Blue Water Bridge Plaza Study
St. Clair County, Michigan

MDOT J.N. 57779

Technical Memorandum
Delay Analysis

Prepared by:

The Michigan Department of Transportation

and

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Introduction

This technical memorandum analyzes existing and future delay at the Blue Water Bridge (BWB) plaza resulting from the proposed expansion of the Land Port of Entry (LPOE) in Port Huron, Michigan. The results show delay in the form of wait times and queue length at the existing plaza compared to the 2030 No-Build Alternative and the 2030 Recommended Alternative, given the same processing assumptions.

Need for Delay Analysis

The purpose of performing a delay analysis is to verify that the delay currently experienced on the BWB plaza will be improved after implementing the Recommended Alternative. This analysis was produced as a result of public comments received on the BWB Draft Environmental Impact Statement which was released in September 2007. Commenter's asked for additional justification of the anticipated performance levels from the Recommended Alternative and the associated facility improvements.

The Study Team used traffic analysis software to produce a microsimulation traffic model of primary inspection lanes based on average processing times. Primary inspection is the biggest cause for concern at the Blue Water Bridge Plaza as delay at this location results in major backups on the 402 expressway in Canada. Table 1 below shows the historic traffic backups in Canada between 2005 and 2007. Outbound traffic (heading east toward Canada) delays are far less frequent and are addressed with the improvements proposed to the I-94/I-69 corridor and BWB plaza which include separating local traffic from plaza traffic prior to the Lapeer Connector interchange and Water Street interchange, and providing 5-lanes for eastbound traffic compared to the existing 2-lanes. The proposed 8-tollbooths on the plaza can sufficiently process all outbound traffic at peak traffic times. Other factors which may cause a delay are very difficult to predict, such as Canadian inspections, and potential new CBP outbound processing requirements.

Table 1 Historic Backups into Canada

Border Crossing	Type of Backup	Frequency of Occurrences
Westbound to USA	Passenger Vehicles	Mainly associated with holidays and summer weekends
	Commercial Vehicles	Once a week on heavy commercial days
	Highway 402	Averages twice a month
	Severe Weather/	Once or twice a

	Vehicle Incidents	year
	Number of 1 Hour or Greater Delays:	
	2005	Not Available
	2006	26
	2007	117
Eastbound to Canada	Passenger Vehicles	Associated with holidays, summer weekends, or Canadian work related slowdowns
	Severe Weather/ Vehicle Incidents	Once or twice a year
	Number of 1 Hour or Greater Delays:	
	2005	8
	2006	6
	2007	25

Delay Analysis Model

To provide an accurate analysis of traffic operations on the Blue Water Bridge, it is essential that the entire border crossing be treated as a system. The toll facilities, bridge structures, customs facilities, approach roadways, and the off-site routing of agricultural inspections all affect traffic movements and delay times at the Port Huron port of entry. The Study Team utilized WATSim©, a computer simulation software, for the Blue Water Bridge delay analysis to model the proposed improvements.

WATSim is a microscopic traffic simulation model developed by KLD Associates, Inc. This model is an extension of the TRAF-NETSIM simulation model originally developed by KLD for the Federal Highway Administration (FHWA). The model's strength lies in its ability to accurately represent the performance characteristics of individual vehicles as well as driver behavior over the full range of decision processes.

WATSim models driver behavior to select the most appropriate toll, customs, or CBP lane based on current queue. Simulated drivers "decide" which lane will offer the fastest service based on a realistic assessment of current conditions. The model also simulates weaving and merging movements on the plaza and bridge and was utilized to calculate delay and the spatial extent and duration of queues based upon plaza processing times. Just as important, WATSim© represents driver behavior along the local road and freeway approaches and exits. This enables the simulation to accurately predict the effectiveness of the proposed improvements and confirm that plaza improvements do not result in adverse traffic operations on the I-69/I-94 corridor and the local roads downstream from the plaza.

The model was used to validate and calibrate a delay condition for inbound primary inspection based on the existing number of car and truck lanes, current volume of traffic, and existing average Customs and Border Protection (CBP) processing times. It should be noted that processing times are dependant on many factors that can produce significantly different results. For example processing times may vary greatly based on the national security threat level, the mix of vehicles, (trucks vs. cars), the types of contents of trucks passing through the plaza, and CBP staffing levels.

The existing model was validated and was then used to simulate Future 2030 Build and No-Build conditions and analyze traffic operations. Delay is a measure of the time added to the normal travel time of a particular movement travelling below the free flow speed.

Data Collection

The relationship between traffic volume and the corresponding wait time at the Primary Inspection Lanes (PILs) varies by time of year, CBP average processing times, national security level, the number of PILs open, and the number of lanes designated as truck or car only lanes based on demand. Therefore, it was important to select an existing traffic condition that reflected average wait times under a national security level of orange (elevated) on a typical busy day.

MDOT provided traffic and plaza operations data for the last week in July, 2008 as shown in Appendix A, based on the criteria above. The goal for the existing model was to provide validated processing capacities of the PILs in comparison to corresponding observed average queue lengths and wait times. These validated values for processing rates, queue length and wait time were then applied to the 2030 forecasted volumes to provide a prediction of the existing plaza under future traffic conditions and the proposed plaza. The Study Team selected Tuesday, July 29, 2008 as the sample to model, which demonstrated average heavy traffic volumes and queue lengths that reflected average wait times on an average busy day with all 13 PILs open, as summarized below in Table 2. The traffic volumes shown below are between 10 am and 4 pm, which were the heaviest volumes of that particular day. The data in Table 2 was taken from CBP's log from July 29th, 2008.

Table 2 Recorded Sample Traffic Data

Hour Ending	Cars	Lanes Open	Trucks	Lanes Open
Tuesday July 29th, 2008				
10 a.m.	418	5 + 1	160	6 + 1
11 a.m.	425	7 + 1	134	4 + 1
12 p.m.	359	7 + 1	140	4 + 1
1 p.m.	291	7 + 1	140	4 + 1
2 p.m.	391	6 + 1	134	5 + 1

3 p.m.	340	6 + 1	130	5 + 1
4 p.m.	348	7 + 1	102	4 + 1

In Table 2, the "+1" in the Lanes Open column designates an open FAST or Nexus lane. FAST (Free and Secure Trade) is a program between the United States and Canada to expedite processing of pre-screened trucks. Key to the effectiveness of this program is providing dedicated lanes for use by FAST vehicles. NEXUS is a program that allows pre-approved low risk travelers to enjoy a simplified border crossing process. NEXUS pass holders can use dedicated lanes at border crossings, thereby reducing their waiting time.

The data above at 11 am to 12 pm produced car queues to the center of the Blue Water Bridge with approximately 15 to 25 minutes delay, and truck queues from the U.S. inspection plaza over the bridge to the Canadian plaza with approximately 40 to 50 minutes delay as verified by MDOT Bridge personnel. This does not include CBP inspection time (approximately 1 to 3 minutes per vehicle) or the time taken to travel the same distance at free flow speed. It measures the time taken for a vehicle to travel from the queue end to the vehicle stop prior to U.S. Inspections excluding the free flow speed time. The average time for a vehicle to travel from the Canadian plaza to the stop prior to U.S. inspection at free flow speed is approximately 3 minutes based on an average speed of 30 mph over a distance of 1.3 miles. Therefore, delay is a measure of the additional time taken to cross the border on top of free flow time (Canadian plaza to U.S. plaza) and processing time, in this case equal to an average of 5 minutes.

The same data in Table 2 later in the day resulted in queues along the 402 expressway in Canada, with approximately 60 minutes of delay per vehicle. The Study team felt that modeling a truck queue length ending before the Canadian plaza provided the simplest case to calibrate the model. Other elements on the Canadian plaza such as tollbooths and stacked trucks make calibration more complicated and require more subjective assumptions. The selected queue length corresponds to an average truck wait time of approximately 35 minutes according to the ***Western Hemisphere Travel Initiative Baseline Study,*** prepared by Homeland Security as shown in the Appendix A, which further validates the queue lengths and wait times calibrated in the model.

Model Assumptions

To validate the existing model the following assumptions were made in conjunction with the inputs located in Appendix A.

- All PILs are open for processing (fully staffed)
- Car queues backup to center of bridge and truck queues backup to Canadian plaza during existing peak periods
- 17 percent of traffic uses FAST/NEXUS (both trucks and cars) for existing traffic
- A mid-week, mid-day peak hour model was used, Tuesday July 29th, 2008
- 7 car lanes, 4 truck lanes, 1 FAST lane, & 1 NEXUS lane were used

- Processing rates were deemed to be reflective of a national security level of orange on a typical day in July (2008)
- 25 percent commercial vehicles
- The validated average processing times were directly applied to the future No-Build scenario and the Recommended Alternative for 2030 traffic
- The FAST/NEXUS percentages were modified to 30% for the future models. There will be a capability in proposed plaza to have up to two FAST and two NEXUS lanes, but this model assumes only one FAST and One Nexus lane.

BWB Traffic Projections

To provide validation of the previously prepared traffic forecast the Study Team cross checked the recorded traffic volumes for July 29th, 2008 with the projected 2008 and 2030 Design Hour Volume (DHV) as shown below in Table 3.

In the Traffic Report two peak hours were calculated to represent the heavier car peak scenario typical of a summer Sunday and a heavier truck peak typical of a Tuesday, Wednesday, or Thursday in October.

Table 3 Design Hour Volume Traffic Data

Vehicle Type	2005 Summer DHV	Projected 2008 Summer DHV	2005 Fall DHV	Projected 2008 Fall DHV	2008 Recorded Traffic (07/29/2008 10am -11am)	2030 Car Vehicles Processed	2030 Truck Vehicles Processed
Car	777	797	298	306	418	944	362
Truck	86	98	237	268	160	181	496
Total	863	894	535	574	578	1,124	858

Table 3 shows that the mid-week volumes for 2008 fit within the range of forecasted 2008 volumes for car and truck peaks. The recorded 2008 volumes fit with the projected 2008 volumes forecasted from 2005 at an average growth rate of 4.4% for trucks and 0.9% for cars. This verifies that the 2030 forecast still represents a reasonable estimate of future traffic growth. The high growth truck forecast was used to assume a worst-case scenario for truck traffic.

The validated existing 2008 plaza model with assumptions as discussed above was applied to the 2030 traffic volumes for the car and truck peaks to establish a No-Build model to use as a comparison for the proposed Recommended Alternative. The same assumptions were then applied to the Recommended Alternative for car and truck peaks. Because the existing model was validated during a different peak period than the proposed peaks, a direct comparison can not be made between existing and no-build models. The existing traffic model was used simply to verify assumptions validated in the existing model to be applied to the future models.

Existing 2008 Model

The existing model was calibrated using the traffic volumes described in Table 2 with all 13 booths open as 7 car lanes, 4 truck lanes, 1 FAST lane and 1 NEXUS lane. The approach lanes on the bridge include the left lane for trucks, the center lane for FAST/Nexus vehicles, and the right lane for cars. The processing rates were assigned based on the same average rates observed for the time slot based on a national security level of orange. FAST and Nexus vehicles are processed separately and at a quicker rate than standard processing, therefore 17 percent of vehicles were set as FAST and Nexus vehicles. The results were validated to field observations as displayed in Table 4. Note that average delay is a measure of the time taken to cross the bridge in addition to a non-delayed travel time i.e. The normal time taken to cross the bridge from the Canadian plaza to the US plaza is approximately 5 minutes without any delay, therefore this would indicate 0 minutes of delay. In the example below 26.3 minutes of delay would equal a total travel time of approximately 31.3 minutes including the 5 minutes to travel the same distance without delay. This does not include the processing time at primary inspection.

Table 4 Model Outputs versus Field Observations

Description	Field Observations	Simulation
Vehicles Processed at Facility (per hour)	575 vehicles (average)	585 vehicles
Maximum Queue	Cars ~ 0.6 mile (half way across bridge) Trucks ~ 1.3 miles (close to Canadian Plaza)	Cars ~ 0.5 mile Trucks ~ 1.3 miles
Average Delay*	26.3 min/vehicle (weighted average)	22.3 min/vehicle (weighted average) Range: 13.4 to 33.8 min/vehicle

* Delay is the queue time from beginning to end not including the time taken to drive the same distance at free flow speed (delay = total wait time in queue – normal travel time).

The results show that the existing model closely replicates the field observations on Tuesday July 29th, 2008 and hence confirms a validated model.

Proposed 2030 Models

The proposed traffic forecasts calculated truck and car Two different peak periods were analyzed; peak passenger traffic in July, and peak commercial traffic in October. These peaks are different to the peak used for the existing model (Tuesday, July 29th), providing a different

spread of truck and cars than the The FAST/Nexus traffic was assumed to increase to 30 percent of total traffic.

No-Build 2030 Model

The same assumptions and average processing times used for the existing model were applied to the existing plaza with 2030 traffic volumes based on fully staffed booths and optimized lane configurations. Below in Table 5 is the summary of results for 2030 passenger and commercial design hours.

Table 5 2030 No-Build Passenger and Commercial Results

	Passenger Design Hour	Commercial Design Hour
PILs Configuration	8 Car Lanes 3 Truck Lanes 1 FAST Lane 1 NEXUS Lane	4 Car Lanes 7 Truck Lanes 1 FAST Lane 1 NEXUS Lane
Maximum Queue	Cars – 1.7 miles Trucks – 1.5 miles	Cars - 0.1 miles Trucks – beyond model parameters (over 1.8 miles)
Average Delay*	31.8 minutes/vehicle	19.5 minutes/vehicle
Delay Range	20.0 to 43.3 minutes/vehicle	16.0 to 27.2 minutes/vehicle
Hourly Throughput	814 Total vehicles processed in model	696 Total vehicles processed in model

* Delay is the queue time from beginning to end not including the time taken to drive the same distance at free flow speed (delay = total wait time in queue – normal travel time).

The 2030 No-Build results show that the existing plaza would experience greater delays and backups in 2030 than with existing traffic for commercial and passenger design hours.

Proposed 2030 Build Models

The same assumptions and average processing times used for the existing model were applied to the proposed plaza with 2030 traffic volumes. The same peak periods used for the future No-Build model were used for the future peak along with the high range volumes from the traffic forecast. The reason for using the high range forecast was to analyze a potential worst case scenario. The model assumes that all 20 future Primary Inspection Lanes (PILs) are operational. The results for the passenger and truck 2030 design hours are presented in Table 6.

Table 6 Passenger and Commercial Results

	Passenger Design Hour	Commercial Design Hour
PILs Configuration	13 Car Lanes 5 Truck Lanes 1 FAST Lane 1 NEXUS Lane	5 Car Lanes 13 Truck Lanes 1 FAST Lane 1 NEXUS Lane
Maximum Queue	Cars – contained within plaza	Contained within plaza area

	Trucks – contained within plaza	
Average Delay*	3.4 minutes/vehicle	3.1 minutes/vehicle
Delay Range	2.8 to 4.2 minutes/vehicle	2.5 to 3.6 minutes/vehicle
Hourly Throughput	944 Cars DHV 166 Trucks DHV 1110 Total vehicles processed in model	348 Cars DHV 496 Trucks DHV 844 Total vehicles processed in model

* Delay is the queue time from beginning to end not including the time taken to drive the same distance at free flow speed (delay = total wait time in queue – normal travel time).

The results show that given the proposed plaza configuration and the 20 PILs operational, all traffic in the passenger and commercial design hours can be adequately processed with minimal delay. It is important to note that the two scenarios modeled are based on the following factors:

- Proposed 2030 DHV forecast
- Average CBP processing times
- Fully staffed booths
- A set booth configuration
- No downstream impact on booth operation

All of the factors above are fluctuating variables that will affect the operation of the PILs. However, the 2030 models developed provide a level of confidence that given two conservative design hours the proposed plaza will operate well. The delay analysis results are summarized in Table 7 below.

Table 7 Delay Analysis Summary

Model Output	Passenger Peak		Commercial Peak	
	Future No-Build	Future Build	Future No-Build	Future Build
Vehicles Processed per hour	814	1110	696	844
Average delay* (min/veh)	31.8	3.4	19.5	3.1
Maximum Queue Cars	1.7 miles	Within Plaza	Within Plaza	Within Plaza
Maximum Queue Trucks	1.5 miles	Within Plaza	Beyond Study Area (>1.8 miles)	Within Plaza

* Delay is the queue time from beginning to end not including the time taken to drive the same distance at free flow speed (delay = total wait time in queue – normal travel time).

Sensitivity Check

In order to provide a level of confidence of how close to capacity the proposed model plaza would be operating during the two design hours, a sensitivity check was developed. The number of PILs open during the passenger and trucks design hour models were decreased to assess the change in delay given the same traffic loads. During the passenger peak, commercial booths were closed and during the commercial peak, passenger lanes were closed to see the affect on delay. Below in Tables 8 and 9 are the summary of the sensitivity results.

Table 8 Sensitivity of Passenger Results

Case	Delay*	Maximum Queue (Cars)	Maximum Queue (Trucks)	Vehicles Processed per hour
18 Staffed Lanes	3.4 minutes/ vehicle	Within Plaza	Within Plaza	1110
15 Staffed Lanes	9.2 minutes/ vehicle	Within Plaza	Beyond Study area (more than ½ mile beyond Canadian Plaza)	1036
13 Staffed Lanes	15.5 minutes/ vehicle	0.1 mile	Beyond Study area (more than ½ mile beyond Canadian Plaza)	922
No-Build 11 Staffed Lanes	31.8 minutes/ vehicle	1.7 miles	1.5 miles	814

* Delay is the queue time from beginning to end not including the time taken to drive the same distance at free flow speed (delay = total wait time in queue – normal travel time).

Table 9 Sensitivity of Commercial Results

Case	Delay*	Maximum Queue (Cars)	Maximum Queue (Trucks)	Vehicles Processed per hour
18 Staffed Lanes	3.1 minutes/ vehicle	Within Plaza	Within Plaza	844
15 Staffed Lanes	19.5 minutes/ vehicle	1.0 mile	Within Plaza	705
13 Staffed Lanes	22.8 minutes/ vehicle	1.0 mile	0.5 mile	668
No-Build 11 Staffed Lanes	23.7 minutes/ vehicle	Within Plaza	Beyond Study area (more than ½ mile beyond Canadian Plaza)	539

* Delay is the queue time from beginning to end not including the time taken to drive the same distance at free flow speed (delay = total wait time in queue – normal travel time).

During the passenger design hour, the model predicts that closure of 3-commercial lanes would result in severe delay into Canada. During the commercial design hour, the model predicts that closure of 3-passenger lanes would result in some additional delay.

Conclusion

Based on the delay analysis summarized in this report and the assumptions made pertaining to traffic volumes and the Port Operating Requirements provided by CBP, the proposed Recommended Alternative appears to have an appropriate number of primary inspection lanes to significantly reduce future delays at the Port Huron POE.

Appendix A – Data

Report ID: T01

Blue Water Bridge Authority
VEHICLES BY HOUR

Page: 1
Date: 9/11/2008
Time: 11:05:23AM

From: 07/28/08 12:00:00 AM To: 07/28/08 11:59:59 PM

Lane(s): All Mon

Vehicle Type	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	Totals
Car/RV																									
Single Vehicle	110	35	44	33	43	69	165	217	360	443	489	464	458	410	363	335	356	354	297	186	198	129	104	62	5,724
SubTotal:	110	35	44	33	43	69	165	217	360	443	489	464	458	410	363	335	356	354	297	186	198	129	104	62	5,724
Car/RV/Ex-Axl																									
Car+1 axle	1	1	3	1	0	2	2	4	8	1	1	6	6	8	10	10	5	3	5	0	5	0	2	2	86
Car+2 axles	0	2	0	0	0	0	1	1	3	5	6	6	6	9	3	2	4	0	3	1	5	2	0	2	61
Car+3 axles	0	0	0	0	0	0	0	0	0	1	0	0	0	1	0	0	0	1	0	0	0	0	0	0	3
SubTotal:	1	3	3	1	0	2	3	5	11	7	7	12	12	18	13	12	9	4	8	1	10	2	2	4	150
Bus																									
2 axles	0	1	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2
3 axles	0	0	0	0	0	0	0	1	1	0	0	0	1	0	0	1	1	0	2	2	1	1	0	0	11
SubTotal:	0	1	0	0	0	0	0	2	1	0	0	0	1	0	0	1	1	0	2	2	1	1	0	0	13
Truck																									
2 axles	2	1	4	2	1	3	8	6	8	4	8	4	7	3	10	7	7	4	8	4	10	5	5	2	123
3 axles	3	0	0	0	1	2	2	3	3	1	0	2	1	2	0	1	1	1	2	3	2	4	1	0	35
4 axles	0	0	0	1	0	1	0	0	1	2	1	0	1	4	1	2	2	0	3	0	1	2	1	0	23
5 axles	36	31	22	40	54	56	60	58	84	56	78	63	71	67	99	124	71	124	102	85	90	101	72	51	1,695
6 axles	0	2	2	2	3	4	6	3	4	5	4	2	3	2	3	14	4	2	3	2	1	3	2	1	77
7 axles	0	2	0	2	6	4	4	3	4	2	4	2	1	2	3	8	2	2	1	2	1	2	0	0	57
8 axles	2	5	6	7	8	5	5	8	8	9	9	4	1	3	4	1	1	0	2	0	2	0	1	7	98
9 axles	5	7	11	16	26	49	40	43	37	38	38	17	19	11	17	4	4	3	1	4	5	7	3	2	407
10 axles	1	2	1	0	0	2	4	2	2	3	1	0	0	0	1	0	1	2	0	1	2	3	1	0	29
11 axles	0	0	1	0	1	0	0	0	1	2	2	1	1	1	2	3	1	0	0	0	0	0	0	0	16
SubTotal:	49	50	47	70	100	126	129	126	152	122	145	85	105	95	140	164	94	138	122	101	114	127	86	63	2,560
Total:	160	89	94	104	143	197	297	350	524	572	641	571	576	523	516	512	460	495	429	290	323	259	192	129	8,447

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Report ID: T01

Blue Water Bridge Authority
VEHICLES BY HOUR

Page: 1
Date: 9/11/2008
Time: 11:05:28AM

From: 07/29/08 12:00:00 AM To: 07/29/08 11:59:59 PM

Lane(s): All

Tue

Vehicle Type	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	Totals
Car/RV																									
Single Vehicle	41	28	25	21	39	56	123	183	321	411	412	350	278	384	326	339	286	310	261	200	138	112	86	61	4,791
SubTotal:	41	28	25	21	39	56	123	183	321	411	412	350	278	384	326	339	286	310	261	200	138	112	86	61	4,791
Car/RV/Ex-Axl																									
Car+1 axle	0	0	0	0	0	2	0	0	3	5	3	6	2	4	7	5	0	8	0	2	0	1	0	0	40
Car+2 axles	0	1	0	0	1	0	0	2	2	2	10	3	11	3	7	3	5	3	2	2	0	2	0	0	59
Car+3 axles	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	1	0	0	4
SubTotal:	0	1	0	0	3	2	0	2	5	7	13	9	13	7	14	9	5	3	2	4	0	4	0	0	103
Bus																									
2 axles	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	1
3 axles	0	0	0	0	1	0	1	0	1	0	0	0	0	0	0	0	0	0	1	0	0	0	1	0	5
SubTotal:	0	0	0	0	1	0	1	0	1	0	0	0	0	1	0	0	0	0	1	0	0	0	1	0	6
Truck																									
2 axles	2	4	3	4	3	2	8	4	12	10	7	7	13	8	12	4	7	8	8	10	4	2	8	6	156
3 axles	5	0	1	0	1	0	1	2	4	0	0	4	1	1	2	0	1	0	1	1	1	1	2	0	29
4 axles	0	1	0	0	1	0	0	2	3	1	0	0	0	0	1	2	4	1	0	2	0	0	0	0	18
5 axles	50	44	44	43	69	82	67	72	88	89	74	88	94	103	90	83	81	113	104	118	83	72	56	65	1,872
6 axles	0	1	2	3	2	4	2	2	3	8	5	3	6	4	6	2	1	1	1	2	2	1	2	3	66
7 axles	0	2	1	3	4	5	5	5	2	3	5	5	3	2	3	3	0	4	2	2	1	1	0	1	62
8 axles	4	3	6	9	7	11	7	10	10	12	4	10	3	1	3	0	2	0	1	0	1	1	3	5	113
9 axles	2	5	13	19	27	38	47	43	31	32	35	22	20	13	11	7	5	2	9	6	9	6	2	4	408
10 axles	0	0	3	3	2	6	4	3	4	3	3	0	0	1	2	0	4	5	1	0	2	1	0	1	48
11 axles	0	0	0	0	0	0	0	0	0	2	1	1	0	1	0	1	1	0	1	0	0	0	1	0	9
SubTotal:	63	60	73	84	116	148	141	143	157	160	134	140	140	134	130	102	106	134	128	141	103	85	74	85	2,781
Total:	104	89	98	105	159	206	265	328	484	578	559	499	431	526	470	450	397	447	392	345	241	201	161	146	7,681

Sep. 11. 2008 1:32PM No. 3950 P. 6

Report ID: T01

Blue Water Bridge Authority
VEHICLES BY HOUR

Page: 1
Date: 8/11/2008
Time: 11:05:32AM

From: 07/30/08 12:00:00 AM To: 07/30/08 11:59:59 PM

Lane(s): All Wed

Vehicle Type	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	Totals
Car/RV																									
Single Vehicle	49	29	23	27	36	75	126	204	329	382	429	417	362	336	411	347	417	314	249	240	176	164	124	60	5,326
SubTotal:	49	29	23	27	36	75	126	204	329	382	429	417	362	336	411	347	417	314	249	240	176	164	124	60	5,326
Car/RV/Ex-Axl																									
Car+1 axle	1	0	0	0	1	1	1	1	3	4	2	3	4	7	2	3	1	5	7	3	1	1	0	0	51
Car+2 axles	1	0	0	0	0	0	0	0	2	7	6	4	6	3	2	2	1	3	0	2	7	2	0	1	49
Car+3 axles	0	1	0	0	0	1	1	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	5
SubTotal:	2	1	0	0	1	2	2	1	5	11	8	7	10	12	4	5	2	8	7	5	8	3	0	1	105
Bus																									
2 axles	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1
3 axles	1	0	0	0	0	0	2	0	0	0	1	0	0	0	0	0	0	1	1	0	0	0	0	0	6
SubTotal:	1	0	0	0	0	0	2	0	0	0	1	0	0	0	0	0	0	1	1	0	0	0	0	1	7
Truck																									
2 axles	1	1	0	3	5	4	5	5	17	5	7	10	9	6	7	12	8	7	8	9	5	3	6	1	144
3 axles	0	0	2	0	2	2	5	3	1	4	5	3	1	2	5	1	1	2	0	5	1	1	2	0	48
4 axles	1	0	0	0	3	0	1	0	1	1	1	0	4	1	1	0	1	1	0	0	2	1	0	0	19
5 axles	44	35	50	52	78	72	69	77	80	81	96	51	111	93	124	68	111	114	110	106	81	73	80	64	1,920
6 axles	2	2	2	2	5	2	1	3	8	5	2	1	7	5	7	4	0	5	2	4	2	0	5	3	79
7 axles	0	0	0	1	7	6	3	4	4	4	3	2	8	1	1	1	3	4	2	0	1	0	0	1	56
8 axles	6	2	7	7	6	7	7	9	8	15	3	2	6	0	2	1	1	1	1	1	1	0	1	5	99
9 axles	4	12	12	20	30	48	43	31	31	42	39	14	17	18	14	4	4	1	8	4	7	7	3	4	417
10 axles	1	3	0	0	1	2	3	4	7	1	2	2	2	1	1	1	2	2	1	5	3	3	3	2	53
11 axles	0	1	0	0	0	0	1	2	1	3	1	0	0	0	1	1	2	2	2	2	0	0	0	0	19
12 axles	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	1
13 axles	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1
SubTotal:	59	56	73	85	137	143	138	138	158	161	160	85	166	127	163	93	133	139	134	137	103	88	100	80	2,856
Total:	111	86	96	112	174	220	268	343	492	554	598	509	538	475	578	445	552	462	391	382	287	255	224	142	8,294

Sep. 11. 2008 1:37PM No. 3950 P. 7

Report ID: T01

Blue Water Bridge Authority
VEHICLES BY HOUR

Page: 1
Date: 9/10/2008
Time: 8:25:28AM

From: 07/31/08 12:00:00 AM To: 07/31/08 11:59:59 PM

Lane(s): All

Thur

Vehicle Type	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	0	Totals
Car/RV																									
Single Vehicle	68	39	37	35	31	72	139	234	345	455	400	314	373	352	417	480	440	374	290	354	232	211	183	129	6,004
SubTotal:	68	39	37	35	31	72	139	234	345	455	400	314	373	352	417	480	440	374	290	354	232	211	183	129	6,004
Car/RV/Ex-Axl																									
Car+1 axle	1	0	0	0	1	2	3	1	2	0	9	3	11	4	11	2	3	5	6	2	2	4	3	1	76
Car+2 axles	1	2	1	0	0	0	0	1	3	6	5	10	11	6	9	5	4	3	10	3	9	6	5	1	101
Car+3 axles	1	0	0	0	0	0	0	3	0	0	0	0	1	1	1	0	1	3	0	0	1	1	1	0	14
Car+4 axles	0	0	0	0	0	0	1	0	0	0	0	0	1	0	1	0	0	0	0	0	0	0	0	0	3
SubTotal:	3	2	1	0	1	2	4	5	5	6	14	13	24	11	22	7	8	11	16	5	12	11	9	2	194
Truck																									
2 axles	3	5	3	4	1	6	4	12	13	10	5	6	11	5	15	6	11	10	8	4	4	8	2	0	156
3 axles	2	1	0	1	0	3	1	2	3	2	2	2	0	1	4	2	2	1	0	0	1	0	3	0	33
4 axles	1	0	1	0	0	0	1	1	0	1	2	0	2	0	4	1	1	1	0	0	0	0	1	0	17
5 axles	75	41	30	46	55	58	67	65	78	71	68	80	72	46	106	89	116	117	99	46	68	42	59	69	1,663
6 axles	3	2	2	3	2	2	6	4	4	9	1	5	4	6	5	4	2	5	1	1	4	1	2	1	79
7 axles	2	0	1	3	3	8	8	3	6	2	4	4	1	2	1	0	3	3	0	2	2	0	0	2	60
8 axles	5	5	7	4	11	9	12	13	9	13	5	1	2	4	1	1	3	0	2	2	0	1	1	7	118
9 axles	4	11	16	15	33	47	47	28	29	37	29	25	23	12	18	9	7	6	5	8	4	4	1	3	421
10 axles	4	5	1	0	2	2	7	3	4	2	2	1	2	1	2	2	5	1	1	2	1	2	1	1	54
11 axles	0	0	0	0	0	0	2	1	1	2	2	1	3	2	4	1	2	1	0	0	0	2	1	1	26
13 axles	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	1
SubTotal:	99	70	61	76	107	135	155	132	147	149	120	125	120	79	160	115	153	145	116	65	84	60	71	84	2,628
Total:	170	111	99	111	139	209	298	371	497	610	534	452	517	442	599	602	691	530	422	424	328	282	263	215	8,826

Sep. 10. 2008 9:07AM No. 3932 P. 3

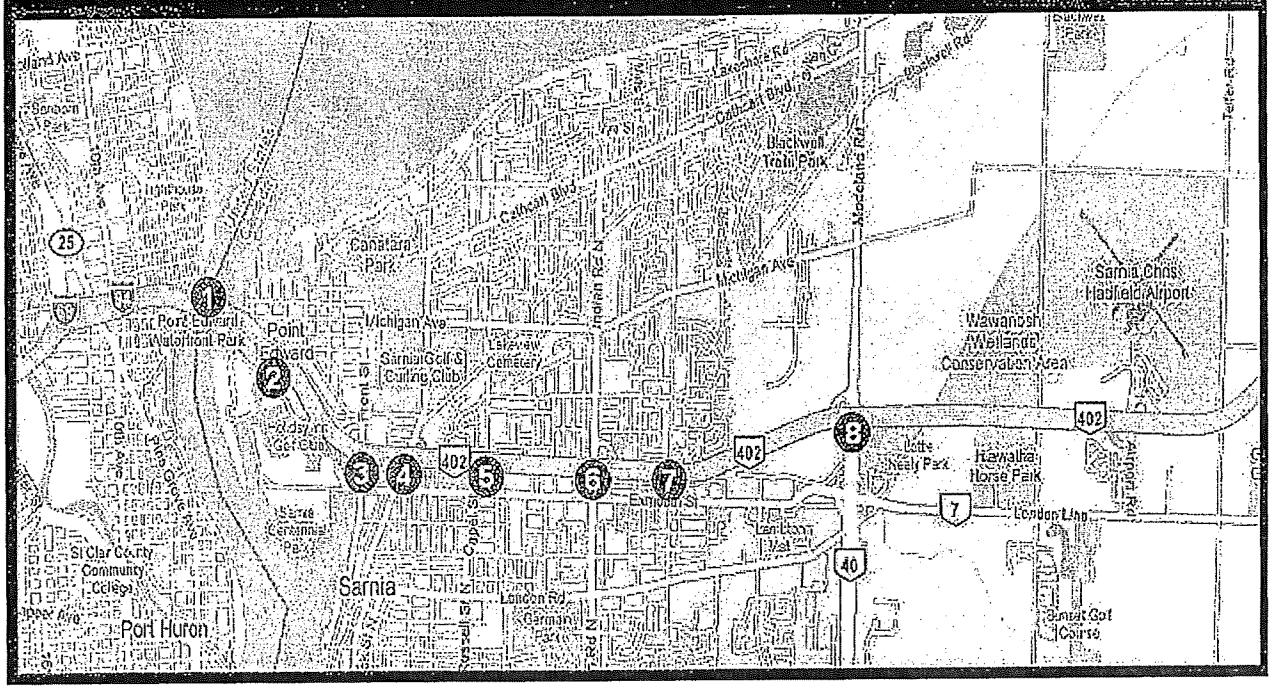
1Date	Traffic back-ups-reasons, etc
Oct.11-06	Cars and trucks backed up. Started with 4 truck lanes + Fast and 4 car lanes, and then went down to 3 car lanes. They stated budgetary reasons.
Oct. 16, 2006	Cars backed up. They have only 3 car lanes open all day because they are short staffed. Trucks backed up. They have 5 + Fast. They say they are having computer problems.
Oct.17, 2006	4:50am: Trucks backed up...said lane #7 was having computer problems. Had 5 + Fast open. 12pm: Trucks still backed up and now cars are backed up. 4 car lanes and 5+Fast truck lanes. They say they are short staffed. Trucks-cleared at 10:15pm.
Oct.18,2006	0430 to 2000 hrs trucks backing up as far as Blackwell at times. 5 + F till 1300 hrs then 6 + F after.
Oct.18,2006	6.30 pm backed up to Indian Road. Back up over 8.30 pm
Oct.19,2006	We started holding trucks at 4.30 am.5 + FAST open according to MDOT
Oct. 20 - 2006	5: a.m. it started (4 + FAST open) Backed up when I came in (to corner) clear at 8:a.m
Oct. 20, 2006	5:30 p.m. Cars and trucks backing up. 5 truck lanes open – 5 car lanes and Nexus. Sharon called Customs and they said that is all they can open.
Oct 20	7 pm trucks were backed up to corner

APPENDIX B – BENCHMARKING SYSTEM USED BY BWBC AND CBP

In September 2007, a survey was performed by BWBC and CBP to determine wait times from various inbound points into the U.S. The guidance document below was created and serves as the benchmarking guidance tool for use by CBP supervisors. There are plans to re-validate the guidance document on a regular basis.

Border Wait Time Analysis - Port Huron (ave times) 09/13/2007

	Mid Span	Toll Booth	Front St	Christina St	Colburn Rd	Murphy Rd	Indian Road	Modeland Rd	Airport Rd
Distance	1.0k	2.2k	2.0k	3.6k	4.5k		5.4k	8k	10.8k
	27	60	65	60	57	0	53	50	0
	31	69	53	49	65		115	120	
	25	31	39	52	74		93	135	
	30	32	42	67	80		75	98	
	35	78	60	72			93	109	
		28	57				53	123	
		22	63				68		
		35					91		
		39							
	1	2	3	4	5	7	6	8	
AVE									
MIN	30	44	51	63	68	0	85	113	0
		35	45	60	75	115	90	120	



Appendix B – Data

BLUE WATER BRIDGE DELAY ANALYSIS

September 2008

WilburSmith ASSOCIATES ENGINEERS PLANNERS ECONOMISTS

KLD ASSOCIATES, INC.

BLUE WATER BRIDGE DELAY ANALYSIS

Outline

- WATSim Simulation Software
- Simulation Models
  - Existing Conditions
  - Future No-Build Conditions
    - Commercial Peak
    - Passenger Peak
  - Future Build Conditions
    - Commercial Peak
    - Passenger Peak
- Sensitivity Studies

BLUE WATER BRIDGE DELAY ANALYSIS

Project Objective

- Construct a validated/calibrated simulation model representing existing conditions
- Construct simulation models of Future Build and Future No-Build conditions
- Analyze traffic operations for Future year (2030) conditions

BLUE WATER BRIDGE DELAY ANALYSIS

WATSim Simulation Software

- Microscopic traffic simulation
- Represents individual vehicles and driver decision processes
- Extension of FHWA's TRAF-NETSIM
- Includes a model expressly designed for toll plazas – GENTOPS
- Developed with funding from NYSERDA and New York Bridge Authority
- Applied extensively to facilities across the country

BLUE WATER BRIDGE DELAY ANALYSIS

WATSim Simulation Software

- Clients include
  - CALTRANS
  - Port Authority of New York and New Jersey
  - Metropolitan Transportation Authority of New York
  - Pennsylvania Turnpike Commission
  - Delaware Joint Toll Bridge Commission
  - New York State Thruway Authority
  - New Jersey Turnpike Authority

BLUE WATER BRIDGE DELAY ANALYSIS

Existing Conditions

- Inbound Plaza: 13 lane facility
- Operations vary by time of year and time of day
  - 1 lane for FAST
  - 1 lane for NEXUS
  - Varying levels of CBP staffing and processing times
  - Truck and Car lanes opened based on demand
- Allocation of approach lanes on bridge
  - Left Lane – Trucks
  - Center Lane – FAST/NEXUS
  - Right Lane – Cars
- Peak passenger operations July/August
- Peak commercial operations May/October

BLUE WATER BRIDGE DELAY ANALYSIS

Field Data

- Traffic Volumes – peak period traffic volumes estimated from 2005 AADT counts
- Signal Timing Plans - peak period signal phasing and timing (SYNCHRO)
- Daily traffic data including hourly processing times from CBP for the week of July 28, 2008
- Inbound plaza delay and queue observations for the week of July 28, 2008

BLUE WATER BRIDGE DELAY ANALYSIS

Model of Existing Conditions

- Mid-week, mid-day peak hour model
- Fully staffed
- 7 Car lanes, 4 Truck lanes, 1 FAST lane and 1 NEXUS lane
- Processing Rates
  - Normal CBP processing rates
  - Visual observations
  - Orange threat level
- 17% of traffic uses FAST or NEXUS
- 25% commercial vehicles

BLUE WATER BRIDGE DELAY ANALYSIS

Existing Model Validation/Calibration

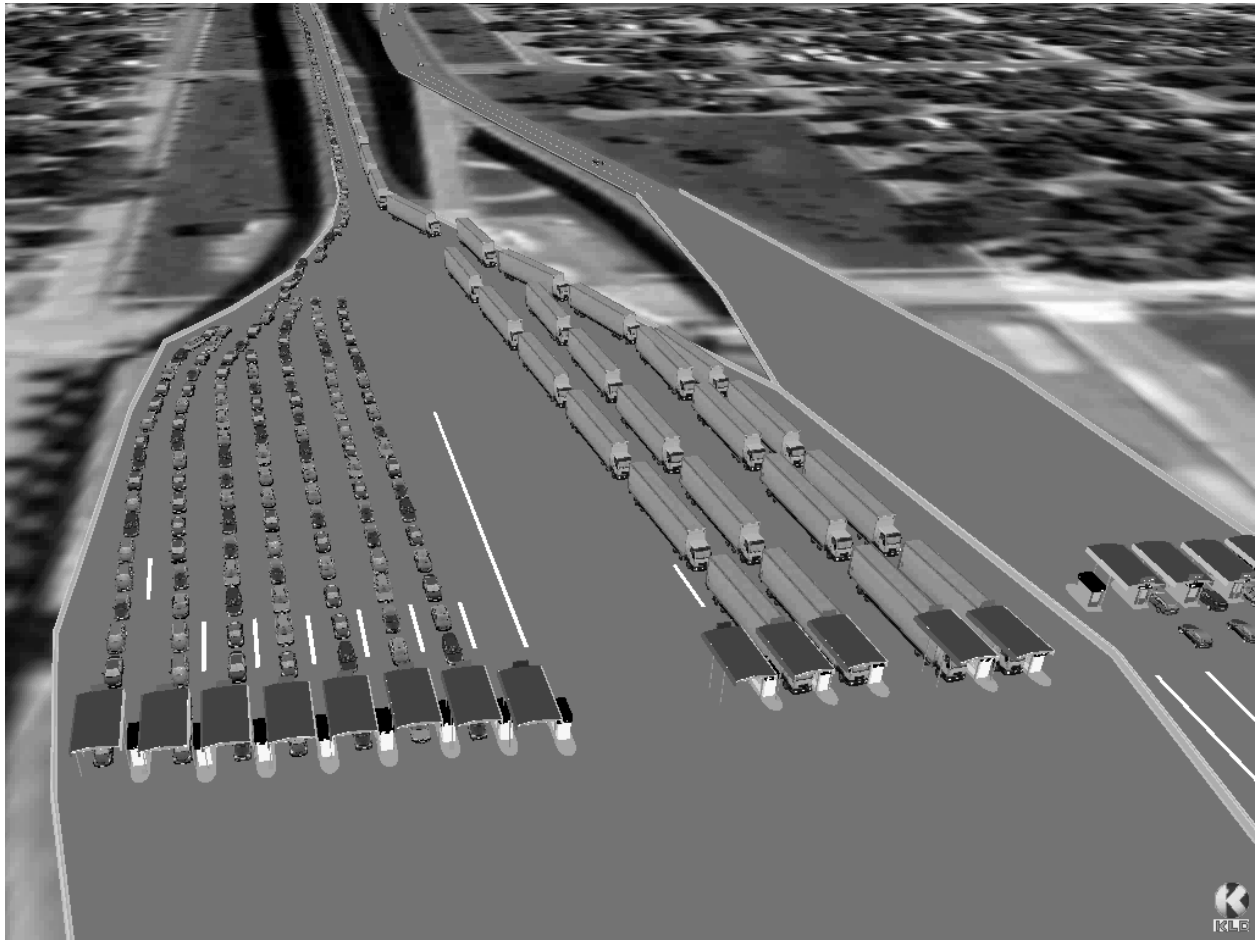
- Model output versus field observations

Description	Field Observations	Simulation
Vehicles Processed at Facility (per hour)	575 vehicles (average)	585 vehicles
Maximum queue	CARS ~ 0.6 miles (half way across bridge) TRUCKS ~ 1.3 miles (close to Canadian Plaza)	CARS ~ 0.5 mi TRUCKS ~ 1.3 mi
Average Delay*	26.3 min/vehicle	22.3 min/vehicle Range: 13.4 to 33.8

* Weighted average between cars and trucks. Delay measured over a distance of 1.8 miles starting from 0.5 miles upstream of Canadian Plaza up to US Inbound plaza.

BLUE WATER BRIDGE DELAY ANALYSIS

Existing PM Peak



Max. Queue Cars: 0.5 miles

Max. Queue Trucks: 1.3 miles

BLUE WATER BRIDGE DELAY ANALYSIS

Future Year Conditions (2030)

- Analyzed two different peak periods
  - Peak passenger traffic in July
  - Peak commercial traffic in October
- Same processing rates as existing model
- Optimal plaza layout based on traffic
- Fully staffed

BLUE WATER BRIDGE DELAY ANALYSIS

Future Year Conditions (2030)

- Forecasted Demand Volumes
  - Passenger Design Hour
    - 944 cars/hour
    - 181 trucks/hour
  - Commercial Design Hour
    - 362 cars/hour
    - 496 trucks/hour
  - 30% of vehicles expected to use FAST/NEXUS
  - Used high growth DHV to assume worst-case scenario for commercial traffic

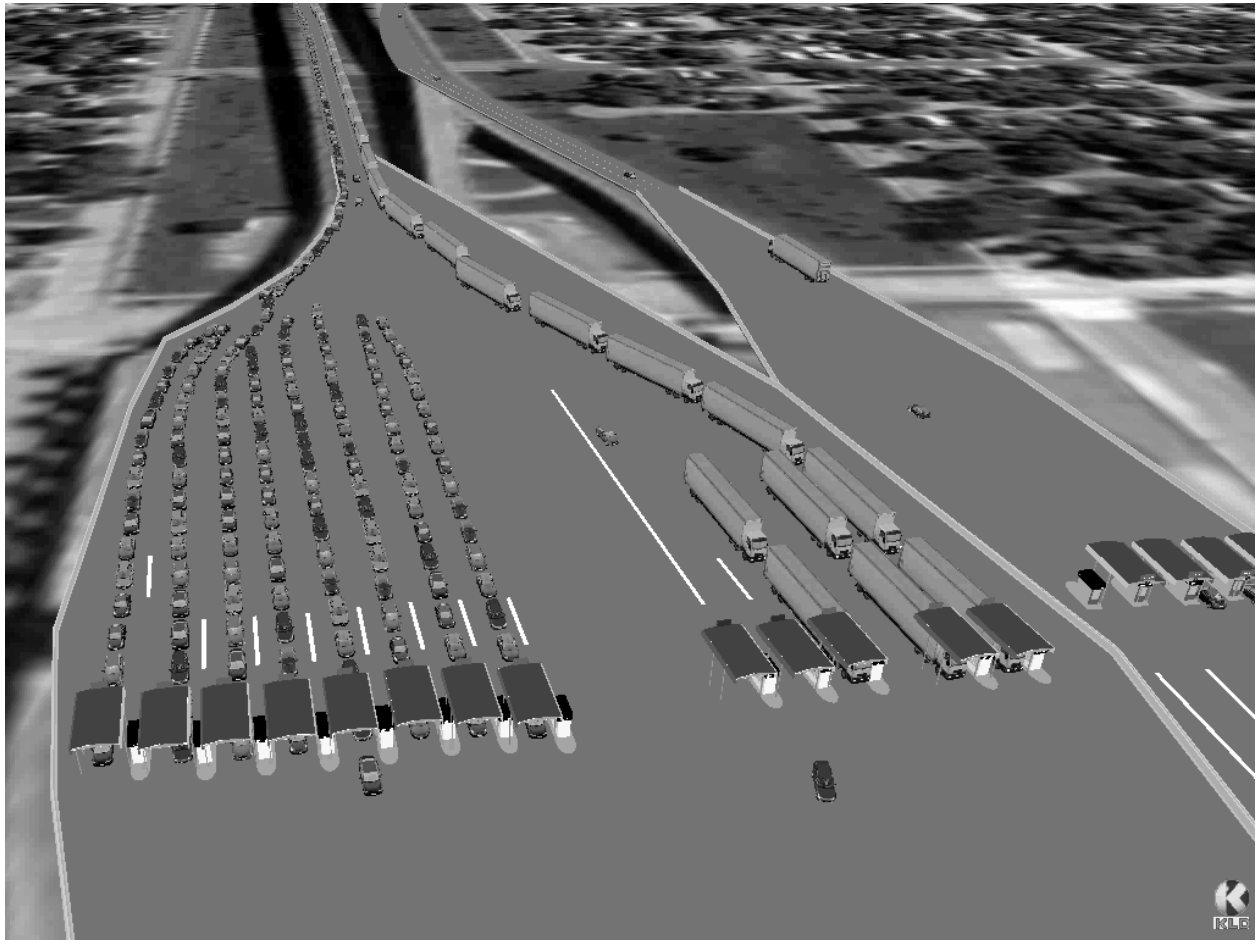
BLUE WATER BRIDGE DELAY ANALYSIS

Passenger Design Hour, No-Build 2030

- Inbound Plaza Layout
  - 8 Car lanes
  - 3 Truck lanes
  - 1 FAST
  - 1 NEXUS
- Preliminary Simulation Results
  - Average delay – 31.8 minutes/vehicle
  - Delay range – 20.0 to 43.3 minutes/vehicle
  - Vehicles processed – 814 vehicles/hour
  - Maximum queue: Cars – 1.7 miles
  - Maximum queue: Trucks – 1.5 miles

BLUE WATER BRIDGE DELAY ANALYSIS

2030:
No-Build
Passenger
Peak



Max.
Queue
Cars:
1.7 miles

Max. Queue
Trucks:
1.5 miles

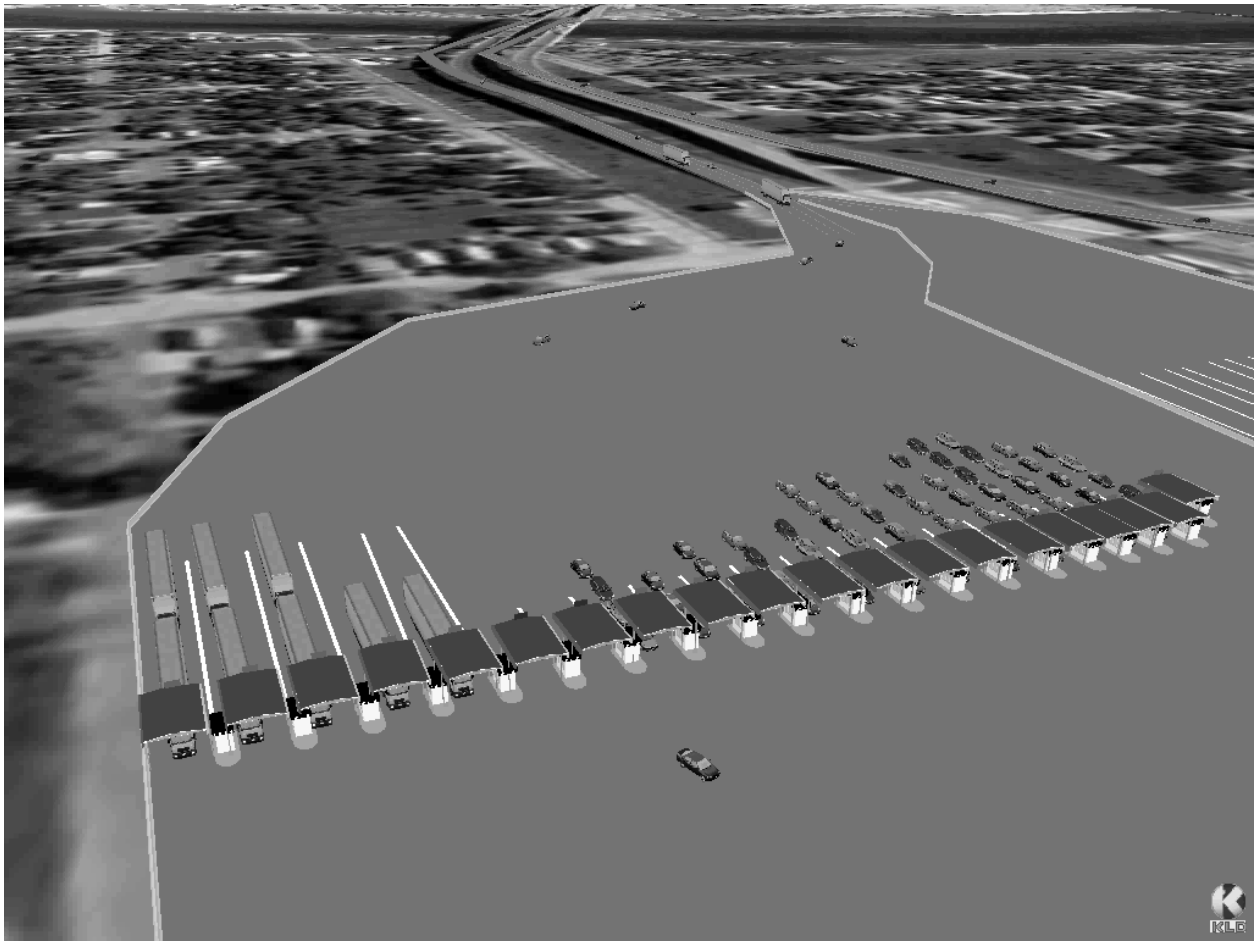
BLUE WATER BRIDGE DELAY ANALYSIS

Passenger Design Hour, Build 2030

- Suggested Layout
  - 13 Car lanes
  - 5 Truck lanes
  - 1 FAST
  - 1 NEXUS
- Preliminary Simulation Results
  - Average delay – 3.4 minutes/vehicle
  - Delay range – 2.8 to 4.2 minutes/vehicle
  - Vehicles processed – 1110 vehicles/hour
  - Maximum queue: Cars – within plaza
  - Maximum queue: Trucks – within plaza

BLUE WATER BRIDGE DELAY ANALYSIS

2030:
Build
Passenger
Peak



Max. Queue
Cars:
Within Plaza

Max. Queue
Trucks:
Within Plaza

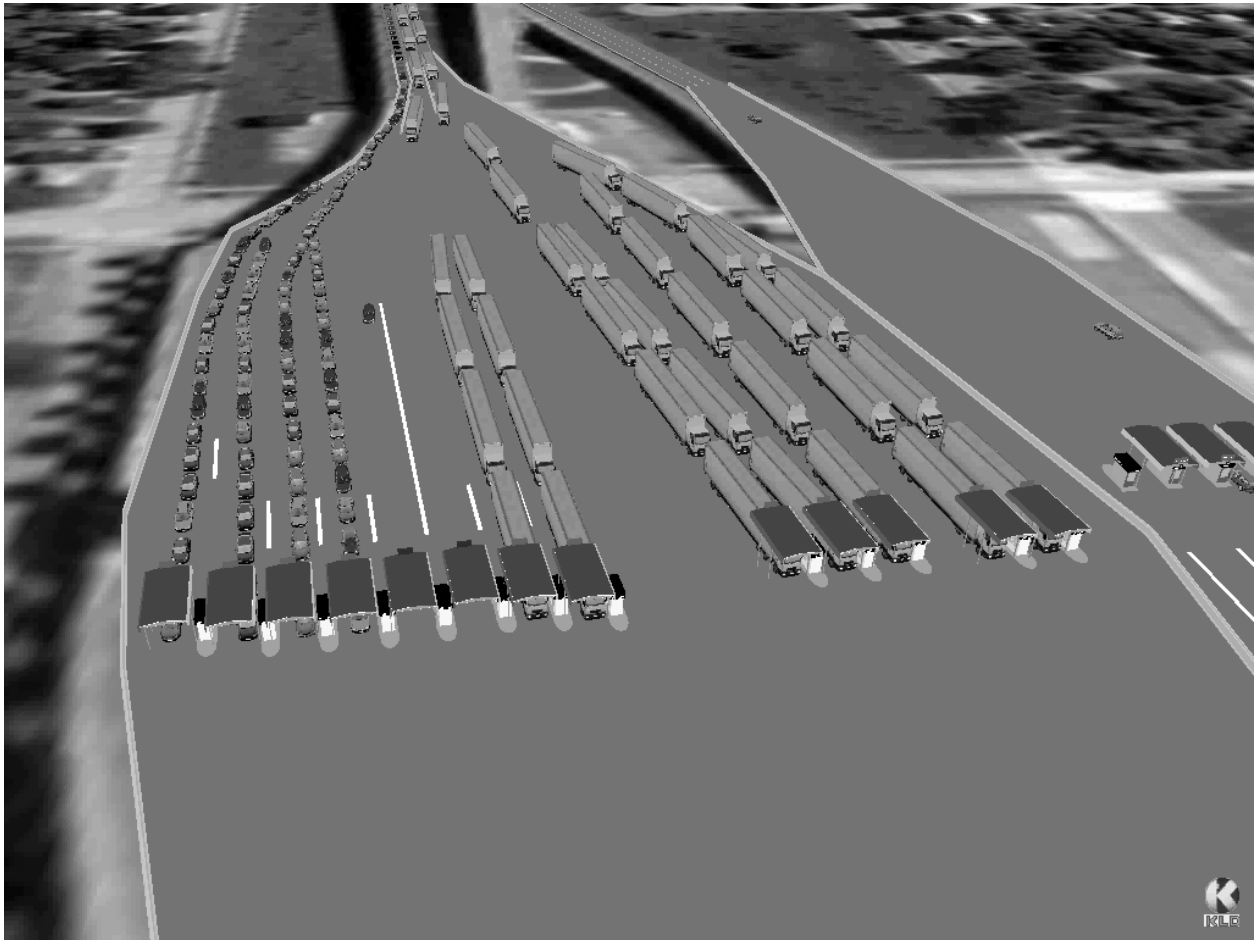
BLUE WATER BRIDGE DELAY ANALYSIS

Commercial Design Hour, No-Build 2030

- Suggested Layout
  - 4 Car lanes
  - 7 Truck lanes
  - 1 FAST
  - 1 NEXUS
- Preliminary Simulation Results
  - Average delay – 19.5 minutes/vehicle
  - Delay range – 16.0 to 27.2 minutes/vehicle
  - Vehicles processed – 696 vehicles/hour
  - Maximum queue: Cars – 0.1 miles
  - Maximum queue: Trucks – beyond study area (> 1.8 miles)

BLUE WATER BRIDGE DELAY ANALYSIS

2030:
No-Build
Commercial
Peak



Max.
Queue
Cars:
0.1 miles

Max. Queue
Trucks:
Beyond
study area
(>1.8 miles)

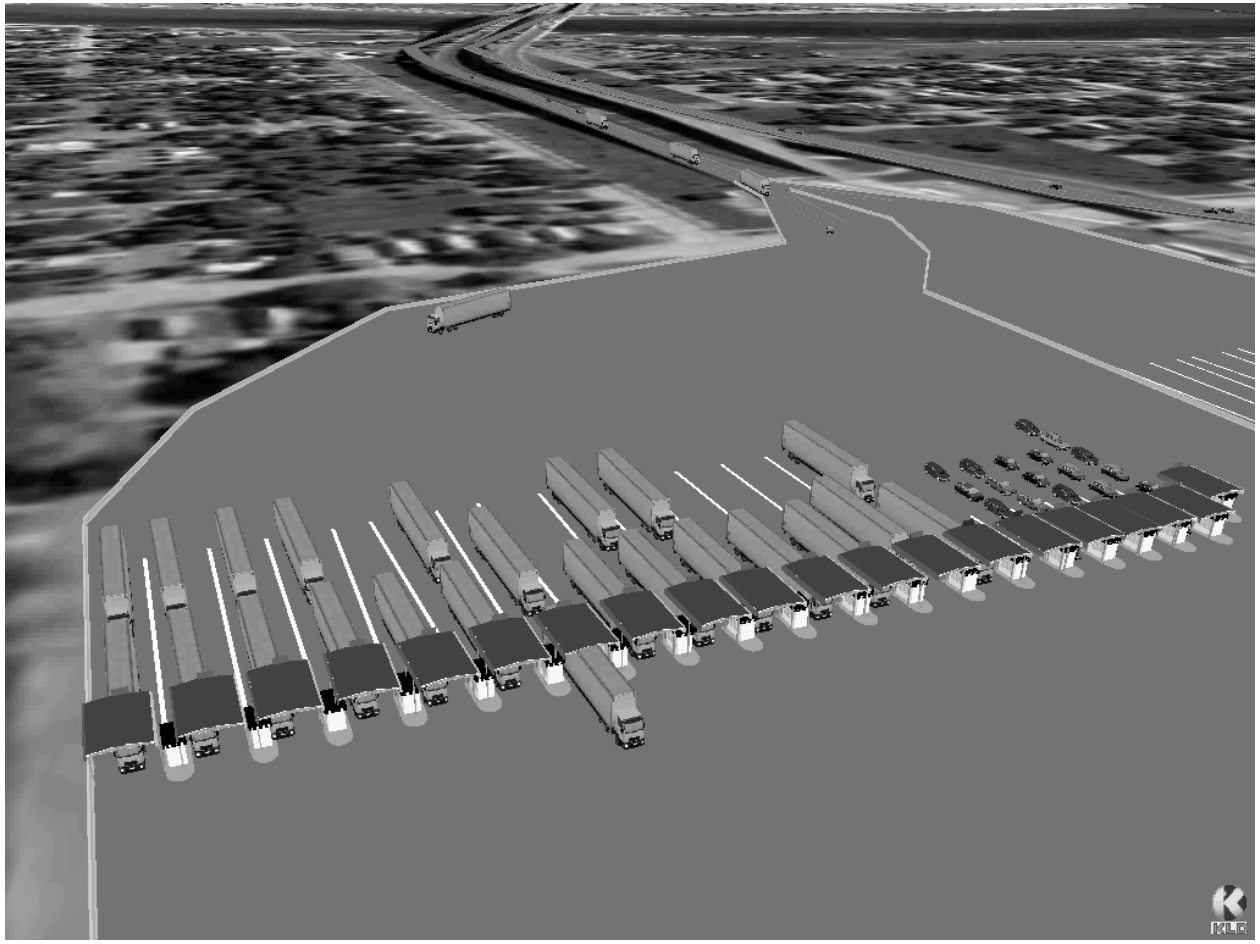
BLUE WATER BRIDGE DELAY ANALYSIS

Commercial Design Hour, Build 2030

- Suggested Layout
  - 5 Car lanes
  - 13 Truck lanes
  - 1 FAST
  - 1 NEXUS
- Preliminary Simulation Results
  - Average delay – 3.1 minutes/vehicle
  - Delay range – 2.5 to 3.6 minutes/vehicle
  - Vehicles processed – 844 vehicles/hour
  - Maximum queue: Cars – within plaza
  - Maximum queue: Trucks – within plaza

BLUE WATER BRIDGE DELAY ANALYSIS

2030:
Build
Commercial
Peak



Max. Queue
Cars:
Within Plaza

Max. Queue
Trucks:
Within Plaza

BLUE WATER BRIDGE DELAY ANALYSIS

Model Output	Passenger peak		Commercial Peak	
	Future No-Build	Future Build	Future No-Build	Future Build
Vehicles Processed per hour	814	1110	696	844
Average Delay (min/veh)	31.8	3.4	19.5	3.1
Maximum Queue Cars	1.7 miles	Within plaza	0.1 miles	Within plaza
Maximum Queue Trucks	1.5 miles	Within plaza	Beyond study area (> 1.8 miles)	Within plaza

BLUE WATER BRIDGE DELAY ANALYSIS

Sensitivity Studies on Future Build Conditions

- Base: Fully staffed
  - 18 Staffed lanes
- Case 1: 80% staffed
  - 15 Staffed lanes
- Case 2: 70% staffed
  - 13 Staffed lanes
- All cases include 1 FAST and 1 NEXUS lanes

Note: No-Build includes 11 staffed lanes

BLUE WATER BRIDGE DELAY ANALYSIS

Passenger Peak Preliminary Results

Case	Delay (min/veh)	Maximum Queue Cars	Maximum Queue Trucks	Vehicles Processed per hour
18 Staffed Lanes	3.4	Within plaza	Within plaza	1110
15 Staffed Lanes	9.2	Within plaza	Beyond study area (>1.8 miles)	1036
13 Staffed Lanes	15.5	0.1 miles	Beyond study area (>1.8 miles)	922
No-Build 11 Staffed Lanes	31.8	1.7 miles	1.5 miles	814

BLUE WATER BRIDGE DELAY ANALYSIS

Commercial Peak Preliminary Results

Case	Delay (min/veh)	Maximum Queue Cars	Maximum Queue Trucks	Vehicles Processed per hour
18 Staffed Lanes	3.1	Within plaza	Within plaza	844
15 Staffed Lanes	19.5	1.0 mile	Within plaza	705
13 Staffed Lanes	22.8	1.0 mile	0.5 miles	668
No-Build 11 Staffed Lanes	19.7	0.1 miles	Beyond study area (>1.8 miles)	696

BLUE WATER BRIDGE DELAY ANALYSIS

Closing Thoughts

- Models are a tool and show a potential snapshot of future events based on reasonable assumptions and known conditions at that point in time
- The model was run under optimal conditions
- Reduction of queue length is a safety improvement

- Prepare technical memorandum
- Summarize results in FEIS