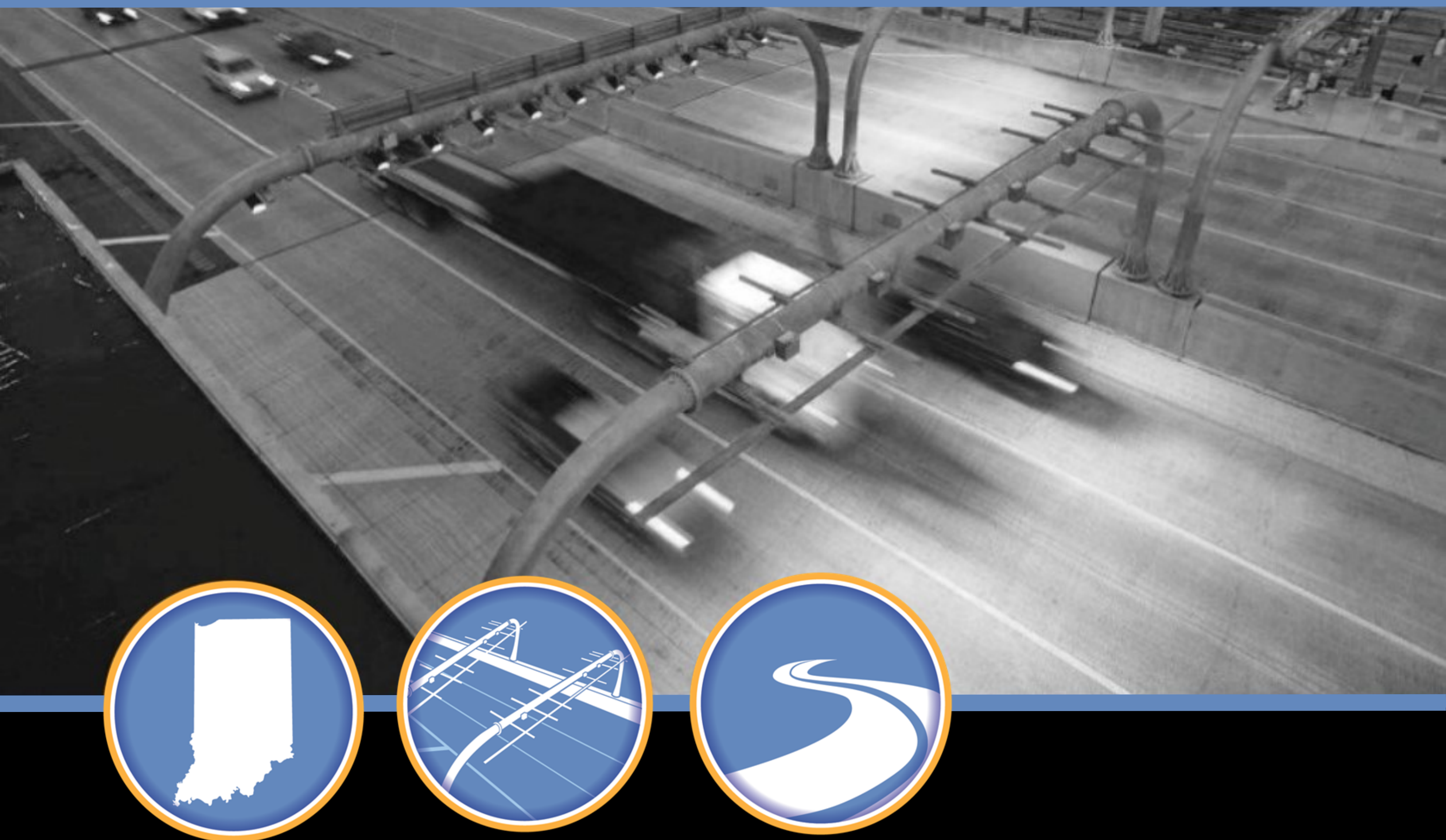

Statewide Interstate Tolling Strategic Plan

APPENDIX C: TRAFFIC & REVENUE ANALYSIS

Indiana Department of Transportation

November 2018

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1. INTRODUCTION

This document summarizes the traffic and revenue analysis that supported INDOT's strategic planning effort. The report provides illustrative examples of potential revenue and traffic impacts under multiple toll rate scenarios and toll sequencing options

1.1 Overview of Traffic & Revenue Analysis

The objectives of the traffic and revenue analysis effort were to:

- Develop a statewide model suitable for testing tolling on the study corridors;
- Develop initial traffic and revenue forecasts; and
- Refine the statewide model including calibration to actual traffic counts, revised value of time based on demographic statistics, network and analysis zone refinement, and origin-destination flows refinement.

For planning purposes, a simplified modeling approach was used to enable the testing of a large number of potential projects and combinations of their sequencing. The modeling approach accounted for:

- Separate toll rates for vehicles with and without a registered transponder;
- Three categories of vehicles (2-axle, 3- and 4-axle, and 5 or more axles);
- Tolls based on cost per mile of travel; and
- Expansion projects which may be funded by tolling.

The information and analysis contained in this report are intended to support the strategic planning process. This report is not intended to preclude or replace more detailed traffic and revenue studies that could be completed in subsequent phases of INDOT's project development process.

There are many factors which could contribute to alternative results. Major factors include: economic growth, share of electronic toll collection payment, commercial vehicle share of traffic, execution of currently programmed transportation improvements, execution of the toll funded improvements, and on a more limited basis, construction schedules as they may impact traffic on the studied routes.

Moving forward, additional refinements could be applied which should improve the model's ability and help INDOT understand sensitivity to key factors. These include:

- Compile traffic counts on key highway segments and ramps in corridors to develop a more detailed traffic profile;

- Update the tolling model to be based on the upcoming revised statewide model, ISTDM8, which will include an updated network, socioeconomic data, trip distribution, and other components;
- In urban areas, develop time of day tolling models from regional urban models to account for time of day variations and congestion;
- Conduct stated preference surveys to help inform model input factors, origin-destination patterns, and state of residence; and
- Conduct sensitivity tests on factors which affect traffic and toll revenue outcomes including economic growth, electronic toll collection share, and truck proportions.

1.2 Corridor Definitions

Figure 1-1 and Table 1-1 present the corridors included in the tolling analysis.

The following naming conventions should be noted:

- I-94 is commonly referred to as the Borman Expressway from the Illinois state line to I-65.
- I-94 is combined with I-80 for 16.0 miles from the Illinois state line; and
- I-70 is combined with I-65 for 2.2 miles in downtown Indianapolis.

Figure 1-1. Indiana Tolling Corridors

Table 1-1. Corridor Locations

Name	Description	Mile Markers
I-94	Encompasses all of I-94 from the Illinois State line to the Michigan state line	1 to 45
I-65	Begins at the Kentucky state line and ends just south of I-90, the Indiana Toll Road	1 to 261
I-70	Begins at the Illinois state line and ends at the Ohio state line	1 to 156

2. STATEWIDE TOLL MODEL

As part of the tolling strategic planning process, a statewide travel demand model was developed to assist with the estimation of future year toll transactions and toll revenue. The basis for this model was INDOT's current Indiana Statewide Travel Demand Model version 7 (ISTDM7). ISTDM7 covers Indiana and portions of the four surrounding states (Illinois, Kentucky, Michigan, and Ohio). INDOT uses ISTDM7 to forecast future traffic volumes.

This chapter describes how the project team used ISTDM7 as the basis for a statewide tolling model. The Supplemental Information provides additional detail regarding model calibration and assumed values used in the tolling model (see Section 7.1).

2.1 Data Inputs

INDOT provided the project team with all files necessary to run the ISTDM7, relevant modeling documentation, traffic counts, and a list of existing and future highway improvements.

During the tolling strategic planning process, INDOT was in the process of updating ISTDM7 to a new version, referred to as ISTDM8. Although ISTDM8 was not fully available for this effort, INDOT was able to provide updated socioeconomic data, which includes population and employment forecasts.

2.2 Conversion to a Tolling Model

The project team used the ISTDM7 modeling files to project traffic volumes with and without the potential widening of I-65 and I-70 outside of I-465. It then incorporated the results into a new model that uses CDM Smith's proprietary tolling algorithm.

2.3 Model Calibration

The study team calibrated the tolling model so that the 2017 traffic volumes were consistent with INDOT's observed traffic counts.

3. TRAFFIC AND REVENUE RESULTS

3.1 Toll Rate Scenarios

For planning purposes, the project team evaluated the example tolling scenarios presented in Table 3-1. The rates range from the rates presented in INDOT's *Toll Feasibility Study* (Scenario 1) to the current rates used by the Indiana Toll Road (Scenario 4).

Table 3-1. Toll Rate Scenarios for per Mile for Vehicles with a Transponder (2018$)

Vehicle Class	Scenario 1	Scenario 2	Scenario 3	Scenario 4
2 axles	$0.04	$0.05	$0.06	$0.07
3 and 4 axles	$0.06	$0.07	$0.08	$0.10
5 or more axles	$0.19	$0.20	$0.24	$0.38

Vehicles that do not pay with a transponder would be billed by mail, based on an image of their license plate. Billing by mail costs more than billing electronically because it requires reading a license plate number from a photo, tracking down contact information for the driver associated with the plates, and mailing an invoice. INDOT would increase the toll rates for vehicles without a transponder to cover these additional costs. For planning purposes, the project team assumed a 50 percent increase in toll rates for vehicles without a transponder in good standing. A 50 percent increase is consistent with increases used by tolling agencies throughout the U.S.

Following are the assumptions regarding the percent of vehicles paying via transponder:

- Vehicles with 2, 3, and 4 axles
  - Year 1 = 60 percent
  - Year 10 = 80 percent
  - Year 15 = 85 percent
- Vehicles with 5 or more axles
  - Year 1 = 75 percent
  - Year 10 = 90 percent

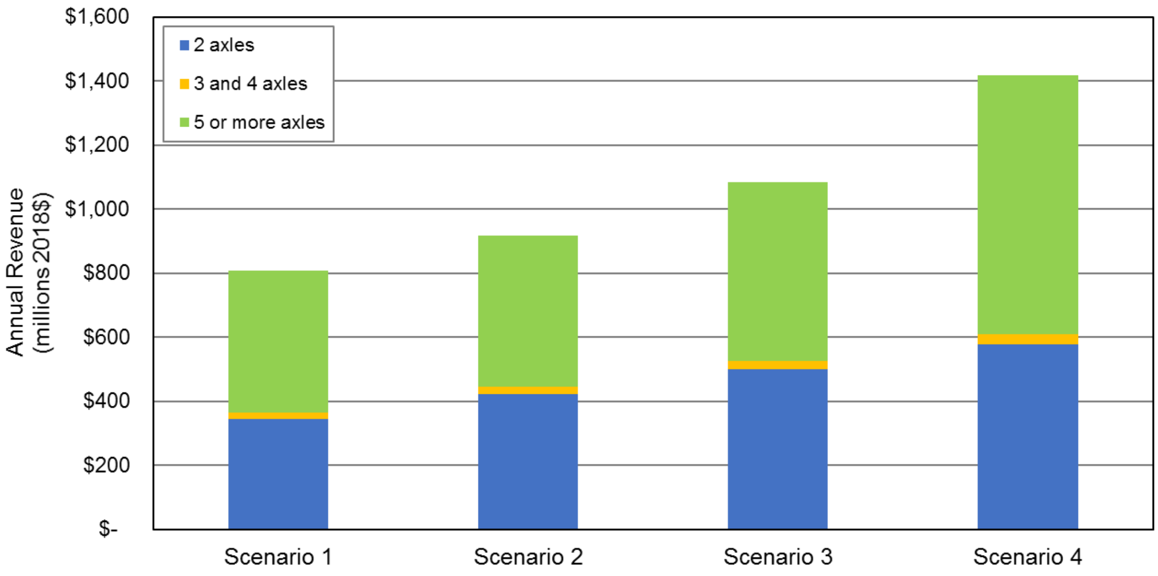
Results for the four example tolling scenarios are shown in Table 3-2 and Figure 3-1. The revenue figures here and elsewhere in this report represent gross revenue. Net revenue adjustments would include cost to collect and revenue leakage from uncollectable transactions as well as other factors.

Toll transactions for 2045 are shown to be about 3.8 million for the lowest toll rate tested, decreasing to 3.6 million for the highest toll rate tested. Gross revenue for 2045 is modeled to be approximately $807M for the lowest toll rate scenario, increasing to $1.417B for the highest toll level. Overall diversion from tolled facilities (vs non-tolled) is estimated to be about 6 percent of all segment trips for the lowest toll rate scenario to nearly 9 percent for the highest toll rate scenario. Diversion occurs when vehicles choose to take an un-tolled roadway to avoid tolls.

Table 3-2. Toll Rate Scenarios – Traffic and Gross Revenue Projections

	Scenario 1	Scenario 2	Scenario 3	Scenario 4
Transactions in 2045 (Millions)				
2 axles	3,042	3,009	2,984	2,967
3 or 4 axles	133	133	133	133
5 or more axles	576	582	575	534
Total	3,751	3,724	3,692	3,633
Annual Gross Revenue in 2045 (Millions of 2018 dollars)				
2 axles	$344	$423	$501	$577
3 or 4 axles	$20	$23	$26	$32
5 or more axles	$443	$471	$558	$807
Total	$807	$917	$1,084	$1,417
Estimated Diversion in 2045				
2 axles	-5.7%	-6.8%	-7.6%	-8.1%
3 or 4 axles	-3.8%	-3.7%	-3.6%	-3.8%
5 or more axles	-7.8%	-6.8%	-7.8%	-14.5%
Total	-6.0%	-6.7%	-7.5%	-8.9%

Figure 3-1. Toll Rate Scenarios – Projected Annual Gross Revenue in 2045



3.2 Toll Sequencing Options

In addition to evaluating different toll rate scenarios, the study team evaluated different toll sequencing options. Each sequencing option represents a potential approach for phasing in tolls over time. In each option, tolling begins on a segment of I-65, I-70, and I-94 after one of the following events:

- The segment is widened;
- A bridge on the segment is reconstructed; or
- INDOT receives authorization from FHWA to use tolling as a congestion management toll on the segment.

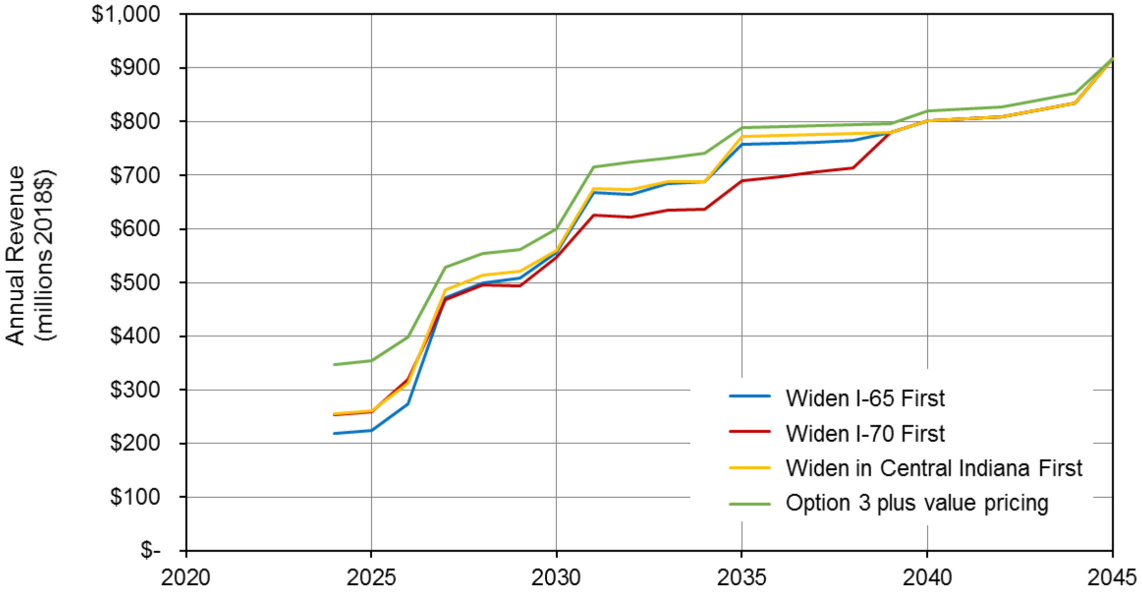
The project team evaluated the following options for toll sequencing, focusing on widening I-65 and I-70. These options are shown graphically in the Supplemental Information (see Section 7.2).

- Option 1: Widen I-65 first. In this option, INDOT would first widen four-lane portions of I-65 outside of I-465 and then widen four-lane portions of I-70 outside of I-465.
- Option 2: Widen I-70 first. In this option, INDOT would first widen four-lane portions of I-70 outside of I-465 and then widen four-lane portions of I-65 outside of I-465.
- Option 3: Central Indiana first. In this option, the widening work would begin on both I-65 and I-70 in the central part of the state and proceed out towards the state's borders.

- Option 4: Option 3 plus early tolling in congested urban areas. In this option, widening proceeds as described for Option 3. In addition, it was assumed that tolling along I-65 and I-70 within I-465, and along I-94 from I-65 to the Illinois state line would be done through the FHWA's value pricing pilot program. In this program, tolling is used as a congestion management tool by varying tolls by time of day. For example, the toll rate during rush hour could be higher than the rate during other parts of the day. The project team did not analyze this type of variable toll rate structure as part of this effort. For the purposes of this study, the project team applied a single toll rate, but assumed tolling on these segments would begin in the phase 1 of the sequencing plan.

The project team projected traffic and revenue for each sequencing option using toll rate scenario 2 described in Table 3-1. The results of this analysis are provided in Figure 3-2. **For this analysis, it was assumed that tolling could begin in 2024. This assumption is an example and not meant to suggest that any type of tolling implementation timeframe has been established.**

Figure 3-2. Projected Gross Revenue by Toll Sequencing Option



4. IN-STATE VS. OUT-OF-STATE TRAVEL

It is assumed that INDOT would use the same toll rates for in-state and out-of-state vehicles. However, because I-65, I-70, and I-94 serve a significant role in interstate travel, the project team estimated the split between in-state and out-of-state travel on these corridors.

The project team used data from the U.S. Census American Community Survey (ACS) commuting flows to estimate in-state and out-of-state traffic at county and state levels.[1] To estimate traffic on individual travel corridors, the team analyzed vehicle probe data.

4.1 Census Data

Table 4-1 summarizes worker residence information from ACS data. The ACS data shows that 94.7 percent of Indiana residents live and work within Indiana.

Table 4-1. Worker Residence by State

Residence	Workplace				
	Illinois	Indiana	Kentucky	Michigan	Ohio
Illinois	99.3%	0.5%	0.1%	0.0%	0.0%
Indiana	2.4%	94.7%	1.8%	0.3%	0.8%
Kentucky	0.2%	1.4%	95.0%	0.0%	3.4%
Michigan	0.1%	0.6%	0.0%	98.7%	0.6%
Ohio	0.0%	0.3%	0.7%	0.2%	98.7%

Table 4-2 summarizes commuting patterns for select counties and geographies in Indiana. Northwest Indiana near Chicago and Southeast Indiana near Louisville both experience higher shares of workers commuting out of and into Indiana than other significant population centers in the state. The data generally indicates that the closer a county is to a bordering state with a significant city, the higher the percentage of workers commuting out of and into Indiana. For example, Lake County, bordering Illinois near Chicago, has a higher share of residents working outside Indiana (25.1 percent) compared to Porter County (8.6 percent) and LaPorte County (5.8 percent) to the east. Also, a higher share of workers in Lake County live outside Indiana (8.6 percent) compared to 1.7 percent of workers in Porter County and 2.5 percent in LaPorte County. In the southeast portion of the state, 36.6 percent of residents in Clark

[1] U.S. Census Bureau, *American Community Survey*. Table of Residence County to Workplace County Flows for the United States and Puerto Rico Sorted by Residence Geography, https://www.census.gov/topics/employment/commuting/guidance/flows.html

County and Floyd County work outside of Indiana and 14.5 percent of workers in the two counties live outside Indiana.

Terre Haute, in Vigo County near Illinois, and Richmond, in Wayne County near Ohio, are cities in Indiana located near rural areas in bordering states. A higher percentage of workers in these areas live outside the state compared to the percentage of residents that work outside the state. In Vigo County, 1.5 percent of residents work outside the state while 4.6 percent of workers reside outside of Indiana. In Wayne County, 5 percent of residents work outside the state while 7.8 percent of workers reside outside of Indiana.

In summary, Lake County bordering the Chicago area and Clark County and Floyd County bordering Louisville have a higher share of residents working outside the state. Other counties are relatively far from urban locations outside Indiana and as a result, relatively few residents work outside the state.

Table 4-2. Census-Based Commuting Patterns

Geographic Area	Commuting out of Indiana	Commuting into Indiana
State of Indiana	5.3%	0.7%
Northwest Indiana	18.6%	6.4%
Lake County	25.1%	8.6%
Porter County	8.6%	1.7%
LaPorte County	5.8%	2.5%
Central Indiana	0.4%	0.5%
Boone County	0.5%	0.2%
Hamilton County	0.4%	0.4%
Hancock County	0.5%	0.2%
Marion County	0.3%	0.6%
Hendricks County	0.5%	0.3%
Morgan County	0.7%	0.5%
Johnson County	0.6%	0.4%
Shelby County	0.4%	0.0%
Lafayette (Tippecanoe County)	0.3%	0.6%
Terre Haute (Vigo County)	1.5%	4.6%
Richmond (Wayne County)	5.0%	7.8%
Southeast Indiana	36.6%	14.5%
Clark County	36.8%	16.8%
Floyd County	36.4%	11.1%

4.2 Vehicle Probe Data

The project team obtained and analyzed proprietary vehicle probe data to estimate the share of travel on the tolling corridors by motorists who live inside and outside Indiana. Details of this analysis are provided in the Supplemental Information (see Section 6.3).

Table 4-3 presents the results of the analysis. It shows the split of in-state versus out-of-state passenger cars and commercial vehicles by corridor. In this analysis, passenger cars are roughly equivalent to the 2-axle vehicles described in Chapter 4, and commercial vehicles are roughly equivalent to vehicles with three or more axles. The results are presented as a percent of vehicle miles traveled (VMT).

Table 4-3. In-State vs. Out-of-State VMT for Toll Rate Scenario 2 in 2045

	Passenger Cars		Commercial Vehicles		Total	
	In-State VMT%	Out-of-State VMT%	In-State VMT%	Out-of-State VMT%	In-State VMT%	Out-of-State VMT%
I-65	81%	19%	75%	25%	80%	20%
I-70	82%	18%	59%	41%	73%	27%
I-94	50%	50%	39%	61%	48%	52%
Total	**75%**	**25%**	**65%**	**35%**	**73%**	**27%**

While VMT provides a good indication of possible usage on the studied corridors, applying the splits by vehicle type to revenue in each segment yields a slightly different in-state vs. out-of-state breakout since commercial vehicles were studied with higher per mile toll rates than passenger cars. The results are provided in Table 4-4. While the passenger car and commercial vehicle shares stay essentially the same as the VMT shares, the in-state revenue share drops from 73 percent to 70 percent and the out-of-state revenue share increases from 27 percent to 30 percent. This is due to the commercial vehicles having higher toll rates and higher out-of-state shares than passenger cars.

Table 4-4. In-State vs. Out-of-State Revenue for Toll Rate Scenario 2 in 2045

	Passenger Cars		Commercial Vehicles		Total	
	In-State Revenue Share	Out-of-State Revenue Share	In-State Revenue Share	Out-of-State Revenue Share	In-State Revenue Share	Out-of-State Revenue Share
I-65	81%	19%	74%	26%	77%	23%
I-70	82%	18%	58%	42%	66%	34%
I-94	50%	50%	38%	62%	45%	55%
Total	**75%**	**25%**	**65%**	**35%**	**70%**	**30%**

5. CONCLUSION

This report provides illustrative traffic and gross toll revenue estimates for several toll rate scenarios and toll sequencing options. The analysis shows how toll revenue and diversion are dependent on toll rates. For the range of toll rates evaluated as part of the strategic planning process, higher toll rates result in higher revenues and higher traffic diversion rates. The analysis also shows how toll revenue would vary for four example toll sequencing options.

There are many factors which could contribute to results that are different from the ones presented in this document. Examples include: economic growth, the percent of vehicles that pay tolls electronically via a transponder, the amount of commercial vehicles that use the tolled corridors, the execution of roadway improvements, and on a more limited basis, construction schedules as they may impact traffic on the studied routes. These assumptions would be revisited if INDOT conducted any subsequent project-specific analysis.

6. SUPPLEMENTAL INFORMATION

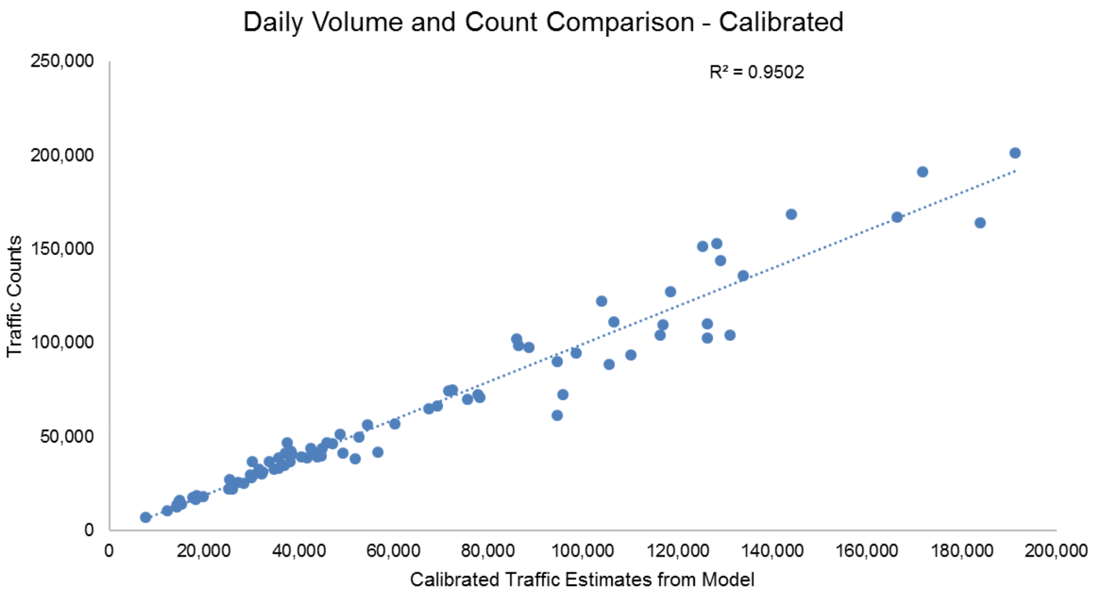
This chapter provides additional details for the analysis described in this report.

6.1 Statewide Model Details

Model Calibration

As part of the modeling effort, the project team compared 2017 volumes in the new tolling model to actual traffic volumes observed by INDOT, and calibrated the model accordingly. The adjustments made during the calibration process included refinements to the highway network and minor capacity or input speed changes. These adjustments were based on observed traffic counts and experience-based professional judgment. Figure 6-1 shows the results of the calibration process. A reasonably good fit was accomplished in the calibration process for all vehicle types.

Figure 6-1. Calibration Results



Value of Time and Vehicle Operating Costs

Motorists' perception of their value of time (VOT) is one of the key components of the decision to use a toll facility or an alternative non-tolled route. People attach different values to their time depending on the purpose of their trip. Values of time were developed for the toll diversion analysis, where the relative advantage of driving on the toll road is weighed against taking an alternate route.

For the current study, regional VOTs were estimated. These regional VOTs were developed based on Indiana household income data from the U.S. Census and the number of trips from the model. The VOTs for the model area averaged $10.80 per hour for passenger cars, $12.00 for small commercial vehicles, $24.00 for medium commercial vehicles, and $36.00 for large commercial vehicles. The VOTs are in 2018 dollars.

In the case of vehicle operating costs (VOC), past studies have shown that drivers primarily perceive the fuel cost as the most important in decisions regarding trip path, but also give some consideration to other usage-related costs, such as maintenance, oil, and tires at a discounted level. Factors such as depreciation and insurance are not included in the operating cost estimate. Based on current information from the American Automobile Association and US Energy Information Administration, vehicle operating costs of $0.18 per mile for passenger cars and small trucks, and $0.35/$0.53 per mile for medium/large trucks were assumed. All values are in 2018 dollars.

Modeling Diversion

A key part of modeling traffic on a tolled corridor is estimating the amount of diversion that results from drivers opting to leave the corridor and take an alternative, non-tolled route. The first step in estimating diversion is to compute travel time and travel costs between each origin-destination zone pair for a tolled and non-tolled path. Travel time and cost matrices are developed using a path-building process in the model. Using the time, distance, and toll cost, a ratio of generalized cost for each path is calculated as follows:

$$CR = \frac{Toll\ Path\ Cost}{Free\ Path\ Cost} = \frac{VOT * Tt + OC * Dt + Toll}{VOT * Tf + OC * Df}$$

Where,
CR= Cost Ratio
VOT= Value of Time
Tt= Travel Time on Toll Path
OC= Vehicle Operating Cost
Dt= Distance traveled on Toll Path
Toll= Toll Cost
Tf= Travel Time on Non-Tolled Path
Df= Distance traveled on Non-Tolled Path

The cost ratio calculated for each movement is then used to split the original trip tables into “toll” and “non-tolled” components which are then assigned in the model network. The model used for this purpose resembles an S-curve that assumes that if the costs are the same, a trip maker would be indifferent, and a 50/50 split would occur between the tolled and non-tolled paths. As the toll path cost increases, the share of tolled trips decreases, and more trips are assigned to the non-tolled path. However, the resulting congestion on the non-tolled path would cause some trips in the next iteration to shift back to the tolled path. In each iteration, the toll trips are assigned to the tolled path and non-toll trips to the non-tolled path. This process is repeated until a user equilibrium criterion is satisfied, (i.e., no further rerouting is possible without user cost degradation). This traffic assignment methodology is referred to as User Equilibrium Assignment and is common in travel demand models.

Information obtained from the assignment process includes the number of vehicles using the tolled and non-tolled paths. The number of vehicles assigned to each tolled segment was used to determine the revenue. In addition, by running a non-tolled version of the model, and comparing the results to each toll scenario, the diversion due to tolling can be estimated.

Generally, diversion occurs on an individual tolled segment basis. The main factors in diversion include capacity and congestion on the tolled segments, capacity and congestion on alternative non-tolled segments, the length of trip, value of time, and vehicle operating cost. In particular, as the length of trip increases, the tolled segments of the trip may make up a smaller portion of overall trip cost. With higher values of time, the tolled vs. non-tolled trade-off leans towards using the tolled roadway, particularly for trucks which often have a higher value of time.

Estimating Annual Traffic Volumes

INDOT's statewide travel demand model is designed to project daily traffic volumes. For the strategic planning process it was important to understand annual traffic volumes; therefore the project team needed to develop an annualization factor for converting daily traffic volumes to annual traffic volumes. The study team reviewed traffic data from 15 permanent count stations maintained by INDOT along the I-80/94, I-65, and I-70 interstate corridors. The data provided detailed average weekday traffic and annualized average daily traffic for each location. The data from these locations were combined to develop a system wide estimate to convert average weekday traffic to annual traffic. The annualization factor for daily traffic was assumed to be 335. The annualization factor was applied to the daily traffic output produced by the traffic model and corresponding toll rates to estimate annual gross toll revenue.

6.2 Toll Sequencing Details

To support the strategic planning process, the project team developed four illustrative examples of how tolling could be sequenced. The results are illustrated in Figures 6-2 through 6-5. In each figure, the top series of maps identifies the work that INDOT could perform by phase that would make a segment of interstate eligible for tolling. The bottom series of maps identifies the portion of the interstate system that would be eligible for tolling by the end of the phase.

The figures present examples of how tolling could be sequenced based on interstate widening, bridge reconstruction performed without widening, and the potential use of tolling as a congestion management tool in congested urban areas.

Table 6-5 presents estimates of gross toll revenue and toll transactions by year for the each sequencing option.

Figure 6-2. Sequencing Option 1: Widen I-65 First

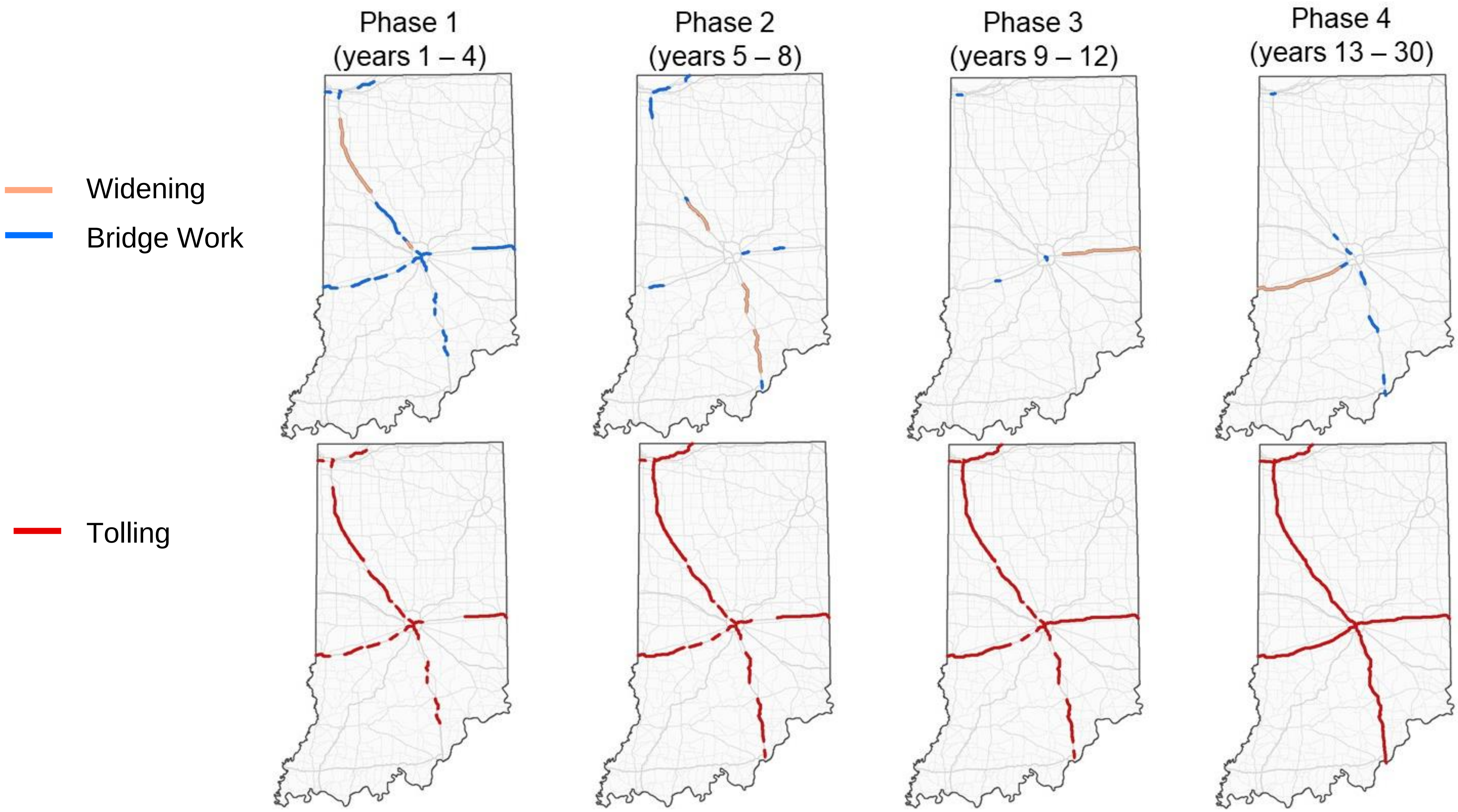


Figure 6-3. Sequencing Option 2: Widen I-70 First

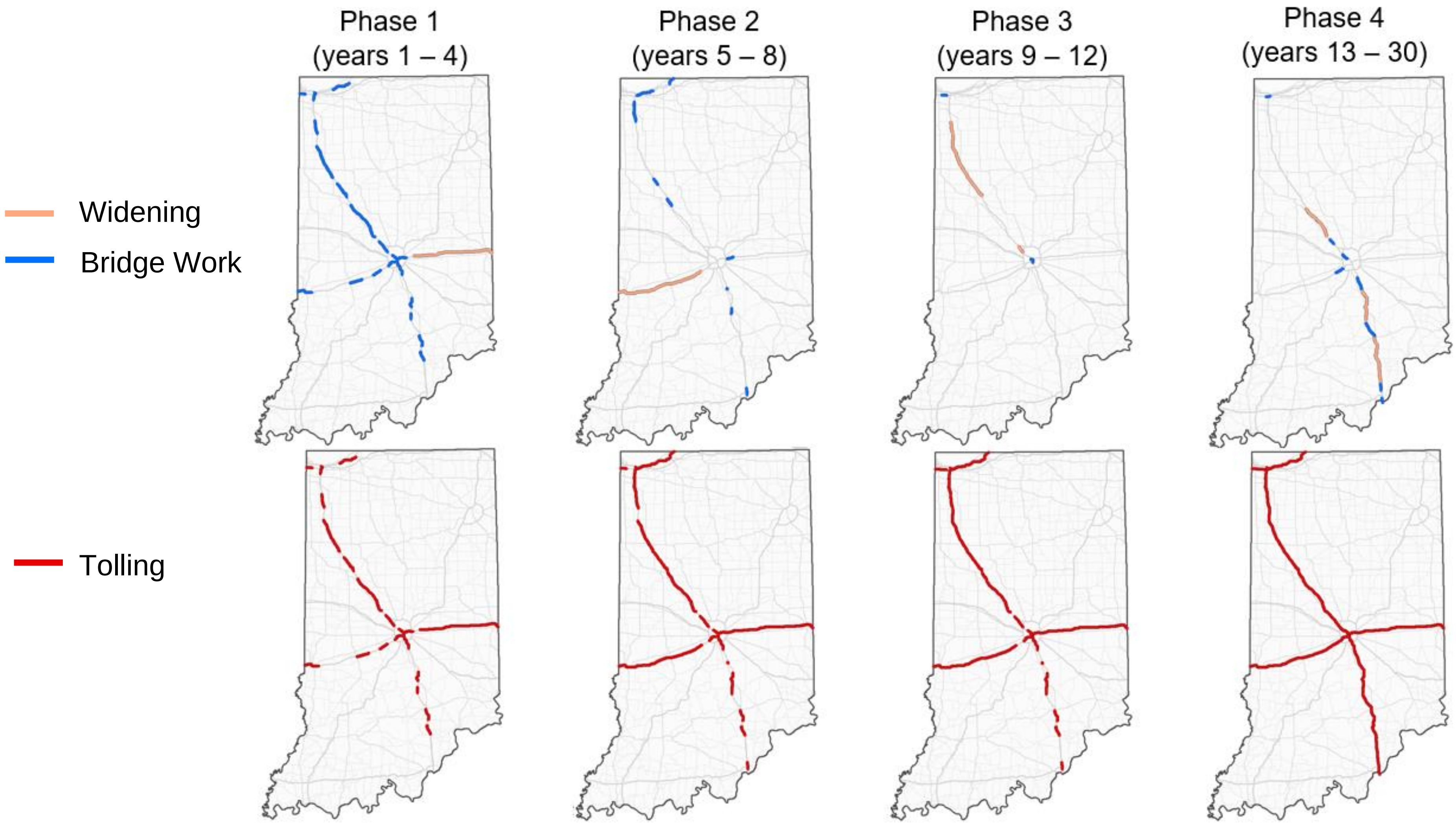


Figure 6-4. Sequencing Option 3: Widen in Central Indiana First

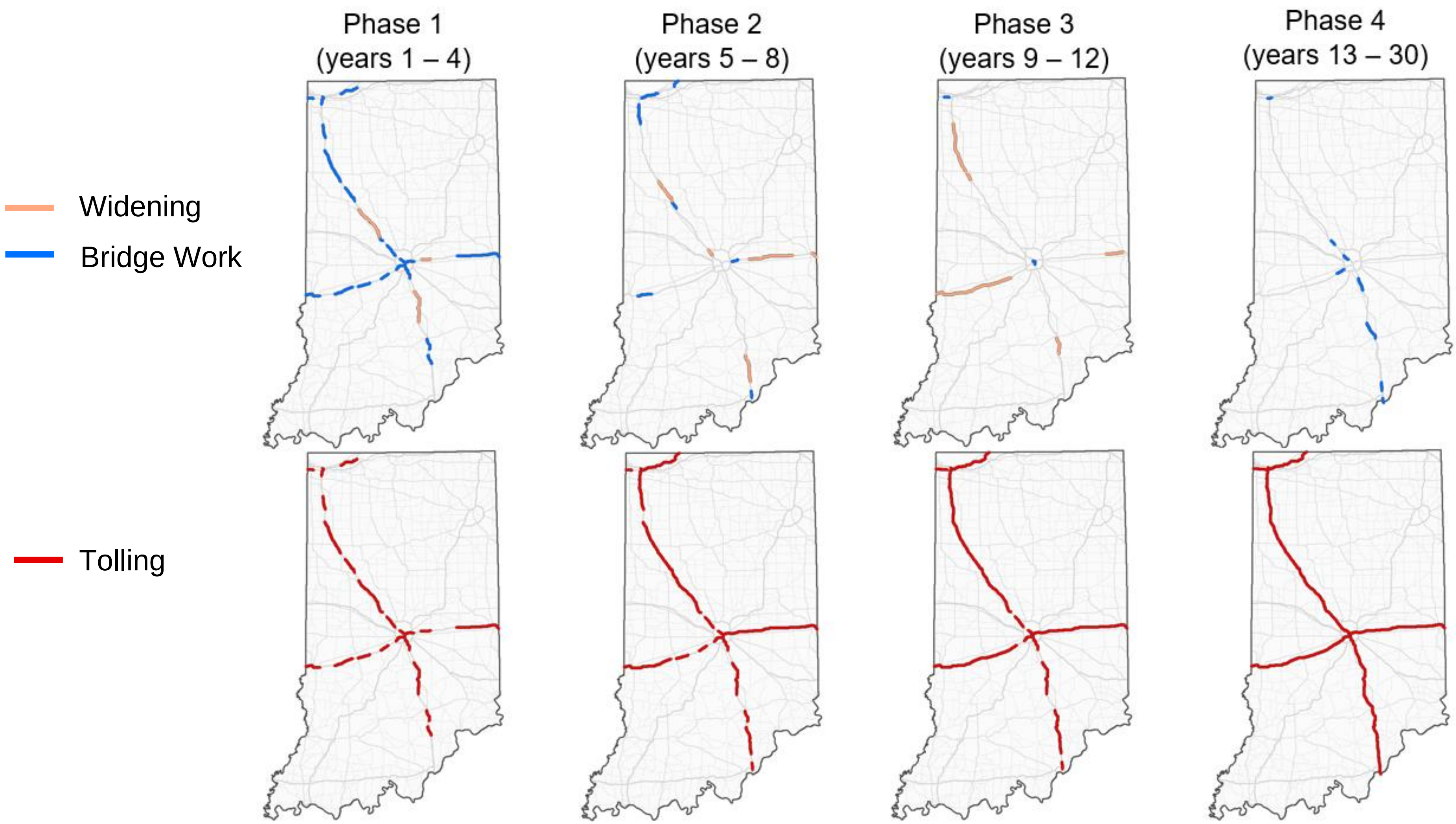


Figure 6-5. Sequencing Option 4: Option 3 Plus Early Tolling in Congested Urban Areas

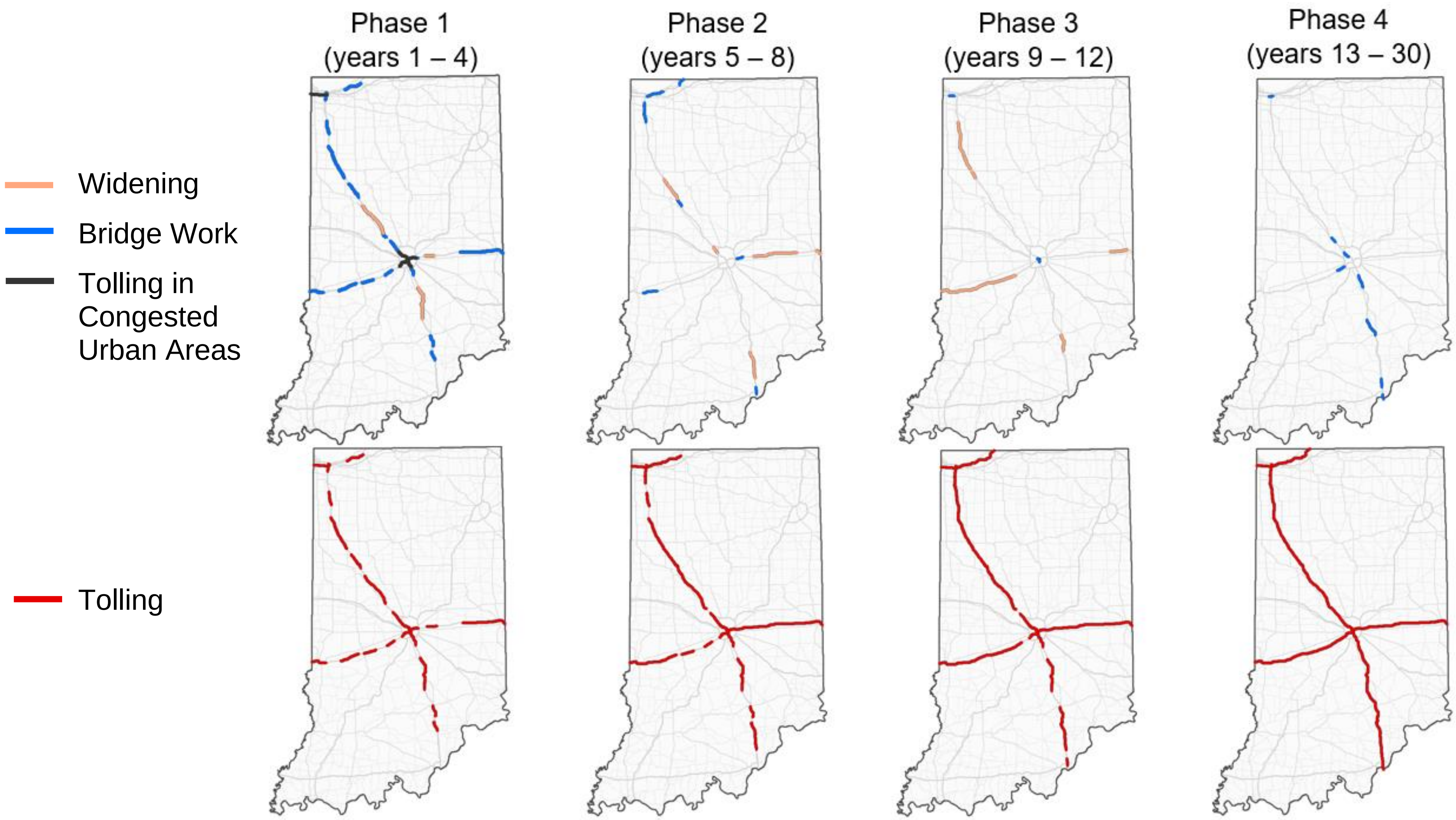


Table 6-1. Annual Transactions and Gross Revenue

	Sequence 1: Widen I-65 First		Sequence 2: Widen I-70 First		Sequence 3: Widen in Central Indiana First		Sequence 4: Option 3 Plus Early Tolling IN Contested Urban Areas	
	Annual Transactions (millions)	Annual Gross Revenue (millions 2018$)	Annual Transactions (millions)	Annual Gross Revenue (millions 2018$)	Annual Transactions (millions)	Annual Gross Revenue (millions 2018$)	Annual Transactions (millions)	Annual Gross Revenue (millions 2018$)
2024	910.2	$218.9	1,003.5	$253.1	1,030.9	$254.7	1,927.0	$48.0
2025	929.5	$225.0	1,026.0	$260.0	1,050.3	$261.1	1,951.3	$354.9
2026	1,118.7	$273.0	1,229.5	$319.4	1,223.9	$312.9	2,038.0	$398.1
2027	1,849.3	$471.0	1,840.0	$468.8	1,913.7	$486.8	2,316.7	$528.6
2028	1,981.3	$498.9	1,970.0	$496.3	2,046.7	$513.7	2,449.5	$554.6
2029	2,002.5	$509.0	1,980.5	$493.6	2,065.1	$521.8	2,467.3	$562.1
2030	2,184.4	$556.0	2,179.6	$547.3	2,236.7	$558.9	2,641.1	$599.3
2031	2,487.1	$667.2	2,375.1	$626.6	2,475.4	$676.0	2,880.3	$716.3
2032	2,497.0	$665.0	2,383.7	$622.4	2,485.4	$673.4	2,910.3	$724.4
2033	2,633.9	$684.6	2,508.4	$635.1	2,611.4	$687.7	2,940.4	$732.5
2034	2,781.3	$687.7	2,648.4	$637.5	2,752.6	$688.5	2,970.4	$740.6
2035	2,880.1	$757.5	2,737.4	$689.7	2,901.9	$772.3	3,063.8	$789.3
2036	2,894.1	$759.8	2,762.9	$697.9	2,912.2	$773.9	3,074.7	$791.2
2037	2,908.0	$762.1	2,788.3	$706.0	2,922.4	$775.6	3,085.6	$793.1
2038	2,921.9	$764.4	2,813.7	$714.2	2,932.6	$777.3	3,096.5	$795.0
2039	2,949.4	$779.1	2,949.4	$779.1	2,942.9	$778.9	3,107.4	$796.9
2040	2,983.4	$801.3	2,983.4	$801.3	2,983.4	$801.3	3,148.7	$819.5

	Sequence 1: Widen I-65 First		Sequence 2: Widen I-70 First		Sequence 3: Widen in Central Indiana First		Sequence 4: Option 3 Plus Early Tolling IN Contested Urban Areas	
	Annual Transactions (millions)	Annual Gross Revenue (millions 2018$)	Annual Transactions (millions)	Annual Gross Revenue (millions 2018$)	Annual Transactions (millions)	Annual Gross Revenue (millions 2018$)	Annual Transactions (millions)	Annual Gross Revenue (millions 2018$)
2041	2,996.9	$805.0	2,996.9	$805.0	2,996.9	$805.0	3,164.7	$823.5
2042	3,010.4	$808.7	3,010.4	$808.7	3,010.4	$808.7	3,180.8	$827.5
2043	3,292.0	$821.4	3,292.0	$821.4	3,292.0	$821.4	3,463.8	$840.4
2044	3,301.9	$834.6	3,301.9	$834.6	3,301.9	$834.6	3,472.5	$853.4
2045	3,723.7	$ 916.9	3,723.7	$916.9	3,723.7	$916.9	3,723.7	$916.9
Total	**55,237.0**	**$14,267.1**	**54,504.7**	**$13,934.8**	**55,812.4**	**$14,501.4**	**63,074.6**	**$15,306.3**

6.3 Vehicle Probe Data Analysis Details

The project team obtained and analyzed proprietary vehicle probe data to estimate the split between in-state and out-of-state travel on the tolling corridors. Two subscription databases are available from the selected vehicle probe data platform: Navigation-GPS data and Location Based Services (LBS) data.

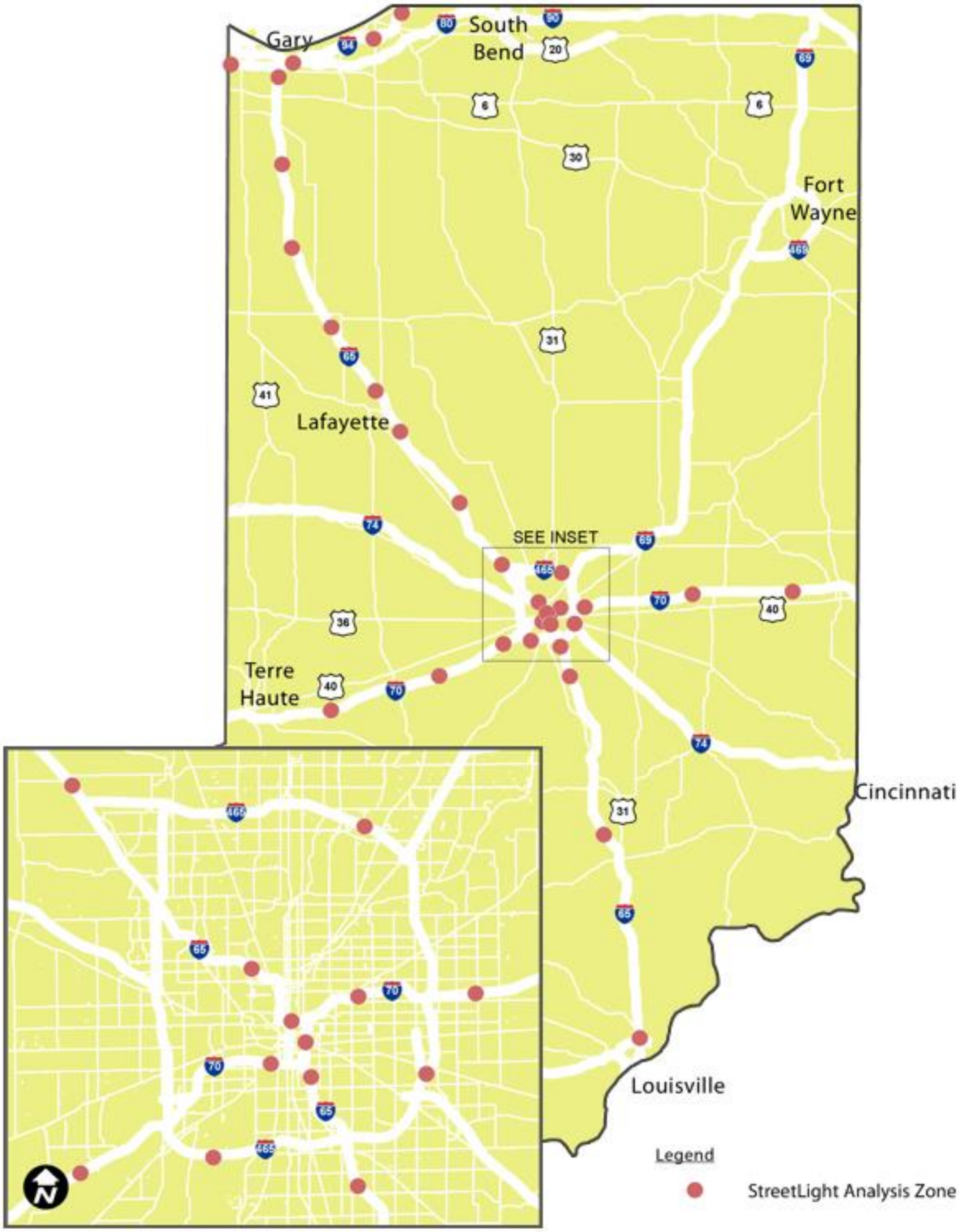
Navigation-GPS data originates from GPS devices in connected cars, smart phones using GPS navigation, and connected commercial trucks. The data was collected from vehicles traveling the potential toll corridors, which makes it helpful in analyzing traffic between specific origins and destinations. Commercial navigation-GPS data samples cover 10 percent to 12 percent of commercial vehicles.

LBS data is derived from smart phone apps that use location-based data to provide their services, such as weather, shopping, or navigation applications, all of which provide services that are fundamentally linked to a user's location. LBS data is more representative of the total population than GPS data, as users do not have to travel on the road to be counted in the LBS data.

Vehicle probe data analyzes the data to derive user activity trips between start and end points. This data was used as a secondary source in analyzing traffic between origins and destinations to estimate in-state and out-of-state traffic. Additionally, vehicle probe data analyzes smartphone-based LBS data over time and infers devices' home and work locations. Figure 6-6 illustrates where data for in-state and out-of-state travelers were examined.

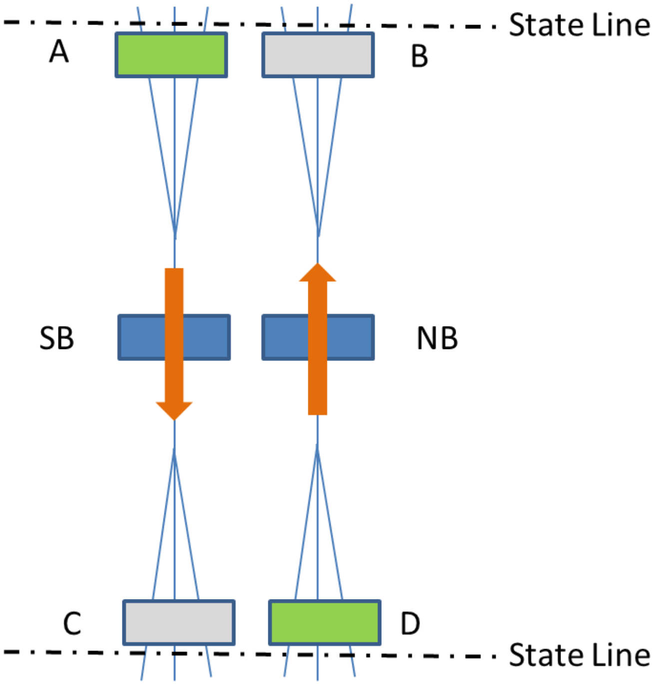
The project team analyzed LBS and GPS traffic data from personal vehicles during five time periods: early AM (12:00-6:00 AM), morning peak (6:01-10:00 AM), mid-day (10:01 AM-3:00 PM), evening peak (3:01-7:00 PM) and late PM (7:01 PM-11:59 PM).

Figure 6-6. Travel Analysis Zones



The project team devised an intuitive process to estimate out-of-state traffic in morning peak and early morning time periods. Directional traffic was estimated at the specific analysis zones along each study corridor and broken down by the share of traffic passing through state borders (Illinois, Kentucky, Ohio, Michigan) both before and after passing through each analysis zone. As seen in Figure 6-7, the share of traffic traveling northbound through analysis zone "NB" which also crossed through zone D represents northbound traffic from out-of-state that passed through or originated at the Indiana state line. The share of traffic traveling northbound through analysis zone "NB" which also crossed through zone B represents the share of northbound traffic that exited at the state line. Similarly, the share of traffic traveling southbound through analysis zone "SB" which also crossed through zone A represents southbound traffic from out-of-state that passed through or originated at the Indiana state line. The share of traffic traveling southbound through analysis zone "SB" which also crossed through zone C represents the share of southbound traffic that exited at the state line. It is assumed that all the traffic that originated out-of-state (i.e. traveling through A and D) are workers or visitors who live outside Indiana since these trips began in the early AM period.

Figure 6-7. AM Origin-Destination Analysis



Similar to the process for the morning peak, it is assumed for the evening peak and late PM all trips ending outside Indiana are workers living outside Indiana or visitors to Indiana. In Figure 6-8, the share of traffic at analysis zone NB crossing zone B and the share of traffic at analysis zone SB crossing zone C is out-of-state traffic.

To derive in-state traffic shares for the mid-day period, a combination of morning and evening peak period estimation is used, assuming half the trips with an origin or destination out of state are out-of-state based trips and half are Indiana based trips. To derive a daily estimate, the directional traffic is weighted by traffic during the different time periods. (It should be noted that the estimated numbers represented by A, B, C, and D vary by time period.)

Figure 6-8. PM Origin-Destination Analysis

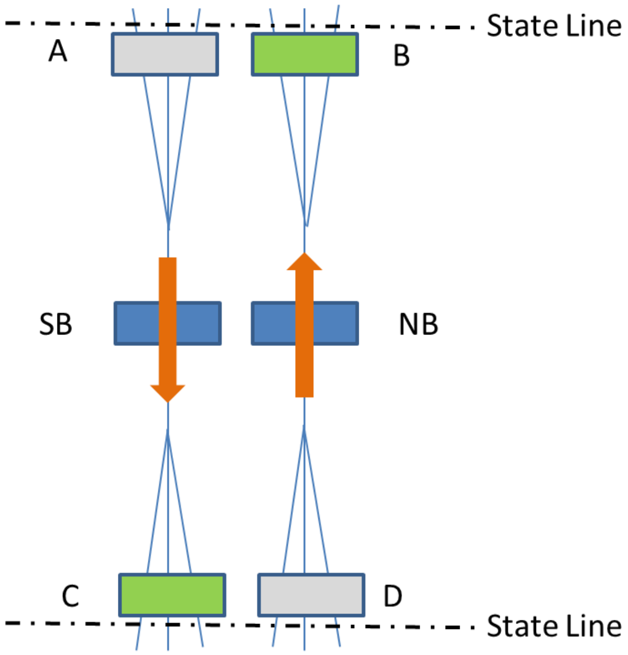


Table 6-2 shows out-of-state traffic estimates for personal vehicles using LBS data and GPS data, and Table 6-3 shows out-of-state traffic estimates for commercial vehicles using GPS data. In general, GPS data led to a higher estimate of out-of-state traffic for personal vehicles.

Table 6-2. Out-of-State Traffic Estimates for Personal Vehicles

Location	Data Source	
	LBS	GPS
I-94		
At Illinois state line	50%	57%
I-94 East of I-65	32%	43%
I-94 West of US 421	37%	57%
I-94 at Michigan state line	76%	87%
I-65 North of Indianapolis		
I-65 South of Gary	14%	34%
I-65 South of Dinwiddie	28%	39%
I-65 South of Fair Oaks	31%	36%
I-65 South of Remington	31%	34%
I-65 North of Lafayette	30%	33%
I-65 East of Lafayette	19%	23%
I-65 West of Mechanicsburg	21%	22%
I-65 NW of I-465 Loop/I-865	6%	13%
Inside I-465 Loop in Indianapolis		
I-65 North of Downtown	2%	4%
I-65 near Downtown	3%	5%
I-65/I-70 Dual East of Downtown	3%	6%
I-65 South of Downtown	1%	5%
I-465 Loop in Indianapolis		
I-465 between I-69 N and US 31 N at the White River	1%	3%
I-465 between I-74 E and US 52 E	2%	8%
I-465 between IN 37 S and IN 67 S at the White River	2%	7%
I-65 South of Indianapolis		
I-65 SE of I-465 Loop	2%	5%
I-65 South of Greenwood	4%	9%
I-65 South of Columbus	12%	18%
I-65 N of I-265	13%	23%

Location	Data Source	
	LBS	GPS
I-70 West of Indianapolis		
I-70 East of Terre Haute	25%	28%
I-70 East of Little Point	20%	24%
I-70 W of I-465 Loop	6%	13%
Inside I-465 Loop		
I-70 SW of Downtown	2%	5%
I-65/I-70 Dual East of Downtown	3%	6%
I-70 East of Downtown	2%	4%
I-70 East of Indianapolis		
I-70 East of I-465 Loop	8%	18%
I-70 East of IN 109	29%	37%
I-70 West of Richmond	35%	43%

Table 6-3. Out-of-State Traffic Estimates by Commercial Vehicle GPS

Location	Out-of-State Traffic
I-94	
At Illinois state line	60%
I-94 East of I-65	59%
I-94 West of US 421	58%
I-94 at Michigan state line	78%
I-65 North of Indianapolis	
I-65 South of Gary	37%
I-65 South of Dinwiddie	35%
I-65 South of Fair Oaks	31%
I-65 South of Remington	30%
I-65 North of Lafayette	30%
I-65 East of Lafayette	28%
I-65 West of Mechanicsburg	27%
I-65 NW of I-465 Loop/I-865	25%
Inside I-465 Loop in Indianapolis	
I-65 North of Downtown	20%
I-65 near Downtown	19%
I-65/I-70 Dual East of Downtown	27%
I-65 South of Downtown	14%
I-465 Loop in Indianapolis	
I-465 between I-69 N and US 31 N at the White River	25%
I-465 between I-74 E and US 52 E	27%

I-465 between IN 37 S and IN 67 S at the White River	27%
I-65 South of Indianapolis	
I-65 SE of I-465 Loop	14%
I-65 South of Greenwood	15%
I-65 South of Columbus	19%
I-65 N of I-265	26%
I-70 West of Indianapolis	
I-70 East of Terre Haute	46%
I-70 East of Little Point	43%
I-70 W of I-465 Loop	35%
Inside I-465 Loop	
I-70 SW of Downtown	28%
I-65/I-70 Dual East of Downtown	27%
I-70 East of Downtown	28%
I-70 East of Indianapolis	
I-70 East of I-465 Loop	37%
I-70 East of IN 109	46%
I-70 West of Richmond	51%

DISCLAIMER

Projections in this report are intended for planning and illustrative purposes only and are not of sufficient depth or rigor to be used in financial planning, funding, or bonding.

CDM Smith used currently accepted professional practices and procedures in the development of the traffic and revenue 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 INDOT. 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 traffic an revenue 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.

All estimates and projections reported herein are based on CDM Smith's experience and judgment and on a review of information obtained from multiple agencies, including INDOT. These estimates and projections may not be indicative of actual or future values and are therefore subject to substantial uncertainty. Future developments cannot be predicted with certainty and may affect the estimates or projections expressed in this report, such that CDM Smith does not specifically guarantee or warrant any estimate or projection contained within this report.

While CDM Smith believes that the projections and other forward-looking statements contained within the report are based on reasonable assumptions as of the date of the report, such forward-looking statements involve risks and uncertainties that may cause actual results to differ materially from the results predicted. Therefore, following the date of this report, CDM Smith will take no responsibility or assume any obligation to advise of changes that may affect its assumptions contained within the report, as they pertain to socioeconomic and demographic forecasts, proposed residential or commercial land use development projects and/or potential improvements to the regional transportation network.

NOTES

- The analysis contained within this document addresses potential tolling along I-65, I-70, I-94. However, no final decisions have been made about if and where to toll. Additionally, tolling may be considered along other interstates (e.g., I-64, I-74, etc.).
- To support the strategic planning process, INDOT evaluated the traffic and revenue implications of various toll rates and implementation timelines. However, neither toll rates nor a timeline have been determined. The actual toll rates and timeline may be different than those analyzed. Additionally, the financial analysis does not take into account any toll discount programs that may be adopted.
- INDOT evaluated the potential to pair tolling with the widening of I-65 and I-70 outside of I-465 to six lanes border-to-border. The analysis assumes that widening these corridors would include bridge reconstruction work that meets the legal basis for tolling under the federal Section 129 General Tolling Program.