8.28	**38.19**	$ 15.22	$ 46.06	$ 4.30	$ 90.19	**$ 155.77**
2037	15.07	14.14	0.92	8.35	**38.48**	$ 15.27	$ 46.39	$ 4.33	$ 90.99	**$ 156.98**
2038	15.19	14.24	0.93	8.43	**38.79**	$ 15.32	$ 46.73	$ 4.37	$ 91.80	**$ 158.22**
2039	15.32	14.33	0.94	8.50	**39.09**	$ 15.37	$ 47.07	$ 4.40	$ 92.63	**$ 159.47**
2040	15.44	14.43	0.95	8.58	**39.40**	$ 15.43	$ 47.42	$ 4.43	$ 93.46	**$ 160.74**
2041	15.56	14.47	0.95	8.62	**39.60**	$ 15.43	$ 47.60	$ 4.46	$ 93.82	**$ 161.31**
2042	15.69	14.51	0.96	8.65	**39.81**	$ 15.43	$ 47.80	$ 4.49	$ 94.19	**$ 161.91**
2043	15.81	14.56	0.96	8.68	**40.01**	$ 15.43	$ 47.99	$ 4.52	$ 94.56	**$ 162.50**
2044	15.94	14.61	0.97	8.72	**40.24**	$ 15.43	$ 48.20	$ 4.55	$ 94.94	**$ 163.12**
2045	16.06	14.66	0.97	8.76	**40.45**	$ 15.43	$ 48.41	$ 4.57	$ 95.33	**$ 163.74**
2046	16.19	14.71	0.98	8.79	**40.67**	$ 15.43	$ 48.63	$ 4.60	$ 95.72	**$ 164.38**
2047	16.32	14.76	0.99	8.83	**40.90**	$ 15.43	$ 48.86	$ 4.63	$ 96.12	**$ 165.04**
2048	16.44	14.82	0.99	8.87	**41.12**	$ 15.44	$ 49.10	$ 4.66	$ 96.53	**$ 165.73**
2049	16.57	14.88	1.00	8.91	**41.36**	$ 15.44	$ 49.34	$ 4.69	$ 96.94	**$ 166.41**
2050	16.70	14.94	1.00	8.95	**41.59**	$ 15.44	$ 49.60	$ 4.72	$ 97.36	**$ 167.12**

(1) 2012-2016: Actual values
(2) 2017: Estimated values subject to change
(3) 2019: Toll rates double, flat fee is $25 per year
Source: CDM Smith Analysis

Under Example 1, Class 1 revenue share (including the flat fee) slips to about 35%, Classes 2-4 share increases to 3%, and Classes 5-10 revenue share increases to 62%. Consequently, any losses in Class 1 revenue due to the revised flat fee program are more than made up for by the revenue increases in the other class, particularly Classes 5-10.

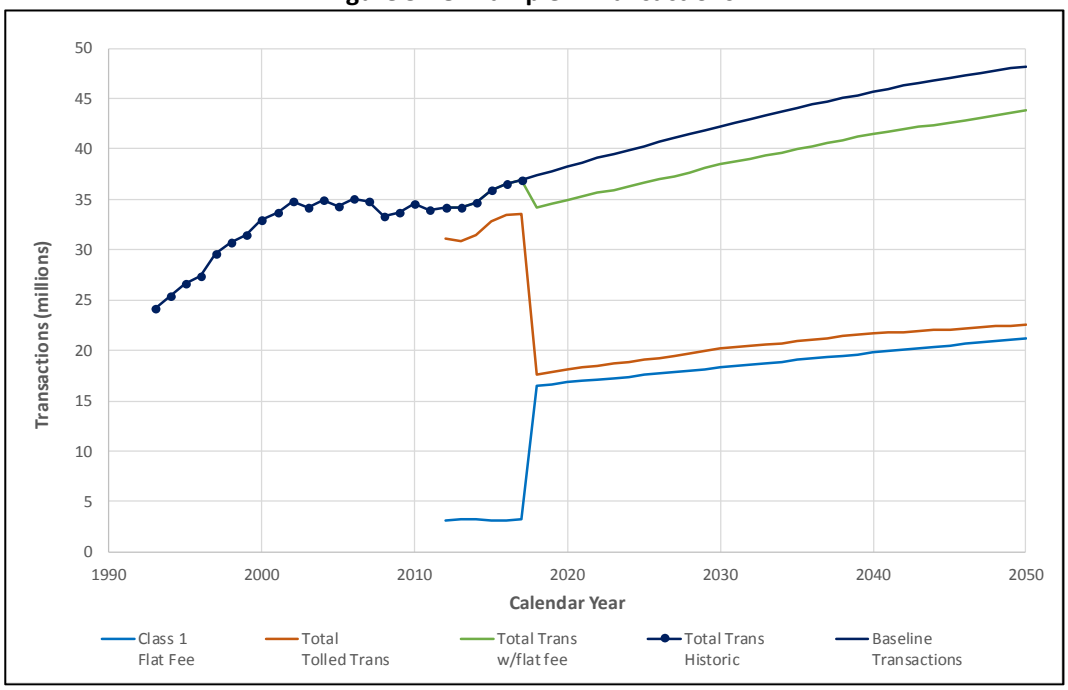
Transactions share results are similar for Example 2. However, Class 1 revenue share drops from about 48% to 41%, Classes 2-4 is similar at 3%, and Classes 5-10 revenue share rises only to about 56%.

Figures 5-18 and **5-19** illustrate Example 1 results and **Figures 5-20 and 5-21** illustrate Example 2 results.

In Example 1, the combination of introducing the revised flat fee program and doubling tolls results in a large increase in flat fee transactions over the current flat fee program (Personal Discount Plan 1) transactions, increasing from just over three million transactions annually to over 16 million in 2018 and growing to 21 million by 2050. Tolled transactions decrease from about 34 million to about 18 million in 2018 and increase slowly to about 23 million by 2050. Total transactions drop from about 37 million to 34 million in 2018 and then grow to 44 million by 2050. Consequently, while the revised flat fee program results in a larger number of transactions, the doubling of toll rates causes a reduction in transactions compared to the baseline forecast. For revenue, flat fee revenue increases from about $1.2 million today to about $7M in 2018 and stays relatively flat over time. Tolled revenue increases from about $89 million today to $110 million in 2018 with the toll increase, and grows to about $144 million by 2050. Total revenue grows from about $90 million today to $117 million in 2018 to $152 million by 2050, well above the baseline forecast.

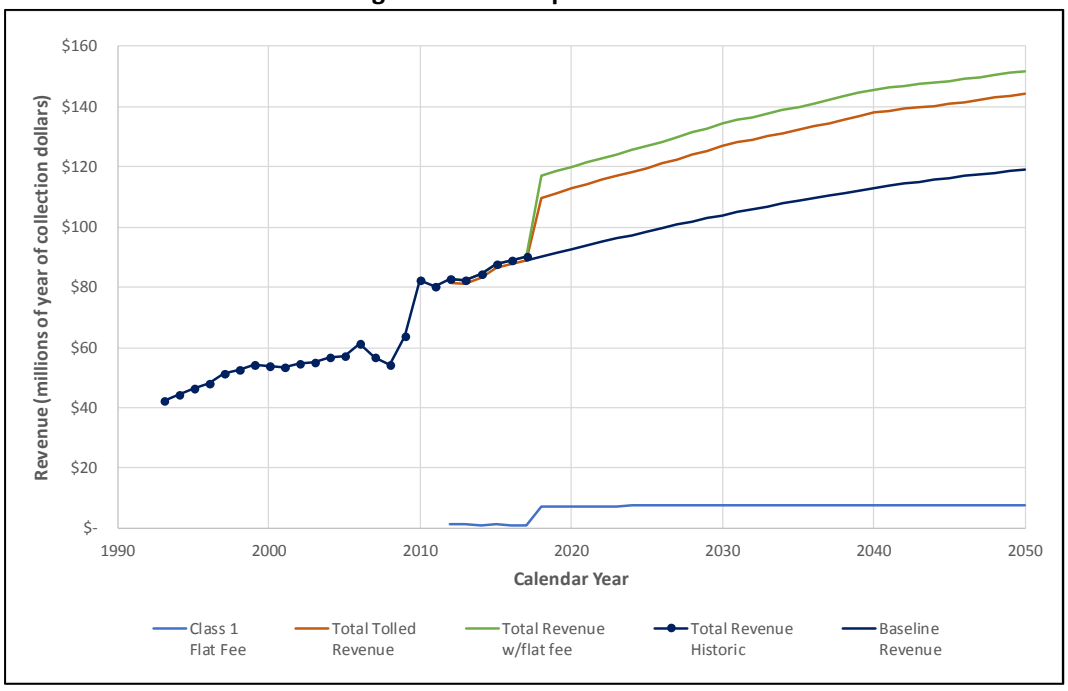
In Example 2, the increase in flat fee transactions is not as dramatic, only increasing to 13 million in 2018 and growing to about 17 million by 2050. Fewer people enter the flat fee program due to its higher cost. Tolled transactions decrease from about 34 million to about 20 million in 2018 and increase slowly to about 25 million by 2050. Overall, Example 2 has about 2 million less transactions than Example 1. In terms of revenue, flat fee revenue is more for Example 2 at about $15M annually over the forecast horizon. Tolled revenue increases from about $89 million in 2018 to about $116M in 2018 and increasing to $152M by 2050. The total annual revenues for Example 2 are approximately $15 million more than Example 1 and approximately $45 million more than the Baseline.

Figure 5-18 Example 1 Transactions



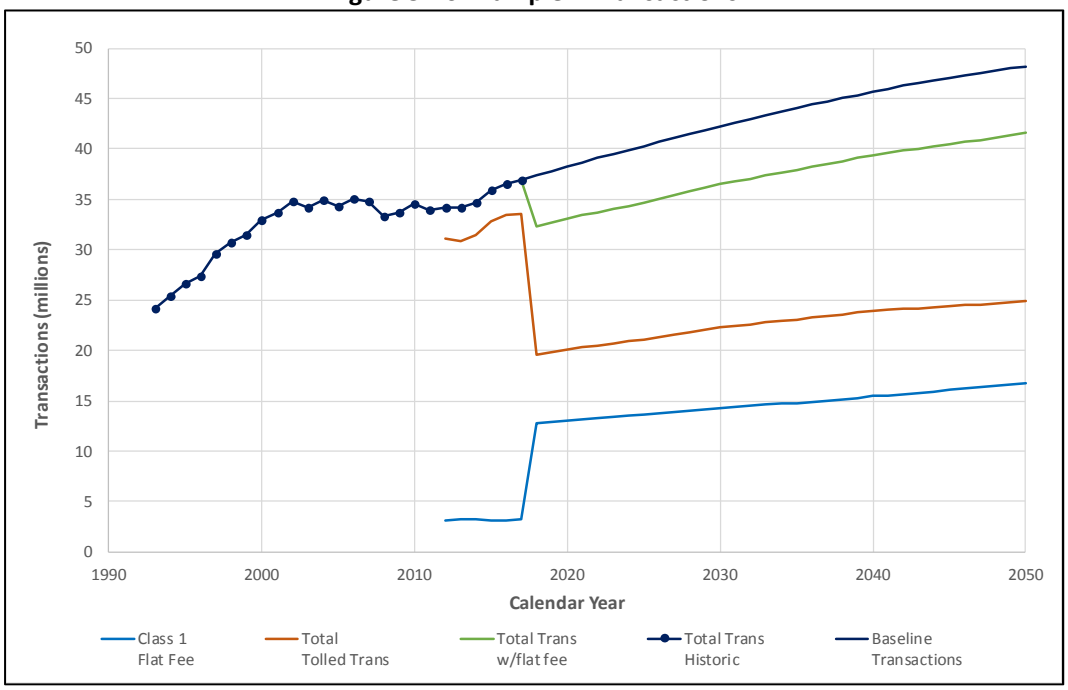
Source: CDM Smith Analysis

Figure 5-19 Example 1 Revenue



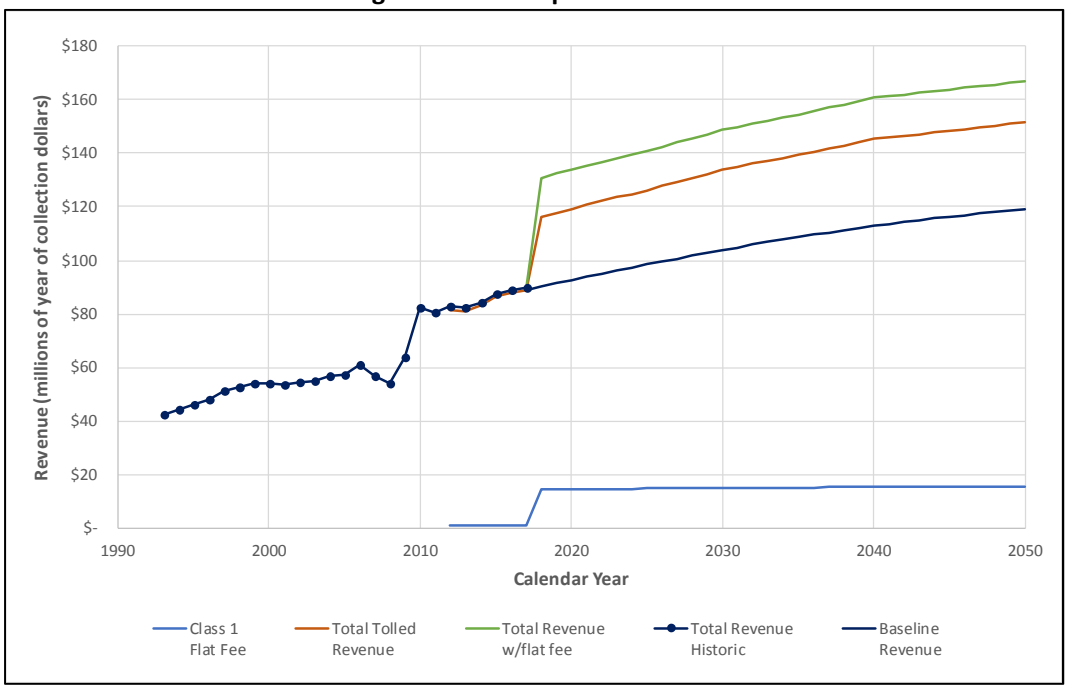
Source: CDM Smith Analysis

Figure 5-20 Example 2 Transactions



Source: CDM Smith Analysis

Figure 5-21 Example 2 Revenue



Source: CDM Smith Analysis

5.6 Prospective Scenario

WVPA's goal is to support the improvements to the Turnpike and to access roads connecting to the Turnpike, as identified in Governor Justice's ***Roads to Prosperity*** program. The intent of WVPA staff has been to maximize the amount of toll revenue bonds that can be sold, while maintaining the benefits of the flat fee program and retaining reasonable toll rates. Of course, WVPA will continue to keep the Turnpike in a good state of repair and operating efficiently. After reviewing a number of potential toll scenarios and taking into account desired toll policy and outcomes, WVPA staff and advisors identified a prospective toll scenario for further analysis and evaluation, that is a hybrid between Examples 1 and 2 with an indexing of toll rates and fees to achieve desired revenue levels. The prospective scenario includes a revised flat fee program with an early enrollment option, a large toll rate increase in 2019, and modest long-term escalation of toll rates and flat fee program costs.

At the introduction of this prospective scenario, Class 1 customers will have the opportunity to choose an early enrollment option which covers tolls for a three-year period at a discounted cost of $24 (plus a $13 issuance fee if not already part of the WV E-ZPass program). To participate in this early enrollment option, customers will need to enroll in the flat fee program and pay the flat fee by December 31, 2018. Customers in this program will enjoy unlimited, toll-free use of the Turnpike from time of joining through December 31, 2021. For all other customers:

- The CY 2018 toll rates will remain the same as CY 2017
- In CY 2019, the annual cost of the Class 1 flat fee program will be $25 and cover CY 2019 only; and toll rates for all other customers paying tolls (Classes 1-10) will double
- The toll policies in CY 2020 and 2021 are the same as CY 2019
- Starting in CY 2022 and beyond, the $25 flat fee program and all toll rates will increase nominally at 1.6% annually (including CY 2022) subject to rounding

Results of this prospective scenario are covered in Chapter 6.

Chapter 6

Transactions and Revenue Forecast

This chapter presents the T&R forecasts for the prospective scenario identified by WVPA staff and advisors for further evaluation. At the introduction of this prospective scenario, Class 1 customers will have the opportunity to choose an early enrollment option which covers tolls for a three-year period at a discounted cost of $24 (plus a $13 issuance fee if not already part of the WV E-ZPass program). To participate in this early enrollment option, customers will need to enroll in the flat fee program and pay the flat fee by December 31, 2018. Customers in this program will enjoy unlimited, toll-free use of the Turnpike from time of joining through December 31, 2021. For all other customers:

- The CY 2018 toll rates will remain the same as CY 2017
- In CY 2019, the annual cost of the Class 1 flat fee program will be $25 and cover CY 2019 only; and toll rates for all other customers paying tolls (Classes 1-10) will double
- The toll policies in CY 2020 and 2021 are the same as CY 2019
- Starting in CY 2022 and beyond, the $25 flat fee program and all toll rates will increase nominally at 1.6% annually (including CY 2022) subject to rounding

6.1 Forecasts

The T&R forecast is presented in **Table 6-1**, **Figure 6-1,** and **Figure 6-2**. Annual transactions increase from about 37 million in 2017 to about 40 million in 2018 due to the unlimited transactions allowed under the flat fee program and the early enrollment option which draws more customers. Transactions drop to about 35 million in 2019 due to the toll rate increase. There is a noticeable decrease in transactions in 2022 due to the ending of the early enrollment option coverage. Transactions increase slowly to about 35 million by 2030, but then begin to decrease as toll rates escalate and overall growth tapers off, shrinking to about 32 million by 2050.

Early on, approximately 48% of the transactions are from customers that opt for the flat fee program early enrollment prior to December 31, 2018 and others who join the annual flat fee program later through 2021. In 2022, annual flat fee transactions decrease to approximately 40% of all transactions since the early enrollment option coverage ends and fewer customers choose the $25.40 ($25.00 plus 1.6% escalation) flat fee program. The flat fee share of transactions increases to 54% by 2050 reflecting the relative attraction of the revised flat fee program despite both escalation in the flat fee amount and regular toll rates.

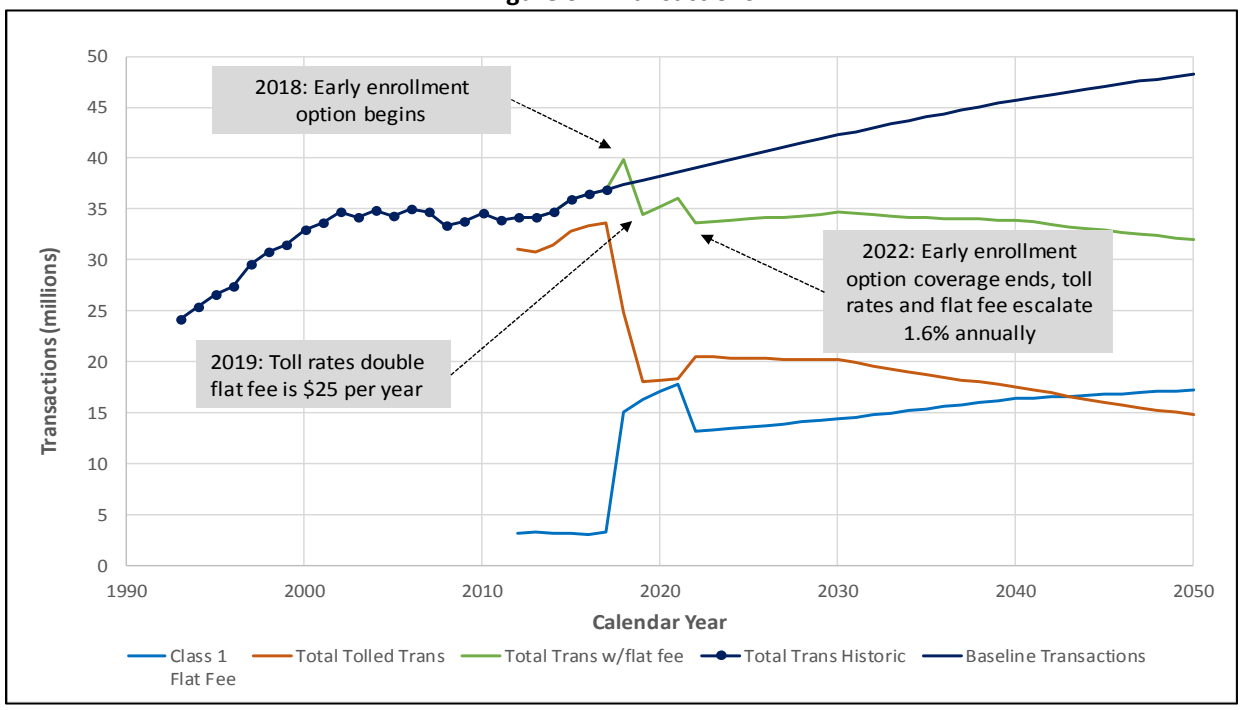
Among tolled transactions, approximately 62% are PC transactions and 38% are CV transactions during the early enrollment option coverage. The share of PC toll transactions increases to 66% in 2022 when the early enrollment option coverage ends and slowly decreases to approximately 57% by 2050 as more passenger car customers select the flat fee program.

Table 6-1 Toll Transactions and Revenue Forecast

Calendar Year	Toll Transactions (millions)					Revenue (millions year of collection dollars)				
	Class 1 Flat Fee	Class 1 Tolled	Class 2-4 Tolled	Class 5-10 (CV) Tolled	Total Trans w/flat fee	Class 1 Flat Fee	Class 1 Tolled	Class 2-4 Tolled	Class 5-10 (CV) Tolled	Total Revenue w/flat fee
2012 (1)	3.16	22.86	0.78	7.40	**34.20**	$ 1.18	$ 39.02	$ 1.83	$ 40.67	**$ 82.70**
2013 (1)	3.30	22.63	0.79	7.40	**34.12**	$ 1.17	$ 38.79	$ 1.83	$ 40.41	**$ 82.20**
2014 (1)	3.23	22.99	0.80	7.64	**34.66**	$ 1.06	$ 39.51	$ 1.87	$ 41.79	**$ 84.23**
2015 (1)	3.13	24.11	0.87	7.84	**35.95**	$ 1.23	$ 41.53	$ 2.03	$ 42.81	**$ 87.60**
2016 (1)	3.09	24.50	0.92	7.98	**36.49**	$ 1.15	$ 42.24	$ 2.14	$ 43.46	**$ 88.99**
2017 (2)	3.31	24.55	0.93	8.11	**36.90**	$ 1.13	$ 42.37	$ 2.18	$ 44.33	**$ 90.01**
2018 (3)	15.03	15.64	0.95	8.26	**39.88**	$ 19.81	$ 25.82	$ 2.21	$ 45.33	**$ 93.17**
2019 (4)	16.38	10.61	0.77	6.75	**34.51**	$ 1.47	$ 34.15	$ 3.60	$ 74.06	**$ 113.28**
2020	17.10	10.57	0.78	6.86	**35.31**	$ 2.20	$ 34.00	$ 3.63	$ 75.18	**$ 115.01**
2021	17.82	10.53	0.78	6.97	**36.10**	$ 2.94	$ 33.87	$ 3.67	$ 76.30	**$ 116.78**
2022 (5)	13.14	12.75	0.79	7.02	**33.70**	$ 14.77	$ 41.61	$ 3.71	$ 78.04	**$ 138.13**
2023	13.29	12.66	0.79	7.05	**33.79**	$ 15.15	$ 41.86	$ 3.79	$ 79.54	**$ 140.34**
2024	13.45	12.57	0.80	7.08	**33.90**	$ 15.54	$ 42.12	$ 3.86	$ 81.09	**$ 142.61**
2025	13.61	12.48	0.80	7.11	**34.00**	$ 15.95	$ 42.41	$ 3.94	$ 82.67	**$ 144.97**
2026	13.77	12.41	0.80	7.14	**34.12**	$ 16.36	$ 42.71	$ 4.03	$ 84.31	**$ 147.41**
2027	13.93	12.33	0.80	7.17	**34.23**	$ 16.78	$ 43.03	$ 4.11	$ 85.98	**$ 149.90**
2028	14.10	12.26	0.81	7.20	**34.37**	$ 17.22	$ 43.37	$ 4.20	$ 87.71	**$ 152.50**
2029	14.26	12.20	0.81	7.23	**34.50**	$ 17.67	$ 43.73	$ 4.28	$ 89.48	**$ 155.16**
2030	14.43	12.14	0.81	7.27	**34.65**	$ 18.13	$ 44.11	$ 4.37	$ 91.30	**$ 157.91**
2031	14.62	11.86	0.81	7.25	**34.54**	$ 18.72	$ 43.68	$ 4.43	$ 92.54	**$ 159.37**
2032	14.80	11.58	0.81	7.24	**34.43**	$ 19.34	$ 43.25	$ 4.49	$ 93.80	**$ 160.88**
2033	14.99	11.31	0.80	7.22	**34.32**	$ 19.98	$ 42.84	$ 4.54	$ 95.08	**$ 162.44**
2034	15.18	11.05	0.80	7.20	**34.23**	$ 20.64	$ 42.43	$ 4.60	$ 96.39	**$ 164.06**
2035	15.38	10.80	0.80	7.19	**34.17**	$ 21.32	$ 42.03	$ 4.66	$ 97.71	**$ 165.72**
2036	15.58	10.55	0.80	7.17	**34.10**	$ 22.03	$ 41.64	$ 4.72	$ 99.05	**$ 167.44**
2037	15.78	10.32	0.79	7.16	**34.05**	$ 22.75	$ 41.26	$ 4.78	$ 100.42	**$ 169.21**
2038	15.98	10.09	0.79	7.14	**34.00**	$ 23.51	$ 40.88	$ 4.84	$ 101.81	**$ 171.04**
2039	16.18	9.87	0.79	7.12	**33.96**	$ 24.29	$ 40.52	$ 4.90	$ 103.22	**$ 172.93**
2040	16.39	9.66	0.78	7.11	**33.94**	$ 25.09	$ 40.16	$ 4.96	$ 104.66	**$ 174.87**
2041	16.48	9.43	0.78	7.03	**33.72**	$ 25.48	$ 39.61	$ 5.00	$ 105.18	**$ 175.27**
2042	16.56	9.21	0.77	6.96	**33.50**	$ 25.88	$ 39.07	$ 5.04	$ 105.71	**$ 175.70**
2043	16.65	9.00	0.76	6.88	**33.29**	$ 26.29	$ 38.54	$ 5.07	$ 106.25	**$ 176.15**
2044	16.73	8.80	0.75	6.81	**33.09**	$ 26.70	$ 38.03	$ 5.11	$ 106.80	**$ 176.64**
2045	16.82	8.60	0.75	6.74	**32.91**	$ 27.12	$ 37.53	$ 5.15	$ 107.36	**$ 177.16**
2046	16.91	8.40	0.74	6.67	**32.72**	$ 27.54	$ 37.04	$ 5.19	$ 107.93	**$ 177.70**
2047	16.99	8.22	0.73	6.60	**32.54**	$ 27.98	$ 36.57	$ 5.23	$ 108.50	**$ 178.28**
2048	17.08	8.04	0.73	6.53	**32.38**	$ 28.42	$ 36.11	$ 5.27	$ 109.09	**$ 178.89**
2049	17.17	7.86	0.72	6.46	**32.21**	$ 28.86	$ 35.66	$ 5.31	$ 109.68	**$ 179.51**
2050	17.26	7.69	0.71	6.40	**32.06**	$ 29.31	$ 35.22	$ 5.35	$ 110.28	**$ 180.16**

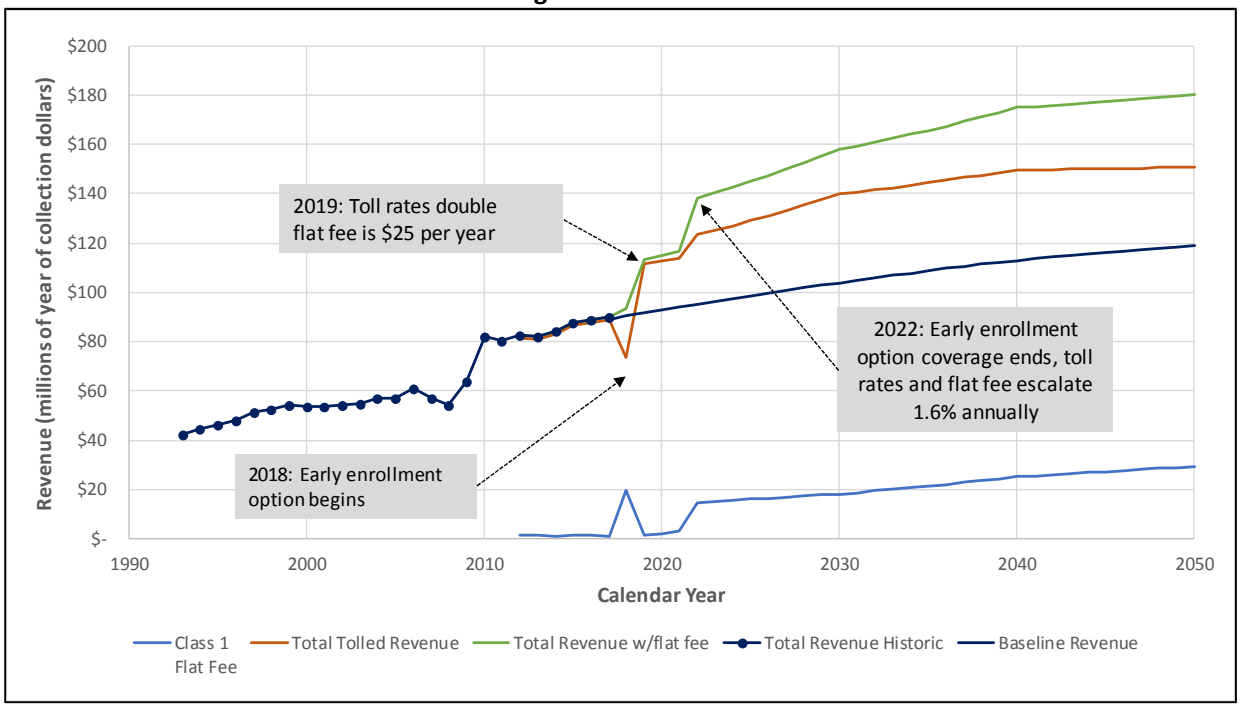
(1) 2012-2016: Actual values
(2) 2017: Estimated values subject to change
(3) 2018: Early enrollment option begins
(4) 2019: Toll rates double, flat fee is $25 per year
(5) 2022: Early enrollment option coverage ends 12/31/2021, toll rates and flat fee escalate 1.6% annually
Source: CDM Smith Analysis

Figure 6-1 Transactions



Source: CDM Smith Analysis

Figure 6-2 Revenue



Source: CDM Smith Analysis

Annual revenue increases from about $90 million in 2017 to $93 million in 2018 with a large increase in the Class 1 Flat Fee revenue from the early enrollment option and a large decrease in Class 1 tolled revenue. During the period 2019-2021, total revenue increases due to the initial toll rate increase, but is moderated by the early enrollment option. In 2022, a noticeable jump up in revenue accompanies the end of the early enrollment coverage and revenue increases over time due to escalating toll rates. The revenue generated by the flat fee program represents about 21% of all revenue in 2018, about 1% to 3% in the years 2019-2021 (those who choose the flat fee program just for each year), and about 11% starting in 2022 growing to 16% by 2050. Among total tolled revenue, about one-third comes from passenger cars while two-thirds comes from commercial vehicles. From 2022 to 2030, total revenue is expected to grow about 1.7% annually, slowing to about 1.0% growth annually through 2040, and slowing further to about 0.3% growth through 2050.

Note that the flat fee program was assumed to start on January 1, 2018. WVPA will investigate and may implement ways for customers to join the flat fee program throughout the year. Also, since the toll rate setting process will extend into 2018, the effective date will be later and the forecast for 2018 will be adjusted in the financial analysis.

6.2 Comparison with Baseline Forecast

Compared to the baseline forecast (i.e. without any changes in toll policies), transactions are about 7% higher in 2018 mostly due to the early enrollment option coverage and about 8% lower in the years 2019-2021 primarily due to the toll increase. A further step down to about 14% lower than baseline occurs in 2022 due to the ending of the early enrollment option coverage and the higher toll rates. Starting in 2030, total transactions decline due to the escalating toll rates, reaching 33% lower than the baseline by 2050.

Revenue is about 3% higher than the baseline in 2018 primarily due to the early enrollment option and about 24% higher in the years 2019-2021 due to the toll increase. Once the early enrollment option coverage ends, revenue is about 45% higher in 2022 rising slowly to about 55% higher than the baseline in 2040 and then ends up about 51% higher than the baseline by 2050.

6.3 Comparison with Examples 1 and 2

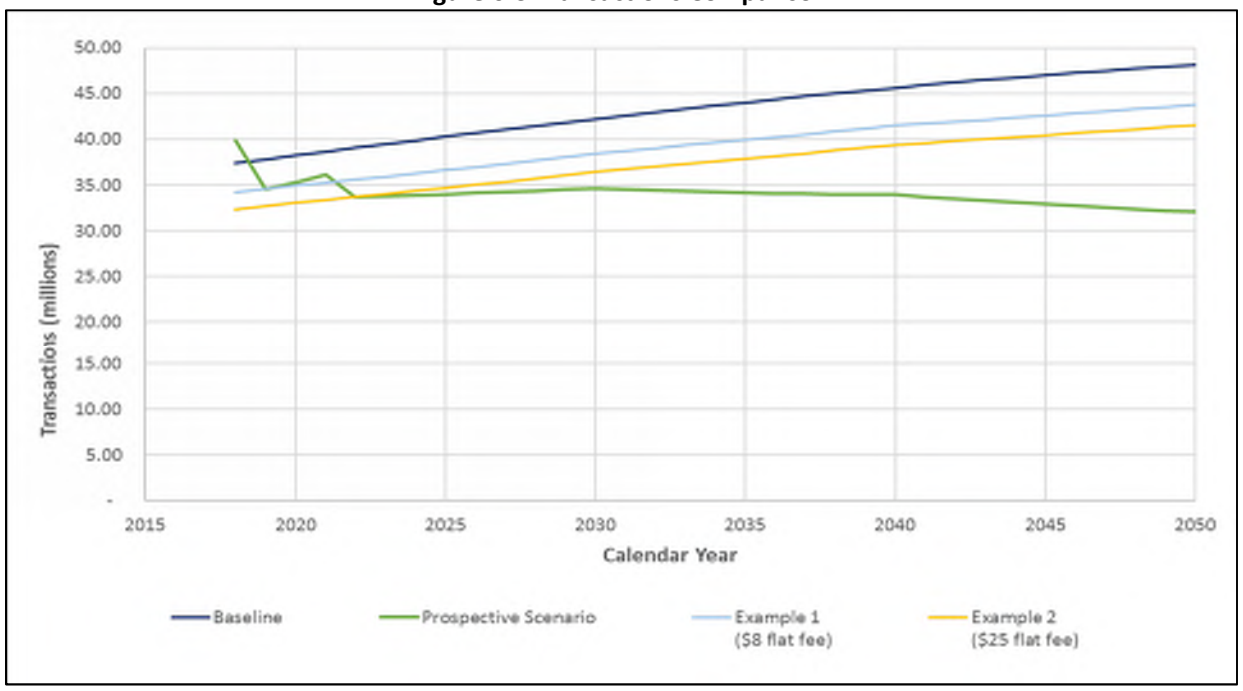
The prospective scenario is a hybrid of Examples 1 and 2 from Chapter 5. The results for Example 1 ($8 flat fee program), Example 2 ($25 flat fee program), and the baseline forecast are shown in **Figures 6-3** and **6-4**. These figures illustrate the relationship between the prospective scenario and the baseline and the examples covered in Chapter 5.

Transactions in the prospective scenario are higher initially than the other three, since there is no assumed toll increase for 2018 and the early enrollment option is assumed to be in place inducing some additional transactions above the baseline. In 2019-2021, transactions in the prospective scenario drop down to the Example 1 level since the early enrollment option at $24 for three years is similar to the $8 per year flat fee program of Example 1. Once the early enrollment option coverage ends in 2022, transactions decrease to a level similar to the $25 per year flat fee program of Example 2. However, as time goes on, the escalation in toll rates slowly reduces transactions below Example 2. While some Class 1 customers will convert to the flat fee program, others will stop using the Turnpike as will some of the Classes 2-10 customers who are not eligible for the flat fee program.

In terms of revenue, the prospective scenario starts very close to the baseline forecast because there is some balance between revenues from the early enrollment option and regular per trip tolls. Revenue increases to almost the Example 1 level in 2019 due to the large toll increase and since the early

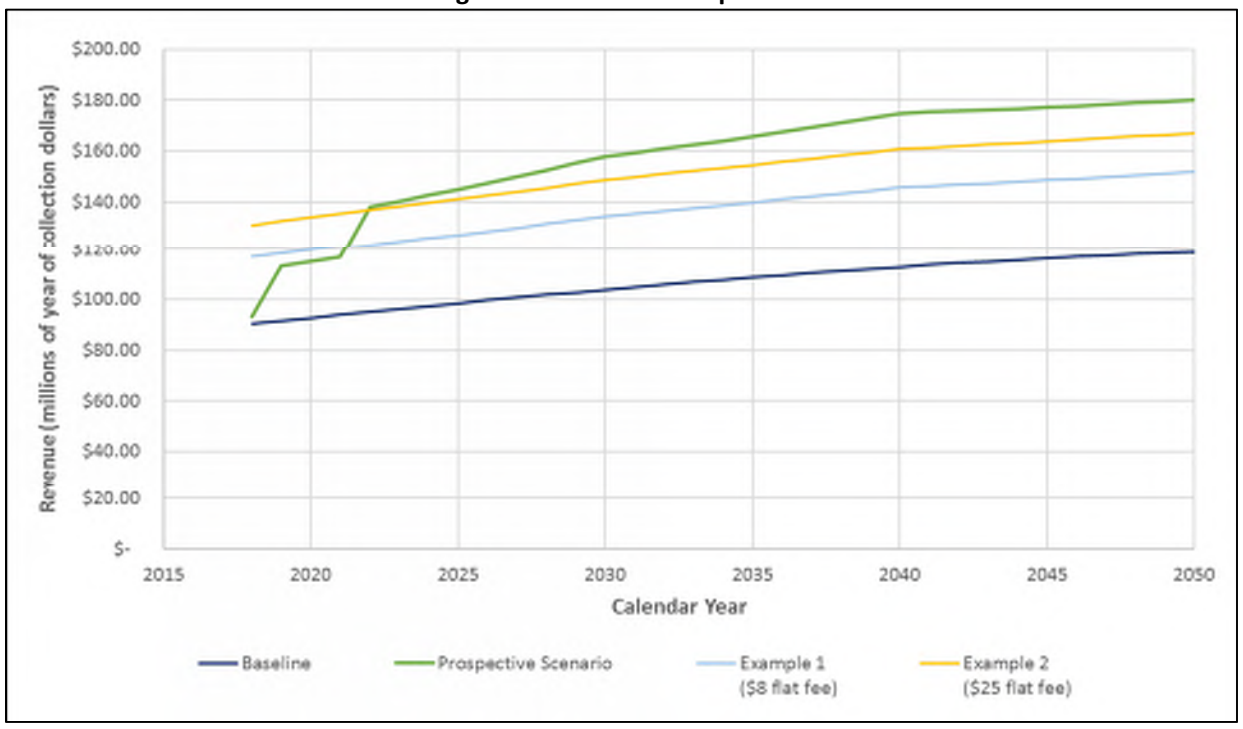
enrollment option at $24 is similar to the $8 per year flat fee program of Example 1. In 2022 revenue jumps up to Example 2 levels since the early enrollment option coverage ends and the $25.40 ($25 plus 1.6% increase) cost to be in the flat fee program applies for all, similar to Example 2. Revenue continues to rise over time due to the escalation in both the flat fee program rate and toll rates.

Figure 6-3 Transactions Comparison



Source: CDM Smith Analysis

Figure 6-4 Revenue Comparison



Source: CDM Smith Analysis

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Chapter 7
Sensitivity Tests

This chapter presents test results conducted to measure the sensitivity of T&R estimates to key study assumptions. As described in CDM Smith's Disclaimer, the T&R estimates are forecasts of an uncertain future. The assumptions chosen for the tests are those that present risks and have a potential impact on the estimates. The purpose of the sensitivity tests is to help identify the sources of risk. All sensitivity tests were conducted for year 2030, and results were compared to the prospective scenario identified by WVPA staff for further evaluation.

Each parameter was tested individually; the results are not necessarily additive or multiplicative, and do not provide an estimate of the overall impact if they were to occur in combinations. The tests include the following:

- Regional growth (all classes)
- Toll rates (all classes)
- Elasticity to toll rates (all classes)
- Pay share proportions (all classes)
- Frequency of use (Class 1)
- Annual flat fee program cost (Class 1)
- Transponder issuance cost (Class 1)
- Multi-plaza divider (Class 1)

7.1 Regional Growth

Sensitivity to regional growth assumptions was tested in terms of their impact on overall T&R estimates for all vehicle classes.

The prospective scenario T&R estimates presented in Chapter 6 are based on the "baseline" socioeconomic forecast derived from an econometric analysis. Along with the baseline socioeconomic forecast, a more pessimistic socioeconomic forecast was prepared as described in Chapter 3.

Using the downside socioeconomic forecast for year 2030, transaction and toll revenue forecasts were prepared and the results were compared against the prospective scenario. The results are presented in **Table 7-1**.

Table 7-1 Regional Growth Sensitivity Test

2030 Regional Growth Test	Toll Transactions (millions)					Revenue (millions year of collection dollars)				
	Class 1 Flat Fee	Class 1 Tolled	Class 2-4 Tolled	Class 5-10 (CV) Tolled	Total Trans w/fat fee	Class 1 Flat Fee	Class 1 Tolled	Class 2-4 Tolled	Class 5-10 (CV) Tolled	Total Revenue
Prospective Scenario	14.43	12.14	0.81	7.27	**34.66**	$ 18.13	$ 44.11	$ 4.37	$ 91.30	**$ 157.92**
Downside Socioeconomic	13.57	11.36	0.76	6.54	**32.23**	$ 17.09	$ 41.55	$ 4.12	$ 82.85	**$ 145.61**
% Change	*-6.0%*	*-6.5%*	*-6.0%*	*-10.1%*	***-7.0%***	*-5.7%*	*-5.8%*	*-5.7%*	*-9.3%*	***-7.8%***

Source: CDM Smith Analysis

For 2030, under the downside regional growth scenario, total transactions and revenue are expected to be reduced by approximately 7.0% and 7.8%, respectively.

7.2 Toll Rates

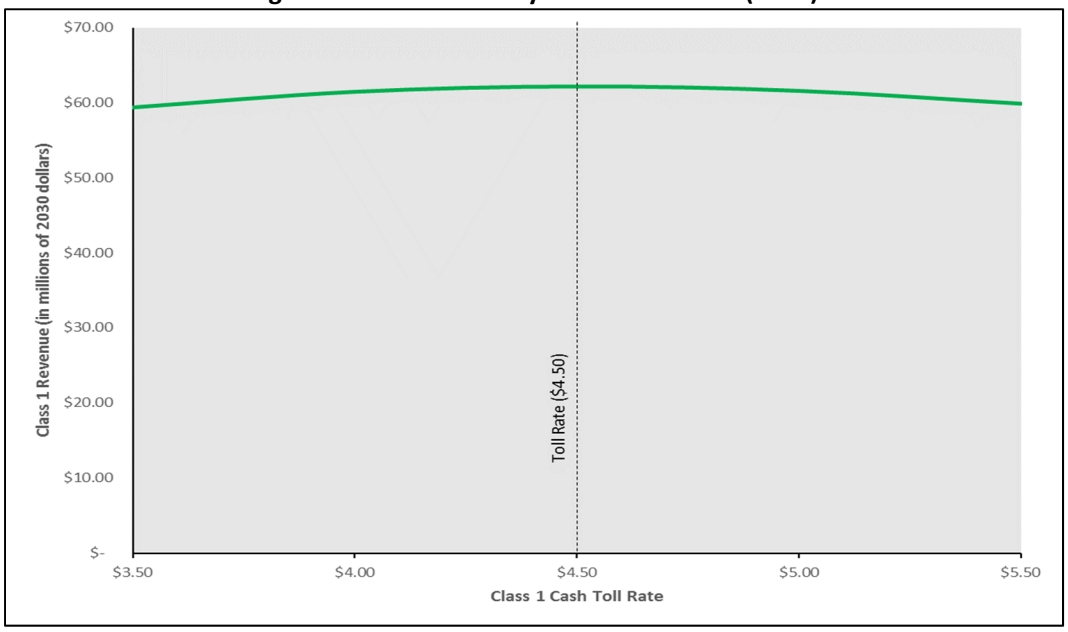
Toll rate sensitivity was tested in terms of the impact on T&R estimates, first for Class 1 vehicles only, then for Classes 2-10, and finally for all vehicles. The prospective scenario is based on a 2030 cash toll rate of $4.50 for Class 1 vehicles and $15.50 for Class 8 vehicles. Toll sensitivity curves show the impact of varying toll rates on toll revenue.

7.2.1 Class 1 Toll Rate Sensitivity

A range of Class 1 cash toll rates from $3.50 to $5.50 in $0.50 increment was tested for year 2030. Toll rates for Classes 2-10 were kept unchanged in this test.

Figure 7-1 shows the toll sensitivity curve for 2030 Class 1 revenue including flat fee and toll revenues. The graph shows where the toll rate ($4.50 for Class 1 cash payment) in the prospective scenario corresponds to the revenue-maximizing toll rate.

Figure 7-1 Toll Sensitivity Curve for Class 1 (2030)



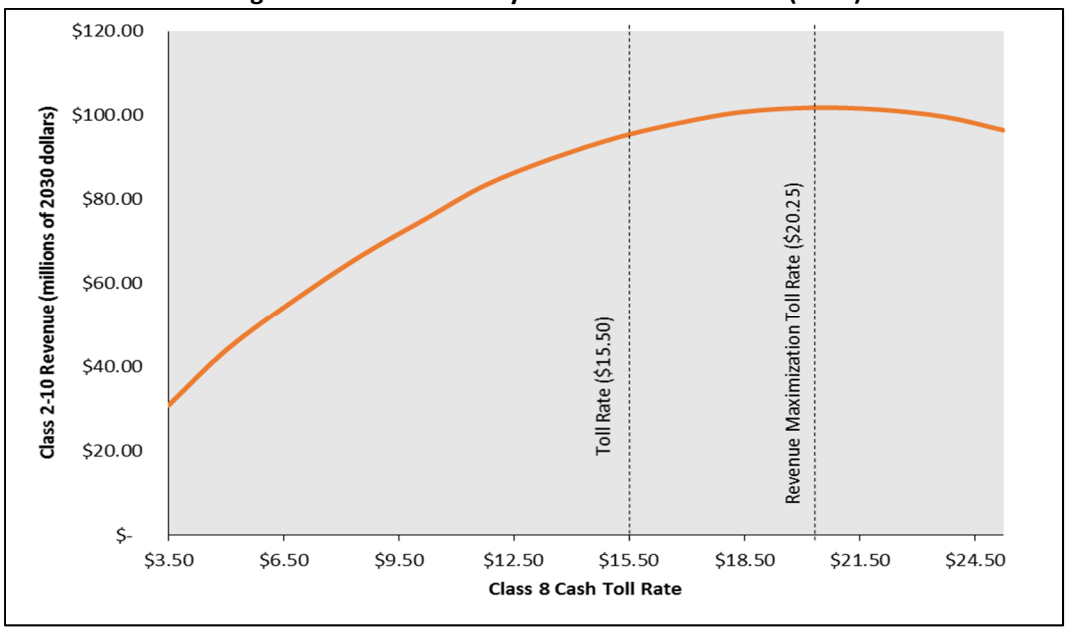
Source: CDM Smith Analysis

7.2.2 Classes 2-10 Toll Rate Sensitivity

Using the Class 8 cash toll rate as a heading to describe the range of toll rates, Class 8 cash toll rates from $3.50 to $25.25 were tested for year 2030. Toll rates for Class 1 vehicles were kept unchanged in this test. Toll rates for other payment types and other vehicle classes 2-10 were varied using the same proportions as the current toll rates.

Figure 7-2 shows the toll sensitivity curve for 2030 Classes 2-10 toll revenue. The graph shows the toll rate ($15.50 for Class 8 cash payment) used in the prospective scenario is lower than the revenue-maximizing toll rate, which would correspond to about $20.25 for Class 8 cash payment.

Figure 7-2 Toll Sensitivity Curve for Classes 2-10 (2030)



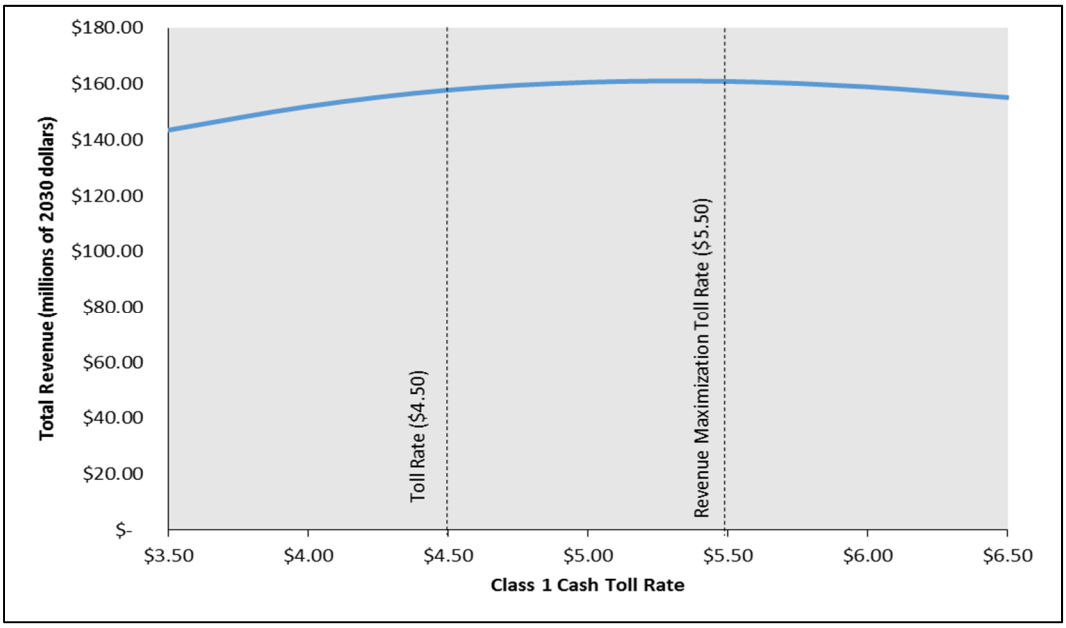
Source: CDM Smith Analysis

7.2.3 All Classes Toll Rate Sensitivity

For this test, a range of Class 1 cash toll rates from $3.50 to $6.50 in $0.50 increments was tested for year 2030. Toll rates for other payment types and other vehicle classes were varied using the same proportions as the current toll rates.

Figure 7-3 shows the toll sensitivity curve for 2030 total revenue including Classes 1 through 10. The graph shows the toll rates ($4.50 for Class 1 cash payment; $15.50 for Class 8 cash payment) used in the prospective scenario are lower than the revenue-maximizing toll rates, which would correspond to about $5.50 for Class 1 cash payment.

Figure 7-3 Toll Sensitivity Curve for All Classes (2030)



Source: CDM Smith Analysis

7.3 Toll Rate Elasticity

Sensitivity to toll rate elasticity factors was tested in terms of their impact on transactions and revenue forecasts, first for Class 1 vehicles only, and then for Classes 2-10 vehicles. The prospective scenario uses elasticity factors of -0.18 for Class 1 vehicles and -0.196 for Classes 2-10 vehicles.

7.3.1 Class 1 Toll Rate Elasticity

In the Class 1 sensitivity test, an elasticity of -0.30 (instead of -0.18) was used. This elasticity factor only applies to the Class 1 vehicles that continue to pay cash after the flat fee program option is offered. The elasticity factor controls the percentage of suppressed trips in response to tolls. A higher elasticity leads to fewer trips, therefore less revenue from tolls.

The results of the Class 1 elasticity test are presented in **Table 7-2**. For 2030, under the scenario with a higher elasticity, the number of Class 1 transactions is reduced by 2.3%, and the Class 1 revenue decreases by 2.9%. As a percentage of the overall revenue, the test scenario leads to a 1.1% reduction.

Table 7-2 Class 1 Elasticity Sensitivity Test

2030 Class 1 Elasticity Test	Toll Transactions (millions)					Revenue (millions year of collection dollars)					
	Class 1 Flat Fee	Class 1 Cash	Class 1 WV E-ZPass	Class 1 Non-WV E-ZPass	Total Class 1	Class 1 Flat Fee	Class 1 Cash	Class 1 WV E-ZPass	Class 1 Non-WV E-ZPass	Total Class 1	Total All Classes
Prospective Scenario (-0.18)	14.43	7.50	0.78	3.86	**26.58**	$ 18.13	$ 28.24	$ 1.09	$ 14.78	**$ 62.24**	**$ 157.92**
Elasticity -0.30	14.43	6.89	0.78	3.86	**25.97**	$ 18.13	$ 26.45	$ 1.09	$ 14.78	**$ 60.44**	**$ 156.12**
% Change	*0.0%*	*-8.1%*	*0.0%*	*0.0%*	***-2.3%***	*0.0%*	*-6.4%*	*0.0%*	*0.0%*	***-2.9%***	***-1.1%***

Source: CDM Smith Analysis

7.3.2 Classes 2-10 Toll Rate Elasticity

A separate elasticity test was performed for Classes 2-10 vehicles, with the Class 1 elasticity factor remaining unchanged compared to the prospective scenario. For Classes 2-10 vehicles, the prospective scenario uses an elasticity factor of -0.196. As part of the sensitivity test, two lower values (-0.161 and -0.126) as well as two higher values (-0.231 and -0.266) were tested. The results are presented in **Table 7-3**.

Table 7-3 Classes 2-10 Elasticity Sensitivity Test

2030 Class 2-10 Elasticity Test	Toll Transactions (millions)			Revenue (millions year of collection $)			
	Class 2-4 Tolled	Class 5-10 (CV) Tolled	Total Class 2-10	Class 2-4 Tolled	Class 5-10 (CV) Tolled	Total Class 2-10	Total All Classes
Prospective Scenario (-0.196)	0.81	7.27	**8.08**	$ 4.37	$ 91.30	**$ 95.68**	**$ 157.92**
Elasticity -0.126	0.91	8.16	**9.07**	$ 4.91	$ 102.52	**$ 107.43**	**$ 169.67**
% Change	*12.2%*	*12.3%*	***12.3%***	*12.2%*	*12.3%*	***12.3%***	***7.4%***
Elasticity -0.161	0.86	7.72	**8.58**	$ 4.64	$ 96.91	**$ 101.55**	**$ 163.79**
% Change	*6.1%*	*6.1%*	***6.1%***	*6.1%*	*6.1%*	***6.1%***	***3.7%***
Elasticity -0.231	0.76	6.82	**7.59**	$ 4.11	$ 85.70	**$ 89.81**	**$ 152.05**
% Change	*-6.1%*	*-6.1%*	***-6.1%***	*-6.1%*	*-6.1%*	***-6.1%***	***-3.7%***
Elasticity -0.266	0.71	6.38	**7.09**	$ 3.84	$ 80.09	**$ 83.93**	**$ 146.17**
% Change	*-12.2%*	*-12.3%*	***-12.3%***	*-12.2%*	*-12.3%*	***-12.3%***	***-7.4%***

Source: CDM Smith Analysis

For 2030, under the scenario with the highest elasticity (-0.266), the number of Classes 2-10 transactions is reduced by 12.3%, and the Classes 2-10 revenue decreases by the same percentage. As a percentage of the overall revenue, this scenario leads to a 7.4% reduction.

7.4 Pay Share Proportions

As described in Chapter 6, the prospective scenario is based on certain assumptions regarding methods of payment (cash, WV E-ZPass, and Non-WV E-ZPass) for all classes of vehicles prior to implementation of the flat fee program, i.e., with no change in current toll policies. As part of this sensitivity test, different initial pay share proportions were tested to determine the impact on T&R forecasts. The sensitivity test was performed separately for Class 1 vehicles and for Classes 2-10 vehicles.

7.4.1 Class 1 Pay Share Proportions

As part of the Class 1 sensitivity test, two scenarios were tested for year 2030: a decrease or increase the initial cash share assumed in the prospective scenario by 10% at each plaza and splitting the remaining share according to the current proportion between the two E-ZPass types.

The results of this test are presented in **Table 7-4**.

Table 7-4 Class 1 Pay Share Proportions Sensitivity Test

2030 Class 1 Pay Share Test	Toll Transactions (millions)					Revenue (millions year of collection dollars)					
	Class 1 Flat Fee	Class 1 Cash	Class 1 WV E-ZPass	Class 1 Non-WV E-ZPass	Total Class 1	Class 1 Flat Fee	Class 1 Cash	Class 1 WV E-ZPass	Class 1 Non-WV E-ZPass	Total Class 1	Total All Classes
Prospective Scenario	14.43	7.50	0.78	3.86	**26.58**	$ 18.13	$ 28.24	$ 1.09	$ 14.78	**$ 62.24**	**$ 157.92**
Lower initial cash share	15.15	5.69	0.94	4.85	**26.63**	$ 15.72	$ 21.59	$ 1.33	$ 18.77	**$ 57.41**	**$ 153.09**
% Change	*5.0%*	*-24.1%*	*19.5%*	*25.5%*	***0.2%***	*-13.3%*	*-23.6%*	*22.2%*	*27.0%*	***-7.8%***	***-3.1%***
Higher initial cash share	13.51	9.48	0.63	2.88	**26.50**	$ 20.69	$ 35.62	$ 0.85	$ 10.79	**$ 67.95**	**$ 163.63**
% Change	*-6.4%*	*26.5%*	*-19.5%*	*-25.5%*	***-0.3%***	*14.1%*	*26.1%*	*-22.2%*	*-27.0%*	***9.2%***	***3.6%***

Source: CDM Smith Analysis

For 2030, under the scenario with a lower initial cash share, Class 1 transactions increase by 0.2%, and Class 1 revenue decreases by 7.8%. The impact on overall revenue is a 3.1% reduction.

For 2030, under the scenario with a higher initial cash share, Class 1 transactions decrease by 0.3%, and Class 1 revenue increases by 9.2%. The impact on overall revenue is a 3.6% increase.

The impact on revenue is primarily driven by the amount of cash transactions. With a lower initial cash share, there are fewer remaining cash payers after the revised flat fee is offered, therefore less revenue. The opposite trend is observed with a higher initial cash share, which leads to higher revenue.

7.4.2 Classes 2-10 Pay Share Proportions

A separate sensitivity test was performed for Classes 2-10 vehicles pay share proportions, with the Class 1 shares remaining unchanged compared to the prospective scenario. As part of the Classes 2-10 sensitivity test, two tests were performed for year 2030. Pay Share Test 1 involved lowering the initial cash share by 10% and distributing the remainder proportionally to WV E-ZPass and Non-WV E-ZPass. Pay Share Test 2 consisted of keeping the initial cash share unchanged, but lowering the Non-WV E-ZPass share by 10% and increasing the WV E-ZPass share to compensate.

The results of this test are presented in **Table 7-5**.

Table 7-5 Classes 2-10 Pay Share Proportions Sensitivity Test

2030 Class 2-10 Pay Share Test	Toll Transactions (millions)			Revenue (millions year of collection dollars)			
	Class 2-4 Tolled	Class 5-10 (CV) Tolled	Total Class 2-10	Class 2-4 Tolled	Class 5-10 (CV) Tolled	Total Class 2-10	Total All Classes
Prospective Scenario	0.81	7.27	**8.08**	$ 4.37	$ 91.30	**$ 95.68**	**$ 157.92**
Pay Share Test 1	0.81	7.27	**8.08**	$ 4.32	$ 90.02	**$ 94.33**	**$ 156.57**
% Change	*0.0%*	*0.0%*	***0.0%***	*-1.4%*	*-1.4%*	***-1.4%***	***-0.9%***
Pay Share Test 2	0.81	7.27	**8.08**	$ 4.33	$ 90.58	**$ 94.91**	**$ 157.15**
% Change	*0.0%*	*0.0%*	***0.0%***	*-1.0%*	*-0.8%*	***-0.8%***	***-0.5%***

Source: CDM Smith Analysis

The amount of tolled transactions does not vary in this test, it is only the share by payment type that changes. In Pay Share Test 1, revenue from Classes 2-10 vehicles is expected to decrease by 1.4%, leading to an overall revenue decrease of 0.9%. In Pay Share Test 2, revenue from Classes 2-10 vehicles is expected to decrease by 0.8%, leading to an overall revenue decrease of 0.5%.

7.5 Frequency of Use

As described in Chapter 5, the Class 1 forecasting approach was based on certain assumptions to derive the frequency of use for cash customers since this information was not directly available from the collected data.

CDM Smith used a Pareto function, statistically fit, to describe the frequency of use at each plaza. The Pareto distributions at each plaza and model year were then adjusted so that the number of overall trips in the 30+ trips per year bin prior to implementation of the flat fee program exceeded the number of E-ZPass trips in that bin by 10%. The total trips met the baseline transactions forecast for the year being modeled. The sensitivity test held the number of WV E-ZPass customers constant but increased the cash exceedance to 15%. By increasing the share of high frequency cash users, the share of low frequency cash users was decreased accordingly.

The results of this test are presented in **Table 7-6**. For 2030, under the scenario with an increased initial share of high frequency cash trips, the number of Class 1 transactions is nearly unchanged, while the Class 1 revenue decreases by 1.4%. As a percentage of the overall revenue, the test scenario leads to a 0.6% reduction.

In this test, there is a swing toward more transactions being covered in the flat fee program since it is assumed more customers are high frequency users and they tend to choose the flat fee program more often. This results in fewer cash paying toll trips and less cash toll revenue. Additionally, the reduction in flat fee customers in the lower frequency bins exceeds the additional customers in the high frequency bins. Consequently, there is less flat fee revenue.

Table 7-6 Frequency of Use Sensitivity Test

2030 Frequency Test	Toll Transactions (millions)					Revenue (millions year of collection dollars)					
	Class 1 Flat Fee	Class 1 Cash	Class 1 WV E-ZPass	Class 1 Non-WV E-ZPass	Total Class 1	Class 1 Flat Fee	Class 1 Cash	Class 1 WV E-ZPass	Class 1 Non-WV E-ZPass	Total Class 1	Total All Classes
Prospective Scenario	14.43	7.50	0.78	3.86	**26.58**	$ 18.13	$ 28.24	$ 1.09	$ 14.78	**$ 62.24**	**$157.92**
Higher Initial Share of High Frequency Cash Trips	14.60	7.35	0.78	3.86	**26.59**	$ 17.86	$ 27.64	$ 1.09	$ 14.78	**$ 61.37**	**$157.05**
% Change	*1.2%*	*-2.0%*	*0.0%*	*0.0%*	***0.1%***	*-1.5%*	*-2.1%*	*0.0%*	*0.0%*	***-1.4%***	***-0.6%***

Source: CDM Smith Analysis

7.6 Annual Flat Fee Cost

The prospective scenario assumes an annual flat fee cost of $28.84 in 2030, escalated from $25 in 2021. The sensitivity of this parameter was tested by changing the value to either a lower value ($25), or a higher value ($30 and $35). The results are presented on **Table 7-7**.

With a lower annual flat fee cost ($25 in the test), more customers switch to the flat fee program, which reduces the amount of tolled revenue from cash, WV E-ZPass, and Non-WV E-ZPass. While there are more customers in the flat fee program, the lower fee results in a net loss in flat fee revenue. The opposite trend is observed with a higher flat fee cost. Fewer customers switch to the flat fee program, generating more toll revenue and the higher fee, despite fewer flat fee customers, increases flat fee revenue. With a flat fee of $35 (i.e. 21% higher than the prospective scenario), the overall revenue increases by 1.7%.

Table 7-7 Annual Flat Fee Cost Sensitivity Test

2030 Flat Fee Test	Toll Transactions (millions)					Revenue (millions year of collection dollars)					
	Class 1 Flat Fee	Class 1 Cash	Class 1 WV E-ZPass	Class 1 Non-WV E-ZPass	Total Class 1	Class 1 Flat Fee	Class 1 Cash	Class 1 WV E-ZPass	Class 1 Non-WV E-ZPass	Total Class 1	Total All Classes
Prospective Scenario ($28.84)	14.43	7.50	0.78	3.86	**26.58**	$ 18.13	$ 28.24	$ 1.09	$ 14.78	**$ 62.24**	**$ 157.92**
$25 Flat Fee	15.35	7.21	0.72	3.81	**27.09**	$ 17.41	$ 27.09	$ 0.98	$ 14.55	**$ 60.03**	**$ 155.71**
% Change	*6.4%*	*-3.8%*	*-8.7%*	*-1.3%*	***1.9%***	*-4.0%*	*-4.1%*	*-10.1%*	*-1.5%*	***-3.5%***	***-1.4%***
$30 Flat Fee	14.16	7.58	0.80	3.88	**26.42**	$ 18.27	$ 28.59	$ 1.12	$ 14.84	**$ 62.83**	**$ 158.51**
% Change	*-1.9%*	*1.1%*	*2.7%*	*0.4%*	***-0.6%***	*0.8%*	*1.2%*	*3.2%*	*0.4%*	***0.9%***	***0.4%***
$35 Flat Fee	12.98	7.94	0.89	3.93	**25.75**	$ 18.60	$ 30.02	$ 1.28	$ 15.10	**$ 64.99**	**$ 160.67**
% Change	*-10.0%*	*5.9%*	*14.2%*	*1.8%*	***-3.1%***	*2.6%*	*6.3%*	*17.3%*	*2.1%*	***4.4%***	***1.7%***

Source: CDM Smith Analysis

7.7 Transponder Issuance Cost

The prospective scenario assumes that WV E-ZPass transponders are issued at a one-time initial cost of $13 (for those who do not already have a transponder). The sensitivity of this parameter was tested by changing the value to $5, $10, $15, and $20. The results are presented on **Table 7-8**.

While the revenue forecast does not include the revenue generated from the transponder sales, the issuance cost does affect customers' choice of payment method (flat fee program, cash, or E-ZPass) and therefore influences the revenue generated from the various payment types.

With a lower issuance cost ($5 or $10), there is a higher incentive to enter the flat fee program, producing more revenue from the annual flat fee and less revenue from cash payment. The increased revenue from the flat fee exceeds the reduction in toll revenue, leading to an overall revenue increase. The opposite trend is observed in the case of a higher issuance cost ($15 or $20) which produces a decrease in revenue. For instance, with an issuance cost of $20 (i.e. 54% higher than the prospective scenario), the overall revenue decreases by 0.4%.

Table 7-8 Transponder Issuance Cost Sensitivity Test

2030 Issuance Cost Test	Toll Transactions (millions)					Revenue (millions year of collection dollars)					
	Class 1 Flat Fee	Class 1 Cash	Class 1 WV E-ZPass	Class 1 Non-WV E-ZPass	Total Class 1	Class 1 Flat Fee	Class 1 Cash	Class 1 WV E-ZPass	Class 1 Non-WV E-ZPass	Total Class 1	Total All Classes
Prospective Scenario ($13)	14.43	7.50	0.78	3.86	**26.58**	$ 18.13	$ 28.24	$ 1.09	$ 14.78	**$ 62.24**	**$ 157.92**
$5 Issuance Cost	16.01	6.99	0.67	3.78	**27.45**	$ 21.78	$ 26.19	$ 0.92	$ 14.40	**$ 63.28**	**$ 158.96**
% Change	*10.9%*	*-6.8%*	*-13.9%*	*-2.2%*	***3.3%***	*20.1%*	*-7.3%*	*-15.9%*	*-2.6%*	***1.7%***	***0.7%***
$10 Issuance Cost	15.01	7.31	0.74	3.83	**26.90**	$ 19.42	$ 27.49	$ 1.02	$ 14.65	**$ 62.58**	**$ 158.26**
% Change	*4.0%*	*-2.5%*	*-5.3%*	*-0.8%*	***1.2%***	*7.2%*	*-2.7%*	*-6.1%*	*-0.9%*	***0.6%***	***0.2%***
$15 Issuance Cost	14.05	7.62	0.81	3.88	**26.36**	$ 17.31	$ 28.73	$ 1.14	$ 14.87	**$ 62.04**	**$ 157.72**
% Change	*-2.7%*	*1.6%*	*3.5%*	*0.5%*	***-0.8%***	*-4.5%*	*1.7%*	*4.2%*	*0.6%*	***-0.3%***	***-0.1%***
$20 Issuance Cost	13.11	7.91	0.88	3.93	**25.82**	$ 15.41	$ 29.91	$ 1.25	$ 15.06	**$ 61.63**	**$ 157.31**
% Change	*-9.2%*	*5.5%*	*12.5%*	*1.6%*	***-2.8%***	*-15.0%*	*5.9%*	*15.1%*	*1.9%*	***-1.0%***	***-0.4%***

Source: CDM Smith Analysis

7.8 Multi-plaza Divider

In the prospective scenario, the number of Class 1 customers was initially derived from the number of customers at each plaza. The total number of customers at all plazas was divided by three to account for one-way trips involving travel through more than one plaza. The sensitivity of this parameter was tested by changing the value from 3 to 2.5. The results are presented in **Table 7-9**.

Table 7-9 Multi-plaza Divider Sensitivity Test

2030 Multiplaza Divider Test	Toll Transactions (millions)					Revenue (millions year of collection dollars)					
	Class 1 Flat Fee	Class 1 Cash	Class 1 WV E-ZPass	Class 1 Non-WV E-ZPass	Total Class 1	Class 1 Flat Fee	Class 1 Cash	Class 1 WV E-ZPass	Class 1 Non-WV E-ZPass	Total Class 1	Total All Classes
Prospective Scenario (Divider = 3)	14.43	7.50	0.78	3.86	**26.58**	$ 18.13	$ 28.24	$ 1.09	$ 14.78	**$ 62.24**	**$ 157.92**
Divider 2.5	14.43	7.50	0.78	3.86	**26.58**	$ 21.75	$ 28.24	$ 1.09	$ 14.78	**$ 65.87**	**$ 161.54**
% Change	*0.0%*	*0.0%*	*0.0%*	*0.0%*	***0.0%***	*20.0%*	*0.0%*	*0.0%*	*0.0%*	***5.8%***	***2.3%***

Source: CDM Smith Analysis

The divider factor does not have any impact on transactions or tolled revenue, it only affects the amount of fee generated by customers entering the flat fee program. By changing the parameter from 3 to 2.5, the revenue from Class 1 vehicles increases by 5.8%, which represents a 2.3% increase in overall revenue.

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Disclaimer

CDM Smith used currently-accepted professional practices and procedures in the development of the traffic and revenue (T&R) estimates in this report. However, as with any forecast, differences between forecasted and actual results may occur, as caused by events and circumstances beyond the control of the forecasters. In formulating the estimates, CDM Smith reasonably relied upon the accuracy and completeness of information provided (both written and oral) by the West Virginia Parkways Authority (WVPA), Resource Systems Group, Inc. and StreetLight Data, Inc. CDM Smith also relied upon the reasonable assurances of independent parties and is not aware of any material facts that would make such information misleading.

CDM Smith made qualitative judgments related to several key variables in the development and analysis of the T&R estimates that must be considered as a whole; therefore, selecting portions of any individual result without consideration of the intent of the whole may create a misleading or incomplete view of the results and the underlying methodologies used to obtain the results. CDM Smith gives no opinion as to the value or merit of partial information extracted from this report.

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