Appendix A: Demand Modeling and Traffic Forecasting

A. INTRODUCTION

This appendix discusses the methodology and results of the market demand analysis and forecast prepared to evaluate the potential for each of the Cross Harbor Freight Program (CHFP) Build Alternatives.

The work addresses three fundamental questions:

- How much freight is moving to, from, within and through the study area today, and by what modes?
- How much freight is likely to move in the future, and by what modes, absent Cross Harbor improvements?
- What are the specific, quantifiable effects of Cross Harbor alternatives on the volumes, modes, routes, and origin-destination patterns of freight movement?

The approach to estimating the market demand for Cross Harbor alternatives addressed each of these questions in turn.

- First, key logistics patterns were identified and base year commodity flow estimates were developed.
- Second, future year commodity flow forecasts were developed.
- Third, estimates of future year demand for each of the Cross Harbor alternatives were generated based on a combination of total volumes and mode/route shares. The Cross Harbor alternatives generate their demand from a variety of sources:
  - Relocation of rail-truck transfer terminals from the west-of-Hudson to the east-of-Hudson region (allowing rail crossings that are now accomplished by truck to remain on rail over a longer distance);
  - Diversion of all-truck freight trips to rail (the analysis of which required the development of a Shipper Mode Choice Model through an extensive process of interviews and surveys); and
  - Changes in rail routing patterns (the analysis of which required the development and use of rail network and highway network models, customized specifically for this project).

  For most alternatives, at least two of the three tools mentioned above were used to estimate demand, as a means of validation.
- Because the Lift On-Lift Off (LOLO)/Roll On-Roll Off (RORO) Container Barge Alternatives do not seek to capture domestic freight, but instead divert a portion of international container traffic traveling to/from Port Newark and Port Elizabeth, analysis of origins and destinations, mode splits, and drayage costs for international container traffic was conducted specifically for these alternatives. This process and results are described in Section G of this appendix.

The overall process is illustrated in **Figure A-1** and explained in detail through the remainder of this appendix.

B. CURRENT FREIGHT FLOWS

FREIGHT LOGISTICS

Logistics and market demand are closely related issues, because decisions about how to move freight—by what mode, and what route—generate demand over the transportation system. The Market Demand study prepared for the CHFP addressed freight logistics as a necessary and appropriate starting point. The analysis requires an identification and description, in qualitative and quantitative terms, of the types of freight movements that occur today to serve shippers and receivers in the east-of-Hudson market, emphasizing the critical differences between direct moves (from shipper to receiver via a single mode), intermodal moves (from shipper to receiver via multiple modes), and indirect moves (via intermediate warehouse and distribution facilities located in the New York/New Jersey region). The locations and capacities of intermodal facilities and warehouse/distribution clusters are recognized as critical factors in determining the types of logistics patterns that could potentially benefit from enhanced Cross Harbor freight movement infrastructure and operations.

To identify the logistics patterns that are most likely to benefit from Cross Harbor freight enhancements, findings from review of freight movement databases and industry interviews (as described later in this appendix) provide critical information to supplement "lessons learned" from past studies. Past studies and current industry trends suggest the following types of moves should be of particular interest:

- **Historic and current east-of-Hudson rail freight commodities.** The opportunity is to serve commodity types that are generally most amenable to rail service, but do not fully use rail because of infrastructure or service limitations.
- **Long-haul rail trips that terminate at rail yards west-of-Hudson, and then continue by truck to destinations east-of-Hudson, and vice-versa.** The opportunity is to move the transfer point between truck and rail to the east-of-Hudson region, reducing truck vehicle miles traveled (VMT) and eliminating Hudson River truck crossings. The location and utilization of distribution centers, where truck and rail loads would be consolidated and de-consolidated, is a critical factor.
- **Long-haul truck trips (more than 400-500 miles) that originate or terminate in the east-of-Hudson region.** In 2007, approximately 86 percent of long-haul tonnage was moved by truck within the 54-county freight modeling area. For long-haul tonnage, the east-of-Hudson region has a rail share of just 3 percent compared to 24 percent for the west-of-Hudson region. Typically, rail is most competitive for freight moving 500 miles or more (longer than a one day truck drive). There are many potential explanations for the existing preference for long-haul freight shipments by truck, rather than rail including: rail infrastructure and service limitations, competitive pricing factors, and/or special handling requirements. The opportunity is to address as many of these factors as possible.
- **Short-haul truck trips (less than 400-500 miles).** There is opportunity to divert these truck trips to rail "unit trains" which comprise a single type of traffic that can be effective at shorter distances, provided that corridor volumes are high. Many regions, including New York/New Jersey, are investigating these "shuttle train" services.

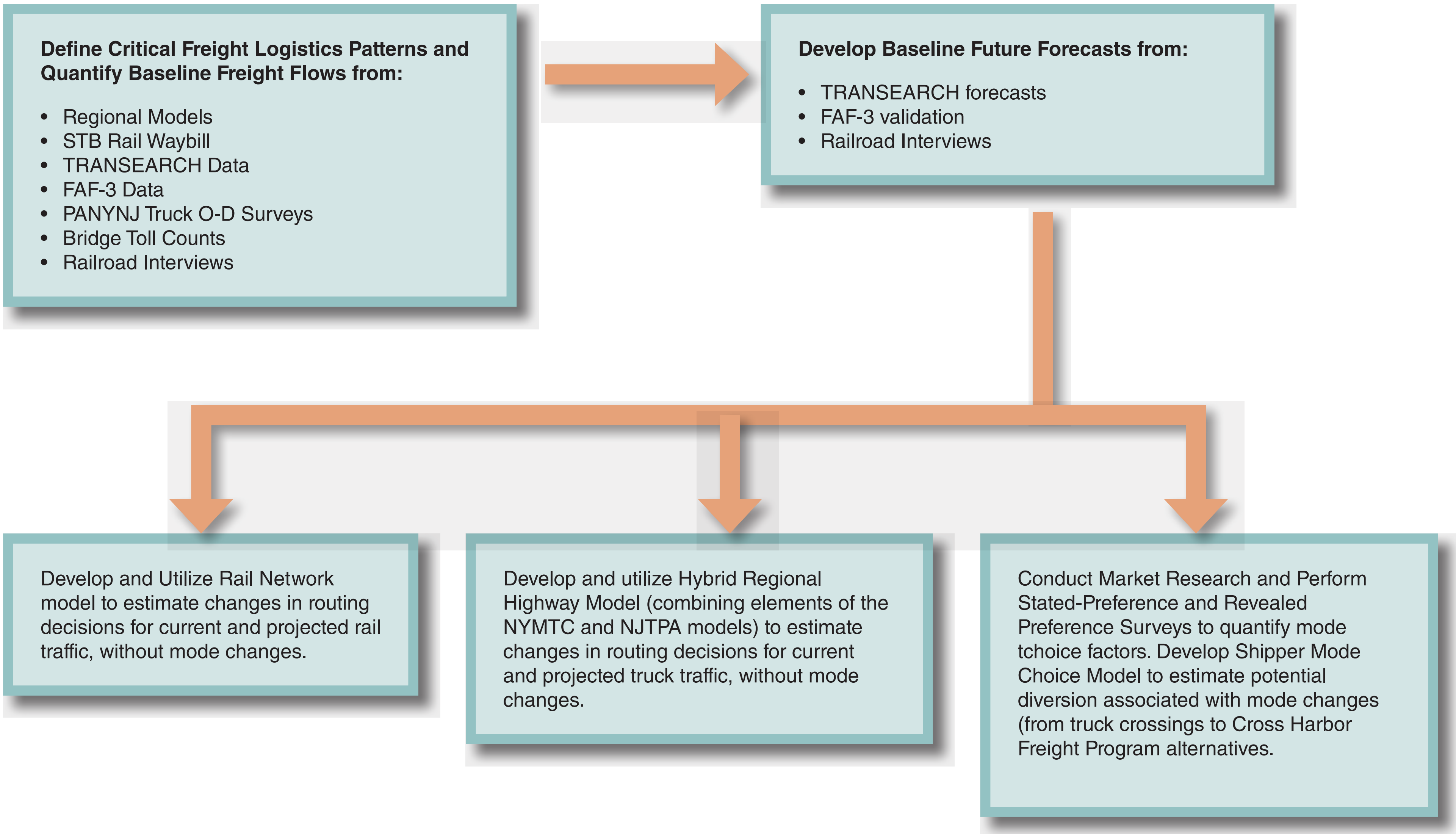

FIGURE A-1

CROSS HARBOR FREIGHT PROGRAM

- **Rail traffic that passes through, but does not originate or terminate within the region.** Some of these "through" rail trips could be routed through improved Cross Harbor infrastructure to take advantage of potential cost and/or time savings. The benefits of capturing this market are likely to accrue primarily to areas outside the New York/New Jersey region, but the possibility of through traffic diversion to an improved harbor crossing is worthy of consideration.

These logistics considerations provide a basis for quantifying and classifying freight movement data in a manner that is most useful to the evaluation of CHFP alternatives.

DATA ANALYSIS REGION

The Tier I EIS has modeled goods movement in a 54-county multi-state area, comprising portions of southern New York, northern and central New Jersey, western and southern Connecticut, and a portion of eastern Pennsylvania. All references to freight movements to, from, within, or through the "freight modeling area" refer to this 54-county region. The counties of this modeling study area have been selected by the Port Authority of New York and New Jersey (PANYNJ) to reflect the following:

- PANYNJ core planning region, which includes the five boroughs of New York City (Bronx, Kings, New York, Queens, Richmond counties), Long Island (Nassau and Suffolk counties), lower Hudson Valley (Westchester and Rockland counties), and northern New Jersey (Passaic, Bergen, Morris, Essex, Hudson, Union, Somerset, and Middlesex counties);
- Surrounding counties that are also part of the New York Metropolitan Transportation Council (NYMTC) and the North Jersey Transportation Planning Authority (NJTPA) planning regions;
- Counties that accommodate truck/rail terminals and freight corridors that are important in serving the region;
- Additional counties that accommodate important Hudson River crossings that are, or may be, used to bypass infrastructure in the core planning region.

The regional study area includes: major interstate highways leading to the existing cross-harbor connections (I-278, I-495, I-95); a number of highways serving northern New Jersey (such as New Jersey Turnpike/I-95, I-78, I-80, and I-287); and many state and local routes that are important for local freight movement. The EIS also investigates major freight rail lines and facilities west of the Hudson River (such as lines within the Consolidated Rail Company (Conrail), the CSX Corporation (CSX) River Line, the Norfolk Southern (NS) Lehigh Line, Chemical Coast Line and important rail yards at Croxton, Kearny, Oak Island, Greenville, Port Newark/Elizabeth in New Jersey) and strategic rail assets east of the Hudson River, which may be affected by the proposed alternatives (such as the 65th Street Yard, the Bay Ridge Branch, Montauk Branch, the Oak Point and Harlem River yards, and railcar float facilities at 51st and 65th streets in Brooklyn). Conditions at area marine terminals and airports are also included in the regional study area. It also includes major highway crossings and rail crossings as far north as Albany.

This data analysis region ensures that all traffic to, from and within the "core" PANYNJ planning region is captured in the data, along with nearly all other traffic crossing the Hudson River even if it does not directly or currently impact the core planning region. The Cross Harbor alternatives can potentially impact all crossing tonnage, so it is critical to include all crossing tonnage in the baseline data at the outset.

FREIGHT DATA

With the key logistics patterns and study area boundaries defined, the next step was the collection of best available data on commodity and vehicle flows relevant to these patterns. The goal was not to describe the universe of freight activity; rather, it was to develop a clear, focused, and easily communicated picture of the freight flows that are most critical for enhanced Cross Harbor infrastructure. Several sources have been utilized:

- Existing regional models (NYMTC Best Practices Model [BPM], and NJTPA Regional Transportation Model-Enhanced [RTM-E]), which contain truck movement information.
- TRANSEARCH commodity flow database, which the PANYNJ has acquired. The database contains modeled flows of freight between origin and destination pairs (at the county-level within the 54-county freight modeling area, and at aggregated regions of counties and states beyond) by commodity classification, mode, tonnage and value. The database has a 2007 base year and 2035 forecast.
- Rail Waybill data for key states from the Surface Transportation Board, which contain confidential information on rail shipments.
- Truck origin-destination surveys at the Port Authority's crossings, completed in 2009. TRANSEARCH is useful for describing truck origin-destination pairs and commodity mixes, but less useful for estimating route-by-route truck volumes. Empirical data from on-the-ground surveys is therefore helpful to validate and, if necessary, adjust the TRANSEARCH data. This validation step significantly increased confidence in the underlying estimates of freight flows, and in the resulting estimates of potential utilization of enhanced Cross Harbor rail infrastructure. This information provided best-practice estimates of full truck loads for east-of-Hudson.
- Marine Terminal Gate surveys, collected by the Port Authority in 2005, provide assistance in estimating the destinations of imported containers leaving the gates of Port Authority marine terminals. This information is especially helpful in estimating the volume of containers moving from west-of-Hudson marine terminals to east-of-Hudson destinations by truck, which could be diverted to the Truck Float/Ferry Alternatives or the LOLO/RORO Container Barge Alternatives.
- Rail terminal surveys and observations aimed at developing defensible estimates of the volumes, types, and percentages of rail traffic that could proceed as full moves to the east-of-Hudson region, as opposed to rail traffic requiring handling in the west-of-Hudson region. Gate surveys performed by the railroads, which are on file with the STB, were used for this purpose.
- The United States Department of Transportation (USDOT) Freight Analysis Framework 3 (FAF3) database, which contains region-to-region commodity flow data by mode. The FAF3 database has been used to validate and adjust the TRANSEARCH commodity flow data.
- Historic and forecast data on municipal solid waste (MSW) movements from New York State Department of Environmental Conservation (NYSDEC) and the Department of Sanitation of New York (DSNY).
- One-on-one interviews with knowledgeable individuals in the freight industry. Approximately 20 interviews were performed with representatives of carriers, shippers, third-party logistics providers, and public agency stakeholders The findings from the interviews were used to help describe existing freight movements and to focus further analyses on the most important aspects of shipping decisions.

DATA ENHANCEMENT PROCESS

The TRANSEARCH commodity flow database for year 2007, obtained by the PANYNJ from IHS/Global Insight, is a key source of data for estimating regional freight flows and potential demand for CHFP alternatives. After assigning the TRANSEARCH truck trip table to the FAF national highway network, it was determined that the TRANSEARCH data contained a disproportionately higher volume of traffic on the Hudson crossings than to FAF3, the BPM, and the Port Authority's origin-destination surveys suggested. TRANSEARCH has unique and undeniable strengths, particularly its level of geographic and commodity specificity. At the same time, it appeared that FAF3 was representing cross-harbor truck flows—which are of critical importance to the CHFP analysis—in a manner more consistent with actual counts and regional models.

The commodity flow data enhancement process consisted of five steps:

1. Evaluate the TRANSEARCH database, USDOT's Freight Analysis Framework (FAF), NYMTC's Best Practices Model (BPM), and NJTPA's Regional Transportation Model-Enhanced (RTM-E), and identify obvious inconsistencies;
2. Using the strengths of each the TRANSEARCH and FAF databases, develop an enhanced national commodity flow database and origin-destination matrix;
3. Adjust county-level tonnage in several east-of-Hudson counties to correspond to regional transportation model and origin-destination survey data;
4. Estimate flows of municipal solid waste, a commodity not sufficiently represented in the TRANSEARCH and FAF databases; and
5. Estimate short haul truck tons associated with drayage from rail intermodal terminals in eastern Pennsylvania and upstate New York.

COMMODITY FLOW DATABASE EVALUATION

The first dataset delivered by IHS/Global Insight (referred to here as "TRANSEARCH A") was examined by assigning TRANSEARCH truck data (which is provided in the form of annual zone-to-zone origin-destination tonnages and units) to the USDOT's FAF national highway network and to NYMTC BPM and NJTPA Regional Transportation Model- Enhanced RTM-E highway network models. The models assigned the TRANSEARCH A truck volumes to network routes and the number of truck crossings between I-84 and the Outerbridge Crossing in the eastbound direction were then tabulated.

For large trucks, the NYMTC and NJTPA models agree, but TRANSEARCH was significantly higher. Recognizing that a "model day" may not accurately represent an average day, a further analysis was performed. Annual toll counts were obtained from NYMTC for eastbound large truck crossings between the Tappan Zee and Outerbridge Crossing, and annual records were standardized to an average day (assuming 295 days per year, the same factor that was applied to TRANSEARCH A). For these crossings, the BPM daily volume was 6 percent higher than the estimated daily crossing count; the RTM-E daily volume was 16 percent higher than the crossing count; and the TRANSEARCH A volume was 61 percent higher than the crossing count.

The fact that TRANSEARCH A crossing volume for large trucks was much higher than both actual and modeled counts generated questions. Not all large trucks are freight-carrying trucks—many of them are service trucks, or Municipal Solid Waste trucks, or other types that are not captured in the TRANSEARCH dataset. Based on past experience, TRANSEARCH trucks should be lower than actual large truck counts, generally by approximately 25 to 50 percent. In this case, they were higher than actual large truck counts by 61 percent.

Global Insight and PANYNJ team held a number of productive and positive discussions of this issue. As a result, Global Insight applied their most current thinking to the question, and as a result supplied a series of interim revisions (the "TRANSEARCH B" series) and a final revised dataset ("TRANSEARCH C"). The same validation process that had been applied to TRANSEARCH A was then undertaken for TRANSEARCH C. After assigning the TRANSEARCH C data to the FAF national highway network, it was determined that while total truck tonnage was slightly lower in TRANSEARCH C, eastbound crossings of the Hudson River only decreased by 1.2 percent versus TRANSEARCH A. The discrepancy between TRANSEARCH C and other data sources was corrected by developing an enhanced commodity flow database based on TRANSEARCH C and USDOT's FAF3 database.

TRANSEARCH/FAF3 ENHANCEMENT

The project team, in cooperation with the Port Authority, NYSDOT and NJDOT, implemented a data enhancement process, using FAF3 flows as "control totals" and using TRANSEARCH data as a means to disaggregate the FAF3 data (only available at multi-county group levels and fairly aggregated commodity groupings) down to the level of individual counties and finer commodity groupings. The process is most accurately described as "FAF3 enhancement," since FAF3 is providing the control totals. However, both datasets make equally important contributions. The approach included:

- Establishing the FAF-3 tonnages as controls for each multi-county group, and re-scaling the TRANSEARCH tonnages (inbound, outbound, and internal) to match ("Iterative Proportional Fitting");
- Assigning the data to national network and comparing resulting crossing and link volumes to expected volumes and commodity mixes;
- Comparing the results to crossing counts;
- Making additional adjustments if good matches were not observed, using Origin-Destination Matrix Estimation, with calibration points as trucks at the Hudson River crossings (if good matches to crossing counts were observed, no additional adjustments were made);
- Clearly documenting all adjustments;
- Using the resulting data to estimate potentially divertible trucks, updating the highway network models, and developing the final survey sampling protocol; and

The adjustments were limited to the following flows: New Jersey part of New York City CSA (NYC CSA) to New York part of the NYC CSA, west-of-Hudson short-haul to New York part of the NYC CSA, and west-of-Hudson long-haul to New York part of the NYC CSA.

Additional adjustments to the commodity flow database were undertaken to account for shortcomings in TRANSEARCH and/or FAF3. These additional adjustments include the addition of commodity flows of municipal solid waste (MSW) and the identification of "linked" truck trips that represent the "first mile" or "last mile" of trips going to or from rail terminals in the west-of-Hudson region that serve markets in the east-of-Hudson region. Quantifying this linkage was essential to estimate the effects of relocating rail-truck transfer terminals.

Following these adjustments, the enhancement process was guided by the general rule that FAF3 would control total tonnages for the now-compatible flows, while TRANSEARCH would be used to distribute those flows to smaller zones (counties, etc.) based on proportional representation in the original TRANSEARCH data. A second enhancement step was undertaken, which eliminated TRANSEARCH crossing flows that were not also present in FAF3 and re-scaled the remaining flows to FAF3 control totals. This approach yielded a very conservative and highly defensible estimate of truck flows generating eastbound Hudson River crossings, because it required that trucks be reported in both FAF3 and TRANSEARCH. It eliminated the need to rely on one dataset versus the other, or to make value judgments about which is "better" or more reliable, because each reported flow requires corroboration. The result generated 14,951 eastbound loaded large truck crossings per day between I-84 and Outerbridge on an average day, based on 295 days per year. This number—14,951 eastbound loaded large truck crossings per day—is lower than the 26,202 eastbound large truck crossings reported from the NYMTC BPM, or the 31,928 eastbound large truck crossings reported from the NJTPA RTM-E.

However, one must remember that the 14,951 number represents only loaded commodity freight-carrying trucks with a destination in one of the nine New York counties east of the Hudson River. It does not include:

- Empty trucks;
- Trucks crossing the Hudson on their way to destinations in New England, beyond the nine New York counties located east of the Hudson River (according to PANYNJ surveys on toll bridges, this is a small percentage on the Outerbridge, Goethals, and George Washington Bridge crossings);
- Some percentage of short-haul truck moves, which are not fully represented in FAF3 or TRANSEARCH, especially "last mile" local deliveries from warehouses to retail outlets, other businesses, and/or homes; and
- Trucks that are not carrying commodities, such as service trucks.

Taking these factors into account, the number of 14,951 eastbound loaded large truck crossings from FAF3 and TRANSEARCH commodity tonnage is reasonable. Further validation evidence is provided by a PANYNJ truck origin-destination survey performed in October and November of 2009 at the George Washington Bridge, Lincoln Tunnel, Bayonne Bridge, Goethals Bridge, and Outerbridge Crossing.

- On the survey day, the number of long-haul eastbound loaded large trucks (with 3 or more axles) counted on these facilities in the course of making trips to the nine New York State counties located east of the Hudson River[1] was 1,959. (This number excludes empty trucks, through trucks, and trucks moving to counties not requiring a Hudson River crossing.) From the second enhancement dataset, there are 14,951 eastbound loaded large truck crossings per day between the I-84 Bridge and Outerbridge Crossing. Excluding crossings that were not part of the PANYNJ origin-destination survey, the number is 12,042 per day. Almost 20 percent of the eastbound crossing tonnage in the second enhancement dataset is associated with long-haul trips, so the adjusted number for long-haul eastbound truck crossings is 2,359 per day. This number is 20 percent higher than the PANYNJ origin-destination survey estimate.

[1] The nine east-of-Hudson counties include: Bronx, Dutchess, Kings, Nassau, New York, Putnam, Queens, Suffolk, and Westchester. These counties are east-of-Hudson counties within the Bureau of Economic Analysis Zone named "NY part NYC" in the Freight Analysis Framework (FAF) database. It includes New York State counties that are within the greater New York City metropolitan area.

- On the survey day, the number of short-haul eastbound loaded large trucks (3 or more axles) counted on these facilities in the course of making trips to the nine New York counties located east of the Hudson River was 13,513. The equivalent number from the second enhancement dataset is 9,683 eastbound loaded large truck crossings, which is approximately 28 percent less than the PANYNJ origin-destination survey number. This would be expected, since the origin-destination survey data captures all types of short-haul traffic, including traffic that is not well represented in national datasets such as TRANSEARCH and FAF3.

In summary, the result from the second enhancement reflects areas of agreement between TRANSEARCH and FAF3 and is consistent with toll counts, regional highway network models, FAF3 control totals, PANYNJ origin-destination surveys, and professional experience. Based on this finding, further enhancement steps (such as origin-destination matrix estimation) were not considered necessary or desirable. The data, following the second enhancement, was well-suited to provide the most accurate and defensible basis for CHFP analyses.

One of the most important findings of this effort was the generally good correspondence between FAF3 and TRANSEARCH with respect to total tonnage. The main discrepancies were limited to the geographic distributions of flows, which led in turn to discrepancies in the number of eastbound Hudson large truck crossings generated by each dataset.

TRANSEARCH and FAF3 both retain their original utility as descriptive databases providing “big picture” data on freight flows to, from, and within the region. They can be reliably used for this purpose, without modification, not only within the CHFP, but also for other planning efforts in the region.

However, for CHFP analyses specifically related to the estimation of cross-harbor truck movements, the second enhancement dataset will be used in lieu of either TRANSEARCH or FAF3 alone. The second enhancement data is considered most reliable for loaded long-haul truck moves to and from the study area, which are well represented in both TRANSEARCH and FAF3 data. This is important, because the diversion of long-haul truck trips to alternative modes and facilities is a key opportunity for the CHFP.

BRONX COUNTY ORIGIN/DESTINATION ENHANCEMENT

One of the most significant geographic distribution discrepancies between TRANSEARCH D and previous versions of TRANSEARCH, as well as the Port Authority Origin-Destination surveys, is the 2007 inbound truck tonnage for Bronx County. The other data sources suggest that Bronx County should be the destination for approximately 10 percent of the inbound truck tonnage destined for counties east of the Hudson River, yet approximately 2.6 percent of inbound east-of-Hudson tonnage was destined for Bronx County in TRANSEARCH D. The shares of inbound truck tonnage to Fairfield, Kings, and Westchester counties were significantly higher than in previous TRANSEARCH databases and the Port Authority Origin-Destination surveys. This discrepancy was corrected by removing 50 percent of the TRANSEARCH D inbound truck tonnage from Fairfield County, 9 percent from Kings County, and 25 percent from Westchester County, and applying those commodity flows to Bronx County. This resulted in a geographic and commodity distribution that corresponded reasonably well with the other data sources. The result of this adjustment was a database referred to as “TRANSEARCH D+”, as shown in **Table A-1**.

MUNICIPAL SOLID WASTE ENHANCEMENT

The TRANSEARCH database does not include municipal solid waste (MSW) truck flows. To estimate the volume and distribution of MSW trucked from the east-of-Hudson region, an MSW truck trip table, see **Table A-2,** was prepared using publicly available waste generation and disposal information.[1] **Table A-3** was prepared to account for waste disposal using modes other than truck. The NYSDEC report, "Beyond Waste: A Sustainable Materials Management Strategy for New York State,"[2] contains waste generation, transfer station throughput, and disposal location data for all of the solid waste planning units in the state, including the 17 planning units covering Nassau, Suffolk and Westchester counties and New York City. These data were used to develop a county-level trip table for outbound MSW materials that are transported from municipal collections and transfer stations east-of-Hudson to landfills and resource recovery facilities on either side of the Hudson.

Table A-1
TRANSEARCH D Adjustments to 2007 Inbound Truck Tonnage East-of-Hudson

East-of-Hudson Destination County	TRANSEARCH D	TRANSEARCH D+	Difference	Change
Bronx	6,534,931	25,242,813	18,707,882	286%
Columbia	1,322,983	1,322,983	0	0%
Dutchess	3,550,893	3,550,893	0	0%
Fairfield	18,853,271	9,426,635	-9,426,636	-50%
Hartford	31,663,361	31,663,361	0	0%
Kings	57,521,854	52,521,854	-5,000,000	-9%
Litchfield	4,807,982	4,807,982	0	0%
Middlesex	3,385,653	3,385,653	0	0%
Nassau	13,278,271	13,278,271	0	0%
New Haven	22,637,946	22,637,946	0	0%
New London	3,911,314	3,911,314	0	0%
New York	20,239,174	20,239,174	0	0%
Putnam	1,168,361	1,168,361	0	0%
Queens	20,587,592	20,587,592	0	0%
Rensselaer	3,347,441	3,347,441	0	0%
Suffolk	20,922,318	20,922,318	0	0%
Westchester	17,124,984	12,843,738	-4,281,246	-25%
Grand Total	*250,858,330*	*250,858,330*	*0*	*0%*

MSW generation and disposal data published by the New York State Department of Environmental Conservation provided the basis for the development of the 2035 MSW trip table, **Table A-4**, as well. The report established a goal of reducing per capita MSW generation by more than 85 percent (a reduction from 4.1 pounds per person per day to 0.6 pounds per person per day by 2030). The reduced per capita generation rate was applied to the 2035 county level population forecasts from NYMTC to estimate the 2035 MSW generation by county. The

[1] New York City Department of Sanitation, *Comprehensive Solid Waste Management Plan*, 2006, available from: http://www.nyc.gov/html/dsny/html/swmp/swmp-4oct.shtml

[2] "Beyond Waste: A Sustainable Materials Management Strategy for New York State," New York State Department of Environmental Conservation, 2010, available from http://www.dec.ny.gov/chemical/41831.html (accessed 05/01/2012).

distribution of tonnage among destination counties was unchanged from the 2007 trip table. MSW flows from the New York City counties were shifted from truck to rail to account for the New York City Department of Sanitation's (DSNY) goal to shift all outbound MSW to rail or a combination of barge and rail, as shown in **Table A-5**.[1] The 2035 MSW trip table assumes outbound flows of MSW from Nassau, Suffolk, and Westchester counties would continue to be moved primarily by truck.

Table A-2
MSW Truck Tons Originating East-of-Hudson by Destination Region, 2007

East-of-Hudson Origin County	Long Island	West-chester	Upstate/ Western NY	New Jersey	Penn-sylvania	Maryland	Virginia	Ohio	South Carolina	Total
Bronx	36,967	46,920	92,419	1,422	577,260	0	392,423	103,793	170,619	**1,421,823**
Kings	281,361	56,698	132,898	24,571	769,921	7,074	499,772	283,216	206,173	**2,261,684**
Nassau	207,801		127,522	15,275	171,360	0	106,069	239,061	0	**867,088**
New York	15,992	20,298	39,981	615	249,726	0	169,765	44,901	73,811	**615,089**
Queens	331,141	40,305	106,226	30,128	587,407	8,947	369,442	288,750	146,563	**1,908,908**
Richmond	4,579	5,812	11,448	176	71,509	0	48,612	12,858	21,136	**176,131**
Suffolk	110,725		127,522	16,245	171,360	0	112,811	212,577	0	**751,240**
Westchester	9,204		356,240	12,272	92,043	0	0	3,068	0	**472,828**
Total	**997,772**	**170,033**	**994,255**	**100,704**	**2,690,586**	**16,021**	**1,698,894**	**1,188,224**	**618,301**	**8,474,790**

Table A-3
MSW Tons, Other Modes, Originating East-of-Hudson by Destination Region, 2007

East-of-Hudson Origin County	Long Island	West-chester	Upstate/ Western NY	New Jersey	Penn-sylvania	Maryland	Virginia	Ohio	South Carolina	Total
Bronx	3,041	3,859	7,602	117	47,480		32,277	8,537	14,034	**116,946**
Kings	23,142	4,663	10,931	2,021	63,327	582	41,107	23,295	16,958	**186,026**
Nassau	17,092		10,489	1,256	14,095		8,724	19,663		**71,319**
New York	1,315	1,670	3,288	51	20,540		13,963	3,693	6,071	**50,592**
Queens	27,237	3,315	8,737	2,478	48,315	736	30,387	23,750	12,055	**157,010**
Richmond	377	478	942	14	5,882		3,998	1,058	1,738	**14,487**
Suffolk	9,107		10,489	1,336	14,095		9,279	17,485		**61,790**
Westchester	757		29,301	1,009	7,571			252		**38,891**
Total	**82,068**	**13,985**	**81,779**	**8,283**	**221,304**	**1,318**	**139,736**	**97,733**	**50,856**	**697,061**

[1] "Comprehensive Solid Waste Management Plan," New York City Department of Sanitation, 2006, available from: http://www.nyc.gov/html/dsny/html/swmp/swmp-4oct.shtml (accessed 05/01/2012).

Table A-4
MSW Truck Tons Originating East-of-Hudson by Destination Region, 2035

East-of-Hudson Origin County	Long Island	Westchester	Upstate/ Western NY	New Jersey	Pennsylvania	Maryland	Virginia	Ohio	South Carolina	Total
Bronx	0	0	0	0	0	0	0	0	0	**0**
Kings	0	0	0	0	0	0	0	0	0	**0**
Nassau	35,093	0	0	2,580	28,939	0	17,913	40,372	0	**124,895**
New York	0	0	0	0	0	0	0	0	0	**0**
Queens	0	0	0	0	0	0	0	0	0	**0**
Richmond	0	0	0	0	0	0	0	0	0	**0**
Suffolk	20,316	0	23,398	2,981	31,441	0	20,698	39,003	0	**137,837**
Westchester	1,597	0	61,795	2,129	15,966	0	0	532	0	**82,019**
Total	**57,005**	**0**	**85,193**	**7,689**	**76,346**	**0**	**38,611**	**79,907**	**0**	**344,751**

Table A-5
MSW Tons, Other Modes, Originating East-of-Hudson by Destination Region, 2035

East-of-Hudson Origin County	Long Island	West-chester	Upstate/ Western NY	New Jersey	Penn-sylvania	Maryland	Virginia	Ohio	South Carolina	Total
Bronx	6,517	8,272	16,293	251	103,528	0	69,183	18,298	30,080	**252,423**
Kings	50,461	10,168	23,834	4,407	138,081	1,269	89,631	50,793	36,976	**405,621**
Nassau	0	0	0	0	0	0	0	0	0	**0**
New York	2,870	3,643	7,175	110	44,814	0	30,465	8,058	13,245	**110,379**
Queens	63,325	7,708	20,314	5,761	112,331	1,711	70,649	55,218	28,028	**365,045**
Richmond	845	1,072	2,112	32	13,191	0	8,967	2,372	3,899	**32,490**
Suffolk	0	0	0	0	0	0	0	0	0	**0**
Westchester	0	0	0	0	0	0	0	0	0	**0**
Total	**124,018**	**30,863**	**69,728**	**10,562**	**411,946**	**2,980**	**268,896**	**134,739**	**112,228**	**1,165,958**

INTERMODAL TERMINALS DRAYAGE ENHANCEMENT

A trip that uses multiple modes is reported as multiple trips (separately for each mode) in TRANSEARCH. Thus a trip which goes from, for example, Chicago to northern New Jersey by rail and then from northern New Jersey to Brooklyn by truck is reported in TRANSEARCH as two trips: the first trip record with a Chicago origin and a northern New Jersey destination by rail, and the second trip record with a northern New Jersey origin and a Brooklyn destination by truck. In order for the Choice Model to treat this trip properly, the trip had to be considered as a single trip with a Chicago origin, a Brooklyn destination, and a mode of truck-rail (intermodal rail).

By contrast FHWA's Freight Analysis framework treats this same trip as a single record with an origin of Chicago, a destination of Brooklyn, and a mode of Multiple Mode (truck-rail). There is an additional difference in how TRANSEARCH and FAF report the commodity. FAF reports the single combined trip by its long haul SCTG code, for which crosswalks exist to the Standard Transportation Commodity Classification (STCC) codes 01-49 as used in TRANSEARCH. TRANSEARCH reports the first leg of the trip by its STCC2 code, but the second leg of the trip by its own proprietary Commodity Code of STCC 50X, where STCC 501 is secondary truck (where presumably the first leg is either by the truck mode or value added happens at the transfer point such that the previous mode is unknown); and STCC 502 is truck-rail drayage.

TRANSEARCH truck flows have been made to match FAF truck flows across the Hudson River. This means that flows which TRANSEARCH reports as 50X have been included in the total of TRANSEARCH Flows. The task of linking rail trips to the STCC 50X is what had been expected.

Originally, the intent was to link STCC502 and a west-of-Hudson rail trip in order to determine the STCC2 commodity of that STCC502 trip and to assign its mode diversion origin as the origin of the rail trip. However, it was determined that the location information for STCC502 records in TRANSEARCH might be incorrect as to the location of the beginning of the dray. Unless there are no rail dray trips from the northern New Jersey origin, the effect would be to allocate those STCC 502 dray trip using the wrong rail terminal allocations, not that they would be given no external rail origin and STCC code.

Instead, a procedure was followed that used the FAF. The goal was to address STCC 01-39 (there are no reported STCC 40-49 truck trips in TRANSEARCH), as well as STCC501 truck trips with an external rail origin. This was done because for those distribution centers outside of the 54-county TRANSEARCH freight modeling area purchased, the rail portion of the trip is not reported (it will not have a either an origin or a destination within the 54-county freight modeling area (See Figure 1-8). This includes Harrisburg and Philadelphia, while Albany is on the fringe of the 54-county freight modeling area). By contrast, the information for that rail trip from the FAF includes all national commodity flows, because all flows, not just those to, from, within, or though the 54-county freight modeling area, are included in FAF.

There were several issues which had to be considered in this processing:

- The FAF uses the SCTG commodity classification system and TRANSEARCH uses the STCC commodity classification system. These systems do not nest except at the STCC7-SCTG 5 level. There are available crosswalks between SCTG2 and STCC4 but they are approximations.
- It is not known if the STCC01-39 flows reported for the regions, originate or are consumed in the regions, or are merely passing through a distribution center. Treating those flows as beginning or ending at as distribution center might be an oversimplification. Accounting for the regional consumption/distribution of the SCTG commodity becomes problematic because of the geographic size difference of the FAF region. For example, just because flows are transloaded in a FAF region which is Pennsylvania Remainder, the one that is associated with Harrisburg, does not mean that this is the case for that entire FAF region.
- The FAF flows were intended to produce both rail/truck flows and total splits from which to allocate flow from the Distribution Center/C/IM. There was no way to determine that the inferred connection would exist at this finer geographic detail when aggregating and splitting across both mode and commodity. For example a FAF truck flow from Bedford County, PA which has no service should not be inferred as a truck trip from Harrisburg. Similarly a rail trip from form the FAF region Oregon Remainder to Pennsylvania Remainder might not even be to Harrisburg.

The primary intent was to connect those flows within TRANSEARCH which are reported as STCC502 in northern New Jersey with a rail trips to/from outside of the 54-county modeling study area to northern New Jersey. The effort also helped synthesize rail flows for Philadelphia and Harrisburg which are not reported in TRANSEARCH in order to link those trips with truck flows in TRANSEARCH from those locations. There was no intent to link long-haul truck with short-haul truck.

BASELINE COMMODITY FLOWS

Analysis of the enhanced commodity flow database shows that in 2007, approximately 1 billion tons of freight moved into, out of, through, or within the 54-county freight modeling area by truck or rail. The top three commodities in 2007 are secondary traffic, nonmetallic minerals, and food or kindred products. Together they account for over half of the total commodities by weight. **Figure A-2** illustrates the distribution of commodities by tonnage in 2007. The top truck commodity is secondary traffic, which accounts for 26 percent of total truck tonnage. Second is nonmetallic minerals (16 percent of total truck tonnage), and third is food or kindred products (11 percent of total truck tonnage). The top rail commodity is "secondary traffic" (consisting largely of mixed shipments of consumer products that pass through warehouse/distribution centers), which accounts for 20 percent of total rail tonnage. Second commodity is chemicals or allied products (19 percent), and third is waste or scrap materials (14 percent).

The top three trading partners for the 54-county modeling study area are (1) the rest of Pennsylvania (outside the 54-county area), (2) the rest of New York (outside the 54-county area), and (3) Ohio. These top three trading partners account for approximately 25 percent of total flows by weight. These three regions accounted for over 38 percent of inbound flows, and approximately 44 percent of outbound flows in 2007. The top trading partners by tonnage are illustrated in **Figure A-3**. Top commodities traded with the top three trading partners include:

- The top commodity moved to and from the "rest of Pennsylvania" was secondary traffic, accounting for just over 27 percent of total tonnage. This was followed by nonmetallic minerals at 16 percent, and clay, concrete, glass, or stone products at 12 percent.
- The top commodity group moved to and from the "rest of New York" was clay, concrete, glass, or stone products, accounting for just over 21 percent of total tonnage. This was followed by secondary traffic at 19 percent, and food or kindred products at 17 percent.
- The top commodity moved to and from Ohio was chemicals or allied products, accounting for just over 23 percent of total tonnage. This was followed by secondary traffic at 13 percent, and primary metal products at 12 percent.

For the study area as a whole, approximately 910 million tons (90.4 percent) of surface tonnage is moved by truck, 80 million tons (8.0 percent) by carload rail, and 17 million tons (1.6 percent) by intermodal rail, as shown in **Table A-6**, below.

Commodity flows that cross New York Harbor or the Hudson River represent the source of potential demand for CHFP alternatives. Approximately 27 percent of the region's total commodity flows crossed the Hudson in 2007, on any of the crossings between the Verrazano-Narrows Bridge, in New York City, and Interstate 90, near Albany.

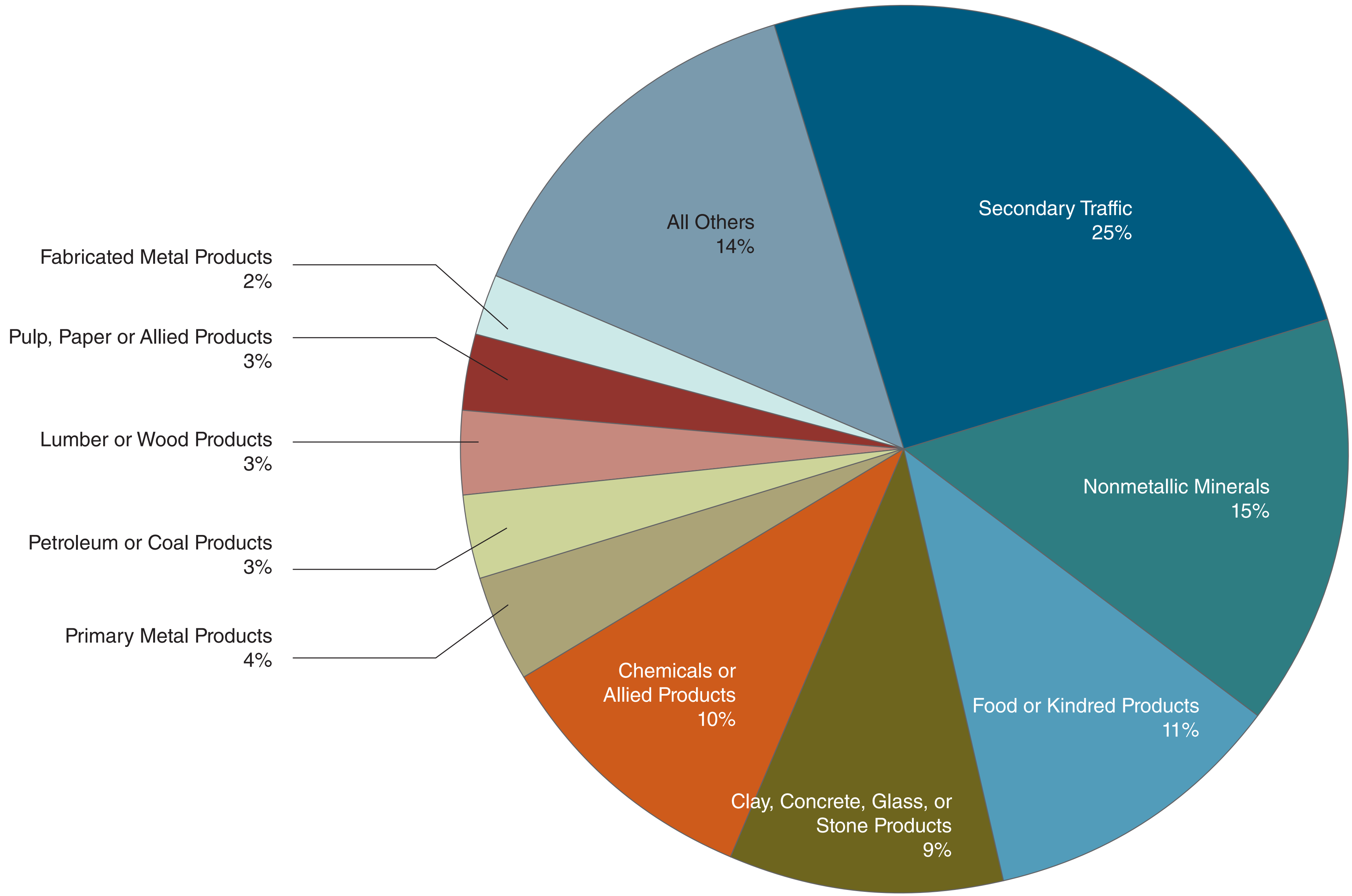

Figure A-2
Top Ten Commodities by Weight (2007) for
Trips Originating from, Destined for, or Passing through the 54-County Study Area

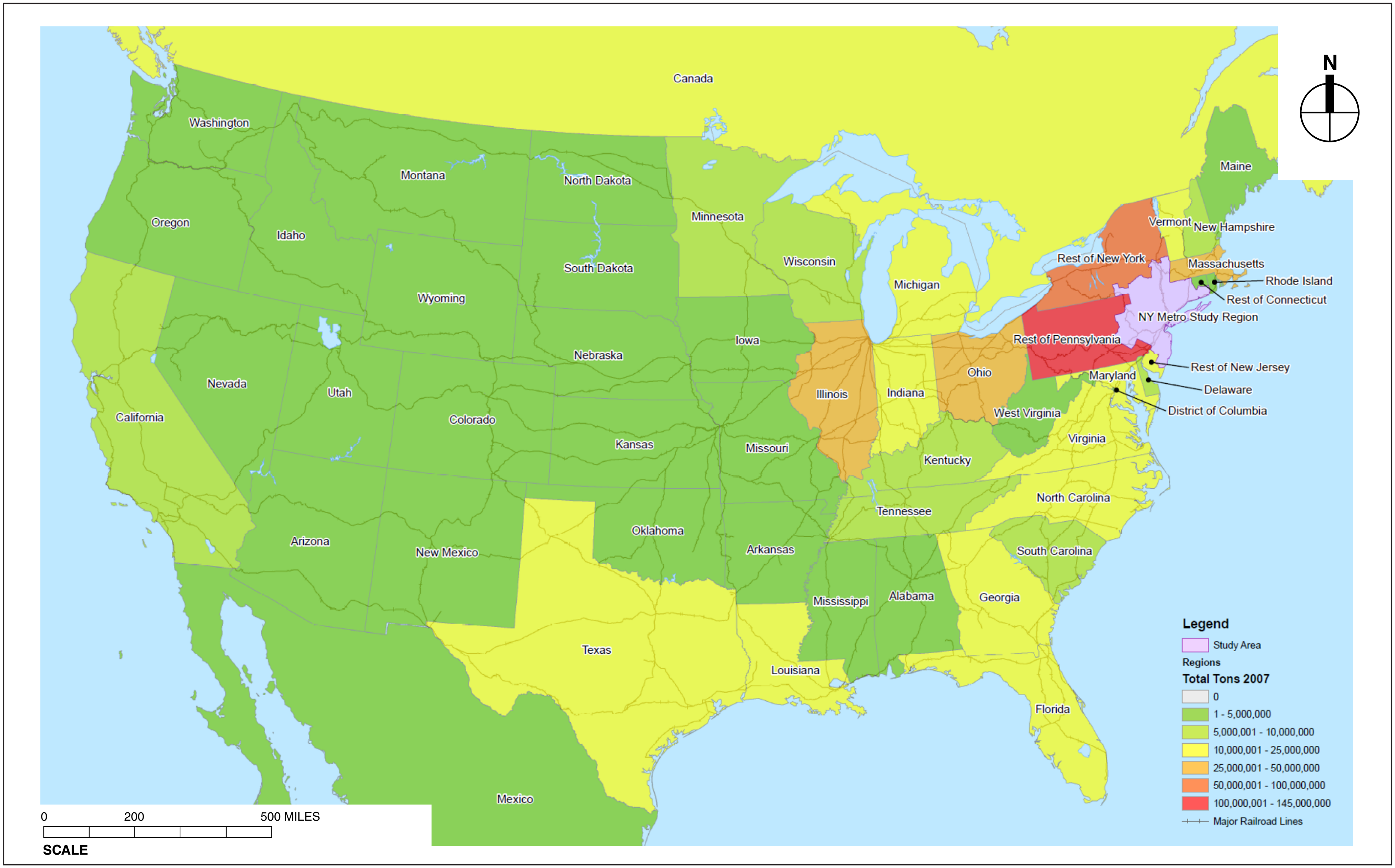

FIGURE A-3

Trading Partners by Weight, 2007

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Table A-6
Modeling Study Area Commodity Flow and Mode Shares, 2007

Mode	Total Commodity Flow (Million Tons)	Total Mode Shares	Share of Total Commodities that Cross the Hudson	Hudson Crossing Commodity Flow (Million Tons)	Hudson Crossing Mode Shares
Truck	909.6	90.4%	28%	252.4	91.2%
Carload Rail	80.0	8.0%	27%	21.4	7.7%
Intermodal Rail	16.7	1.6%	18%	2.9	1.1%
Total	**1,006.3**	**100.0%**	**27%**	**276.7**	**100.0%**

Sources: Cambridge Systematics analysis using Commodity Flow Database

Interestingly, the mode shares of crossing tonnage are quite similar to those of total tonnage. This may seem counter-intuitive, because the core of the east-of-Hudson study area—Kings, Queens, Nassau, and Suffolk—has had low rail tonnage in recent years. However, other east-of-Hudson counties in the 54-county freight modeling area are reasonably well served by rail today, so on the whole, crossing tonnage is only slightly more truck dependent than the region as a whole. Probably the most significant difference is the lack of intermodal rail facilities east of Hudson, which has historically limited that service option. It should be noted that since 2007, CSX has developed new intermodal terminal capacity in Massachusetts and NS has partnered with the PanAm Railway to offer "Patriot Corridor" service, so today the intermodal rail share may be higher than shown.

Of the 252 million truck tons crossing the Hudson River, approximately 41 percent are passing through the region between origins and destinations outside the 54-county modeling study area. Approximately 32 percent are traveling between origins and destinations within the region, and 27 percent are traveling between a point within the region and a point outside the region. These percentages vary significantly at the level of individual counties. Some counties, like Albany, NY or Richmond (Staten Island, NY), are "gateways," with high levels of pass-through traffic; others, like Kings, Queens, Nassau, and Suffolk, are origins and destinations with low levels of pass-through traffic.

Short-haul crossing trucks (defined as trucks making trips less than 400 miles) carried 111 million tons of freight, representing approximately 44 percent of all crossing truck tonnage.

- Of these short haul crossing trucks, 59 percent travelled less than 100 miles, while 41 percent travelled between 100 and 400 miles.
- The vast majority of short-haul crossing truck tonnage (approximately 106 million tons, or 42 percent of all crossing truck tonnage) had an origin, destination, or both, within the study area. Top commodities carried by short-haul trucks included food (18 percent), refined petroleum products (15 percent), clay/concrete/glass/stone (13 percent), and nonmetallic minerals (13 percent). Approximately 72 percent of the short haul crossing truck tonnage moved from west-to-east. As shown in **Table A-7**, approximately 64 million of these 111 million short haul truck tons had an origin or destination in Westchester County, New York City, or Long Island. Among these downstate counties, Kings County (Brooklyn) was the top origin/destination for short haul truck tonnage, followed by Queens County.
- Approximately 5 million tons of short-haul crossing truck tonnage (approximately 2 percent of all crossing truck tonnage) passed through the study area. This was primarily traffic moving from areas just west of the study area (NJ, NY, PA) to New England.

Table A-7
Hudson Crossing Freight, Short-Haul Trucks, 2007[1]

County	2007 Crossing Truck Tons, Short Haul (millions)	Share
Kings	28	25%
Queens	12	11%
Suffolk	8	7%
Bronx	8	7%
Nassau	5	5%
Westchester	2	2%
All Other	47	42%
Total	**111**	**100%**

Long haul crossing trucks (defined as trucks making trips that exceed 400 miles) carried 141 million tons of freight across the Hudson in 2007, representing approximately 56 percent of all crossing truck tonnage.

- Approximately 36 million tons of long-haul crossing truck freight (representing 14 percent of all crossing truck tonnage) had an origin or destination in the study area. Top commodities included food (17 percent), chemical products (13 percent), metals (10 percent), and municipal solid waste (9 percent). Kings County was the top origin/destination for long-haul crossing truck tonnage in the region.
- Approximately 105 million tons of long-haul crossing truck freight (representing 42 percent of all crossing truck tonnage) passed through the study area. Most of the this freight (approximately 95 percent) crossed on bridges between the Tappan Zee Bridge and Interstate 90; only approximately 5 percent crossed on the George Washington, Goethals, and Outerbridge Bridges. Traffic to/from Massachusetts accounted for the top ten leading origin-destination pairs, as shown in **Table A-8**.

Table A-8
Top Hudson Crossing Through Truck Origin-Destination Pairs, 2007

Origin-Destination Pair	Share of Through Tons	Cumulative Share of Through Tons
Ohio to/from Massachusetts	8%	8%
Pennsylvania to/from Massachusetts	5%	13%
Florida to/from Massachusetts	3%	16%
Illinois to/from Massachusetts	3%	19%
Wisconsin to/from Massachusetts	2%	21%
Georgia to/from Massachusetts	2%	23%
Kentucky to/from Massachusetts	2%	25%
Texas to/from Massachusetts	2%	27%
Michigan to/from Massachusetts	2%	29%
North Carolina to/from Massachusetts	2%	31%

[1] Internal tons are counted at both ends of the trip.

C. FREIGHT DEMAND FORECASTING

VALIDATION OF BASE YEAR

The PANYNJ TRANSEARCH dataset, like FAF-3, utilizes a base year of 2007. The year 2007, prior to the recession was a high-water mark for freight tonnage nationally. Freight volumes actually declined in subsequent years due to the recession, before beginning to recover. The most recent available metrics (PANYNJ marine cargo and truck toll counts, NJ Turnpike toll counts, and national rail statistics) suggest that 2010-2011 volumes were still below 2007 levels, as shown in **Table A-9**. With continuing recovery, we can speculate that 2012 volumes may be closer to 2007 levels. Overall, the use of 2007 base year data appears to provide a reasonable basis for projecting forward from 2012 conditions, as shown in **Table A-9**.

Table A-9
Comparison of 2007 and Recent Freight Volumes

Metric	2007 Volume	Recent Volume	Percent Difference
Loaded Import/Export TEUs through PANYNJ Marine Terminals	4,097,495	4,307,954 (2011)	+ 5.1%
Annual Truck Volumes, NJTPK	23,170,974	20,463,549 (2011)	- 11.7%
Annual Truck Volumes, PANYNJ Toll Crossings	8,516,000	7,611,000 (2011)	- 10.6%
NY Statewide Rail Tons Originated and Terminated	33.7 million	29.3 million (2010)	-13.1%
NJ Statewide Rail Tons Originated and Terminated	34.9 million	32.8 million (2010)	-6.0%

Notes: TEU or twenty-foot equivalent unit represents the cargo capacity of a standard intermodal container.
Sources: Port Authority of New York and New Jersey, New Jersey Turnpike Authority, Association of American Railroads.

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STUDY AREA GROWTH FORECAST 2007-2035

The PANYNJ TRANSEARCH database included year 2035 forecasts. These forecasts were based on a macroeconomic forecast developed by IHS Global Insight, Inc., applied to each record in the TRANSEARCH dataset. This provided estimates of growth by mode, commodity, and origin-destination pair.

It is projected that by 2035 approximately 1.4 billion tons of freight would travel into, out of, through, or within the 54-county modeling study area. This total is 39 percent greater than the 2007 total freight flows. Intermodal rail is expected to grow fastest (40 percent), though trucking will grow by the greatest volume (340 million tons). Growth by mode between 2007 and 2035 is shown in **Table A-6**. Using 2007 as a base year, the total forecast annual growth rate is 1.1 percent per year; assuming that 2007 and 2012 volumes are comparable and looking at growth between 2012 and 2035, the total annual growth rate is 1.4 percent per year, as shown in **Table A-10**.

This forecast is independent of planned or proposed changes in transportation infrastructure or services and is based on historic utilization of different modes. The New York and Atlantic Railway (NY&A), CSX, and NS are all expecting higher growth rates. For example, NY&A is planning for 2.5 percent annual growth in its service to Long Island. The railroad forecasts reflect, at least in part, the assumption that railroad improvements, effective rail service marketing, and increased highway congestion, will act in combination to drive railroad growth. However, if the railroads do not act, independently or in concert with public partners, those increases are unlikely to be realized. Therefore, the projections in **Table A-10** represent a reasonable No Action condition for the study area. Implementation of CHFP alternatives would result in different growth rates for truck and rail as would implementation of other rail improvement projects throughout the region over the course of the forecast period.

Table A-10
Study Area Commodity Flow (million tons) and Mode Share

Mode	2007	2035	Flow Increase (million tons)	Percent Increase	CAGR 2007-2035	CAGR 2012-2035
Truck	909.6 90.4%	1,272.4 91.0%	362.9	39.9%	1.2%	1.5%
Carload Rail	80.0 8.0%	102.3 7.3%	22.2	27.8%	0.9%	1.1%
Intermodal Rail	16.7 1.6%	23.3 1.7%	6.6	39.4%	1.2%	1.5%
Total	**1,006.3 100.0%**	**1,398.0 100.0%**	**391.7**	**37.6%**	**1.2%**	**1.4%**

Notes: CAGR is the compound annual growth rate.

The top three commodities in 2007, secondary traffic, nonmetallic minerals, and food or kindred products, are expected to remain the top three commodities in 2035, and will continue to account for over half or total commodities by weight. **Figure A-4** illustrates the distribution of commodities by tonnage in 2035.

The “rest of Pennsylvania” (outside the 54-county freight modeling area), the “rest of New York” (outside the 54-county area), and Ohio are expected to remain the three greatest trading partners with the 54-county modeling study area in 2035. The share of total tonnage traded with these three partners is expected to decline; however, as trade with Canada, southern states, and western states is expected to grow at a faster rate than trade with northeastern and Great Lakes states. In 2007, the top three trading partners accounted for 44 percent of all trade with other regions. In 2035, the top three trading partners are expected to account for less than 41 percent of all trade with other regions**. Figure A-5** illustrates trade with other regions throughout the country by tonnage.

POTENTIALLY DIVERTIBLE TONNAGE

Some, but not all, future study area tonnage could potentially be impacted by CHFP alternatives. To estimate the pool of tonnage from which Cross Harbor improvements could potentially generate demand—refer to here as “potentially divertible tonnage”—the following adjustments were made:

- **Tonnage that is not forecast to cross the Hudson River was excluded.** The CHFP alternatives would not impact these types of moves.
- **Pass-through long-haul truck tonnage that is linked to land border crossings with Canada was excluded.** This tonnage is almost exclusively handled via truck crossings at the far northern edge of the study area (New York Thruway/Massachusetts Turnpike) and would not be attracted by CHFP alternatives. This pass-through freight represented approximately 8 million tons of truck traffic in 2007. (Long-haul truck tonnage between domestic U.S.

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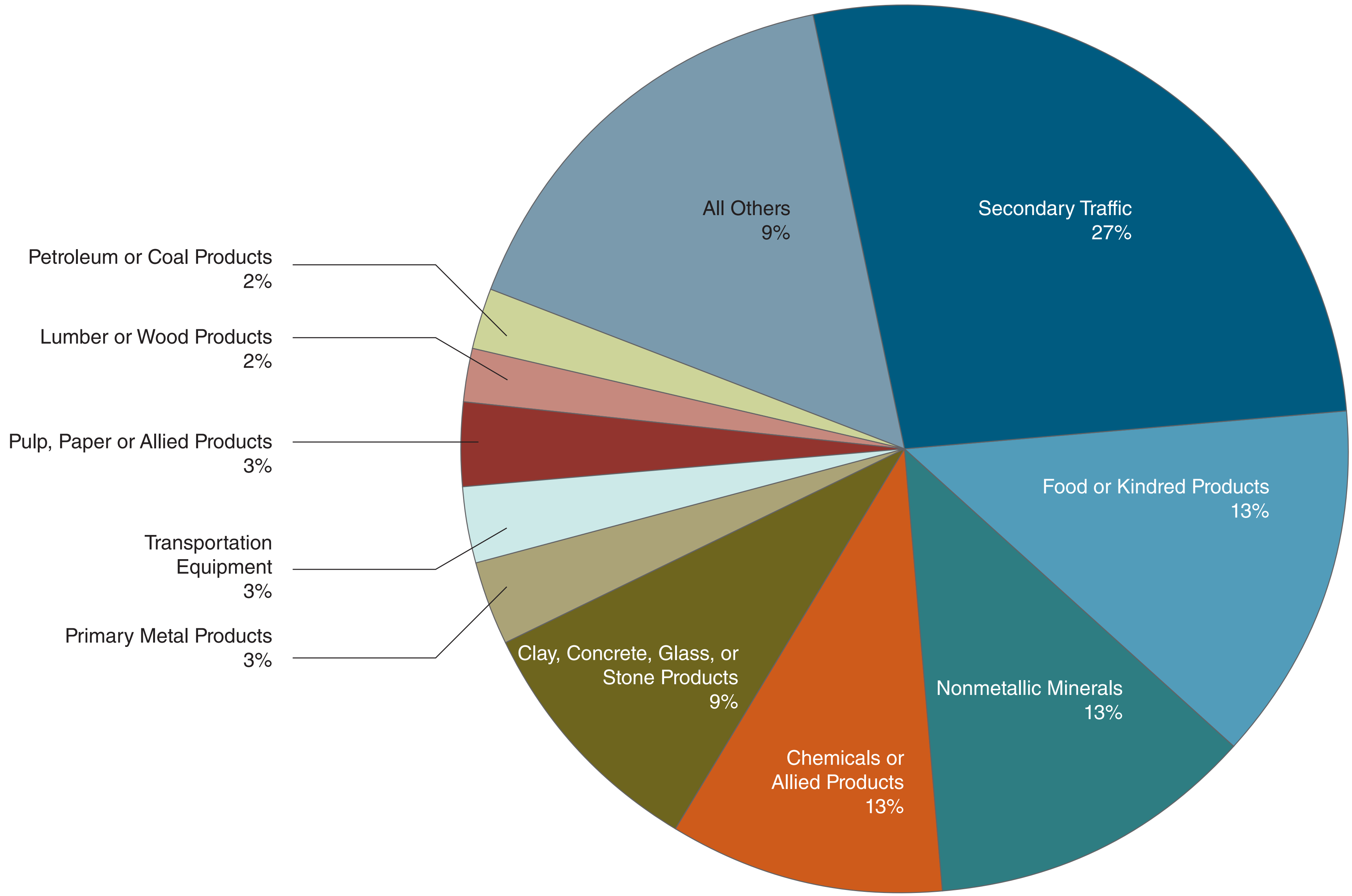

Figure A-4
Top Ten Commodities by Weight (2035) for
Trips Originating from, Destined for, or Passing through the 54-County Study Area

CROSS HARBOR FREIGHT PROGRAM

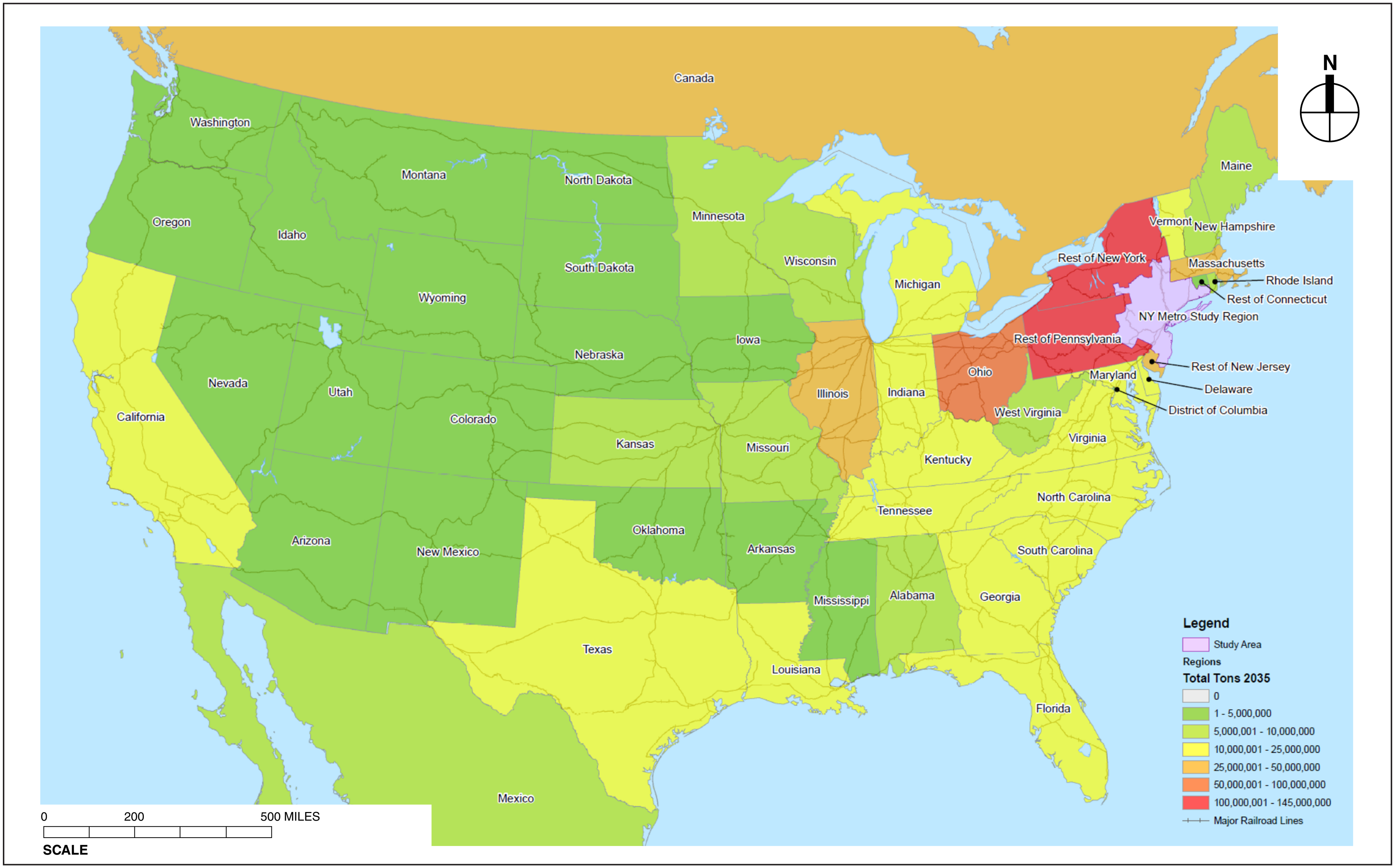

FIGURE A-5
Trading Partners by Weight, 2035
CROSS HARBOR FREIGHT PROGRAM

origins and destinations was retained as a potential market opportunity, representing approximately 73 million tons of truck traffic in 2007.)

- **Pass-through short-haul truck tonnage was excluded.** These moves are very unlikely to shift from truck to rail, or to change their highway routings based on CHFP alternatives. This represented approximately 23 million tons of truck traffic in 2007.

Excluding long-haul pass-through international trucks and short-haul pass-through trucks, all other crossing tonnage was retained and treated as potentially divertible tonnage, as shown in **Table A-11**. TRANSEARCH growth rates were applied to 2007 volumes for each type of move, except that long-haul pass-through trucks were grown at a lower rate, reflecting differences between TRANSEARCH and FAF-3 datasets with respect to this particular type of traffic.

Table A-11
Potentially Divertible Freight (million tons) and Mode Shares

Mode	2007	2035	Tonnage Increase	Percentage Increase	CAGR 2007-2035	CAGR 2012-2035
Truck	221.0 90.1%	292.5 89.6%	71.5	32.4%	1.0%	1.2%
Carload Rail	21.4 8.7%	29.7 9.1%	8.3	38.8%	1.2%	1.4%
Intermodal Rail	2.9 1.1%	4.2 1.3%	1.3	44.8%	1.2%	1.5%
Total	**245.4 100.0%**	**326.4 100.0%**	**81.0**	**33.0%**	**1.0%**	**1.2%**

Notes: CAGR is the compound annual growth rate.

As discussed later in this appendix and elsewhere in this EIS, the market forecasting methodology considered the potential for CHFP alternatives to divert a certain percentage of truck traffic to rail, and/or to divert a certain percentage of truck traffic from existing highway routes to new highway routes. These effects were calculated using a Mode Choice Model and a Highway Network Model. These diversion percentages were applied to a total of 292.5 million tons of truck traffic in year 2035, consisting of the following submarkets:

- 5.1 million tons from "last mile" short-haul truck trips to and from rail yards (2.7 million tons carload and 2.4 million tons intermodal);
- 6.7 million tons from "last mile" short-haul truck trips to and from marine container terminals (2.7 million tons for Kings-Queens-Nassau-Suffolk and 4.0 million tons for New England);
- 134.7 million tons from other short-haul truck trips with an origin or destination in the region;
- 61.0 million tons from long-haul truck trips with an origin or destination in the region; and
- 85.0 million tons from long-haul truck trips passing through the region.

As discussed in the following sections of this appendix and elsewhere in this EIS, the market forecasting methodology considered the potential for CHFP alternatives to attract a certain percentage of rail traffic from existing rail crossings. This effect was calculated using a rail network diversion model, and also considered railroad forecasts of 2.5 percent annual growth for traffic over the CSX Selkirk and NS Patriot crossings in the absence of Cross Harbor alternatives. The diversion percentages were applied to a total of 29.7 million carload rail tons and 4.2 million intermodal rail tons in 2035, consisting of the following submarkets:

- 0.1 million tons of rail carload trips with an origin or destination in the region via New York New Jersey Rail (NYNJR);
- 9.4 million tons of rail carload trips with an origin or destination in the region via CSX/NS crossings near Albany;
- 20.2 million tons of rail carload through trips via CSX/NS crossings near Albany;
- 0.4 million tons of intermodal trips with an origin or destination in the region via CSX/NS crossings near Albany; and
- 3.8 million tons of intermodal through traffic via CSX/NS crossings near Albany.

Once the market potential by segment was identified, the portion of that demand that could be captured by each of the CHFP alternatives was evaluated using three separate analyses—rail network modeling, highway network modeling, and mode choice modeling.

D. RAIL NETWORK MODELING

Cross Harbor rail infrastructure enhancements from the alternatives could lead to substantial changes in rail operations. At the same time, rail traffic growth over the regional rail freight network, absent the improvements, must be accommodated as well. Therefore, a rail operations analysis was performed by developing high-level rail traffic density projections and evaluating the broad implications in terms of rail network capacity.

The process started with the development of a model representation of the rail network in the study area, plus extensions over key national corridors where changes in traffic density arising from the CHFP were reasonably expected. The rail network model area therefore considered not only the study area west-of-Hudson and east-of-Hudson, but also corridors through New Jersey, Pennsylvania, New York, and other adjoining states.

To create the baseline model, the Oak Ridge National Laboratory's national rail network attributes regarding mileage, ownership, subdivision, number of tracks, track class and type, and control system were used as default values in the CHFP rail network (see Chapter 5, "Transportation"), and adjustments were made according to stakeholder input. Impedances were added to reflect changes in railroad ownership, operating rights, service delays, extra costs, and other factors. Link level capacities, in terms of average train moves per day, were estimated based on track configuration and operating parameters.

Train volumes were projected by applying the following annual growth rates to 2007 train volumes:[1]

- Carload freight – 1.39 percent annual growth
- Intermodal freight – 1.41 percent annual growth
- Passenger Trains – 0 percent growth

These growth rates were applied equally to loaded and empty cars. The 0 percent growth in passenger trains does not reflect a belief of no growth in passenger service, but instead, it allows

[1] Annual growth rates were provided by Cambridge Systematics. 2007 data was the latest available at the time of the analysis.

isolation of the freight service to determine the rail congestion impacts of increased freight business.

The practical capacity was derived from the values in **Table A-12**, using the methodology established in the "National Freight Infrastructure Capacity and Investment Study."[1] The number of tracks and the type of control (signaling) system for each rail segment were matched to the values shown in **Table A-12** to determine the lower and upper bounds on the number of trains per day. The mix of traffic was accounted for, since a rail line with a homogeneous fleet of trains all running at the same speed has a higher capacity then a rail line with a mixed fleet of trains running at different speeds. The adjustment for train mix is based on multiplying the standard deviation of the percentages of carload, intermodal, and passenger trains by the adjustment for train mix value in **Table A-12**. The final practical capacity is then defined as the lower bound capacity plus the product of the standard deviation times the train mix value.

Table A-12
Practical Capacity Ranges by Track Characteristic

# Tracks	Control	Capacity (trains/day)		Adjustment For Train Mix
		Lower Bound	Upper Bound	
1	Manual	15	20	10.6
1	ABS	20	25	10.6
1	CTC	30	45	31.8
2	Manual	35	40	10.6
2	ABS	45	80	74.2
2	CTC	70	100	63.6
3	CTC	115	150	74.2

The three types of control systems included were[2]:

- **Automatic Block Signaling (ABS)** – is a signal system that controls when a train can advance into the next track block by determining if a train is already occupying that block. A block is a section of track with traffic control signals at each end.
- **Centralized Traffic Control (CTC)** – is a system that uses electrical circuits in the tracks to monitor the location of trains, allowing railroad dispatchers to control train movements from a remote location, typically a central dispatching office. CTC increases capacity by detecting track occupancy and allowing dispatchers to safely decrease the spacing between trains.
- **Manual (No Signal or Track Warrant Control)** – is the least expensive and lowest capacity train control system, and is generally reserved for low-volume track. It requires train crews to obtain permission or warrants before entering a section of track; usually by radio, phone, or electronic transmission from the dispatcher.

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[1] A more detailed methodology explanation can be found in the "National Rail Freight Infrastructure Capacity and Investment Study," prepared for the Association of American Railroads, prepared by Cambridge Systematics, September 2007.

[2] Positive Train Control (PTC), which has been maintained by the Federal Railroad Administration for selected rail lines in the U.S., is not considered in this analysis. As currently defined, PTC will be overlaid on top of the existing control system providing additional safety, but no additional capacity.

The practical capacity was then converted into a theoretical capacity by dividing the practical capacity by 0.7. This was largely done for consistency with highway capacity studies, where a Volume/Capacity Ratio (V/C) below 70 percent implies no congestion issues.

A base year (2007) rail traffic database was developed, utilizing the Surface Transportation Board's Full Waybill Sample. Additional traffic representing the movement of empty rail equipment and other types of traffic not included in the STB Waybill data was estimated and included. Finally, this traffic was "flowed" over the network in a manner that provided the most efficient flows while controlling for "ownership" of the move by the originating or terminating Class I railroad. As expected, the model shows the vast majority of railcars crossing the Hudson River at Selkirk and Mechanicville, in upstate New York, as is currently the case.

Three alternative scenarios were then tested, by creating and coding new railroad service links within the model. The model was run to determine the amount of traffic that may be attracted by the proposed links from the existing crossings at Selkirk and Mechanicville. The alternatives were:

- The Enhanced Railcar Float Alternative (reflecting reduced impedances on this link);
- The Rail Tunnel Alternative under the Base Operating Scenario (reflecting current railroad interchange practices in the east-of-Hudson region);
- The Rail Tunnel Alternative under the Seamless Operating Scenario (reflecting reductions in interchange delays and costs in the east-of-Hudson region, consistent with "run through" service by a single Class I railroad);
- The Rail Tunnel Alternative under the Limited Operating Scenario (reflecting increased interchange delays and costs in the east-of-Hudson region); and
- The Rail Tunnel Alternative with Chunnel, Automated Guided Vehicle (AGV), and Shuttle service options, including the addition of extra trains to accommodate the incremental growth in traffic on portions of the network associated with each service alternative.

One important value-added result from this effort was to quantify the amount of rail traffic that the Rail Tunnel Alternative or the Enhanced Railcar Float Alternative would be likely to attract from existing Selkirk and Mechanicville rail routings. The diversion percentages and totals were calculated for year 2007 traffic, and inflated to 2035 projected volumes based on the growth rates discussed previously. The analysis was sensitive to different levels of service (interchange costs, service delays, etc.) between the three operating scenarios associated with the Rail Tunnel Alternative (Seamless, Base, and Limited Operating Scenarios), the Rail Tunnel with Shuttle Service Alternative, the Rail Tunnel with AGV Technology Alternative, the Rail Tunnel with Chunnel Service Alternative, and the Enhanced Railcar Float Alternative. In every case, traffic over Selkirk and Mechanicville was projected to grow substantially and the rate of that growth was projected to be modestly reduced by the Rail Tunnel Alternative and the Rail Tunnel Alternatives with service and technology options, and only slightly by the Enhanced Railcar Float Alternative. Another important finding was the relative difference in the likely attractiveness of the Rail Tunnel Alternative operating scenarios (Seamless, Base, and Limited) for pass-through rail traffic. The rail network model results were used to develop scaling factors, which were applied to Rail Tunnel Alternative under the Base Operating Scenario forecasts of demand that were developed using the Mode Choice Model.

Alternatives that would not have the potential to affect the rail network (LOLO/RORO Container Barge Alternatives, Truck Float/Ferry Alternatives, and Rail Tunnel with Truck

Access Alternative) were not modeled. The results were analyzed to determine the portion and amount of freight likely to be attracted from the existing crossings at Selkirk and Mechanicville by improved or new Cross Harbor rail service. Under all alternatives traffic over Selkirk and Mechanicville is projected to grow substantially. However, the rate of that growth is affected by Cross Harbor alternatives. The Enhanced Railcar Float Alternative would attract the smallest amount of commodity flows from the Selkirk/Mechanicville route, while the Rail Tunnel under the Seamless Operating Scenario would divert the greatest amount of that freight to the Cross Harbor tunnel crossing.

The alternatives mentioned here are described in Chapter 4, "Alternatives," where the results of the analyses are also shown. The results were analyzed to determine the relative ability of different alternatives to attract pass-through rail traffic. As might be expected, the Rail Tunnel Alternative under the Seamless Operating Scenario performs better than under the Base Operating Scenario, due to its lower impedances (e.g., impacts on cost, speed, and reliability associated with interchange between rail carriers).

E. HIGHWAY NETWORK MODELING AND IMPACTS

One of the Cross Harbor alternatives initially considered was a truck tunnel, in which an entirely new truck route would be constructed in the Bay Ridge cut. The Mode Choice Model (see described in Section F of this appendix) was used to estimate the likely diversion to this alternative from other routes based on tonnage; and the project highway network model was used to estimate the likely utilization of this alternative based on truck moves per day.

The development of a highway network model was necessary to test the highway impacts of all Cross Harbor alternatives, in terms of additions and subtractions of truck trips and VMT on specific links and over the regional network as a whole. The highway network model was also used to evaluate the demand for the alternatives that would establish new truck routes across the Hudson either on a rail platform (Rail Tunnel with Chunnel Service Alternative and Rail Tunnel with Shuttle Service Alternative), automated guidance vehicles (Rail Tunnel with AGV Technology Alternative), roadway (Rail Tunnel with Truck Access Alternative), or by water (Truck Float Alternative, and Truck Ferry Alternative). The Mode Choice Model, described in the following section was used to estimate the likely demand for a truck crossing based on tonnage; and the highway network model was used to estimate demand based on the number of trucks per day. Once the model was constructed for this purpose, it also became a useful tool to evaluate link demand for the truck tunnel alternative.

The analysis used a combination of two regional model systems—NJTPA's North Jersey Regional Transportation Model-Enhanced (RTM-E) and New York Metropolitan Transportation Council's (NYMTC) Best Practices Model (BPM). Developing a "hybrid" model that resolved inconsistencies between the RTM-E and BPM, and translating county and regional-level annual commodity flows into zone-level daily truck trips, required a number of technical steps:

1. Develop No Action truck trip tables using the enhanced TRANSEARCH 2007 and 2035 database;
2. Develop 2035 truck trip tables that reflect demand for the Cross Harbor alternatives;
3. Reconcile differences between the RTM-E and BPM zone detail;
4. Test the network impacts of the truck ferry, Enhanced Railcar Float Alternative, and Rail Tunnel Alternatives; and
5. Post-process adjustments for additional factors.

The approach and findings of each step are described in the following paragraphs.

DEVELOPING NO ACTION TRUCK TRIP TABLES

Annual truck tonnages from the TRANSEARCH 2007 and 2035 dataset were converted to average daily truck trips, based on tons per truck and days per year factors. The geography of TRANSEARCH flows (which were county-to-county in the study area, and multi-county outside the study area) was converted to the geographies of BPM and RTM-E (which are far more detailed inside their regions, and non-existent outside their regions) in a three-step process. First, flows were assigned to a national truck model network (FAF-3) to identify which origin-destination pairs would enter and exit the BPM and RTM-E networks at which highway points. Second, truck volumes at each model entry and exit point were compiled. Third, truck trips with origins and destinations within the model networks were disaggregated from counties to traffic analysis zones according to the proportions of large trucks in the models. It should be noted that TRANSEARCH data reports only loaded large trucks, and does not include other types of trucks (empty trucks, smaller/local delivery trucks, and non-freight carrying trucks) which are present on the highway network. TRANSEARCH trucks were integrated as a special purpose trip type within BPM and RTM-E, and grown according to TRANSEARCH projected rates; non-TRANSEARCH trucks were also retained within the models, and were allowed to grow at the corresponding rates specified in the models.

TRAFFIC ASSIGNMENT

The traffic assignment process was run in both BPM and RTME model using the trip tables developed by the methods described above. The assignment process was run along with other modes on the highway network. The MPO models' assignment routines require the daily trip table to be divided into four time of day periods: AM, PM, mid-day and night. The daily truck trips were distributed into four time of day using the time of day factors used by the MPO models. Finally, the assigned flows by the time of day were combined to generate the flows at daily level. The flow developed by RTME model was used to analyze the travel pattern in the west-of-Hudson region. The flow from BPM model was used for analysis of east-of-Hudson travel pattern.

The national enhanced TRANSEARCH commodity flow database described was used as the starting point for developing the no action truck trip table. This database contains a flow table which contains origin zone, destination zone, and number of annual trucks and a commodity type, stated as a Standard Transportation Commodity Classification (STCC) code. This information was used to convert the database into a trip table. The FHWA website provided hyperlinks to a downloadable version of the FAF2 network available as a TransCAD network, including attribute fields used in assignment. The assignment process is described in the FAF2 technical documentation and this description was used to develop suitable code in the TransCAD software platform. TransCAD subarea extraction module was used to window out the national level database at the level of the MPO model boundaries.

The TRANSEARCH commodity flow database was converted to a weekday truck origin-destination (OD) table since the traffic assignment process used by the MPO models require the trips to be in daily trucks. The STCC is a hierarchical classification system and the additional STCC4 detail in the PANYNJ TRANSEARCH database is not needed and the flows were aggregated to STCC2 digit codes. The flows in TRANSEARCH are reported both as annual tons and annual trucks. For this analysis the annual tons unit was used. The payload factors tons per truck by STCC2 code, shown in **Table A-13**, were used to convert annual tons to annual trucks.

A comparison of average mid-weekday to annual flows from continuous truck classification count stations in northern New Jersey was used to determine that the weekday truck flow was equivalent to dividing the annual flow by 295.

Table A-13
Tons per Truck by STCC2 Code

STCC	Tons per truck	STCC	Tons per truck	STCC	Tons per truck
1	12.91	23	14.76	34	17.99
8	24.93	24	22.54	35	11.61
9	21.06	25	12.65	36	14.98
10	17.28	26	20.07	37	11.32
11	12.80	27	15.35	38	11.39
13	21.05	28	18.40	39	17.97
14	22.07	29	18.60	40	21.01
19	20.39	30	10.88	41	20.71
20	20.45	31	13.67	49	21.72
21	11.05	32	14.43	50	18.04
22	21.38	33	24.84		

The zone numbering system in the PANYNJ database uses county FIPS codes for 54 zones in a core study surrounding New York City, county FIPS codes for 190 counties in a buffer area surrounding the core study area, FAF3 regions for the rest of the U.S., Canadian Census Metropolitan Areas and provinces, and Mexico. Any sound process, including professional judgment, can be used to select the county centroid corresponding to zones which are aggregations of counties. This step has no statistical meaning and the choice of this centroid is merely a convenience in the assignment process which allows the direct use of the national highway system described in the following section. Using a database of truck trip ends by county, the FIPS county within each FAF3 region was selected to represent the weighted county loading centroid within each FAF3 region. In addition, the U.S. county which is used to cross the U.S. border from Canadian zones and Mexico was chosen based on professional judgment.

FAF3 NETWORK CODING

The FHWA website provides a hyperlink to download the FAF3 network as a TransCAD network. This network does not provide county centroids, but county centroids can easily be added by most travel demand modeling packages given the zonal boundaries, in this case—counties. The county centroids were added to the FAF3 network in the vicinity of the centroid of activities within the counties. The FAF3 technical documentation describes the method used to calculate link impedances, including such attributes as truck restrictions and non-freight truck congestion, to assign the FAF3 daily highway trucks. These procedures were coded into TransCAD.

The commodity truck trip table described previously can be assigned to the national highway network. As described, the flow units of that trip table were converted from annual truck to weekday trucks. The FIPS county centroids of the national network have been associated with the appropriate zones of the commodity table. The assignment of the commodity truck table to the national network considers congestion for both commodity and non-commodity highway traffic and the infrastructure of the highway links.

WINDOWING TO MPO NETWORK BOUNDARIES

The zonal layers of the respective MPO models were obtained for the same projection as the loaded national highway network. These shapefiles were overlaid on the national highway network and GIS was used to define a select set of national network highway links that cross the MPO boundaries. The subarea extraction procedure in TransCAD was used to create an origin-destination commodity truck trip table for the sub-areas defined by the MPO boundaries.

DEVELOPING WITH-PROJECT TRUCK TRIP TABLES

The mode choice model application calculates changes in truck trips as a result of CHFP improvements. For each alternative involving a change in truck demand, as calculated by the Mode Choice Model, corresponding changes were made in the 2035 Truck Trip Tables. The results of the demand modeling—reflecting reductions in truck traffic on key corridors, as well as potential increased concentrations of truck traffic at local facilities—were exported into the updated BPM and RTM-E travel demand models. Corresponding modifications were made to truck trip tables and to physical highway networks, to the extent that such improvements are part of the CHFP alternatives.

The locations of new and expanded freight facilities and associated demand were built into the model for each alternative and operating scenario. The travel demand modeling then produced quantitative estimates of changes in the volume and distribution of trucks over the regional highway network, changes in associated congestion and travel speed and level of service, changes in emissions, and other metrics, as reported by the specific modeling tool.

RECONCILING RTM-E AND BPM DIFFERENCES

Although the RTM-E and BPM model study areas are largely overlapping, the models do not maintain the same level of zone detail for non-core areas as they do for their core counties. In particular, the NJTPA model has very little detail east of the Hudson, except for Manhattan. Due to these zonal differences, the modeling platform for Cross Harbor analysis relied on a combination of these two model systems. The highway assignment for the east-of-Hudson region and Staten Island was performed using the BPM model due to the existence of detailed roadways of in the BPM network for this geography. The RTM-E model was used for truck trips in the west-of-Hudson region (excluding Staten Island) due to the more detailed network in the model for this geography. For trips between west and east of Hudson, a crosswalk between these two models was used. A hybrid model approach was developed for this purpose.

BPM/RTM-E HYBRID MODEL

A highway network modeling platform was developed for the CHFP, which was used to estimate the effect of the Build Alternatives on the highway network. In the hybrid modeling approach, the trip tables from the two MPO models were synthesized based on the fact that the Hudson River crossings are the only connections between the highway network in the east-Hudson and west-of-Hudson regions. These river crossings are:

- Newburgh Beacon Bridge
- Bear Mountain Bridge
- Tappan Zee Bridge
- George Washington Bridge
- Lincoln Tunnel

- Holland Tunnel
- Goethals Bridge
- Outerbridge Crossing
- Bayonne Bridge

The river crossing truck flows on both of the MPO models were compared with the existing count data. The comparison showed that the performance of both models in matching the river-crossing counts is similar. The total river-crossing flows from each of the models are close. Based on this comparison, the BPM model was considered as the pivoting point in the trip table development of the hybrid model. In the hybrid model approach, the BPM model was run to develop the flows on the east-of-Hudson highway network and RTME was run to develop flows on the west-of-Hudson highway network. The RTME truck trip table was adjusted so that the river crossing truck flow in RTME model becomes same as that in BPM model. In order to get the river-crossing trips in both of the models, select link analysis was performed. The steps in hybrid model approach are shown schematically in **Figure A-6.**

DISAGGREGATION FROM COUNTY LEVEL TO MODEL ZONES

The conversion of the sub-area trip table to a geographic format consistent with the MPO trip tables is a two-step process. First the national highway links that have been selected as sub-area external stations were associated with the external stations of the respective MPO models. This was done by visually obtaining the equivalent numerical codes. Secondly, for the internal zones, the disaggregation factors were developed based on the trip distribution pattern of the models. The model distributes the trips among the transportation analysis zones (TAZ) based on its trip distribution model. The model trips at the county level can be developed by aggregating the trip table at the county level. The disaggregation factors were developed from the ratio of the trips at TAZ level to the trips at county level. The following equation describes the calculation of the disaggregation factors for each origin-destination pair in the origin-destination table:

$Factor_{ij} = T_{ij}/CT_{ij}$

Where,

i = origin

j = destination

T = trips at TAZ level

CT = trips at county level

The subarea trips were multiplied by the disaggregation factors to disaggregate the county level trips at the TAZ level.

RTM-E TRIP TABLE MODIFICATION

This model has three modes which are used during the assignment process: Single Occupant Vehicle (SOV), High Occupant Vehicle (HOV) and heavy truck. However, the SOV trip table includes medium trucks. This medium truck trip table was separated from SOV table. The heavy truck was divided into two categories: commodity and non-commodity. The revised model has five modes: SOV, HOV, Medium Truck, Heavy Commodity Truck and Heavy Non-commodity Truck. The commodity truck trip table developed by the windowing process described above

5.9.14

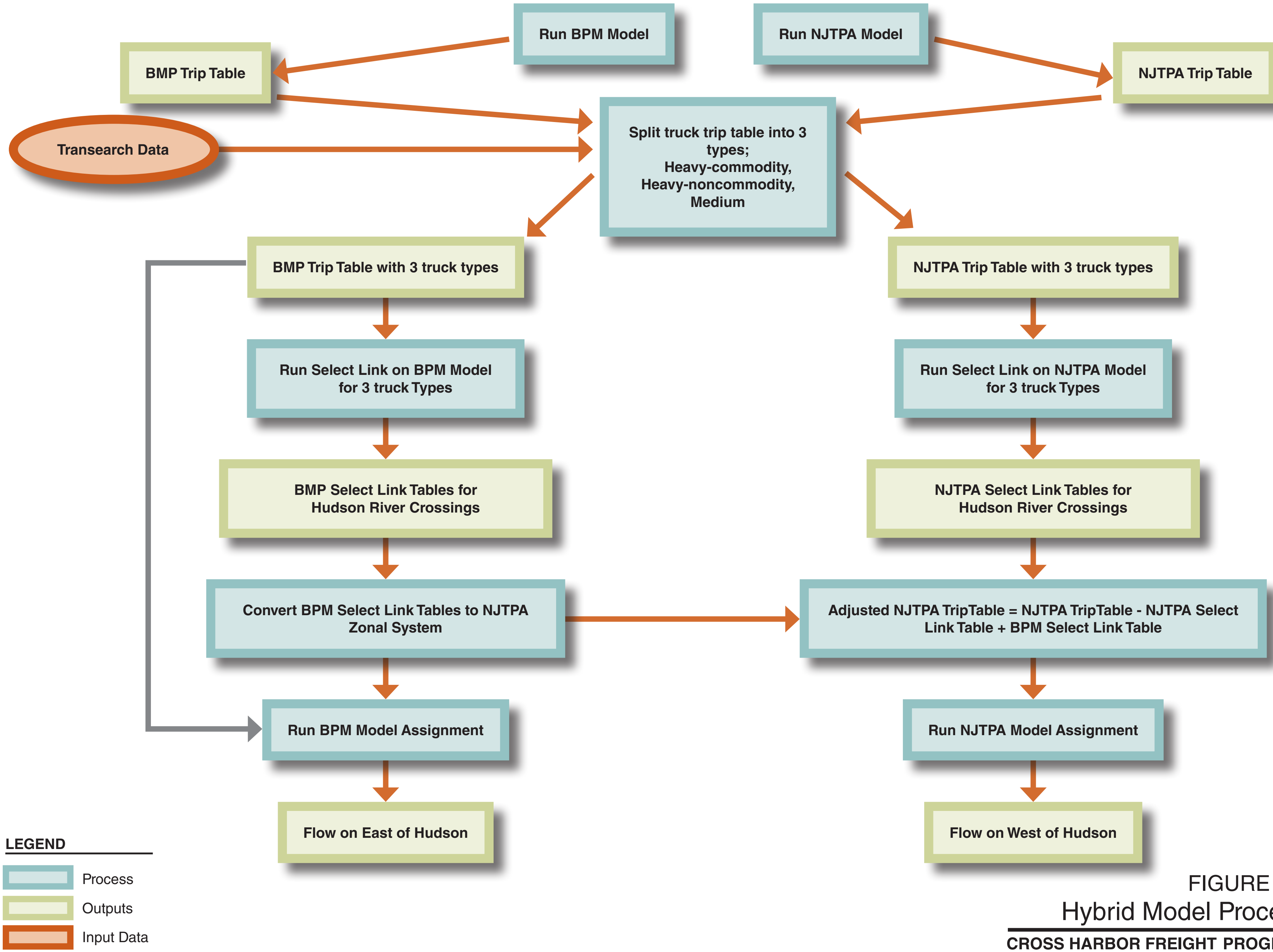

FIGURE A-6
Hybrid Model Process

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was used as the heavy commodity truck trip table. This trip table was then subtracted from the heavy truck table developed by the model to develop non-commodity truck trip table.

BPM TRIP TABLE MODIFICATION

The BPM model includes SOV, HOV2, HOV3, Taxi, Commercial Vehicles, and Trucks. According to the BPM documentation, trucks are defined as commercial vehicles with 2 or more axles and 6 or more tires. All other commercial vehicles are defined as "Commercial." Trucks are defined as a combination of medium and large trucks as in the RTME model. A process was developed to separate these two types of trucks. Using the RTM-E truck model, the share of medium and heavy trucks was calculated for each origin-destination pair based on a distance group, which was defined based on the distance between the origin and the destination. These factors were then used to split trucks in BPM model into medium and heavy trucks. **Table A-14** shows the distance groups used for this purpose.

Table A-14
Light and Heavy Truck Shares by Distance Traveled

Distance Traveled	Medium Truck	Heavy Truck
<5	60%	40%
5 to 10	59%	41%
10 to 20	55%	45%
20 to 30	52%	48%
30 to 40	37%	63%
40 to 50	29%	71%
50 to 60	24%	76%
60 to 70	18%	82%
70 to 80	13%	87%
80 to 90	12%	88%
90 to 100	28%	72%
100 to 110	55%	45%
110 to 120	48%	52%
120 to 130	11%	89%
130 to 140	10%	90%
140 to 150	5%	95%
150 to 160	12%	88%
160 to 170	5%	95%
170 to 180	5%	95%
180 to190	3%	97%
190 to 200	4%	96%
>200	28%	72%

Manhattan was treated as a special case based on the fact that within Manhattan the percent of large trucks is lower. **Table A-15** was developed for Manhattan TAZs. In the final factor matrix, the percentages of medium and heavy trucks were adjusted for origin-destination pairs that have Manhattan TAZ as their origin and/or destination.

Table A-15
Light and Heavy Truck Shares by Distance Traveled for Manhattan TAZs

From Manhattan			To Manhattan		
Distance Traveled	Medium Truck	Heavy truck	Distance Traveled	Medium Truck	Large truck
<5	0.86	0.14	<5	0.86	0.14
5 to 10	0.79	0.21	5 to 10	0.79	0.21
10 to 20	0.80	0.20	10 to 20	0.80	0.20
20 to 30	0.68	0.32	20 to 30	0.70	0.30
30 to 40	0.67	0.33	30 to 40	0.69	0.31
40 to 50	0.58	0.42	40 to 50	0.62	0.38
50 to 60	0.54	0.46	50 to 60	0.54	0.46
60 to 70	0.33	0.67	60 to 70	0.33	0.67
70 to 80	0.54	0.46	70 to 80	0.54	0.46
80 to 90	0.50	0.50	80 to 90	0.40	0.60
90 to 100	0.34	0.66	90 to 100	0.34	0.66
100 to 110	0.63	0.37	100 to 110	0.70	0.30
110 to 120	0.96	0.04	110 to 120	0.96	0.04
120 to 130	0.28	0.72	120 to 130	0.28	0.72
130 to 140	0.25	0.75	130 to 140	0.24	0.76
140 to 150	0.26	0.74	140 to 150	0.26	0.74
150 to 160	0.26	0.74	150 to 160	0.22	0.78

Table A-16 shows a comparison of total medium, large truck commodity and heavy non-commodity truck in both of the models for year 2035. These numbers show consistency between the two models even though the RTM-E model shows a slightly higher number. Because these MPO models cover different geographies, a difference was expected. The similarity shows how much of the trucking activity in each model is in the shared area, common to both models.

Table A-16
Comparison of Light and Large Truck in BPM and RTM-E Models

	BPM	RTME
Heavy Commodity Truck	167,580	204,420
Heavy non-commodity Truck	642,145	617,640
Medium Truck	915,684	925,881
Total	**1,725,409**	**1,747,941**

RIVER CROSSING ADJUSTMENT

The network links representing the river-crossings between east-of-Hudson and west-of-Hudson, listed previously, were identified on both RTME and BPM model networks. The select link analysis was run on both of the models to develop the river-crossing trip tables. The river-crossing trip tables include only the OD trips that cross the bridges and the tunnels on Hudson River between east-of-Hudson and west-of-Hudson.

The modified RTME trip table developed by the process described earlier was adjusted for the river-crossing trips. The objective of this adjustment was to make the river-crossing truck trips in the adjusted RTME trip table the same as those in BPM model. The river-crossing trips in both of the models were developed by the select link analysis discussed earlier. The adjustment process is based on the following equation.

Adjusted RTME Trip = RTME Trip – RTME River Crossing Trip + BPM River Crossing Trip

In order to make this adjustment, the river-crossing trip table developed by select-link analysis on the BPM network is converted from BPM zonal structure to RTME zonal structure. An equivalency table was developed between the zones of the two models to implement this conversion. **Figure A-7** shows the RTME/RTME and BPM TAZ layers. It can be noted that there are overlapping and non-overlapping areas between the two models.

For the overlapping portion, the zonal equivalency between the two models was developed based on the area of TAZs. The overlapped areas between BPM and RTME TAZs were developed by GIS processes. Based on the overlapped area and the area of the model TAZs, the relationship and the equivalency factors between BPM and RTME zones were developed.

The equivalency factors for the non-overlapped portion were calculated by aggregating the BPM zones into several zones. The BPM trips for the aggregated BPM zones were distributed among the RTME zones that exist within the corresponding aggregated zone. The distribution factor was calculated from the share of RTME trip ends within the aggregated zones.

NETWORK CHANGES FOR THE BUILD ALTERNATIVES

The Truck Float/Ferry, Enhanced Railcar Float and the Rail Tunnel Alternatives (with all service and technology options) did not require changes to the highway network. The analysis required only that the truck trip tables be adjusted with respect to volumes, origins, and destinations. Each alternative was analyzed for its potential to impact truck traffic on an average weekday, as quantitatively measured by changes in:

- Vehicle miles traveled (VMT)
- Vehicle hours of travel time (VHT)
- Vehicles hour of delay (VHD)
- Change in travel time
- Peak period traffic and truck volumes
- Link volumes and levels of service, representing demand for existing and new routes

To estimate demand for the Rail Tunnel with Truck Access Alternative, one additional step was performed. The truck tunnel was coded as a new highway link in the model, reflecting its potential alignment, access points, number of lanes, and toll cost (matching other PANYNJ toll crossings). Then the model was run with the 2035 No Action truck trip table to determine how many trucks would use the new link, versus other crossings. This finding was combined with the tonnage-based estimate of demand from the Mode Choice Model process.

Different alternative river crossing scenarios with associated levels of service (LOS) and changes in freight demand were developed for CHFP alternatives. Each scenario resulted in changes in commodity flow demand. These changes occurred due to the diversion of truck trips from the existing Hudson River crossing facilities to the crossings that would be established or improved by the Build Alternatives. The diversion of truck trips to the rail carload was accounted for by complete removal of truck trips from the original or No Action scenario trip table developed from TRANSEARCH database. The intermodal trips diverted to rail were removed from the original demand and added back at the intermodal terminals.

The shipper path-choice analysis was used to develop truck trips diverted to rail. The path-choice analysis considered only the commodity truck trips developed from commodity flow database that have one trip end (origin/destination) located at the outside of the study area and another trip end within the study area. The path-choice market does not include the through trips that have both trip ends outside the study area. The tonnage for the trough-trip market was

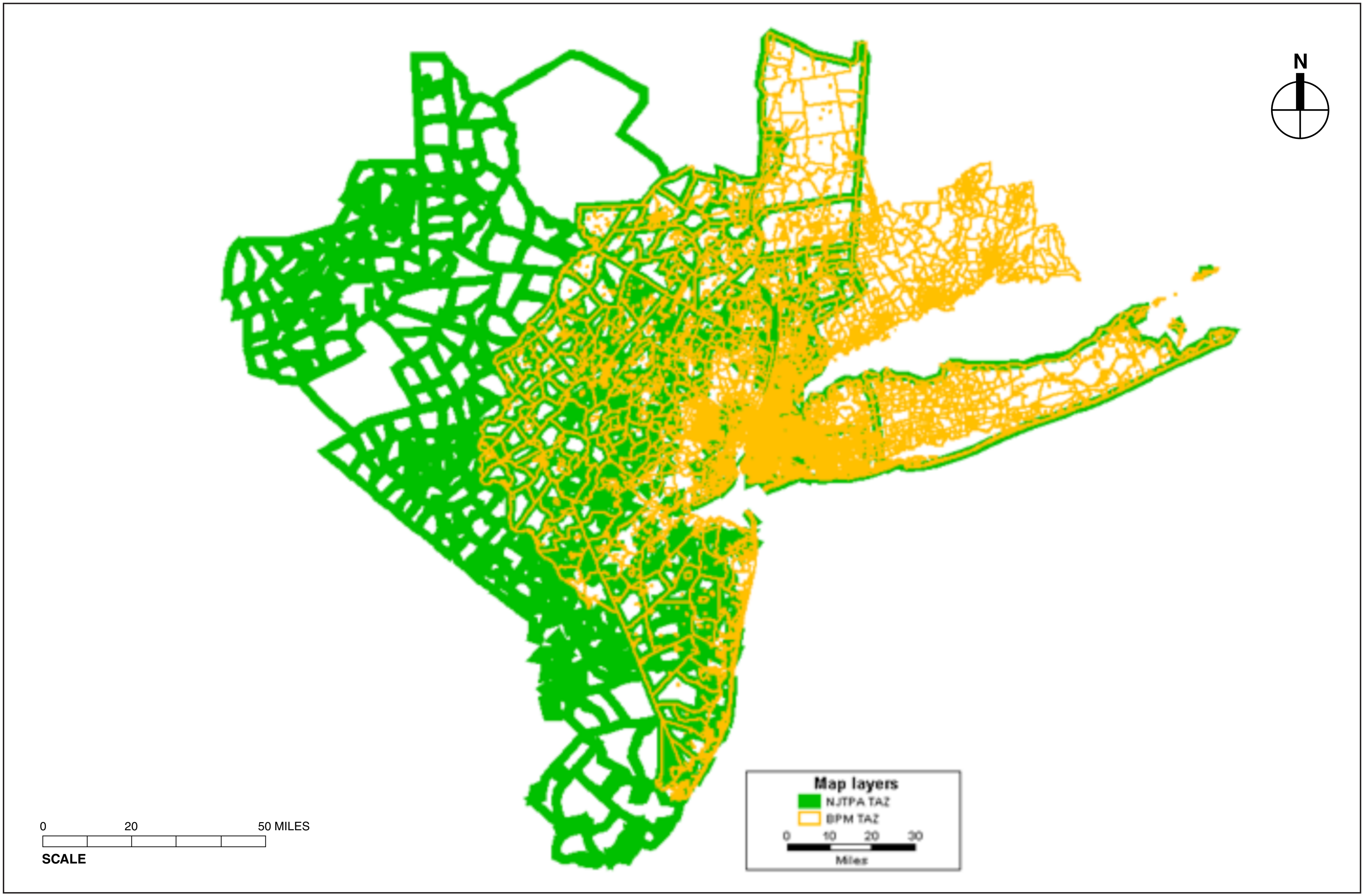

FIGURE A-7
BPM and RTME Zones

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developed from the commodity flow. A diversion factor was developed from the cumulative response of the diversion of long-distance trips for the New York City east-of-Hudson market. As noted previously, the TRANSEARCH database did not include all of the intermodal drayage within the study region. This portion of demand was estimated from FHWA's FAF3 database as previously described. The diversion of container drayage from west-of-Hudson locations resulted in a relocation of the rail portion of the container trips from these locations to intermodal terminals in the east-of-Hudson region. The rail portion of container trips were removed from the original truck trip table and the truck portion of these trips start or end at intermodal terminals in the east-of-Hudson region. The diversion of inland port trips was also considered in the trip table adjustment process.

The adjusted trip tables developed for different alternative scenarios were assigned on BPM and RTME network to get the flow on both sides of Hudson River. The assignment process required the trips to be expressed as daily trucks. Therefore, the truck trips in annual tons were converted to daily trucks by using the payload factors stated in **Table A-13** and by using 295 days in a year reported in National Cooperative Freight Research Program Report 8.[1] The adjusted trip table was converted to the zonal system of each of the MPO models using the approach described earlier.

POST-PROCESS TRIP TABLE ADJUSTMENTS

Additional adjustments were made to accommodate for cross-harbor logistics patterns, including:

- **Adjustments for Empty Trucks Crossing the Hudson.** When trucks make their pickups and deliveries, the presumption is they are loaded in one direction and empty in another. The empty trucks then circulate until they find another load. In some cases, finding the next load involves another Hudson crossing, and in other cases it does not. From the PANYNJ crossing surveys, it appears that 25.2 percent of crossing trucks (both directions summed) are empty, and 75 percent are loaded. So for each three loaded crossing trucks, there is one empty crossing truck. This, in turn, suggests the number of total truck crossings eliminated should be the loaded truck crossings eliminated times 1.33. This adjustment was applied to each crossing facility.
- **Adjustments for Empty Truck VMT.** Within the model area, empty trucks crossing the Hudson presumably generate as much VMT as loaded trucks crossing the Hudson, on average. However, empty trucks that do not cross the Hudson are presumably generating less VMT because they are finding a load on their own side of the river. In other words, they do not have to go as far to find their next load. The adjustment factor applied to calculate the VMT eliminated from the loaded truck VMT eliminated was 1.67.[2]

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[1] National Cooperative Freight Research Program (NCFRP) Report 8, Freight-Demand Modeling to Support Public-Sector Decision Making,

[2] Assuming 100 truck crossings with 75 loaded trucks and 25 empty trucks, one-third of the empty trucks generate VMT at the same rate as loaded crossing trucks, while two-thirds generate VMT at a lower rate because they are not crossing; assumed to be half of the full rate. So, to the loaded truck VMT, 33 percent were added (for one-third of empties at the full VMT generation rate) plus 33 percent (for two-thirds of empties at half the VMT generation rate). This suggests the total VMT eliminated should be the loaded truck VMT eliminated times 1.67. This adjustment was applied to each county.

F. MODE CHOICE MODEL

One of the most important effects of the CHFP Build Alternatives is that some freight shippers will use the alternative mode/route instead of the current mode/route they use. The share of shippers that would change their current practices as a result of the Build Alternatives would depend on the attractiveness of the Build Alternative as compared with their current practice. For most shippers, the leading decision factors are: cost, speed, and reliability.

Estimating the potential attractiveness of each alternative therefore requires answering these questions:

- Which of these advantages (cost, speed, reliability) are most important to freight shippers?
- What service advantages would be offered by Cross Harbor Build Alternatives, compared to current modes?
- For each type of freight move (origin-destination pair and travel route/mode), what percentage of freight shippers would choose a Build Alternative, based on the different levels of services being offered? What is the total estimated demand for each Build Alternative? This is a function of the percentage of freight shippers choosing a specific Build Alternative, times the year 2035 base of demand, specific to each origin-destination pair and travel route/mode.

SHIPPER SURVEYS

The first step was to clearly understand and describe the factors used by decision-makers to select a particular mode of transportation. To do so, surveys of and qualitative research with freight shippers and receivers in the corridor have been completed. The objectives of this research were:

- Understand how cross-harbor shippers make decisions regarding freight transportation, including mode and carrier choices, through a coordinated program of one-on-one interviews and focus groups.
- Understand the role of supply chain logistics on these decisions through a coordinated program of one-on-one interviews and focus groups.

Focus groups sessions and executive interviews with shippers and other logistics professionals were used to gather information regarding the needs and behaviors that influence logistics decisions. This information helped to develop and “pre-test” both the revealed-preference and stated-preference surveys. Participants were recruited from a list of companies that are likely to make/receive freight shipments in the New York (Manhattan), Bronx, Kings (Brooklyn), Queens, and Nassau counties. The primary qualification for the groups required transportation of freight shipments across the Hudson River. Participants also were asked for the percentage of shipments designated as long haul (more than 400 miles) versus short haul. In addition, a mix of industries and geographies were obtained for each group.

Two focus group sessions were held in Manhattan on February 23, 2010. There were six participants in the long-haul group (6:00 PM) and seven in the short-haul group (8:00 PM). Some information describing the participants is listed below.

- **Focus Group 1 –** All participants were either in managerial positions in their respective firms or business owners. None of the participants owned their own fleet of trucks. Three out of the six participants shipped textiles and apparel. The remaining three shipped heavy machinery (elevator equipment), computer products, and plastic (PVC), respectively.

- **Focus Group 2 –** All participants were either in managerial positions in their respective firms or business owners. Two of the participants owned trucks/delivery vans to make local deliveries. The group was drawn from more diverse industries. Typically, shipped goods included lighting fixtures and home furnishings, plastic goods and fiber optics, cosmetics, ladders, and catalytic converters.

The focus group participants were engaged in a discussion that focused on four key areas:

1. Shipment decision process;
2. Considerations for cross-harbor shipments;
3. Pretest of a Stated-Preference Survey; and
4. Possible infrastructure improvements for the cross-Harbor corridor

Following up on the findings of the Focus Groups, a series of structured, professionally facilitated, in-depth interviews were conducted by the project team. A total of 10 interviews were conducted, 9 by telephone and one in person. The interviews were administered on April 28, April 29, May 4, May 19, and May 27, 2010. Establishments were recruited based on two criteria:

1. **Intermodal Experience –** Only those firms that reported using multiple modes for transporting their freight were included in the study. This limiting condition was placed so that the project team could probe the respondents for the rationale behind choosing different modes for goods movement.
2. **Cross-Harbor Movement –** Only those individuals who reported shipping goods across the Hudson Bay were selected. This criterion was established so that individuals with knowledge of the local freight infrastructure were included in the interviews.

All recruited individuals were knowledgeable shipping professionals who hold key positions within the logistics arms of their organizations. Common titles included managers (traffic, transportation, or operations), chief operating officers, director of operations, vice president of supply chain, and logistics coach. In total, employees from five major logistics companies and three large retailers were recruited for the interviews.

Three large retailers were interviewed, including one of the largest drugstore chains, a leading discount warehouse club, and a major household goods retailer. These establishments reported shipping at least 50 million pounds of freight annually. Seven freight logistics companies were interviewed. Five were large national transportation firms that had a huge operational presence in the region.

The variables reported as most significant in making freight shipping decisions included: cost, travel time, and reliability.

LEVEL OF SERVICE ESTIMATION

The next step was to quantify the performance of Cross Harbor alternatives in terms of these key variables—cost, speed, and reliability—to allow for comparison against current freight shipment modes and methods. These estimates of cost, speed, and reliability represent the Level of Service (LOS) for an alternative. If an alternative offers an improved level of service for the parameter(s) that matter most to users, it is likely to succeed in attracting traffic.

The 2035 TRANSEARCH dataset provides individual records of tonnage by mode, origin-destination, and commodity type. Level-of-service attributes were developed for each record, reflecting: average travel time; average travel cost; and reliability (frequency of delivering within a specified delivery window). This information represents the No Action level of service for each database record.

For records involving only truck trips, highway routes and distances and travel times were determined nationally based on least-distance travel paths, using the Freight Analysis Framework truck network. Truck costs were estimated on a per-mile basis, using FHWA average factors modified by local cost information derived from Cross Harbor stakeholder interviews.

For records involving rail trips, rail routes and distances and travel times were estimated using the Oak Ridge National Laboratory's (ORNL) Center for Transportation Analysis (CTA) national rail network.[1] Additional time was added to rail trips to reflect transfers to/from trucks, associated with local pickup and delivery. Rail costs can vary quite significantly depending on the volume being handled by the railroad on a particular route. Unit trains tend to be the most affordable configuration, while a small number of "loose cars" being tend to be the least affordable. To represent average conditions, the costs of end-to-end rail service (including truck pickup and delivery) were set at 90 percent of the equivalent all-truck cost. This approach is fully consistent with previous USDOT TIGER (Transportation Investments Generating Economic Recovery) grant applications prepared for both NS and CSX.

NO ACTION LEVEL OF SERVICE ESTIMATION

For the No Action Alternative, existing truck and existing carload and intermodal rail distances were used to develop truck, carload rail, and intermodal rail times and costs. Also included in the No Action LOS are extremely poor carload rail and truck ferry times and costs. The times and costs of non-truck modes were used in the No Action mode choice analysis in order to establish base diversion estimates for all the modes that were considered.

Truck Highway Time

The basic travel time of a truck is taken to be the highway distance in miles, from the skim distance adjustment, traveling at 50 miles per hour. To these driving times, rest periods are added, according to the Federal Motor Carrier Safety Administration Hour of Service rules (49 CFR Part 395). This requires a rest period of 10 hours, after every 14 hours of on-duty service. The on-duty period may not include more than 11 hours of driving, followed by that 10 hour rest period. This is expressed mathematically as:

> *Highway distance/50 MPH + 14 hours *Truncate (Highway Distance/ (50 mph* 11 Hours))**

[1] Center for Transportation Analysis (CTA) in the Oak Ridge National Laboratory (ORNL). CTA Transportation Networks; County-to-County Distance Matrix, "A matrix of distances and network impedances (commonly called a "skim tree") between each pair of county centroids via highway, railroad, water, and combined highway-rail paths. The matrix is called "CtyODp4," and was calculated in 2011 Apr using the intermodal network ce07". http://cta.ornl.gov/transnet/SkimTree.htm, accessed June 3, 2011.

NYC Penalty

In addition to the normal travel time for a truck, an additional time penalty is added to travel which has an origin or destination in the New York City boroughs and Nassau and Suffolk Counties. This penalty was determined based on the constant dollar surcharge established by a regression of truck drayage charges for New York City. The fixed cost from that regression was $188 and at value of truck time of $85 per hour, as commonly used in Benefit-Cost Analysis, this equates to approximately 2.2 hours.

Truck Cost

Truck rates are most commonly expressed to shippers as a cost per mile with no constant term. The U.S. Bureau of Transportation Statistics has calculated truck rates to be approximately $0.13 per ton-mile in 2003.[1] Adjusted for inflation to 2007 USD, using the Producer Price Index requires that this charge be multiplied by 1.3. This can be expressed mathematically as:

*$0.1314per ton-mile * 1.3* Highway distance*

Hudson River Crossing

Tractor trailer freight trucks which cross the Hudson River must pay a bridge or tunnel crossing toll. This toll, as a cash price, is $40 per eastbound crossing. Modal costs must be expressed as costs per ton. At an assumed full load of approximately 20 tons per truck this equates to $2 per ton. This charge is applied to all trips with an origin west-of-Hudson and a destination east-of-Hudson.

East-of-Hudson and NYC Penalty

As previously discussed, a regression of New York City truck drayage rates established that the fixed costs component was $188 per truck. At an assumed full load of approximately 20 tons, this equates to:

=IF (Origin="NY NYC east-of-Hudson" or Destination="NY NYC east-of-Hudson") THEN (NYC Penalty cost =$188/20tons per truck) ELSE (NYC Penalty Cost =$0)

Carload Rail Time

Over 19,000 rail distances and times between county locations through North America and locations in New Jersey, Brooklyn, and Queens were obtained. From those times and distances, a linear regression of total carload rail (as manifest trains) travel time as a function of distance was calculated with a constant term of 48.84 hours and a variable term of distance of 0.081 hours per mile (which as an inverse can be expressed as 12.35 MPH). This total time consisted of terminal times at both ends; time during interchanges between railroads, if any; time at intermediate yards of the same railroad, if any; and transit time at approximately 22.4 MPH. The linear regression had an R-square of 0.9586. This can be expressed mathematically as:

*48.84 hours + Rail Distance * 0.081 hours per mile, or * (1/12.35 MPH):*

[1] Bureau of Transportation Statistics, National Transportation Statistics, Table 3-21, Average Freight Revenue Per Ton-mile by Mode., http://www.bts.gov/publications/national_transportation_statistics/html/table_03_21.html

It should be noted that this formula does not mean that carload transit running speed is 12.35 MPH and that dwell time is 48.84 hours. It only means that these constant and variable terms, when used with distance, provide a reasonable estimate of carload rail total travel time.

Carload Rail Cost

Unlike truck costs, carload rail costs are considered to have both a fixed cost and a variable cost component based on distance, where the rail distance is that taken from the adjusted CTA distance skims. Based on costs and distances as established for the 2004 *Cross Harbor Freight Movement Project DEIS*, a formula was developed for carload rail costs as a function of distance. Those carload rail costs, when adjusted for inflation, in 2007 USD are $20.93 per ton as the fixed costs component and a variable cost component of $0.0304 per ton mile. This can be expressed mathematically as:

*$20.93 per ton + $.0304 per ton-mile * rail distance*

Intermodal Rail Time

As previously discussed, over 19,000 rail distances and times between county locations between North American and locations in New Jersey, Brooklyn, and Queens were obtained. From those times and distances, a linear regression of total intermodal rail (as intermodal trains) travel time as a function of distance was calculated with a constant term of 52.76 hours and a variable term of distance of 0.0437 hours per mile (which as an inverse can be expressed as 22.9 MPH). This total time consisted of terminal times at both ends; time during interchanges between railroads, if any; and transit time at approximately 31.3 MPH. The linear regression had an R-square of 0.8895. This can be expressed mathematically as:

*52.76 hours + Rail Distance * 0.0437 hours per mile, or * (1/22.9 MPH):*

It should be noted that this formula does not mean that intermodal rail running speed is 22.9 MPH and that dwell time is 52.76 hours, only that these constant and variable terms when used with distance provide a reasonable estimate of intermodal rail total travel time.

Intermodal Rail Costs

Unlike truck costs, intermodal rail costs are considered to have both a fixed cost and a variable cost component based on distance, where the rail distance is that taken from the adjusted CTA distance skims. Based on costs and distances as established for the Cross Harbor Freight Movement Project DEIS which included dray truck charges at either end of the trip, a formula was developed for intermodal rail costs as a function of distance. Those costs, when adjusted for inflation, in 2007 USD are $60.96 per ton as the fixed cost component and a variable cost component of $0.06305 per ton mile. This can be expressed mathematically as:

$60.96 per ton + $.06305 per ton-mile times rail distance

At these respective costs for truck, and intermodal rail, the break-even point where truck and carload rail costs are equal, according to these equations, is 565 miles.

CROSS HARBOR ALTERNATIVES LEVELS OF SERVICE ESTIMATION

For trips that begin or end exactly where one of the Cross Harbor alternatives begins or ends, or in cases where there is a change in mode, the Cross Harbor alternative provides a substitute for the entire trip. Where trips do not involve a change in mode, but only a change of route, the No Action LOS is used for the unchanged portion of the trip and the Alternative LOS is used for the changed part of the trip. For example, two types of Rail Tunnel Alternative analyses are identified as follows:

- A rail trip from Suffolk County to Ohio, currently routed over Selkirk, would have the option to use a Cross Harbor rail tunnel, under the Rail Tunnel Alternative. The No Action LOS is calculated based on the rail distance from Suffolk County to Fresh Pond to Selkirk to Ohio, with local truck delivery. The Rail Tunnel Alternative LOS is calculated based on the rail distance from Suffolk County to Fresh Pond, through the tunnel, and then to Ohio, with local truck delivery.
- A truck trip from Suffolk County to Ohio, currently routed over the George Washington Bridge, would have the option to use a Cross Harbor rail tunnel, under the Rail Tunnel Alternative. The No Action LOS is calculated based on the truck distance from Suffolk County to Ohio. The Rail Tunnel Alternative LOS is calculated based on the rail distance from Suffolk County to Fresh Pond, through the tunnel, and then to Ohio, with local truck delivery.

As these examples show, the LOS calculations must consider the entire end-to-end trip, not just in the study area, but over the entire national highway and rail networks. In most cases, the majority of the trip mileage is outside the study area and is not physically impacted by the CHFP Build Alternatives. Therefore, LOS for highway and rail mileage not physically constructed or improved as part of the Cross Harbor Build Alternatives was estimated in exactly the same way as for the No Action Alternative, using FAF3 highway routings, ORNL rail routings, and other sources mentioned above.

For rail and truck network segments that would be physically and/or operationally improved as part of a CHFP Build Alternative, the No Action LOS factors were not applicable and new LOS factors were developed.

TRUCK FERRY ALTERNATIVE

The Truck Ferry Alternative was defined as frequent drive-on and drive-off ferry service for trucks between points in New Jersey west-of-Hudson and point in New York east-of-Hudson. Travel times were estimated based on a ferry speed of 20 knots, with an average of 45 minutes of schedule delay (the average difference between truck arrivals and ferry departures), loading time, and unloading time. Fares were based on an assumption of $20 fixed cost plus $8.75 per nautical mile per truck (based on average rates for existing regional services) and a fully loaded truck of 20 tons. Services from Greenville to 65th Street and Greenville to Hunts Point were examined separately. A truck ferry would substitute for roadway travel for some portion of a longer end-to-end truck trip but not all of it, so the application of these LOS factors involves three separate steps: the No Action LOS for the truck move from origin to ferry terminal; the No Action LOS for the truck move from ferry terminal to destination; and the LOS for the ferry segment. The end-to-end approach identifies geographic routings and origin-destination pairs for which the truck ferry is most advantaged. For example, a move from Bayonne to Brooklyn, where both ends are directly linked to the ferry service, would be especially advantaged, as the ferry would eliminate trips over the Goethals/Verrazano-Narrows Bridges or George Washington Bridge. However, a move from Albany to Nassau County would have to go far out of its way to use the ferry, compared to using the crossing at the Throgs Neck or Whitestone Bridges, and would be unlikely to make use of the Truck Ferry Alternative. The LOS for the ferry segment is shown in **Table A-17**.

Table A-17
Truck Ferry LOS (Ferry Segment Only)

West-of-Hudson Terminal	East-of-Hudson Terminal	Nautical Miles	Time (minutes)	Fare	Time (Hours)
Greenville, Hudson County, NJ	Hunts Point Bronx County, NY	11.4	79.2	$119.75	1.32
	65th Street Kings County, NY	2.1	51.3	$38.38	0.86

RAIL TUNNEL ALTERNATIVE

Travel time through the tunnel includes expected waiting, administrative, and safety times to allow proper clearances and operation. Actual transit times at typical carload or rail operating speeds would be expected to be only 4 to 6 minutes. The travel costs are only the variable costs for carload and intermodal rail service; total costs do not at this time include administrative fixed charges including tolls per railcar or intermodal box which could increase costs. As with the Truck Ferry Alternative, total end-to-end LOS was calculated based on three components:

- No Action LOS from origin to the vicinity of the tunnel;
- No Action LOS from the vicinity of the tunnel to destination; and
- LOS through the tunnel and related access improvements, which extend some distance from the tunnel portals.

Again, the end-to-end approach identifies geographic routings and origin-destination pairs for which the Rail Tunnel Alternative is most advantaged. For example, the tunnel is a direct route from Atlanta to Brooklyn, and its LOS should be superior to a rail routing over Selkirk. However, for a rail trip between Ohio and Boston, the tunnel will likely offer a worse LOS than a rail routing over Selkirk, and is unlikely to attract significant traffic. For a truck trip from Atlanta to Brooklyn, the rail tunnel would probably offer worse travel times but better travel costs, and it would be up to each shipper to decide which factor is more important. The LOS for the tunnel segment is shown in **Table A-18**.

Table A-18
Rail Tunnel Service LOS

West-of-Hudson Terminal	East-of-Hudson Terminal	Tunnel Miles	Rail Time (minutes)	Carload Rail Cost (Per ton)	Intermodal Rail Cost (per ton)	Rail (Hours)
Greenville, Hudson County, NJ	65th Street Kings County, NY	2.1	20 min	$0.06 (0.0304 per ton-mile)	$0.13 per ton ($0.06035 per ton-mile)	Base LOS: 0.33, add 4 hours for Nassau – Suffolk[1] Poor LOS: Add 4 hours to all traffic[2]

Notes:

1. The Base LOS for the rail tunnel included a time penalty for rail traffic originating or terminating in Nassau and Suffolk Counties, reflecting delays associated with railroad interchanges and filleting/toupee container trains. For Tier 1 analysis purposes no cost penalty is assumed.
2. The Mode Choice Model is based on surveys of freight shipments originating or terminating in the study area. To extrapolate the likely choices of shippers outside the region—who will make decisions regarding through traffic—an additional "Poor" LOS scenario was created. The term "Poor" arose from the fact that under this scenario, all traffic was subject to additional time penalties of 4 hours. This reflects the fact that all through traffic would require some level of additional handling through Fresh Pond. Even in the best case scenario (the Seamless Operating Scenario of the Rail Tunnel Alternative), traffic moving to/from points north of Fresh Pond would incur delays (fillet/toupee, track availability, etc.). The Mode Choice Model was run with both the Base LOS and Poor LOS. The Base LOS diversion percentages were applied to traffic with an origin or destination in Kings, Queens, Nassau, and Suffolk. The Poor LOS diversion percentages, approximating the behavior of through traffic shippers, were applied to traffic with an origin or destination north of Fresh Pond. As a further modifier, the scalar factors derived from the Rail Network Model—which differentiate between the attractiveness of Seamless, Base, and Limited Operating Scenarios—were applied.

ENHANCED RAILCAR FLOAT ALTERNATIVE

The Enhanced Railcar Float Alternative was defined as frequent float service for carload and intermodal rail cars between terminals in New Jersey west-of-Hudson (Greenville Yard) and points in New York east-of-Hudson (65th Street and Hunts Point). Those terminals and the distance in nautical miles between them are shown in **Table A-19**. Travel times were estimated based on a float speed of 9 knots, with 240 minutes of schedule delay, yard handling, loading, and unloading time. Costs were based on an assumption of $600 for the railcar float between Greenville and 65th Street, which at 2.1 miles per rail car and a fully loaded railcar of 70 tons is $4.08 per ton-mile, and a fully loaded intermodal rail car of 42 tons is $6.80 per ton-mile. The variable costs for this service are likely to be small, such that cost differences for 65th Street and Hunts Point services would be small.

Table A-19
Enhanced Railcar Float LOS

West-of-Hudson Terminal	East-of-Hudson Terminal	Nautical Miles	Rail Time (minutes)	Rail Cost (Per ton)	Rail (Hours)
Greenville, Hudson County, NJ	65th Street Kings County, NY	2.1	255	Carload: $8.56 Intermodal: $12.76	1.25
	Hunts Point Bronx County, NY	6.3	280	Carload: $8.56 Intermodal: $12.76	1.67

RAIL TUNNEL WITH TRUCK ACCESS ALTERNATIVE

The Rail Tunnel with Truck Access Alternative was defined as day-time operation through the rail tunnel by trucks between the tunnel portal in New Jersey west-of-Hudson and the tunnel portal in New York east-the-Hudson. The terminals and the distance in miles between the terminals are shown in **Table A-20**. The speed through the tunnel was estimated at 40 miles per hour and the fare was equal to the cash toll on other PANYNJ crossings. 20 tons per fully loaded truck was assumed.

Table A-20
Truck Tunnel LOS

West-of-Hudson Tunnel Portal	East-of-Hudson Tunnel Portal	Highway Miles	Highway Time (minutes)	Highway Cost (per ton)	Highway Time (Hours)
Greenville Hudson County, NJ	Bay Ridge Branch Kings County, NY	2.4	5	$2	0.08

RAIL TUNNEL WITH CHUNNEL SERVICE ALTERNATIVE (BASE OPERATING SCENARIO)

The chunnel service would be provided in parallel with the Rail Tunnel Base Alternative. The chunnel service involves trucks driving onto and off of railcars at terminals in northern New Jersey and Brooklyn. The service terminals considered and the distance in miles between them are shown in **Table A-21**. The estimated truck chunnel times are 30 minutes for loading plus 15 minutes waiting (half of 30 minute headway) plus 30 minutes travel in the tunnel. The cost is projected at 90 percent of the bridge and tunnel cash toll of $40 at 20 per ton per full truck, or $1.80 per ton.[1]

[1] This is consistent with the project assumption that the pricing target for rail services should be 90 percent of their all-truck equivalent.

Table A-21
Truck Chunnel LOS

West-of-Hudson Terminal	East-of-Hudson Terminal	Truck Miles	Truck Time (minutes)	Truck Cost (Per ton)	Truck Time (Hours)
Oak Island Yard Essex County, NJ	East New York Kings County, NY	15.0	75	$1.80	1.15

RAIL TUNNEL WITH SHUTTLE ("OPEN TECHNOLOGY") SERVICE ALTERNATIVE (BASE OPERATING SCENARIO)

Under this alternative, the shuttle service would be an incremental service provided in parallel with the Rail Tunnel Alternative. The shuttle service involves loading domestic trailers onto railcars at terminals in a to-be-determined facility outside the Port Authority district west-of-Hudson, and at Maspeth Yard in Queens. The distance between the western tunnel portal and Maspeth Yard are shown in **Table A-22**. The estimated shuttle times are 60 minutes for loading and waiting. The travel time through the tunnel and along the Bay Ridge Branch to Maspeth will be 56 minutes. The estimated cost is $1.37 per ton.[1]

Table A-22
Rail Tunnel (Base) with Shuttle Service LOS

West-of-Hudson Terminal	East-of-Hudson Terminal	Miles	Time (minutes)	Intermodal Rail Cost (per ton)	Rail (Hours)
West-of-Hudson Tunnel Portal: Greenville Hudson County, NJ (ultimate West-of-Hudson origin TBD)	Maspeth, Queens County, NY	21.58	56 min	$1.37 per ton ($0.06035 per ton-mile)	0.94

RAIL TUNNEL BASE PLUS AUTOMATED GUIDED VEHICLE

The Rail Tunnel with AGV Technology Alternative was defined as advanced technology, implemented in parallel with the rail tunnel base, which would allow a truck trailer chassis to be connected with an automated vehicle which would then travel on rail track in the rail tunnel between New Jersey West of the Hudson and points in New York East of the Hudson. This service would be operated during the daytime hours when traditional rail service need not be operating. Those points and the distance in miles between these points are shown in **Table A-23**. The estimated truck chunnel times are 10 minutes for loading plus 10 minutes for unloading plus 30 minutes travel in the tunnel. The cost is 90 percent of the bridge and tunnel cash toll of $40 at 20 per ton per full truck, or $1.80 per ton.

[1] This is consistent with the project assumption that the pricing target for rail services should be 90 percent of their all-truck equivalent.

Table A-23
Automated Guidance Vehicle LOS

West-of-Hudson Terminal	East-of-Hudson Terminal	Truck Miles	Truck Time (minutes)	Truck Cost (Per ton)	Truck Time (Hours)
Greenville, Hudson County, NJ	65th Street Kings County, NY	2.4	50	$1.80	0.83

MODE CHOICE MODELING

The next step in the analysis process was to perform detailed interviews and surveys to determine which decision factors—cost, speed, reliability—were most important for different types of shipments, and to develop a statistical Mode Choice Model that could quantify the likely demand for the Cross Harbor Build Alternatives based on the differences between the No Action LOS and the Build Alternative LOS. The key steps were:

- Obtain detailed information on representative actual recent shipments in the study area via revealed-preference surveys conducted via telephone.
- Obtain detailed information on the extent to which shipping decision-makers would change their choices under different hypothetical transportation scenarios, via stated-preference choice exercises.
- Construct a set of Mode Choice Models reflecting the critical logistics patterns, commodities and rail equipment, and trade lanes. The models were populated with best-practice data on current and future baseline forecast activity; modeling equations were constructed based on the preference surveys; and different level-of-service values were specified. As the level of service for rail was improved compared to trucking—in terms of cost, speed, and reliability—the attractiveness of rail alternatives, and their market share increased, and the increase was quantified by the models. The forecasting tool allowed for various logistics adjustments as well—for example, the minimum shipment size required to “trigger” the availability of rail service could be adjusted to reflect likely rail marketing practices, which have increasingly targeted larger shippers and “mixing centers” in recent years. This tool allowed a wide range of rail enhancement strategies to be tested, including simple or complex float networks, single-track or double-track tunnels, rail AGV services, “open technology” rail versus conventional technology, and other options. Essentially, any rail service that could be defined in terms of a particular cost, speed, and reliability could be tested and its potential demand estimated.

The market research effort involved five steps:

1. Initial Survey Design
2. Focus Groups and Interviews
3. Sample Identification
4. Recruiting Interviews and Revealed-Preference Surveys
5. Stated-Preference Surveys

STEP 1. INITIAL SURVEY DESIGN

The design of the survey was driven by the modeling needs and practical data collection considerations. A survey of shipping decision-makers, in which the project team gathered information on actual and hypothetical shipping choices, was completed first. The primary outputs of the initial survey design included findings from the focus group sessions, finalized scripts of the telephone-based revealed-preference surveys and a standard template for the follow-up internet or faxed-based stated-preference surveys. The survey plan consisted of four key elements:

- **Defining Universe/Sampling Units**. The survey results were used to represent the total commodity flows of freight movements in each of the relevant logistics market areas. The total freight flows for each market area developed from the TRANSEARCH commodity flow database and other available commodity flow data sources were used to define the shipment population of interest and to determine the expansion factors.
- **Sampling Frame**. Sampling by individual company allowed each survey to be weighted based on relative contribution to total commodity flows. Therefore, the ideal sampling frame was a comprehensive list of all businesses that make shipments within the logistics market areas in the New York/New Jersey region.
- **Sampling Approach**. The sample for this study was stratified by logistics market area, commodity type, and trip distance. These variables are relevant with respect to mode choice characteristics of freight. The Standard Industry Classification code or the North American Industry Classification System code from the sampling database was used to identify company business sectors that are most closely related to the STCC classifications within the TRANSEARCH database. If the shipper/receiver or carrier drawn from the sample was shown to have qualifying shipments, then it was included. A shipping/receiving decision-maker at the selected sample establishment was contacted during recruitment to determine whether they should be included in the sample. This procedure was followed until the desired number of surveys was collected for each logistics market area. For sampling purposes, approximate ranges for each stratum were identified, to enable a reasonable distribution of business sectors and commodity shipment types to be captured in the surveys. The final sampling plan was based on a review of the sampling frame and the variables that were identified from the commodity flow data.
- **Defining Survey Methods**. A two-stage survey was completed, involving an initial telephone interview focusing on respondent revealed-preferences, followed by a mail/fax/Internet survey that included stated-preference tradeoff exercises.

The stated-preference technique is typically used to forecast consumer response to products and services that do not presently exist. Typical applications include a new public transportation service, such as a rapid transit system in a region that has only bus service; or innovative consumer products, such as new types of cellular telephones and paging devices. The advantage of this approach compared to standard survey techniques is that it tests respondent's choice preference against a range of future service attributes, and these results are then used to develop a model that can predict choices under a specific set of service attributes.

For the stated-preference surveys, the design approach was to offer fully customized choice tradeoff exercises based on actual reported shipments for each participating respondent. In the choice exercises, the values of each of these attributes for each potential mode were systematically varied according to a pre-established experimental design. Shipping decision-makers were asked to choose alternatives under varying levels of service. Since the exercises were based on actual shipments, and the attribute levels (cost, speed, frequency, reliability, mode, etc.) were based on reasonable variations in the potential service levels, respondents were able to make realistic choices. By basing the hypothetical choices on reasonable variations of actual service conditions and actual potential improvements, the responses were as realistic and relevant to each individual as possible. Furthermore, basing the choice exercises on actual recent shipments enhanced the study team's ability to combine the revealed and stated-preference data, improving the quality of the results.

To accomplish this customization, it was essential that each survey respondent participate at two stages of the process: the revealed-preference stage (at which information on actual reported shipments was obtained), and at the stated-preference stage (at which respondents were given custom-tailored choices reflecting a range of freight shipment options). Each tailored stated-preference questionnaire offered between four and eight different trade-off exercises.

Approximately 400 stated-preference questionnaires were completed. A survey response was deemed useable only if both the revealed-preference telephone survey and the stated-preference tradeoff survey were completed. A cash incentive for completing both portions of the survey was used as part of the data collection strategy to: increase the cooperation rate of potential respondents (reducing the cost of recruiting respondents); reduce biases associated with data collection by attracting a larger proportion of the total sample; and speed up the data collection effort.

STEP 2. FOCUS GROUPS AND INTERVIEWS

Focus group sessions and executive interviews with shippers and other logistics professionals were used to gather information regarding the needs and behaviors that influence logistics decisions. This information helped to develop and "pre-test" both the revealed-preference and stated-preference surveys. Participants were recruited from a list of companies that were likely to make/receive freight shipments in the New York (Manhattan), Bronx, Kings (Brooklyn), Queens, and Nassau counties. The primary qualification for the groups required transportation of freight shipments across the Hudson River. Participants were also asked for the percentage of shipments designated as long haul (more than 400 miles) versus short haul. In addition, a mix of industries and geographies were obtained for each group.

Two focus group sessions were held in Manhattan on February 23, 2010. There were six participants in the long-haul group (6:00 PM) and seven in the short-haul group (8:00 PM). Some information describing the participants is listed below.

- **Focus Group 1 –** All participants were either in a managerial position in their respective firms or business owners. None of the participants owned their own fleet of trucks. Three out of the six participants shipped textiles and apparel. The remaining three shipped heavy machinery (elevator equipment), computer products, and plastic PVC, respectively.
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The focus group participants were engaged in a discussion that focused on four key areas:

- Shipment Decision Process;
- Considerations for Cross-Harbor Shipments;
- Pretest a Stated-Preference Survey Instrument; and
- Possible Infrastructure Improvements for the Cross-Harbor Corridor

Following up on the findings of the Focus Groups, a series of structured, professionally facilitated, in-depth interviews were conducted by the project team. A total of 10 interviews were conducted, 9 by telephone and 1 in person. The interviews were administered on April 28, April 29, May 4, May 19, and May 27, 2010. Establishments were recruited based on two criteria:

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- **Cross-Harbor Movement –** Only those individuals who reported shipping goods across the Hudson Bay were selected. This criterion was established so that individuals with knowledge of the local freight infrastructure were included in the interviews.

All recruited individuals were knowledgeable shipping professionals who hold key positions within the logistics arms of their organizations. Common titles included managers (traffic, transportation, or operations), chief operating officers, director of operations, vice president of supply chain, and logistics coach. In total, employees from five major logistics companies and three large retailers were recruited for the interviews.

Three large retailers were interviewed, including one of the largest drugstore chains, a leading discount warehouse club, and a major household goods retailer. These establishments reported shipping at least 50 million pounds of freight annually. Seven freight logistics companies were interviewed. Five were large national transportation firms that had a huge operational presence in the region.

STEP 3. SAMPLE IDENTIFICATION

A pool of regional shipping interests for purposes of conducting revealed-preference surveys (primarily conducted by telephone) and stated-preference surveys (primarily conducted via internet or fax) was identified, according to the following protocol:

- Assemble establishment data for the relevant geography from which a sample of businesses can be drawn.
- Draw a sample of establishments, stratified by geography and primary business definition (NAICS code).
- Send selected establishments pre-notification letters undersigned or endorsed by PANYNJ.
- Contact sampled establishments by telephone, and identify one or more shipping decision-makers (either within or external to the establishments, themselves).

The business establishment information for sample identification was developed from Global Insight's Freight Locator database and the InfoUSA database. Using the establishment contact information in these databases, a random sample of establishments, stratified by geographic grouping and primary industry grouping, was developed. Establishments in industry categories that are not likely to generate or attract divertible cross-Harbor freight shipments were excluded from the survey population.

STEP 4. RECRUITING INTERVIEWS AND REVEALED-PREFERENCE SURVEYS

The revealed-preference survey was designed to obtain more specific information about shipments within, into, or out of the region that were used as bases for the stated-preference choice exercises, including: commodity details, including shipment size, shipment value, and special transportation considerations (hazardous materials, etc.); transportation mode level-of-service information (travel time, freight shipping cost, delivery windows and requirements, origin and destination facility types, and reliability estimates); and respondents' assessments of the availability and levels-of-service of alternative freight modes. The revealed-preference survey was administered by telephone, as discussed below.

Working from the sample identification data, interviewers contacted the key transportation managers of the businesses by telephone, ascertained whether they are shipping or receiving qualifying shipments, and sought their permission to be surveyed.

The telephone survey included the collection of several data elements related to the overall shipping activity of the respondents' establishments, including: number of inbound and outbound shipments by commodity type; origins and destinations of the inbound and outbound shipments; and logistics arrangements and transportation modes used for the shipments.

In addition, the survey obtained more specific information about shipments within the study area that were used as bases for the stated-preference choice exercises, including: commodity details, including shipment size, shipment value, and special transportation considerations (hazardous materials, etc.); transportation mode level-of-service information (travel time, freight shipping cost, delivery windows and requirements, origin and destination facility types, and reliability estimates); and respondents' assessments of the availability and levels-of-service of alternative freight modes.

Prior to implementing the full revealed-preference survey, a two-stage pre-test was conducted. As previously noted, in the first stage, focus group participants reviewed and responded to the survey questions. The second stage was a full test of the survey, in which the survey procedures were applied to a smaller sample (20 interviews) of the survey population. This provided information necessary to fine tune the interview process and the revealed-preference survey itself.

STEP 5. STATED-PREFERENCE SURVEYS

Next, qualifying regional shipping decision-makers, identified through the recruiting interview and revealed-preference survey process, were contacted to complete stated-preference surveys.

The main exercises in these surveys described alternative shipping options, including possible new services and improved service alternatives. In these choice exercises, different shipping alternatives were defined in terms of their key attributes, such as mode, travel time, cost, reliability, frequency of service, delivery window, origin and destination facility types, and transportation access.

Initially, the telephone survey responses for each individual to be surveyed were reviewed, and customized stated-preference surveys reflecting a realistic range of choices developed. These stated-preference questionnaires were then sent back to respondents. Finally, interviewers re-contacted the participants by phone to collect the stated choice data or to clarify responses.

As with the revealed-preference survey, there was a two-stage pre-test. In the first stage, focus group participants were asked to complete stated-preference trade-off exercises. Based on the results, and on results from fielding the revealed-preference survey, the stated-preference trade-off exercises were customized for a small test sample of 20 participants. These trade-off exercises were formatted and mailed or faxed to participants. Once the survey procedures and content were finalized based on the pre-test results, the full surveys were completed. As mentioned previously, approximately 400 stated-preference questionnaires were completed.

MODE CHOICE MODEL DEVELOPMENT

The collected revealed-preference/stated-preference survey data enabled the development of discrete choice (multinomial and nested logit) models that could be used to predict how shippers would react to corridor transportation improvements and CHFP Build Alternatives.

The mode choice model development effort involved the estimation and validation of a group of market-specific models. The data collected through the stated-preference surveys were used to guide the assessment of the attractiveness of new and improved CHFP rail and railcar float services. The mode choice models relate the choice of shipment mode to specific characteristics of the shippers/receivers, the shipments being made, and the level-of-service attributes of each mode.

For this program, a form of logit mode choice model was estimated and applied. In the logit model, it was assumed that each available freight shipment alternative provided the shipper with a utility, and the decision-maker was modeled as selecting the alternative with the highest utility. However, the model recognizes these utilities as random variables, so rather than estimating a specific choice, it estimated the probability of a specific choice, under the given conditions. This probability is defined as the likelihood, given the utility of that choice, compared to the likelihood of all available alternatives, given their utilities among available alternatives.

In the logit model, the utility is specified as a linear combination of the different observed independent variables available from the survey, multiplied by unknown parameters. The process of model estimation involves finding the values of the parameters that result in the highest probabilities being assigned to actual observed choices from the revealed-preference surveys. Once the parameters were estimated, the model was used to estimate the choice probabilities of different alternatives with different characteristics.

The basic decisions in developing the mode choice models included: (a) selection of the variables to be included in the utility function for each mode along with the mathematical forms of each variable; and (b) selection of the appropriate model structure (multinomial logit or nested logit) as allowed by the data and the nature of the choice behavior under study. The model estimation effort was an iterative process. Different model specifications, with various combinations of variables and levels of complexity, were tested until a set of final models was developed.

This process did not estimate the percentage of total freight that would move by a particular mode (e.g., by truck or by rail). The development of such a model would have been impractical, given the size of the sample that would be required. Instead, the results of the logit choice model were applied in a comparative process, to calculate how the relative utility of a change in rail service would compare to the relative utility of the base traffic moving by truck. This incremental approach, which “pivots” from the existing tons and shipments moved by truck to calculate the amount that might divert based on changes in the utility of competing modes, particularly rail service, allowed for a more robust range of alternatives to be tested against a broader range of commodities and origin destinations, by maximizing the information from the stated-preference surveys.

The logistics of special handling, value of shipment, and size of shipment were explicitly considered through the development of filters and equations for specific commodities. Previous studies found that while small amounts of annual diversion of freight might be consistent with the mode choice equation, such traffic rarely materializes in practice because rail is an inefficient handler of small quantities of traffic. Previous studies also found that the validation of freight mode choice was improved if utility equations were developed for classes of commodities with similar values per ton or similar handling requirements.

Once the best model specifications were identified, validation was performed by applying the models to present conditions and comparing the results to available commodity flow data. Mode choice models were re-calibrated as applicable. Validation consisted of the following steps: reasonableness checks, disaggregate validation, and aggregate validation.

- Reasonableness checks of model parameters and results to known or expected values, based on revealed-preference surveys and other data. This form of model validation was conducted throughout the model estimation process on each interim model result.
- Disaggregate validation, in which the model is applied to see whether the results match observed or expected values. Each model was applied to a disaggregate data set other than the one from which the model was estimated.
- Aggregate validation comparing model results to known aggregate data not used in model estimation, such as commodity flow data sets.

MODE CHOICE MODEL APPLICATION

The stated technical objective of the work was to develop a model capable of estimating modal diversion shares for freight shipments under different operating scenarios. To develop such a model, the following key goals were targeted:

- Estimate the values of time from the stated preference models to support the estimates of diversion involving new technologies currently not in use.
- Simplify the diversion model such that it may be applied within the existing modeling framework; while retaining enough complexity to model differences in diversions by key market segments.

The survey results were compiled into a spreadsheet model, and “choice coefficients”—the likelihood of behavioral change in response to differences in cost, speed, or reliability—were calculated. The model was structured to differentiate between broad commodity classes and respondents that are involved in short haul shipping and long haul shipping as follows.

  - Short haul respondents, whose typical trip was shorter than 400 miles, were presented with the Rail Tunnel, Truck Ferry, and Rail Tunnel with Chunnel Service Alternatives.
  - Long haul respondents, whose typical trip was greater than 400 miles, evaluated all Cross Harbor alternatives.

Overall, the mode choice model suggested:

- High reliability routes (more than 90 percent) were preferred over medium reliability (85-90 percent) routes, which were in turn were preferred over low (<85 percent) reliability routes. This result is logical and consistent with expected behavior in freight decision-making.
- As expected, higher transportation costs and higher travel times negatively impact route decision-making. In other words, shorter routes with lower costs are more preferred than longer routes with higher costs.
- However, the cost and time variables behave in a non-linear fashion. Shippers moving goods long haul are actually less sensitive to unit savings of cost and time than short haul movers. This is a critical observation and somewhat counterintuitive. Our reading is that truck shippers making long trips are invested in their current modes, and would already be using

rail if it met their needs; they must be presented with substantial travel time or cost savings to influence a shift in mode choice behavior. Conversely, the choices presented to short haul truckers all represent alternative truck routings—there is no shift from truck to rail; the choices are analogous to different highway routes with different levels of speed and cost, and the normal rules of highway route selection (fastest and cheapest, even if only by a small percentage) will apply.

The mode choice model was then used to examine freight movement in the validated TRANSEARCH 2035 database, comparing the No Action LOS for each database record against the LOS for each applicable Cross Harbor alternative. In some cases, the mode choice model determined that the LOS differences were significant enough to attract demand to the alternative. In other cases, the mode choice model did not project a change in behavior.

Mode choice model results are presented in **Table A-24**.

CROSS HARBOR IMPROVEMENT TRUCK TRIP CHANGES IN DEMAND MODELS

The mode choice model application calculates changes in truck trips as a result of CHFP alternatives. The results of the demand modeling have been exported—reflecting reductions in truck traffic on key corridors, as well as potential increased concentrations of truck traffic at local facilities—into the updated BPM and NJTRE travel demand models. Corresponding modifications were made to truck trip tables and to physical highway networks, to the extent that such improvements are part of the CHFP alternatives.

The CHFP improvements were incorporated into the model systems using information on the specific locations of new or expanded facilities. The travel demand modeling then produced quantitative estimates of changes in the volume and distribution of trucks over the regional highway network, changes in associated congestion and travel speed and level of service, and other metrics, as reported by the specific modeling tool.

Table A-24
Mode Choice Model Estimation Results

Variable	Variable Description	Coefficient Value	T-Stat
Alternative Specific Constant	Truck on Rail Modal Constant	-1.69	-9.5
	Truck on Ferry Modal Constant	-1.53	-10.2
	Rail on Float Modal Constant	-4.23	-5.1
	Rail in Tunnel Modal Constant	-4.69	-4.4
	Truck Modal Constant	0	0.0
On-Time Reliability	Low Reliability (<85% on time)	-1.030	-6.0
	Medium Reliability (85-90% on time)	-0.341	-3.1
	High Reliability (Over 90 percent on time)	0	0.0
Shipment Cost by Commodity ($)	Agriculture Goods	-0.0028	-3.1
	Metal and Mining Goods	-0.0035	-3.9
	Construction Goods	-0.0033	-5.7
	Chemical Goods	-0.0045	-6.6
	Wood and Paper Goods	-0.0036	-5.2
	Electronics Goods	-0.0034	-5.7
	Transportation and Utility Goods	-0.0026	-3.7
	Wholesale and Retail Goods	-0.0036	-7.5
Travel Time (hrs)	Truck Mode	-0.138	-6.1
	Truck on Rail Mode	-0.143	-5.5
	Truck on Ferry Mode	-0.119	-4.9
	Rail and Rail Float Modes	-0.0122	-2.2
Cost Spline ($)	Truck Spline (applied if Shipment Cost > $900)	0.0013	4.5
	Truck on Ferry Spline (applied if Shipment Cost > $900)	0.0015	4.5
	Truck on Rail Spline (applied if Shipment Cost > $900)	0.0014	4.3
Travel Time Spline (hrs)	Truck Spline (applied if travel time > 25 hours)	0.127	5.4
	Truck on Ferry Spline(applied if travel time > 25 hours)	0.131	4.7
	Truck on Rail Spline (applied if travel time > 25 hours)	0.109	4.3

FORECASTING SHIFTS IN COMMODITY DEMAND BY ALTERNATIVE

The choice model was calibrated against base year freight flows in the study region. Minor adjustments needed to be made to the choice model coefficients so they would better reflect rail and truck mode share in the region. These calibrated models were used to quantify diversion from truck to other modes under a variety of operating conditions.

G. LIFT ON-LIFT OFF (LOLO)/ROLL ON-ROLL OFF (RORO) CONTAINER BARGE ALTERNATIVE DEMAND ANALYSIS

Because the Container Barge Alternatives are intended to capture international containers traveling to or from the Port Authority of New York and New Jersey's Port Newark and Elizabeth marine terminals, the demand estimation used Port Authority container data, marine terminal gate survey data, and Port Authority Hudson River crossing origin-destination data instead of the domestic commodity flow database developed using TRANSEARCH and Freight Analysis Framework. **Table A-25** presents the distribution of eastbound containers and dry van units and tonnage by destination, based on the results of the Port Authority marine terminal gate survey and Hudson River crossing origin-destination surveys.

Table A-25
Container Moves from Port Newark/Elizabeth to East-of-Hudson, 2005/2009 to 2035

	Nassau/ Suffolk	Brooklyn/ Queens	Bronx	Connect-icut	Massa-chusetts	Rhode Island	Maine	Total
Maximum Daily Eastbound Crossings, 2005/2009	67	207	57	167	77	4	7	587
Eastbound Daily Crossings Plus Westbound Returns	135	414	114	334	154	8	15	1,174
2005/2009 Moves per Year (295 days/year)	39,719	122,272	33,630	98,530	45,430	2,360	4,283	346,224
2035 Moves per Year (3.6% per year growth)[1]	99,621	306,676	84,349	247,128	113,945	5,919	10,743	868,381
2035 Annual Tons (20 tons per container, average)	1,115,445	3,433,820	944,450	2,767,071	1,275,835	66,277	120,293	9,723,190

Note:
1. Growth rate is based upon Freight Analysis Framework projection of import and export tonnage by water, 2007-2035.

The volume of containers transported via container barge can be influenced by public policy as well as private-sector market demand. Assuming the RORO/LOLO Container Barge Alternative service options to Brooklyn and to New England can capture 10 percent of the container moves to/from their respective regions, an estimated 343,382 tons (30,668 container units) would be diverted to the Brooklyn Container Barge service, and 422,948 tons (37,774 container units) would be diverted to the New England Container Barge service.

H. SUMMARY OF DEMAND ESTIMATES

The results of these various tools and analyses were compiled as follows:

- The mode choice model produced estimates of annual tonnage demand for each of the Build Alternatives, excluding estimates of rail traffic diverted from Selkirk and Mechanicville, and excluding the Seamless and Limited Operating Scenarios of the Rail Tunnel Alternative.
- The Rail Network Model produced estimates of demand for rail traffic diverted from Selkirk and Mechanicville, and also provided scalar factors to differentiate the amount of pass-through traffic handled by the Rail Tunnel under the Seamless, Base and Limited Operating Scenarios.
- The Highway Network Model provided a validation of the Rail Tunnel with Truck Access Alternative demand, in terms of projected trucks per day.

The full diversion results, by alternative and by source of demand, are presented in Table 5-4 in Chapter 5, "Transportation." ✷