

APPENDIX E
TRANSPORTATION

2011 PATRON SURVEYS

Demographics

Question 8

Place of residence:

	Qualifying Aug 25	Qualifying Aug 26	Day 1 Aug 29	Day 2 Aug 30	Day 3 Aug 31	Day 4 Sept 1	Day 5 Sept 2	Day 6 Sept 3	Day 7 Sept 4
State of New York	56.6%	67.5%	45.8%	45.0%	43.9%	36.3%	38.6%	33.4%	33.1%
State of New Jersey	15.8%	14.1%	16.7%	15.9%	18.0%	13.5%	12.2%	10.1%	12.0%
State of Connecticut	1.6%	1.3%	6.0%	2.6%	3.6%	3.7%	3.7%	5.6%	3.8%
Commonwealth of Pennsylvania	3.0%	5.1%	2.7%	4.1%	4.9%	5.7%	5.7%	5.3%	5.5%
Another State	7.8%	5.6%	15.9%	18.6%	16.8%	26.0%	29.3%	37.1%	37.8%
Another Country	15.2%	6.4%	12.8%	13.9%	12.9%	14.7%	10.6%	8.5%	7.8%
Total	565	701	911	958	1080	1079	1144	1243	1254
								Aggregate (Mainround)	Aggregate
State of New York	50.6%	39.3%	35.7%	44.4%	44.0%	43.9%	49.4%	41.0%	42.9%
State of New Jersey	13.2%	13.0%	13.0%	11.1%	9.3%	10.9%	15.7%	13.2%	13.4%
State of Connecticut	5.3%	2.5%	4.2%	2.3%	4.8%	4.2%	4.0%	4.1%	3.9%
Commonwealth of Pennsylvania	3.8%	3.7%	2.8%	1.8%	1.6%	2.9%	2.1%	4.1%	4.1%
Another State	17.9%	19.9%	21.6%	15.4%	23.2%	22.1%	18.6%	23.9%	22.4%
Another Country	9.2%	21.5%	22.7%	25.1%	17.1%	16.1%	10.2%	13.7%	13.5%
Total	1270	669	1108	606	621	697	522	13162	14428

Demographics

Question 13

About what distance from Flushing Meadows do you live?

Answered only if "State of New Jersey", "State of Connecticut" or "State of Pennsylvania" in Question 8 or "Other" in Question 9 was selected

	Qualifying		Day 1		Day 2		Day 3		Day 4		Day 5		Day 6		Day 7		
	Aug 25	Aug 26	Aug 29	Aug 30	Aug 31	Sept 1	Sept 2	Sept 3	Sept 4	Sept 5	Sept 6	Sept 7	Sept 8	Sept 9	Sept 10	Sept 11	
I live within this area	0.0%	1.9%	2.0%	0.4%	0.3%	0.0%	0.7%	0.0%	0.0%	0.7%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	2.0%
5 to 30 miles	43.7%	30.9%	35.9%	21.0%	21.0%	20.9%	19.8%	16.5%	20.1%	19.8%	16.5%	20.1%	16.5%	20.1%	20.9%	19.8%	20.1%
31 to 60 miles	24.4%	34.6%	25.1%	28.2%	33.4%	31.8%	33.2%	26.3%	27.4%	33.2%	26.3%	27.4%	26.3%	27.4%	31.8%	33.2%	27.4%
61 to 90 miles	13.5%	14.8%	18.7%	21.8%	20.1%	20.5%	15.2%	17.9%	18.1%	15.2%	17.9%	18.1%	17.9%	18.1%	20.5%	15.2%	18.1%
91 to 150 miles	10.1%	14.2%	13.9%	18.6%	16.2%	20.1%	20.9%	22.6%	19.7%	20.9%	22.6%	19.7%	22.6%	19.7%	20.1%	20.9%	19.7%
Over 150 miles	8.4%	3.7%	4.4%	10.1%	8.9%	6.7%	10.3%	16.8%	12.7%	10.3%	16.8%	12.7%	16.8%	12.7%	6.7%	10.3%	12.7%
Total	119	162	251	248	314	283	283	297	299	283	297	299	297	299	283	283	299
Calculated Mean (miles)	56.2	56.1	56.5	73.4	69.7	69.9	73.6	85.8	76.3	73.6	85.8	76.3	85.8	76.3	69.9	73.6	85.8

	Day 8		Day 9		Day 10		Day 11		Day 12		Day 13		Day 14		Aggregate	
	Sept 5	Sept 6	Sept 6	Sept 7	Sept 7	Sept 8	Sept 8	Sept 9	Sept 9	Sept 10	Sept 10	Sept 11	Sept 11	Aggregate (Mainround)	Aggregate	Aggregate
I live within this area	1.3%	0.7%	0.7%	0.8%	0.8%	0.0%	0.0%	1.9%	1.9%	1.5%	1.5%	1.6%	0.9%	0.9%	0.9%	0.9%
5 to 30 miles	27.7%	28.1%	28.1%	23.2%	23.2%	34.6%	24.3%	24.3%	27.7%	27.7%	27.7%	37.7%	24.2%	24.2%	25.2%	25.2%
31 to 60 miles	33.7%	33.8%	33.8%	37.2%	37.2%	31.8%	40.2%	40.2%	26.3%	26.3%	26.3%	36.9%	31.3%	31.3%	31.2%	31.2%
61 to 90 miles	16.2%	17.3%	17.3%	20.4%	20.4%	15.0%	7.5%	7.5%	25.6%	25.6%	25.6%	7.4%	18.0%	18.0%	17.7%	17.7%
91 to 150 miles	12.5%	8.6%	8.6%	10.8%	10.8%	9.4%	12.2%	12.2%	11.7%	11.7%	11.7%	10.7%	16.0%	16.0%	15.7%	15.7%
Over 150 miles	8.6%	11.5%	11.5%	7.6%	7.6%	9.4%	14.0%	14.0%	7.3%	7.3%	7.3%	5.7%	9.7%	9.7%	9.3%	9.3%
Total	303	139	139	250	250	107	107	107	137	137	137	122	3140	3140	3421	3421
Calculated Mean (miles)	62.9	64.5	64.5	63.1	63.1	59.9	59.9	68.1	63.3	63.3	63.3	52.1	68.7	68.7	67.7	67.7

Attendance Characteristics

Question 21

How did you travel to the USTA Billie Jean King National Tennis Center today?

	Qualifying		Day 1		Day 2		Day 3		Day 4		Day 5		Day 6		Day 7		
	Aug 25	Aug 26	Aug 29	Aug 30	Aug 31	Sept 1	Sept 2	Sept 3	Sept 4	Sept 5	Sept 6	Sept 7	Sept 8	Sept 9	Sept 10	Sept 11	
Subway	42.4%	47.2%	40.8%	53.9%	40.4%	47.0%	49.8%	41.6%	46.2%	41.6%	49.8%	41.6%	49.1%	46.2%	41.6%	49.8%	48.7%
Car/Private vehicle and parked	29.6%	30.3%	36.9%	24.7%	25.9%	26.3%	27.0%	24.0%	27.3%	24.0%	27.0%	24.0%	24.2%	27.3%	24.0%	27.0%	24.8%
Car/Private vehicle and dropped off	12.0%	9.2%	13.4%	5.5%	11.4%	8.5%	6.4%	12.2%	11.8%	12.2%	6.4%	12.2%	9.8%	11.8%	12.2%	6.4%	9.9%
Long Island Railroad	5.6%	6.3%	2.6%	6.0%	13.0%	10.8%	9.9%	10.1%	7.6%	10.1%	9.9%	10.1%	8.6%	7.6%	10.1%	9.9%	8.4%
Taxi/car service	2.4%	0.7%	1.9%	1.7%	0.5%	1.9%	2.2%	3.4%	3.4%	3.4%	2.2%	3.4%	3.0%	3.4%	3.4%	2.2%	2.8%
Chartered Bus	3.2%	4.2%	2.6%	4.4%	4.2%	2.4%	2.2%	2.1%	1.7%	2.1%	2.2%	2.1%	2.0%	1.7%	2.1%	2.2%	2.2%
Walked	3.2%	1.4%	0.6%	1.7%	0.0%	0.5%	0.9%	0.8%	0.4%	0.5%	0.9%	0.8%	0.7%	0.4%	0.5%	0.9%	0.8%
MTA Bus	0.8%	0.7%	0.0%	0.0%	1.0%	1.4%	0.9%	1.3%	0.8%	1.4%	0.9%	1.3%	0.6%	0.8%	1.4%	0.9%	0.6%
Biked	0.8%	0.0%	0.6%	0.6%	1.0%	0.0%	0.0%	0.4%	0.0%	0.0%	0.0%	0.4%	0.6%	0.0%	0.0%	0.0%	0.4%
Other	0.0%	0.0%	0.6%	1.7%	2.6%	1.4%	0.9%	4.2%	0.8%	1.4%	0.9%	4.2%	1.6%	0.4%	1.4%	1.0%	1.5%
Total	125	142	157	182	193	213	233	238	238	238	233	238	2491	238	238	103	2758
													Aggregate		Aggregate		Aggregate
													(Mainround)				
Subway	48.5%	51.9%	53.1%	61.2%	59.6%	57.2%	51.5%	49.1%	48.7%	57.2%	51.5%	49.1%	48.7%	48.7%	57.2%	51.5%	48.7%
Car/Private vehicle and parked	21.7%	18.8%	17.8%	26.2%	19.3%	19.3%	19.4%	24.2%	24.8%	19.3%	19.4%	24.2%	24.8%	24.8%	19.3%	19.4%	24.8%
Car/Private vehicle and dropped off	13.0%	12.0%	11.3%	2.9%	7.3%	8.3%	7.8%	9.8%	9.9%	8.3%	7.8%	9.8%	9.9%	9.9%	8.3%	7.8%	9.9%
Long Island Railroad	9.5%	10.5%	7.5%	4.9%	7.3%	7.6%	10.7%	8.6%	8.4%	7.6%	10.7%	8.6%	8.4%	8.4%	7.6%	10.7%	8.4%
Taxi/car service	2.6%	3.0%	5.6%	2.9%	2.8%	4.1%	7.8%	3.0%	2.8%	4.1%	7.8%	3.0%	2.8%	2.8%	4.1%	7.8%	2.8%
Chartered Bus	1.3%	0.8%	2.4%	0.0%	0.9%	0.7%	0.0%	2.0%	2.2%	0.7%	0.0%	2.0%	2.0%	2.2%	0.7%	0.0%	2.2%
Walked	1.7%	0.8%	0.5%	0.0%	0.0%	0.0%	1.9%	0.7%	0.9%	0.0%	1.9%	0.7%	0.9%	0.9%	0.0%	1.9%	0.9%
MTA Bus	0.0%	0.0%	0.0%	0.0%	0.9%	0.7%	0.0%	0.6%	0.6%	0.7%	0.0%	0.6%	0.6%	0.6%	0.7%	0.0%	0.6%
Biked	0.9%	0.0%	0.9%	0.0%	0.0%	0.7%	0.0%	0.4%	0.4%	0.7%	0.0%	0.4%	0.4%	0.4%	0.7%	0.0%	0.4%
Other	0.9%	2.3%	0.9%	1.9%	1.8%	1.4%	1.0%	1.6%	1.5%	1.4%	1.0%	1.6%	1.6%	1.5%	1.4%	1.0%	1.5%
Total	231	133	213	103	109	145	103	2491	238	145	103	2491	2758	238	145	103	2758

Attendance Characteristics

Question 30

How many people are you here with today?

	Qualifying	Day 1	Day 2	Day 3	Day 4	Day 5	Day 6	Day 7
	Aug 25	Aug 29	Aug 30	Aug 31	Sept 1	Sept 2	Sept 3	Sept 4
I am here by myself	22.6%	10.0%	12.8%	10.4%	9.7%	9.6%	6.1%	5.4%
One other person	31.3%	50.0%	52.9%	44.3%	53.8%	52.2%	52.7%	46.9%
Two other people	20.0%	13.2%	12.8%	16.7%	13.5%	16.3%	15.9%	13.7%
Three other people	7.0%	12.7%	9.8%	13.1%	14.3%	12.4%	15.5%	18.4%
Four other people	4.4%	5.9%	4.9%	5.0%	5.9%	3.6%	3.6%	6.5%
Five other people	1.7%	3.6%	1.5%	4.5%	0.8%	2.0%	2.9%	3.3%
Six other people	0.9%	2.3%	2.0%	0.5%	0.4%	1.2%	1.8%	1.8%
Seven other people	1.7%	0.5%	1.0%	1.8%	0.4%	0.8%	0.7%	1.1%
Eight other people	2.6%	0.5%	0.5%	0.0%	0.0%	0.0%	0.4%	0.4%
Nine or more other persons	7.8%	1.4%	2.0%	3.6%	1.3%	2.0%	0.4%	2.5%
Total	115	220	204	221	238	251	277	277
Calculated Mean (group size)	3.4	2.9	2.8	3.1	2.7	2.8	2.8	3.2

	Day 8	Day 9	Day 10	Day 11	Day 12	Day 13	Day 14	Aggregate
	Sept 5	Sept 6	Sept 7	Sept 8	Sept 9	Sept 10	Sept 11 (Mainround)	Aggregate
I am here by myself	9.2%	17.7%	13.6%	13.1%	12.2%	15.6%	7.1%	11.6%
One other person	51.2%	61.4%	59.1%	48.9%	59.2%	55.2%	60.3%	51.3%
Two other people	11.7%	10.1%	11.4%	15.3%	12.2%	15.6%	15.9%	14.0%
Three other people	15.6%	5.7%	8.7%	11.0%	11.6%	8.4%	11.1%	12.4%
Four other people	5.3%	0.6%	2.7%	5.8%	2.7%	3.3%	4.0%	4.4%
Five other people	2.8%	1.3%	2.3%	2.9%	1.4%	0.7%	0.8%	2.3%
Six other people	2.1%	0.6%	1.5%	0.7%	0.0%	0.7%	0.8%	1.3%
Seven other people	0.7%	1.3%	0.0%	0.7%	0.0%	0.7%	0.0%	0.8%
Eight other people	0.4%	0.0%	0.4%	0.0%	0.0%	0.0%	0.0%	0.3%
Nine or more other persons	1.1%	1.3%	0.4%	1.5%	0.7%	0.0%	0.0%	1.7%
Total	283	158	264	137	147	154	126	3212
Calculated Mean (group size)	2.9	2.3	2.5	2.8	2.4	2.4	2.5	2.8

VISSIM MODEL CALIBRATION AND VALIDATION



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Memorandum

To: Project Files
From: Michael Beattie
Date: August 9, 2012
Re: USTA Existing VISSIM Model Calibration and Validation
cc:

The New York City Department of Parks and Recreation with the United States Tennis Association (USTA) will be proposing a number of improvements and modifications to the National Tennis Center (NTC) as part of their NTC Strategic Vision. The NTC is primarily a public recreational facility, except for a two-week period at the end of August and early September, when it hosts the US Open. As part of the study to identify potential impacts due to the increase in day-time visitation, an analysis of the adjacent freeway system was conducted to determine if vehicles would spill back from the freeway to local surface streets.

Due to existing congestion on the adjacent freeways and the existing queues created from downstream bottlenecks, traditional analysis of freeway operations are beyond the capabilities of standard traffic operations software (i.e. Highway Capacity Software). Therefore, a VISSIM model representing a weekday PM peak hour (6:00-7:00 PM) was developed to quantify the potential impacts generated by an increase in the volume of patrons departing the day-time session at the US Open. **Figure 1** presents the extents of the VISSIM model.

VISSIM micro-simulation software provides the capability to model complex interchange configurations and merge/diverge areas that operate at capacity that other traditional software packages are not able to analyze. Output from the VISSIM model provides the ability to quantify the operational impacts of queuing from downstream bottlenecks. The VISSIM micro-simulation model can also provide a three dimensional representation of these interactions within the study area. For this application, the VISSIM model was used to determine the back of queue length within the study area for a one-hour peak condition.

EXISTING CONDITIONS DEVELOPMENT AND CALIBRATION

The main objective of model calibration is to ensure that the model accurately reflects special event traffic conditions experienced on the date of the survey. This includes reasonably replicating traffic flow to match observed operating conditions, volume data and queue observations.

Lane geometries (lane widths, interchange designs, etc.) were coded into the model based on field observations and existing aerials. Existing counts collected during the opening week of the US Open were also coded into the model in 15-minute intervals.

During calibration of a VISSIM model, individual components are adjusted to match field-observed data. Calibration involves setting background traffic operation and driver behavior characteristics including yielding right-of-way, gap acceptance, driver aggressiveness, and vehicle characteristics. The default values were adjusted during this process so that the model would accurately reflect observed conditions. Adjusted default values and other refinements made to calibrate/validate the VISSIM model are described below:

- At Long Island Expressway (LIE) off-ramp and College Point on-ramp merge, while stripped as a three lane to two lane merge, based on field observations this section acts as a three lane section.
- Adjusted CC1 (Headway Time) factor on LIE/College Point merge from default 0.9 seconds to 0.65 seconds to replicate field conditions
- Adjusted CC1 (Headway Time) factor on between LIE/College Point collector-distributor road between Grand Central Parkway loop ramps from default 0.9 seconds to 0.65 seconds to replicate field conditions
- Adjusted CC1 (Headway Time) factor on Grand Central Parkway collector-distributor road from default 0.9 seconds to 0.65 seconds to replicate field conditions

Since the VISSIM model output is based on the random arrival of vehicles, multiple runs were required to provide a reasonable level of statistical accuracy and validity. Ten separate model runs utilizing random seeds were averaged to determine the final performance measures. The VISSIM model was calibrated and validated to 6:00-7:00 PM existing conditions based on traffic volumes and observed vehicle queues. During this process, the model was visually inspected to ensure that it reflected observed conditions.

FREE FLOW TRAVEL SPEEDS

Table 1 presents the free-flow travel speed ranges for passenger vehicles and trucks coded into the VISSIM model.

Table 1		
Free Flow Speeds		
Location	Free Flow Speed (MPH)	
	Passenger Cars	Trucks
Grand Central Parkway	50-60	-
Collector-Distributor Roads	33-37	33-37
Loop Ramps	20-30	-
Direct Ramps	40-45	-
Perimeter Road	13-17	-

MODEL VALIDATION

During validation, the VISSIM model output is compared against field data to determine if the output is within acceptable levels. The following criteria, based on the “Guidelines for Applying Traffic Microsimulation Modeling Software Volume III (Federal Highway Administration, 2003)” were used for the model calibration:

Hourly Flows, VISSIM Model vs. Field Counts

Individual Link Flows

Within 15% for 700 vph < Flow < 2,700 vph	>85% of Cases
Within 100 vph, for Flow < 700 vph	>85% of Cases
Within 400 vph, for Flow > 2,700 vph	>85% of Cases

GEH Statistic

GEH < 5	> 85% of Cases
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The GEH statistic is computed as follows:

$$GEH = \sqrt{\frac{(V - C)^2}{(V + C)/2}}$$

where:

GEH = The statistic

V = model estimated directional hourly volume at a location.

C = directional hourly count at a location.

The results from the VISSIM analysis are summarized **Table 2**. This table presents the field counts and the resulting VISSIM simulated volumes. This table shows that the VISSIM model is successfully meeting the calibration criteria for the model area.

Table 2						
Volume Comparison						
Location	Field Counts	VISSIM	Difference¹	Percent Served²	GEH	Meets Criteria?
College Point on-ramp to Horace Harding Expressway	1,360	1360	0	0%	0.0	YES
LIE off-ramp to Horace Harding Expressway	1,204	1220	-16	-1%	0.5	YES
Horace Harding Expressway to Grand Central Parkway (GCP) westbound direct ramp	955	934	+21	2%	0.7	YES
GCP westbound to loop ramp service road	1,700	1688	+12	1%	0.3	YES
Horace Harding Expressway to GCP east loop ramp	75	72	+3	4%	0.3	YES
GCP service road westbound at loop ramp	325	324	+1	0%	0.1	YES
GCP mainline westbound at loop ramps	3,572	3574	-2	0%	0.0	YES
GCP westbound on-ramp from Horace Harding Expressway	1,280	1247	+33	3%	0.9	YES
GCP westbound off-ramp to Exit 9P USTA	802	750	+52	6%	1.9	YES
GCP westbound mainline at off-ramp to Exit 9P USTA	4,050	4046	+4	0%	0.1	YES
GCP westbound mainline (after split)	2,535	2522	+13	1%	0.3	YES
GCP westbound service road (after split)	1,515	1515	0	0%	0.0	YES
GCP westbound on-ramp from Exit 9P	244	235	+9	4%	0.6	YES
Notes: Average of ten simulation runs.						
1. Difference = Field Counts – VISSIM						
2. Percent Served = (Field Counts – VISSIM) / Field Counts						

In addition to validating the model to field counts, the simulation was checked to demonstrate queuing that is consistent with the field observations. During the 6:00 PM to 7:00 PM peak period, the Grand

Central Parkway westbound off-ramp to Exit 9P was observed to queue back to the GCP mainline, growing throughout the peak hour. By the end of the peak hour (around 7:00 PM), the queue from the Exit 9P exit ramp extended to the Horace Harding Expressway.

The VISSIM model replicated this queue length during the simulation, with queues from the Exit 9P off-ramp extending through the peak hour, spilling back onto the Horace Harding Expressway and back to the College Point Boulevard and LIE approaches at the end of the simulation peak hour.