TECHNICAL MEMORANDUM

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DATE: 3/17/2014

SUBJECT: Modeling and Traffic Impacts Analysis for Brent Spence Bridge

HNTB JOB NUMBER: 59402

This memorandum describes the technical modeling methodology and analysis for the Brent Spence Bridge project. It outlines a process to incorporate tolling into the trip distribution and traffic assignment steps of the regional Ohio-Kentucky-Indiana (OKI) travel demand model. A summary of model results based on the toll analysis using the OKI regional travel demand model are presented.

This preliminary analysis conducted by HNTB for the Owner (ODOT/KYTC) is not intended for toll traffic and revenue forecasting, but primarily for evaluating the impacts of toll traffic on local roadways. The modeling analysis presented here is also being used to support the re-evaluation of the approved Environmental Assessment (EA) for the Brent Spence Bridge project. HNTB's sub-consultant on this project, Steer Davies Gleave (SDG), is responsible for developing the traffic and revenue analysis.

Project Study Area

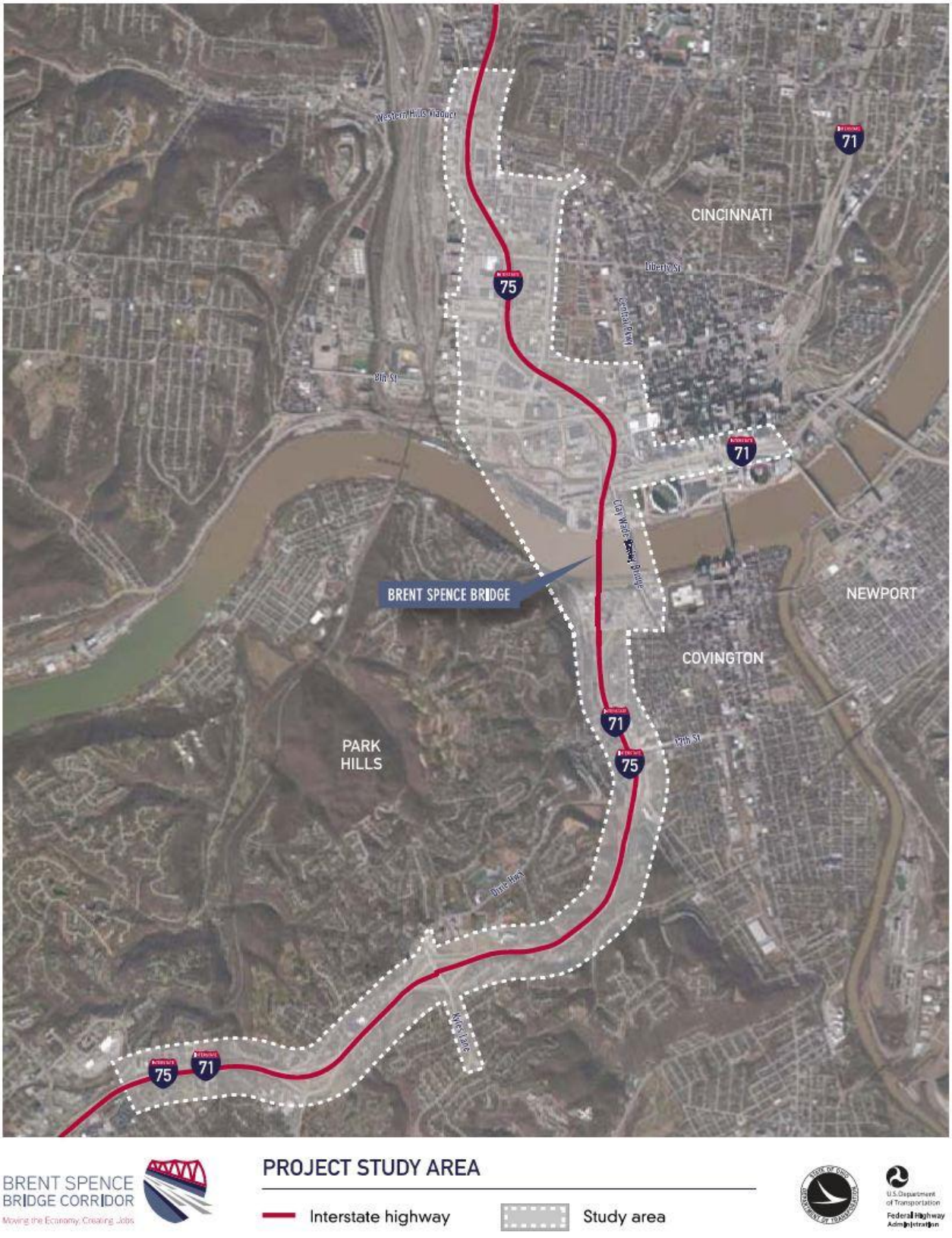
As shown in Figure 1, the Brent Spence Bridge corridor consists of 7.8 total miles of I-75 located within portions of Ohio and Kentucky. Interstate 75 within the Greater Cincinnati/Northern Kentucky region is a major thoroughfare for local and regional mobility. Locally, it connects to I-71, I-74 and US 50. The Brent Spence Bridge provides an interstate connection over the Ohio River and carries both I-71 and I-75 traffic. The bridge facilitates local travel by providing access to downtown Cincinnati, Hamilton County, Ohio and Covington, Kenton County, Kentucky. Regionally, the I-75 corridor connects states from southern Florida to northern Michigan and is one of the busiest freight movement (trucking) routes in the United States.

Model Used

HNTB received an updated copy of OKI Model Version 7.6 from OKI in September 2012. The model included year 2010 and a future network, which included existing and committed (E+C) projects. OKI also provided future year socioeconomic data files.

The main purpose of the modeling analysis is to modify the existing modeling tool to provide reasonable traffic diversion impacts due to the introduction of tolls on the Brent Spence Bridge. Since the model does not include a toll component, HNTB incorporated the effect of tolls on the trip distribution and trip assignment phase of the OKI model after consulting with the Owner and OKI staff on November 5, 2012 and again in early November 2013.

Figure 1: Project Study Area



It is anticipated that a tolled river crossing will have the effect of reducing some of the traffic crossing the Brent Spence bridges (and the Ohio River in general), and that the magnitude of the reduction in traffic would be dependent on the toll rate. This reduction in trips crossing the bridges is reflected in the district-to-district trip tables that HNTB has developed.

OKI Model Background

The OKI travel demand model encompasses all the regions under the jurisdiction of the Ohio-Kentucky-Indiana (OKI) Regional Council of Governments and the Miami Valley Regional Planning Commission (MVRPC). It includes the following counties: Hamilton, Clermont, Warren, Butler, Montgomery, Greene and Miami counties in Ohio, Boone, Kenton and Campbell in Kentucky, and Dearborn in Indiana.

The version of the model used for Brent Spence toll analysis is OKI Model version 7.6. The OKI model is a four-step travel demand model, and is based on traditional trip-based modeling. It estimates traffic flows and trips on each link in the roadway network using socio-economic data inputs and roadway network attributes. It includes the four traditional phases: a trip generation phase, a trip distribution phase, a mode choice phase and a trip assignment phase.

A separate sub-model is used to estimate trips to and from CVG Airport and King's Island Amusement Park. Truck trip generation and distribution steps are carried out separately from the auto trip generation and distribution.

There are a total of 2425 internal zones with 1608 in OKI region and 817 in the MVRPC region. There are 106 external stations with 63 in the OKI region and 43 in the MVRPC region.

The OKI Travel Model Validation Summary provides an overview of the different phases and components of model execution. The model execution takes place in three broad phases:

- Initial phase - In this phase, network building, transit path building, trip generation, initial trip distribution, initial mode choice, truck and external trip table development and initial AM highway assignment is executed.
- Feedback phase (with similar steps as the network building, initial trip distribution, initial mode choice and initial highway AM assignment steps) where loaded speeds and per lane capacities from the assignment phase are fed back to trip distribution and modal choice phases.
- Final phase, which includes highway and transit assignment. Highway assignment is executed by four time periods (AM, MD, PM, NT), and an all-or-nothing transit assignment is executed.

Trip Generation: Trip purposes (for trip generation, distribution and mode choice steps) include HBW (home-based work), HBU (home-based university), HBO (home-based other), HBSC transit (home-based school transit), NHB (non-home-based), TRUCK (truck), EI (external-internal), EE (external-external). A web link to the OKI Travel Model Validation Summary is provided in the references.

Trip Distribution: During trip distribution, gravity models are developed for HBW, HBU, HBO, NHB, and EI trips. The truck trip tables are developed externally using modified truck models from FHWA's "Quick Response Freight Manual" and traffic counts.

Mode Choice: A nested logit model is used for mode choice. The auto trips are broken into drive-alone (DA), and shared ride mode (SR2 and SR3) trips. On the transit side, trips are divided into local bus, express bus, intercity bus, light rail, or commuter rail and also by choice of mode of access to transit (walk, park & ride, or kiss & ride). (Source: OKI Travel Model Validation Summary, September 2013).

Model Externals
A brief background of the development of traffic volumes at the externals is shown below (this is based on information provided to HNTB by the Owner in early January 2014).

- 1997: Conducted special intercept surveys on bridges when cordon survey was developed for updating model externals. The OKI Model was updated a few times in this period around 1997.
- In 2006, preliminary modeling was conducted. Also at that time, a second intercept survey was conducted specific to the Brent Spence Bridge. Details of the cordon survey and model external development are shown in Appendix A1 and A2. In 2008 and 2010, Burgess and Niple and the Owner produced design traffic for many alternatives assuming toll free conditions on the Brent Spence Bridge.
- Also in 2008, the Owner was asked to provide some market segmentation information, which was derived from the statewide model.

Base Year Model Reasonableness
The following comparisons were developed to show the reasonableness of the results from the base year 2010 model:

1. Base Year District-to-District Traffic Flows Compared to Journey to Work Census Data
2. Base Year 2010 Validation
3. Screenline Analysis

Base Year District-to-District Home Based Work Trips Compared to Journey to Work Census Data
The home-based work person trip table from the OKI base year 2010 travel demand model was aggregated to illustrate county-to-county flows. A similar trip table was summarized using Journey to Work Census data.

In each case, the share of trips from each origin county to destination counties compared to the total trips originating from that county was computed. Cells representing a river crossing are highlighted in blue in each table. Table 5 indicates that the percent shares are comparable when comparing the shares from the model and the shares from the Journey to Work Census data.

Table 1: Base Year 2010 County-to-County Home Based Work Trips from Model

	Boone Co, KY	Butler Co, OH	Campbell Co, KY	Clermont Co, OH	Dearborn Co, IN	Hamilton Co, OH	Kenton Co, KY	Montgomery Co, Greene Co, Miami Co, OH	Warren Co, OH
Boone Co, KY	50,756	431	3,889	590	1,022	9,948	18,303	1	235
Butler Co, OH	1,165	110,852	1,178	2,580	562	80,309	1,992	7,317	21,151
Campbell Co, KY	6,452	702	13,243	887	132	23,544	11,774	10	555
Clermont Co, OH	2,717	5,220	2,942	48,313	91	62,625	4,045	115	6,016
Dearborn Co, IN	4,568	1,001	527	112	11,761	10,697	1,886	12	144
Hamilton Co, OH	3,879	34,407	4,483	14,219	3,372	419,653	6,758	692	14,575
Kenton Co, KY	28,362	869	9,019	1,089	473	25,354	35,628	14	544
Montgomery Co, Greene Co, Miami Co, OH	33	5,840	39	94	1	3,744	50	541,380	7,951
Warren Co, OH	569	23,117	869	4,036	106	45,107	1,182	15,812	47,176

Table 2: 2010 County-to-County Home Based Work Trips from Census

	Boone Co, KY	Butler Co, OH	Campbell Co, KY	Clermont Co, OH	Dearborn Co, IN	Hamilton Co, OH	Kenton Co, KY	Montgomery Co, Greene Co, Miami Co, OH	Warren Co, OH
Boone Co, KY	30,444	860	1,391	597	614	10,662	10,879	64	490
Butler Co, OH	732	96,977	245	1,314	164	45,965	1,087	5,172	14,201
Campbell Co, KY	3,878	735	16,028	841	99	14,183	6,506	66	460
Clermont Co, OH	1,699	3,529	851	37,767	50	40,247	1,694	261	4,131
Dearborn Co, IN	1,688	761	135	156	10,030	8,330	665	7	152
Hamilton Co, OH	6,736	20,856	3,333	8,176	1,312	310,370	8,260	2,007	11,619
Kenton Co, KY	16,743	754	5,148	937	262	19,752	31,736	129	467
Montgomery Co, Greene Co, Miami Co, OH	256	4,296	65	270	11	4,206	114	325,990	7,027
Warren Co, OH	253	10,577	206	1,857	49	25,797	509	14,993	40,972

Source: U.S. Census Bureau, 2006-2010 American Community Survey

Table 3: Base Year 2010 County-to-County Home Based Work Trips from Model – Percent Shares

	Boone Co, KY	Butler Co, OH	Campbell Co, KY	Clermont Co, OH	Dearborn Co, IN	Hamilton Co, OH	Kenton Co, KY	Montgomery Co, Greene Co, Miami Co, OH	Warren Co, OH
Boone Co, KY	59.6%	0.5%	4.6%	0.7%	1.2%	11.7%	21.5%	0.0%	0.3%
Butler Co, OH	0.5%	48.8%	0.5%	1.1%	0.2%	35.4%	0.9%	3.2%	9.3%
Campbell Co, KY	11.3%	1.2%	23.1%	1.5%	0.2%	41.1%	20.5%	0.0%	1.0%
Clermont Co, OH	2.1%	4.0%	2.2%	36.6%	0.1%	47.4%	3.1%	0.1%	4.6%
Dearborn Co, IN	14.9%	3.3%	1.7%	0.4%	38.3%	34.8%	6.1%	0.0%	0.5%
Hamilton Co, OH	0.8%	6.9%	0.9%	2.8%	0.7%	83.6%	1.3%	0.1%	2.9%
Kenton Co, KY	28.0%	0.9%	8.9%	1.1%	0.5%	25.0%	35.2%	0.0%	0.5%
Montgomery Co, Greene Co, Miami Co, OH	0.0%	1.0%	0.0%	0.0%	0.0%	0.7%	0.0%	96.8%	1.4%
Warren Co, OH	0.4%	16.8%	0.6%	2.9%	0.1%	32.7%	0.9%	11.5%	34.2%

Table 4: 2010 County-to-County Home Based Work Trips from Census - Percent Shares

	Boone Co, KY	Butler Co, OH	Campbell Co, KY	Clermont Co, OH	Dearborn Co, IN	Hamilton Co, OH	Kenton Co, KY	Montgomery Co, Greene Co, Miami Co, OH	Warren Co, OH
Boone Co, KY	54.4%	1.5%	2.5%	1.1%	1.1%	19.0%	19.4%	0.1%	0.9%
Butler Co, OH	0.4%	58.5%	0.1%	0.8%	0.1%	27.7%	0.7%	3.1%	8.6%
Campbell Co, KY	9.1%	1.7%	37.5%	2.0%	0.2%	33.1%	15.2%	0.2%	1.1%
Clermont Co, OH	1.9%	3.9%	0.9%	41.9%	0.1%	44.6%	1.9%	0.3%	4.6%
Dearborn Co, IN	7.7%	3.5%	0.6%	0.7%	45.7%	38.0%	3.0%	0.0%	0.7%
Hamilton Co, OH	1.8%	5.6%	0.9%	2.2%	0.4%	83.3%	2.2%	0.5%	3.1%
Kenton Co, KY	22.1%	1.0%	6.8%	1.2%	0.3%	26.0%	41.8%	0.2%	0.6%
Montgomery Co, Greene Co, Miami Co, OH	0.1%	1.3%	0.0%	0.1%	0.0%	1.2%	0.0%	95.3%	2.1%
Warren Co, OH	0.3%	11.1%	0.2%	2.0%	0.1%	27.1%	0.5%	15.7%	43.0%

Table 5: 2010 County-to-County Home Based Work Trips - 2010 Model Data Percent Shares minus 2010 Census Data Percent Shares

	Boone Co, KY	Butler Co, OH	Campbell Co, KY	Clermont Co, OH	Dearborn Co, IN	Hamilton Co, OH	Kenton Co, KY	Montgomery Co, Greene Co, Miami Co, OH	Warren Co, OH
Boone Co, KY	**5.2%**	**-1.0%**	**2.1%**	-0.4%	0.1%	**-7.4%**	**2.1%**	-0.1%	-0.6%
Butler Co, OH	0.1%	**-9.7%**	0.4%	0.3%	0.1%	**7.6%**	0.2%	0.1%	0.8%
Campbell Co, KY	**2.2%**	-0.5%	**-14.3%**	-0.4%	0.0%	**7.9%**	**5.3%**	-0.1%	-0.1%
Clermont Co, OH	0.2%	0.0%	**1.3%**	**-5.3%**	0.0%	**2.8%**	**1.2%**	-0.2%	0.0%
Dearborn Co, IN	**7.2%**	-0.2%	**1.1%**	-0.3%	**-7.4%**	**-3.2%**	**3.1%**	0.0%	-0.2%
Hamilton Co, OH	**-1.0%**	**1.3%**	0.0%	0.6%	0.3%	0.3%	-0.9%	-0.4%	-0.2%
Kenton Co, KY	**5.9%**	-0.1%	**2.1%**	-0.2%	0.1%	-1.0%	**-6.6%**	-0.2%	-0.1%
Montgomery Co, Greene Co, Miami Co, OH	-0.1%	-0.2%	0.0%	-0.1%	0.0%	-0.6%	0.0%	**1.6%**	-0.6%
Warren Co, OH	0.1%	**5.6%**	0.4%	1.0%	0.0%	**5.6%**	0.3%	**-4.3%**	**-8.8%**

Base Year 2010 Validation

Network modifications
HNTB made the following network modifications:

- Centroid connector loadings and access to roadway networks modified
- Capacity on local bridges and roadways leading to local Ohio River bridges reduced
- Functional class (and ADMCLASS) fields were modified for Licking River bridges modified
- Local streets were added near I-75 in Covington, KY- Crescent, Philadelphia and Western Avenue

The table below summarizes some of the base year 2010 model validation results comparing model traffic volumes to daily traffic counts in the study area. The performance measures include RMSE, R-Squared and volume-count percent error by assignment group.

Table 6: Base Year 2010 Model/Count Validation Results

Roadway Assignment Group	RMSE Prior to Validation	RMSE After Validation
Freeway & Ramp Control Expressways	0.18	0.17
Signal Control Expressways, On-Ramps & Major Roads	0.39	0.36
Major Roads (sparse intersections)	0.13	0.06
Major Roads (dense intersections), Off -ramps	0.60	0.53
Minor Road	0.66	0.53
Average RMSE of Study Area Roadways	**0.34**	**0.31**
Roadway Assignment Group	**Volume to Count-Percent Error Prior to Validation**	**Volume to Count-Percent Error After Validation**
Freeway & Ramp Control Expressways	-3%	-6%
Signal Control Expressways, On-Ramps & Major Roads	14%	11%
Major Road (sparse intersections)	12%	6%
Major Road (dense intersections), Off -ramps	19%	6%
Minor Road	11%	6%
Average Volume-Count Percent Error of Study Area Roadways	**5%**	**-3%**
Roadway Assignment Group	**R-Squared Value Prior to Validation**	**R-Squared Value After Validation**
Average R-Squared Value of Study Area Roadways	**0.94**	**0.95**

Screenlines
Three screenlines (shown in figure below) were drawn to compare model traffic assignments to counts:

1. Screenline 1: Ohio River
2. Screenline 2: Licking River
3. Screenline 3: Downtown Cincinnati

Figure 2: Screenline Locations

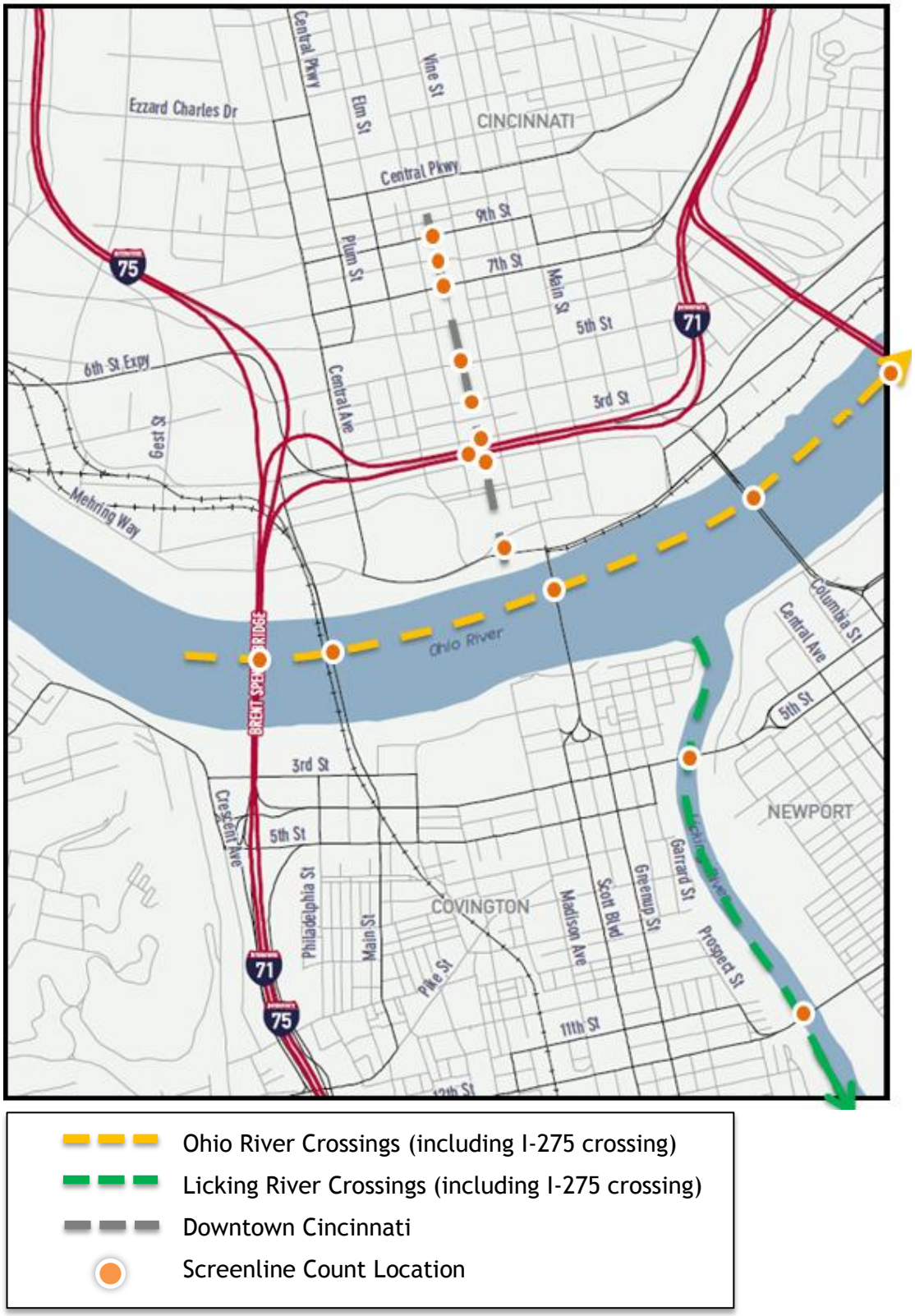


Table 7: Ohio River Screenline Comparison of Base Year Model Volumes to Counts

Ohio River Screenlines	Direction	Model Volumes	Count Volumes	Volume-Count Ratio
Brent Spence Bridge	NB	83,816	87,452	0.96
C.W. Bailey Bridge	NB	9,447	8,102	1.17
Roebling Suspension Bridge	NB	5,425	3,987	1.36
Taylor Southgate Bridge	NB	10,255	5,514	1.86
Dan C Beard Bridge (I-471)	NB	57,834	52,781	1.10
I-275 Bridge	NB	45,655	42,746	1.07
Brent Spence Bridge	SB	85,815	79,442	1.08
C.W. Bailey Bridge	SB	6,377	8,102	0.79
Roebling Suspension Bridge	SB	5,688	5,461	1.04
Taylor Southgate Bridge	SB	10,422	8,376	1.24
Dan C Beard Bridge (I-471)	SB	60,724	52,781	1.15
I-275 Bridge	SB	45,781	42,746	1.07

Table 8: Licking River Screenline Comparison of Base Year Model Volumes to Counts

Licking River Screenlines	Direction	Model Volumes	Count Volumes	Volume-Count Ratio
SR 8 Bridge	WB	14,099	11,240	1.25
E 12th Street Bridge	WB	8,707	8,686	1.00
I-275 Bridge	WB	50,170	51,374	0.98
SR 8 Bridge	EB	7,037	8,040	0.88
E 12th Street Bridge	EB	11,942	8,686	1.37
I-275 Bridge	EB	51,901	51,374	1.01

Table 9: Downtown Cincinnati Screenline Comparison of Base Year Model Volumes to Counts

Cincinnati Screenlines	Direction	Model Volumes	Count Volumes	Volume-Count Ratio
Mehring Way	WB	2,184	5,594	0.39
I-71	WB	43,607	43,545	1.00
W 3rd St (one-way)	WB	19,360	11,502	1.68
W 4th St (one-way)	WB	4,310	6,370	0.68
Garfield Pl	WB	4,114	4,032	1.02
US 22 (one-way)	WB	5,949	4,680	1.27
Mehring Way	EB	1,406	5,594	0.25
W 2nd St (one-way)	EB	26,215	9,752	2.69
I-71	EB	52,997	43,545	1.22
5th St (one-way)	EB	9,113	8,768	1.04
US 22 (one-way)	EB	9,497	6,909	1.37
Garfield Pl	EB	833	4,032	0.21

Table 10: Total Screenline Comparison of Base Year Model Volumes to Counts

Screenline Description	Model Volumes	Count Volumes	Volume-Count Ratio
Ohio River Crossings	427,239	397,490	1.07
Licking River Crossings	143,857	139,400	1.03
Downtown Cincinnati	179,584	154,323	1.16

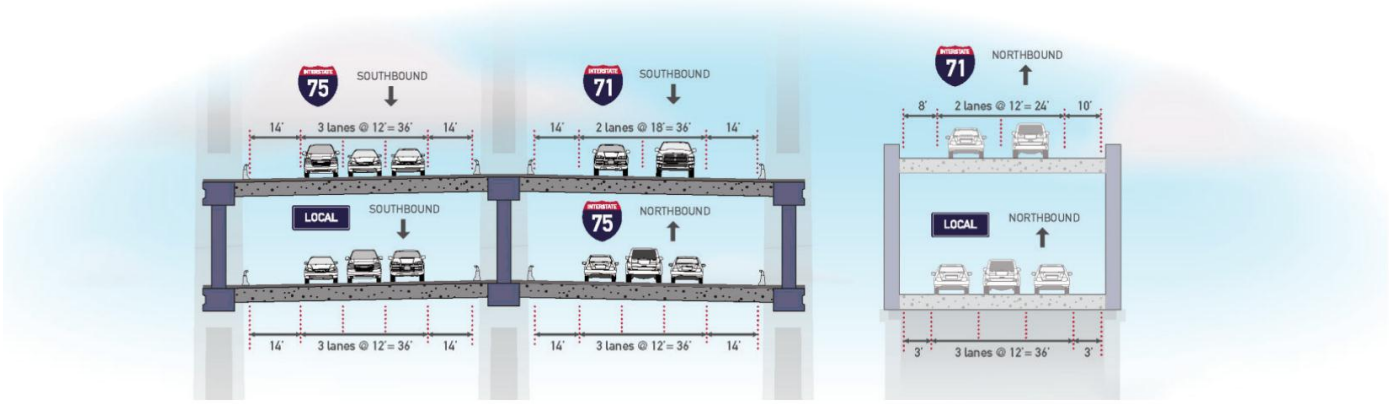
Future Year Models
HNTB used the future year socioeconomic data and future year (E+C) networks provided by OKI for future year models. No specific adjustments were made for High Occupancy Vehicles (HOV) because there are no HOV projects being proposed in the TIP or long-range plans. Networks for future year 2040 (including all projects expected to be completed) were developed. As directed by the Owner, a few additional projects such as Mill Creek Expressway project and the "Thru the Valley" project were included/verified in addition to projects in the E+C network. Additional details about existing and committed roadway projects are available in Appendix B.

Alternative I
Development of conceptual alternatives for the Brent Spence Bridge was initiated in 2003 by KYTC. These 25 initial alternatives were documented in the *Planning Study Report* (September 2006). This report recommended a series of potential feasible build alternatives for replacement and/or rehabilitation of the Brent Spence Bridge structure and improvement to its approaches and surrounding transportation system. Refer to the references section for a web link to the report.

The alternative being analyzed is Alternative I, the preferred alternative from the Preferred Alignment Verification Report or PAVR (May 2011). Alternative I is a combination of Alternatives C and D with certain design elements of Alternative G. Alternative I utilizes the existing I-71/I-75 alignment from the southern project limits at the Dixie Highway Interchange north to the Kyles Lane Interchange. A CD roadway will be constructed along both sides of I-71/I-75 between the two interchanges.

As Figure 3 illustrates, a new double deck bridge will be built just west of the existing Brent Spence Bridge. The existing Brent Spence Bridge will be rehabilitated to carry two lanes for northbound I-71 and three lanes for northbound local traffic. In Ohio, a local CD roadway will be constructed along both sides of I-75.

Figure 3: Alternative I Cross-Section (utilizing existing Brent Spence Bridge superstructure)



Source: Brent Spence Bridge Project Options Analysis, September 2013 (Figure 3-5)

The new bridge (designed in Alternative I as a double deck two-way bridge) is assumed to be tolled for all traffic using this bridge. It is assumed to carry 3 lanes of I-75 northbound traffic, 3 lanes of I-75 southbound traffic, 2 lanes of I-71 southbound traffic and 3 lanes of southbound local traffic.

In this alternative, several connections are provided to allow travelers to make almost every possible movement from the existing or new Brent Spence Bridge to the existing roadway network. Alternative I provides indirect access to interstate by way of a local CD road, I-75 access between KY 12th Street and Ezzard Charles Drive. Direct access to interstate includes 1 direct access point to I-71 NB in KY at Pike Street, direct access to I-71/I-75 SB at KY 12th Street, 1 direct access point to/from I-75 NB and SB at OH

3rd Street, and 1 direct access point to/from I-75 NB and SB at Freeman Avenue. Indirect access to Covington from I-75 is via a CD road providing NB access at KY 12th Street, and SB access at KY 5th and 9th Street. Additional detail on Alternative I is available in the PAVR document.

Toll Rate Assumptions
HNTB ran travel demand models for year 2020 and 2040 for different toll rates – toll free, and $2 converted to 1995 dollars. Additional toll rates of $0.01, $1, and $5 have also been tested to demonstrate model sensitivity.

Toll Assumptions
Trucks were assumed to have an average toll rate per mile of three times that of the auto toll rate. HOV vehicles pay the same rate as autos.

Value of Time
Values of time (VOT) are calculated using the household income because there is a correlation between VOT and household income. It is common to use a weighted value of time calculation based on VOTs for different trip purposes. A weighted value of time was provided by SDG to HNTB based on household incomes from Census data (See the Options Analysis document in references). The methodology used in the calculation of the value of time used in this modeling memorandum is described below.

For each county in Ohio, Kentucky and Indiana, socioeconomic variables including population, household income, households and workers were summarized using data from Census 2000. The average workers per household and wage rate per household worker (in year 2012 dollars) were computed from this table. The value of time for work trips was then calculated as 50 percent of the wage rate per household worker, and the value of time for non-work trips was calculated as 35 percent of the wage rate per household worker. Table 11 shows the calculated values of time for work and non-work trips by county.

Table 11: Value of Time by County

County Name	State	Population	HH Income	Workers	HH	Workers/ HH	Wage Rate/ HH Worker	2012 Wage Rate / HH Worker	VOT Work	VOT Non-Work
DEARBORN	IN	46,109	$ 48,899	22,711	16,822	1.35	$ 17.41	$25.62	$12.81	$8.97
BOONE	KY	85,991	$ 53,593	44,507	31,331	1.42	$ 18.14	$26.69	$13.34	$9.34
CAMPBELL	KY	88,616	$ 41,903	42,820	34,831	1.23	$ 16.39	$24.11	$12.05	$8.44
KENTON	KY	151,464	$ 43,906	76,169	59,453	1.28	$ 16.48	$24.24	$12.12	$8.48
WARREN	OH	158,383	$ 57,952	76,548	56,020	1.37	$ 20.39	$30.00	$15.00	$10.50
CLERMONT	OH	177,977	$ 49,386	88,372	65,981	1.34	$ 17.73	$26.08	$13.04	$9.13
BUTLER	OH	332,807	$ 47,885	160,314	123,125	1.30	$ 17.68	$26.01	$13.01	$9.10
HAMILTON	OH	845,303	$ 40,964	398,465	346,831	1.15	$ 17.14	$25.22	$12.61	$8.83
GREENE	OH	161,573	$ 48,656	43,097	62,681	0.69	$ 34.02	$50.06	$25.03	$17.52
MONTGOMEREY	OH	559,062	$ 40,156	273,729	229,229	1.19	$ 16.17	$23.79	$11.89	$8.33
MIAMI	OH	98,868	$ 44,109	24,318	38,437	0.63	$ 33.52	$49.31	$24.66	$17.26
								Weighted Average VOT	$ 13.32	$ 9.69

The average VOT for work trips was calculated by weighting by workers, and the average VOT for non-work trips were weighted by population. Using the OKI travel demand models, the share of the person trips that are home-based work trips was computed. Work trips accounted for 23 percent of all trips. These final weighted average value of time was then calculated by weighting the work value of time of $13.32 (in 2012 dollars) and the non-work value of time of $9.69 (in 2012 dollars), using the shares of work and non-work trips. This results in a weighted VOT of $10.53 in 2012 dollars. Subsequent comments from the Owner indicated that values of time should be converted to 1995 dollars to be consistent with other parameters in the model.

Based on these calculations and assuming a 1 percent real annual increase (this accounts for the increase in willingness to pay beyond rate of inflation) and accounting for the rate of inflation (2.41 percent), a value of time of $12.85 for the year 2018 (in 2018 dollars) was calculated. Additionally, the 1 percent real annual increase was applied to the 2018 value of time to derive the 2040 value of time of $16.00 (in 2018 dollars). Subsequently, the VOT was recalculated to 2013 dollars using the 2.41 percent rate of inflation, resulting in a VOT of $14.20 (in 2013 dollars). Finally, the 2040 VOT was converted from 2013 to 1995 dollars using the historic CPI change of 2.45 percent annually, resulting in $9.19. This VOT was used in the model to represent 2040 VOT in 1995 dollars (in both the bridge penalties and trip assignment impedance functions).

For commercial vehicles, there are several studies that have been conducted to estimate the value of time. Because many of the commercial vehicle trips are regional in nature, the value of time for these vehicles is larger than the wage-rate of the truck driver. NCHRP 722 has recommended a truck VOT that is approximately three times the SOV VOT (Table 14: NCHRP Report 722 Volume 2, TRB, 2012). Based on this assumption, commercial vehicles were assumed to have a VOT that is three times that of the average auto.

Although it may be possible to run assignments by trip purpose (home-based work, etc.) using different values of time for each purpose, the detailed values of time by purpose from the stated preference surveys are not yet available. NCHRP 722 (Section 4.3.2) suggests using consistency between model components and the network modeling procedure, i.e., if travel purpose or income segments are used in aggregated form on a portion of the model, that level of detail should be held throughout the model. Due to the difficulty with modifying the trip distribution and model choice components of the model in relation to varied VOT by income groups/markets, a more simplified approach that consistently considered VOT throughout the model was used. So, tolled model runs are being run using a single composite value of time based on the household income, as agreed to during the 2012 phone call with Owner.

Toll Methodology
After consultation with the Owner and OKI, HNTB incorporated tolls in two steps into the trip distribution and trip assignment steps of the model, respectively.

- Trip Distribution:
  - The OKI model includes an existing bridge penalty on the existing river bridge crossings, including the Brent Spence Bridge. The future No Build and toll-free scenarios retain this same time penalty on the Brent Spence bridge spans.
  - For the new Brent Spence Bridge crossing links, an additional bridge penalty (corresponding to the time equivalent, i.e., toll rate being tested divided by value of time, converted to year 1995 dollars) was added to these tolled links in addition to the existing bridge penalty. For the tolled runs, the time skims now take into account the additional time penalty to travel across the tolled Brent Spence Bridges. This may result in new shortest paths for certain origins and destinations, with the incremental impedance of the toll being less than the value of the toll due to the new path. In this manner, the toll impedance was reflected in the trip distribution step of the OKI model. This methodology of introducing the effect of tolls into the trip distribution

step was implemented in the full model runs based on suggestions by the Owner staff in November 2012 and again in early November 2013.

- Trip Assignment:
  - The original OKI impedance function only included time and distance costs in the calculation. After consultation with the Owner and OKI staff on November 5, 2012, HNTB also modified the OKI model assignment script to include the equivalent toll cost into the impedance function for trip assignment. This methodology is consistent with previous efforts of the Owner to test toll sensitivity and has been used by HNTB for similar toll modeling exercises to support environmental documentation.

    The impedance used takes the general form:
    Cost = A*travel time + B * travel distance + C * dollar costs (mainly tolls)

    As part of the feedback loop, congested times at the end of assignment are provided as new travel times (based on congested levels) on all links for the next feedback iteration. At the end of iteration, the model feeds back recalculated time only. So, this is the only thing that changes at link level based on free-flow time, capacity and volumes, and not the tolls.

    When the networks are re-skimmed for trip distribution in each iteration of feedback, the bridge toll needs to be applied again at the trip distribution level.

    The feedback process continues iteratively until closure is achieved.

A technical memorandum of the toll methodology that HNTB is using was submitted to the Owner for comment and review in December 2012. This memorandum includes all the details of the toll methodology proposed in that December 2012 memorandum. Also, the concept of applying tolls at the trip distribution and trip assignment steps of the model is consistent with the methodology used by ODOT staff in toll testing and implementation for the OKI model. The two modeling-related suggestions from the Owner included:

(a) conversion of toll rates into 1995 dollars, and
(b) conversion of values of time into 1995 dollars (and conversion to the equivalent bridge penalties and assignment impedances).

These two aspects have been addressed in HNTB's recent modeling efforts.

District to District Distribution effects associated with bridge penalty
The tables below show the total daily vehicle trip tables (AM, MD, PM, NT periods and all vehicle types combined) for year 2040 build toll free and 2040 build tolled scenarios.

The differences in the trip tables by district are also shown. As the district-to-district trip tables indicate, the number of trips from Kenton and Boone counties in Kentucky to Hamilton County in Ohio (crossing the Ohio River) decreased from the build toll-free to the build tolled scenario. There was also an increase in trips that occurred on the same side of the river. For example, trips increased within Kenton and Campbell Counties.

Similarly, trips crossing the Ohio River in the opposite direction (from Ohio to Kentucky) also decreased.

Table 12: District-to-District Vehicle Trips for Year 2040 - Build Toll-Free Scenario

DAILY	Downtown Cincinnati, OH	Cincinnati and Hamilton Co., OH	Butler Co., OH	Warren Co., OH	Clermont Co., OH	Dearborn Co., IN	Covington, Kenton Co., KY	Newport, Campbell Co., KY	Boone Co., KY	W of Covington, Kenton Co., KY	Outside 275 Loop, Campbell Co., KY	Outside 275 Loop, Kenton Co., KY	Montgomery Co., Greene Co.,& Miami Co., OH	Externals in Ohio, Indiana	Externals in Kentucky
Downtown Cincinnati, OH	**30448**	93165	4659	3178	7465	795	6838	8974	8339	3748	3499	4617	558	3349	3054
Cincinnati and Hamilton Co., OH	86403	**1656325**	197254	126804	121802	16624	11125	16114	29463	7691	8689	11131	6551	40860	15334
Butler Co., OH	4499	192040	**722494**	108388	8629	1416	1388	1331	8615	864	655	971	15019	27736	5348
Warren Co., OH	3358	125397	108947	**458848**	16846	209	863	1057	4803	431	728	549	56442	32265	8166
Clermont Co., OH	7508	121132	8865	16613	**355499**	234	2180	2841	5774	1529	2861	1877	995	41339	2668
Dearborn Co., IN	835	16957	1599	211	224	**70864**	756	429	8242	984	619	1821	179	12014	422
Covington, Kenton Co., KY	6870	11527	1416	869	1990	739	**55396**	16025	13675	14723	5837	13952	157	1636	1456
Newport, Campbell Co., KY	8179	15840	1444	1167	2915	448	16057	**59536**	7749	5466	10573	6590	122	1276	1472
Boone Co., KY	8800	30499	8893	4964	6476	7505	13737	7820	**373673**	23864	8834	63901	1287	12072	35738
W of Covington, Kenton Co., KY	3889	7513	844	530	1290	991	14191	5499	23759	**41201**	3339	19679	152	986	1654
Outside 275 Loop, Campbell Co., KY	3315	8481	795	692	3033	610	5394	10439	8560	3509	**49647**	8749	78	950	3421
Outside 275 Loop, Kenton Co., KY	4784	11245	1106	563	1844	1727	14179	6456	63484	20072	8435	**89618**	207	2787	7065
Montgomery Co., Greene Co.,& Miami Co., OH	700	6590	11323	51167	911	760	328	206	4751	331	415	988	**2154079**	43385	175929
Externals in Ohio, Indiana	3328	40998	27252	31212	40641	12295	1624	1297	12076	996	942	2528	43433	**10379**	12743
Externals in Kentucky	3121	15889	5543	7905	2699	447	1460	1521	35093	1638	3193	6833	173765	12850	**107500**

Table 13: District-to-District Vehicle Trips for Year 2040 - Build Tolled Scenario

DAILY	Downtown Cincinnati, OH	Cincinnati and Hamilton Co., OH	Butler Co., OH	Warren Co., OH	Clermont Co., OH	Dearborn Co., IN	Covington, Kenton Co., KY	Newport, Campbell Co., KY	Boone Co., KY	W of Covington, Kenton Co., KY	Outside 275 Loop, Campbell Co., KY	Outside 275 Loop, Kenton Co., KY	Montgomery Co., Greene Co.,& Miami Co., OH	Externals in Ohio, Indiana	Externals in Kentucky
Downtown Cincinnati, OH	**30689**	93971	4748	3253	7572	793	6667	9179	7685	3330	3612	4176	561	3349	3054
Cincinnati and Hamilton Co., OH	87325	**1657579**	197620	126980	121923	16829	10665	16249	28090	6665	8778	9945	6571	40860	15334
Butler Co., OH	4568	192380	**722284**	108381	8693	1421	1281	1310	8398	756	674	788	14984	27736	5348
Warren Co., OH	3425	125560	108971	**458669**	16815	210	819	1030	4714	376	717	520	56477	32265	8166
Clermont Co., OH	7625	121253	8892	16583	**355491**	237	2092	2773	5725	1427	2830	1815	997	41339	2668
Dearborn Co., IN	832	17179	1618	217	222	**70771**	742	418	8192	969	606	1773	171	12014	422
Covington, Kenton Co., KY	6638	10952	1328	821	1897	732	**55883**	15946	13880	15093	5818	14250	162	1636	1456
Newport, Campbell Co., KY	8419	15992	1432	1140	2854	437	15964	**59274**	7790	5542	10506	6675	122	1276	1472
Boone Co., KY	8127	29301	8657	4873	6443	7470	13937	7887	**375442**	24201	8903	64368	1301	12072	35740
W of Covington, Kenton Co., KY	3464	6633	709	453	1201	971	14473	5552	24064	**41948**	3355	20025	149	986	1654
Outside 275 Loop, Campbell Co., KY	3460	8602	813	685	3016	597	5359	10393	8591	3492	**49574**	8784	77	950	3421
Outside 275 Loop, Kenton Co., KY	4299	10066	930	545	1807	1695	14461	6572	64031	20412	8525	**90423**	207	2787	7065
Montgomery Co., Greene Co.,& Miami Co., OH	704	6623	11277	51113	909	763	339	207	5127	341	420	1218	**2153352**	43385	175929
Externals in Ohio, Indiana	3328	40998	27252	31212	40641	12295	1624	1297	12075	996	942	2528	43433	**10379**	12743
Externals in Kentucky	3121	15889	5543	7905	2699	447	1460	1521	35095	1638	3193	6833	173765	12850	**107500**

Table 14: Numerical Differences - Build Tolled Minus Build Toll-Free

DAILY	Downtown Cincinnati, OH	Cincinnati and Hamilton Co., OH	Butler Co., OH	Warren Co., OH	Clermont Co., OH	Dearborn Co., IN	Covington, Kenton Co., KY	Newport, Campbell Co., KY	Boone Co., KY	W of Covington, Kenton Co., KY	Outside 275 Loop, Campbell Co., KY	Outside 275 Loop, Kenton Co., KY	Montgomery Co., Greene Co.,& Miami Co., OH	Externals in Ohio, Indiana	Externals in Kentucky
Downtown Cincinnati, OH	**241**	806	90	75	108	-2	-172	205	-654	-417	113	-441	3	241	806
Cincinnati and Hamilton Co., OH	922	**1254**	366	176	122	204	-459	135	-1374	-1026	88	-1186	20	922	1254
Butler Co., OH	69	341	**-211**	-6	64	5	-108	-22	-217	-108	19	-183	-35	69	341
Warren Co., OH	67	163	24	**-179**	-31	1	-44	-27	-89	-56	-11	-29	35	67	163
Clermont Co., OH	117	121	27	-30	**-8**	2	-89	-68	-49	-102	-31	-62	1	117	121
Dearborn Co., IN	-3	223	19	7	-2	**-93**	-14	-11	-50	-15	-13	-47	-9	-3	223
Covington, Kenton Co., KY	-232	-576	-87	-48	-94	-7	**488**	-78	204	370	-19	298	5	-232	-576
Newport, Campbell Co., KY	240	152	-12	-27	-61	-11	-93	**-262**	41	75	-67	85	1	240	152
Boone Co., KY	-673	-1197	-236	-92	-34	-35	200	67	**1769**	337	69	466	14	-673	-1197
W of Covington, Kenton Co., KY	-425	-880	-135	-77	-89	-20	282	54	305	**747**	15	346	-4	-425	-880
Outside 275 Loop, Campbell Co., KY	145	122	17	-6	-18	-13	-35	-46	31	-17	**-73**	34	-1	145	122
Outside 275 Loop, Kenton Co., KY	-485	-1179	-176	-18	-37	-32	282	117	548	340	90	**805**	0	-485	-1179
Montgomery Co., Greene Co.,& Miami Co., OH	3	33	-47	-54	-2	3	10	1	376	11	5	230	**-727**	3	33
Externals in Ohio, Indiana	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**	0
Externals in Kentucky	0	0	0	0	0	0	0	0	2	0	0	0	0	0	**0**

Table 15: Percentage Differences - Build Tolled Minus Build Toll-Free

DAILY	Downtown Cincinnati, OH	Cincinnati and Hamilton Co., OH	Butler Co., OH	Warren Co., OH	Clermont Co., OH	Dearborn Co., IN	Covington, Kenton Co., KY	Newport, Campbell Co., KY	Boone Co., KY	W of Covington, Kenton Co., KY	Outside 275 Loop, Campbell Co., KY	Outside 275 Loop, Kenton Co., KY	Montgomery Co., Greene Co.,& Miami Co., OH	Externals in Ohio, Indiana	Externals in Kentucky
Downtown Cincinnati, OH	0.8%	0.9%	1.9%	2.4%	1.4%	-0.2%	-2.5%	2.3%	-7.8%	-11.1%	3.2%	-9.5%	0.5%	0.0%	0.0%
Cincinnati and Hamilton Co., OH	1.1%	0.1%	0.2%	0.1%	0.1%	1.2%	-4.1%	0.8%	-4.7%	-13.3%	1.0%	-10.7%	0.3%	0.0%	0.0%
Butler Co., OH	1.5%	0.2%	0.0%	0.0%	0.7%	0.4%	-7.8%	-1.6%	-2.5%	-12.5%	2.9%	-18.9%	-0.2%	0.0%	0.0%
Warren Co., OH	2.0%	0.1%	0.0%	0.0%	-0.2%	0.3%	-5.1%	-2.6%	-1.9%	-12.9%	-1.5%	-5.4%	0.1%	0.0%	0.0%
Clermont Co., OH	1.6%	0.1%	0.3%	-0.2%	0.0%	1.0%	-4.1%	-2.4%	-0.9%	-6.7%	-1.1%	-3.3%	0.1%	0.0%	0.0%
Dearborn Co., IN	-0.4%	1.3%	1.2%	3.1%	-0.8%	-0.1%	-1.8%	-2.6%	-0.6%	-1.5%	-2.1%	-2.6%	-4.8%	0.0%	0.0%
Covington, Kenton Co., KY	-3.4%	-5.0%	-6.2%	-5.5%	-4.7%	-1.0%	0.9%	-0.5%	1.5%	2.5%	-0.3%	2.1%	3.0%	0.0%	0.0%
Newport, Campbell Co., KY	2.9%	1.0%	-0.8%	-2.3%	-2.1%	-2.5%	-0.6%	-0.4%	0.5%	1.4%	-0.6%	1.3%	0.6%	0.0%	0.0%
Boone Co., KY	-7.6%	-3.9%	-2.7%	-1.8%	-0.5%	-0.5%	1.5%	0.9%	0.5%	1.4%	0.8%	0.7%	1.1%	0.0%	0.0%
W of Covington, Kenton Co., KY	-10.9%	-11.7%	-16.0%	-14.5%	-6.9%	-2.0%	2.0%	1.0%	1.3%	1.8%	0.5%	1.8%	-2.5%	0.0%	0.0%
Outside 275 Loop, Campbell Co., KY	4.4%	1.4%	2.2%	-0.9%	-0.6%	-2.1%	-0.6%	-0.4%	0.4%	-0.5%	-0.1%	0.4%	-1.3%	0.0%	0.0%
Outside 275 Loop, Kenton Co., KY	-10.1%	-10.5%	-15.9%	-3.1%	-2.0%	-1.8%	2.0%	1.8%	0.9%	1.7%	1.1%	0.9%	0.0%	0.0%	0.0%
Montgomery Co., Greene Co.,& Miami Co., OH	0.5%	0.5%	-0.4%	-0.1%	-0.3%	0.4%	3.1%	0.3%	7.9%	3.2%	1.2%	23.3%	0.0%	0.0%	0.0%
Externals in Ohio, Indiana	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Externals in Kentucky	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%

Comparison of Travel Times for Build Toll-Free and Build Tolled Scenarios

Table 16 and Table 17 show the congested travel times for the Build Toll-Free and Build Tolled scenarios. Both the route using the Brent Spence Bridge and the alternative path for AM and PM peak periods are depicted in the tables. As the tables indicate, the travel time along the Brent Spence Bridge route is generally shorter in the Build Tolled scenario compared to the Build Toll-Free scenario. Conversely, the alternative paths tend to have a larger travel time in the Build Tolled scenario compared to the Build Toll-Free scenario (because more traffic is diverting to local bridges to avoid tolls). TANK routes use the bridges and as such the highway travel time affect transit as well.

Table 16: Build Toll-Free Travel Times

			BSB Route			Alternate Path		
Time Period	Origin	Destination	Travel Time (min)	Travel Distance (miles)	Speed (mph)	Travel Time (min)	Travel Distance (miles)	Speed (mph)
AM	EJ zone in Covington	3rd St / Main St in Cincinnati	7.46	2.29	18.4	5.13	1.36	15.9
	3rd St / Main St in Cincinnati	EJ zone in Covington	5.71	2.62	27.5	2.96	1.36	27.6
	EJ zone in Cincinnati	4th/5th St ramp in Covington	3.89	1.93	29.7	**5.16**	1.78	20.7
	4th/5th St ramp in Covington	EJ zone in Cincinnati	3.67	1.39	22.7	**6.54**	**1.95**	17.9
PM	EJ zone in Covington	3rd St / Main St in Cincinnati	7.11	2.29	19.3	3.82	1.36	21.4
	3rd St / Main St in Cincinnati	EJ zone in Covington	7.70	2.62	20.4	4.18	1.36	19.5
	EJ zone in Cincinnati	4th/5th St ramp in Covington	6.10	1.93	19.0	**7.15**	1.78	15.0
	4th/5th St ramp in Covington	EJ zone in Cincinnati	2.87	1.39	29.0	**5.04**	**1.95**	23.2

Table 17: Build Tolled Travel Times

			BSB Route			Alternate Path		
Time Period	Origin	Destination	Travel Time (min)	Travel Distance (miles)	Speed (mph)	Travel Time (min)	Travel Distance (miles)	Speed (mph)
AM	EJ zone in Covington	3rd St / Main St in Cincinnati	7.46	2.29	18.4	5.13	1.36	15.9
	3rd St / Main St in Cincinnati	EJ zone in Covington	6.03	2.62	26.0	2.96	1.36	27.6
	EJ zone in Cincinnati	4th/5th St ramp in Covington	3.89	1.93	29.7	**5.16**	1.78	20.7
	4th/5th St ramp in Covington	EJ zone in Cincinnati	3.67	1.39	22.7	**6.16**	**1.76**	17.1
PM	EJ zone in Covington	3rd St / Main St in Cincinnati	11.37	2.29	12.1	10.38	1.36	7.9
	3rd St / Main St in Cincinnati	EJ zone in Covington	6.61	2.62	23.8	4.66	1.36	17.5
	EJ zone in Cincinnati	4th/5th St ramp in Covington	4.79	1.93	24.1	**12.11**	1.78	8.8
	4th/5th St ramp in Covington	EJ zone in Cincinnati	2.61	1.39	31.9	**11.60**	**1.95**	10.1

Diversion Results
The table below shows the traffic assignments on each of the bridges and the total river crossing for no-build, toll-free and tolled scenarios for different toll rates based on travel demand model runs:

Table 18: Traffic on Ohio River Crossings for No build, Build Toll-Free and Build I Tolled

Description	Direction	2010 Base Year	2040 No Build	2040 Toll Free	2040 Tolled $2
Brent Spence Existing Bridge Northbound	NB	83,816	107,624	120,933	95,579
Brent Spence Existing Bridge Southbound	SB	85,815	111,719	123,692	104,269
Clay Wade Bailey Bridge (US 42 and US 127)	NB	9,447	15,912	12,639	21,853
Clay Wade Bailey Bridge (US 42 and US 127)	SB	6,377	15,435	11,649	15,130
Roebling Suspension Bridge (STH 17)	NB	5,425	6,231	5,241	6,605
Roebling Suspension Bridge (STH 17)	SB	5,688	6,579	5,606	6,807
Taylor Southgate Bridge (STH 27)	NB	10,255	11,797	11,132	11,113
Taylor Southgate Bridge (STH 27)	SB	10,422	12,658	11,894	11,508
Dan C Beard Bridge (I-471 Northbound)	NB	57,834	75,322	70,027	70,269
Dan C Beard Bridge (I-471 Southbound)	SB	60,724	78,224	73,742	74,249
I-275 Bridge	NB	45,655	62,226	61,874	62,536
I-275 Bridge	SB	45,781	60,580	59,492	60,298
Total Ohio River Crossing Traffic		427,239	564,306	567,921	540,216
Total Northbound	NB	212,432	279,111	281,846	267,955
Total Southbound	SB	214,807	285,194	286,075	272,261

Sensitivity Testing
HNTB recognizes the benefits of doing a comparison of model traffic results under different combinations of toll rates and values of time. The following sensitivity tests were analyzed and documented:

a) Toll Sensitivity
b) Value of Time Sensitivity
c) Interim Analysis Year 2020

Toll Sensitivity and Value of Time Sensitivity
HNTB has tested various scenarios to evaluate the sensitivity of the model to different toll rates as well as to value of time.

Toll rates of $1and $5 have been tested in addition to the $2 toll rate currently being used for analysis of toll impacts. Additionally, HNTB tested a toll rate of $0.01 which resulted in similar traffic volumes as the build toll-free model run.

Figure 4: 2040 Build Model Volume v. Toll Rate; Ohio River Bridges

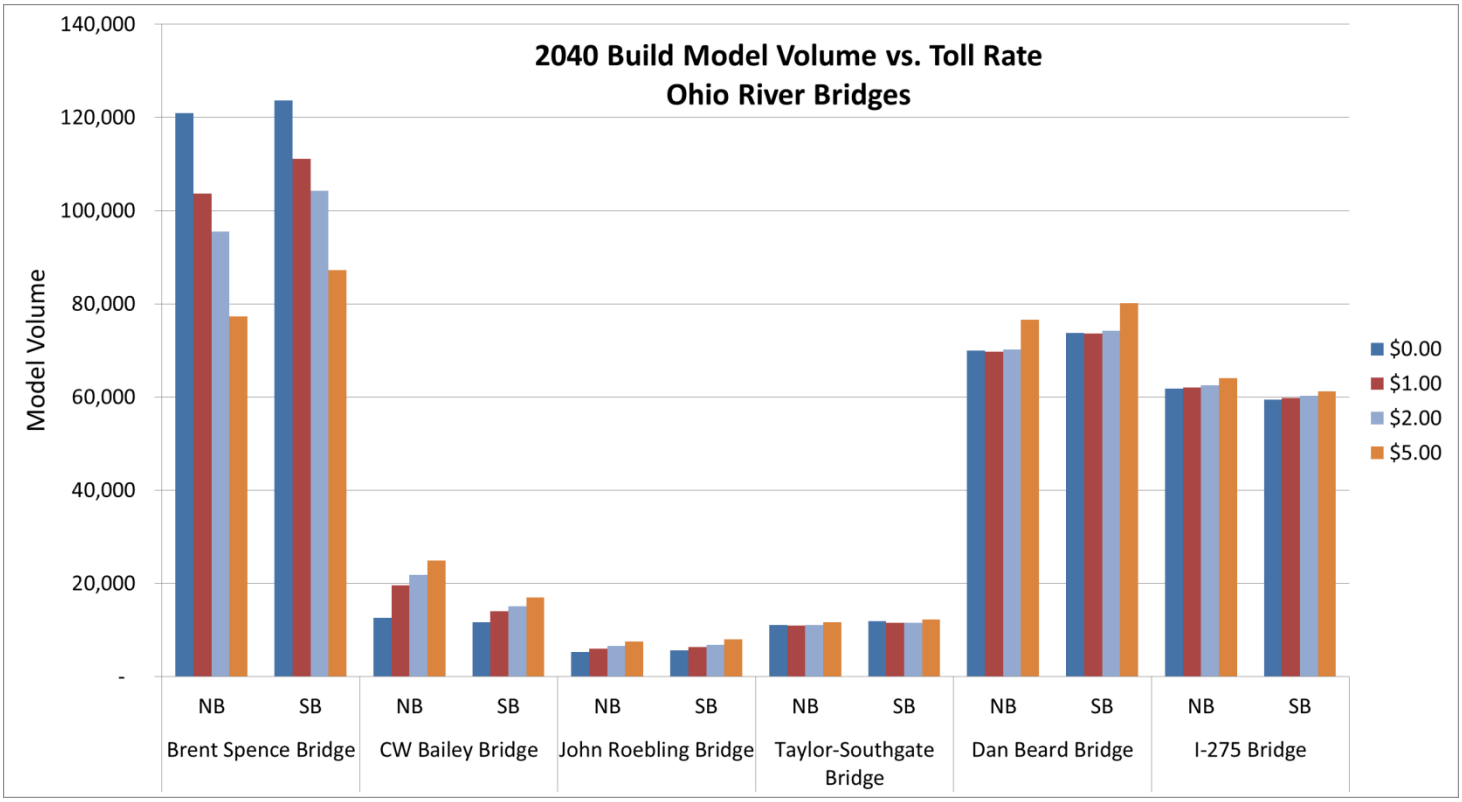


Figure 5: 2020 Build Model Volume v. Toll Rate; Ohio River Bridges

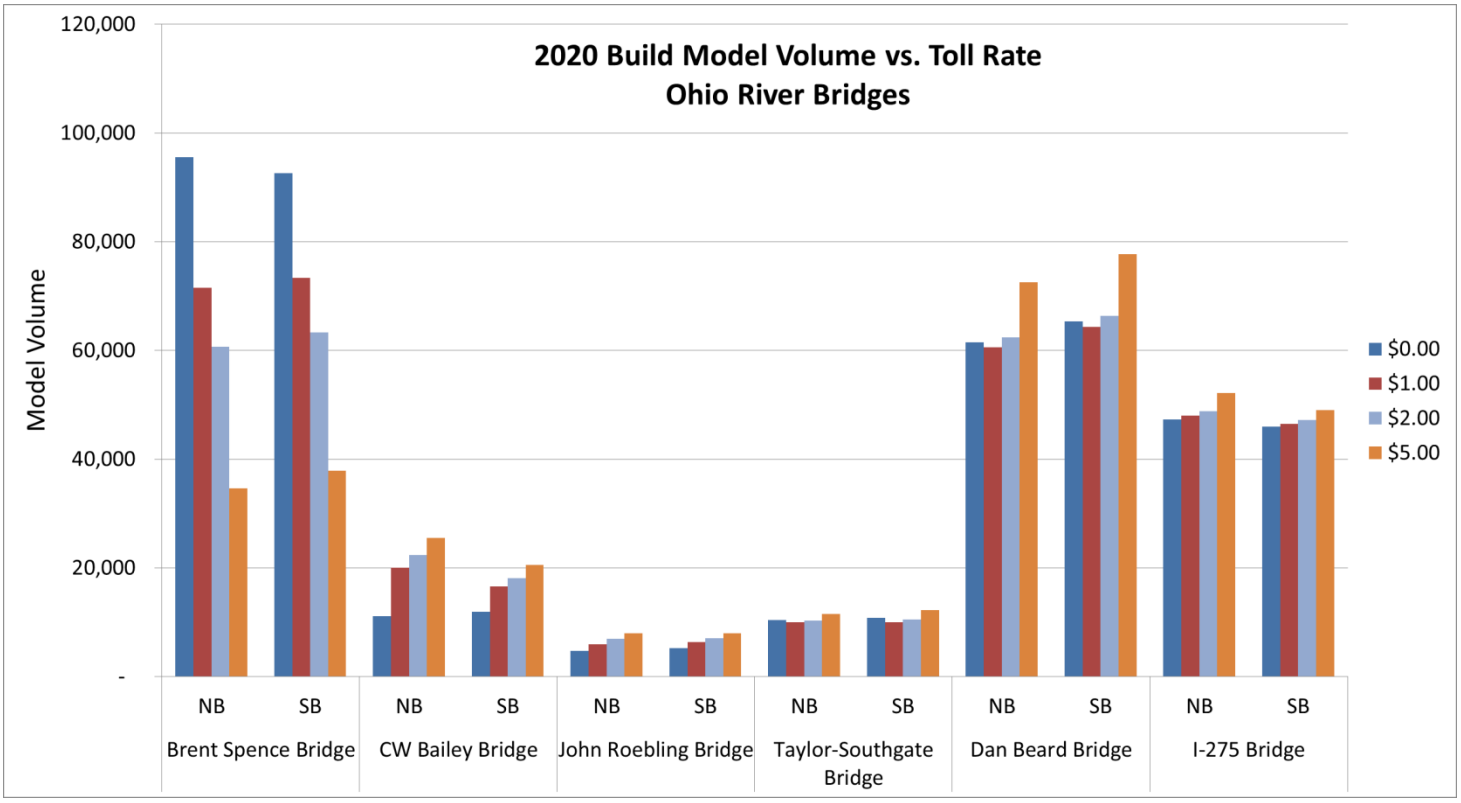
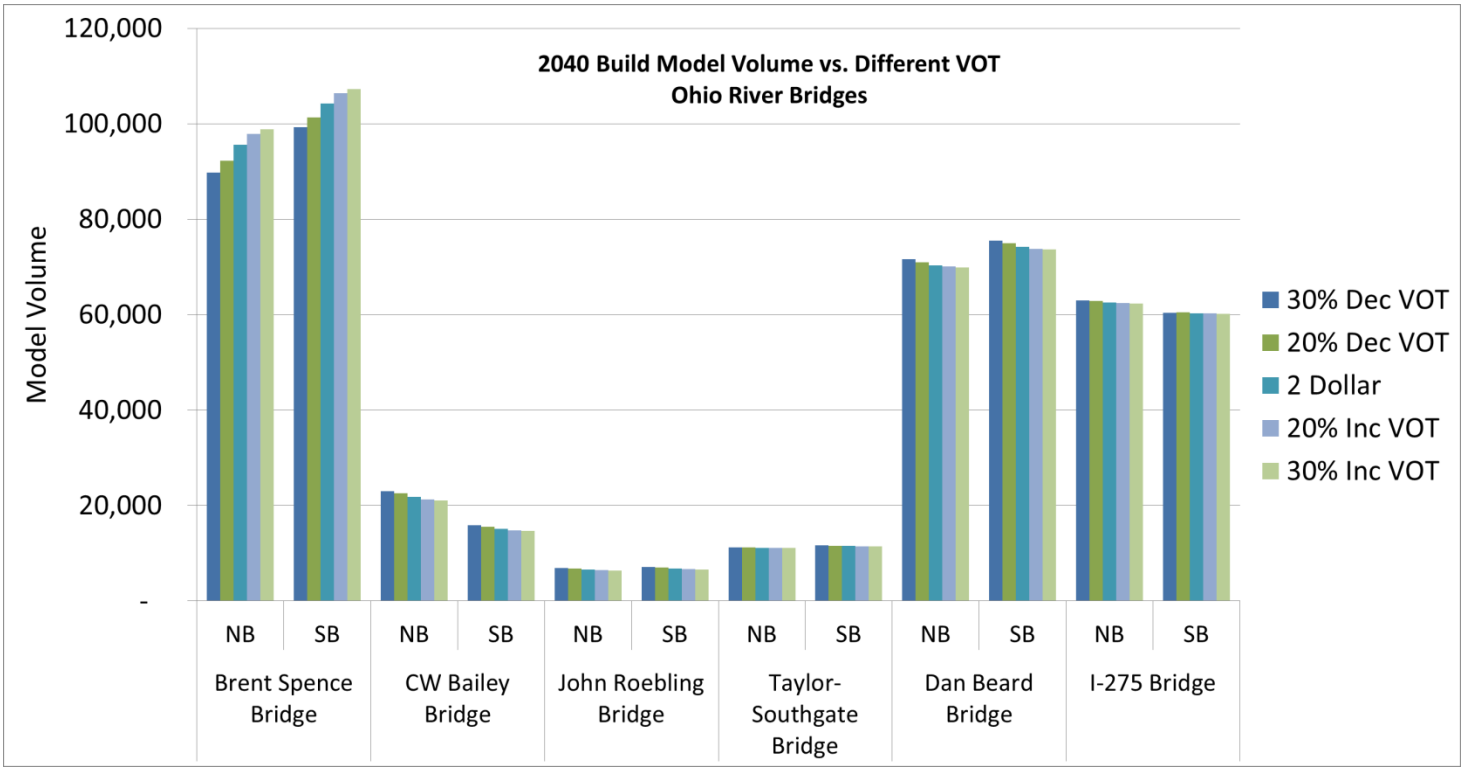


Figure 6: 2040 Build Model Volume v. VOT; Ohio River Bridges



Future Year 2020
Models were run and the results documented to show traffic volumes for the shorter term for interim analysis year 2020. Figure 5 shows the model sensitivity for year 2020 at various toll rates.

Socio-Economic Inputs
It is not anticipated that the proposed new Brent Spence Bridge will result in a significant change in socio-economic inputs like households and employment. Therefore, the same OKI baseline set of 2010 and future year socio-economic inputs were used for all scenarios – base year 2010, and future year no build, build toll free and build tolled forecasts.

The original IMS – Certified Traffic report from 2010 did not make any assumptions about changes in socio-economic inputs related to the proposed Brent Spence Bridge.

Traffic Impacts Analysis

Selection of Toll Rates for Impacts Analysis
As part of toll sensitivity analysis, traffic volumes on the Brent Spence Bridge at various different toll rates were compared.

At the start of Phase II of HNTB's work, based on direction from the Owner, a toll rate in the range of $1-$2 (nominal auto toll rate) was proposed for further study. For purposes of evaluating traffic impacts due to tolls, HNTB selected a toll rate in the higher range of the anticipated toll rates (i.e., $2 nominal auto toll rate) to identify impacts to local intersections. If an even higher rate ends up being chosen based on guidance from rating agencies, the impacted area may expand a little further depending on the magnitude of the toll increase. However, given that we wanted to select a toll rate that is going to be in the probable range of toll rates being proposed, HNTB evaluated traffic impacts to local roadways based on the $2 rate

(this was considered to be conservative from a traffic impacts standpoint because it is at the higher end of probable toll rates).

Traffic Impacts Methodology and Thresholds Used

The traffic impacts methodology proposed as part of the Louisville Ohio River Bridges study was first tested, but this did not results in significant impacts on the roadway network for the Brent Spence project.

Since the methodology proposed in the Louisville study resulted only in minimal impacts (3-4 links in the entire network), HNTB developed a procedure to identify the areas in cities near the project that were based on stricter criteria in the peak AM, MD and PM hours. A web link to the Louisville Ohio River Bridges Study can be found in the references section.

Traffic Impacts Methodology to Identify Affected Area

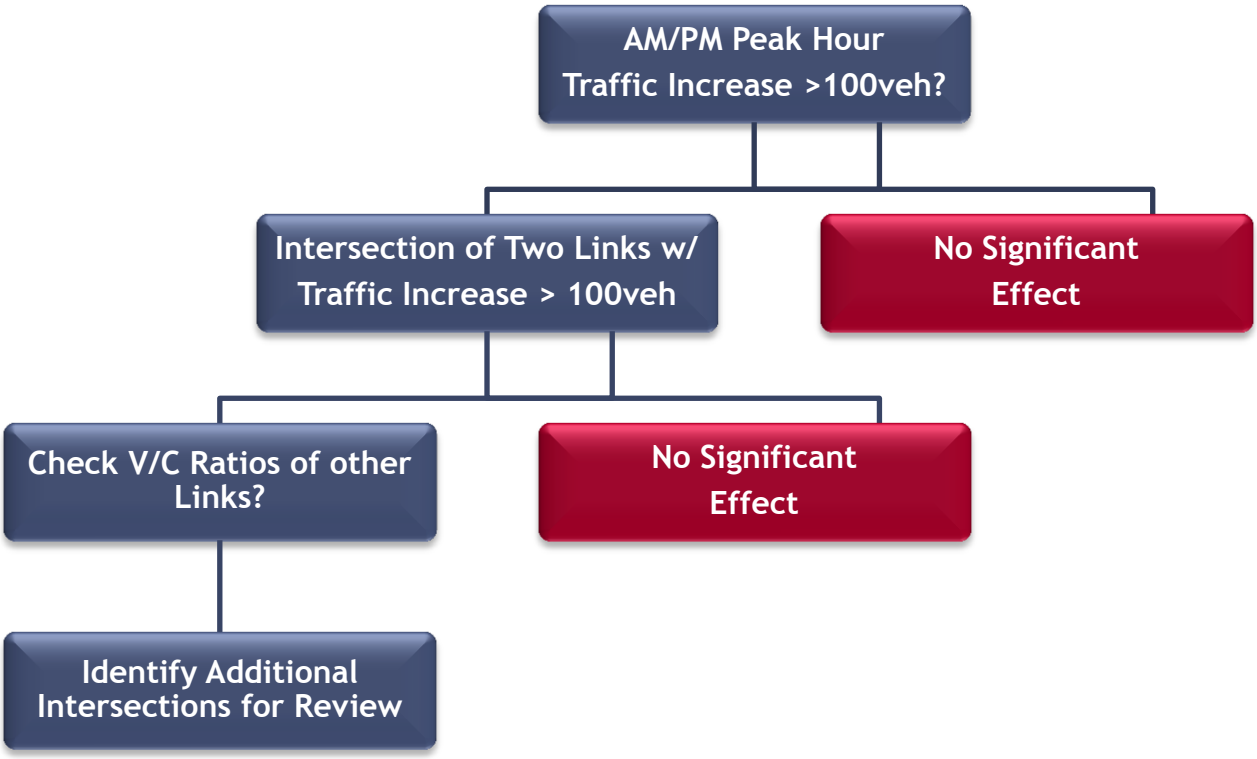
HNTB developed a methodology to identify areas affected by adding tolls to the Brent Spence Bridge using difference plots. Difference plots for AM, PM and MD peak hours were developed from the travel demand model outputs comparing Build Toll-Free and Build Tolled model runs for the year 2040.

The following procedure was used to determine if an intersection needed to be reviewed for traffic impacts in each peak hour:

1. Identify ADT impacts using the Louisville Ohio River Bridges study methodology
2. Identify all links with an increase in peak hour traffic of more than 100 vehicles per hour
3. If two links with traffic increases of more than 100 vehicles per hour intersect, consider that intersection for further review.
4. A final check is made to check if any other intersections need to be included based on high V/C ratios

The items for review are primarily direct traffic impacts. Other items such as air quality and noise and indirect impacts may be included as part of the Environmental Analysis. V/C ratios and level of service for forecasted mainlines, ramps, and intersections will be prepared for locations impacted due to tolls.

Figure 7: Process of Identifying Affected Area



Difference Plots
Difference plots for AM, PM and MD peak hours were developed from the travel demand model outputs comparing Build Toll-Free and Build Tolled model runs for the year 2040.

Intersection Screening
Using the process illustrated in Figure 7, several intersections were considered for further review. These intersections are shown in Figure 14 and were first screened using Synchro® to determine if further analysis was required for specific intersections.

As part of the Synchro screening, any intersection that had an LOS D or better in both the build toll free and build toll was not considered for screening.

If an intersection had an LOS of worse than D, a second level of screening was conducted. If an intersection with a LOS of D or better in the Build Toll Free scenario deteriorates to a LOS of E or F in the Build Tolled scenario, those intersections were identified for more detailed traffic operations analysis.

Figure 8: AM Peak Hour Volume Changes - 2040 Build Toll-Free to 2040 Build Tolled ($2) Kentucky Side

Figure 9: AM Peak Hour Volume Changes - 2040 Build Toll-Free to 2040 Build Tolled ($2) Ohio Side

Figure 10: PM Peak Hour Volume Changes - 2040 Build Toll-Free to 2040 Build Tolled ($2) Kentucky Side

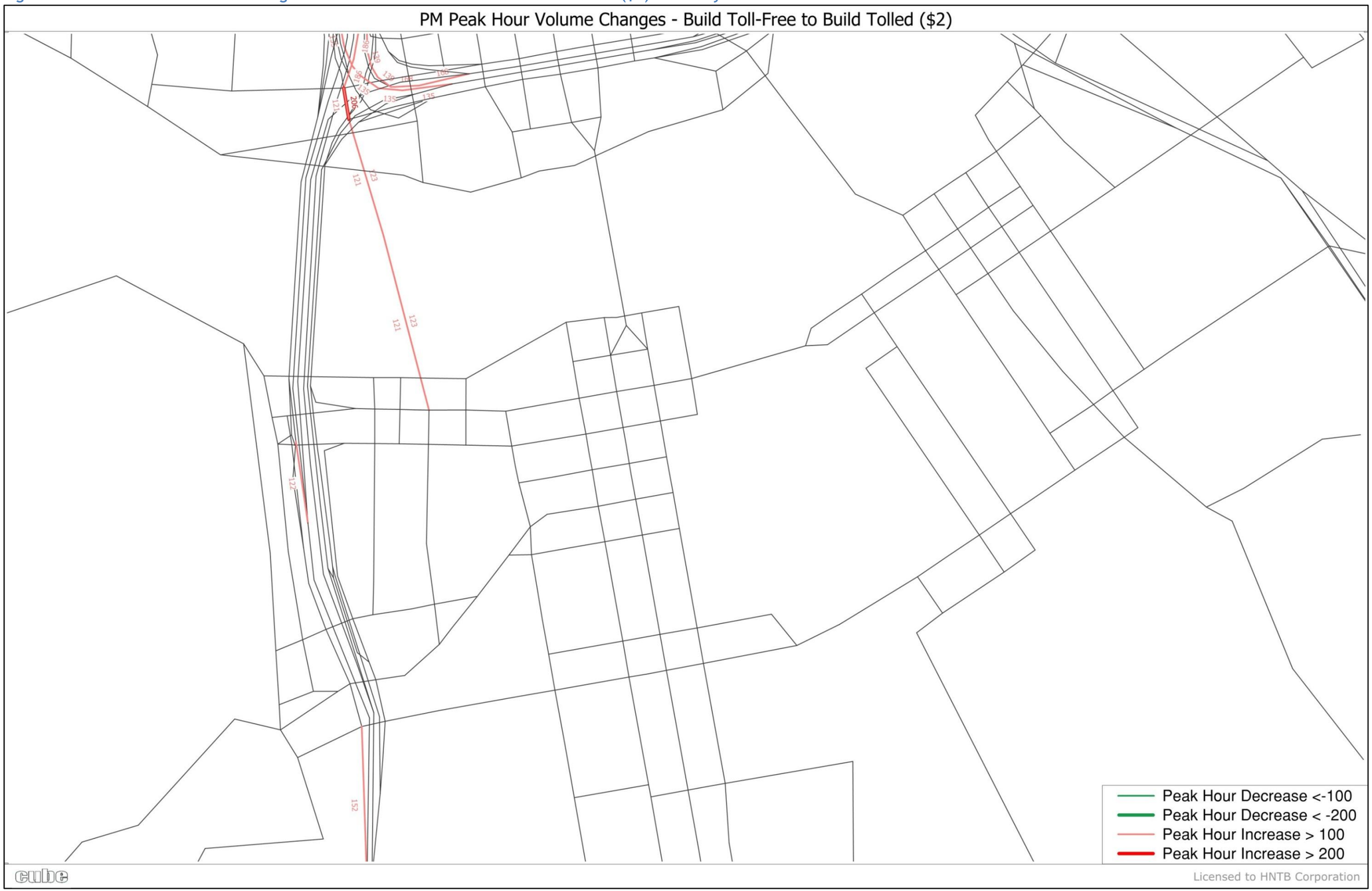


Figure 11: PM Peak Hour Volume Changes – 2040 Build Toll-Free to 2040 Build Tolled ($2) Ohio Side

Figure 12: MD Peak Hour Volume Changes - 2040 Build Toll-Free to 2040 Build Tolled ($2) Kentucky Side

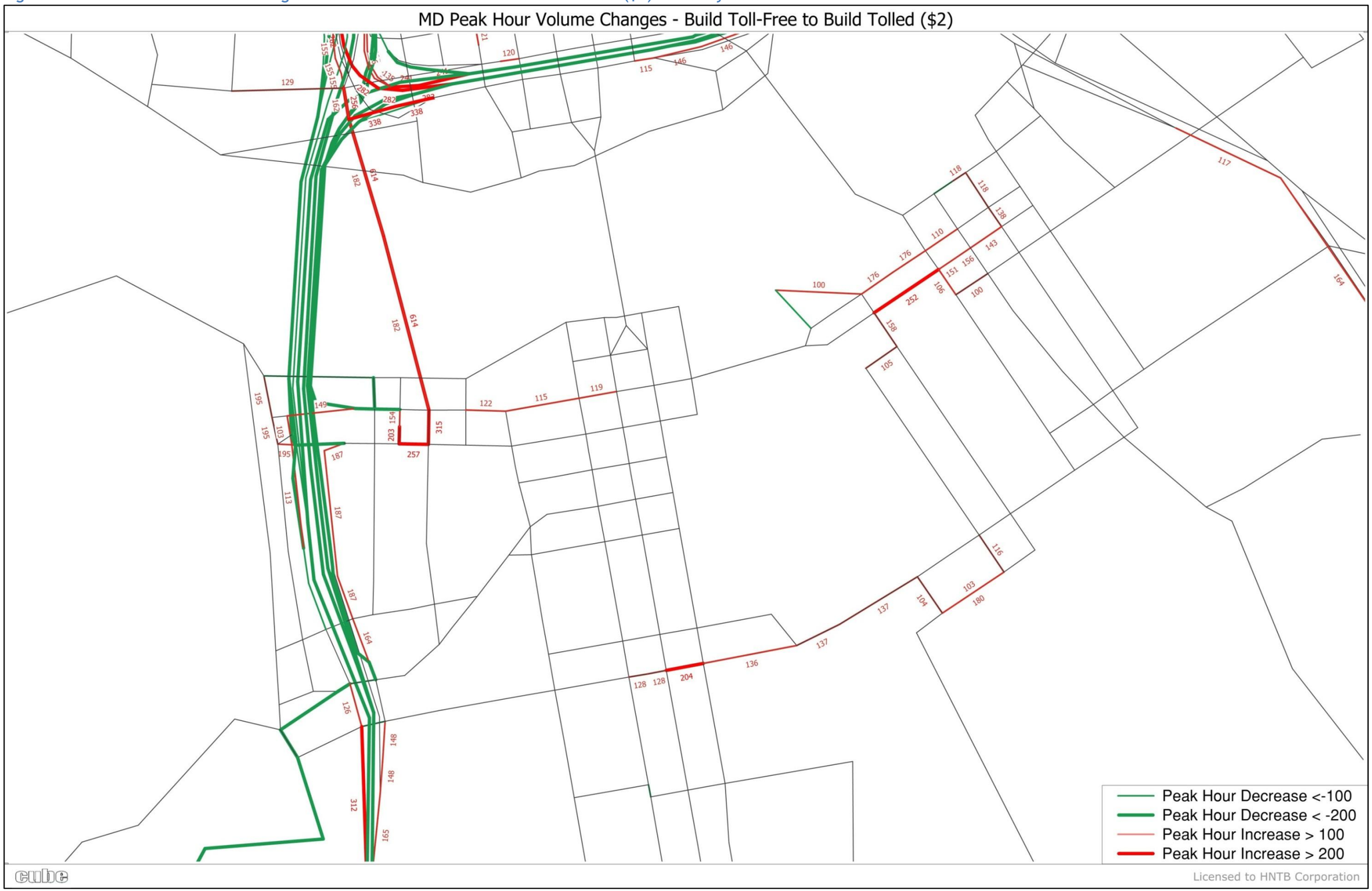


Figure 13: MD Peak Hour Volume Changes - 2040 Build Toll-Free to 2040 Build Tolled ($2) Ohio Side

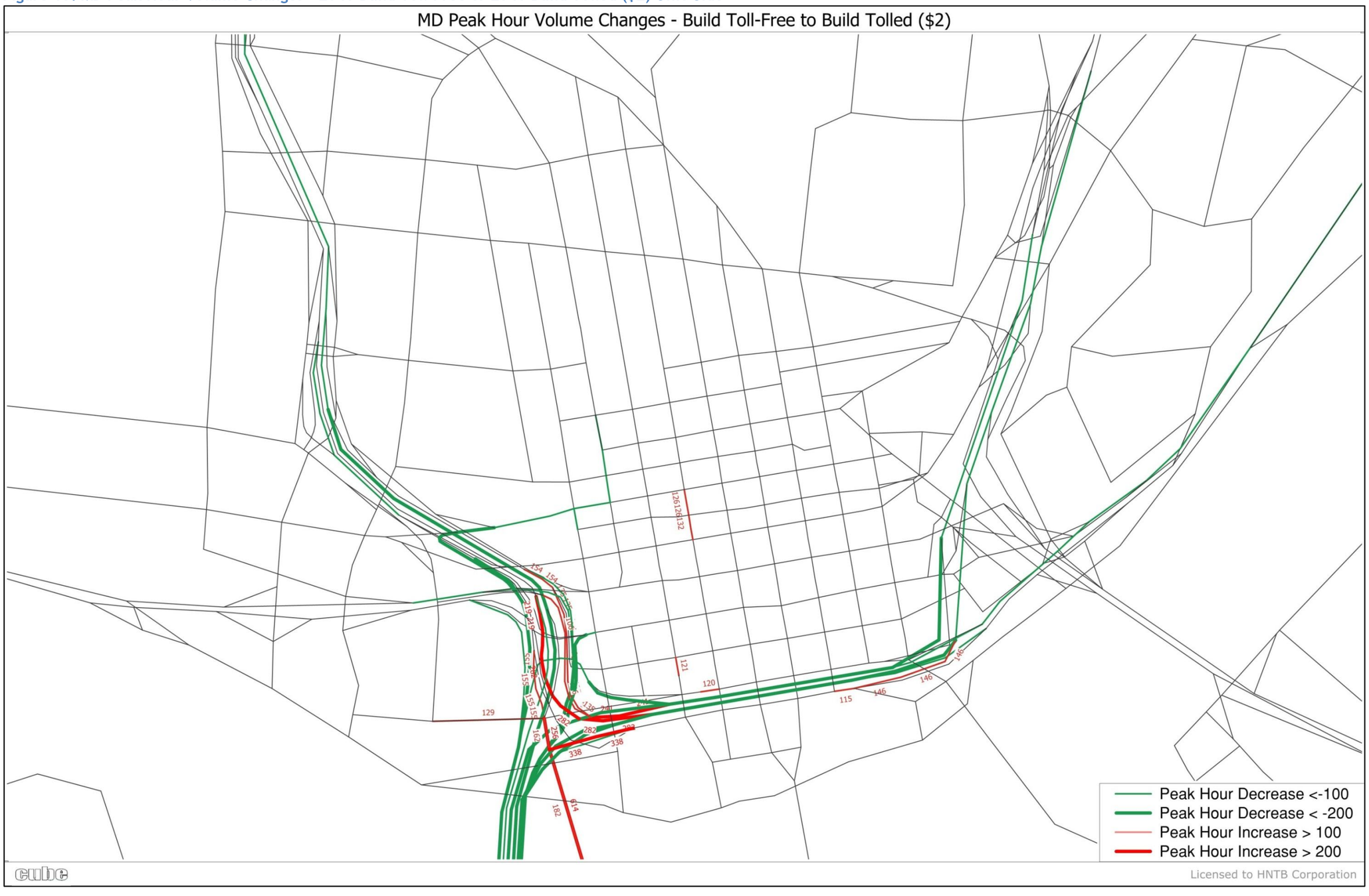


Figure 14: Intersections for Further Review

Traffic Forecasting Methodology

HNTB proposed a methodology to develop traffic forecasts for mainlines, CD lanes and ramps. This procedure will also be used to develop traffic forecasts for local intersections that were identified as locations of traffic impacts due to tolls (turning movement traffic counts are underway in Cincinnati, Covington and Newport). A detailed Traffic Forecasting Memorandum includes both the methodology and traffic plates for mainlines, CD roads, ramps, and local intersections in the Brent Spence Bridge corridor.

Based on the methodology approved by the Owner and FHWA, preliminary traffic forecasts have been developed for mainline, CD lanes and ramp locations for the Build Tolled scenario. Those results will be used to analyze traffic operations for the project corridor using Vissim®.

Similarly, the methodology will be also used to develop Build Tolled scenario forecasts for local intersections affected by tolls in Cincinnati, Covington and Newport.

Traffic based estimates of emissions or noise

Future toll traffic forecasts may be used for air quality emissions and noise analyses, if they demonstrate a substantial difference when compared to the toll free traffic volumes utilized for the noise and air quality analyses previously approved in the Environmental Assessment (EA). This determination will be made in consultation with the Owner and FHWA.

Limitations of Analysis

Several broad assumptions were made to complete this analysis:
- Demographic data for the model are based on models provided by OKI with no attempts to alter this data based on the presence of toll on Brent Spence Bridge. Land use assumptions were not altered from the OKI model inputs. As indicated earlier, it is also assumed that there will be no significant changes in demographics such as increases in households or employment due to the addition of the Brent Spence Bridge.
- The future year roadway assumptions are based on the networks provided by OKI, review of the Transportation Improvement Plan (TIP) and a few other ongoing roadway projects that are known to HNTB at this time.

Disclaimer

HNTB has adopted several assumptions in coordination with the Owner to develop the analysis presented in this study. However, for any traffic forecasting process, there could be differences between forecasts and actual future traffic volumes due to circumstances beyond the purview of the study.

The preliminary traffic trends in this study are only intended to broadly reflect the overall long-term effects of traffic on overall river crossings and impacts on major roadways in the vicinity of the project.

Some other general disclaimers:

- HNTB is not responsible for the socio-economic or demographic forecasts that drive the traffic
- Several external factors such as major changes in fuel costs, or unexpected major trip attractors or generators can materially affect the traffic forecasts and diversion.

References

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