Traffic Impact Study: Proposed Conversion of a Segment of the Jones Falls Expressway (JFX) to a Boulevard

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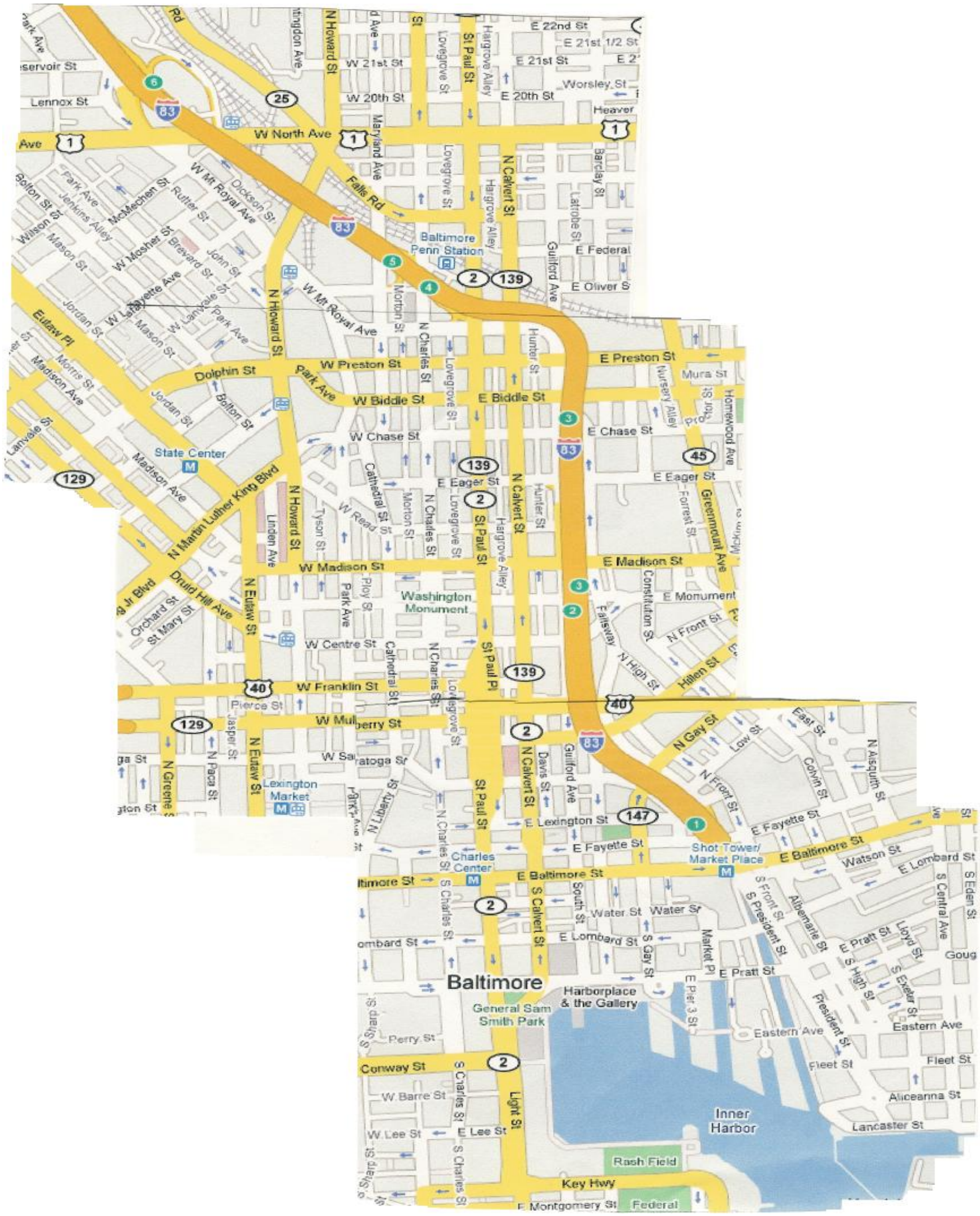
INTRODUCTION

The Jones Falls Expressway (JFX, or I-83), built as part of the interstate highway system, serves as the major artery that connects the North Baltimore region to downtown Baltimore. I-83 was initially designed to extend as an elevated interstate connection through downtown, linking to I-95. Construction of the JFX north of the Guilford Avenue exit was completed in 1963. However, concerns over potential environmental, historical and social impacts of the original configuration resulted in a redesign of the JFX terminating at its intersection with Fayette Street. The construction south of the Guilford Avenue exit dates from the mid 1970s and was completed with the present reconfiguration of President Street in 1987. From the end of the JFX, traffic continues southbound onto President Street, a divided at-grade boulevard leads to Inner Harbor East a few blocks south (Figure 1).

The primary function of the JFX is to carry suburban commuter traffic to and from downtown Baltimore. The peak direction of traffic on the JFX is consequently southbound during the morning peak period and northbound during the evening peak period. Field observations and results obtained from data analysis indicate that the morning peak hour flow is 10% higher than the evening peak hour flow, and therefore accommodating the morning peak hour traffic is considered more critical the evening peak hour flow.

As part of a larger redevelopment plan for the Fallsway area by Edison Properties, a proposal has been suggested to explore a rebuild of the elevated portion of the JFX and convert the function into a multi-lane at-grade boulevard with a wide landscaped median.

<u>Figure 1:</u> JFX Corridor



This new boulevard would ideally improve network connectivity to sustain the access and mobility requirements of the existing JFX traffic and any proposed future high-density mixed-use development. Unlike the existing JFX, which collects traffic from a wide traffic shed and funnels this traffic at its terminus into a saturated traffic access point, the proposed boulevard would be expected to uniformly disperse the north-south traffic at signal-controlled intersections with the adjacent crossing streets, thereby relieving congestion at the Fayette Street intersection and beyond. The boulevard is also proposed to be pedestrian and transit friendly, enhancing development opportunities for neighborhoods on either side of the existing JFX.

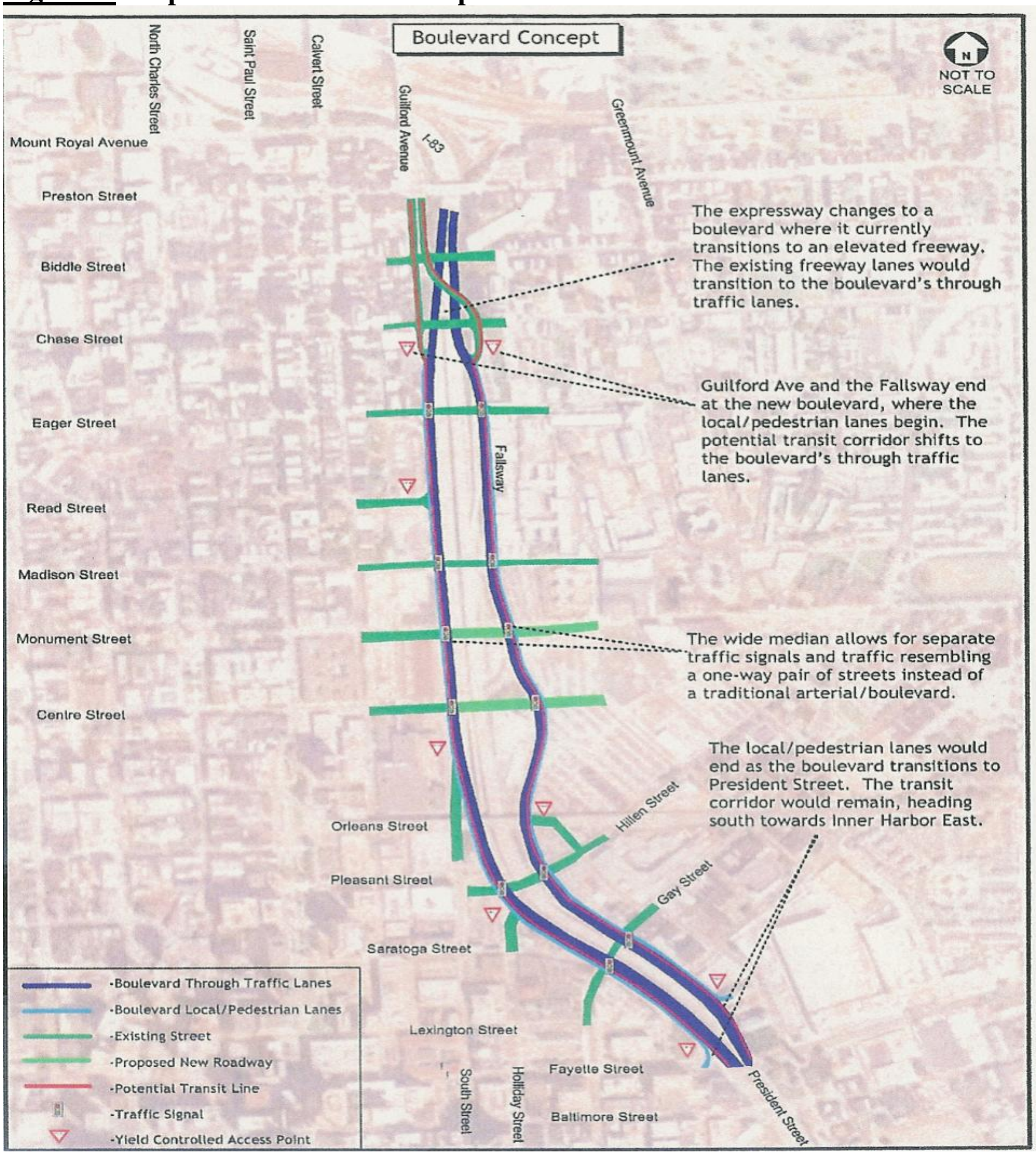
Objective

The primary objective of the project was to undertake a detailed traffic study to evaluate the projected impacts of the proposed conversion of the lower portion of the JFX south of the Guilford Street exit to an at-grade boulevard with signalized intersections. A second objective was to determine what level of nearby roadway capacity for the proposed boulevard concept would be required to utilize if the existing operational condition on the JFX corridor would be maintained or even improved (Figure 2).

Scope

This report focuses on the projected traffic impact of converting a segment of the JFX south of the Guilford Avenue exit to an at-grade multilane boulevard and providing for increased connectivity with the adjacent streets (Figure 2). It does not address the traffic impact and the required roadway capacity of the mixed-use development envisioned as part of the conversion of the lower portion of the JFX to a boulevard. This effect will need to be addressed in a separate traffic impact study.

<u>Figure 2:</u> Proposed Boulevard Concept



Source: Fallsway - A New Downtown Neighborhood for Baltimore, Maryland, Edison Properties, LLC.

METHODOLOGY

The study involved five major activities briefly described below: Demarcation of study area, Data Collection, Data Analysis, Modeling, and Capacity Determination.

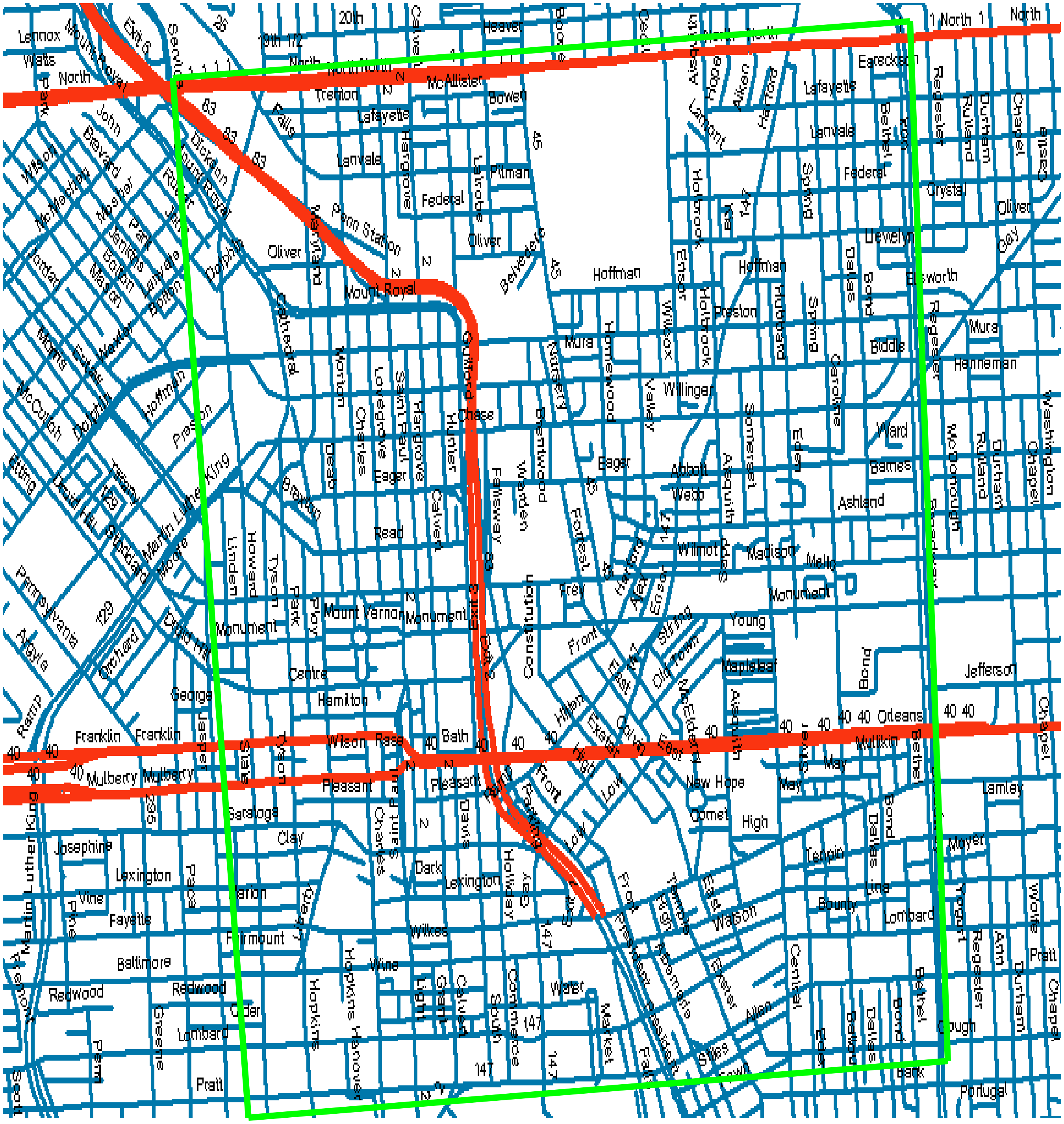
1. Demarcation of Study Area

The existing JFX traffic is collected from and distributed to a number of activity centers in Baltimore via many collector and local roads. Consequently, it was necessary to extend the study area beyond the JFX corridor to encompass adjoining roadway corridors and comprehensively evaluate the traffic impact of the proposed boulevard concept for existing and future conditions. The study area is bounded by North Avenue to the north, Pratt Street to the south, Broadway to the east, and Howard Street to the west (Figure 3).

2. Data Collection

Pertinent traffic and roadway data needed to model and analyze the traffic operational condition for current and proposed roadway scenarios were collected at over thirty strategic locations within the study area, including all ramp junctions on the JFX. Data included directional turning movements, collected in fifteen-minute intervals for morning and evening peak hour periods, travel time data on the JFX, and roadway geometric data.

<u>Figure 3:</u> Study Area Boundary



Secondary data, including zonal socio-economic data and network attribute data obtained from Baltimore Metropolitan Council (BMC), the Metropolitan Planning Organization (MPO) for the Baltimore region, was used in the development of transportation models to simulate the traffic pattern for the study area.

3. Data Analysis

The raw traffic data was analyzed to determine the morning and evening peak-hourly flow rates and associated Peak Hour Factors (PHF) used in capacity analysis. In the morning, the critical southbound peak hour flow rate on the JFX was found to be 5600 Vehicles Per Hour (VPH, or the flow rate) just north of Fayette Street and 9350 VPH just south of North Avenue. The northbound flow rate was recorded as 1650 VPH just north of Fayette Street to 3400 VPH north of the Charles Street on-ramp at exit 5. The two-way peak hour volume, therefore, ranges from 7250 VPH to 12750 VPH. Assuming a standard peak-hour to daily-traffic ratio of 0.10 these peak hour volumes translate into daily traffic volumes ranging from 72500 to 127500 Vehicles Per Day (VPD).

4. Modeling

Two types of simulation models were developed to evaluate the traffic flow patterns for existing and proposed roadway configurations in the study area. The first type of model, a Sub-Regional Simulation Model, analyzes the regional impact of the proposed conversion of the JFX to a boulevard utilizing zonal socio-economic data, including household and employment information, and network attribute data, including roadway geometry, capacity, and speed, to capture the associated traffic flow patterns.

The second type of model, known as a Local Simulation Model, was conducted on a corridor street level, treating network and traffic data as exogenous in order to capture the operational performance of the network, including point-to-point travel time, travel distance or Vehicle Miles of Travel (VMT), travel speed, delay and queue statistics. This network performance data was evaluated to determine the required sustainable capacity (i.e. number of roadway lanes) to support the network configuration and operational scenario.

<u>Table 1:</u> Summary of Morning Peak Hour Volumes on the JFX Corridor

Traffic Count Data Collected by Morgan State University, May - September 2007.

Facility Name	**NBT**	**NBR**	**NBL**	**SBT**	**SBR**	**SBL**	**EBT**	**EBR**	**EBL**	**WBT**	**WBR**	**WBL**
JFX/President Street	1502	235	200	2673	1429	1610						
Fayette Street							215	155		314	590	91
Fallsway-JFX	120										107	
Orleans Street							1679	150	195	1967	113	160
Madison Street										1770	102	75
Monument Avenue							1455	135	145			
On JFX Ramp 2	544											
Exit 3 Off ramp JFX	159											
On JFX Ramp 3	156											
Greenmount Avenue	365	12	80	1727	64	65						
Chase Street							137	22	36	256	92	24
Fallsway	121	128		84		55						
Gay Street							640	128	128	-	-	-
On JFX Ramp 2	549											
Fallsway	161	30										
Centre Street							1940	853	357			
Fallsway	243	95	123									
Madison Street										709	61	
On JFX Ramp 3											425	
Exit 3 Mainstream	2680											
Fallsway	243	74	118									
Chase Street							73	-	17	109	45	
Biddle Street							359	42	18			
Fallsway	200	18										
Guilford Avenue				432		153						
Preston Street										533	110	133
Guilford & Fallsway	173	-	39	397	40							
North Avenue							1034	816	79	-	-	81
Maryland				790	148	148						
On JFX Ramp 3	156											
On JFX at Exit 4/5	1003											
Exit 5 Mt. Royal Avenue				1282								
Exit 4 SBR to Mt. Royal					230							
Exit 4 SBL to St. Paul						725						
Exit 4 Main Stream				7120								
On JFX Ramp Exit 3				185								
Eager Street							125					
Center Street							784	69				
Exit 3 Guilford Avenue				455		964						
Madison Street										822		261
Guilford Avenue				1684	198							
Centre Street							716	420				
St. Paul Street				1871		725						
Centre Street							812	156				
Cathedral Street				808		84						
JFX Exit 2 Mt. Pleasant					174							
SBL on Holiday Street						123						
Exit 5 Main Stream JFX	3683			8195								
Exit 2 Main Stream				5886								
Centre Street							1940	235				
Guilford Avenue				455		964						
Exit 3 Main Stream				5701								
Exit 1 Main Stream				5712								

5. Capacity Analysis

In order to adequately evaluate the ramification of the proposed boulevard concept, it was necessary to undertake a capacity analysis to determine the prevailing levels of service on the JFX corridor. Capacity analysis was performed using the Highway Capacity Software, including freeway segments, merge areas (on-ramp junction), diverge areas (off-ramp junction), and signalized intersections (President Street/I-83 & Fayette Street). The detailed output of the capacity analysis is presented in Appendix B.

For critical peak-hour flow direction, the analysis of the existing conditions resulted in an estimated level of service of F, which indicates an oversaturated traffic flow with varied operational situation, including fluctuating vehicular speed and travel time (Tables 2a and 2b).

Table 2a: **Summary of Capacity Analysis Results – Freeway & Ramps Junctions[1]**

JFX Segment Southbound	**Observed Mainline Volume, V_{12} (PC/H)**	**Observed Ramp Volume, V_R (PC/H)**	**Observed Volume in Merge Influence Area, V_{R12} (PC/H)**	**Maximum Desirable Flow Entering Diverge Influence Area, V_{12} (PC/H)**	**Maximum Desirable Flow Entering Merge Influence Area, V_{R12} (PC/H)**	**Maximum Desirable Flow Exceeded?**
Upstream of Exit 5 Off-ramp	5653	1362	N/A	4400	N/A	Yes
Upstream of Exit 4 Off-ramp	4798	1014	N/A	4400	N/A	Yes
Upstream of Exit 3 Off-ramp (Guilford Avenue)	4537	1508	N/A	4400	N/A	Yes
Upstream of Exit 3 On-ramp (Eager Street)	3363	197	3560	N/A	4600	No *
Upstream of Exit 2 Off-ramp	3220	184	N/A	4400	N/A	No *

[1]Highway Capacity Manual 2000. Transportation Research Board, National Research Council, Washington, DC.
Source: Traffic data collected by Morgan State University Students May-September 2007. Reasonable peak hour factor of 0.95 and 2% heavy vehicles were assumed in converting Vehicles Per Hour (V/H) to Personal Cars Per Hour (PC/H).

* Note: The shockwave effect of the downstream signalized intersection of the JFX at Fayette Street is not captured in this analysis, and may cause results that falsely indicate that the maximum desirable flow is not exceeded.

<u>Table 2b:</u> Summary of Capacity Analysis Results – Signalized Intersection

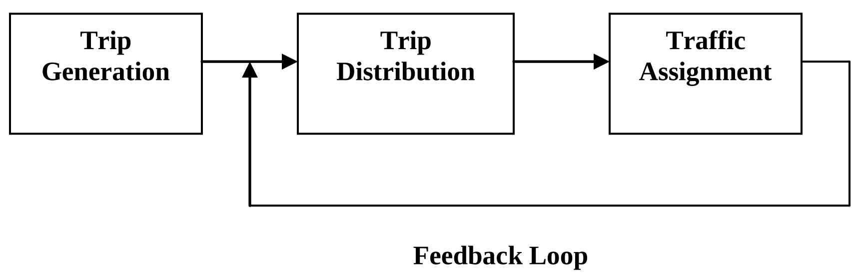
Signalized Intersection of I-83/President Street & Fayette Street	**Critical Eastbound and Westbound Left-turn Movement (VPHPL)**	**Critical Eastbound and Westbound Through Movement (VPHPL)**	**Critical Northbound and Southbound Left-turn Movement (VPHPL)**	**Critical Northbound and Southbound Through/Right Movement (VPHPL)**	**Sum of Critical Lane Volume (VPHPL)**
East-West Direction (Fayette Street)	0	590	N/A	N/A	590
North-South Direction (I-83 and President Street)	N/A	N/A	805	541	1346
Total	0	590	805	541	1936*

* Note: The total sum of the critical lane volume for both the East-West traffic on Fayette Street and the North-South traffic on the JFX at President Street, as measured in Vehicles Per Hour Per Lane (VPHPL), corresponds to a level of service of F, or an oversaturated flow condition.

SUB-REGIONAL SIMULATION MODEL

The JFX Sub-Regional Simulation Model is based on a four-step transportation planning model of trip generation, trip distribution, and traffic assignment.[2] Trip generation estimates are based on socio-economic data, and are used to calculate trip ends at the Transportation Analysis Zone (TAZ) level. These trip ends are organized into origins and destinations during trip distribution. Vehicle trips are then assigned to the highway network during traffic assignment. The model includes a feedback loop between assignment and trip distribution in order to reach a convergent solution (Figure 4).

Figure 4: The Sub-Regional Simulation Model Structure

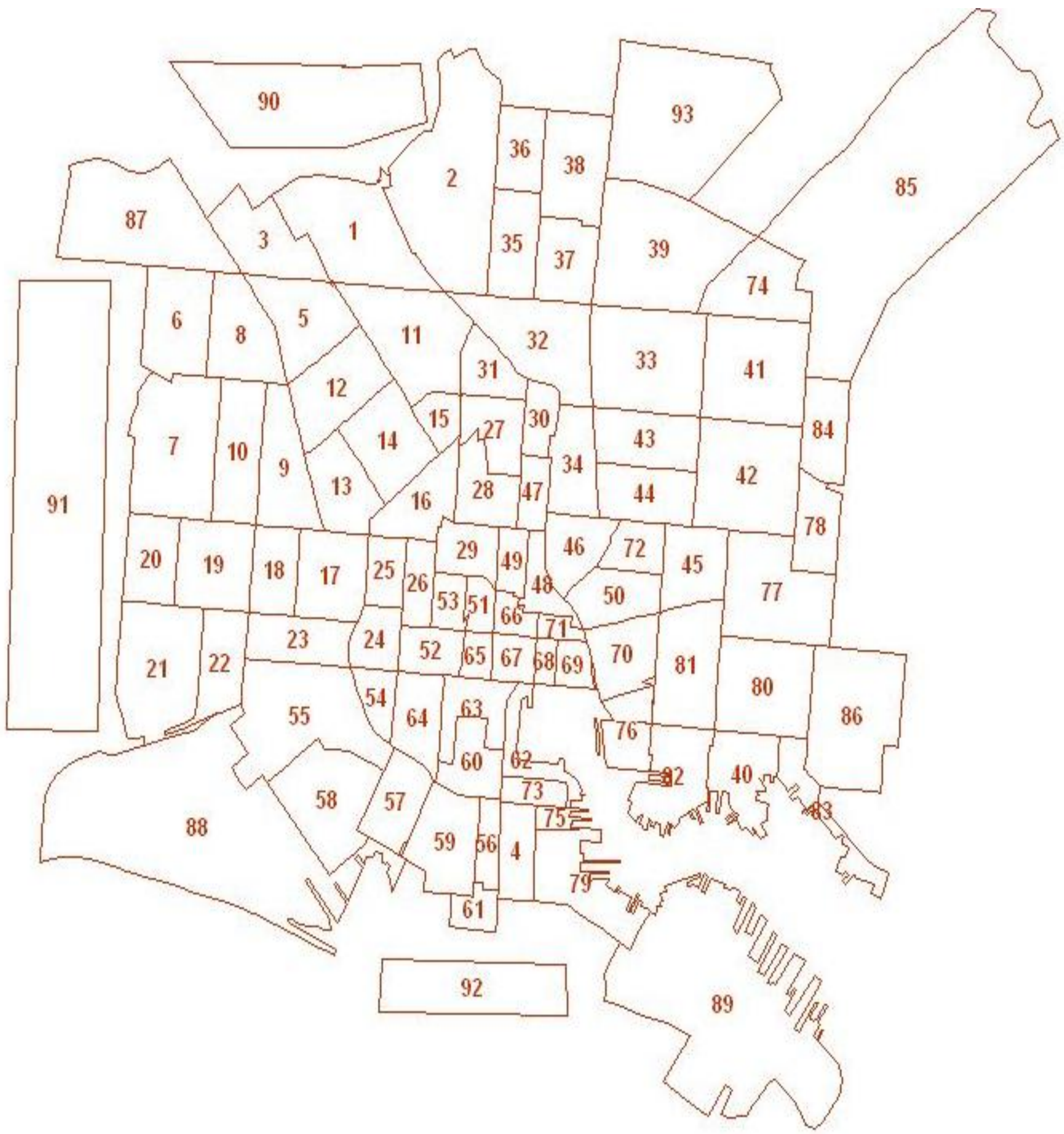


The regional highway network includes 217 TAZs, and was obtained from Baltimore Metropolitan Council (BMC). The study area, which includes 93 individual TAZs in order to encompass the JFX corridor from exit 6 to exit 1 and the surrounding streets, was extracted from this network (Figure 5). A total of 9 external TAZs (TAZ numbers 85 through 93) were used in the model to reasonably capture those trips

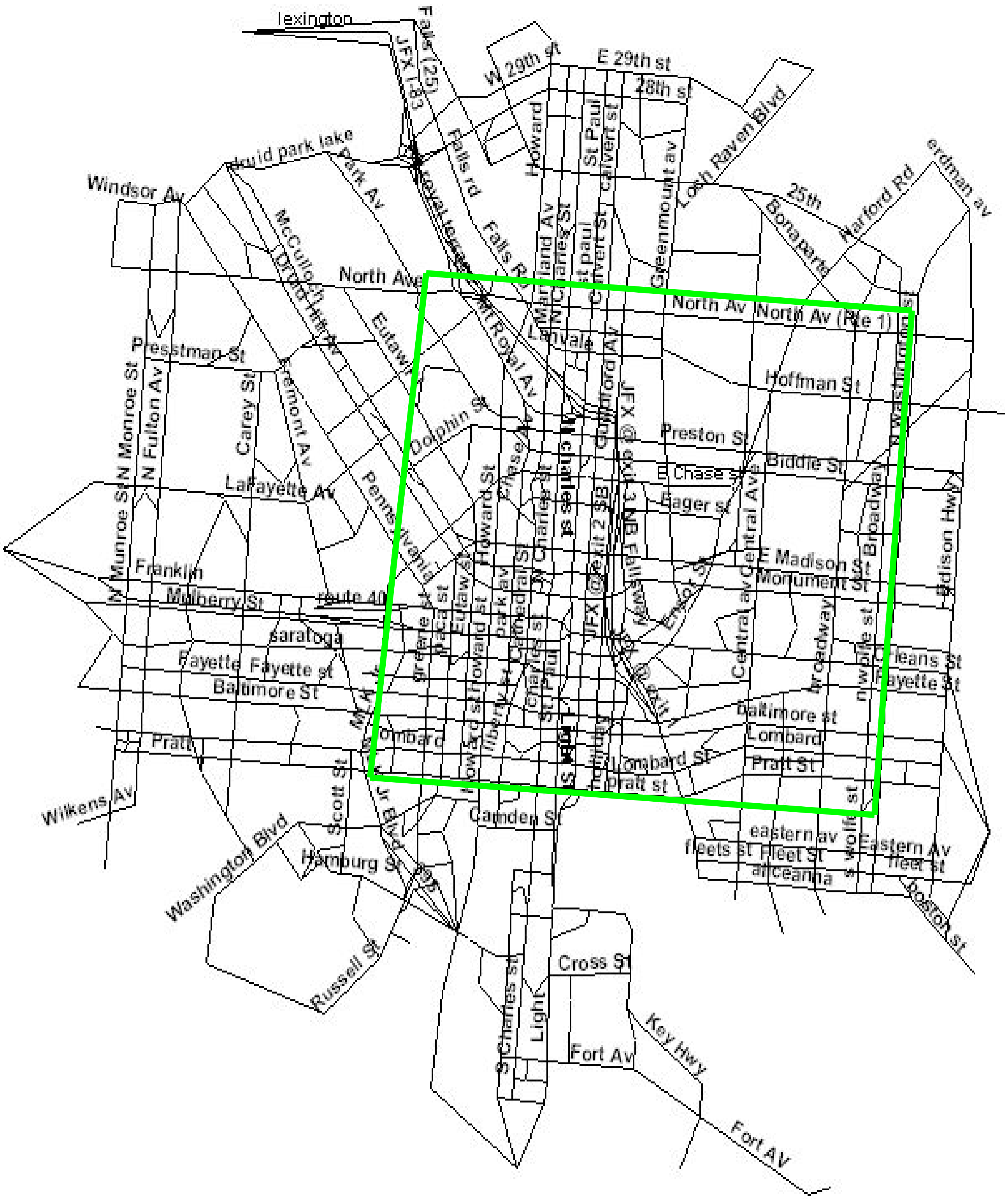
[2] Since the JFX corridor almost exclusively serves vehicular traffic, the individual's choice of mode of transportation, or Mode Choice (including public transit) was not included.

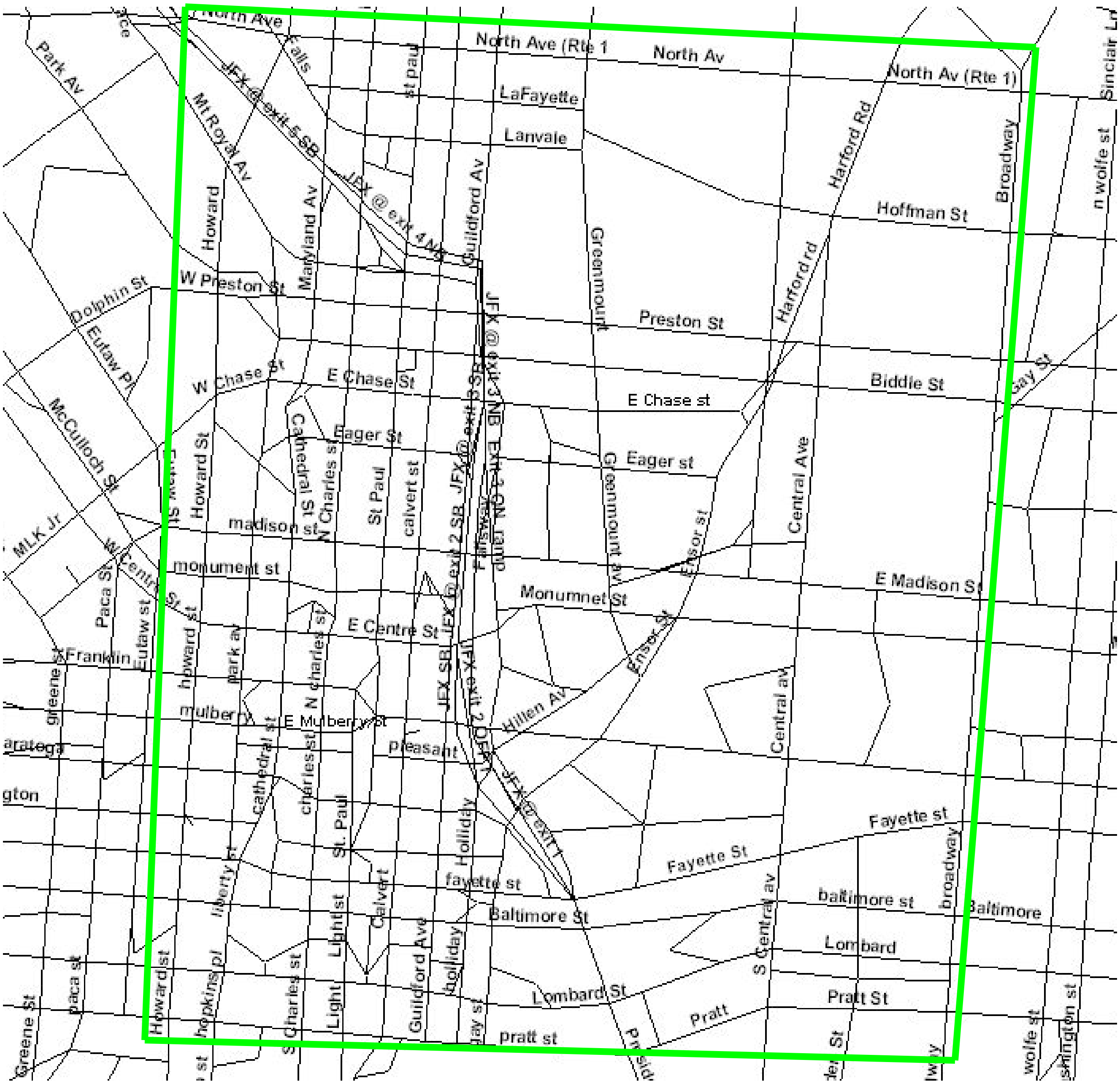
originating or terminating outside the study area. The study area network includes 1526 links representing road segments and 964 nodes representing endpoints (Figure 6). The model was developed and run using the TransCAD platform.

<u>Figure 5:</u> TAZ Structure of the Study Area



<u>Figure 6:</u> The Links and Nodes of the Study Area




North Ave
North Ave (Rte 1
North Av
North Av (Rte 1)
Park Av
Falls
st paul
JFX @ exit 5 SB
Mt Royal Av
LaFayette
Lanvale
Harford Rd
Broadway
n wolfe st
Sinclair Ln
JFX @ exit 4 NB
Howard
Maryland Av
Guilford Av
Hoffman St
Greenmount
Harford rd
W Preston St
Dolphin St
Eutaw Pl
JFX @ exit 3 SB
Preston St
Biddle St
Gay St
W Chase St
E Chase St
E Chase st
McCulloch St
Cathedral St
Eager St
Eager st
Howard St
N Charles st
St Paul
calvert st
JFX @ exit 3 NB
Exit 3 ON ramp
Fallsway
Greenmount av
Ensor st
Central Ave
MLK Jr
madison st
monument st
E Madison St
W Centre St
Paca St
Eutaw st
howard st
park av
N charles st
Monumnet St
E Centre St
JFX SB
JFX exit 2 SB
JFX exit 2 OFF
Franklin
greene st
Ensor St
Hillen Av
Central av
mulberry
E Mulberry St
cathedral st
charles st
pleasant
aratoga
gton
St. Paul
Holliday
JFX @ exit 1
Fayette st
Fayette St
liberty st
Calvert
fayette st
Baltimore St
baltimore st
broadway
Baltimore
Light st
Guilford Ave
holliday
S Central av
Lombard
Lombard St
Pratt St
Pratt
pratt st
Howard st
hopkins pl
S Charles st
Light
Greene St
paca st
wolfe st

Trip Generation

Estimates of trips originating in and destined for each TAZ in the model were used in order to develop the trip generation portion of the Sub-Regional Simulation Model. These estimates are the result of the TransCAD Quick Response Method (QRM) trip generation procedure. Trip production is estimated using cross-classification methods, with classifications based on household characteristics. Trip attractions are estimated utilizing a regression analysis including factors such as retail employment, non-retail employment, and dwelling units.

Variables utilized in this regression analysis are drawn from the 2005 BMC socio-economic data including population, employment, retail employment, non-retail employment, and number of households recorded by TAZ. Other factors are the network and TAZ structure. This regression analysis results in estimated levels of productions (origins) and attractions (destinations) for each TAZ by trip type. Trip types are defined as Home-Based Work (HBW), Home-Based Non-Work (HBNW), and Non- Home-Based (NHB) (Table 3).

Table 3: The Estimated Number of Trips by Trip Type

Trip Type	Productions	Attractions
HBW	613638	613638
HBNW	534770	534770
NHB	215784	215784

Trip Distribution

Trip distribution estimates number of trips between each pair of TAZs for each trip type. The doubly constrained Gravity Model for trip distribution assumes trip end locations that are closer to each other have a stronger attraction than those that are further apart. The determination of TAZ "closeness" is a factor known as impedance, which can be measured in travel distance, travel time, or travel cost. We have utilized travel time in this model. Since our study area is small, we use K-factors (i.e. socioeconomic and environmental factors) to adjust the predicted flows determined by Gravity Model.

The Gravity Model is represented mathematically as follows:

$$T_{ij} = P_i . \frac{K_{ij} A_j f(d_{ij})}{\sum_{all\ zones\ z} K_{iz} A_z f(d_{iz})} \quad \text{(Constrained to Productions)}$$

$$T_{ij} = A_j . \frac{K_{ij} P_i . f(d_{ij})}{\sum_{all\ zones\ z} K_{zj} P_z f(d_{zj})} \quad \text{(Constrained to Attractions)}$$

where,

T_{ij}= the forecast flow produced by zone i and attracted to zone j

P_i = the forecast number of trips produced by zone i

A_j = the forecast number of trips attracted to zone j

K_{ij} = the K - Factor for flow between zone i and zone j

d_{ij} = the impedance between zone i and zone j

$f(d_{ij})$ = the friction factor between zone i and zone j

The inputs of trip distribution are the origin-destination trip table, which is the trip generation output, and an impedance matrix. The impedance matrix includes auto travel times between zones (inter-zonal) and within individual zones (intra-zonal) and terminal times. Free-flow travel time was used in the first iteration and the output of the previous assignment run was used as input in subsequent iterations. Terminal time was assumed to be one minute for internal trips and ten minutes for external trips.

A formula was used to create a friction factor matrix for each trip type with different coefficients for HBW, HBNW and NHB trip types:

$$f(d_{ij}) = e^{(c_1 + c_2 * d_{ij} + c_3 * \ln(d_{ij}))}$$

where,

$f(d_{ij})$ = the friction factor between zone i and zone j

d_{ij} = the impedence between zone i and zone j

c_1 = constant for trip type HBW

c_2 = constant for trip type HBNW

c_3 = constant for trip type NHB

The coefficients associated with each trip type reflect the fact that most of the trips using JFX are commuter trips external to the study area. In the Sub-Regional Simulation Model most trips are associated with external zones. The output of trip distribution is zone-to-zone trips by trip type.

Traffic Assignment

Traffic assignment estimates the flow of traffic on each road (or "link") of the network. The input of this module is a matrix of traffic flow that indicates the volume of traffic between each Origin and Destination Zone (O-D). The flows for each O-D pair were assigned to the network links based on the travel time. The O-D flow matrix was calculated by converting the person trips to vehicle trips by trip type, converting daily trips to peak hour trips, and then aggregating zone to zone person trips.

The calculated O-D flow matrix was assigned to the network by the user equilibrium model, which utilizes an iterative process to achieve a convergent solution such that no traveler could improve his travel time by switching to another route. In the first iteration, the network was empty and link travel times were free-flow travel times. Link volumes, link speeds and link travel times were estimated in each iteration based on the Bureau of Public Roads (BPR) volume delay function, which is represented mathematically as follows:

$$t = t_f [1 + \alpha (\frac{V}{C})^{\beta}]$$

where,

t = congested link travel time

t_f = link free-flow travel time

V = link volume

C = link capacity

α , β: calibration parameters

The default value for α is 0.15 and β is 4, but the value of α used in the Sub-Regional Model varies depending on road types. The eight different road types used in the model and associated calibration parameters for α are presented below (Table 4).

<u>Table 4:</u> Road Classifications

Road Type	Roadway	*α*	*β*
1	Interstate	0.5	4
2	Non-Interstate	0.15	4
3	Principal Arterial	1.2	4
4	Minor Arterial	1.3	4
5	Collector	1.2	4
7	Medium-speed ramp	0.15	4
8	Low-speed Ramp	0.5	4
11	Centroid Connector	0.15	4

Feedback Loop

The updated link travel times and link costs (a combination of travel time and distance) from traffic assignment module were used as input to trip distribution module and a new pairing between origin and destination zones for each trip type was performed in three iterations to obtain more realistic and convergent results.

Evaluation

Evaluation of the results for robustness was conducted for the trip generation, trip distribution, and traffic assignment portions of the Sub-Regional Simulation Model. Ground counts were obtained for approximately 10% of the links within the study area (161 counts out of 1527 links) and individual link errors were calculated by subtracting the estimated model volume from the ground count for that link. The model parameters were calibrated using the Federal Highway Administration (FHWA) guideline.[2] Both a correlation coefficient (compared to the FHWA guidelines in Table 5) and a modified chi-squared test known as the GEH (Table 6) were used to evaluate the accuracy with

[2] Ismart, D. Calibration and Adjustment of System Planning Models. U.S. Department of Transportation, Federal Highway Administration Publication. FHWA-ED-90-015. Washington DC, December 1990.

which the Sub-Regional Simulation Model predicted traffic volume relative to observed existing conditions. The correlation coefficient was calculated as follows:

$$r = \frac{\sum (x.y) - n\bar{x}\bar{y}}{\sqrt{(\sum (x^2) - n\bar{x}^2)(\sum (y^2) - n\bar{y}^2)}}$$

$$RMSE = \frac{\sqrt{\frac{\sum [(x-y)^2]}{n}}}{\frac{\sum x}{n}} ee$$

$$AE = \frac{\sum | y - x |}{\sum x} \times 100\%$$

where,

r = correlation coefficient

RMSE = root mean square error

X = ground count

Y = estimated volume

N = number of observations

<u>Table 5:</u> **Morning Peak Hour Evaluation**

	FHWA Guideline	**Model**
Correlation Coefficient	0.88*	.92*
Percent Error Region-wide	5%	5%
Sum of Differences by Functional Class:		
Freeway	7%	4.6%
Principal Arterial	10%	9.8%
Minor Arterial	15%	2.4%
Collector	25%	11.5%

* <u>Note:</u> The correlation coefficient exceeded the FHWA guideline and indicates the robustness of the results of the Sub-Regional Simulation Model.

<u>Table 6:</u> Estimated Volumes Versus Ground Counts

Road	Count (VPH) (O)	Estimated Volume (VPH) (E)	Percent Difference (%)	GEH = [(O-E)^2/ (0.5(O+E)]^0.5	Validation Criteria Met?[3] (GEH < 5)
Exit 5 Off-ramp	1282	1186	8.1	2.73	Yes
Southbound JFX North of Exit 1	5712	5894	3.2	2.39	Yes
Exit 1 Off-ramp	1429	1481	3.6	1.36	Yes
Northbound JFX, North of Exit 1	2646	2978	12.5	6.26	No *
Exit 4 Main Stream	7120	6690	6.4	5.1	No *
Exit 5 Main Stream	8075	7878	4	2.2	Yes

* Note: A GEH of between 5 and 10 is not considered to indicate that the model is a poor fit, but does indicate that further investigation is required.

[3] Oketch T. and M. Carrick. Calibration and Validation of a Micro-Simulation Model in Network Analysis. Paper #05-1938: Presented at the TRB Annual Meeting, January 2005.

Analysis of Proposed Removal of JFX

With the structure of the Sub-Regional Simulation Model confirmed by the robustness of the relationship between the volumes estimated by the model and the ground counts, the model can now be utilized to model various scenarios that deviate from the existing traffic patterns. There are two alternatives explored here, the first is the No-JFX alternative which models the traffic impacts of the existing JFX south of the Guildford Avenue exit being shut down, without any additional capacity to the traffic infrastructure being added. This is essentially a model of the traffic conditions associated with the proposed dismantling of the subject portion of the JFX and during the construction of the replacement boulevard. The second scenario is known as the boulevard alternative, and models the traffic conditions associated with the completed boulevard replacement to the existing JFX south of the Guilford Street exit.

No-JFX Alternative

The No-JFX alternative considers the traffic conditions resulting from the closure of the existing JFX from exit 3, with trips rerouting to Guilford, St. Paul, and Maryland streets. In this alternative, the off-ramp exits 5, 4, and 3 were determined to experience a significant traffic increase, with peak hourly flow rates of 1186 to 1616 VPH, and 565 to 2876 VHP, 623 to 2108 VHP, respectively. Maryland Street peak hour flow increased from 1682 to 1912 VPH, St. Paul's increased from 1353 to 2733 VPH, and Guilford's increased from 1145 to 2266 VPH (Figure 7). An investigation was also made to evaluate the No-JFX alternative while closing the JFX off-ramp exit 4 to St. Paul Street, reducing the No-JFX traffic flow on St. Paul from 2733 to 1800 VPH during the peak hour.

Boulevard Alternative

The boulevard alternative considers the completion of the replacement of the existing JFX with an at-grade boulevard south of the Guilford Avenue exit, with intersections at Madison Street, Monument Street, Center Street, Pleasant/Hillen Street, Gay Street, and Fayette Street. In order to determine a suitable roadway capacity for the proposed boulevard alternative, the number of lanes was gradually increased in iterative steps until the base case level of performance measured by hourly throughput was achieved. It was determined through the model that the resulting boulevard should have at least six lanes in each direction in order to match or surpass the performance of existing network. More travelers were shown to use the boulevard vis-à-vis the No-JFX alternative (Figure 8). St. Paul Street and Maryland Avenue were also projected to have lower volumes than the existing conditions.

<u>Figure 7:</u> Link Flow Differences between No-JFX Alternative and the Existing Conditions

<u>Note:</u> Flows significantly decreased (between 50% and 100%) on streets highlighted in purple, significantly increased (between 50% and 100%) on streets highlighted in blue; severely increased (between 100% and 200%) on streets highlighted in green; and dramatically increased (between 200% and 500%) on streets highlighted in red.

Figure 8: **Link Flow Differences between Boulevard Alternative and the Existing Conditions**

A summary of the results obtained from comparing the existing conditions with the No-JFX and boulevard alternatives assumes a 12-lane boulevard (six lanes per direction), resulting in almost the same Vehicle Miles Traveled (VMT, i.e. travel distance) and Vehicle Hours Traveled (VHT, i.e. travel time) as the existing conditions (Table 7).

<u>Table 7:</u> Percentage Change for Vehicle Miles Traveled (VMT) and Vehicle Hours Traveled (VHT) Comparing the No-JFX and Boulevard Alternatives with the Existing Conditions

	Percent Change in Study Area VMT (%)	**Percent Change in Study Area VHT (%)**
No-JFX Alternative	-3.1%	2.5%
Boulevard Alternative	-0.9%	-0.05%

LOCAL SIMULATION MODEL

The local simulation model is based on the VISSIM platform, which is a commonly utilized traffic simulation method. The model utilizes network data, including roadways, traffic control devices, and routes, as well as vehicular data, including volumes, traffic composition, and speed distribution to produce a graphically-animated transportation system. The graphically animated transportation system approximates network performance data under various conditions, including vehicle-miles of travel, vehicle-hours of travel, speed, density, and throughput statistics.

Parameters of the models were calibrated for the JFX corridor by iteratively comparing output of the models with observed driving behavior, adjusting as needed to reasonably replicate the observed condition. A local simulation model is deemed calibrated if it can reasonably replicate actual/observed conditions within acceptable levels of error.

The accuracy of the Local Simulation Model is accessed utilizing a modified chi-squared test known as the GEH by comparing the simulated traffic data with traffic counts for the JFX corridor. The difference between the model’s simulated throughputs and the observed traffic counts are well within acceptable error margin, indicating that the model adequately simulates the traffic flow pattern in the study area (Table 8).

<u>Table 8:</u> Observed Versus Simulated Throughputs in Study Area

JFX Segment Southbound	Observed Volume (VHP) (O)	Simulated Volume Range (VPH) (E)	GEH = [(O -E)^2/ 0.5(O+E)]^0.5	Validation Criteria Met?[4] (GEH < 5)
Between Exit 5 and Exit 4	8075	7595 – 7879	2.20	Yes
Between Exit 4 and Exit 3	7120	7434 – 7731	3.68	Yes
Between Exit 3 and Exit 2	5886	5979 – 6184	1.21	Yes
Between Exit 2 and Exit 1	5712	5141 – 5497	2.87	Yes
Southbound Right onto Fayette Street	1429	1284 – 1428	0.00	Yes
Southbound through onto President Street	2673	2097 – 2336	6.73	No *
Southbound Left onto Fayette Street	1610	1392 - 1592	0.45	Yes

* <u>Note:</u> A GEH of between 5 and 10 is not considered to indicate that the model is a poor fit, but does indicate that further investigation is required.

Capacity Analysis

In order to adequately evaluate the ramification of the proposed boulevard concept, it was necessary to undertake a capacity analysis to determine the prevailing levels of service on the JFX corridor. The capacity analysis was performed using the Highway Capacity Software and included analysis of freeway segments, merge areas (on-ramp junctions), diverge areas (off-ramp junctions), and signalized intersections (President Street/I-83 & Fayette Street). The detailed output of the capacity analysis is presented in Appendix B.

[4] Oketch T. and M. Carrick. Calibration and Validation of a Micro-Simulation Model in Network Analysis. Paper #05-1938: Presented at the TRB Annual Meeting, January 2005.

For critical peak-hour flow, the analysis of the existing JFX again resulted in a level of service of F, indicating an oversaturated traffic flow with varied operational situations, including fluctuating vehicular speed and travel time (Tables 9a and 9b).

Capacity Determination for Boulevard Alternative

The proposed boulevard alternative to the existing JFX envisions an at-grade road with signalized intersections at Eager Street, Madison Street, Monument Street, Center Street, Pleasant/Hillen Street, and Gay Street. This roadway configuration was used to develop the Local Simulation Model for evaluating the viability of the boulevard alternative. Consistent with the results obtained from the Sub-Regional Simulation Model, by gradually increasing the number of lanes in iterative steps of the Local Simulation Model analysis, the required capacity of the boulevard alternative was determined to be six lanes per travel direction for a total of 12 lanes. This capacity results in a similar or higher network performance than that of the existing JFX. Specifically, the 12-lane divided boulevard alternative results in an approximately 6 percent higher Vehicle Miles Traveled (VMT) than the existing condition (22,546 versus 21,183 VMT), and similar network Vehicle Hours Traveled (VHT) of approximately 20 mph (Table 10).

Table 9a: Summary of Capacity Analysis Results – Freeway & Ramps Junctions[1]

JFX Segment Southbound	Observed Mainline Volume, V_{12} (PC/H)	Observed Ramp Volume, V_R (PC/H)	Observed Volume in Merge Influence Area, V_{R12} (PC/H)	Maximum Desirable Flow Entering Diverge Influence Area, V_{12} (PC/H)	Maximum Desirable Flow Entering Merge Influence Area, V_{R12} (PC/H)	Maximum Desirable Flow Exceeded?
Upstream of Exit 5 Off-ramp	5653	1362	N/A	4400	N/A	Yes
Upstream of Exit 4 Off-ramp	4798	1014	N/A	4400	N/A	Yes
Upstream of Exit 3 Off-ramp (Guilford Avenue)	4537	1508	N/A	4400	N/A	Yes
Upstream of Exit 3 On-ramp (Eager Street)	3363	197	3560	N/A	4600	No *
Upstream of Exit 2 Off-ramp	3220	184	N/A	4400	N/A	No *

[1]Highway Capacity Manual 2000. Transportation Research Board, National Research Council, Washington, DC.
Source: Traffic data collected by Morgan State University Students May-September 2007. Reasonable peak hour factor of 0.95 and 2% heavy vehicles were assumed in converting Vehicles Per Hour (V/H) to Personal Cars Per Hour (PC/H).

* Note: The shockwave effect of the downstream signalized intersection of the JFX with Fayette Street is not captured in this analysis, and may cause results that falsely indicate that the maximum desirable flow is not exceeded.

<u>Table 9b:</u> Summary of Capacity Analysis Results – Signalized Intersection

Signalized Intersection of I-83/President Street & Fayette Street	Critical Eastbound and Westbound Left-turn Movement (VPHPL)	Critical Eastbound and Westbound Through Movement (VPHPL)	Critical Northbound and Southbound Left-turn Movement (VPHPL)	Critical Northbound and Southbound Through/right Movement (VPHPL)	Sum of Critical Lane Volume (VPHPL)
East-West Direction (Fayette Street)	0	590	N/A	N/A	590
North-South Direction (I-83 and President Street)	N/A	N/A	805	541	1346
Total	0	590	805	541	1936*

* <u>Note:</u> The total sum of the critical lane volume for both the East-West traffic on Fayette Street and the North-South traffic on the JFX and President Street, as measured in Vehicles Per Hour Per Lane (VPHPL), corresponds to a level of service of F, or an oversaturated flow condition.

<u>Table 10:</u> Comparison of Network Performance for Boulevard Alternative and Existing Conditions

Boulevard Alternative	Existing Conditions
Network Performance File: c:\jfx\base\antoblvd2.inp Comment: Boulevard Scenario Date: Monday, September 17, 2007 12:07:43 AM Simulation time from 0.0 to 4500.0. Parameter ; Value; Total Path Distance [mi], All Vehicle Types ; 22546.409; Average speed [mph], All Vehicle Types ; 19.919; Number of vehicles in the network, All Vehicle Types ; 852; Number of vehicles that have left the network, All Vehicle Types ; 23017; Total travel time [h], All Vehicle Types ; 1131.933;	Network Performance File: c:\jfx\base\sakajfx1.inp Comment: Current Scenario Date: Thursday, September 06, 2007 11:18:08 PM Simulation time from 0.0 to 4500.0. Parameter ; Value; Total Path Distance [mi], All Vehicle Types ; 21183.003; Average speed [mph], All Vehicle Types ; 19.878; Number of vehicles in the network, All Vehicle Types ; 985; Number of vehicles that have left the network, All Vehicle Types ; 19814; Total travel time [h], All Vehicle Types ; 1065.669;

CONCLUSIONS

This traffic impact study concludes that conversion of a segment of the JFX to a boulevard with signalized at-grade intersections at Eager Street, Madison Street, Monument Street, Center Street, Mount Pleasant/Hillen Road, and Gay Street is plausible proposal that would result in capacity and travel times that are comparable to or exceed the existing conditions. Detailed analysis has indicated that the proposed boulevard should be twelve lanes (six lanes per travel direction) from Chase Street to Fayette Street in order to preserve and potentially enhance the existing levels of service along the JFX corridor.

Recommendations

It was determined from the Local Simulation Model analysis that southbound left-turn movement should be prohibited at Monument Street intersection and accommodated with dual turn-lanes at Center Street intersection in order to reduce the effects of lane-changing traffic that could result in queue overflow and capacity reduction at these two closely spaced intersections.

Finally, it is also recommended that at least two of the required six lanes in each direction of the proposed boulevard be designed as a parallel collector-distributor road to provide for adequate connectivity to the adjacent neighborhoods and serve as a corridor for public transportation, pedestrian and other non-vehicular transportation modes.