Caliper Corporation

Final Report

NYMTC Transit Modules for the Flowchart Best Practices Model in TransCAD 6.0

July, 2011

Introduction

This report documents the conversion of the BPM transit modules from the BPM Central model to the BPM GUI TransCAD 6.0 model. This report also describes the development of new transit network creation, skimming, and assignment modules for the BPM, and the updated reports and display utilities related to the transit modules. In addition, this report describes model performance improvements. Lastly, this report discusses recommendations for future model development.

Creation of Transit Networks

Creation of Transit Routes and Line Databases

For the BPM GUI model, the base year for both highway and transit networks is 2005. For the 2005 transit networks, the more precise NYCTA transit routes and line geography was used in place of the Central BPM network. This replacement occurred within the 5 borough area. The NYCTA transit routes were chosen due to both its geographic and data accuracy, as NYCTA meticulously maintains and updates its transit route and stop inventory. For this work, a version of the 2005 NYCTA transit routes was used.

The NYCTA transit routes and line layer extended only to the borders of the 5 boroughs (Manhattan, Bronx, Brooklyn, Queens and Yonkers). The NYMTC model area, however, encompasses a much larger area of 29 counties around New York City. Therefore, to complete the transit network, the existing 2005 Base Year NYMTC transit routes and underlying line database was used for the region outside of the 5 boroughs. The two transit routes and line databases were then merged together.

During the merging process, both the transit routes and the underlying line database were merged. For the line database, particular attention was paid to the links and nodes that bordered the two databases. Duplicated links and nodes at the border were eliminated, and border nodes of both databases were connected with each other to ensure a seamless connection in the merged database. Special care had to be taken to connect the bridges and tunnels from New Jersey to Manhattan, especially around the Lincoln Tunnel area, due to the number of routes that use these links. A zoomed in example of the merging at the borders is shown in Figure 1:

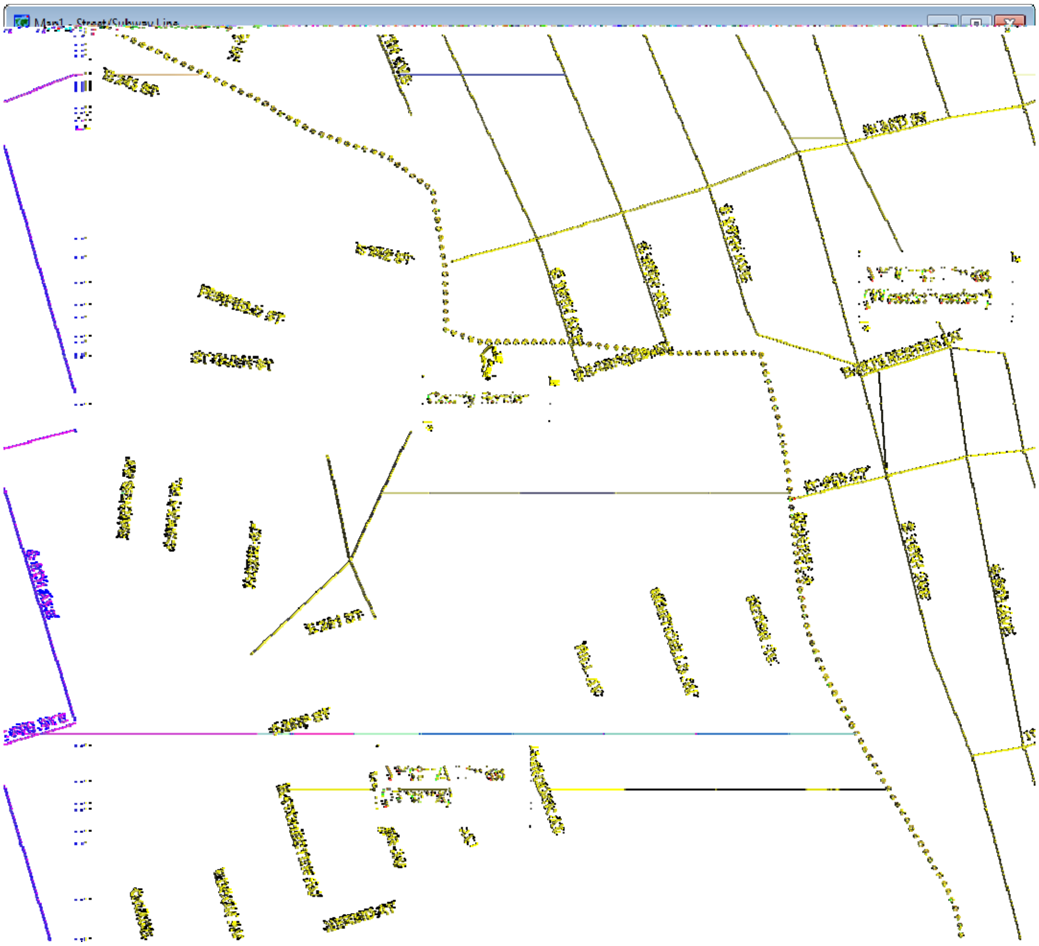


Figure 1: Border between NYCTA and NYMTC Links

From the link merging process, and from some inspections, both data and geographic issues were found in both line datasets. Duplicated links were found in the original NYMTC line database. All the duplicates resulting from this process where eliminated. Link directionality information was missing in the NYCTA dataset. This information was therefore added onto the merged database based on the latest LION dataset. A special tagging program was used to transfer directionality among the databases. Caliper reviewed the output of this task for links used by the merged route system.

For the link and node attributes of the merged line geography, all attributes from both source databases were initially maintained. In addition, attribute fields were added to help determine the original source of the link or node. Later on, link and node attributes were optimized to reduce the number of required attributes for the model. A full list of final link and node attributes used for this model appears later in this document.

For the merging of the transit routes, the process was more involved. The transit routes were divided up into three categories, and each category was processed separately:

1. Routes that are completely within the 5 borough boundary
2. Routes that are completely outside of the 5 borough boundary
3. Routes that cross the 5 borough boundary

For Category 1 routes, all of the NYCTA routes were used. The NYCTA routes were placed directly on the NYCTA-sourced line database within the 5 borough region. Thus, no NYMTC sourced routes are used in this category.

For the Category 2 routes, all of the NYMTC routes were used. The NYMTC routes were placed directly on the NYMTC-sourced line database outside of the 5 borough region. Thus, no NYCTA sourced routes are used in this category.

For the Category 3 routes, all of these routes came from the NYMTC route system. NYMTC-sourced routes were first identified using both automated and manual methods. Each of these routes were then divided into two portions: the portion of the route outside the 5 boroughs and the portion inside. The portion outside of the 5 boroughs was placed directly on the NYMTC-sourced line database. For the portion inside the 5 boroughs, the route and stop alignment was transferred from the NYMTC links to the NYCTA links. An automated procedure was developed that matched the NYMTC links to the corresponding NYCTA links, and transferred the route. Each route was then manually checked as necessary.

Our checks discovered problems in some of the routes in the system. Most of the errors are due to either duplication of links in the original NYMTC line layer or bad alignment of the transit routes (U-Turns, strange connections through neighborhoods without stops, etc). Some of these errors were correct but some may still be in the dataset. The next couple of figures illustrates example errors in routes.

Figure 2: Transit Route U-turn Example

Figure 3: Probable Connectivity Problem

Like the link attributes, the NYMTC and NYCTA route and stop attributes were also merged together. All fields from both route systems were initially kept, and then reduced to only necessary attributes for the model. Quality checks and changes for both the route and stop attributes were performed by Caliper, AECOM, and NYMTC. Some examples of these checks and changes are as follows:

1. The 2005 NYCTA transit network contained reliable AM headway information, but incomplete MD headways. AECOM estimated and completed the MD headways based upon equivalent NYMTC route headways and manual edits.

2. AECOM found that subway and local bus fares were incorrectly coded as $1.50. The fares were updated to $2.00.

3. PB and AECOM recommended adjustments of many subway and commuter rail walk entrance and rail-to-rail transfer walk times. NYCTA provided some observed data on entrance and transfer times, which were then manually coded in the network.

Creation of Walk and Drive Access Links and Transfer Links

In the Central BPM model, access, egress, and transfer links are created by external programs. These travel links are "stick" links which connect TAZs directly to nearby stops and stations directly to other stations. After these stick links are created, they are merged into the transit line database. For the BPM GUI model, these external programs have been replaced with GISDK procedures that are directly built into the model run. These procedures directly utilize the street network portion of the transit line database to help determine walk and drive travel times.

Drive Access Building

The drive access building process emulates in many parts the logic of the external programs used in the Central BPM model. The building steps are as follows:

1. Identify all nodes associated with stops on premium routes (CR, Subway, etc.) and associate each node with the nearest highway and transit node ID, and county. Perform similar operation on bus PNR nodes
2. In the station point database, associate each station with a nearby highway node, transit node, and premium node. Perform similar operation on bus PNR stations.
   a. Based on "Ring" lookup table, determine the maximum drive distance for each station based upon transit mode, county, and available parking spaces.
   b. Calculate drive distances from all stations to all centroids using a highway skim procedure minimizing congested travel times, and cut off distances based on maximum drive distance limits.
   c. Apply TAZ, MCD and Village parking restrictions (e.g. certain station lots are restricted to TAZs from the same MCD or Village)

The result of the process is a skim matrix of travel times and distances from TAZ to premium node and bus PNR nodes. Only valid TAZ-to-Node connections are present in this matrix. This skim matrix is used directly in the transit network Park and Ride settings. In the 4.8 version of the model, these connections would be converted into physical links that are merged into the transit line database, then selected as part of the drive access link set. In the GUI model, a skim matrix substitutes for these drive access links, saving the need for link generation and selection. In the 4.8 version of the model, the drive access procedures are executed from external programs. In the GUI model, all drive access procedures are executed within GISDK code.

The following tables and files are input into the drive access procedure:

Parameter Name:	[Premium Stations]
Parameter File:	0_input\5_tnet\nymtc_stations.dbd

Field	Description
ID	Internally generated station id
Longitude	Longitude of station
Latitude	Latitude of station
PTZ_ID	PTZ_ID of station
CSI_ID	Not used
MODE_Service	Verbal description of mode used for identifying the mode service by the station: (Subway, Ferry, Rail, PATH, Tram, or Bus)
Serv_ID	Not used
Serv_id2	Not used
Sta_ID	Not used
Name	Station Name
Source	Source of data (for information only)
Schedule	Not Used
Fare Area	Not Used
FareZone	Fare Zone for Fare Processing (not used
Mega_id	Not used
NSPACES	General number of parking spaces (for information only)
ParkCost	General Parking Cost (for information only)
WalkTime	Information purposes only
TAZ	TAZ where parking lot is located
Station_limit	Station Access Limitations: Blank = inactive station RW = Rail/Ferry Walk Access only RKR = Rail/Ferry Walk or Kiss-Ride Access Only RPR = Rail/Ferry Walk/Kiss-Ride/Park-Ride Access CW = Commuter Rail Walk Access only CKR = Commuter Rail Walk or Kiss-Ride Access Only CPR = Commuter Rail Walk/Kiss-Ride/Park-Ride Access
Service1-Service10	Code for first and subsequent service available at station. See below for service codes
Int_walk_time	Not Used
Bus_Feed_walk	Not used
KR_Walk	Not used
PR_Walk	Park-Ride walk time from parking to Station in minutes
UNREST_PARK	Number of unrestricted parking spaces
REST_PARK	Number of restricted parking spaces
Restriction1, Restriction2	City/Town/Village Restrictions
UNREST_Cost	Unrestricted Daily Parking Cost in cents
Rest_Cost	Restricted Daily Parking Cost in cents
Notes	Not used
Rest_code1, Rest_code2	Code indicating sets of zones that are allowed to use restricted parking CCMMM Where: CC=NYMTC County Code

Field	Description
	MMM=MCD or Village Code
County	NYMTC County Code
OTH_CODE	Other code (not used)
HIGHWAY_NODE_ID	Nearest node to station on highway network (calculated)
Transit_node_ID	Nearest node to station on transit line layer (calculated)
Ring	Ring number associated with station (calculated)
MAXDIST	Maximum distance allowed from station to TAZ (calculated)

Service Codes:

FERRIES
FATL Atlantic Highlands
FBAT Brooklyn Army Terminal
FCOLG Colgate Ferry Terminal
FHARB Harborside
FHIGH Highlands (Seastreak)
FHOB Hoboken
FHUNT Long Island City
FLGA LaGuardia
FLIB Liberty Harbor
FLINC Lincoln Harbor
FPLIB Port Liberte
FROOS Roosevelt Island Tram
FSHOOK Sandy Hook/Highlands Fast Ferry
FSI Staten Island Ferry
FWEEH Weehawken
LONG ISLAND RAIL ROAD
LBABY Babylon Branch
LFROCK Far Rockaway Branch
LGPT Greenport (beyond end of electrification at Ronkonkoma)
LHEMP Hempstead Branch
LLBCH Long Beach Branch
LLONGB Long Beach Branch (applied to City Terminal Zone Stations)
LMONT Montauk Branch
LOYST Oyster Bay Branch
LPJEF1 Port Jefferson Branch (beyond end of electrification at Port Jefferson)
LPJEF2 Port Jefferson Branch (electrified territory)
LPWASH Port Washington
LROCK Key Mainline Stations
LRONK Ronkonkoma
LWHEMP West Hempstead
METRO-NORTH RAILROAD
MHAR1 Harlem Line (Brewster North and out to Dover Plains)
MHAR2 Harlem Line (Brewster North and in)
MHUD1 Hudson Line (Croton Harmon and out to Poughkeepsie)
MHUD2 Hudson Line (Croton Harmon and in)
MNHAV1 New Haven Line
MNHAV2 New Canaan Branch
MNHAV3 Danbury Branch
MNHAV4 Waterbury Branch
NEW JERSEY TRANSIT
NBOON Boonton Line
NCS Newark City Subway
NGLAD Gladstone Branch
NMAIN Main Line

NMDXG Midtown Direct - Gladstone
NMDXM Midtown Direct – Morris & Essex
NMONT Montclair Branch
NMORR Morris & Essex
NNEC Northeast Corridor
NNJC1 North Jersey Coast Line (Diesel service: Bay Head to Newark)
NNJC2 North Jersey Coast Line (Electric service: Long Branch to New York)
NPASC Pascack Valley Line
NPJER Port Jervis Line
NRAR1 Raritan Valley Line (High Bridge to Newark)
NRAR2 Raritan Valley Line (Raritan to Newark)
SUBWAY AND PATH
S1 1
S2 2
S3 3
S4 4
S5 5
S6 6
S7 7
S9 9
SA A
SB B
SBROOK Brooklyn CBD
SC C
SD D
SE E
SF F
SG G
SJ J
SL L
SM M
SN N
SQ Q
SR R
SS S
SSIR Staten Island Rapid Transit
STSQ Times Square
SZ Z

Parameter Name:	[Bus PNR Stations]
Parameter File:	0_input\2_Tnet\bus_pnr_stations.dbd

Field	Description
ID	Internally generated station id
Longitude	Longitude of station
Latitude	Latitude of station
PNR_ID	Not used
PNR_Sequence	Not used
Name	Station Name
CO_Name	Not used
Serv1-Serv10	Not used
PNR_Longitude	Longitude (not used)
PNR_Latitude	Latitude (not used)
RPNR_Longitude	Longitude (not used)
RPNR_Latitude	Latitude (not used)
NJT_Zone	NJT Zone (not used)
TAZ	TAZ of station
County	Not used
Mode	Mode of Transit at PNR Lot (Must be 1)
No_of_spaces	Number of parking spaces at PNR
Parking_cost	Parking cost
Walk_Time	Walk time
Connect_flag	Must be 1
OTH_CODE	Other code (not used)
HIGHWAY_NODE_ID	Nearest node to station on highway network (calculated)
Transit_node_ID	Nearest node to station on transit line layer (calculated)
CountyCode	County of station (calculated)

Parameter Name:	[BPM Rings]
Parameter File:	3_GIS\bpm_rings.dbd

Field	Description
ID	Ring ID
Area	Area in square miles
[Entity ID]	1
Width	Width of ring

Parameter Name:	[Premium Max Distances]
Parameter File:	0_Setup\2_LUT\5_TNET\prem_distances.bin

Field	Description
Ring	Ring of station
CR_Space1	CR Parking space cutoff for distance 1
CR_Space2	CR Parking space cutoff for distance 2
CR_Dist1	Max distance if parking spaces < CR_Space1
CR_Dist2	Max distance if parking space > CR_Space1 and < CR_Space2
CR_Dist3	Max distance if parking space > CR_Space3
F_Space1	Ferry Parking space cutoff for distance 1
F_Space2	Ferry Parking space cutoff for distance 2
F_Dist1	Max distance if parking spaces < F_Space1
F_Dist2	Max distance if parking space > F_Space1 and < F_Space2
F_Dist3	Max distance if parking space > F_Space3

Field	Description
S_Space1	Subway Parking space cutoff for distance 1
S_Space2	Subway Parking space cutoff for distance 2
S_Dist1	Max distance if parking spaces < S_Space1
S_Dist2	Max distance if parking space > S_Space1 and < S_Space2
S_Dist3	Max distance if parking space > S_Space3

Parameter Name:	[Local TAZ]
Parameter File:	0_Input\2_tnet\taz_local.dbd

Field	Description
ID	Internally generated TAZ id
Longitude	Longitude of TAZ
Latitude	Latitude of TAZ
TAZ	TAZ Number
County	County number of TAZ
MCD	MCD Number (table 3-13 from transit network data coding report copied below
Village	Village Code (see below)
Long	Longitude
Lat	Latitude
Transit_Node_ID	Tagged transit nearest node id (calculated)

Table 3-13 MCD Codes for Use in TAZ Locality File

Part A County and MCD Codes

County	County Code	MCD Code	FIPS Code	Name
Nassau	6	1	3605956000	Oyster Bay town
Nassau	6	2	3605929113	Glen Cove city
Nassau	6	3	3605934000	Hempstead town
Nassau	6	4	3605953000	North Hemspstead town
Nassau	6	5	3605943335	Long Beach city
Suffolk	7	1	3610337000	Huntington town
Suffolk	7	2	3610304000	Babylon town
Suffolk	7	3	3610369463	Southold town
Suffolk	7	4	3610368473	Southampton town
Suffolk	7	5	3610310000	Brookhaven town
Suffolk	7	6	3610368000	Smithtown town
Suffolk	7	7	3610361984	Riverhead town
Suffolk	7	8	3610366839	Shelter Island town
Suffolk	7	9	3610338000	Islip town
Suffolk	7	10	3610359106	Poospatuck reservation
Suffolk	7	11	3610367059	Shinnecock reservation
Suffolk	7	12	3610322194	East Hampton town
Westchester	8	1	3611950617	New Rochelle city
Westchester	8	2	3611949121	Mount Vernon city
Westchester	8	3	3611957012	Pelham town
Westchester	8	4	3611918410	Cortlandt town
Westchester	8	5	3611956979	Peekskill city
Westchester	8	6	3611942136	Lewisboro town
Westchester	8	7	3611905320	Bedford town
Westchester	8	8	3611955541	Ossining town
Westchester	8	9	3611950078	New Castle town
Westchester	8	10	3611968308	Somers town
Westchester	8	11	3611949011	Mount Pleasant town
Westchester	8	12	3611964309	Rye city
Westchester	8	13	3611951693	North Castle town
Westchester	8	14	3611953517	North Salem town
Westchester	8	15	3611964320	Rye town
Westchester	8	16	3611959685	Round Ridge town
Westchester	8	17	3611930367	Greenburgh town
Westchester	8	18	3611981677	White Plains city
Westchester	8	19	3611932413	Harrison town
Westchester	8	20	3611965442	Scarsdale town
Westchester	8	21	3611921820	Eastchester town

Table 3-13 Locality Codes for Use in TAZ Locality File (continued)
Part A County and MCD Codes

County	County Code	MCD Code	FIPS Code	Name
Westchester	8	22	3611984000	Yonkers city
Westchester	8	23	3611944842	Mamaroneck town
Westchester	8	24	3611984077	Yorktown town
Westchester	8	25	3611948895	Mount Kisco town
Rockland	9	1	3608715968	Clarkstown town
Rockland	9	2	3608755211	Orangetown town
Rockland	9	3	3608760510	Ramapo town
Rockland	9	4	3608771674	Stony Point town
Rockland	9	5	3608732765	Haverstraw town
Putnam	10	1	3607957584	Philipstown town
Putnam	10	2	3607960147	Putnam Valley town
Putnam	10	3	3607912529	Carmel town
Putnam	10	4	3607968924	Southeast town
Putnam	10	5	3607939331	Kent town
Putnam	10	6	3607956748	Patterson town
Orange	11	1	3607129553	Goshen town
Orange	11	2	3607178839	Wawayanda town
Orange	11	3	3607177992	Wallkill town
Orange	11	4	3607147042	Middletown city
Orange	11	5	3607178366	Warwick town
Orange	11	6	3607119961	Deerpark town
Orange	11	7	3607130631	Greenville town
Orange	11	8	3607148857	Mount Hope town
Orange	11	9	3607159388	Port Jervis city
Orange	11	10	3607147713	Minisink town
Orange	11	11	3607107003	Blooming Grove town
Orange	11	12	3607118300	Cornwall town
Orange	11	13	3607131907	Hamptonburgh town
Orange	11	14	3607134550	Highlands town
Orange	11	15	3607147999	Monroe town
Orange	11	16	3607175781	Tuxedo town
Orange	11	17	3607115308	Chester town
Orange	11	18	3607182755	Woodbury town
Orange	11	19	3607150848	New Windsor town
Orange	11	20	3607148153	Montgomery town
Orange	11	21	3607118916	Crawford town
Orange	11	22	3607150045	Newburgh town
Orange	11	23	3607150034	Newburgh city

Table 3-13 Locality Codes for Use in TAZ Locality File (continued)
Part A County and MCD Codes

County	County Code	MCD Code	FIPS Code	Name
Dutchess	12	1	3602747207	Milan town
Dutchess	12	2	3602761357	Rhinebeck town
Dutchess	12	3	3602758156	Pine Plains town
Dutchess	12	4	3602751891	North East town
Dutchess	12	5	3602770662	Stanford town
Dutchess	12	6	3602759641	Poughkeepsie city
Dutchess	12	7	3602759652	Poughkeepsie town
Dutchess	12	8	3602778157	Wappinger town
Dutchess	12	9	3602725978	Fishkill town
Dutchess	12	10	3602737209	Hyde Park town
Dutchess	12	11	3602705100	Beacon city
Dutchess	12	12	3602720819	Dover town
Dutchess	12	13	3602778388	Washington town
Dutchess	12	14	3602776166	Union Vale town
Dutchess	12	15	3602740299	La Grange town
Dutchess	12	16	3602705452	Beekman town
Dutchess	12	17	3602756825	Pawling town
Dutchess	12	18	3602721996	East Fishkill town
Dutchess	12	19	3602716408	Clinton town
Dutchess	12	20	3602758695	Pleasant Valley town
Dutchess	12	21	3602701693	Amenia town
Dutchess	12	22	3602760928	Red Hook town

Parameter Name:	[County File]
Parameter File:	3_GIS\4_Counties\BPM_Counties.dbd
Description:	Only used to tag the county codes to the stations and nodes

Parameter Name:	[Max Bus Distance File]
Parameter File:	0_input\2_TNet\MAX_BUS_DIST_BY_COUNTY.MTX
Description:	Maximum county-to-county bus access distances matrix

The output files are as follows:

Parameter Name:	[Premium PNR Skim]
Parameter File:	1_out\5_tnet\PREM_PNR_SKIM.MTX
Description:	Premium modes TAZ to PNR node skimmed time and distance matrix

Parameter Name:	[Bus PNR Skim]
Parameter File:	1_out\4_hnet\BUS_PNR_SKIM.MTX
Description:	Bus TAZ to bus TAZ node skimmed time and distance matrix

Transit Walk Access Links

A special utility was written to identify walk and drive access links between centroids and stops in the transit system. The resulting walk and walk transfer links were identified in street layer fields called walk_link and walk_transfer_link. These links are used during the transit network building process and will replace the previous straight line access and transfer links. Links that are not “walkable”, such as rail tracks, highways and similar are excluded from these sets. Since the walk links follow real roads, better estimates of walk or drive access times can be developed at the skimming stages of the BPM model.

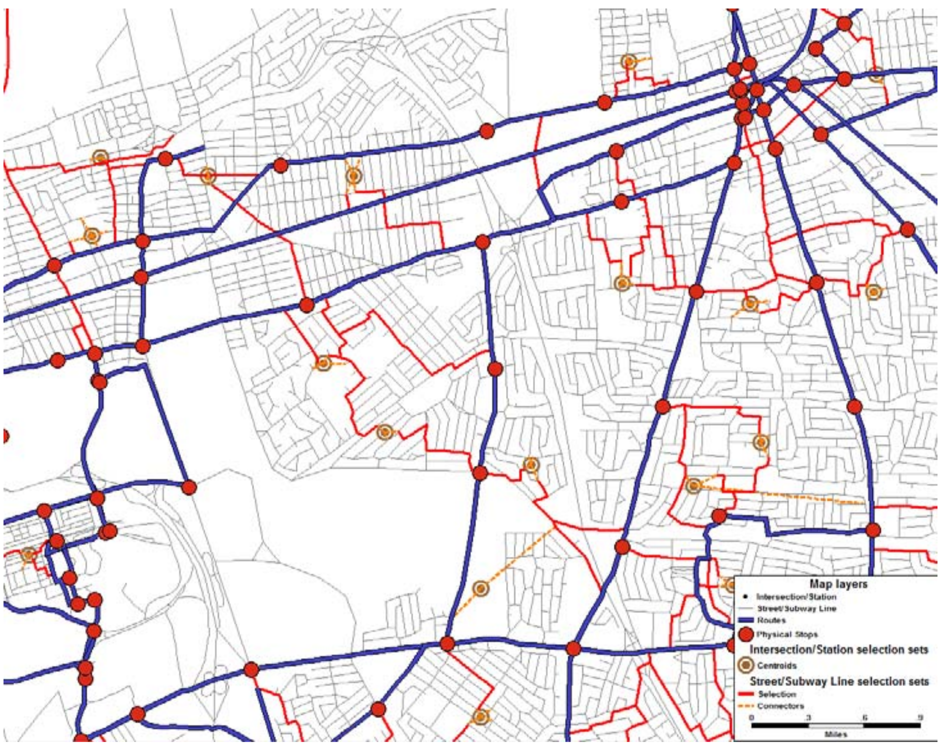


Figure 1: Portion of Routes in Long Island with Walk Access Selection

The process used to determine the walk links is as follows:

1. Select centroid nodes nearest to the stops of selected routes
2. Build shortest paths from centroids to selected nodes

3. For each centroid:
    a. Select all stops within minimum distance parameter.
    b. Remove stops that are not included
    c. If no stops are found, find nearest stop
    d. Sort stops by route and for each stop-route grouping,
        i. find closest one(by node) in the Ingress path (if route crosses a river, closest SP stop could be further than closest “air” stop)
        ii. If node has already been processed for this centroid only, continue, otherwise add to set of nodes that have been processed. (This used to be the physical stop handling but I realized it’s really a node issue.)
        iii. Get the shortest path for that centroid-stop pair
        iv. Add the links to the links selection set

Walk Transfer Links

For transfer links, all walkable links within 0.15 miles of a bus or train station are selected and added to the set of available links for transfers. The walk time is based on a walk speed of 2.5 miles/hr. The calculation of walk links and walk transfer links is incorporated in a utility that can be called from the BPM Menu. This utility is **not** performed during the model run. In addition several link types such as subway/commuter rail entrance and exit link, and subway-to-subway transfer links are excluded from this calculation. Instead, the walk times for these links are directly coded from survey data or modeler’s prerogative.

Special walk transfer subway or commuter rail stations are coded in manually, and the travel times are also coded in manually. The NYCTA line database had an extensive list of both walk transfer and station entrance links, and these links and times were directly transferred into the BPM GUI transit line database. For the areas outside of the 5 borough, the NYMTC database also contained transfer and entrance links with times. These links were also transferred to the BPM GUI line database. The links and times were then modified manually as necessary.

Transit Attributes

The following table describes the attributes found in the route layer of the [Transit Routes] route system (1_Out\5_TNet\NYMTC Merged.rts):

Parameter Name	[Transit Routes]
Parameter File	1_Out\5_TNet\NYMTC Merged.rts

Field	Description
Route_ID	Internal unique number assigned to each route
Route_Name	Unique route name
Source	M = MTA, N = BPM NYMTC
MTA_ModeID	Mode ID assigned from MTA for MTA routes
NYMTC_ModeID	Mode ID assigned from BPM for original NYTMC routes
Mode_ID	Modes consistent with the input mode table: 1 : Commuter Rail 2 : NYC Bus 1.50 3 : NYC Bus 3.00 4 : PATH 5 : Suburban .50 6 : Suburban .75 7 : Suburban 1.00 8 : Suburban 1.25 9 : Suburban 1.50 10 : Suburban 1.75 11 : Suburban 2.00 12 : Suburban 2.50 13 : Suburban 3.00 14 : Suburban 4.00 15 : Suburban 5.00 16 : Suburban 6.00 17 : Ferry 18 : Ferry Bus 19 : NYC Subway 1.50 20 : Local
MODE	Mode (used for categorizing transit submodes) 1=Local Bus (all operators, excluding ferry shuttles) 2=Limited Bus (NYCT bus) 3=Express Bus (all operators) 4=Commuter Rail (LIRR, MNR, NJT) 5=Subway (NYC Subway, PATH, Newark City Subway) 7=Ferry/Tram/Ferry Shuttlebus
ModeName	Mode in name format consistent with the MODE field
Company	Route operator name
RouteFamily	Route Group (used for summarizations in the transit reports and displays)
RAIL_CODE	Rail Code Name for Commuter Rail Stations (used for fare calculations). These are only coded for commuter rail routes. The codes are: BAB: Babylon BER: Bergen BNT: Boonton HAR: Harlem HUD: Hudson MAN: Ronkonkoma, Oyster Bay, Port Jefferson, Hempstead ME: Morris and Essex NEC: NorthEast Corridor NHV: New Haven PAS: Pascack PTW: Port Washington RAR: Raritan
ALPHA	BPR Alpha parameter used to model route congestion effects

Field	Description
BETA	BPR Beta parameter used to model route congestion effects
HWAY_AM	AM Headways, 999 = Not in service for time period
HWAY_MID	Midday Headways
HWAY_PM	PM Headways
HWAY_EVE	Evening Headways
HWAY_NT	Night Headways
CAP_AM	AM period vehicle passenger capacity
CAP_MID	Midday vehicle passenger capacity
CAP_PM	PM vehicle passenger capacity
CAP_EVE	Evening vehicle passenger capacity
CAP_NT	Night passenger capacity
Fare	One-way full fare for routes with a fixed fare (fare is the same for entire route)
FareCore	Fare Matrix number to use for zonal based fare routes (this is automatically calculated during the model run)
RouteLength	Length of route in miles (not used in model)
FareType	Type of route fare: 1 = Flat fare 2 = Zonal fare
Capacity	Total period capacity = Period Capacity/0.425*1.15 for Transit Routes = Period Capacity/0.487*1.25 for commuter rail routes. This is calculated in the model.

The following table describes the attributes in the route stops layer:

Field	Description
ID	Internally generated unique ID for the route stop
Longitude	Stop longitude
Latitude	Stop latitude
Route_ID	Route ID associated with the stop
Pass_Count	If a route passes along a link more than once, the pass that the stop is on (e.g. 1 = first pass, 2 = second pass, etc.)
Milepost	Stop milepost, with the start of the route at milepost = 0
Physical_Stop_ID	The physical stop ID that the stop is associated with
STOP_ID	Internally generated unique ID for the route stop
Source	M = MTA, N = BPM NYMTC
STOPLABEL	Name of Stop from MTA portion of source
STATION_NA	Station name from both MTA and NYMTC sources
PTZ_ID	PTZ Number of station, used for fare calculations
RUNTIME	Stop-to-stop raw travel time (calculated in model for non-rail modes, input for rail modes)
BUSIVTT	Bus Stop-to-Stop travel time (calculated in model)
XBUSIVTT	Express bus stop-to-stop travel time (calculated in model)
RAILIVTT	Subway stop-to-stop travel time (calculated in model)
CRIVTT	Commuter Rail stop-to-stop travel time (calculated in model)
FERRYIVTT	Ferry stop-to-stop travel time (calculated in model)
PATH1TIME	Weighted Bus time (calculated in model)
PATH2TIME	Weighted Subway/Ferry time (calculated in model)
PATH3TIME	Weighted Commuter Rail time (calculated in model)
TAGGED_NODEID	Tagged node used for transit network building
Choose_Stop	1 = Use stop in the transit network build
MTA_Station	MTA Station name from MTA source
FER_FZ	Calculated Ferry fare zone number (calculated in model)
LIR_FZ	Calculated LIRR fare zone number (calculated in model)
MNR_FZ	Calculated Metro North fare zone number (calculated in model)

Field	Description
NJT_FZ	Calculated NJT fare zone number (calculated in model)
ALL_FZ	Combined fare zone number of stop (calculated in model)
STRTagged_NodeID	String version of tagged node
STOPID_MTA	Tagged stop id value from 2006 version MTA route system (not used in model)
Boardings_MTA	Boarding counts from MTA count database
Alightings_MTA	Alighting counts from MTA count database
STOPNAME	Combination of STOPLABEL, STATION_NA, and MTA_Station fields to produce fully representative station name field. This stop name is displayed in the transit display utilities.
COUNTKEY	Key field for linking to transit count database (not used in model)
COUNTBOX	MTA box number (not used in model)
LastStop	Flag field to denote last stop in a route

Bus travel times are coded in the stop layer's BUSIVTT and XBUSIVTT fields. For more information on transit travel times, see the next section.

The following table describes the attributes found in the underlying line layer:

Parameter Name:	[Transit Links]
Parameter File:	1_Out\5_TNet\mergedlinks.dbd

Field	Description
ID	Internally generated link ID
Length	Length, in miles of link
DIR	0 = two way 1 = 1-way with topology -1 = 1-way against topology
[Route(s)]	From MTA, subway routes served by link
Source	MTA or NYMTC
NYMTC_TYPE	Linktype field from NYMTC (not used in model)
NYMTC_ALT_NAME	Alternate NYMTC Name (not used in model)
NYMTC_ALT_TYPE	Alternate NYMTC Type (not used in model)
FCLASS	Facility Class, carried over from older NYMTC network (not used in model)
FromNID	From node id (not used in model)
ToNID	To node ID (not used in model)
TT	Estimated travel time (not used in model)
CON_TYPE	Con_type of link (not used in model)
XferMode	Not used
Ct_Descrip	Not used
Premium	Not used
Non_prem	Not used
DRIVE_AM	Not used
DRIVE_PM	Not used
Transit_IVTT	Not used
LINK_MODE	Contains the file mode for the link (not used)
AUTOTIME	Link auto ivtt placeholder, field values get replaced by stop ivtt
AUTOCOST	Link auto time placeholder, field values get replaced by stop ivtt
BUSIVTT	Link bus ivtt placeholder, field values get replaced by stop ivtt
XBUSIVTT	Link express bus ivtt placeholder
RAILIVTT	Same as above
CRIVTT	Same as above
FERRYIVTT	Same as above
ACCOVTT	Access out of vehicle time (calculated from walk time)
EGROVTT	Egress out of vehicle time (calculated from walk time)
XFROVTT	Transfer time = walk time for transfer links, 0 otherwise
CentroidConnector	Flag for centroid connector, used for display reports
Prohibit_Walk	Flag for prohibiting walking on freeways, ramps, etc. (not used in model)
Rail_links	Flag for rail link (not used in model)
Walk_transfer_links	Flag for walk transfer link, created by walk access procedure
Walk_links	Flag for walk access/egress link, created by walk access procedure
WalkTime	Walk travel time (calculated using transit walk links utilities, entered in manually for subway-subway transfer links and station entrance links)
Temp_Transit_IVTT	Transit IVTT (not used in model)
LMode	101: walk or transfer link, otherwise missing
Trv_time	Calculated drive time (placeholder which is then overridden by stop-to-stop calculated times for all routes)
ABTEST/BATEST	Not used
SUBWAY_LINK	Flag field for subway link (used in display reports)
FERRY_LINK	Flag field for ferry link
Tram_LINK	Flag field for tram link
MajorCrossingName	Link marked with major crossing screenline name (e.g. East River-Brooklyn) used in the transit screenlines report
MinorCrossingName	Link marked with minor screenline within the major screenline (e.g.

Field	Description
	Manhattan Bridge) used in the transit screenlines report
ABCrossingDirection	The crossing direction on the AB direction of the link (e.g. Eastbound, Westbound, Northbound or Southbound)
BACrossingDirection	The crossing direction on the BA direction of the link (e.g. Eastbound, Westbound, Northbound or Southbound)

The following table describes the attributes found in the underlying node layer:

Field	Description
ID	Internally generated node id
Longitude	Longitude of node
Latitude	Latitude of node
[Station/Location]	From MTA: Subway station node name (not used in model)
DIV	From MTA: Division of node (not used in model)
Line	From MTA: Subway line of node (not used in model)
[Route(s)]	From MTA: Routes served by node (not used in model)
ZONE_ID	From NYMTC: Zone and PTZ ID, not used in model
TAZ_ID	From NYMTC: TAZ ID, not used in model
PTZ_ID	From NYMTC: Transit Station ID, not used in model
STOPID	From NYMTC: tagged stop id, not used in model
DUMMYZID	From NYMTC: Dummy ID, not used in model
SELECTID	Not used
CentroidNode	TAZ Number
ParkNode	Flag to designate node as park enabled
CountyCode	Tagged county of node (not used in model)
Parking_Capacity	For parking lot nodes, parking capacity taken from parking lot file (calculated during model run)
ParkNode	Flag field to denote parking node (calculated during model run)

The BPM Model assumes that all transit routes, transit stops, and underlying network links have already been pre-specified and input for the scenario. The model also assumes that all other supplementary transit inputs (e.g. mode table, mode transfer table, fare matrices, etc.) have also been specified. All transit inputs can be found in the C:\0_BPM1\2_ALTS\<SCEN>\0_INPUT\2_TNET directory. The BPM model includes a utility that assists the user in viewing, editing, and reviewing transit routes. This utility is described in the subsection **Displaying Transit Routes** under the section **Running Various BPM Utilities** section of this User's Manual.

The next section describes the substeps in the Transit Network Building and Skimming step

Transit Time Calculations

For bus travel times, a DK macro was ported from the 4.8 model that calculates transit link in-vehicle times based on vehicle performance characteristics and county. The bus times are calculated from derived bus speeds documented in the BPM Final Report under Section 4.3.1.10: In-Vehicle Times. The main descriptive table and section from that report is shown below:

Table 4.3.2 Parameters for Automatic Bus Travel Time Calculation

Location	Top Speed (Short stop-to-stop segments, mph)	Top Speed (Long stop-to-stop segments, mph)	Acceleration (mph/s)	Dwell Time (sec)	Deceleration (mph/s)
Manhattan	10	18	1.0	20	1.0
Other NYC	10	18	1.2	0	1.2
Suburban NY Counties	7	35	1.4	0	1.4
Suburban NJ Counties	12	50	1.6	0	1.6
Suburban CT Counties	16	55	1.1	20	1.1

Other key parameters used to compute bus travel times include:

- Inter-county segments are average of values for each county
- Breakpoint between short and long stop-to-stop segments is 0.3 miles
- Queens-to-Manhattan segments (13 mph + 2 minute delay)

Commuter rail, subway, ferries, and other mode travel times are stored directly in the route system's route stop layer under the RUNTIME, RAILIVTT, CRIVTT and FERRYIVTT fields respectively. For the NYMTC portion of the route system, these values were directly used from the output transit network. For the MTA portion of the route system, the direct stop-to-stop travel times for the rail routes are maintained by NYCTA staff in a separate table, which is then linked to the route stops. These stop-to-stop values were transferred to the merged route system.

Transit Fare Calculations

The transit fare calculation procedures in the GUI version of BPM are slightly different than the Central version. There are still two types of transit fare systems modeled in the BPM: flat fares for routes that charge the same base or transfer fare for the entire route, and zonal fares where the fare varies depending upon the boarding and alighting stop. In the Central model, fare types and fares were determined at the mode level. As a result, there are more required modes due to differing pricing policies (see table below).

Current Mode	Description
1	Commuter Rail
2	NYC Bus 2.00
3	NYC Bus 3.00
4	PATH
5	Suburban .50
6	Suburban .75
7	Suburban 1.00
8	Suburban 1.25

9	Suburban 1.50
10	Suburban 1.75
11	Suburban 2.00
12	Suburban 2.50
13	Suburban 3.00
14	Suburban 4.00
15	Suburban 5.00
16	Suburban 6.00
17	Ferry
18	Ferry Bus
19	NYC Subway 1.50
20	Local

In the GUI version, fare types and fares are defined by individual route. There are several inherent advantages of defining fares at the route level over the modal level:

- Fewer modes are necessary, and there are no longer multiple mode fields required
- Flat boarding and transfer fares can be varied individually by route rather than by mode, adding flexibility
- Zonal fares are defined individually by route rather than by mode. This leads to more fare flexibility and smaller zone fare matrices, which only need to be defined at the route level rather than be forced to cover all stops for a mode

All flat fares were directly entered into the route system layer's FARE field. A GISDK macro was written to determine zonal fares for the commuter rail routes. The macro uses as input equivalent zone tables for each commuter rail authority (Metro North, LIRR, NJT, Ferry). The input files and their parameters are listed below

Parameter Name	Value
[Ferry Fare Zones]	(0_input\2_tnet\equiv_ferfare.bin)
[LIRR Fare Zones]	(0_input\2_tnet\equiv_lirfare.bin)
[Metro North Fare Zones]	(0_input\2_tnet\equiv_mnrfare.bin)
[NJT Fare Zones]	(0_input\2_tnet\equiv_njtfare.bin)

Each table consists of the following fields:

Field	Description
PTZ_Node	PTZ Node of Station
Station Name	Name of station
Line	Line that station serves
Branch	Branch that station serves
FZ	Fare zone number of station

The macro also takes as input fare zone matrices for each rail company ([Ferry/LIRR/Metro North/NJT Fare Matrix] 0_input\2_tnet\<fer/lir/mnr/njt>fare.mtx). The IDs in the matrix are consistent with the fare zones in the equivalency tables. The macro processes the input files, creates a union fare zone matrix, and codes in the following fields in the route system layer: FARETYPE, FER_FZ, NJT_FZ, LIR_FZ, MNR_FZ, ALL_FZ. These fields are then directly used in transit network building and setting.

Transit Network Building

Once the walk access and transfer links are identified, and once the drive access skim matrix is created, the transit network is built and set using Pathfinder settings. In this iteration of the transit conversion process, similar weights and settings are used compared with the 4.8 model. Separate transit networks are built for the AM and MD periods, and separate networks are built for the following access modes:

- Walk-Subway
- Drive-Subway
- Walk-CR
- Drive-CR

Aside from the transit route system and underlying link database, the following input files are used to create the transit network:

Parameter Name	[Mode Table]
Parameter Value	0_input\2_TNet\modes_2005.bin

Field	Description
Mode_Name	Name of Mode
Mode_ID	Mode ID
Type	T = Transit W = Walk or drive
Description	Mode description
USE_B_W	Flag to enable mode for walk-bus
USE_B_D	Flag to enable mode for drive-bus
USE_BSF_W	Flag to enable mode for walk-subway
USE_BSF_D	Flag to enable mode for drive-subway
USE_BSR_W	Flag to enable mode for walk-CR
USE_BSR_D	Flag to enable mode for drive-CR
IMP_FIELD	Not used
Fare_type	Not used
Fare_field	Not used
Fare_Core	Not used
Fare	Not used
XFare	Not used
XFER_Time	Transfer Time for non-rail mode
XFER_TIM2	Transfer time for rail mode
IN_V_W	Not used
Walk_w	Not Used
Wait_W	Not used
XFER_W	Not used
Dwell_W	Not used
Wait_Wght	Wait weight
Comments	
Min_wait	Minimum wait time
Max_wait	Maximum wait time
Wait_Wght2	Not used
Max_Acc_Time	Maximum Walk Access/Egress Time

Parameter Name	[Mode Xfer Table]
Parameter Value	0_Input\2_TNet\mxfer_2005.bin

Field	Description
From	From Mode
To	To Mode
Stop	At Stop (optional)
Cost	Transfer cost
Fare	Fare to switch modes

The transit network was built with the settings listed below:

Parameter	Description	Value
[Max Initial Wait]	Maximum initial waiting time	120 min
[Min Initial Wait]	Minimum initial waiting time	0 min
[Max Transfer Wait]	Maximum transfer waiting time	120 min
[Min Transfer Wait]	Minimum transfer waiting time	2 min
[Layover time]	Layover time between route end and beginning	5 min
[Max WACC Path]	Maximum number of walk access paths between TAZ and stop by mode	10
[Max Access Time]	Maximum walk time between TAZ and stop	25 min
[Max Egress Time]	Maximum walk time between stop and TAZ	25 min
[Max Xfer Number]	Maximum number of transfers	5
[Max Xfer Time]	Maximum walk time between transfers	25 min
[Combination Factor]	Combination factor	0.1
[Initial wait weight]	Weight factor on initial wait	In mode table WAIT_WGHT field, varies between 0.5 and 1.5
[Transfer wait weight]	Weight factor on transfer wait	In mode table WAIT_WGHT field, varies between 0.5 and 1.5
[Transfer Time Penalty]	Penalty for transferring between modes	4.7 minutes
[Transfer Time Weight]	Weight on transfer penalty	1.5
[Walk Weight]	Weight for walking	1.5

As the model continues to be calibrated and validated, the settings values are subject to change. Most of the setting values are consistent with the BPM Central model. The transit networks are stored as .tnw files, described below:

Parameter	File	Description
[AM Transit Network]	1_Out\5_TNet\transit_am.tnw	AM Transit Network
[MID Transit Network]	01_Out\5_TNet\transit_mid.tnw	MD Transit Network

Transit Skimming

After the transit networks are built, transit skim matrices are calculated. These skim matrices are used as inputs into the MDC model and the accessibility models. The GUI version produces the same skim matrices with the same settings as the Central model in order to guarantee compatibility with the existing MCD and Accessibility procedures. The GUI model also uses the same pathfinding method for transit skimming as the Central, which is the Pathfinder method.

The Pathfinder method was developed by Caliper as a generalization of the TRANPLAN and optimal strategies method. It was developed in response to the desires of consultants who wanted a skimming method similar to that in other packages. The development of Pathfinder was also used to add some other features that were thought to be important advances. Principally among these were a more elaborate and realistic treatment of access, egress, and transfer links and the use of fares in the computation of the best paths.

In addition to the transit skim matrices, the skim procedures also produce parking lot matrices for each drive access mode. The parking lot matrices output, for each origin-destination pair, the parking node ID utilized. The parking lot matrix is not used in any downstream model, but it is a useful output file that helps determine access station choice. The output matrices are as follows:

Matrix	File	Description
[AM Transit Walk-Subway Preskim]	0_Input\3_TSKIM\TAMWSb.mtx	AM Walk access to subway
[AM Transit Drive-Subway Preskim]	0_Input\3_TSKIM\TAMDSb.mtx	AM Drive access to subway
[AM Transit Walk-CR Preskim]	0_Input\3_TSKIM\TAMWCb.mtx	AM Walk access to commuter rail
[AM Transit Drive-CR Preskim]	0_Input\3_TSKIM\TAMWCb.mtx	AM Drive access to commuter rail
[MD Transit Walk-Subway Preskim]	0_Input\3_TSKIM\TMDWSb.mtx	MD Walk access to subway
[MD Transit Drive-Subway Preskim]	0_Input\3_TSKIM\TMDDSb.mtx	MD Drive access to subway
[MD Transit Walk-CR Preskim]	0_Input\3_TSKIM\TMDWCb.mtx	MD Walk access to commuter rail
[MD Transit Drive-CR Preskim]	0_Input\3_TSKIM\TMDWCb.mtx	MD Drive access to commuter rail
[AM Transit Walk-Best Skim]	0_Input\3_TSKIM\TAMDTB.mtx	AM Walk access to best mode
[MD Transit Walk-Best Skim]	0_Input\3_TSKIM\TMDDTB.mtx	MD walk access to best mode
[AM Transit Drive-Bus Parking]	0_Input\3_TSKIM\TAMDBb_park.mtx	AM drive bus parking matrix
[AM Transit Drive-Subway Parking]	0_Input\3_TSKIM\TAMDSb_park.mtx	AM drive subway parking matrix
[AM Transit Drive-CR Parking]	0_Input\3_TSKIM\TAMDCb_park.mtx	AM drive CR parking matrix

The skim matrices were tested with both the MDC and the Accessibility model to ensure that these procedures worked properly with these inputs. Both procedures worked properly with these matrices, but the aggregate results are slightly different from the original skim outputs from Central version, which is based on TransCAD 4.8. This is to be expected since the route systems are very different, the access generation techniques are different, and the 6.0 transit pathfinding algorithm is more efficient and finds better paths than the 4.8 algorithm.

The output tables of each matrix are similar and are described below:

Matrix Table Name	Description
Fare	Fare in Dollars
Initial Wait	First Waiting Time
Transfer Wait	Wait time for Transfers
Number of Transfers	Number of Transfers
Bus IVTT	Local Bus IVTT
Xbus IVTT	Express Bus IVTT
Subway/PATH IVTT	Subway/PATH IVTT
Commuter Rail IVTT	Commuter Rail IVTT
Ferry IVTT	Ferry IVTT
Access Walk Time	Walk Time on Access Links
Egress Walk Time	Walk Time on Egress Links
Transfer Walk Time	Walk Time on Transfer Links
Auto Time	Auto Access Link Time
Auto Cost	Parking Cost/2

PB compared the skim results from the GUI and the Central versions of the model. Comparisons of costs, paths, and component costs were made between select origin-destination pairs. Below is a sample of their results:

Compare AM Transit Skims: BPM 2005 Network+TransCAD 5.0+CENTRAL with Current Network+TransCAD 6.0+GUI

Geo Long Island Origins to Midtown										
	TAZ						GUI substantially < CENTRAL			
Origin:	**495**	495-100		**Queens: Flushing LIRR**						**1**
Destination:	100			to Midtown						
		Best			W-TR			W-CR		
	CENTRAL	GUI	DIFF	CENTRAL	GUI	DIFF	CENTRAL	GUI	DIFF	
ACC *	**3,299**	**3,272**	**-26**							
IVT	29.50	29.50	0.00	29.50	29.50	0.00	0.00	19.50	19.50	
OVT	7.78	3.84	-3.94	7.78	3.84	-3.94	0.00	16.48	16.48	
WAIT	2.15	2.25	0.10	2.15	2.25	0.10	0.00	15.00	15.00	
FARE	2.00	2.00		2.00	2.00		0.00	3.85		
....										
....										
IVT+OVT+WAIT	**64.36**	**56.68**	**-7.68**	**64.36**	**56.68**	**-7.68**	**0.00**	**103.83**	**103.83**	
	OTH TR	*OTH TR*	-11.9%	*MIN*	*MIN*					
				Is CR IVTT Zero ??				No		

In the above table, Central vs. GUI results by access, in-vehicle, out of vehicle, wait times, and fares were compared. In addition, overall generalized costs were compared. The comparisons were performed for both the Walk-Transit and Walk-Commuter rail modes. In many cases, the GUI model found paths that were not found in the Central version, or found paths that had lower costs. The full set of results can be found in Appendix A: Transit Skim Results. Using these tests, PB concluded that the skim results for all tested origin-destination pairs produced reasonable results.

Transit Assignment

For transit assignment, an updated assignment methodology was implemented in the GUI model in place of the method used in the Central version of the model. The method was as follows:

1. For each access mode (walk-subway, drive-subway, walk-cr, drive-cr), perform a Pathfinder assignment.
2. Aggregate all assignment results and use a crowding formulation and input route capacities to determine route-link congestion.
3. Using the congested times, calculate congested transit skim matrices.
4. Input these skim matrices into a mini “mode choice” program to recalculate the access model transit trip matrices.
5. Re-compute steps 1 through 4 several times

This methodology is replaced with a new transit assignment procedure that is available in TransCAD Version 6.0 called Multi-Class Pathfinder User Equilibrium, or PFUE.PFUE is an extension of the TransCAD Pathfinder method that takes route and non-transit link capacity into account. Non-transit links are network links such as access links, egress links, transfer links and station access links. Capacities are commonly placed on routes to constrain flow so that it doesn't exceed the carrying capacity of the routes. Another common place to put capacity is on links that access a transit station to model platform capacities. Additionally, capacities are placed on parking lot nodes in cases where stations have limited parking spaces. These additional link, route, and parking lot capacity inputs are used to run the Pathfinder algorithm in an equilibrium iterative loop. During each iteration of the loop, the volume assigned is compared with the capacity of the links and parking lots. Based upon the volume over capacity (V/C) ratio, congested link and parking lot times are determined based upon the Bureau of Public Roads (BPR) equation presented later in this document. These congested costs are now input into the next iteration loop, and volumes are updated depending upon the congested costs. Volumes are updated using the Method of Successive Averages (MSA) on the volume flows. After a sufficient number of iterations, the differences in results between iterations decreases until it reaches a convergence limit and assignment is said to be at equilibrium.

In addition to adding an iterative loop to Pathfinder, the new procedure is multi-classed. The multi-class allows the access mode specific assignments to be run simultaneously instead of sequentially, both saving on run times and eliminating the need for aggregation post-processing. A multi-class assignment is also necessary to keep the modes separated within the equilibrium assignment context.

The UE Pathfinder method combines many of the desirable attributes of all previous transit assignment methods. Since UE Pathfinder builds upon the current BPM transit assignment model, it is not a radical departure from either the current assignment or skim method and generates favorable results. This method also allows various capacity restraints that were not available before, such as parking, route, and non-transit link capacities. The multi-class nature of the method allows the four classes of OD transit trips to be assigned simultaneously, saving model run times and GISDK coding efforts. In addition, the UE and capacity algorithm is internal to the procedure and does not need to be coded in the GISDK, as is presently the case in the Central version of the BPM model.

The implementation and migration of the transit assignment method to UE Pathfinder method conducted over several phases: initial debugging/testing, multi-class testing, and GUI Integration.

Initial Debugging/Testing Phase

The goal of the debugging/testing phase was to ensure that the basic UE Pathfinder would work properly with the BPM route system and transit OD matrices. Another goal was to ensure that the model produces reasonable results. During this phase, transit OD matrices directly from the Central version of the BPM model were used. For performance purposes, the four classes of the transit OD matrix (Walk-Transit, Drive-Transit, Walk-Commuter Rail, Drive-Commuter Rail) were collapsed into one class.

On the transit networks, route capacities were specified in a manner similar to that used in the Central BPM model. Parking lot capacities were added at the node level
In the model, a cost penalties were calculated using the Bureau of Public Roads (BPR) formula:

$$t_i \cdot \left[1 + \alpha_i \left(\frac{x_i}{C_i} \right)^{\beta_i} \right]$$

where:

t_i	= Free flow travel time on link i
C_i	= Capacity of link i
x_i	= Flow on link i
α	= Constant
β	= Constant

Model runs were set for the single class UE pathfinder to run for a maximum of 50 iterations or a relative gap of 0.001, whichever came first. In practice, convergence is achieved in about 40+ iterations. These model runs take about 1 hr, 10 min on HARLEY and about 1 hr, 30 min on HEXAD. The UE Pathfinder method requires a large amount of memory and is multithreaded, thus computers with more available threads and more available memory will be able to run the procedure faster.

In this initial phase, we wanted to ensure that overall transit boardings for the region and for the five boroughs (Manhattan, Brooklyn, Yonkers, Queens, Staten Island) were consistent with the previous model results and with general boarding counts. Most model runs produced consistent results of about 2.2 million subway boardings in the five boroughs and 2.3 million boardings regionwide (with PATH), and about 800,000 bus boardings in the five boroughs and 1.1 million bus boarding regionwide. Commuter rail trips were about 300,000 trips regionwide. Small changes in the parameters such as wait weights, mode time weights, mode transfer penalties, etc. cause small changes in modal trips.

Multi-Class Testing Phase

The goal of the multi-class phase was to implement the multi-class option of UE Pathfinder, record and optimize the model run times, and to ensure that the model is producing reasonable results. The goal of this phase was also to determine the generic transit network parameter values that will produce optimal results. As an initial first pass, a multi-class assignment was performed using the same settings as the single-class assignment. The four classes assigned were Walk-Transit, Walk-Commuter Rail, Drive-Transit and Drive-Commuter Rail. The main differences in the transit network settings were the inclusion of park and ride settings and the PNR skim matrix for the Drive classes, and the exclusion of the commuter rail mode for the Transit-only classes. The run time of this assignment was about 4 hours, 14 minutes to run 32 iterations and converge at a 0.001 relative gap. The overall trip boardings by mode were as follows:

Subway: 2.2 million
Bus: 1.2 million
Commuter Rail: 250,000

Transit model boardings were also compared with MTA fare card boardings by mode at an overall level:

Mode	*MTA Count*	*Flow*	*Difference*
Subway	1,160,000	1,130,000	-2.9%
Bus	325,000	337,000	3.8%
Overall	1,485,000	1,467,000	-1.2%

From an overall standpoint, the transit boardings are matching expected targets plus expected counts.

Implementation Phase

Both the Testing/Debugging and the Multi-class/Path-Size Logit phases proved that the UE Pathfinder method could be used effectively and efficiently for the BPM datasets. The last phase was to implement the UE Pathfinder method fully into the BPM GUI and run UE Pathfinder both separately and within the entire model stream. In addition, the previous tests used the final BPM transit OD matrices generated from the Central model to perform the loadings. In this phase, the transit OD matrices are generated directly from the feedback model run. The full 3-loop feedback model run time on the HEXAD machine is about 11-12 hours using single-class UE Pathfinder and 16-17 hours using Muli-Class UE Pathfinder. The Mode-Destination Choice (MDC), highway assignment, and transit assignment procedures make up the bulk of the run time. The run times incorporate the full runs of both the highway and transit models.

After UE Pathfinder was integrated into the overall model stream, model parameters were adjusted to produce the following model boardings by mode:

Subway:	2.1 million
Bus:	1.15 million
Commuter Rail:	240,000
Ferry:	35,000

The subway and bus trips are consistent with previous model results, but the commuter rail trips were a little low. Subsequent investigations by PB and AECOM found various path and data issues in the dataset. Once those were addressed, the commuter rail trips were more in line with expectations.

The transit skims resulting from the integrated model were generated and sent to PB. PB, AECOM, and Caliper performed several validation checks and changes to ensure that path and skim results were reasonable. PB then ran auto-calibration routines to calibrate the MDC model. Updated parameters from PB were then integrated into the BPM GUI.

The transit assignment procedure takes as input the output transit OD trip matrices from the PAP and TOD procedures. The following transit matrices are produced from these procedures:

1_OUT\3_PAP\transit_am.mtx
1_OUT\3_PAP\transit_md.mtx
1_OUT\3_PAP\transit_pm.mtx
1_OUT\3_PAP\transit_nt.mtx

Of these 4 matrices, only the AM matrix is assigned. Each matrix contains the following tables:

- Walk to Transit
- Drive to Transit
- Walk to Commuter Rail
- Drive to Commuter Rail

In the Central version of the model, the trips for each one of these access modes are assigned separately. The results are then summed together to calculate the total flows and congestion. In the updated method, all of the above classes are assigned simultaneously. This ensures the proper levels of flow and congestion levels.

Below is the list of input files into the transit assignment and reporting models:

Parameter Name	Value
[Transit Routes]	(1_Out\5_TNet\NYMTC Merged.rts)
[Transit Links]	(1_Out\5_TNet\mergedlinks.dbd)
[Mode Table]	(0_input\2_TNet\modes_2005.bin)
[Mode Xfer Table]	(0_Input\2_TNet\mxfer_2005.bin)
[All Fare Matrix]	(0_Input\2_Tnet\all_zfare.mtx)
[Transit AM Matrix]	(1_Out\3_PAP\transit_am.mtx)
[AM Transit Assignment Network]	(1_out\5_TNET\transit_am_assign.tnw)

There are several files that are output from the transit assignment step. These are the standard output files created from the PFUE assignment procedure, and are documented below:

First, the transit assignment model makes a copy of the transit network .TNW file and inserts the multiple classes into them. The specific files are:

Parameter Name:	[AM Transit Assignment Network]
Parameter File:	1_out\5_TNET\transit_am_assign.tnw
Description:	Conversion of [AM Transit Network] to include all transit classes

Parameter Name:	[MD Transit Assignment Network]
Parameter File:	1_out\5_TNET\transit_md_assign.tnw
Description:	Conversion of [MD Transit Network] to include all transit classes

After the assignment is performed, several files are output:

Parameter Name:	[AM Transit Flow]
Parameter File:	1_Out\5_TNet\am_transit_flow.bin
Field	**Description**
Route	Route ID number
From_Stop	From stop ID of route link
To_Stop	To stop ID of route link
Centroid	Flag field to identify centroid link
From_MP	Beginning milepost of link
End_MP	End milepost of link
TransitFlow	Passenger flow on link
BaseIVTT	In-vehicle travel time of link
Cost	In-vehicle cost of link, in dollars
Voc	Volume over capacity ratio of link
[Flow_Walk to Transit]	Passenger flow from Walk to Transit class
[Flow Drive to Transit]	Passenger flow from Drive to Transit class
[Flow Walk to Commuter Rail]	Passenger flow from Walk to Commuter Rail class
[Flow Drive to Commuter Rail]	Passenger flow from Drive to Commuter Rail class

Parameter Name:	[AM Transit Walk Flow]
Parameter File:	1_Out\5_TNet\am_transit_walk.bin
Field	**Description**
ID1	Link ID of the underlying transit line database
AB/BA/TOT_WalkFlow	Non-transit link flow
AB/BA/TOT_Access_Walk_Flow	Non-transit link flow used for access
AB/BA/TOT_Xfer_Walk_Flow	Non-transit link flow used for walk transfers
AB/BA/TOT_Egress_Walk_Flow	Non-transit link flow used for walk egress
AB/BA/…Flow_by_Class	All of the above flows separated out by transit class

Parameter Name:	[AM Transit Aggregate Flow]
Parameter File:	1_Out\5_TNet\am_transit_agg.bin
Field	**Description**
ID1	Link ID of the underlying transit line database
AB/BA/_Transit_Flow	Transit flow on all routes aggregated to the transit line
AB/BA_NonTransit	Non-transit link flow
AB/BA_TotalFlow	Transit flow plus non-transit flow
AB/BA/TOT_Access_Walk_Flow	Non-transit link flow used for access
AB/BA/TOT_Xfer_Walk_Flow	Non-transit link flow used for walk transfers
AB/BA/TOT_Egress_Walk_Flow	Non-transit link flow used for walk egress
AB/BA/…Flow_by_Class	All of the above flows separated out by transit class

Parameter Name:	[AM Transit On-Off Flow]

Parameter File:	1_Out\5_TNet\am_transit_of.bin
Field	**Description**
STOP	Stop ID
Route	Route ID of stop
ON	Number of boardings at stop
OFF	Number of alightings at stop
DriveAccessOn	Boardings based on drive access
WalkAccessOn	Boardings based on walk access
DirectTransferOn	Boardings based on direct transfer to stop
WalkTransferOn	Boardings based on walk transfer to stop
EgressOff	Alightings based on walk egress from final stop
DirectTransferOff	Alightings based on direct transfer from stop
WalkTransferOff	Alightings based on walk transfer to stop
On/Off…[by class]	Boardings or alightings by above fields separated by class

Transit Reports

The BPM model includes a route reporting macro that reproduces the route report module in the previous version of the BPM model. The route report is generated after the transit assignment process and produces various statistics on the assignment results such as route boardings, cumulative route run times, CBD cordon crossing volumes etc. The current version generates binary tables and dBASE files from TransCAD outputs, which can be more easily queried and processed. These reports outputs are different from the Crystal and display reports generated in the BPM Reports menu.

Report Files Generated

The route report module generates the following files:

1. **Transit Assignment Summary**: This output table contains detailed stop to stop assignment results. For every route, the table contains several records with one record for each successive set of stops (successive mileposts). The structure of the output transit assignment summary table is shown below:

Parameter Name:	[Transit Assignment Summary]
Parameter File:	1_Out\5_TNet\temprte2.bin
Field	**Description**
Route_ID	Route ID number
Route_Name	Name of the route
Mode_ID	The mode ID of the route (varies from 1 to 20)
Cap_AM	The AM Route Capacity
Hway_AM	The AM Route Headway
Stop	The ID of the current stop
Station Name	The location of the current stop
PTZ_ID	The ID of the corresponding PTZ (Premium Transit Zone) station.
FareZone	The zonal fare code to which the stop belongs
From_MP	The milepost of the current stop on the route
To_MP	The milepost of the next stop on the route
Cost	In-vehicle cost of the route segment between the above two mileposts, in dollars
Cumulative_Cost	The In-vehicle of the route segment from the beginning of the route to the next stop on the route (represented by End_MP)
On	The boardings at the current stop
Off	The alightings at the current stop

Field	Description
TransitFlow	The passenger flow between the two mileposts on the route

2. **CBD Cordon Inbound Summary**: This file contains the transit flows by route that enters the Manhattan CBD region. A geographic layer containing the Manhattan CBD region is used as an input to generate this table. This input file has the parameter name [Manhattan CBD Layer] and is stored under "..\..\3_GIS\1_TAZ\Manhattan.dbd".

   The structure of the Cordon Inbound Summary file is shown below:

Parameter Name:	[CBD Cordon Inbound Summary]
Parameter File:	1_Out\5_TNet\CBD_Cordon_Inbound.dbf
Field	**Description**
Route	Route ID
Volume	Passenger or Transit Flow of the route that enters the Manhattan CBD region

3. **CBD Cordon Outbound Summary**: This file contains the transit flows by route that exits the Manhattan CBD region. The structure of the file is:

Parameter Name:	[CBD Cordon Outbound Summary]
Parameter File:	1_Out\5_TNet\CBD_Cordon_Outbound.dbf
Field	**Description**
Route	Route ID
Volume	Passenger or Transit Flow of the route that exits the Manhattan CBD region

4. **PTZ Station Summary File:** This file contains the boardings and alightings at each PTZ Station. The file is generated by aggregating the stop boardings by the PTZ_ID field. The structure of the file is shown below:

Parameter Name:	[PTZ Station Summary]
Parameter File:	1_Out\5_TNet\PTZ_Station_Summary.dbf
Field	**Description**
PTZ_ID	The ID of the PTZ station
Route	Name of one of the routes that passes through a PTZ station
Station	The name of the PTZ station
Ons	The boardings at the PTZ station
Offs	The alightings at the PTZ station

5. **Subway Cordon Summary File:** This file contains the total volumes for subway cordons. Each subway cordon is represented as a section of the subway between two PTZ locations. In order to generate this report, an input file is used that contains the cordon name and the two PTZ stations that make up this cordon. The input file has the following structure:

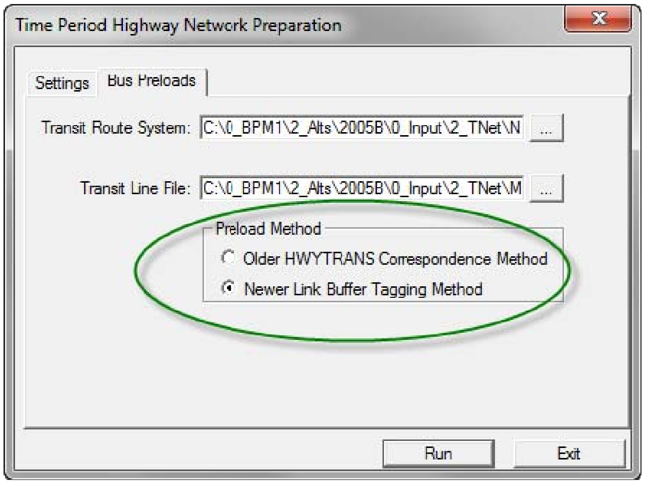
Parameter Name:	[Subway Cordon Input]
Parameter File:	0_Input\2_Tnet\Subway_Cordon_Input.dbf
Field	**Description**
From_PTZ	The starting PTZ station
To_PTZ	The ending PTZ station
Line_Name	The subway cordon defined by the two PTZ stations above

Given the above input file, the transit flow on each subway cordon is computed by aggregating the transit flows of all routes that pass through the cordon. The output summary file is shown below:

Parameter Name:	[Subway Cordon Summary]
Parameter File:	1_Out\2_Tnet\Subway_Cordon_Summary.dbf
Field	**Description**
Line_Name	The subway cordon name
Volume	The transit flow on the subway cordon

BPM Bus Preloads Procedures

There are now two alternate methodologies that can be used to connect the BPM transit network to the highway network, and transfer over bus service flows to preload fields on the highway network. The first method, referred to as the HWYTRANS Correspondence Method in this documentation, is the method used in earlier versions of the BPM model. A second method, called the Link Buffer Tagging Method, was developed to interact better with the updated transit networks developed for this version of the BPM. During the step to prepare time period networks, an option was added that lets the user choose which method to use:



Each method is described below.

HWYTRANS Correspondence Method

The highway to transit correspondence file connects the BPM transit network to the BPM highway network so that bus flows can be included in the highway assignment. The BPM installation includes a base year highway to transit correspondence file. This file should be updated before running the BPM procedures as part of the highway and transit coding procedures for future years. BPM users should edit this file for the following cases:

1. A new highway link has been added to the network, in a location where there is bus service.
2. A new bus route has been added where there previously wasn't any bus service.

If neither of these cases are true, the user does not need to edit the base year highway to transit correspondence file and can use the existing base year file for running the BPM procedures.

The base year highway to transit correspondence file can be found in the following location - C:\0_BPM1\1_Prep\1_HNet\0_Base\Base_HWYTRANS.dbf.

If the user makes updates to this file for the future year scenario, the updated file should be copied and renamed by the user into a scenario specific location. In this case, (Scen) represents the scenario name –
C:\0_BPM1\2_Alts\(Scen)\0_Input\1_Hnet\(Scen)_HWYTRANS.dbf.

The following documentation is split in two sections, the background and development of the BPM Bus Preload process followed by instructions for the user on how to edit the highway to transit correspondence file.

Background and Development of the BPM Bus Preload Process

Connecting the bus network to the highway network via the bus preloads is a three-step process.

1. Creating the Correspondence File
2. Building the Time Period Networks with Bus Preloads
3. Running the Highway Assignment

Step1: Create Correspondence File

The highway to transit correspondence file was created to join all highway line layer links to their corresponding transit line layer links. Although the geographic files are very similar, they are not identical. The transit line layer is larger and contains more detail at the local road level. However, the highway network contains more detail for highways and ramps. Due to these differences in geography, the TransCAD tagging procedure failed to tag the correct transit line layer ID to the highway network in many circumstances. Therefore, many interchanges, highways, and service roads needed to be edited manually and assigned the correct transit line layer ID.

Directionality was an additional issue when working with both networks. Most transit line layer links are given a TransCAD direction of 0, or bi-directional, although the link may be a uni-directional street. To resolve the directional inconsistencies between the highway and transit line layers, a "true" direction has been calculated for each link in the highway network and transit line layer by calculating the arctangent of the difference of the longitude and latitude of the start and end node (discussed in detail later in this section). Two new true directional fields were added to the highway network and transit correspondence file. When the true directions are the same for highway and transit, then all AB Bus flow from the transit line layer is assigned to the highway network as an AB Bus Preload Flow. If the true directions are different, then the AB Bus flow from the transit network is assigned as the BA Bus Preload Flow in the highway network.

Step 2: Building the Time Period Networks with Bus Preloads

To calculate the bus volumes from the transit route system, the utility that builds the time period networks also calculates bus preloads. This utility will loop through all bus routes for each time period, calculating the bus volume for the bus route based on headways and adding the calculated flow to a bus flow field in the transit line layer. The bus volume is calculated by dividing the headway, which is in minutes, by 60 to calculate an hourly bus flow. This is then multiplied by the number of hours for the time period to calculate a period bus flow. This is done for each direction and time period. Finally, using the correspondence file, the bus volumes are appended to the end of the Highway Period Network. In the highway period networks, the bus flow fields, AB_BUS and BA_BUS, are further multiplied by 3 to calculate the Passenger Car Equivalent bus flow.

Step3: Bus Preload Highway Assignment

The highway assignment is done in TransCAD using the User-Equilibrium Multi-Model Assignment with Bus Preloads. The bus preloads are integrated in the highway assignment modules. When the assignment runs, the passenger car equivalents of bus flow will be pre-loaded onto the network and will be used to calculate the VOC after each assignment iteration. The output will have extra fields for the bus volumes, ABBUS and BABUS. The bus volumes will be included into VOC and total flows.

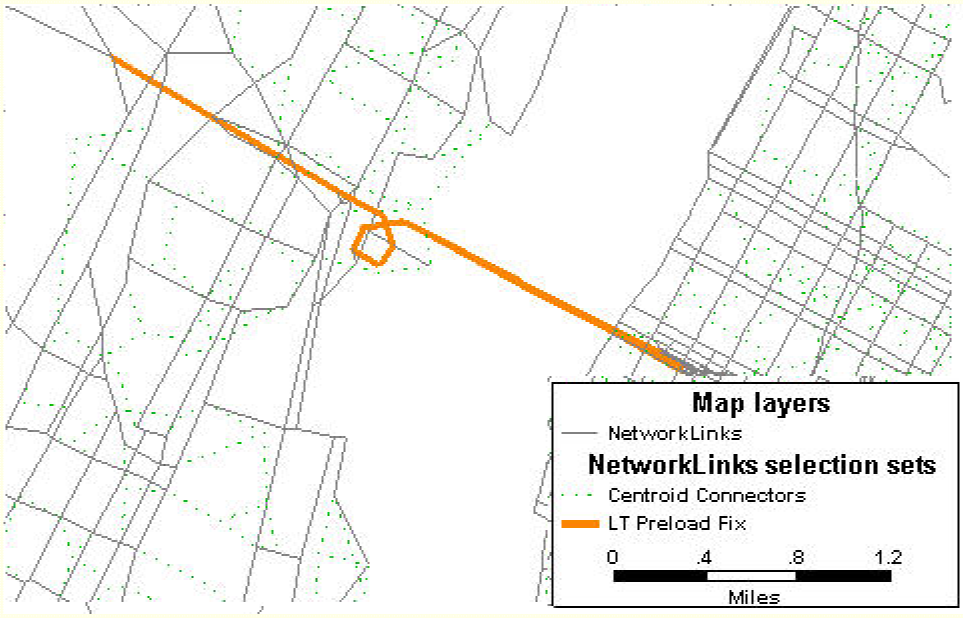
The ABBUS and BABUS fields in the highway assignment output represent the bus flow that is assigned to each link in the AB and BA direction. These fields are not in passenger car equivalents; they represent actual bus flows. In the period geographic files, AB_BUS and BA_BUS have a passenger car equivalence of 3, meaning that the fields are 3 times the actual bus flow.

During Post Assignment reporting, account for the bus volume PCE when calculating VMT and VHT.

Lincoln Tunnel Bus Preload Fix

BPM Update 1: Lincoln Tunnel Bus Preload Fix

TheI-495/XBL/LT/PABT configuration of highway and transit is a complicated one both in terms of network topology and methods, and makes it difficult to accurately and consistently get bus preloads using the hwytrans correspondence method discussed earlier. In 2005 Update, a procedure has been added to overwrite the Lincoln tunnel/XBL bus preloads accounting for XBL-lane exclusion in the highway network (AM period, EB only). A lookup table (*LincolnTunnelPreloads.dbf*) with reasonable representation of the number buses based on bus count data from the PANYNJ is used to generate Lincoln tunnel corridor bus preloads.



The default lookup table is located in "*C:\0_BPM1\0_SetUp\2_LUT\4_HNet*" folder. This file has 2005 hub-bound bus counts with adjustment for XBL buses in AM period. The program first looks for the lookup in scenario specific folder (*C:\0_BPM1\2_Alts\<scenario>\0_Input\1_HNet)* and if the file is not present then it uses the default file. If users want to provide different lookup for different scenario years then they can make a copy of the default file into the scenario folder location and change the bus preload values.

The lookup table has the following fields (1 = yes, 0= no) to help users understand direction of links to fill buspreloads –

EB_AB – if TransCAD link AB direction is EastBound

EB_BA – if TransCAD link BA direction is EastBound

WB_AB – if TransCAD link AB direction is WestBound

WB_BA – if TransCAD link BA direction is WestBound

Only two of the four will have value 1 for bi-directional links and only one field will have value 1 for uni-directional links. If EB_AB =1 then fill the East bound adjusted count in the AB_ambus, AB_mdbus and so on.

Link Buffer Tagging Method for Bus Preloads

In the link buffer tagging method, two-way associations are calculated between highway links and transit links. For each transit link, a nearby highway link is identified. Additionally, for each highway link, a nearby transit link is identified. This is necessary since a many-to-many relationship exists between highway and transit links. That is many transit links can be associated with one highway link, and vice versa.

A buffer methodology is employed in determining corresponding links. For each link, a small band is created, and links in the corresponding layer that intersect that band are identified. Each identified link is compared to the reference link in terms of its exact geography. First, the link is tested to see if it is an exact match. If it is an exact match, then the link is automatically tagged. If it is not an exact match, then it is tested based on a threshold distance. If it is within a threshold distance and it has a similar shape, then the link is tagged. Many-to-one relationships are also tested. If several links are identified within the buffer, then a shortest path is determined to determine the extremities of the nodes. If these match the source link, then all of the links in the path are tagged to the source link.

Only a subset of highway and transit links are tagged. For transit links, only transit links that have routes on them are tagged. For highway links, only highway links that are within a set distance (0.07 miles or 370 feet) of transit links are tagged. In addition, centroid connectors are excluded from tagging.

After link tags are identified in both directions, a join is created between the highway links and the tagged transit links. The bus flows are then transferred from the transit links to the highway links. In addition, a join is created between the transit links and tagged highway links. Bus flows in this joined view are transferred from the transit links to the highway links as well. Links are performed at both ends in order to handle the many-to-many relations between highway links and transit links.

Two correspondence tables are produced as a result of the tagging procedure. Both tables are located in the 0_Input\\1_HNET\ folder. The files are called BUSLINK_TO_HIGHWAY_LINK.BIN and HWYLINK_TO_BUS_LINK.BIN. Thus, each scenario can have its own set of correspondence tables. The fields for each database are described below:

HWYLINK_TO_BUS_LINK.BIN table:

Field	Description
ID	Link ID in the highway link database
TSID	Corresponding link ID in the transit link database
SameTopoDir	Y: Transit link is in the same topological direction as the highway link N: Transit link is in the opposite topological direction
ProcessedLink	1: Highway link is processed and tagged to nearby transit link

BUSLINK_TO_HIGHWAY_LINK.BIN table:

Field	Description
ID	Link ID in the transit link database
HWYID	Corresponding link ID in the highway link database
SameTopoDir	Y: Transit link is in the same topological direction as the highway link N: Transit link is in the opposite topological direction
ProcessedLink	1: Transit link is processed and tagged to nearby highway link

The tagging procedure first checks for the existence of these two tables. If the tables do not exist, then tagging procedure runs for every legitimate transit and highway link found. If these tables exist, the procedure uses the information from the tables to provide the correspondences. For highway and transit links that are not found in the tables, the regular tagging procedure is used.

This procedure can be used when new routes, stops, or highway or transit infrastructure is created. The table is used to provide correspondence with the highway and transit links that have not changed. The tagging procedure is thus used for new highway and transit links, routes, and stops.

Generally, the tagging procedure is a more accurate method to determine correspondences between the highway and transit links. The procedure is not completely accurate, however. Therefore, the correspondence tables should be reviewed for accuracy and adjusted where necessary.

After the link buffer tagging is performed, the step that transfers the bus preloads to the time period networks and the bus preload highway assignment steps are similar to the HWYTRANS method.

Model Performance Improvements

This section of the report documents the transit-related model performance improvements achieved in the updated BPM GUI model. The organization of this section of the report is as follows:

1. Migration of BPM model to TransCAD Version 6
2. Computer hardware used for the BPM GUI
3. Performance enhancements for transit skimming
4. Transit assignment methods
5. Description of chosen transit assignment method, User Equilibrium Pathfinder, and performance enhancements for transit assignment.
6. Validation of transit assignment against AM peak ridership.

Migration of BPM GUI to TransCAD Version 6

TransCAD Version 6 is the forthcoming version of TransCAD, and it includes features that will improve the running times of almost every travel model. Due to the improvements, a decision was made to transfer the entire BPM Flow Chart GUI and model into TransCAD Version 6. Each module of the BPM was tested to ensure that it worked properly in Version 6 and produced results similar to those of the BPM model in TransCAD Version 5. The resulting move into TransCAD Version 6 produced the following model performance enhancements:

- TransCAD Version 6.0 is available as a native 64-bit program that will run on a 64-bit Windows operating system (XP 64, Vista 64, Windows 7 64-bit). A 64-bit program allows access to all of the computer’s available memory. In comparison, TransCAD Version 5 and other 32-bit programs allow access to a maximum of only 2 gigabytes of memory. Therefore, algorithms and datasets that require large amounts of memory will perform better on 64-bit programs versus 32-bit programs if the computer has the available RAM memory.
- In Version 6.0, matrix operations have been multi-threaded. Therefore, a computer with multiple CPUs will use multiple cores to process matrix operations. This can make these operations run many times faster in 6.0 versus 5.0.
- There is a relationship between the multiple threads and memory utilization. For many procedures, running more threads requires more memory.
- TransCAD 6.0 and Revision 4 of TransCAD 5.0 offer an updated UE traffic assignment method called the Bi-Conjugate Method. Proposed by Daneva and Lindberg (2003), the Bi-conjugate descent Frank-Wolfe (FW) method uses a little more memory than the conventional Frank-Wolfe assignment, but not so much that it would typically be a concern today. FW holds two link flow vectors in memory where conjugate descent methods keep three or more link flow vectors in memory, which are used in choosing a more effective search direction than FW. Model run comparisons indicate a very significant improvement in efficiency using the Bi-Conjugate Frank-Wolfe method. The Bi-Conjugate Method, as implemented in TransCAD, cuts the running time by a factor of almost 2 for NYMTC network assignments, when running the model to a relative gap of 0.001. Tests on other examples have shown even more dramatic time savings for smaller gaps.
- TransCAD 6.0 offers an updated transit assignment model called Multi-Class Equilibrium Pathfinder. This model, which is utilized in the BPM GUI, is especially appropriate in that it resolves various issues relevant to the transit services in the NYMTC region.

Computer Hardware used for the BPM GUI

For both the testing and production stages of the model development cycle, the model was run on fairly powerful computers. The best performing machines were the ones running Windows 7 64-bit with a large quantity of available memory and fast Intel i7 processors. These machines were able to take advantage of the fast processing speeds and the high number of processors offered in the i7 chips, the integration of Windows 7 64-bit, and the performance enhancements due to ample available memory. Most of the models were run on two different computers that are specified below:

Brand and Model	Dell Precision T7500
Caliper Assigned Computer Name	HARLEY
Processor	Intel Xeon X5680 Dual i7, 12 Cores @3.33GHz (with hyperthreading capability)
Memory	24GB
OS	Windows 7 64-bit
Available threads	24

Brand and Model	Hewlett Packard HPE-180t
Caliper Assigned Computer Name	HEXAD
Processor	Intel Xeon X980 Core i7, 6 Cores @3.33GHz (with hyperthreading capability)
Memory	24GB
OS	Windows 7 64-bit
Available threads	12

The HARLEY computer is close to but not quite considered a top-of-the-line machine. HEXAD is considered between a mid and top-of-the-line machine except for its available memory. The rest of the memo documents model run times based on these two machine configurations.

Transit Skimming Performance Enhancements

For the BPM Flow Chart GUI model, the transit skimming method used was Pathfinder, which is the similar method used in the Central version of the model. The following run time improvements were observed for the skimming procedure:

1. The model transfer to Version 6.0 dramatically improved transit skim times. With the additional available memory that the 64-bit programming allows, the skimming procedure is no longer memory-constrained and can make full use of multi-threaded programming.
2. Drive access and walk access skims were combined together into a one-step skimming procedure. Pathfinder enables the simultaneous processing of drive-access and walk-access skims, but in the previous versions of the BPM, these skims were still being computed separately. The switch to the simultaneous skims resulted in improved run time performance.

With these two skimming enhancements in place, the skimming portion of the model run time on the HARLEY machine was about 30 minutes. On the HEXAD machine, the run times were about 38 minutes. Distributed computing tests were also performed with the goal of reducing run times. With a base run time of as little as 30 minutes, however, very little model performance was gained by distributing the model. The maintenance overhead of managing the distributed runs (i.e., copying over input files and copying back output files, etc.) almost completely offset the run time reduction achieved through distributed processing. This is because the skimming procedure is naturally only distributed to one other computer. For example, the host computer could run the Walk-Transit and Drive-Transit skim while the slave computer could run the Walk-Commuter Rail and Drive-Commuter Rail skim. In addition, the transit skimming procedure is computed only once within the model stream and is not inside the feedback loop. With the result of an almost negligible run time savings, a decision was made to exclude the distributed processing option for skimming in order to reduce the complexity of the model.

Transit Assignment Performance Enhancements

For transit assignment, the BPM GUI uses the Multi-Class Pathfinder User Equilibrium method. This method, described earlier in this report, completely replaces the iterative multi-step method used in the Central version of the BPM model. The all-inclusive and multi-threaded nature of this procedure contributes to large run time improvements for this component of the model.

The full run time of the multi-class UE Pathfinder Assignment model is about 4-6 hours on either the HARLEY or HEXAD machines. About 10 iterations of assignment are performed, but the number of iterations is user-specified. As a comparison, the Central version of the BPM model performs 4 iterations of Pathfinder assignment under a GISDK loop.

An investigation was conducted into the option of enabling distributed computing for the UE Pathfinder portion of the model. Ultimately, the decision was made not to enable distributed computing for this model due to the following reasons:

- The model performance is already highly efficient. UE Pathfinder runs take about 4-6 hours due to the multi-threaded nature of the assignment. Enabling distributed computing would reduce the times by a small amount only and would make the model and implementation more complex.
- There is no clear separation of the model that can be used to create model parts to distribute. The most likely separations would be by class (Walk-Transit, Drive-Transit, Walk-CR, Drive-CR) and/or by time period. The transit assignment only runs for one time period, however (AM 6-10am), and the multi-class model processes the classes simultaneously and cannot be separated.

Transit Reporting and GIS Display Utilities

Several new transit specific reports and display utilities were added to the GUI model. The display utilities are:

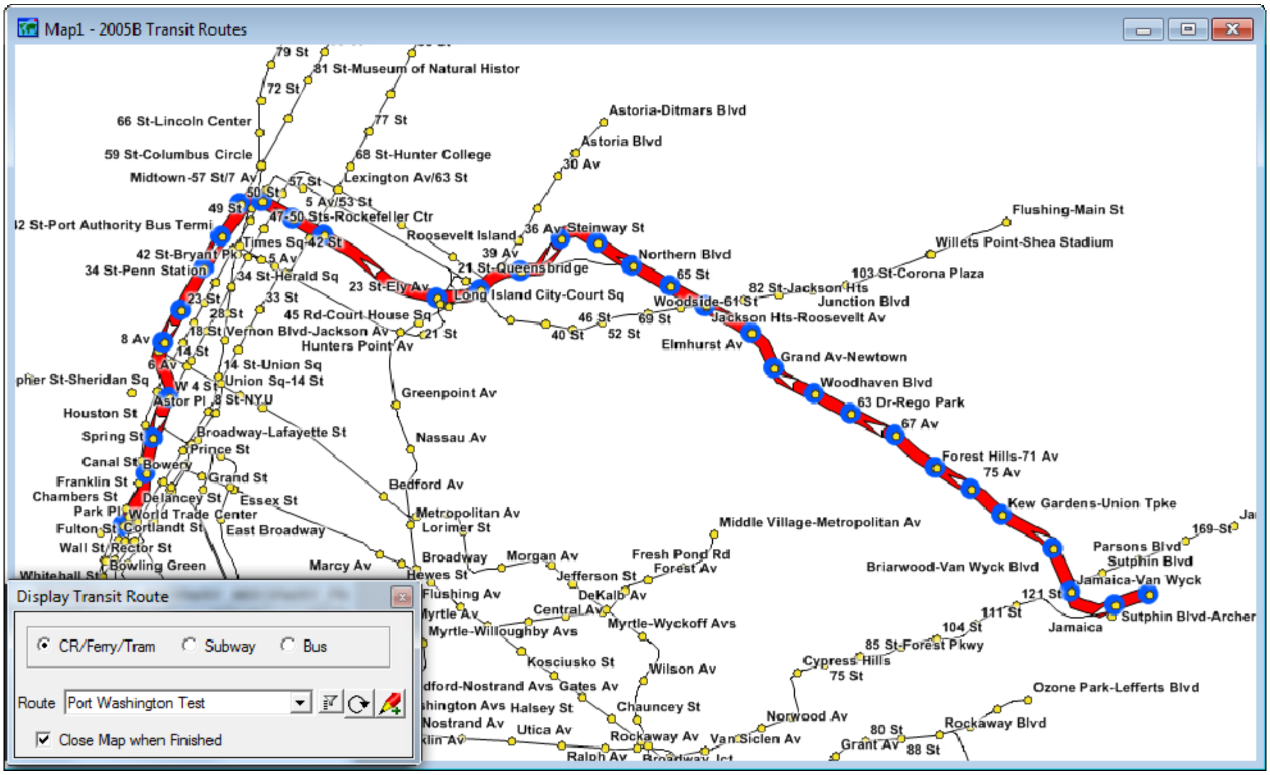
Utility	Description
Display Transit Routes	Utility to assist in editing transit networks
Display Interactive Transit Paths	Utility to assist in displaying transit path costs from user-determined origin-destination pairs
Display Transit Accessibility	Utility to display transit travel time contours
Display Systemwide Transit Flow Results	Utility to display aggregate transit flow results from the transit assignment
Display Transit Route Results	Utility to display route-by-route transit flow results from the transit assignment

Each of these utilities are described below.

Displaying Transit Routes

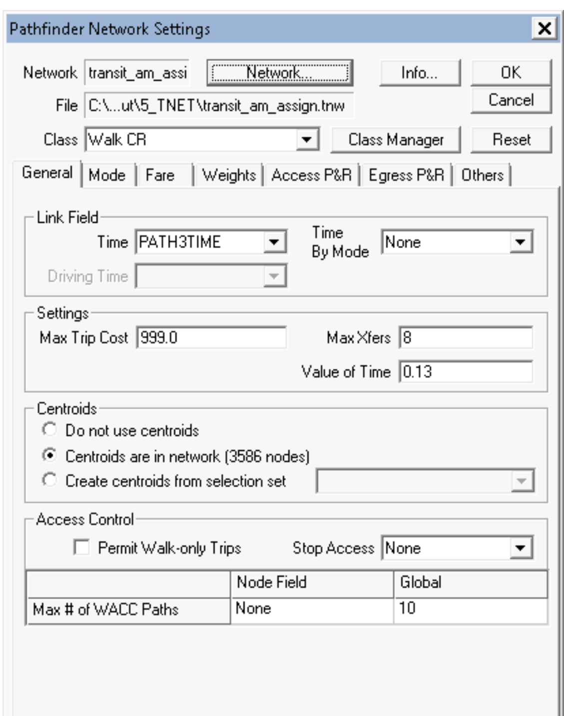
The Display Transit Routes utility quickly lets you display, review, and edit any transit route in the scenario. You would first choose a mode for the route (CR/Ferry/Tram, Subway, or Bus), then choose the route from the mode. The utility will isolate and display the route and the stations that are part of the route. The utility will also isolate all links of the mode. For example, if the subway mode is chosen, then only subway links are displayed. The utility will also display all station entrance links and all transfer links.

Along with displaying the route, the utility displays dataview windows of the route and the route stops of the displayed route. Lastly, the utility includes an option to automatically fill in all missing route and stop information of a selected route with nearby route and stop attributes. In addition to effectively browsing routes, the utility provides good pre-processing and post processing steps to aid in transit route editing. Isolating the route, its stops, and its directionality makes it easier to identify the route to edit. Isolating the mode links makes it easier to select waypoints in the route editor to edit the alignment of the route. Isolating and displaying the route and route stops in their respective dataviews makes it easier to enter route and stop level attributes. Automatically filing in route and stop data makes it easier to enter in attribute data as well. A graphic depicting the Display Transit Routes toolbox is shown below:

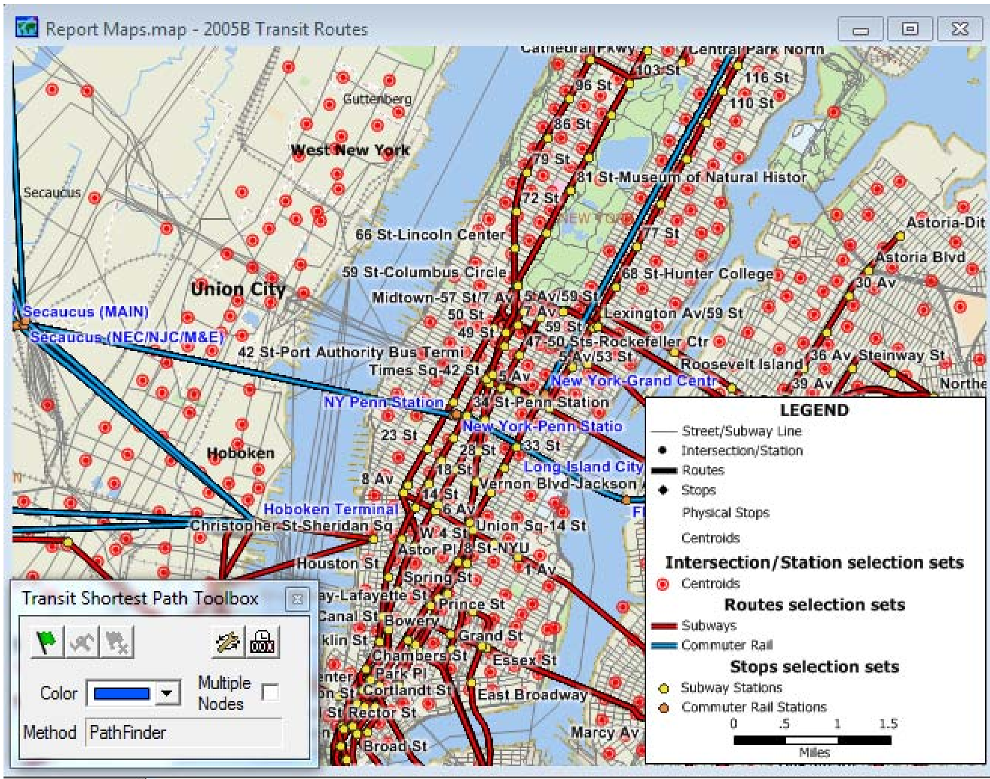


Display Interactive Transit Shortest Paths

The Display Interactive Transit Shortest Paths utility lets the user quickly calculate transit path and cost results from user-specified origin-destination pairs. The utility uses the basic Pathfinder Interactive Shortest Path toolbox that is available in the Standard TransCAD 6.0 software. The utility sets up the toolbox, however, with the correct transit network, transit map, and settings already preloaded:



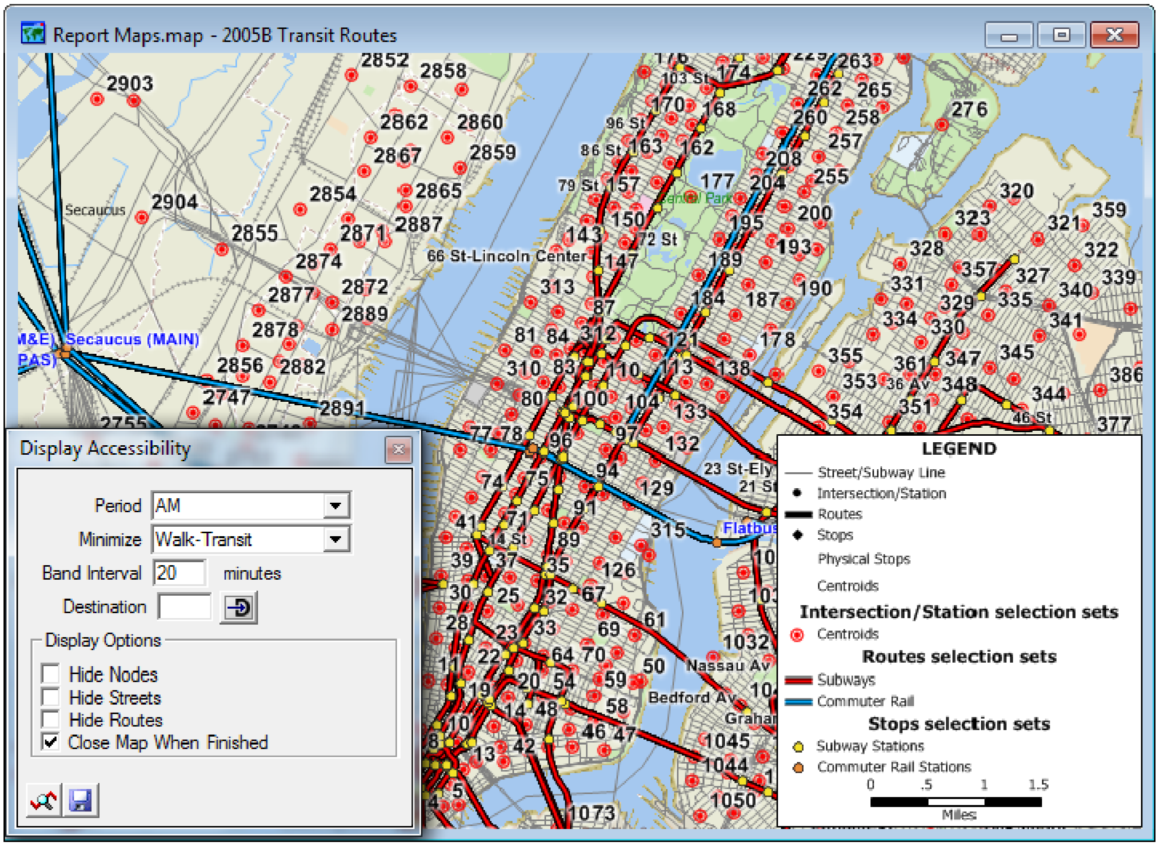
Then the default Pathfinder Shortest Path toolbox will be opened:



Once the map and toolbox are opened, you would create paths using the Transit Shortest Path Toolbox according to the instructions in Chapter 12: Transit Networks, Best Transit Paths, and Path Attributes, section “Solving Transit Best Path Problems” in the TransCAD Travel Demand Manual.

Display Transit Accessibility

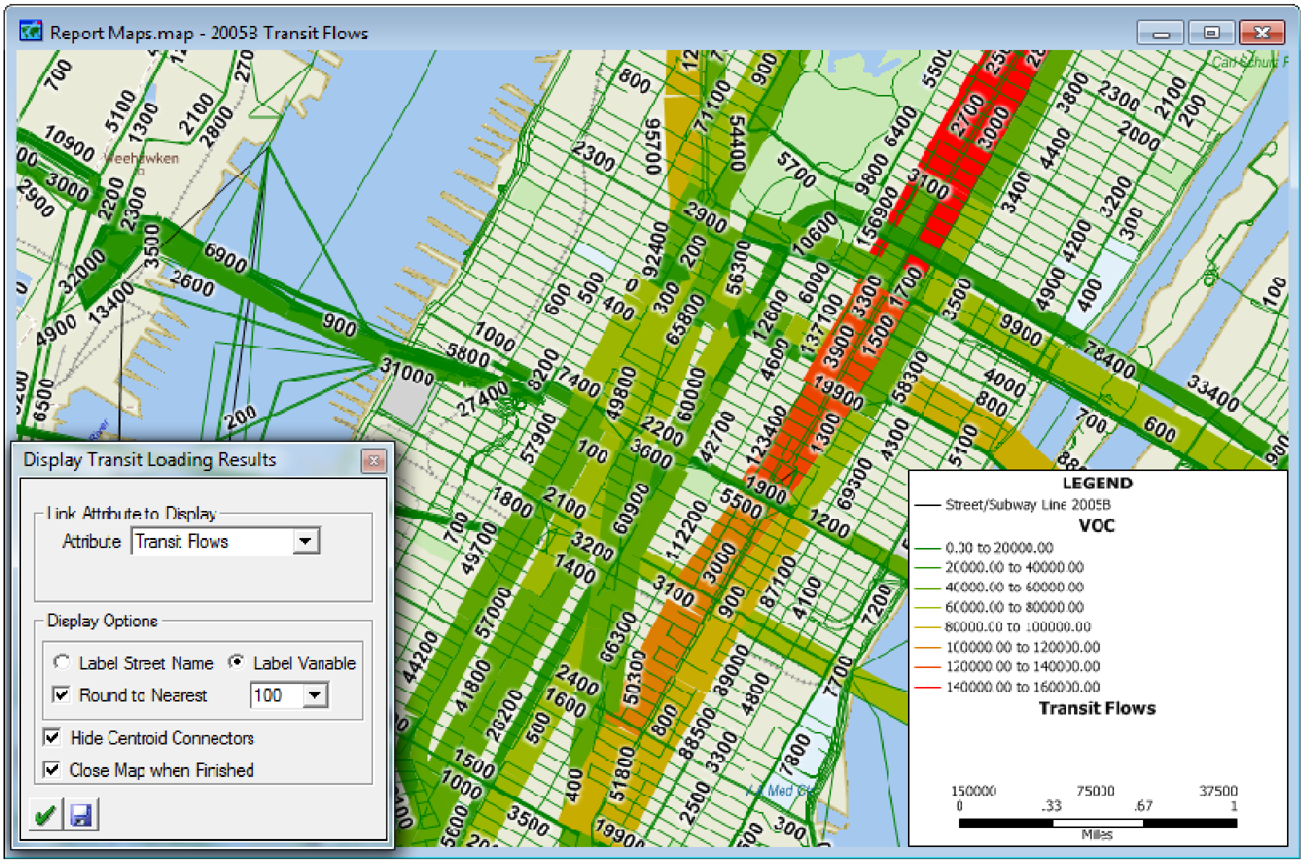
This utility lets the user create transit travel time maps based upon a user-clicked zone:



Once the map and toolbox are opened, the user chooses the time period and transit mode. The user then chooses the band interval and destination zone. This accessibility tool displays transit time bands based on the total time of the path, which includes all walk and/or drive times, waiting times, and in-vehicle travel times. Dwelling times are not included in the total time calculations.

Display System wide Transit Flow Results

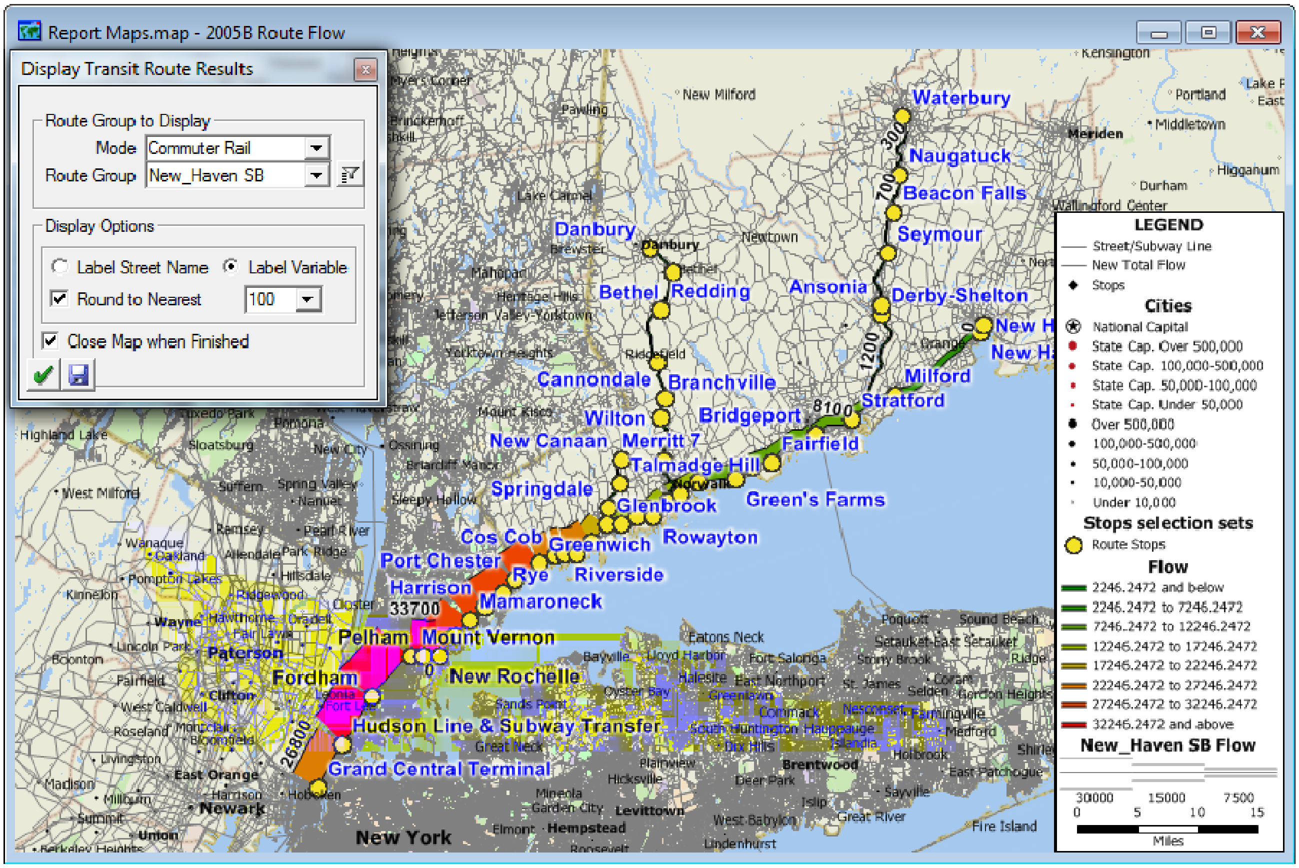
This utility lets the user display output transit and flow volumes for the entire BPM system area. All route level volume flows are summarized to the link they are on. The control dialog box will appear that lets the user choose the transit link attribute to display, the label and rounding to display, and other display options:



Once the map and toolbox are opened, you would choose the transit link attribute to display. There are choices to display the transit flow, the total non-transit flow, the access walk flow, the egress walk flow, or the transfer walk flow. The resulting map will show total transit volume flows for all routes. The flows are shown in a size theme and a color theme. Labels for the volume flows are also displayed.

Display Transit Route Results

This utility lets you display output transit flow volumes for a particular route group. The control dialog box will appear that lets the user choose the mode and route to display transit volume flows for:



Once the map and toolbox are opened, you would choose the transit mode and route group to display. To help filter the route groups, there is an optional filter button that can be used to display only route groups that match an input filter (e.g. Routes beginning with a “G”). You would also choose display options for labeling and rounding. The resulting map will show all links in the route group with their total transit volume flows. The flows are shown in a size theme and a color theme. Labels for the volume flows are also displayed. In addition, all the stations of the chosen route group are displayed.

For each of these transit display utilities, detailed specific information for using these utilities, including interactive examples, can be found in the BPM GUI Users Manual.

Several new transit-specific reports were added to the GUI model. A summary of these reports is shown below:

Transit Report	Description
Transit OD Trip Matrices	• Transit OD trip by time period and access type (WalkSubway, DriveSubway, WalkCR, DriveCR). • All-day transit hub inbound trips by screenline (60th Street, East River, New Jersey)
Transit Trip Length Distributions	Average transit trip lengths by access type (WalkSubway, DriveSubway, WalkCr, DriveCR), time period, and skim variable (Walk Access Time, Drive Access Time, Walk Egress Time, Walk Transfer Time, Initial Wait Time, Transfer Wait Time)
Transit Flows	• Transit boardings, alightings, passenger miles and passenger hours by area • Transit flows by screenline and direction • Both the above reports are displayed as separate report windows and if the aggregation level chosen is an area aggregation • Transit ridership by company, mode, and route group, divided by access type. • Transit boardings and alightings by company, mode, and station, divided by access type.

For each of these transit reports, detailed specific information for creating these reports can be found in the BPM GUI Users Manual.

Model Results

After the transit modules, updated datasets, and updated GUI were inserted into the model, Parsons Brinckerhoff and AECOM calibrated and validated the Base Year 2005 model. The following charts and tables summarize the results after the validation and calibration process.

NYMTC BPM - Highway Assignment Calibration							
BPM GUI Calibration						**Test 30V4 (4)**	
		Compared to Project Screenline Counts					
	Daily Vehicle M	Mean Weekday Count / Volume					
County	Functional Class Group	Scrn. Network Links	SCREEN LINES (Mean Count)	BPM-1 Mean Volume	Diff. BPM - Est.	% Diff. BPM from Est.	% RMSE BPM from Est.
1. Manhattan	1,11,12	42	58,428	59,510	1,082	2%	18%
	2,6,14,16	201	30,549	24,880	(5,669)	-19%	53%
	County Total	255	34,386	29,906	(4,480)	-13%	45%
2. Queens	1,11,12	70	61,374	71,410	10,036	16%	32%
	2,6,14,16	216	19,236	19,023	(213)	-1%	73%
	County Total	288	29,408	31,682	2,274	8%	53%
3. Bronx	1,11,12	61	52,806	51,176	(1,631)	-3%	33%
	2,6,14,16	129	17,402	15,032	(2,370)	-14%	57%
	County Total	227	25,958	23,113	(2,845)	-11%	47%
4. Brooklyn	1,11,12	36	65,777	66,862	1,085	2%	27%
	2,6,14,16	250	18,551	19,116	565	3%	75%
	County Total	297	24,092	24,519	427	2%	59%
5. Staten Island	1,11,12	20	46,594	44,740	(1,853)	-4%	29%
	2,6,14,16	61	18,521	14,289	(4,232)	-23%	51%
	County Total	82	25,289	21,672	(3,617)	-14%	41%
6. Nassau	1,11,12	41	63,944	68,383	4,439	7%	21%
	2,6,14,16	162	18,998	22,136	3,138	17%	69%
	County Total	231	25,564	28,840	3,276	13%	50%
7. Suffolk	1,11,12	31	33,328	37,166	3,837	12%	63%
	2,6,14,16	125	14,276	12,787	(1,488)	-10%	61%
	County Total	177	16,951	16,245	(706)	-4%	69%
8. Westchester	1,11,12	71	38,628	36,136	(2,492)	-6%	20%
	2,6,14,16	133	11,837	8,716	(3,121)	-26%	66%
	County Total	218	20,204	17,521	(2,683)	-13%	38%
9. Rockland	1,11,12	24	42,715	36,025	(6,690)	-16%	26%
	2,6,14,16	85	14,120	11,583	(2,538)	-18%	101%
	County Total	111	20,147	17,178	(2,968)	-15%	70%
10. Putnam	1,11,12	10	24,888	28,707	3,820	15%	18%
	2,6,14,16	25	8,777	5,031	(3,746)	-43%	77%
	County Total	60	9,736	8,546	(1,189)	-12%	57%
NYMTC-10 Region	1,11,12	406	51,583	53,189	1,606	3%	29%
	2,6,14,16	1,387	18,864	17,414	(1,449)	-8%	68%
	7,8,9,17,19	153	9,042	7,088	(1,954)	-22%	104%
	NY-10 Region	**1,946**	**24,918**	**24,066**	**(852)**	**-3%**	**52%**
11. Orange	1,11,12	24	27,578	25,526	(2,051)	-7%	32%
	2,6,14,16	58	14,667	11,744	(2,924)	-20%	59%
	County Total	129	14,280	12,155	(2,125)	-15%	56%
12. Dutchess	1,11,12	10	26,246	22,508	(3,737)	-14%	46%
	2,6,14,16	36	10,774	9,826	(948)	-9%	49%
	County Total	100	8,565	7,681	(884)	-10%	65%
NYMTC-12 Region							
Total (NY, NJ, CT)	1,11,12	440	49,698	50,983	1,285	3%	30%
	2,6,14,16	1,481	18,503	17,008	(1,495)	-8%	67%
	7,8,9,17,19	254	7,556	6,095	(1,461)	-19%	106%
	NY-12 Region	**2,175**	**23,535**	**22,606**	**(929)**	**-4%**	**53%**

BPM GUI Calibration

Test 30V4 (4) vs 2005 Counts

Percent Difference:

Regional Totals — **% Model Volume over Counts**

Inter-County Screenlines

Key	% Model over Counts
Weekday	**0%**
AM Peak	**0%**
PM Peak	**4%**
Midday	**7%**
Night	**-15%**

All Screenlines

Key	# Links	% Model over Counts
1,11,12	440	**3%**
2,6,14,16	1,481	-8%
7,8,9,17,19	254	-19%
NY-10 Region	2,175	**-4%**

Screenline: North of 12 Dutchess

	SB	NB	Total
Day	**1%**	**5%**	**4%**
AM	-28%	-41%	-37%
PM	-12%	-6%	-7%
MD	3%	19%	14%
NT	72%	72%	72%

12 Dutchess — % Model to Counts: *-14%*, *-10%*; in -17%; out -12%

Screenline: North of 11 Orange

	SB	NB	Total
Day	**0%**	**-2%**	**-1%**
AM	-28%	-41%	-34%
PM	-18%	-12%	-15%
MD	3%	6%	4%
NT	67%	50%	58%

Screenline: 11 Orange – 12 Dutchess

	WB	EB	Total
Day	**-16%**	**-13%**	**-15%**
AM	-40%	9%	-19%
PM	-11%	-37%	-25%
MD	-12%	-15%	-14%
NT	8%	1%	4%

Screenline: East of 12 Dutchess

	WB	EB	Total
Day	**-12%**	**-15%**	**-13%**
AM	-25%	-36%	-30%
PM	-19%	-16%	-18%
MD	-13%	-13%	-13%
NT	24%	13%	18%

11 Orange — % Model to Counts: *-7%*, *-15%*; in -12%; out -11%

Screenline: 12 Dutchess – 10 Putnam

	SB	NB	Total
Day	**-24%**	**-26%**	**-25%**
AM	6%	-44%	-21%
PM	-48%	-7%	-29%
MD	-28%	-24%	-26%
NT	-14%	-27%	-21%

10 Putnam — % Model to Counts: *15%*, *-12%*; in -11%; out -11%

Screenline: East of 10 Putnam

	WB	EB	Total
Day	**2%**	**3%**	**2%**
AM	0%	17%	7%
PM	-8%	-14%	-12%
MD	1%	3%	2%
NT	22%	16%	19%

Screenline: New Jersey – 11 Orange

	WB	EB	Total
Day	**-8%**	**-9%**	**-9%**
AM	-36%	-13%	-25%
PM	-4%	-28%	-17%
MD	-4%	-17%	-11%
NT	8%	40%	23%

13 Fairfield

27 New Haven

Screenline: 11 Orange – 8 Westchester

	WB	EB	Total
Day	**12%**	**17%**	**14%**
AM	34%	8%	19%
PM	12%	66%	38%
MD	13%	29%	21%
NT	-25%	-27%	-26%

Screenline: 10 Putnam – 8 Westchester

	SB	NB	Total
Day	**-7%**	**-9%**	**-8%**
AM	20%	-34%	-5%
PM	-38%	5%	-15%
MD	-4%	-7%	-5%
NT	-9%	-3%	-5%

Screenline: 11 Orange – 9 Rockland

	WB/NB	EB/SB	Total
Day	**-25%**	**-23%**	**-24%**
AM	-27%	-23%	-25%
PM	-34%	-31%	-32%
MD	-26%	-22%	-24%
NT	-4%	-13%	-9%

8 Westchester — % Model to Counts: *-6%*, *-13%*; in -2%; out -3%

Screenline: East of 8 Westchester

	WB	EB	Total
Day	**-10%**	**-14%**	**-12%**
AM	-6%	5%	-1%
PM	-4%	-17%	-11%
MD	-13%	-20%	-16%
NT	-19%	-23%	-21%

Screenline: 9 Rockland – 8 Westchester

	WB	EB	Total
Day	**-14%**	**-14%**	**-14%**
AM	-29%	-12%	-19%
PM	16%	-20%	-1%
MD	-17%	-1%	-10%
NT	-30%	-35%	-32%

9 Rockland — % Model to Counts: *-16%*, *-15%*; in -4%; out -4%

KEY

#
County
% Model over Counts
FC: 1,11,12
All Links
Inbound
Outbound

Screenline: 8 Westchester – 3 Bronx

	SB	NB	Total
Day	**4%**	**4%**	**4%**
AM	8%	-2%	3%
PM	0%	19%	9%
MD	17%	8%	12%
NT	-13%	-13%	-13%

Screenline: South of 9 Rockland

	SB	NB	Total
Day	**12%**	**10%**	**11%**
AM	31%	3%	19%
PM	-5%	22%	10%
MD	9%	11%	10%
NT	11%	-2%	4%

BPM: Highway Assignment Validation

Test 30V4 (4)

Screen-line Counts and Flows include all screen-line links, by direction.

3 Bronx — % Model to Counts: *-3%*, *-11%*; in 2%; out 0%

Screenline: East of 3 Bronx

	SB	NB	Total
Day	**-2%**	**7%**	**2%**
AM	27%	-16%	3%
PM	-10%	40%	12%
MD	5%	23%	14%
NT	-33%	-22%	-28%

Screenline: 3 Bronx – 1 Manhattan

	SB	NB	Total
Day	**-3%**	**-2%**	**-2%**
AM	0%	-1%	0%
PM	-5%	17%	7%
MD	15%	8%	11%
NT	-24%	-30%	-27%

New Jersey

2 Queens — % Model over Counts: *16%*, *8%*; in 4%; out 4%

Screenline: 2 Queens – 6 Nassau

	WB	EB	Total
Day	**12%**	**12%**	**12%**
AM	7%	2%	5%
PM	19%	30%	25%
MD	17%	13%	15%
NT	3%	-5%	-1%

6 Nassau — % Model: *7%*, *13%*; in 4%; out 5%

Screenline: 6 Nassau – 7 Suffolk

	WB	EB	Total
Day	**-12%**	**-9%**	**-10%**
AM	0%	-24%	-10%
PM	-20%	1%	-9%
MD	-10%	-12%	-11%
NT	-21%	-4%	-12%

7 Suffolk — % Model: *12%*, *-4%*; in -12%; out -9%

Screenline: 1 Manhattan – 2 Queens

	WB	EB	Total
Day	**-6%**	**-5%**	**-6%**
AM	-6%	34%	8%
PM	-9%	10%	1%
MD	15%	1%	8%
NT	-32%	-40%	-36%

Screenline: New Jersey – 1 Manhattan

	WB	EB	Total
Day	**3%**	**1%**	**2%**
AM	7%	1%	3%
PM	15%	-3%	7%
MD	11%	19%	15%
NT	-19%	-18%	-18%

1 Manhattan — % Model to Counts: *2%*, *-13%*; in 0%; out 0%

Screenline: 2 Queens – 4 Kings

	SB	NB	Total
Day	**-4%**	**-1%**	**-2%**
AM	-2%	5%	1%
PM	5%	8%	7%
MD	7%	5%	6%
NT	-32%	-25%	-28%

Screenline: 1 Manhattan – 4 Kings

	WB	EB	Total
Day	**8%**	**8%**	**8%**
AM	1%	38%	14%
PM	13%	18%	16%
MD	44%	30%	37%
NT	-25%	-31%	-28%

Key to Color Code

High	+ 15%
Slightly Low	-5% to -12%
Consistently Low	-12% to -32%
Very Low	-32% to -58%

Screenline: New Jersey – 5 Richmond

	WB	EB	Total
Day	11%	20%	16%
AM	-13%	50%	16%
PM	46%	-7%	16%
MD	30%	40%	35%
NT	-21%	3%	-8%

5 Richmond — % Model to Counts: *-4%*, *-14%*; in 5%; out 6%

Screenline: 5 Richmond – 4 Kings

	WB	EB	Total
Day	**-10%**	**1%**	**-4%**
AM	-8%	20%	10%
PM	5%	-25%	-8%
MD	-6%	13%	3%
NT	-38%	-12%	-25%

4 Kings — % Model over Counts: *2%*, *2%*; in 0%; out 0%

BPM GUI Calibration - Test 30V4 (4)

DY Total Weekday

	Direction	Daily Counts	Daily Flow	Model minus Counts Diff.	Model minus Counts Percent	Directional Split Counts	Directional Split Flow	Directional Split % Diff.	%HOV
OUTERBRIDGE CROSSING	West-Bound	40,018	35,222	-4,796	-12%	49%	45%	-4%	21%
Middlesex - Richmond	East-Bound	41,090	42,436	1,346	3%	51%	55%	4%	19%
	Total	81,108	77,658	-3,450	-4%	100%	100%		20%
GOETHALS BRIDGE	West-Bound	35,185	49,853	14,668	42%	47%	47%	0%	32%
Union - Richmond	East-Bound	39,954	56,330	16,376	41%	53%	53%	0%	29%
	Total	75,139	106,183	31,044	41%	100%	100%		30%
BAYONNE BRIDGE	West-Bound	10,940	10,317	-623	-6%	45%	41%	-4%	29%
Hudson - Richmond	East-Bound	13,290	14,732	1,442	11%	55%	59%	4%	23%
	Total	24,230	25,049	819	3%	100%	100%		26%
Staten Island Bridges (SIBs) - PANYNJ	West-Bound	86,143	95,392	9,249	11%	48%	46%	-2%	28%
	East-Bound	94,334	113,498	19,164	20%	52%	54%	2%	25%
	Total	180,477	208,891	28,414	16%	100%	100%		26%
HOLLAND TUNNEL	West-Bound	49,992	59,035	9,043	18%	52%	56%	5%	20%
Hudson - New York	East-Bound	46,968	45,906	-1,062	-2%	48%	44%	-5%	23%
	Total	96,960	104,941	7,981	8%	100%	100%		21%
LINCOLN TUNNEL	West-Bound	64,995	67,094	2,099	3%	51%	52%	1%	22%
Hudson - New York	East-Bound	61,460	61,069	-391	-1%	49%	48%	-1%	22%
	Total	126,455	128,164	1,709	1%	100%	100%		22%
G WASHINGTON BRIDGE	West-Bound	156,441	153,875	-2,566	-2%	51%	50%	-1%	26%
Bergen - New York	East-Bound	147,861	152,465	4,604	3%	49%	50%	1%	27%
	Total	304,302	306,339	2,037	1%	100%	100%		27%
Hudson River Crossings (HRX) -PANYNJ	West-Bound	271,428	280,004	8,576	3%	51%	52%	0%	24%
	East-Bound	256,289	259,440	3,151	1%	49%	48%	0%	25%
	Total	527,717	539,444	11,727	2%	100%	100%		24%
TAPPAN ZEE BRIDGE	West-Bound	72,331	61,963	-10,368	-14%	50%	51%	0%	19%
Rockland - Westchester	East-Bound	70,960	60,709	-10,251	-14%	50%	49%	0%	18%
	Total	143,291	122,671	-20,620	-14%	100%	100%		18%
MOUNTAIN BRIDGE RD	West-Bound	8,871	9,899	1,028	12%	46%	45%	-1%	19%
Orange - Westchester	East-Bound	10,499	12,265	1,766	17%	54%	55%	1%	17%
	Total	19,370	22,164	2,794	14%	100%	100%		18%
NEWBURGH BEACON BRIDGE	West-Bound	38,307	32,266	-6,041	-16%	50%	49%	-1%	22%
Orange - Westchester	East-Bound	38,769	33,565	-5,204	-13%	50%	51%	1%	21%
	Total	77,076	65,831	-11,245	-15%	100%	100%		22%
Mid-Hudson Bridges (MHB)	West-Bound	119,509	104,128	-15,381	-13%	50%	49%	0%	20%
Orange - Dutchess	East-Bound	120,228	106,538	-13,690	-11%	50%	51%	0%	19%
	Total	239,737	210,666	-29,071	-12%	100%	100%		19%
VERRAZANO BRIDGE	West-Bound	92,388	82,734	-9,654	-10%	48%	45%	-3%	26%
Kings - Richmond	East-Bound	101,299	102,736	1,437	1%	52%	55%	3%	22%
	Total	193,687	185,470	-8,217	-4%	100%	100%		24%
BROOKLYN BATTERY TUNNEL - MTA	West-Bound	26,276	24,882	-1,394	-5%	54%	57%	4%	55%
Kings - New York	East-Bound	22,767	18,509	-4,258	-19%	46%	43%	-4%	63%
	Total	49,043	43,392	-5,651	-12%	100%	100%		58%
BROOKLYN BRIDGE (F)	West-Bound	68,190	65,164	-3,026	-4%	52%	48%	-4%	17%
Kings - New York	East-Bound	64,020	70,524	6,504	10%	48%	52%	4%	20%
	Total	132,210	135,689	3,479	3%	100%	100%		18%
MANHATTAN BRIDGE (F)	West-Bound	38,989	51,283	12,294	32%	49%	59%	10%	16%
Kings - New York	East-Bound	41,374	35,895	-5,479	-13%	51%	41%	-10%	14%
	Total	80,363	87,178	6,815	8%	100%	100%		15%
WILLIAMSBURG BRIDGE	West-Bound	54,708	62,127	7,419	14%	51%	47%	-4%	20%
Kings - New York	East-Bound	52,322	69,539	17,217	33%	49%	53%	4%	22%
	Total	107,030	131,666	24,636	23%	100%	100%		21%
QUEENS MIDTOWN TUNNEL -MTA	West-Bound	46,309	36,665	-9,644	-21%	54%	57%	3%	43%
	East-Bound	39,754	27,441	-12,313	-31%	46%	43%	-3%	45%
	Total	86,063	64,106	-21,957	-26%	100%	100%		44%
QUEENSBORO BRIDGE (F)	West-Bound	87,635	100,118	12,483	14%	49%	50%	0%	14%
Queens - New York	East-Bound	90,975	102,066	11,091	12%	51%	50%	0%	15%
	Total	178,610	202,184	23,574	13%	100%	100%		15%
TRIBOROUGH BRIDGE (West) -MTA	West-Bound	34,053	21,116	-12,937	-38%	51%	45%	-6%	43%
Queens - New York	East-Bound	33,195	26,159	-7,036	-21%	49%	55%	6%	39%
	Total	67,248	47,274	-19,974	-30%	100%	100%		41%
East River Crossings (ERX) - NYC & MTA	West-Bound	356,160	361,355	5,195	1%	51%	51%	0%	23%
	East-Bound	344,407	350,134	5,727	2%	49%	49%	0%	20%
	Total	700,567	711,489	10,922	2%				4%
TRIBOROUGH BRIDGE (North)	North-Bound	7,884	7,779	-105	-1%	32%	62%	30%	97%
Bronx - New York	South-Bound	16,766	4,790	-11,976	-71%	68%	38%	-30%	93%
	Total	24,650	12,569	-12,081	-49%	100%	100%		95%
TRIBOROUGH BRIDGE (South)	North-Bound	38,533	43,907	5,374	14%	50%	55%	5%	32%
Bronx - Queens	South-Bound	38,724	35,991	-2,733	-7%	50%	45%	-5%	34%
	Total	77,257	79,898	2,641	3%	100%	100%		33%
BRONX WHITESTONE BRIDGE	North-Bound	51,141	49,191	-1,950	-4%	49%	49%	1%	25%
Bronx - Queens	South-Bound	53,918	50,468	-3,450	-6%	51%	51%	-1%	25%
	Total	105,059	99,660	-5,399	-5%	100%	100%		25%
THROGS NECK BRIDGE	North-Bound	56,871	63,150	6,279	11%	49%	51%	1%	29%
Bronx - Queens	South-Bound	58,102	61,016	2,914	5%	51%	49%	-1%	31%
	Total	114,973	124,167	9,194	8%	100%	100%		30%
Bronx Bridges (BB) - MTA	North-Bound	154,429	164,028	9,599	6%	48%	52%	4%	32%
	South-Bound	167,510	152,265	-15,245	-9%	52%	48%	-4%	32%
	Total	321,939	316,293	-5,646	-2%	100%	100%		32%

BPM GUI Calibration - Test 30V4 (4)

DY Total Weekday

	Direction	Daily Counts	Flow	Model minus Counts Diff.	Percent	Directional Split Counts	Flow	% Diff.	%HOV
WILLIS AVENUE BRIDGE - NB	North-Bound	66,972	62,947	-4,025	-6%	100%	100%	0%	18%
Bronx - New York	South-Bound	0	0	0		0%	0%	0%	
	Total	66,972	62,947	-4,025	-6%	100%	100%		18%
3RD AVE BRIDGE - SB	North-Bound	0	0	0		0%	0%	0%	
Bronx - New York	South-Bound	63,356	53,180	-10,176	-16%	100%	100%	0%	19%
	Total	63,356	53,180	-10,176	-16%	100%	100%		19%
MADISON AVENUE BRIDGE	North-Bound	24,544	31,327	6,783	28%	51%	47%	-4%	27%
Bronx - New York	South-Bound	23,853	35,635	11,782	49%	49%	53%	4%	29%
	Total	48,397	66,962	18,565	38%	100%	100%		28%
145TH ST BRIDGE	North-Bound	18,393	13,386	-5,007	-27%	50%	49%	0%	32%
Bronx - New York	South-Bound	18,443	13,657	-4,786	-26%	50%	51%	0%	33%
	Total	36,836	27,043	-9,793	-27%	100%	100%		32%
MACOMBS DAM BRIDGE	North-Bound	20,542	19,266	-1,276	-6%	48%	35%	-13%	30%
Bronx - New York	South-Bound	22,032	35,115	13,083	59%	52%	65%	13%	24%
	Total	42,574	54,381	11,807	28%	100%	100%		26%
CROSS BRONX EXP BRIDGE	North-Bound	92,011	87,248	-4,763	-5%	51%	48%	-3%	27%
Bronx - New York	South-Bound	89,555	96,109	6,554	7%	49%	52%	3%	27%
	Total	181,566	183,357	1,791	1%	100%	100%		27%
WASHINGTON BRIDGE	North-Bound	33,030	25,735	-7,295	-22%	57%	52%	-5%	31%
Bronx - New York	South-Bound	24,989	23,459	-1,530	-6%	43%	48%	5%	31%
	Total	58,019	49,193	-8,826	-15%	100%	100%		31%
W 207TH ST BRIDGE	North-Bound	19,895	29,076	9,181	46%	44%	52%	8%	26%
Bronx - New York	South-Bound	25,043	26,590	1,547	6%	56%	48%	-8%	30%
	Total	44,938	55,666	10,728	24%	100%	100%		28%
BROADWAY AVE BRIDGE	North-Bound	16,514	15,559	-955	-6%	49%	50%	1%	21%
Bronx - New York	South-Bound	17,037	15,412	-1,625	-10%	51%	50%	-1%	18%
	Total	33,551	30,972	-2,579	-8%	100%	100%		19%
HENRY HUDSON PKY BRIDGE	North-Bound	32,745	34,312	1,567	5%	46%	56%	10%	39%
Bronx - New York	South-Bound	38,621	27,253	-11,368	-29%	54%	44%	-10%	41%
	Total	71,366	61,565	-9,801	-14%	100%	100%		40%
Manhattan - Bronx Crossings (MBX)	North-Bound	324,646	318,855	-5,791	-2%	50%	49%	-1%	27%
	South-Bound	322,929	326,411	3,482	1%	50%	51%	1%	27%
	Total	647,575	645,266	-2,309	0%	100%	100%		27%
Free and Tolled Facility Summary									
East River Crossings - NYC & MTA	West_Bound	249,522	278,692	29,170	12%	50%	50%	0%	17%
	East-Bound	248,691	278,025	29,334	12%	50%	50%	0%	18%
** Free Bridges **	Total	498,213	556,717	58,504	12%	100%	100%		17%
East River Crossings - MTA	West-Bound	106,638	82,663	-23,975	-22%	53%	53%	1%	47%
	East-Bound	95,716	72,109	-23,607	-25%	47%	47%	-1%	26%
** Tolled Bridges & Tunnels **	Total	202,354	154,771	-47,583	-24%	100%	100%		-43%
Verrazano Narrows Bridge - MTA	West-Bound	92,388	82,734	-9,654	-10%	48%	45%	-3%	26%
	East-Bound	101,299	102,736	1,437	1%	52%	55%	3%	22%
** Tolled Bridge**	Total	193,687	185,470	-8,217	-4%	100%	100%		24%
East River Crossings - NYC & MTA	West-Bound	448,548	444,089	-4,459	-1%	50%	50%	-1%	24%
	East-Bound	445,706	452,870	7,164	2%	50%	50%	1%	20%
** All Bridges & Tunnels **	Total	894,254	896,959	2,705	0%	100%	100%		8%
Major Crossing Cordon Summary									
Bronx- Manhattan Crossings	North-Bound	291,901	284,543	-7,358	-3%	51%	49%	2%	25%
** Free Bridges **	South-Bound	284,308	299,158	14,850	5%	49%	51%	-2%	26%
	Total	576,209	583,701	7,492	1%	100%	100%	0%	26%
Henry Hudson Bridge - MTA	North-Bound	32,745	34,312	1,567	5%	46%	56%	10%	39%
**Tolled Bridge **	South-Bound	38,621	27,253	-11,368	-29%	54%	44%	-10%	41%
	Total	71,366	61,565	-9,801	-14%	100%	100%	0%	40%
Bronx- Manhattan Crossings	North-Bound	324,646	318,855	-5,791	-2%	50%	49%	-1%	27%
** All Bridges **	South-Bound	322,929	326,411	3,482	1%	50%	51%	1%	27%
	Total	647,575	645,266	-2,309	0%	100%	100%	0%	27%
Bronx- Queens Crossings - MTA	North-Bound	146,545	156,249	9,704	7%	49%	51%	-2%	29%
	South-Bound	150,744	147,475	-3,269	-2%	51%	49%	2%	30%
**Tolled Bridges **	Total	297,289	303,724	6,435	2%	100%	100%	0%	29%
Mid-Hudson Bridges	West_Bound	119,509	104,128	-15,381	-13%	50%	49%	0%	20%
	East-Bound	120,228	106,538	-13,690	-11%	50%	51%	0%	19%
*** Tolled Bridges***	Total	239,737	210,666	-29,071	-12%	100%	100%	0%	19%
Hudson River Crossings -PANYNJ	West_Bound	271,428	280,004	8,576	3%	51%	52%	0%	24%
	East-Bound	256,289	259,440	3,151	1%	49%	48%	0%	25%
** Tolled Bridges & Tunnels **	Total	527,717	539,444	11,727	2%	100%	100%	0%	24%
Staten Island Bridges - PANYNJ	West_Bound	86,143	95,392	9,249	11%	48%	46%	-2%	28%
	East-Bound	94,334	113,498	19,164	20%	52%	54%	2%	25%
** Tolled Bridges**	Total	180,477	208,891	28,414	16%	100%	100%	0%	26%

BPM GUI Calibration - Test 30V4 (4)

AM Peak Period (6-10am)

* bold = peak direction

		6-10 AM		Model minus Counts		Directional Split			
	Direction	**Counts**	**Flow**	**Diff.**	**Percent**	**Counts**	**Flow**	**% Diff.**	**%HOV**
OUTERBRIDGE CROSSING	West-Bound	8,898	6,760	-2,138	-24%	48%	35%	-13%	20%
Middlesex - Richmond	**East-Bound**	**9,820**	**12,713**	**2,893**	**29%**	**52%**	**65%**	**13%**	**16%**
	Total	18,718	19,472	754	4%	100%	100%		17%
GOETHALS BRIDGE	**West-Bound**	**9,972**	**11,101**	**1,129**	**11%**	**56%**	**47%**	**-10%**	**25%**
Union - Richmond	East-Bound	7,711	12,601	4,890	63%	44%	53%	10%	26%
	Total	17,683	23,702	6,019	34%	100%	100%		25%
BAYONNE BR|IDGE	**West-Bound**	**4,456**	**2,416**	**-2,040**	**-46%**	**70%**	**39%**	**-31%**	**20%**
Hudson - Richmond	East-Bound	1,898	3,824	1,926	101%	30%	61%	31%	23%
	Total	6,354	6,241	-113	-2%	100%	100%		22%
Staten Island Bridges (SIBs) - PANYNJ	**West-Bound**	**23,326**	**20,277**	**-3,049**	**-13%**	**55%**	**41%**	**-14%**	**23%**
	East-Bound	19,429	29,138	9,709	50%	45%	59%	14%	21%
	Total	42,755	49,415	6,660	16%	100%	100%		22%
HOLLAND TUNNEL	West-Bound	10,453	10,554	101	1%	46%	46%	0%	22%
Hudson - New York	**East-Bound**	**12,192**	**12,530**	**338**	**3%**	**54%**	**54%**	**0%**	**18%**
	Total	22,645	23,084	439	2%	100%	100%		20%
LINCOLN TUNNEL	West-Bound	8,328	7,939	-389	-5%	30%	31%	0%	19%
Hudson - New York	**East-Bound**	**19,005**	**17,697**	**-1,308**	**-7%**	**70%**	**69%**	**0%**	**19%**
	Total	27,333	25,636	-1,697	-6%	100%	100%		19%
G WASHINGTON BRIDGE	West-Bound	29,363	32,945	3,582	12%	42%	44%	2%	24%
Bergen - New York	**East-Bound**	**39,802**	**41,368**	**1,566**	**4%**	**58%**	**56%**	**-2%**	**22%**
	Total	69,165	74,313	5,148	7%	100%	100%		23%
Hudson River Crossings (HRX) -PANYNJ	West-Bound	48,144	51,438	3,294	7%	40%	42%	1%	23%
	East-Bound	**70,999**	**71,595**	**596**	**1%**	**60%**	**58%**	**-1%**	**20%**
	Total	119,143	123,033	3,890	3%	100%	100%		21%
TAPPAN ZEE BRIDGE	West-Bound	18,661	13,237	-5,424	-29%	44%	38%	-5%	17%
Rockland - Westchester	**East-Bound**	**24,133**	**21,285**	**-2,848**	**-12%**	**56%**	**62%**	**5%**	**15%**
	Total	42,794	34,521	-8,273	-19%	100%	100%		16%
MOUNTAIN BRIDGE RD	West-Bound	2,289	3,066	777	34%	43%	48%	5%	18%
Orange - Westchester	**East-Bound**	**3,076**	**3,308**	**232**	**8%**	**57%**	**52%**	**-5%**	**17%**
	Total	5,365	6,374	1,009	19%	100%	100%		18%
NEWBURGH BEACON BRIDGE	West-Bound	9,866	5,903	-3,963	-40%	56%	41%	-15%	19%
Orange - Westchester	**East-Bound**	**7,708**	**8,372**	**664**	**9%**	**44%**	**59%**	**15%**	**19%**
	Total	17,574	14,275	-3,299	-19%	100%	100%		19%
Mid-Hudson Bridges (MHB)	West-Bound	30,816	22,206	-8,610	-28%	47%	40%	-7%	18%
Orange - Dutchess	**East-Bound**	**34,917**	**32,965**	**-1,952**	**-6%**	**53%**	**60%**	**7%**	**16%**
	Total	65,733	55,171	-10,562	-16%	100%	100%		17%
VERRAZANO BRIDGE	West-Bound	15,512	14,216	-1,296	-8%	35%	29%	-6%	25%
Kings - Richmond	**East-Bound**	**29,146**	**35,019**	**5,873**	**20%**	**65%**	**71%**	**6%**	**18%**
	Total	44,658	49,234	4,576	10%	100%	100%		20%
BROOKLYN BATTERY TUNNEL - MTA	**West-Bound**	**10,788**	**8,788**	**-2,000**	**-19%**	**83%**	**77%**	**-5%**	**50%**
Kings - New York	East-Bound	2,288	2,554	266	12%	17%	23%	5%	63%
	Total	13,076	11,343	-1,733	-13%	100%	100%	140%	53%
BROOKLYN BRIDGE (F)	**West-Bound**	**15,176**	**13,906**	**-1,270**	**-8%**	**59%**	**47%**	**-12%**	**11%**
Kings - New York	East-Bound	10,428	15,380	4,952	47%	41%	53%	12%	16%
	Total	25,604	29,286	3,682	14%	100%	100%		14%
MANHATTAN BRIDGE (F)	**West-Bound**	**10,284**	**13,036**	**2,752**	**27%**	**64%**	**66%**	**1%**	**11%**
Kings - New York	East-Bound	5,690	6,837	1,147	20%	36%	34%	-1%	10%
	Total	15,974	19,872	3,898	24%	100%	100%		10%
WILLIAMSBURG BRIDGE	**West-Bound**	**13,704**	**14,529**	**825**	**6%**	**63%**	**55%**	**-8%**	**18%**
Kings - New York	East-Bound	8,113	11,908	3,795	47%	37%	45%	8%	18%
	Total	21,817	26,437	4,620	21%	100%	100%		18%
QUEENS MIDTOWN TUNNEL -MTA	**West-Bound**	**13,796**	**12,407**	**-1,389**	**-10%**	**73%**	**75%**	**2%**	**33%**
	East-Bound	5,075	4,037	-1,038	-20%	27%	25%	-2%	39%
	Total	18,871	16,443	-2,428	-13%	100%	100%		34%
QUEENSBORO BRIDGE (F)	**West-Bound**	**21,796**	**22,719**	**923**	**4%**	**65%**	**51%**	**-14%**	**10%**
Queens - New York	East-Bound	11,626	21,585	9,959	86%	35%	49%	14%	13%
	Total	33,422	44,304	10,882	33%	100%	100%		11%
TRIBOROUGH BRIDGE (West) -MTA	**West-Bound**	**9,496**	**7,480**	**-2,016**	**-21%**	**61%**	**59%**	**-1%**	**38%**
Queens - New York	East-Bound	6,180	5,119	-1,061	-17%	39%	41%	1%	29%
	Total	15,676	12,599	-3,077	-20%	100%	100%		35%
East River Crossings (ERX) - NYC & MTA	**West-Bound**	**95,040**	**92,865**	**-2,175**	**-2%**	**66%**	**58%**	**-8%**	**20%**
	East-Bound	49,400	67,419	18,019	36%	34%	42%	8%	15%
	Total	144,440	160,284	15,844	11%	100%	100%		17%
TRIBOROUGH BRIDGE (North)	North-Bound	2,011	928	-1,083	-54%	32%	41%	9%	96%
Bronx - New York	**South-Bound**	**4,339**	**1,331**	**-3,008**	**-69%**	**68%**	**59%**	**-9%**	**83%**
	Total	6,350	2,259	-4,091	-64%	100%	100%		88%
TRIBOROUGH BRIDGE (South)	**North-Bound**	**10,004**	**7,669**	**-2,335**	**-23%**	**50%**	**36%**	**-14%**	**31%**
Bronx - Queens	South-Bound	9,849	13,383	3,534	36%	50%	64%	14%	29%
	Total	19,853	21,052	1,199	6%	100%	100%		29%
BRONX WHITESTONE BRIDGE	**North-Bound**	**13,691**	**11,725**	**-1,966**	**-14%**	**56%**	**44%**	**-13%**	**21%**
Bronx - Queens	South-Bound	10,575	15,001	4,426	42%	44%	56%	13%	20%
	Total	24,266	26,727	2,461	10%	100%	100%		21%
THROGS NECK BRIDGE	**North-Bound**	**17,504**	**15,168**	**-2,336**	**-13%**	**58%**	**53%**	**-5%**	**24%**
Bronx - Queens	South-Bound	12,450	13,351	901	7%	42%	47%	5%	29%
	Total	29,954	28,520	-1,434	-5%	100%	100%		26%
Bronx Bridges (BB) - MTA	**North-Bound**	**43,210**	**35,491**	**-7,719**	**-18%**	**54%**	**45%**	**-9%**	**27%**
	South-Bound	37,213	43,067	5,854	16%	46%	55%	9%	27%
	Total	80,423	78,558	-1,865	-2%	100%	100%		27%

BPM GUI Calibration - Test 30V4 (4)

AM Peak Period (6-10am)

		6-10 AM		* bold = peak direction					
				Model minus Counts		Directional Split			
	Direction	Counts	Flow	Diff.	Percent	Counts	Flow	% Diff.	%HOV
WILLIS AVENUE BRIDGE - NB	North-Bound	12,784	10,119	-2,665	-21%	100%	100%	0%	23%
Bronx - New York	**South-Bound**	**0**	**0**	**0**		**0%**	**0%**	**0%**	
	Total	12,784	10,119	-2,665	-21%	100%	100%		23%
3RD AVE BRIDGE - SB	North-Bound	0	0	0		0%	0%	0%	
Bronx - New York	**South-Bound**	**14,691**	**14,518**	**-173**	**-1%**	**100%**	**100%**	**0%**	**15%**
	Total	14,691	14,518	-173	-1%	100%	100%		15%
MADISON AVENUE BRIDGE	North-Bound	4,342	6,698	2,356	54%	40%	43%	3%	31%
Bronx - New York	**South-Bound**	**6,590**	**8,881**	**2,291**	**35%**	**60%**	**57%**	**-3%**	**23%**
	Total	10,932	15,579	4,647	43%	100%	100%		26%
145TH ST BRIDGE	North-Bound	3,097	2,941	-156	-5%	38%	52%	14%	34%
Bronx - New York	**South-Bound**	**5,006**	**2,708**	**-2,298**	**-46%**	**62%**	**48%**	**-14%**	**28%**
	Total	8,103	5,650	-2,453	-30%	100%	100%		31%
MACOMBS DAM BRIDGE	North-Bound	3,842	3,993	151	4%	42%	32%	-10%	28%
Bronx - New York	**South-Bound**	**5,247**	**8,432**	**3,185**	**61%**	**58%**	**68%**	**10%**	**19%**
	Total	9,089	12,425	3,336	37%	100%	100%		22%
CROSS BRONX EXP BRIDGE	North-Bound	19,649	18,643	-1,006	-5%	50%	50%	-1%	21%
Bronx - New York	**South-Bound**	**19,307**	**18,906**	**-401**	**-2%**	**50%**	**50%**	**1%**	**24%**
	Total	38,956	37,549	-1,407	-4%	100%	100%		23%
WASHINGTON BRIDGE	North-Bound	6,941	4,603	-2,338	-34%	57%	47%	-10%	36%
Bronx - New York	**South-Bound**	**5,197**	**5,257**	**60**	**1%**	**43%**	**53%**	**10%**	**30%**
	Total	12,138	9,860	-2,278	-19%	100%	100%		33%
W 207TH ST BRIDGE	North-Bound	3,599	6,172	2,573	71%	39%	50%	11%	25%
Bronx - New York	**South-Bound**	**5,567**	**6,118**	**551**	**10%**	**61%**	**50%**	**-11%**	**25%**
	Total	9,166	12,290	3,124	34%	100%	100%		25%
BROADWAY AVE BRIDGE	North-Bound	2,807	2,664	-143	-5%	40%	34%	-6%	18%
Bronx - New York	**South-Bound**	**4,250**	**5,172**	**922**	**22%**	**60%**	**66%**	**6%**	**13%**
	Total	7,057	7,837	780	11%	100%	100%		15%
HENRY HUDSON PKY BRIDGE	North-Bound	4,726	6,556	1,830	39%	28%	38%	10%	41%
Bronx - New York	**South-Bound**	**12,036**	**10,811**	**-1,225**	**-10%**	**72%**	**62%**	**-10%**	**32%**
	Total	16,762	17,367	605	4%	100%	100%		35%
Manhattan - Bronx Crossings (MBX)	North-Bound	61,787	62,389	602	1%	44%	44%	-1%	27%
	South-Bound	**77,891**	**80,803**	**2,912**	**4%**	**56%**	**56%**	**1%**	**23%**
	Total	139,678	143,193	3,515	3%	100%	100%		25%
Free and Tolled Facility Summary									
East River Crossings - NYC & MTA	**West_Bound**	**60,960**	**64,189**	**3,229**	**5%**	**63%**	**54%**	**-9%**	**12%**
	East-Bound	35,857	55,710	19,853	55%	37%	46%	9%	14%
** Free Bridges **	Total	96,817	119,899	23,082	24%	100%	100%		13%
East River Crossings - MTA	**West-Bound**	**34,080**	**28,676**	**-5,404**	**-16%**	**72%**	**71%**	**-1%**	**39%**
	East-Bound	13,543	11,710	-1,833	-14%	28%	29%	1%	17%
** Tolled Bridges & Tunnels **	Total	47,623	40,385	-7,238	-15%	100%	100%		28%
Verrazano Narrows Bridge - MTA	West-Bound	15,512	14,216	-1,296	-8%	35%	29%	-6%	25%
	East-Bound	**29,146**	**35,019**	**5,873**	**20%**	**65%**	**71%**	**6%**	**18%**
** Tolled Bridge**	Total	44,658	49,234	4,576	10%	100%	100%		20%
East River Crossings - NYC & MTA	**West-Bound**	**110,552**	**107,080**	**-3,472**	**-3%**	**58%**	**51%**	**-7%**	**21%**
	East-Bound	78,546	102,438	23,892	30%	42%	49%	7%	16%
** All Bridges & Tunnels **	Total	189,098	209,518	20,420	11%	100%	100%		18%
Major Crossing Cordon Summary									
Bronx- Manhattan Crossings	North-Bound	57,061	55,834	-1,227	-2%	46%	44%	2%	25%
** Free Bridges **	**South-Bound**	**65,855**	**69,992**	**4,137**	**6%**	**54%**	**56%**	**-2%**	**21%**
	Total	122,916	125,826	2,910	2%	100%	100%	0%	23%
Henry Hudson Bridge - MTA	North-Bound	4,726	6,556	1,830	39%	28%	38%	10%	41%
**Tolled Bridge **	**South-Bound**	**12,036**	**10,811**	**-1,225**	**-10%**	**72%**	**62%**	**-10%**	**32%**
	Total	16,762	17,367	605	4%	100%	100%	0%	35%
Bronx- Manhattan Crossings	North-Bound	61,787	62,389	602	1%	44%	44%	-1%	27%
** All Bridges **	**South-Bound**	**77,891**	**80,803**	**2,912**	**4%**	**56%**	**56%**	**1%**	**23%**
	Total	139,678	143,193	3,515	3%	100%	100%	0%	25%
Bronx- Queens Crossings - MTA	North-Bound	41,199	34,563	-6,636	-16%	56%	45%	10%	25%
	South-Bound	**32,874**	**41,736**	**8,862**	**27%**	**44%**	**55%**	**-10%**	**26%**
**Tolled Bridges **	Total	74,073	76,299	2,226	3%	100%	100%	0%	25%
Mid-Hudson Bridges	West_Bound	30,816	22,206	-8,610	-28%	47%	40%	-7%	18%
	East-Bound	**34,917**	**32,965**	**-1,952**	**-6%**	**53%**	**60%**	**7%**	**16%**
*** Tolled Bridges***	Total	65,733	55,171	-10,562	-16%	100%	100%	0%	17%
Hudson River Crossings -PANYNJ	West_Bound	48,144	51,438	3,294	7%	40%	42%	1%	23%
	East-Bound	**70,999**	**71,595**	**596**	**1%**	**60%**	**58%**	**-1%**	**20%**
** Tolled Bridges & Tunnels **	Total	119,143	123,033	3,890	3%	100%	100%	0%	21%
Staten Island Bridges - PANYNJ	**West_Bound**	**23,326**	**20,277**	**-3,049**	**-13%**	**55%**	**41%**	**-14%**	**23%**
	East-Bound	19,429	29,138	9,709	50%	45%	59%	14%	21%
** Tolled Bridges**	Total	42,755	49,415	6,660	16%	100%	100%	0%	22%

BPM GUI Calibration - Test 30V4 (4)

MD - Midday Period

	Direction	10 AM - 4 PM Counts	Flow	Model minus Counts Diff.	Percent	Directional Split Counts	Flow	% Diff.	%HOV
OUTERBRIDGE CROSSING	West-Bound	12,396	12,250	-146	-1%	51%	45%	-6%	24%
Middlesex - Richmond	East-Bound	11,737	15,028	3,291	28%	49%	55%	6%	20%
	Total	24,133	27,278	3,145	13%	100%	100%		21%
GOETHALS BRIDGE	West-Bound	10,277	16,880	6,603	64%	47%	49%	2%	34%
Union - Richmond	East-Bound	11,608	17,732	6,124	53%	53%	51%	-2%	32%
	Total	21,885	34,612	12,727	58%	100%	100%		33%
BAYONNE BR|IDGE	West-Bound	2,504	3,594	1,090	44%	42%	43%	1%	34%
Hudson - Richmond	East-Bound	3,476	4,704	1,228	35%	58%	57%	-1%	26%
	Total	5,980	8,298	2,318	39%	100%	100%		29%
Staten Island Bridges (SIBs) - PANYNJ	West-Bound	25,177	32,725	7,548	30%	48%	47%	-2%	30%
	East-Bound	26,821	37,464	10,643	40%	52%	53%	2%	26%
	Total	51,998	70,188	18,190	35%	100%	100%		28%
HOLLAND TUNNEL	West-Bound	14,771	16,992	2,221	15%	54%	53%	-1%	22%
Hudson - New York	East-Bound	12,673	15,239	2,566	20%	46%	47%	1%	25%
	Total	27,444	32,231	4,787	17%	100%	100%		23%
LINCOLN TUNNEL	West-Bound	18,315	20,894	2,579	14%	49%	49%	-1%	24%
Hudson - New York	East-Bound	18,895	22,012	3,117	16%	51%	51%	1%	24%
	Total	37,210	42,907	5,697	15%	100%	100%		24%
G WASHINGTON BRIDGE	West-Bound	45,115	48,553	3,438	8%	52%	49%	-3%	29%
Bergen - New York	East-Bound	42,318	50,990	8,672	20%	48%	51%	3%	30%
	Total	87,433	99,542	12,109	14%	100%	100%		29%
Hudson River Crossings (HRX) -PANYNJ	West-Bound	78,201	86,439	8,238	11%	51%	49%	-2%	26%
	East-Bound	73,886	88,241	14,355	19%	49%	51%	2%	28%
	Total	152,087	174,680	22,593	15%	100%	100%		27%
TAPPAN ZEE BRIDGE	West-Bound	24,014	19,931	-4,083	-17%	55%	51%	-4%	21%
Rockland - Westchester	East-Bound	19,488	19,294	-194	-1%	45%	49%	4%	20%
	Total	43,502	39,225	-4,277	-10%	100%	100%		21%
MOUNTAIN BRIDGE RD	West-Bound	2,945	3,317	372	13%	50%	46%	-3%	22%
Orange - Westchester	East-Bound	2,975	3,827	852	29%	50%	54%	3%	19%
	Total	5,920	7,145	1,225	21%	100%	100%		21%
NEWBURGH BEACON BRIDGE	West-Bound	12,718	11,133	-1,585	-12%	50%	50%	1%	25%
Orange - Westchester	East-Bound	12,949	11,024	-1,925	-15%	50%	50%	-1%	24%
	Total	25,667	22,157	-3,510	-14%	100%	100%		24%
Mid-Hudson Bridges (MHB)	West-Bound	39,677	34,382	-5,295	-13%	53%	50%	-3%	23%
Orange - Dutchess	East-Bound	35,412	34,145	-1,267	-4%	47%	50%	3%	21%
	Total	75,089	68,527	-6,562	-9%	100%	100%		22%
VERRAZANO BRIDGE	West-Bound	28,329	26,513	-1,816	-6%	50%	46%	-5%	28%
Kings - Richmond	East-Bound	28,057	31,747	3,690	13%	50%	54%	5%	24%
	Total	56,386	58,260	1,874	3%	100%	100%		26%
BROOKLYN BATTERY TUNNEL - MTA	West-Bound	7,286	11,193	3,907	54%	53%	61%	8%	57%
Kings - New York	East-Bound	6,406	7,216	810	13%	47%	39%	-8%	71%
	Total	13,692	18,408	4,716	34%	100%	100%		63%
BROOKLYN BRIDGE (F)	West-Bound	19,205	22,408	3,203	17%	52%	51%	0%	19%
Kings - New York	East-Bound	17,754	21,125	3,371	19%	48%	49%	0%	22%
	Total	36,959	43,533	6,574	18%	100%	100%		20%
MANHATTAN BRIDGE (F)	West-Bound	11,008	20,281	9,273	84%	52%	62%	10%	18%
Kings - New York	East-Bound	10,063	12,536	2,473	25%	48%	38%	-10%	17%
	Total	21,071	32,817	11,746	56%	100%	100%		18%
WILLIAMSBURG BRIDGE	West-Bound	14,775	21,347	6,572	44%	51%	49%	-2%	23%
Kings - New York	East-Bound	14,133	21,838	7,705	55%	49%	51%	2%	25%
	Total	28,908	43,185	14,277	49%	100%	100%		24%
QUEENS MIDTOWN TUNNEL -MTA	West-Bound	14,728	14,399	-329	-2%	53%	59%	6%	46%
	East-Bound	12,879	10,065	-2,814	-22%	47%	41%	-6%	49%
	Total	27,607	24,463	-3,144	-11%	100%	100%		47%
QUEENSBORO BRIDGE (F)	West-Bound	24,752	34,925	10,173	41%	50%	53%	3%	15%
Queens - New York	East-Bound	24,854	30,934	6,080	24%	50%	47%	-3%	17%
	Total	49,606	65,859	16,253	33%	100%	100%		16%
TRIBOROUGH BRIDGE (West) -MTA	West-Bound	10,533	8,405	-2,128	-20%	48%	50%	1%	46%
Queens - New York	East-Bound	11,313	8,502	-2,811	-25%	52%	50%	-1%	44%
	Total	21,846	16,907	-4,939	-23%	100%	100%		45%
East River Crossings (ERX) - NYC & MTA	West-Bound	102,287	132,958	30,671	30%	51%	54%	3%	26%
	East-Bound	97,402	112,215	14,813	15%	49%	46%	-3%	23%
	Total	199,689	245,172	45,483	23%				4%
TRIBOROUGH BRIDGE (North)	North-Bound	2,563	2,793	230	9%	32%	56%	24%	97%
Bronx - New York	South-Bound	5,412	2,181	-3,231	-60%	68%	44%	-24%	97%
	Total	7,975	4,974	-3,001	-38%	100%	100%		97%
TRIBOROUGH BRIDGE (South)	North-Bound	11,998	15,575	3,577	30%	49%	56%	7%	33%
Bronx - Queens	South-Bound	12,511	12,139	-372	-3%	51%	44%	-7%	36%
	Total	24,509	27,714	3,205	13%	100%	100%		35%
BRONX WHITESTONE BRIDGE	North-Bound	14,772	15,612	840	6%	48%	49%	1%	29%
Bronx - Queens	South-Bound	16,062	16,257	195	1%	52%	51%	-1%	27%
	Total	30,834	31,869	1,035	3%	100%	100%		28%
THROGS NECK BRIDGE	North-Bound	16,765	22,414	5,649	34%	48%	52%	4%	32%
Bronx - Queens	South-Bound	18,334	20,761	2,427	13%	52%	48%	-4%	34%
	Total	35,099	43,175	8,076	23%	100%	100%		33%
Bronx Bridges (BB) - MTA	North-Bound	46,098	56,394	10,296	22%	47%	52%	6%	35%
	South-Bound	52,319	51,338	-981	-2%	53%	48%	-6%	35%
	Total	98,417	107,732	9,315	9%	100%	100%		35%

BPM GUI Calibration - Test 30V4 (4)

MD - Midday Period

	Direction	10 AM - 4 PM Counts	Flow	Model minus Counts Diff.	Percent	Directional Split Counts	Flow	% Diff.	%HOV
WILLIS AVENUE BRIDGE - NB	North-Bound	18,358	18,393	35	0%	100%	100%	0%	18%
Bronx - New York	**South-Bound**	**0**	**0**	**0**		**0%**	**0%**	**0%**	
	Total	18,358	18,393	35	0%	100%	100%		18%
3RD AVE BRIDGE - SB	North-Bound	0	0	0		0%	0%	0%	
Bronx - New York	**South-Bound**	**18,452**	**18,974**	**522**	**3%**	**100%**	**100%**	**0%**	**22%**
	Total	18,452	18,974	522	3%	100%	100%		22%
MADISON AVENUE BRIDGE	North-Bound	6,928	9,254	2,326	34%	50%	44%	-6%	30%
Bronx - New York	**South-Bound**	**6,945**	**11,736**	**4,791**	**69%**	**50%**	**56%**	**6%**	**29%**
	Total	13,873	20,990	7,117	51%	100%	100%		29%
145TH ST BRIDGE	North-Bound	5,899	5,009	-890	-15%	51%	47%	-4%	32%
Bronx - New York	**South-Bound**	**5,647**	**5,637**	**-10**	**0%**	**49%**	**53%**	**4%**	**36%**
	Total	11,546	10,646	-900	-8%	100%	100%		34%
MACOMBS DAM BRIDGE	North-Bound	6,006	6,220	214	4%	47%	33%	-14%	31%
Bronx - New York	**South-Bound**	**6,691**	**12,641**	**5,950**	**89%**	**53%**	**67%**	**14%**	**27%**
	Total	12,697	18,861	6,164	49%	100%	100%		28%
CROSS BRONX EXP BRIDGE	North-Bound	26,365	29,290	2,925	11%	52%	48%	-4%	30%
Bronx - New York	**South-Bound**	**24,355**	**31,829**	**7,474**	**31%**	**48%**	**52%**	**4%**	**30%**
	Total	50,720	61,118	10,398	21%	100%	100%		30%
WASHINGTON BRIDGE	North-Bound	9,197	8,009	-1,188	-13%	53%	50%	-3%	32%
Bronx - New York	**South-Bound**	**7,999**	**7,997**	**-2**	**0%**	**47%**	**50%**	**3%**	**32%**
	Total	17,196	16,007	-1,189	-7%	100%	100%		32%
W 207TH ST BRIDGE	North-Bound	6,273	8,961	2,688	43%	44%	48%	4%	28%
Bronx - New York	**South-Bound**	**7,837**	**9,569**	**1,732**	**22%**	**56%**	**52%**	**-4%**	**31%**
	Total	14,110	18,530	4,420	31%	100%	100%		30%
BROADWAY AVE BRIDGE	North-Bound	5,204	4,545	-659	-13%	49%	47%	-2%	25%
Bronx - New York	**South-Bound**	**5,382**	**5,054**	**-328**	**-6%**	**51%**	**53%**	**2%**	**22%**
	Total	10,586	9,599	-987	-9%	100%	100%		23%
HENRY HUDSON PKY BRIDGE	North-Bound	9,078	11,023	1,945	21%	43%	53%	9%	43%
Bronx - New York	**South-Bound**	**11,921**	**9,941**	**-1,980**	**-17%**	**57%**	**47%**	**-9%**	**45%**
	Total	20,999	20,965	-34	0%	100%	100%		44%
Manhattan - Bronx Crossings (MBX)	North-Bound	93,308	100,705	7,397	8%	49%	47%	-2%	29%
	South-Bound	**95,229**	**113,378**	**18,149**	**19%**	**51%**	**53%**	**2%**	**30%**
	Total	188,537	214,083	25,546	14%	100%	100%		29%

Free and Tolled Facility Summary

	Direction	Counts	Flow	Diff.	Percent	Counts	Flow	% Diff.	%HOV
East River Crossings - NYC & MTA	**West_Bound**	**69,740**	**98,962**	**29,222**	**42%**	**51%**	**53%**	**2%**	**18%**
	East-Bound	66,804	86,432	19,628	29%	49%	47%	-2%	20%
** Free Bridges **	Total	136,544	185,394	48,850	36%	100%	100%		19%
East River Crossings - MTA	**West-Bound**	**32,547**	**33,996**	**1,449**	**4%**	**52%**	**57%**	**5%**	**50%**
	East-Bound	30,598	25,782	-4,816	-16%	48%	43%	-5%	34%
** Tolled Bridges & Tunnels **	Total	63,145	59,778	-3,367	-5%	100%	100%		-42%
Verrazano Narrows Bridge - MTA	West-Bound	28,329	26,513	-1,816	-6%	50%	46%	-5%	28%
	East-Bound	**28,057**	**31,747**	**3,690**	**13%**	**50%**	**54%**	**5%**	**24%**
** Tolled Bridge**	Total	56,386	58,260	1,874	3%	100%	100%		26%
East River Crossings - NYC & MTA	**West-Bound**	**130,616**	**159,470**	**28,854**	**22%**	**51%**	**53%**	**2%**	**27%**
	East-Bound	125,459	143,962	18,503	15%	49%	47%	-2%	23%
** All Bridges & Tunnels **	Total	256,075	303,432	47,357	18%	100%	100%		8%

Major Crossing Cordon Summary

	Direction	Counts	Flow	Diff.	Percent	Counts	Flow	% Diff.	%HOV
Bronx- Manhattan Crossings	North-Bound	84,230	89,682	5,452	6%	50%	46%	4%	27%
** Free Bridges **	**South-Bound**	**83,308**	**103,436**	**20,128**	**24%**	**50%**	**54%**	**-4%**	**28%**
	Total	167,538	193,118	25,580	15%	100%	100%	0%	28%
Henry Hudson Bridge - MTA	North-Bound	9,078	11,023	1,945	21%	43%	53%	9%	43%
**Tolled Bridge **	**South-Bound**	**11,921**	**9,941**	**-1,980**	**-17%**	**57%**	**47%**	**-9%**	**45%**
	Total	20,999	20,965	-34	0%	100%	100%	0%	44%
Bronx- Manhattan Crossings	North-Bound	93,308	100,705	7,397	8%	49%	47%	-2%	29%
** All Bridges **	**South-Bound**	**95,229**	**113,378**	**18,149**	**19%**	**51%**	**53%**	**2%**	**30%**
	Total	188,537	214,083	25,546	14%	100%	100%	0%	29%
Bronx- Queens Crossings - MTA	North-Bound	43,535	53,601	10,066	23%	48%	52%	-4%	32%
	South-Bound	**46,907**	**49,157**	**2,250**	**5%**	**52%**	**48%**	**4%**	**32%**
**Tolled Bridges **	Total	90,442	102,758	12,316	14%	100%	100%	0%	32%
Mid-Hudson Bridges	West_Bound	39,677	34,382	-5,295	-13%	53%	50%	-3%	23%
	East-Bound	**35,412**	**34,145**	**-1,267**	**-4%**	**47%**	**50%**	**3%**	**21%**
*** Tolled Bridges***	Total	75,089	68,527	-6,562	-9%	100%	100%	0%	22%
Hudson River Crossings -PANYNJ	West_Bound	78,201	86,439	8,238	11%	51%	49%	-2%	26%
	East-Bound	**73,886**	**88,241**	**14,355**	**19%**	**49%**	**51%**	**2%**	**28%**
** Tolled Bridges & Tunnels **	Total	152,087	174,680	22,593	15%	100%	100%	0%	27%
Staten Island Bridges - PANYNJ	**West_Bound**	**25,177**	**32,725**	**7,548**	**30%**	**48%**	**47%**	**-2%**	**30%**
	East-Bound	26,821	37,464	10,643	40%	52%	53%	2%	26%
** Tolled Bridges**	Total	51,998	70,188	18,190	35%	100%	100%	0%	28%

BPM GUI Calibration - Test 30V4 (4)				* bold = peak direction					
PM Peak Periods (4-8pm)		4 PM - 8 PM		Model minus Counts		Directional Split			
	Direction	Counts	Flow	Diff.	Percent	Counts	Flow	% Diff.	%HOV
OUTERBRIDGE CROSSING	West-Bound	10,047	11,653	1,606	16%	50%	59%	9%	19%
Middlesex - Richmond	**East-Bound**	**10,229**	**8,245**	**-1,984**	**-19%**	**50%**	**41%**	**-9%**	**22%**
	Total	20,276	19,898	-378	-2%	100%	100%		20%
GOETHALS BRIDGE	**West-Bound**	**7,233**	**12,921**	**5,688**	**79%**	**40%**	**52%**	**12%**	**34%**
Union - Richmond	East-Bound	11,021	11,966	945	9%	60%	48%	-12%	30%
	Total	18,254	24,887	6,633	36%	100%	100%		32%
BAYONNE BR|IDGE	**West-Bound**	**1,677**	**3,112**	**1,435**	**86%**	**27%**	**45%**	**18%**	**30%**
Hudson - Richmond	East-Bound	4,533	3,811	-722	-16%	73%	55%	-18%	23%
	Total	6,210	6,922	712	11%	100%	100%		26%
Staten Island Bridges (SIBs) - PANYNJ	**West-Bound**	**18,957**	**27,686**	**8,729**	**46%**	**42%**	**54%**	**11%**	**27%**
	East-Bound	25,783	24,022	-1,761	-7%	58%	46%	-11%	26%
	Total	44,740	51,708	6,968	16%	100%	100%		27%
HOLLAND TUNNEL	West-Bound	11,078	15,410	4,332	39%	50%	64%	14%	15%
Hudson - New York	**East-Bound**	**10,967**	**8,745**	**-2,222**	**-20%**	**50%**	**36%**	**-14%**	**28%**
	Total	22,045	24,155	2,110	10%	100%	100%		20%
LINCOLN TUNNEL	West-Bound	18,622	23,290	4,668	25%	66%	71%	5%	21%
Hudson - New York	**East-Bound**	**9,416**	**9,403**	**-13**	**0%**	**34%**	**29%**	**-5%**	**24%**
	Total	28,038	32,693	4,655	17%	100%	100%		22%
G WASHINGTON BRIDGE	West-Bound	43,326	45,143	1,817	4%	56%	56%	1%	25%
Bergen - New York	**East-Bound**	**34,504**	**34,894**	**390**	**1%**	**44%**	**44%**	**-1%**	**30%**
	Total	77,830	80,036	2,206	3%	100%	100%		27%
Hudson River Crossings (HRX) -PANYNJ	West-Bound	73,026	83,843	10,817	15%	57%	61%	4%	22%
	East-Bound	**54,887**	**53,042**	**-1,845**	**-3%**	**43%**	**39%**	**-4%**	**29%**
	Total	127,913	136,885	8,972	7%	100%	100%		25%
TAPPAN ZEE BRIDGE	West-Bound	17,432	20,246	2,814	16%	53%	62%	9%	18%
Rockland - Westchester	**East-Bound**	**15,732**	**12,568**	**-3,164**	**-20%**	**47%**	**38%**	**-9%**	**20%**
	Total	33,164	32,814	-350	-1%	100%	100%		19%
MOUNTAIN BRIDGE RD	West-Bound	2,138	2,390	252	12%	51%	41%	-10%	18%
Orange - Westchester	**East-Bound**	**2,030**	**3,371**	**1,341**	**66%**	**49%**	**59%**	**10%**	**15%**
	Total	4,168	5,760	1,592	38%	100%	100%		16%
NEWBURGH BEACON BRIDGE	West-Bound	9,250	8,256	-994	-11%	46%	54%	9%	23%
Orange - Westchester	**East-Bound**	**10,945**	**6,933**	**-4,012**	**-37%**	**54%**	**46%**	**-9%**	**23%**
	Total	20,195	15,189	-5,006	-25%	100%	100%		23%
Mid-Hudson Bridges (MHB)	West-Bound	28,820	30,892	2,072	7%	50%	57%	7%	19%
Orange - Dutchess	**East-Bound**	**28,707**	**22,872**	**-5,835**	**-20%**	**50%**	**43%**	**-7%**	**20%**
	Total	57,527	53,764	-3,763	-7%	100%	100%		20%
VERRAZANO BRIDGE	West-Bound	27,911	29,298	1,387	5%	55%	63%	8%	24%
Kings - Richmond	**East-Bound**	**22,993**	**17,356**	**-5,637**	**-25%**	**45%**	**37%**	**-8%**	**26%**
	Total	50,904	46,654	-4,250	-8%	100%	100%		25%
BROOKLYN BATTERY TUNNEL - MTA	**West-Bound**	**4,625**	**4,709**	**84**	**2%**	**37%**	**36%**	**-1%**	**58%**
Kings - New York	East-Bound	8,027	8,465	438	5%	63%	64%	1%	56%
	Total	12,652	13,174	522	4%	100%	100%		56%
BROOKLYN BRIDGE (F)	**West-Bound**	**13,697**	**14,270**	**573**	**4%**	**48%**	**48%**	**0%**	**13%**
Kings - New York	East-Bound	14,602	15,212	610	4%	52%	52%	0%	14%
	Total	28,299	29,482	1,183	4%	100%	100%		14%
MANHATTAN BRIDGE (F)	**West-Bound**	**6,371**	**9,248**	**2,877**	**45%**	**39%**	**45%**	**6%**	**16%**
Kings - New York	East-Bound	10,175	11,413	1,238	12%	61%	55%	-6%	13%
	Total	16,546	20,662	4,116	25%	100%	100%		15%
WILLIAMSBURG BRIDGE	**West-Bound**	**10,844**	**12,073**	**1,229**	**11%**	**46%**	**39%**	**-7%**	**18%**
Kings - New York	East-Bound	12,691	18,604	5,913	47%	54%	61%	7%	20%
	Total	23,535	30,677	7,142	30%	100%	100%		19%
QUEENS MIDTOWN TUNNEL -MTA	**West-Bound**	**10,151**	**6,875**	**-3,276**	**-32%**	**49%**	**41%**	**-8%**	**48%**
	East-Bound	10,654	9,965	-689	-6%	51%	59%	8%	36%
	Total	20,805	16,840	-3,965	-19%	100%	100%		41%
QUEENSBORO BRIDGE (F)	**West-Bound**	**16,632**	**20,592**	**3,960**	**24%**	**44%**	**45%**	**0%**	**15%**
Queens - New York	East-Bound	20,895	25,508	4,613	22%	56%	55%	0%	13%
	Total	37,527	46,100	8,573	23%	100%	100%		14%
TRIBOROUGH BRIDGE (West) -MTA	**West-Bound**	**7,745**	**3,867**	**-3,878**	**-50%**	**48%**	**31%**	**-16%**	**41%**
Queens - New York	East-Bound	8,549	8,589	40	0%	52%	69%	16%	38%
	Total	16,294	12,456	-3,838	-24%	100%	100%		39%
East River Crossings (ERX) - NYC & MTA	**West-Bound**	**70,065**	**71,633**	**1,568**	**2%**	**45%**	**42%**	**-3%**	**23%**
	East-Bound	85,593	97,757	12,164	14%	55%	58%	3%	19%
	Total	155,658	169,390	13,732	9%				4%
TRIBOROUGH BRIDGE (North)	North-Bound	1,864	3,348	1,484	80%	28%	76%	48%	95%
Bronx - New York	**South-Bound**	**4,747**	**1,033**	**-3,714**	**-78%**	**72%**	**24%**	**-48%**	**96%**
	Total	6,611	4,381	-2,230	-34%	100%	100%		95%
TRIBOROUGH BRIDGE (South)	**North-Bound**	**8,607**	**15,071**	**6,464**	**75%**	**50%**	**66%**	**17%**	**29%**
Bronx - Queens	South-Bound	8,648	7,605	-1,043	-12%	50%	34%	-17%	39%
	Total	17,255	22,675	5,420	31%	100%	100%		32%
BRONX WHITESTONE BRIDGE	**North-Bound**	**11,620**	**14,622**	**3,002**	**26%**	**44%**	**54%**	**11%**	**24%**
Bronx - Queens	South-Bound	15,065	12,383	-2,682	-18%	56%	46%	-11%	29%
	Total	26,685	27,006	321	1%	100%	100%		26%
THROGS NECK BRIDGE	**North-Bound**	**12,147**	**15,572**	**3,425**	**28%**	**42%**	**49%**	**7%**	**30%**
Bronx - Queens	South-Bound	16,606	16,186	-420	-3%	58%	51%	-7%	31%
	Total	28,753	31,758	3,005	10%	100%	100%		30%
Bronx Bridges (BB) - MTA	**North-Bound**	**34,238**	**48,613**	**14,375**	**42%**	**43%**	**57%**	**13%**	**32%**
	South-Bound	45,066	37,207	-7,859	-17%	57%	43%	-13%	33%
	Total	79,304	85,819	6,515	8%	100%	100%		33%

BPM GUI Calibration - Test 30V4 (4)

PM Peak Periods (4-8pm)

* bold = peak direction

	Direction	4 PM - 8 PM Counts	Flow	Model minus Counts: Diff.	Percent	Directional Split: Counts	Flow	% Diff.	%HOV
WILLIS AVENUE BRIDGE - NB	North-Bound	15,999	18,314	2,315	14%	100%	100%	0%	13%
Bronx - New York	South-Bound	0	0	0		0%	0%	0%	
	Total	15,999	18,314	2,315	14%	100%	100%		13%
3RD AVE BRIDGE - SB	North-Bound	0	0	0		0%	0%	0%	
Bronx - New York	South-Bound	13,260	9,943	-3,317	-25%	100%	100%	0%	20%
	Total	13,260	9,943	-3,317	-25%	100%	100%		20%
MADISON AVENUE BRIDGE	North-Bound	6,720	9,574	2,854	42%	56%	58%	3%	22%
Bronx - New York	South-Bound	5,384	6,886	1,502	28%	44%	42%	-3%	34%
	Total	12,104	16,461	4,357	36%	100%	100%		27%
145TH ST BRIDGE	North-Bound	4,478	4,246	-232	-5%	52%	55%	3%	30%
Bronx - New York	South-Bound	4,145	3,512	-633	-15%	48%	45%	-3%	31%
	Total	8,623	7,758	-865	-10%	100%	100%		30%
MACOMBS DAM BRIDGE	North-Bound	4,813	6,025	1,212	25%	50%	44%	-6%	30%
Bronx - New York	South-Bound	4,731	7,519	2,788	59%	50%	56%	6%	24%
	Total	9,544	13,544	4,000	42%	100%	100%		27%
CROSS BRONX EXP BRIDGE	North-Bound	18,201	19,395	1,194	7%	50%	45%	-5%	29%
Bronx - New York	South-Bound	17,906	23,790	5,884	33%	50%	55%	5%	26%
	Total	36,107	43,185	7,078	20%	100%	100%		27%
WASHINGTON BRIDGE	North-Bound	9,190	7,042	-2,148	-23%	60%	58%	-2%	29%
Bronx - New York	South-Bound	6,145	5,158	-987	-16%	40%	42%	2%	28%
	Total	15,335	12,200	-3,135	-20%	100%	100%		29%
W 207TH ST BRIDGE	North-Bound	4,304	8,411	4,107	95%	42%	54%	12%	24%
Bronx - New York	South-Bound	5,834	7,047	1,213	21%	58%	46%	-12%	31%
	Total	10,138	15,459	5,321	52%	100%	100%		27%
BROADWAY AVE BRIDGE	North-Bound	5,076	5,774	698	14%	55%	65%	10%	19%
Bronx - New York	South-Bound	4,185	3,145	-1,040	-25%	45%	35%	-10%	19%
	Total	9,261	8,919	-342	-4%	100%	100%		19%
HENRY HUDSON PKY BRIDGE	North-Bound	10,832	13,486	2,654	24%	51%	73%	22%	34%
Bronx - New York	South-Bound	10,493	4,964	-5,529	-53%	49%	27%	-22%	48%
	Total	21,325	18,449	-2,876	-13%	100%	100%		38%
Manhattan - Bronx Crossings (MBX)	North-Bound	79,613	92,267	12,654	16%	52%	56%	4%	25%
	South-Bound	72,083	71,964	-119	0%	48%	44%	-4%	28%
	Total	151,696	164,231	12,535	8%	100%	100%		26%

Free and Tolled Facility Summary

	Direction	Counts	Flow	Diff.	Percent	Counts	Flow	% Diff.	%HOV
East River Crossings - NYC & MTA	West_Bound	47,544	56,183	8,639	18%	45%	44%	-1%	15%
	East-Bound	58,363	70,737	12,374	21%	55%	56%	1%	15%
** Free Bridges **	Total	105,907	126,920	21,013	20%	100%	100%		15%
East River Crossings - MTA	West-Bound	22,521	15,450	-7,071	-31%	45%	36%	-9%	49%
	East-Bound	27,230	27,020	-210	-1%	55%	64%	9%	31%
** Tolled Bridges & Tunnels **	Total	49,751	42,470	-7,281	-15%	100%	100%		-30%
Verrazano Narrows Bridge - MTA	West-Bound	27,911	29,298	1,387	5%	55%	63%	8%	24%
	East-Bound	22,993	17,356	-5,637	-25%	45%	37%	-8%	26%
** Tolled Bridge**	Total	50,904	46,654	-4,250	-8%	100%	100%		25%
East River Crossings - NYC & MTA	West-Bound	97,976	100,931	2,955	3%	47%	47%	-1%	23%
	East-Bound	108,586	115,113	6,527	6%	53%	53%	1%	20%
** All Bridges & Tunnels **	Total	206,562	216,044	9,482	5%	100%	100%		8%

Major Crossing Cordon Summary

	Direction	Counts	Flow	Diff.	Percent	Counts	Flow	% Diff.	%HOV
Bronx- Manhattan Crossings	North-Bound	68,781	78,782	10,001	15%	53%	54%	-1%	23%
** Free Bridges **	South-Bound	61,590	67,000	5,410	9%	47%	46%	1%	26%
	Total	130,371	145,782	15,411	12%	100%	100%	0%	25%
Henry Hudson Bridge - MTA	North-Bound	10,832	13,486	2,654	24%	51%	73%	22%	34%
**Tolled Bridge **	South-Bound	10,493	4,964	-5,529	-53%	49%	27%	-22%	48%
	Total	21,325	18,449	-2,876	-13%	100%	100%	0%	38%
Bronx- Manhattan Crossings	North-Bound	79,613	92,267	12,654	16%	52%	56%	4%	25%
** All Bridges **	South-Bound	72,083	71,964	-119	0%	48%	44%	-4%	28%
	Total	151,696	164,231	12,535	8%	100%	100%	0%	26%
Bronx- Queens Crossings - MTA	North-Bound	32,374	45,265	12,891	40%	45%	56%	-11%	28%
	South-Bound	40,319	36,173	-4,146	-10%	55%	44%	11%	32%
**Tolled Bridges **	Total	72,693	81,438	8,745	12%	100%	100%	0%	29%
Mid-Hudson Bridges	West_Bound	28,820	30,892	2,072	7%	50%	57%	7%	19%
	East-Bound	28,707	22,872	-5,835	-20%	50%	43%	-7%	20%
*** Tolled Bridges***	Total	57,527	53,764	-3,763	-7%	100%	100%	0%	20%
Hudson River Crossings -PANYNJ	West_Bound	73,026	83,843	10,817	15%	57%	61%	4%	22%
	East-Bound	54,887	53,042	-1,845	-3%	43%	39%	-4%	29%
** Tolled Bridges & Tunnels **	Total	127,913	136,885	8,972	7%	100%	100%	0%	25%
Staten Island Bridges - PANYNJ	West_Bound	18,957	27,686	8,729	46%	42%	54%	11%	27%
	East-Bound	25,783	24,022	-1,761	-7%	58%	46%	-11%	26%
** Tolled Bridges**	Total	44,740	51,708	6,968	16%	100%	100%	0%	27%

BPM GUI Calibration - Test 30V4 (4)				* bold = peak direction					
NT - Night and Early Morning		8PM - 6 AM		Model minus Counts		Directional Split			
	Direction	Counts	Flow	Diff.	Percent	Counts	Flow	% Diff.	%HOV
OUTERBRIDGE CROSSING	West-Bound	8,677	4,560	-4,117	-47%	48%	41%	-7%	20%
Middlesex - Richmond	**East-Bound**	**9,304**	**6,450**	**-2,854**	**-31%**	**52%**	**59%**	**7%**	**21%**
	Total	17,981	11,010	-6,971	-39%	100%	100%		20%
GOETHALS BRIDGE	**West-Bound**	**7,703**	**8,950**	**1,247**	**16%**	**44%**	**39%**	**-6%**	**33%**
Union - Richmond	East-Bound	9,614	14,031	4,417	46%	56%	61%	6%	28%
	Total	17,317	22,982	5,665	33%	100%	100%		30%
BAYONNE BRIDGE	**West-Bound**	**2,303**	**1,195**	**-1,108**	**-48%**	**41%**	**33%**	**-7%**	**32%**
Hudson - Richmond	East-Bound	3,383	2,393	-990	-29%	59%	67%	7%	21%
	Total	5,686	3,588	-2,098	-37%	100%	100%		24%
Staten Island Bridges (SIBs) - PANYNJ	**West-Bound**	**18,683**	**14,705**	**-3,978**	**-21%**	**46%**	**39%**	**-6%**	**29%**
	East-Bound	22,301	22,875	574	3%	54%	61%	6%	25%
	Total	40,984	37,579	-3,405	-8%	100%	100%		27%
HOLLAND TUNNEL	West-Bound	13,690	16,079	2,389	17%	55%	63%	8%	20%
Hudson - New York	**East-Bound**	**11,136**	**9,392**	**-1,744**	**-16%**	**45%**	**37%**	**-8%**	**22%**
	Total	24,826	25,471	645	3%	100%	100%		21%
LINCOLN TUNNEL	West-Bound	19,730	14,971	-4,759	-24%	58%	56%	-3%	21%
Hudson - New York	**East-Bound**	**14,144**	**11,957**	**-2,187**	**-15%**	**42%**	**44%**	**3%**	**21%**
	Total	33,874	26,928	-6,946	-21%	100%	100%		21%
G WASHINGTON BRIDGE	West-Bound	38,637	27,235	-11,402	-30%	55%	52%	-3%	26%
Bergen - New York	**East-Bound**	**31,237**	**25,213**	**-6,024**	**-19%**	**45%**	**48%**	**3%**	**25%**
	Total	69,874	52,448	-17,426	-25%	100%	100%		25%
Hudson River Crossings (HRX) -PANYNJ	West-Bound	72,057	58,285	-13,772	-19%	56%	56%	0%	23%
	East-Bound	**56,517**	**46,562**	**-9,955**	**-18%**	**44%**	**44%**	**0%**	**23%**
	Total	128,574	104,847	-23,727	-18%	100%	100%		23%
TAPPAN ZEE BRIDGE	West-Bound	12,224	8,549	-3,675	-30%	51%	53%	2%	17%
Rockland - Westchester	**East-Bound**	**11,607**	**7,562**	**-4,045**	**-35%**	**49%**	**47%**	**-2%**	**18%**
	Total	23,831	16,110	-7,721	-32%	100%	100%		17%
MOUNTAIN BRIDGE RD	West-Bound	1,499	1,125	-374	-25%	38%	39%	1%	19%
Orange - Westchester	**East-Bound**	**2,418**	**1,759**	**-659**	**-27%**	**62%**	**61%**	**-1%**	**15%**
	Total	3,917	2,885	-1,032	-26%	100%	100%		16%
NEWBURGH BEACON BRIDGE	West-Bound	6,473	6,974	501	8%	47%	49%	2%	19%
Orange - Westchester	**East-Bound**	**7,167**	**7,235**	**68**	**1%**	**53%**	**51%**	**-2%**	**19%**
	Total	13,640	14,209	569	4%	100%	100%		19%
Mid-Hudson Bridges (MHB)	West-Bound	20,196	16,648	-3,548	-18%	49%	50%	1%	18%
Orange - Dutchess	**East-Bound**	**21,192**	**16,556**	**-4,636**	**-22%**	**51%**	**50%**	**-1%**	**18%**
	Total	41,388	33,205	-8,183	-20%	100%	100%		18%
VERRAZANO BRIDGE	West-Bound	20,636	12,708	-7,928	-38%	49%	41%	-9%	26%
Kings - Richmond	**East-Bound**	**21,103**	**18,615**	**-2,488**	**-12%**	**51%**	**59%**	**9%**	**24%**
	Total	41,739	31,322	-10,417	-25%	100%	100%		25%
BROOKLYN BATTERY TUNNEL - MTA	**West-Bound**	**3,577**	**192**	**-3,385**	**-95%**	**37%**	**41%**	**4%**	**86%**
Kings - New York	East-Bound	6,046	274	-5,772	-95%	63%	59%	-4%	91%
	Total	9,623	466	-9,157	-95%	100%	100%		89%
BROOKLYN BRIDGE (F)	**West-Bound**	**20,112**	**14,580**	**-5,532**	**-28%**	**49%**	**44%**	**-5%**	**23%**
Kings - New York	East-Bound	21,236	18,808	-2,428	-11%	51%	56%	5%	25%
	Total	41,348	33,388	-7,960	-19%	100%	100%		24%
MANHATTAN BRIDGE (F)	**West-Bound**	**11,326**	**8,718**	**-2,608**	**-23%**	**42%**	**63%**	**21%**	**20%**
Kings - New York	East-Bound	15,446	5,109	-10,337	-67%	58%	37%	-21%	16%
	Total	26,772	13,826	-12,946	-48%	100%	100%		18%
WILLIAMSBURG BRIDGE	**West-Bound**	**15,385**	**14,178**	**-1,207**	**-8%**	**47%**	**45%**	**-2%**	**22%**
Kings - New York	East-Bound	17,385	17,190	-195	-1%	53%	55%	2%	22%
	Total	32,770	31,368	-1,402	-4%	100%	100%		22%
QUEENS MIDTOWN TUNNEL -MTA	**West-Bound**	**7,634**	**2,985**	**-4,649**	**-61%**	**41%**	**47%**	**6%**	**61%**
	East-Bound	11,146	3,374	-7,772	-70%	59%	53%	-6%	64%
	Total	18,780	6,359	-12,421	-66%	100%	100%		62%
QUEENSBORO BRIDGE (F)	**West-Bound**	**24,455**	**21,883**	**-2,572**	**-11%**	**42%**	**48%**	**6%**	**16%**
Queens - New York	East-Bound	33,600	24,039	-9,561	-28%	58%	52%	-6%	17%
	Total	58,055	45,921	-12,134	-21%	100%	100%		16%
TRIBOROUGH BRIDGE (West) -MTA	**West-Bound**	**6,279**	**1,364**	**-4,915**	**-78%**	**47%**	**26%**	**-21%**	**50%**
Queens - New York	East-Bound	7,153	3,949	-3,204	-45%	53%	74%	21%	44%
	Total	13,432	5,313	-8,119	-60%	100%	100%		46%
East River Crossings (ERX) - NYC & MTA	**West-Bound**	**88,768**	**63,899**	**-24,869**	**-28%**	**44%**	**47%**	**3%**	**22%**
	East-Bound	112,012	72,743	-39,269	-35%	56%	53%	-3%	18%
	Total	200,780	136,642	-64,138	-32%				6%
TRIBOROUGH BRIDGE (North)	North-Bound	1,446	711	-735	-51%	39%	74%	35%	100%
Bronx - New York	**South-Bound**	**2,268**	**244**	**-2,024**	**-89%**	**61%**	**26%**	**-35%**	**99%**
	Total	3,714	955	-2,759	-74%	100%	100%		100%
TRIBOROUGH BRIDGE (South)	**North-Bound**	**7,924**	**5,592**	**-2,332**	**-29%**	**51%**	**66%**	**15%**	**35%**
Bronx - Queens	South-Bound	7,716	2,865	-4,851	-63%	49%	34%	-15%	39%
	Total	15,640	8,457	-7,183	-46%	100%	100%		36%
BRONX WHITESTONE BRIDGE	**North-Bound**	**11,058**	**7,232**	**-3,826**	**-35%**	**48%**	**51%**	**4%**	**24%**
Bronx - Queens	South-Bound	12,216	6,826	-5,390	-44%	52%	49%	-4%	26%
	Total	23,274	14,058	-9,216	-40%	100%	100%		25%
THROGS NECK BRIDGE	**North-Bound**	**10,455**	**9,995**	**-460**	**-4%**	**49%**	**48%**	**-1%**	**29%**
Bronx - Queens	South-Bound	10,712	10,718	6	0%	51%	52%	1%	28%
	Total	21,167	20,714	-453	-2%	100%	100%		29%
Bronx Bridges (BB) - MTA	**North-Bound**	**30,883**	**23,531**	**-7,352**	**-24%**	**48%**	**53%**	**5%**	**31%**
	South-Bound	32,912	20,653	-12,259	-37%	52%	47%	-5%	30%
	Total	63,795	44,184	-19,611	-31%	100%	100%		31%

BPM GUI Calibration - Test 30V4 (4)

NT - Night and Early Morning

* bold = peak direction

		8PM - 6 AM		Model minus Counts		Directional Split			
	Direction	Counts	Flow	Diff.	Percent	Counts	Flow	% Diff.	%HOV
WILLIS AVENUE BRIDGE - NB	North-Bound	19,831	16,121	-3,710	-19%	100%	100%	0%	21%
Bronx - New York	**South-Bound**	**0**	**0**	**0**		**0%**	**0%**	**0%**	
	Total	19,831	16,121	-3,710	-19%	100%	100%		21%
3RD AVE BRIDGE - SB	North-Bound	0	0	0		0%	0%	0%	
Bronx - New York	**South-Bound**	**16,953**	**9,745**	**-7,208**	**-43%**	**100%**	**100%**	**0%**	**18%**
	Total	16,953	9,745	-7,208	-43%	100%	100%		18%
MADISON AVENUE BRIDGE	North-Bound	6,554	5,801	-753	-11%	57%	42%	-15%	24%
Bronx - New York	**South-Bound**	**4,934**	**8,132**	**3,198**	**65%**	**43%**	**58%**	**15%**	**31%**
	Total	11,488	13,933	2,445	21%	100%	100%		28%
145TH ST BRIDGE	North-Bound	4,919	1,190	-3,729	-76%	57%	40%	-18%	27%
Bronx - New York	**South-Bound**	**3,645**	**1,800**	**-1,845**	**-51%**	**43%**	**60%**	**18%**	**33%**
	Total	8,564	2,990	-5,574	-65%	100%	100%		31%
MACOMBS DAM BRIDGE	North-Bound	5,881	3,028	-2,853	-49%	52%	32%	-21%	28%
Bronx - New York	**South-Bound**	**5,363**	**6,524**	**1,161**	**22%**	**48%**	**68%**	**21%**	**27%**
	Total	11,244	9,551	-1,693	-15%	100%	100%		28%
CROSS BRONX EXP BRIDGE	North-Bound	27,796	19,919	-7,877	-28%	50%	48%	-2%	26%
Bronx - New York	**South-Bound**	**27,987**	**21,585**	**-6,402**	**-23%**	**50%**	**52%**	**2%**	**28%**
	Total	55,783	41,504	-14,279	-26%	100%	100%		27%
WASHINGTON BRIDGE	North-Bound	7,702	6,080	-1,622	-21%	58%	55%	-3%	27%
Bronx - New York	**South-Bound**	**5,648**	**5,047**	**-601**	**-11%**	**42%**	**45%**	**3%**	**33%**
	Total	13,350	11,126	-2,224	-17%	100%	100%		30%
W 207TH ST BRIDGE	North-Bound	5,719	5,532	-187	-3%	50%	59%	9%	28%
Bronx - New York	**South-Bound**	**5,805**	**3,856**	**-1,949**	**-34%**	**50%**	**41%**	**-9%**	**30%**
	Total	11,524	9,388	-2,136	-19%	100%	100%		29%
BROADWAY AVE BRIDGE	North-Bound	3,427	2,576	-851	-25%	52%	56%	4%	20%
Bronx - New York	**South-Bound**	**3,220**	**2,041**	**-1,179**	**-37%**	**48%**	**44%**	**-4%**	**16%**
	Total	6,647	4,617	-2,030	-31%	100%	100%		18%
HENRY HUDSON PKY BRIDGE	North-Bound	8,109	3,247	-4,862	-60%	66%	68%	2%	44%
Bronx - New York	**South-Bound**	**4,171**	**1,537**	**-2,634**	**-63%**	**34%**	**32%**	**-2%**	**53%**
	Total	12,280	4,784	-7,496	-61%	100%	100%		47%
Manhattan - Bronx Crossings (MBX)	North-Bound	89,938	63,493	-26,445	-29%	54%	51%	-2%	26%
	South-Bound	**77,726**	**60,267**	**-17,459**	**-22%**	**46%**	**49%**	**2%**	**28%**
	Total	167,664	123,759	-43,905	-26%	100%	100%		27%

Free and Tolled Facility Summary

		Counts	Flow	Diff.	Percent	Counts	Flow	% Diff.	%HOV
East River Crossings - NYC & MTA	**West_Bound**	**71,278**	**59,358**	**-11,920**	**-17%**	**45%**	**48%**	**3%**	**20%**
	East-Bound	87,667	65,146	-22,521	-26%	55%	52%	-3%	20%
** Free Bridges **	Total	158,945	124,504	-34,441	-22%	100%	100%		20%
East River Crossings - MTA	**West-Bound**	**17,490**	**4,541**	**-12,949**	**-74%**	**42%**	**37%**	**-4%**	**59%**
	East-Bound	24,345	7,597	-16,748	-69%	58%	63%	4%	1%
** Tolled Bridges & Tunnels **	Total	41,835	12,138	-29,697	-71%	100%	100%		-144%
Verrazano Narrows Bridge - MTA	West-Bound	20,636	12,708	-7,928	-38%	49%	41%	-9%	26%
	East-Bound	**21,103**	**18,615**	**-2,488**	**-12%**	**51%**	**59%**	**9%**	**24%**
** Tolled Bridge**	Total	41,739	31,322	-10,417	-25%	100%	100%		25%
East River Crossings - NYC & MTA	**West-Bound**	**109,404**	**76,607**	**-32,797**	**-30%**	**45%**	**46%**	**0%**	**23%**
	East-Bound	133,115	91,357	-41,758	-31%	55%	54%	0%	20%
** All Bridges & Tunnels **	Total	242,519	167,964	-74,555	-31%	100%	100%		9%

Major Crossing Cordon Summary

		Counts	Flow	Diff.	Percent	Counts	Flow	% Diff.	%HOV
Bronx- Manhattan Crossings	North-Bound	81,829	60,246	-21,583	-26%	53%	51%	2%	25%
** Free Bridges **	**South-Bound**	**73,555**	**58,730**	**-14,825**	**-20%**	**47%**	**49%**	**-2%**	**27%**
	Total	155,384	118,975	-36,409	-23%	100%	100%	0%	26%
Henry Hudson Bridge - MTA	North-Bound	8,109	3,247	-4,862	-60%	66%	68%	2%	44%
**Tolled Bridge **	**South-Bound**	**4,171**	**1,537**	**-2,634**	**-63%**	**34%**	**32%**	**-2%**	**53%**
	Total	12,280	4,784	-7,496	-61%	100%	100%	0%	47%
Bronx- Manhattan Crossings	North-Bound	89,938	63,493	-26,445	-29%	54%	51%	-2%	26%
** All Bridges **	**South-Bound**	**77,726**	**60,267**	**-17,459**	**-22%**	**46%**	**49%**	**2%**	**28%**
	Total	167,664	123,759	-43,905	-26%	100%	100%	0%	27%
Bronx- Queens Crossings - MTA	North-Bound	29,437	22,820	-6,617	-22%	49%	53%	-4%	29%
	South-Bound	**30,644**	**20,409**	**-10,235**	**-33%**	**51%**	**47%**	**4%**	**29%**
**Tolled Bridges **	Total	60,081	43,229	-16,852	-28%	100%	100%	0%	29%
Mid-Hudson Bridges	West_Bound	20,196	16,648	-3,548	-18%	49%	50%	1%	18%
	East-Bound	**21,192**	**16,556**	**-4,636**	**-22%**	**51%**	**50%**	**-1%**	**18%**
*** Tolled Bridges***	Total	41,388	33,205	-8,183	-20%	100%	100%	0%	18%
Hudson River Crossings -PANYNJ	West_Bound	72,057	58,285	-13,772	-19%	56%	56%	0%	23%
	East-Bound	**56,517**	**46,562**	**-9,955**	**-18%**	**44%**	**44%**	**0%**	**23%**
** Tolled Bridges & Tunnels **	Total	128,574	104,847	-23,727	-18%	100%	100%	0%	23%
Staten Island Bridges - PANYNJ	**West_Bound**	**18,683**	**14,705**	**-3,978**	**-21%**	**46%**	**39%**	**-6%**	**29%**
	East-Bound	22,301	22,875	574	3%	54%	61%	6%	25%
** Tolled Bridges**	Total	40,984	37,579	-3,405	-8%	100%	100%	0%	27%

Scenario: BPM GUI Calibration Test 30V4 (4)

Hub-Bound 2005 (Preliminary) - Daily Inbound

Total - All Transit

Sector		BPM Trips	Counts 05	Error	% Diff
60th St.	1	940,190	902,201	37,989	4%
East River	2	1,276,656	1,244,628	32,028	3%
New Jersey	3	257,702	342,972	-85,270	-25%
		2,474,548	**2,489,801**	**-15,253**	**-1%**

Commuter Rail (only)

Sector		BPM Trips	Counts 05	Error	% Diff
60th St.	1	111,237	97,562	13,675	14%
East River	2	126,553	114,229	12,324	11%
New Jersey	3	70,339	72,364	-2,025	-3%
		308,129	**284,155**	**23,974**	**8%**

Other Transit

Sector		BPM Trips	Counts 05	Error	% Diff
60th St.	1	828,953	804,639	24,314	3%
East River	2	1,150,103	1,130,399	19,704	2%
New Jersey	3	187,363	270,608	-83,245	-31%
		2,166,419	**2,205,646**	**-39,227**	**-2%**

Recommendations

This section of the report recommends future enhancements for the transit sections of the BPM model.

Highway-Transit Network Merging

Currently, the BPM highway and transit networks are on different sets of geographic files. This greatly complicates the process of transferring model and network information between the two datasets. For example, the bus preloading procedure is a complex and inexact process used to transfer bus service flows to the highway network for preload assignment purposes. We recommend that the highway and transit networks be merged onto a common line database. There are several advantages that would arise from this:

1. The bus preload procedure would be much more simple and accurate.
2. Highway congested travel times from the model can be used to estimate bus travel times.
3. Highway network changes will automatically affect the transit network and will not need to be duplicated for the transit network.

Improved Geographic Accuracy and Density of Highway and Transit Networks

The current transit network contains fairly accurate geography inside the 5 borough region, somewhat accurate geography for the rest of New York, and fairly inaccurate stick network geography in New Jersey. In combination with the highway-transit merging recommendation, the networks should be conflated to reflect the most accurate geography possible. Even in the areas where the network has been conflated, much of the network lacks geographic accuracy. In addition, the networks may need to include more links. The figures below compare the NYMTC transit links in green overlayed with NAVTEQ streets and highways (orange, grey, and other colors). The first figure shows the network comparison in Norwalk, CT.

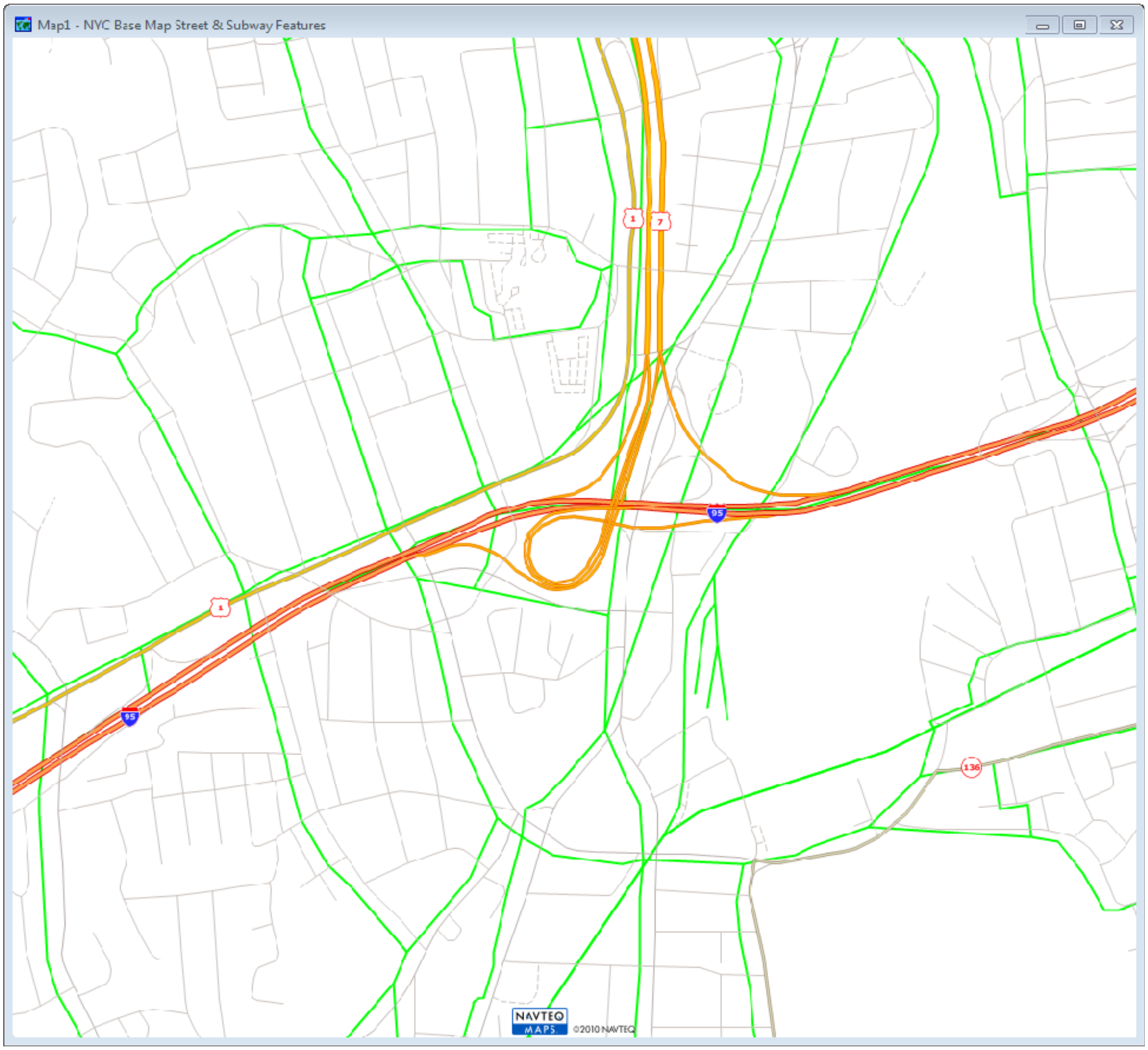


Figure 5: NYMTC and NAVTEQ Network in Norwalk, CT

As can be shown, the NYMTC network is offset slightly from the NAVTEQ network and the freeway geometry is not as detailed as NAVTEQ. The second figure shows the comparison in Newark, NJ near the airport.

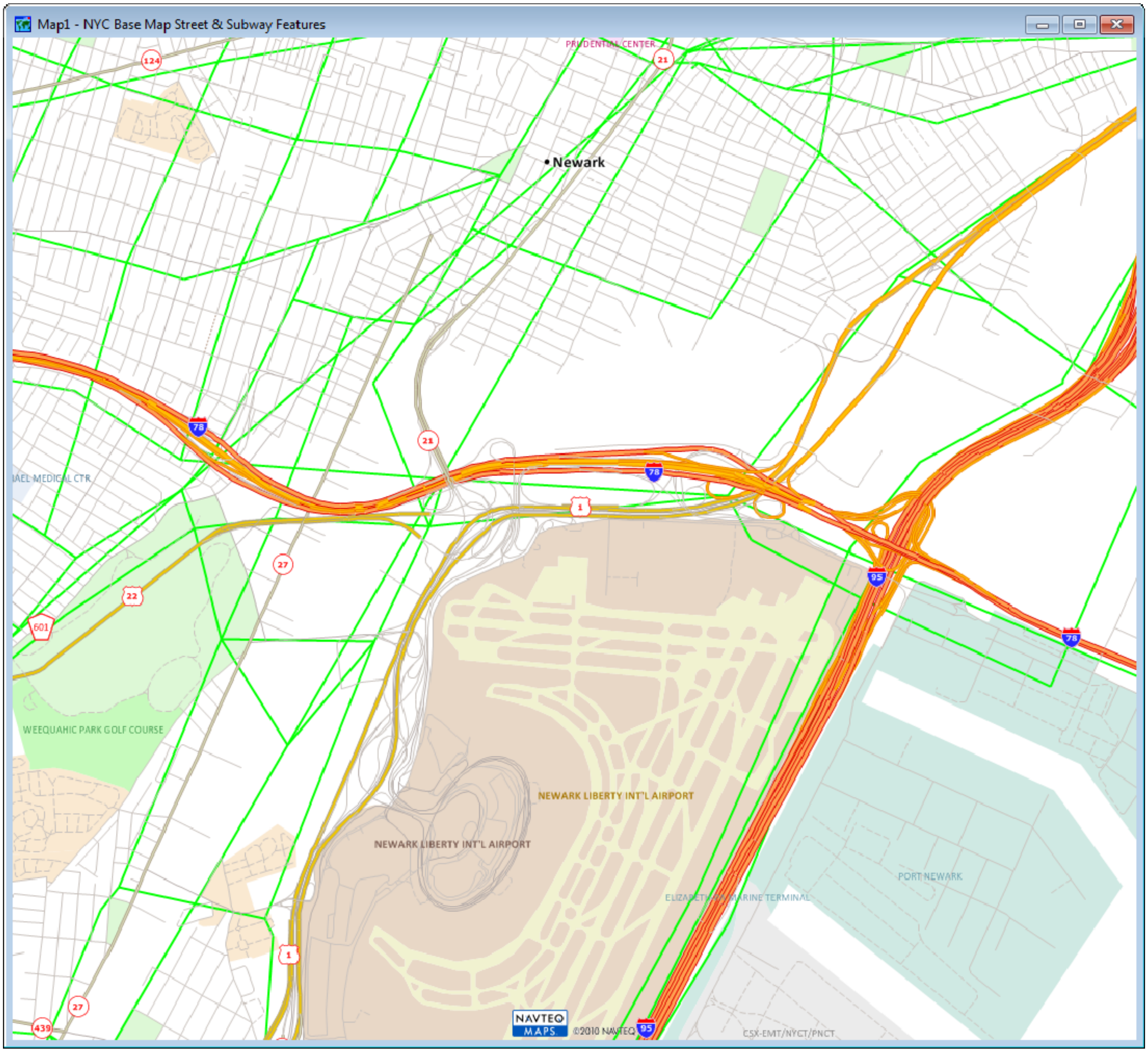


Figure 6: NYMTC and NAVTEQ Network in Newark, NJ

In this part of the network, the links are still represented by stick geometry and very simple representations of freeway links and interchanges. More accurate conflation to NAVTEQ or a similar geographically accurate database or aerial imagery should be performed.

Transit Time Periods

Currently, route frequency and capacity information is being maintained for the 4 time periods in the highway model: AM, MD, PM, and NT. However, transit skimming is only being performed for the peak (AM) and offpeak (MD) periods. In addition, transit assignment is only being performed for the AM peak period. Our recommendation is to expand the model to support transit assignment for more time periods.

Transit Travel Time – Highway Travel Time Interaction

Currently, local bus travel times are calculated as a function of route stop characteristics and the location of the route as per the table below from the PB BPM Final Report:

Table 4.3.2 Parameters for Automatic Bus Travel Time Calculation

Location	Top Speed (Short stop-to-stop segments, mph)	Top Speed (Long stop-to-stop segments, mph)	Acceleration (mph/s)	Dwell Time (sec)	Deceleration (mph/s)
Manhattan	10	18	1.0	20	1.0
Other NYC	10	18	1.2	0	1.2
Suburban NY Counties	7	35	1.4	0	1.4
Suburban NJ Counties	12	50	1.6	0	1.6
Suburban CT Counties	16	55	1.1	20	1.1

Other key parameters used to compute bus travel times include:

- Inter-county segments are average of values for each county
- Breakpoint between short and long stop-to-stop segments is 0.3 miles
- Queens to Manhattan segments (13 mph + 2 minute delay)

There is no connection between highway and transit travel times. We recommend that the calculation of transit travel times take into account highway congested times

Transit User Classes

The BPM GUI model contains the following transit user classes that are both skimmed and assigned:

- Walk-to-Transit
- Drive-to-Transit
- Walk-to-Commuter Rail
- Drive-to-Commuter Rail

The generic transit class includes all non-commuter rail routes. We recommend that the generic user class be separated out into more specific classes such as local bus, express bus, subway, etc. This separation will better describe the operational characteristics of these modes, and the separation may better estimate the intermodal splits between the classes (e.g. local bus vs. subway splits). The separation of user classes will require changes in the MDC procedures.

Transit Master Network Editing

The transit networks in the BPM model are uniquely generated for every Year/Scenario combination. Therefore, any common edits to routes or underlying geography currently need to be applied to every affected scenario and year network separately. We recommend the development of a master network system and dataset that will allow NYMTC to maintain just one master transit network and line database that will have project information for every year and scenario. There are several options available for the implementation of this master network system, and we recommend that NYMTC investigate the available options.