UPPER MIDWEST TRANSPORTATION HUB
MANLY, IOWA
2015 TIGER DISCRETIONARY GRANT APPLICATION

Appendix F

iTRAM

Iowa Traffic Analysis Model
White Paper

Iowa Travel Analysis Model Work Summary for Upper Midwest Transportation Hub in Manly Iowa

Lead applicant
Iowa Department of Transportation

Partnering agency
Minnesota Department of Transportation

iTRAM Rail Passenger Model and Rail Freight Model Technical White Paper

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INTRODUCTION

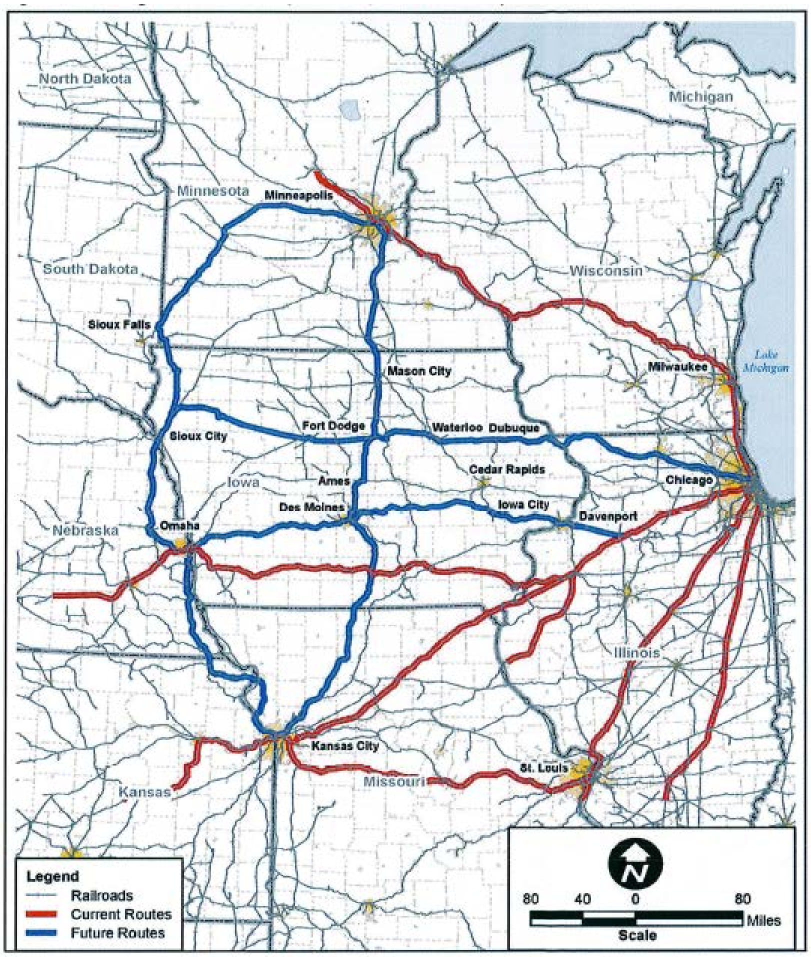
This technical white paper summarizes the key assumptions, methods, and findings of the Phase III iTRAM Rail Passenger and Rail Freight models. These models were developed with a grant from the FRA as additional modules that can be added onto the iTRAM auto and truck model, or run separately.

RAIL PASSENGER MODEL

1. PURPOSE

The iTRAM rail passenger forecasting model is designed to estimate the intercity rail demand for existing as well as new rail systems for the Iowa Statewide Model Area. The Iowa Statewide Model Area includes the State of Iowa as well as significant portions of adjacent states. The model area is shown in **Figure 1**.

Figure 1 – Model Area



As part of the rail passenger estimates, additional estimates of intercity trips by alternative modes (auto, air and intercity bus where service is available) will be produced as well.

2. GENERAL APPROACH

The Iowa Statewide Model's (iTRAM) rail passenger model is a market area based logit model that has an independent rail network that is coordinated with the highway network by designating specific nodes within the iTRAM highway network as rail passenger stations. The rail passenger model uses the long distance work and long distance non-work demand person trip tables as input. Shorter trips with purposes such as work, non-work, socio-recreation, and others which are less than 90 minute trips are not part of the rail model system which concentrates on longer distance intercity trips.

The rail passenger model also uses the auto travel times derived from the highway iTRAM network. The auto travel times are used to calculate access times to the designated passenger rail stations, bus stations, and airports.

The initial rail passenger model was designed with the capability of forecasting future and planned rail service passengers in the Iowa statewide model area as shown in **Figure 1**. For changes to existing service or for newly developed rail service not initially analyzed in the existing model, the user would modify the rail network and station locations as well as various service parameters in order to forecast the passenger rail ridership for the newly user defined system.

The model also has an independently defined bus network and airport network and will forecast ridership for proposed bus and airport service as well as rail ridership within the Iowa model area. Bus stations and airport terminals are also identified and coordinated by designating specific highway nodes as bus or airport terminals.

2.1 Market Sheds

Market sheds (areas) are established around each designated rail station, airport, or bus terminal. The model will establish the market areas by determining which zone centroids are within specified distances from the modal stations. The station to zonal centroid distances are established by using the iTRAM network. Based on the typical distance characteristics of the different modes, the market area for each station is based on the following distances away from a station:

- Rail: 50 Miles
- Bus: 25 Miles
- Air: 100 Miles

Where the market area of two stations of a specific mode (rail-rail station, airport-airport, bus-bus terminal) overlap due to being too close to each other (less than the designated modal distances for the market area of that mode), zones in the market area are assigned to the station that is closest to them.

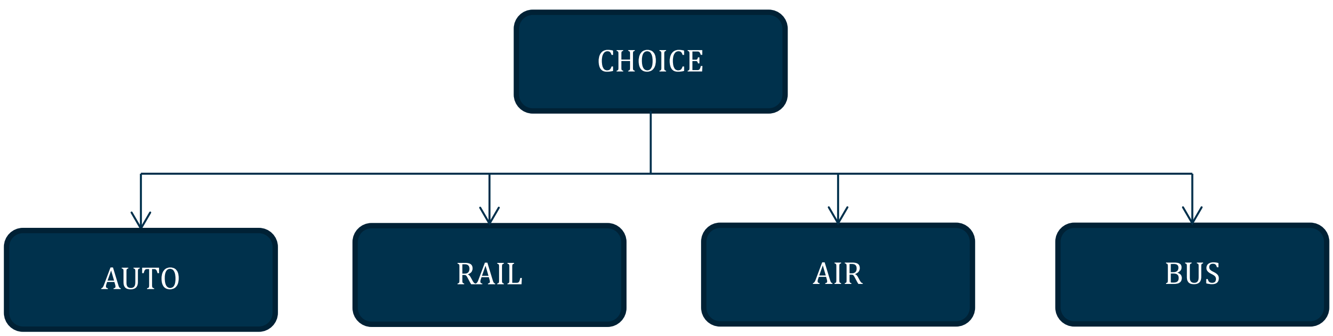
Market Shed Correction for the Chicago Station

During calibration of rail system, it was apparent that loading/unloading for the Chicago station was not happening. After delving into the issue, it was found that during the process for creating centroid connectors for the rail system that the Chicago station was not the closest node to any zones in the surrounding area. There was an override for TAZ's 992038 and 992035 put into place. These two zones were then "forced" to be connected to the Chicago station for connection to the network. This issue only appears in the Rail mode, all other modes provide appropriate connections when developed.

2.2 Mode Choice Model

The mode choice model is applied to all the long distance trips (commercial and non-commercial) from the iTRAM model. For each interchange of I-J trips from market area's zones to market area's zones (I-J level movement) where interconnecting rail, bus, or air service is provided, the mode split model is applied. **Figure 2** shows the mode choice model structure.

Figure 2 – Mode Choice Model Structure



Constants and coefficients were calibrated based on existing boardings and alightings at Iowa rail stations for AMTRAK service in Iowa. The models were also adjusted and compared to the results for the proposed new rail service from Chicago to Omaha. The run results are shown in **Appendix D**.

The mode choice model constants and coefficients are based on two roundtrips per day rail service. The constants and coefficients are shown in **Table 1**.

Table 1: Mode Choice Model Constraints and Coefficients

Coefficient	Long Distance Work	Long Distance Other
Headway	-0.00242	-0.00217
IVTT	-0.00967	-0.00868
OVTT	-0.01451	-0.01302
Rail constant	-0.550170004	-1.341847539
Air Constant	-0.755287528	-1.49466753
Bus Constant	-0.377460003	-1.057994962
Nest	0.726495028	0.81366998

As part of the mode choice model, the value of time is critical for determining the relationship between such parameters as time versus fares and other costs. The value of time allows the mode's fare and costs to be converted into an equivalent time which then can be used in the mode choice model and establish disutility for the trips by modes.

The default value of time for the model is:

Long Distance Business Trips = $60 per hour

Long Distance Non-Business Trips = $20 per hour

2.3 Model Limitations

The results from the rail passenger model do not represent all trips that may use the system within the Iowa Model Area. Only the Iowa Model Area internal – internal trips are assigned to the various rail, bus, and airport modes. External to external iTRAM trips are not assigned to the rail network. These are long distance trips that begin outside of the model area and have destinations outside of the Iowa model area. In addition, external-internal and internal-external trips are also not assigned to the rail, bus, or airport trip forecasting estimates. The model's airport trips represent those trips that have both an origin and destination within the model area and therefore do not include any air trips that involve an air transfer within an airport terminal.

Although the rail model does not include external-external, internal-external, and external-internal trips, the rail assignments from the model represent a significant portion of the Iowa based anticipated rail ridership. The Iowa Model Area which includes significant areas of adjacent states and most of the large urbanized areas within the rail passenger shed represents most of the potential Iowa rail passenger market area.

3. INPUTS AND INTERALATIONSHIP WITH ITRAM

The rail model uses the person trip tables, auto travel times, and the node system of the iTRAM model. More detailed descriptions are discussed in this section:

Trip Tables

The rail passenger model uses the iTRAM person trip tables for long distance trips (business and non-business). The long distance trips are typically longer than 90 to 100 miles. The trip tables produced by iTRAM for the shorter trips (work, shopping, etc.) are not used in the rail passenger model. The model is forecasting the potential for longer distance rail trips rather than the potential rail ridership for commuter trips. Therefore, where intercity rail stations are closer than approximately 90 miles, the rail estimates will not include possible commuter trips between the closely spaced stations. The rail trip estimates also do not include external to external or internal to external and external to internal trips (external trips are defined as trips either beginning or ending outside the model study area as shown in **Figure 1.**)

Auto Travel Time

Auto travel times are based on the iTRAM network. Travel times are from the centroids (those designated within the rail station service area) to the designated rail, air, and bus stations.

Rail Line Travel Time

Rail travel time is based rail network distances from station to station and estimated average rail running speeds including acceleration and deceleration delays.

Air Travel Time

Air travel time is based on scheduled arrival and departure times. Air travel time does not include access time to the airport and other non-air flying time.

Rail Line Network and Station Locations

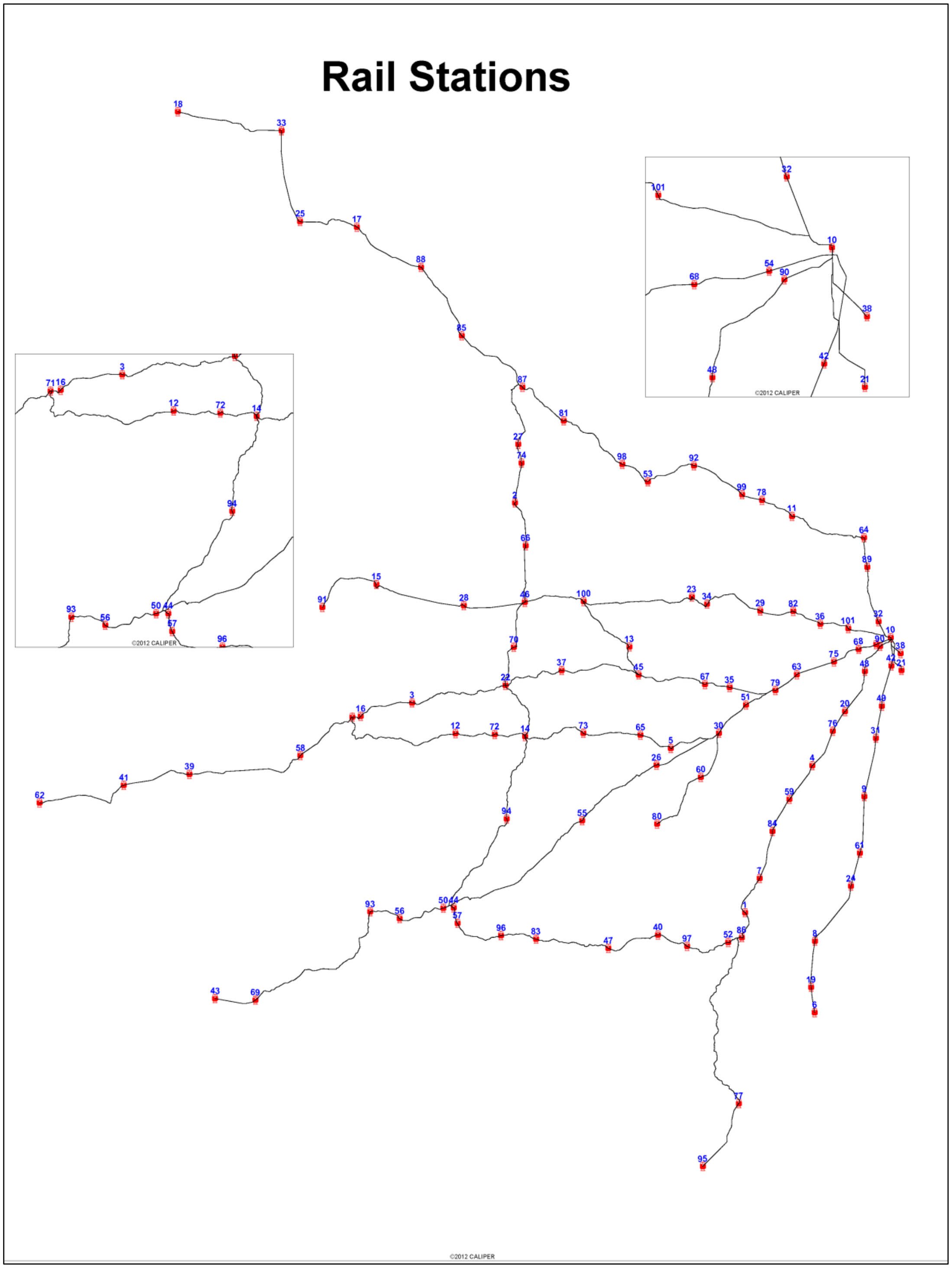
The rail line network consists of existing passenger rail line services as well as proposed future line services as contained in the Iowa rail plan. Shown in **Figure 3** are the initial passenger rail lines (existing plus future lines.)

It should be noted that the passenger rail line network is a free standing geography and independent of the freight rail network. However, in most cases the passenger rail line network will be conflated with rail freight network (in most cases the passenger service will be on the same rail lines as the freight rail system.)

The rail passenger network is interconnected with the Iowa Statewide Models highway network and subsequently to the air network by tagging and identifying existing iTRAM nodes as passenger rail stations. Initially, 101 stations were identified. The location of the passenger rail stations are shown in **Figure 3**. Locations were based on:

- Assumed speed of rail at 54 mph (network attribute)
- Terminal time of three minutes (station node) and transfer penalty of 13 minutes

Figure 3 – Rail Network

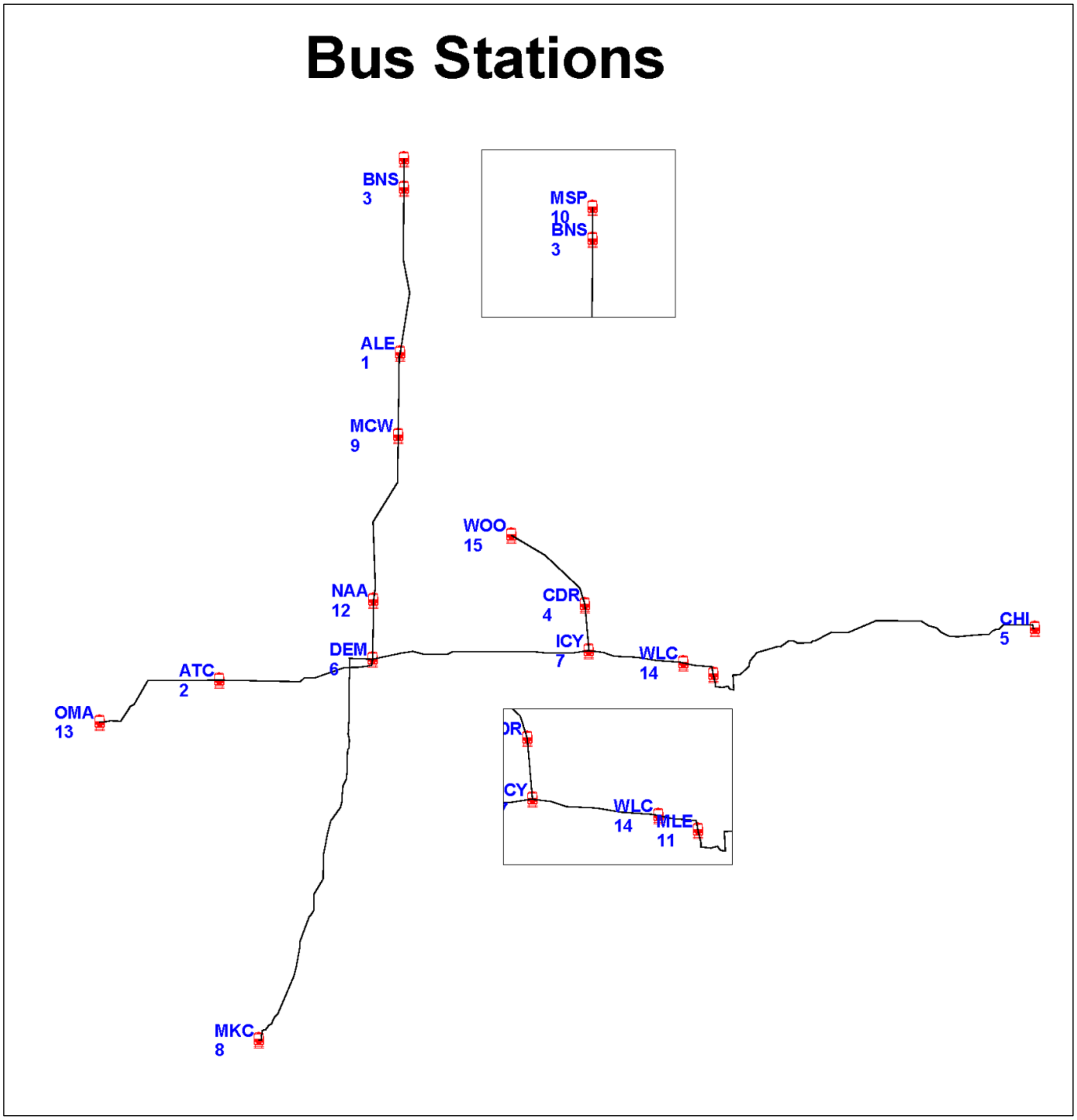


Bus Line Network and Bus Terminals

Figure 4 shows the bus network based on:

- Documented Greyhound routes
- Bus route speeds of 48 mph (network attribute)

Figure 4 – Bus Network

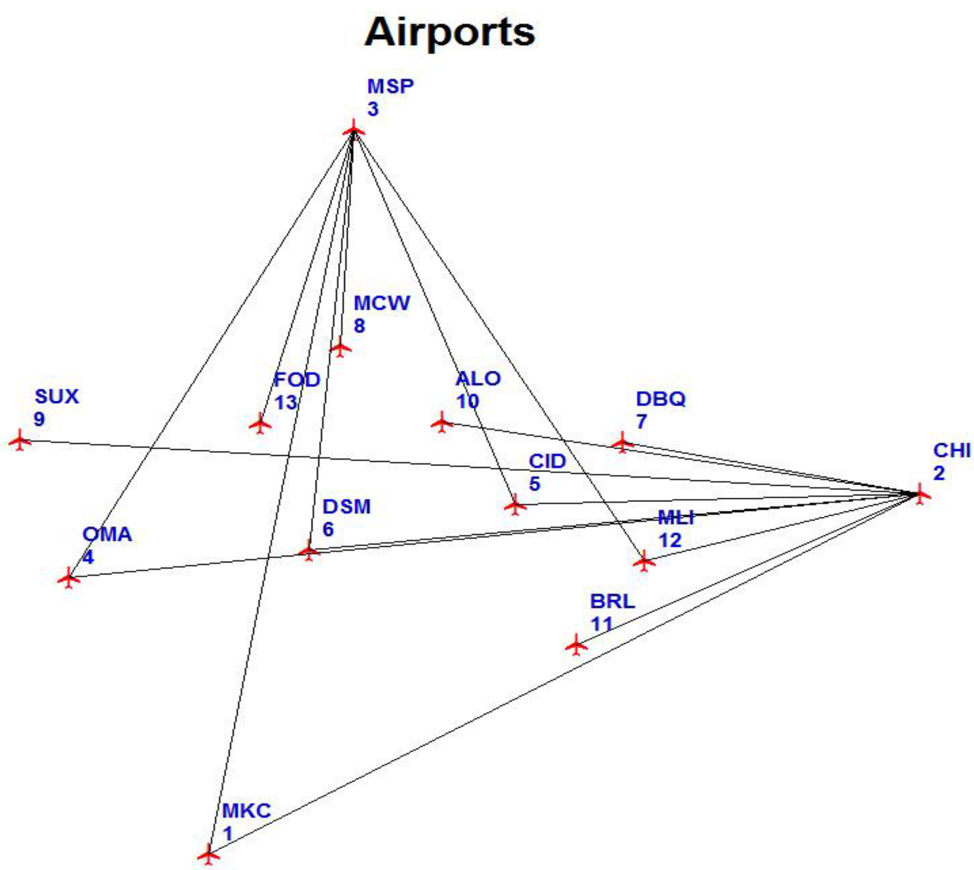


Air Network and Airport Terminals

Figure 5 shows the air network based on:

- Identification of commercial airports in the study area and identified service
- Assumed speed bases on straight line distance and published flight times (network attribute)
- Terminal time built into headway

Figure 5 – Air Network



3.1 Model Parameters

Model parameters are applied in the rail passenger model to establish disutilities for the model's logit function. The disutilities are determined by mode for each trip that provides service from market area to market area.

Rail System:

IVTT – In Vehicle Travel Time – Based on length of rail routes and speed. The default speed is 54 miles per hour and is a network attribute.

Fare Cost – Default cost is $.35 / mile

Access Time (Origin) – The average travel time from each zonal centroid in the designated rail station's market area to the rail station. The travel time is based on iTRAM's highway network.

Egress Time (Destination) – The average travel time from the rail station destination to each zonal centroid in the designated rail station's market area. The travel time is based on iTRAM's highway network.

Access Cost – Parking

Urban Rail Station Origin Zone - $5.00

Rural Rail Station Origin Zone - $0

Egress Cost - Rental Car/ Taxi - $40.00

Terminal Time – Time waiting in terminal for arrival of the passenger train. Typically, the lessor of ½ of the scheduled rail service headway time or a maximum of 30 minutes.

Dwell Station Time – 3 minutes per station

Transfer Time Between Rail Lines – Station dependent ranging from 1o to 30 minutes.

Air System:

IVTT – Published flight times between airports.

Cost – Average air fares between origins and destinations. Default $0.50 per mile.

Access Time (Origin) – The average travel time from each zonal centroid in the designated airport's market area to the airport. The travel time is based on iTRAM's highway network.

Egress Time (Destination) – The average travel time from the airport destination to each zonal centroid in the designated airport's market area. The travel time is based on iTRAM's highway network.

Access Cost – Parking

- Urban Airport Origin Zones - $20.00
- Rural Airport Origin Zones - $10.00

Egress Cost – Rental/ Taxi $40.00

Terminal Time – Security screening, parking, check-in

- Departure Time – 90 Minutes
- Baggage, pickup time, renting car
- Arrival Time – 30 Minutes

Bus System:

IVTT – Time based on network distance and speed of 48 miles per hour.

Fares – Default cost is $0.25

Access Time - The average travel time from each zonal centroid in the designated bus' market area to the bus terminal. The travel time is based on iTRAM's highway network.

Egress Time - The average travel time from the bus terminal destination to each zonal centroid in the designated bus' market area. The travel time is based on iTRAM's highway network.

Terminal Time – Time waiting in terminal for arrival of the bus. Typically, the lessor of ½ of the scheduled bus service headway time or a maximum of 30 minutes.

Dwell Time – 3 minutes per stop

Transfer Time Between Rail Lines – Station dependent ranging from 10 to 30 minutes.

Highway System:

IVTT – Derived from model travel time (based on speed and distance)

Cost – Vehicle Operating Cost X Distance (average distance between Market Origin and Destination Zones)

Terminal Time – Zonal Terminal Time – 5 minutes

4. OUTPUT MODEL RESULTS

The model outputs are person trip tables in a production/attraction format for each mode – auto, rail, air, and bus. The trip tables are by mode for trips that go from market area to market area. Each zone's trips in the origin market area are assigned to a mode for movement to a destination market area. For example, if an origin market area consists of five zones and a destination market area consists of four zones and both zones have a rail station and are served by rail service then the model will calculate the number of rail trips from zone to zone (5 X 4 = 20 IJ movements). The movements are aggregated for simplification and reported out as rail movements from the origin market area to the destination market area.

If in this case the origin market or the destination market area does not have a service then no air trips would be calculated or considered in the mode split model. However, if the origin market area and the destination market area were served by bus service then bus trips between the market areas would be calculated and reported.

Model results are shown for a 2005 model run based on the existing rail, air and simplified intercity bus network in **Table 2**.

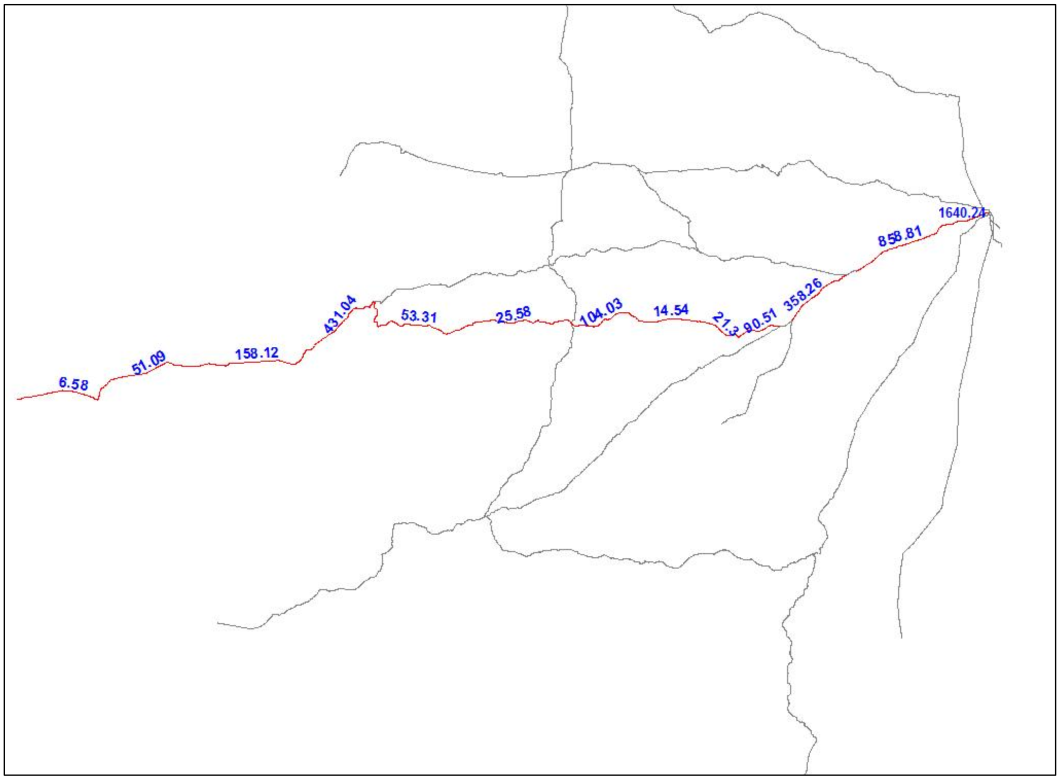
Table 2 – Model Run Summary Example

		Total	Auto	Rail	Air	Bus
Rail	Trips	310,030	280,402	12,503	16,401	724
	Share		90%	4%	5%	>1%
Air	Trips	372,424	341,423	12,503	16,866	1,632
	Share		92%	3%	5%	>1%
Bus	Trips	372,424	341,423	12,503	16,866	1,632
	Share		92%	3%	5%	>1%

It should be noted that when reporting on the rail mode (see rail row above) it only reports the alternative mode trips that are within the rail market areas. For example, this means the air movement may be considered if that zone pair is also within the air market area as well as well as the rail market areas.

The rail model is also able to produce results on a route basis and provide a network assignment for station to station volumes. The example in **Figure 6** shows a trip table aggregation by market areas.

Figure 6 – Trip Table Aggregation Assignment Results on a Route Basis



Trip tables can also be produced by all between market areas for all modes for a specific route, and for the rail-only demand on the same route.

4.1 Traffic Assignment Adjustment

The rail model forecast is based on having two roundtrips of rail service per day. Additional rail service will increase the rail ridership by allowing more flexibility for passenger departure and arrival times. Based on typical distribution of daily trips the following ridership adjustments are recommended for rail passenger forecasting:

Service Adjustment Factor:

1 Roundtrip Per Day = .5
2 Roundtrips Per Day = 1.0
3 Roundtrips Per Day = 1.4
4 Roundtrips Per Day = 1.8

The adjustment factor is applied by multiplying the forecasted ridership by the factor corresponding to the number of rail roundtrips of service being provided.

4.2 Validation

The rail forecasting model results for the base year were compared to the boardings and alightings at each of the Iowa rail stations on the Amtrak Zephyr route. Listed in **Table 3** are the boardings and alightings (B's and A's) at each of the Amtrak stations as listed on the FRA website.

Table 3 - 2011 Amtrak Ridership Counts

	Total Annual Bs and As		Daily B's and A's
Burlington	7,300	-	20 on an average annual day
Creston	4,200	-	11.5 on an average annual day
Mount Pleasant	13,000	-	35.6 on an average annual day
Osceola	14,900	-	40.8 on an average annual day
Ottumwa	10,500	-	28.8 on an average annual day

The model's rail passenger simulation for the Iowa Zephyr stations after adjustment for one roundtrip a day and for a typical average annual day, is shown in **Table 4.** See the **Section 4.1** for further explanation of the model adjustment procedure for frequency of rail service.

Table 4 - Model Simulation

Total Daily B's and A's

Burlington - 27 on an average annual day
Creston - 23 on an average annual day
Mount Pleasant – 27 on an average annual day
Osceola – 69 on an average annual day
Ottumwa – 35 on an average annual day

As can be seen in **Table 5**, the model is replicating reasonably well the boardings and alightings at the Iowa rail stations.

Table 5 - Ridership Comparison Between Actual and Simulation

	Actual B's and A's	Model Simulation
Burlington	20	27
Creston	11.5	23
Mount Pleasant	35.6	27
Osceola	40.8	69
Ottumwa	28.8	35

RAIL FREIGHT MODEL

INTRODUCTION

This technical white paper documentation for the Rail Freight Model has been prepared for two reasons:

1. As a formal documentation of the iTRAM Rail Freight Commodity Model.
2. For submittal to the Federal Railroad Administration (FRA) as a requirement of the grant award to the Iowa DOT.

In the flowing pages we provide an overview of the rail freight data preparation and methodology, its application to the statewide planning efforts, lessons learned, and other relevant technical aspects of the process. In addition, the technical memorandum, produced under separate cover, may be utilized as technical guidance to other states in the development of similar statewide rail freight modeling efforts.

This section on the Rail Freight Model is organized into five parts as described below. The basis of understanding the extensive preparation for the rail freight commodity models is Section 1, Freight Model Data Preparation, followed by Section 2, Rail Freight Model Methodology. Section 3 will be organized around the deliverables which are the interactive commodity flow tool (3a, 3b and 3c) and the Rail Freight Commodity Model (3d and 3e). An extension of those tools will be the applications that evaluate major rail terminals. To wrap up, and provide value to other states undertaking rail freight modeling, Section 4, Lessons Learned, and Section 5, Other Relevant Technical Aspects of the Process will be prepared.

5. FREIGHT RAIL MODEL DATA PREPARATION

Rail freight commodity models are part of an emerging class of models with uses in regional and statewide rail planning. The Iowa DOT effort required two preliminary investigations prior to the rail freight model development. These were:

1. iTRAM Update Data Review
2. iTRAM Architecture

Completed in 2013, both documents brought to the study the data needs and the blueprint on how the model was to be assembled. It was anticipated that the rail commodity model would necessarily conform to the available and relevant data identified as the model work progressed. It is the intent of this memorandum to step through the data, development steps and methodology of the rail freight model.

5.1 Assumptions in the Freight Rail Model

To prepare the best possible tool suitable for the tasks identified by the Iowa DOT, it was important at the outset to establish a set of boundaries on model design. The extensive data processing and preparation that was required drove and focused the rail freight model. The following assumptions were used in the rail freight model:

- Two rail freight models were built: National Rail Freight and Iowa Centric Rail Freight. These two rail freight models are fully described and differentiated in Section 6.1.

- Commodities were processed and prepared for the rail freight model using the annual weight in tons of each commodity. Both weight and value in dollars are provided in the primary database, the Freight Analysis Framework (FAF). Weight (in tons) was chosen for the Iowa rail freight effort.

- Base year of 2010 and future year of 2040 of commodity flows were established for the national rail freight model. The 2007 FAF scenario year is used to represent the base 2010 study year. A straight-line interpolation is used to prepare any commodity demand between 2010 and 2040.

- The Surface Transportation Boards (STB) Confidential Rail Waybill for Iowa (2009 and 2010) was used as the demand element for the Iowa Centric rail freight model.

- Individual commodities or the total for each study year can be assigned by year in each rail freight model.

- Existing data sources were inventoried and utilized in the rail freight models. Use of these free and well-tested data products ensured consistency and conserved project resources.

- Extensive review of existing data and model needs pointed to the fact that time and impedance is the best and most efficient link segment attribute for use in assignment. The impedance for both the national rail and Iowa Centric freight rail models uses three key rail attributes: Main line class, number of tracks and signal type.

- Rail network and attributes were provided by the Iowa DOT and used as the starting point for the local rail network.

- Each of the two rail freight models was designed for a specific set of uses. The national rail freight model has an intended use of generally longer range, strategic, statewide planning. The Iowa Centric Rail Freight Model is a more localized (Iowa) product with an intended use of generally shorter range or more local planning. See Section 6.2 - Iowa Centric Rail Freight.

5.2 Key Data Inputs & Preparation

The data sources identified and used for the iTRAM Rail Freight Model are as follows:

1. FHWA's Freight Analysis Framework (FAF3.4) Commodity Flow Data.
2. 2010 Census County Business Patterns.
3. 2010 Bureau of Economic Analysis local area employment.
4. Woods and Poole Economics, Inc. long-term county employment forecasts for 2040.
5. Oak Ridge National Laboratory's Center for Transportation Analysis public domain rail network.
6. U.S. Surface Transportation Board (STB) Carload Waybill Sample (CWB) commodity flows prepared from combined 2009 and 2010 year Iowa data.
7. CWB freight stations inside Iowa identified by railroad and Freight Station Accounting Code.
8. Iowa DOT Rail Network (TransCAD).

6. RAIL FREIGHT MODEL METHODOLOGY

This section will focus on:

1. Two Rail Freight Models
2. Commodity Disaggregation
3. National Network & Assignment
4. Iowa Centric Network & Assignment

6.1 Two Rail Freight Models – National & Iowa Centric

Review of available data and discussions with the DOT provided focus on the structure of the Iowa Rail Freight Model. Two model products were identified:

- **Product 1**: National Rail Freight Model - a "first" rail assignment with an intended use of generally longer range, strategic, statewide planning.
- **Product 2**: Iowa Centric Freight Model – a national + local rail model with an intended use of generally shorter range or more local planning. See Section 6.2 Iowa Centric Rail Freight.

Table 6 shows the difference in the two rail freight models for Iowa.

Table 6: Summary of the Differences in the Two Rail Freight Models

Inputs	National	Iowa Centric
Network	All Class I railroads plus Iowa Interstate RR and terminal railroads	Base is national rail network; Six additional sub-networks added for Class III railroads inside Iowa
Centroids	County geographic centroid connections to rail sub-network	CWB freight stations inside Iowa identified by railroad and Freight Station Accounting Code; county outside Iowa
Impedance	Rail links estimated using ORNL CTA main line class, track type and signal system, and number of tracks variables	Rail links estimated using ORNL CTA main line class, track tripe and signal system, and number of tracks variables
Demand	FAF Rail Freight Commodity Flows (county-to-county)	Carload Waybill Sample commodity flows (average of 2009 and 2010)
Commodity Classification Scheme	Standard Classification of Transported Goods (SCTG) – 43 categories	Standard Transportation Commodity Codes (STC)
Intended Use	Generally longer range, strategic statewide planning	Intended use generally shorter range more local planning

Table 6 shows that the network structure is essentially the same across the two models, including the impedance calculation with the exception of the centroid connectors. The national rail freight model uses county centroids with one centroid per county in every state while the Iowa Centric uses a sub-county scheme of rail freight stations in Iowa and county outside of Iowa. The commodity flow demand tables use different schemes: the national with the SCTG and the Iowa Centric with the STCC. The national rail freight model allows assignment by commodity only and does not represent any empty rail cars. The Iowa Centric allows assignment by two units: weight and rail cars. The rail car choice includes a transpose of the car assignment and thus reflects empty rail cars returning to their origin. And finally, the intended use of each rail freight model is different. The national model captures wide ranging movements on Class I railroads and can estimate, for example, where rail commodities would divert if a bridge were out on the Missouri or Mississippi River. The Iowa Centric reflects observed data in Iowa on a sub-county level and can be used for sensitivity tests on Class III railroads and commodity shifts. Both rail freight models have future years. The national uses 2010 and 2040 FAF rail commodity flows and uses a straight line interpolation. The Iowa Centric demand table is the CWB (average of 2009-2010). An approach to "growing" this table was integrated in the models.

6.1.1 National Rail Freight Summary Statistics

National rail freight reporting can be done in a number of ways. The national rail freight flows are captured readily in the FAF Commodity Tool to compare commodities between counties, FAF districts or states by study year by mode between 2010 and 2040. The national rail freight model adds a rail network, thus providing information on the paths that commodities use to complete their movements from origin to destination. The county base geography, as the smallest level of geography in the National Rail Freight Model, is the logical reporting framework for this model.

Thus summary statistics can be captured on the origin-destination (O-D) level or at the network level. Graphical User Interfaces (GUIs) have been prepared to streamline the queries of the rail freight flows and assignments.

The following standard reporting functionality is provided in the National Rail Freight Model:

1. Iowa Rail Ton Miles by County by Rail Owner
2. Iowa Rail Ton Miles by Commodity by Rail Owner

6.2 Iowa Centric Rail Freight Model

The second product prepared for rail freight modeling is an Iowa Centric Rail Freight Model. It features a national + local rail network model with an intended use of generally shorter range or more local planning. It is intended that the two rail freight models be used in a complementary fashion. The approach behind the Iowa localized product is similar to the national with the major differences of:

- Class III railroads in Iowa are added to the national rail network.
- Demand takes the form of commodity flows extracted from the Confidential Rail Waybill for 2009-2010 (averaged).

6.2.1 Iowa Rail Freight Summary Statistics

The following standard reporting functionality is provided in the Iowa Centric Rail Freight Model:

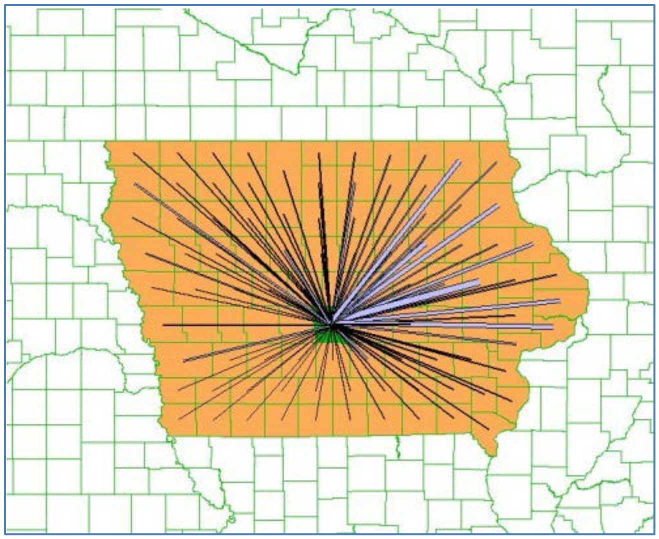
1. Iowa Rail Ton Miles by County by Rail Owner
2. Iowa Rail Ton Miles by Commodity by Rail Owner

7. APPLICATION TO STATEWIDE PLANNING EFFORTS

7.1 Commodity Information Management System

The FAF datasets provided the most comprehensive library of commodity flows available, organized by the 43 SCTG groups and provided for both a base 2010 and 2040 scenario year. The FAF data is available in a standard database format from the official website and also may be queried using the FHWA's Data Tabulation Tool. The Iowa DOT has the benefit of the geographic files of the disaggregation of the FAF into county to county commodity flows, produced for four freight modes for the iTRAM project. The county-to-county commodity flow disaggregation used a consistent a set of assumptions for both the base and future year. Travel demand software often utilizes a visual tool known as "desire lines." **Figure 7** is an example of "desire lines"; they show the volume commodities, between a zone and another zone or set of zones.

Figure 7: Sample Desire Line Plot All Domestic Commodities by Truck Mode to Polk County (from Iowa Counties Only)



A tool to display the county-to-county commodity flows by freight mode was desired by the Iowa DOT. The output would be both visual and tabular. The goals of building such a tool are:

- To take advantage of the county-to-county disaggregation work by building a user-friendly interactive tool to plot and analyze the commodity movements.
- To conduct simple comparisons across freight modes; - for example comparing the tons of coal moved by truck vs. rail into Iowa.

It is important to keep in mind the uses of the tool. The disaggregation is tied to county level employment from U.S. Census 2010 County Business Patterns, Bureau of Economic Analysis and Woods & Poole. The FAF commodity flows and tool report directly the FAF forecasts which will need to be analyzed in conjunction with local county level data.

7.2 Commodity/Freight Flow Analysis (Non-modal)

The iTRAM interactive commodity information tool was prepared directly from disaggregated county-to-county commodity flows using Caliper Corporation's TransCAD GISDK program. It will allow non-modal freight flow analysis by DOT staff. The following "rules" were established for the tool:

Geographic Scale Selection – The foundation geography used is the 3,143 county geographic layer. A single county or a set of counties can be selected for plotting.
Individual commodities or "All" commodities can be selected.
Domestic, Export or Import markets can be selected for eight foreign regions.
The sum of the desire lines are tabulated to obtain the total commodity flow for each selection.
Desire line GIS files, and/or maps can be saved if desired.
Base 2010, 2040 or interpolated year in five-year increments can be selected and saved.

The tool is purposefully made open to facilitate investigation and analysis of individual freight modes and commodity flows by mode.

7.3 Commodity Policy Evaluations

In a similar manner to the analysis tasks that are described in Section 0, policy evaluations can also be conducted using the iTRAM interactive commodity information tool. The domestic, export and import freight markets remaining as separate entities allows review and focused growth analysis of expected changes in the commodity flows by market. As an example, truck imports from the Los Angeles port areas to Iowa can be reviewed as a first step, then increased, decreased or shifted to a different mode as a test scenario. Among the potential comparisons that can be made are:

- Modal comparisons – Compare individual commodities or total tonnage of freight movements between two or more of the modes.
- Commodity comparisons - Compare freight mode tonnage between two or more of the commodities.

The FAF is a powerful database capturing the current estimation of commodity movements for 2010 through 2040. Using a tool that allows interactive queries such as the FAF Tool Graphical User Interface (GUI) extends the use of the FAF in Iowa.

7.4 National/Statewide/Regional Rail Freight Corridor Applications

Corridor Evaluations can be conducted in a number of specific ways using the National Rail Freight Model. Three main categories will be discussed and an example presented.

7.4.1 National Rail Assignment Investigations with U.S. Focus

The National Rail Freight Model can be used to conduct national rail investigations by individual commodity or for all commodities with a very wide focus – the entire U.S. Major commodity flows by rail depend on a stable rail network across all states, particularly those in the Midwest. A change in rail network characteristic in any mid-west state will have a ripple effect on many other states. The national rail model application work can be done without any special focus on Iowa origins and destinations. Examples of this type of investigation are:

- Background national rail through Iowa movements.
- Implications of 2040 FAF forecast on available Iowa rail capacity.
- Implications of alternative freight forecast scenarios (growth factoring of national commodity flow tables).

7.4.2 National Rail Assignment Investigations Focused on Iowa

The National Rail Freight Model can also be used to conduct national rail investigations by individual commodity or for all commodities with a focus on Iowa. Examples of this type of investigation are:

- Where Iowa commodity flows enter national rail network.
- Base and future Iowa commodity mode shares.
- Rail points of entry flows at Iowa study area boundaries.

7.4.3 Rail Network What-if Scenarios

Last, the National Rail Freight Model can be used to examine changes in commodity flows given rail network changes. These changes may reflect changes in rail coverage (new line) rail ownership, rail connectivity, or line haul speed. Scenarios representing infrastructure collapse or natural disaster may also be tested.

- Diversion of rail commodities given broken rail segments (washout or bridge replacement)
- Change in trackage or speed on a rail corridor
- Change in ownership on a rail corridor
- New rail line or segment for Class I system
- Interline changes, adding or removing the ability to transfer.

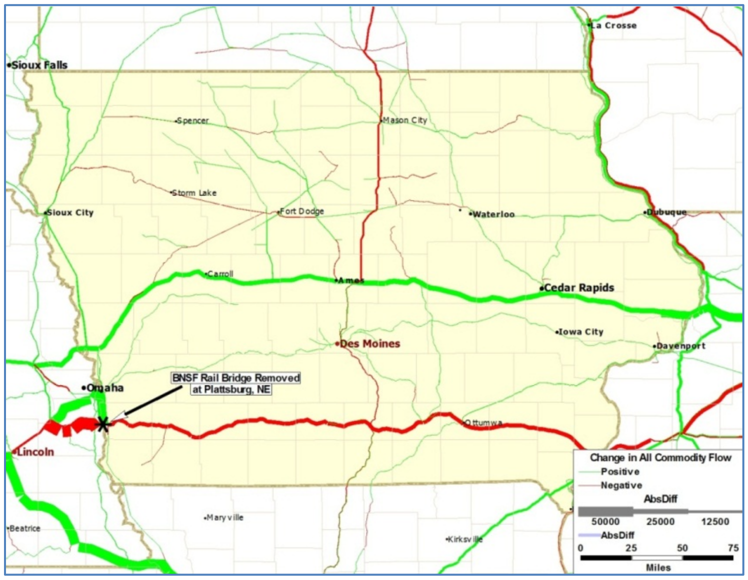
7.4.4 Example of National Rail Freight Model Application

An investigation of what happens when a rail bridge over the Missouri River is removed from service was chosen as an example. The BNSF Bridge at Plattsmouth, Nebraska was selected. There is a great deal of information on this bridge available to peruse; a single track replacement bridge was completed in late2013, although the original bridge will remain in place and will be used to route empty trains. The BNSF is the only railroad that uses the Plattsmouth Bridge. The rail link representing this bridge (ID=923905) was isolated and removed from the network. The National Rail Freight Model assignment was then re-run.

In order to see the differences between the base and the no-Plattsmouth Bridge scenarios, the two rail assignments were compared to make an absolute value difference bandwidth plot. The results are shown in **Figure 8**. All commodities were assigned to get the worst case. The red color represents locations where rail traffic declined. The green color represents locations where rail traffic increased. The location on the Missouri River where the Plattsmouth Bridge is located is shown with a black star. With the bridge out, the BNSF corridor from Plattsmouth on the west to Burlington on the east loses traffic. The rail traffic is diverted in three main ways:

- Rail traffic diverts to the UP, using the UP crossing at the Blair Bridge north of Omaha.
- Rail traffic stays on the BNSF, diverting to use the BNSF diagonal to Kansas City.
- Rail traffic is rerouted through Council Bluffs where there is a potential for Class I railroad transfers.

Figure 8: National Rail Diversions (All Commodities) upon Removal of the BNSF Plattsmouth Bridge



7.4 Summary

In summary, the National Rail Freight Model can be used directly for analysis on rail diversions knowing fully that track ownership, interlines and speed are respected by the all-or-nothing rail assignment. The county level zone system lends itself to national level investigations. The FAF demand data allows commodity flows up to 2040 to be assigned. In summary, the Iowa Centric Rail Freight Model can be used directly for analysis on rail diversions, path investigations, commodity flow changes and expanded or new facilities. This rail freight model allows assignment by weight or by rail cars, with the rail car choice including empty cars returning to their origins. The Rail Station level zone system lends itself to local level investigations. The future year factoring with FAF growth rates allows flows up to 2040 to be assigned.

8. LESSONS LEARNED

The Iowa Rail Freight Commodity Model is among the first of its kind to be developed in the U.S. Additionally, it is the first to look closely at both the national and state rail commodity flows and reference both the FAF and the Rail Waybill Sample. That being said, there are a number of caveats that the Iowa DOT and the consultant team would extend to other entities wishing to build a similar rail freight commodity model.

8.1 Findings & Recommendations

There are a number of challenges that developers will want to review and understand prior to developing their own rail commodity models.

- **A Defined Purpose is Key** – A highly defined purpose for commodity flow modeling is a key to success. The Iowa DOT defined their purpose with the rail freight model at the outset of the project. The purpose and need covered:

- Conducting a non-modal Commodity/Freight Flow Analysis
- Conducting Commodity Policy Evaluations
- Statewide Rail Freight Analysis
- Statewide/Regional Rail Freight Corridor Evaluations
- Major Rail Terminal Evaluations

- **Data Drives the Model Structure** – At the outset of the study, there was a desire to capture rail freight movement and needs at a very fine business level. Many of these needs require data sets and data relationships not used/integrated previously by any DOT. The learning curve for rail commodity models is steep. The Iowa DOT Rail Freight Model contains two levels of detail: national and state, each useful for a different planning use.

- **Sensitivity Testing is a Required Step in the Evolution of Rail Freight Models** – At the outset of the model development, there were a number of "what-if" tests that the developers wanted to see. In reality, rail network design and construction can easily consume a great deal of development time, leaving less time to apply the model. Building and testing rail fright applications will improve the rail commodity model so it can better serve state planning needs.

- **Limitations on the Integration of Rail Freight & Passenger (Scale)** – At the outset of the model development, there was a desire to test capacity of rail lines with a combination of freight and passenger services using them. As the project evolved, it became clear that the Iowa DOT rail freight model cannot replace or replicate business-driven rail operations and that measuring the interaction between these two uses of rail is not feasible in the scope of the present model. Information from the railroads themselves would be required to approach the ability to conduct this task.

8.2 Next Steps

The Iowa DOT and consultant team appreciate the support and guidance of the Federal Railroad Administration. The recommended course of activity with respect to the Iowa DOT Rail Freight Model is:

1. Continue to request and obtain the STB's Carload Waybill Sample to expand the Iowa DOT's library of available rail data.

2. Apply the Iowa DOT rail freight models and identify:
    a. Areas in the models needing attention and enhancement.
    b. Areas that provide reasonable starting point results and can be applied more widely.

3. Prepare and disseminate the rail freight methodology to peers at the national and state level for review and feedback. In particular, review the means of integrating Class I railroads, centroid connector strategy at national and local level, and assignment procedures.

4. If desired by the Iowa DOT, identify additional work tasks to add detail and capability to the Iowa DOT Rail Freight Model.

Technical Memorandum

Iowa Travel Analysis Model Work Summary for Upper Midwest Transportation Hub in Manly Iowa

Prepared For:	Eric Bill, HDR
Prepared By:	Jeff von Brown - Office of Systems Planning
Date:	May 28, 2015

This document summarizes the Iowa Travel Analysis Model [iTRAM] work for the Upper Midwest Transportation Hub [UMTH] TIGER grant application. Work was prepared for HNTB and the Iowa DOT Office of Rail and its purpose is to analyze the potential market for the proposed intermodal terminal at Manly Iowa.

DATA REQUEST

The Office of Systems Planning was asked to review the potential market share for the UMTH operation using the iTRAM, the 2010 base year second generation of the Iowa statewide travel demand model. The previous analysis was performed by the Iowa Northern Railroad [IANR], and was done so with a bottom up approach. The approach involved identifying key industries and businesses that could become a reliable base of traffic to reach a least a break level of business for the railroad. Then the Federal Highway Administration, *Freight Analysis Framework* online data tool was used to estimate the additional traffic beyond the base shipments. This additional traffic was assumed to be possible, as the connecting/partner railroads add significant efficiencies and marketing power for cross-county intermodal traffic.

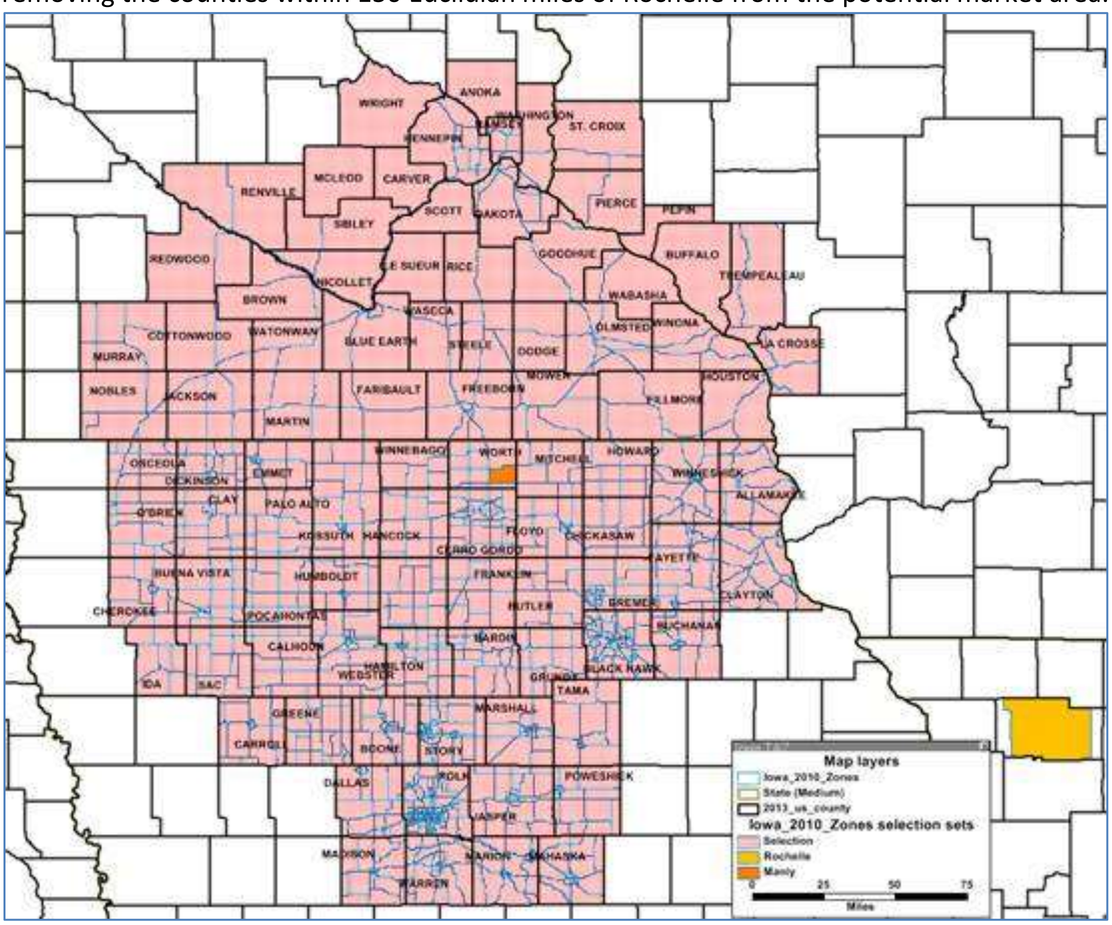
Validation of the previous forecast data was desired, and so the following approach was instituted to review the potential market of traffic

ANALYSIS METHOD

iTRAM was identified for use in the additional analysis, due to the newly created freight movement modeling capabilities. iTRAM has differing levels of freight forecasting potential, and specifically the FAF disaggregated flow tool was used for this analysis. The FHWA Office of Freight creates and maintains freight flow data sets representing the origin/destination movement of domestic and international traffic across different modes, called the Freight Analysis Framework or FAF. The minimum geographical unit in this analysis is a FAF zone, which typically represent an entire state, but fora major metropolitan or industrial areas within a state which are broken out into their own zone. Iowa is treated as one zone, whereas Minnesota has a Twin Cities zone, and a Remainder of the state zone and similar with Wisconsin where Milwaukee is a separate zone from the state. One of the key features of iTRAM is the ability to disaggregate the FAF zone data down to the individual county level, thereby enhancing the usability, such as Iowa going from one zone to ninety-nine zones [ninety-nine being the total number of counties in Iowa]. The disaggregation was done by identifying the employment types [identified categorized using their North American industry Classification System [[NAICS]] code] associated with the commodities moved [identified by their Standard Classification of Transported Goods [[SCTG] code], and reviewing the statistical significance using ANOVA tests. The result is county level information for 43 categories of commodities for all counties in the United States, plus eight generalized foreign markets for import/export traffic [Canada, Mexico, The Americas, Africa, Europe, Southwest Central Asia, Southeast Asia, East Asia]. The disaggregation of data was done on the FAF 3.4 dataset which represents 2007 commodity flows, discussion on changes to the data is mentioned below.

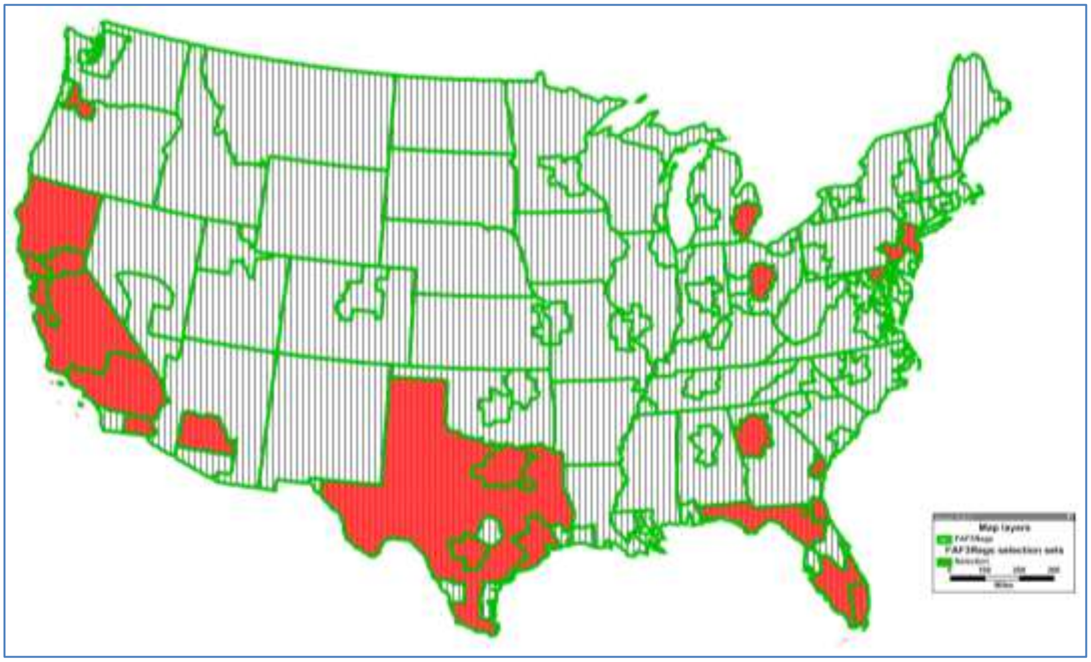
The previous analysis by the Iowa Northern was reviewed and the following assumptions were identified for use or adaptation in the iTRAM analysis.

- ANALYSIS AREA – a 150 mile Euclidian distance radius from Manly was used for the potential market area, including southern Minnesota, the Twin Cities Metro area, and parts of Wisconsin. Counties entirely included, or the majority of which were included. The impact of existing sites in the twin cities was accounted for by looking only at lanes not serviced directly by the railroads offering intermodal services in that area [no lanes in WA or Canada served by the BNSF, Canadian Pacific or Canadian National. The impact of Rochelle Illinois was accounted for by removing the counties within 150 Euclidian miles of Rochelle from the potential market area.



- ANALYSIS LANES – FAF 3.4 data was used to identify the top FAF zones for the study area inbound or outbound truck and intermodal domestic movements with a Euclidean distance greater than 550 miles. These lanes were then compared to specific lanes identified by IANR to establish the top 20 lanes for inbound/outbound, domestic/international shipments. The lanes selected are the following;

- New York NJ
- Columbus OH
- Philadelphia PA
- Detroit MI
- Baltimore MD
- Los Angeles CA
- San Jose CA
- Sacramento CA
- The remainder of CA
- Miami FL
- Jacksonville FL
- The remainder of FL
- Atlanta GA
- Savannah GA
- Phoenix AZ
- Portland OR
- Houston TX
- San Antonio TX
- Dallas-Fort Worth TX
- The remainder of TX



- MARKET SHARE – estimates for the share of shipments captured were determined for each of the following categories

Movement Type	IA Share	MN Share	WI Share
Inbound/Outbound Domestic Truck	5%	5%	5%
Inbound/Outbound Domestic Intermodal	30%	20%	5%
Export Intermodal/Truck	30%	20%	2%
Import Intermodal/Truck	30%	20%`	5%

- FREIGHT CHARACTERISTICS – all FAF commodity categories were included in the analysis. Certain commodities that are not likely to be containerized, such as gravel, are naturally omitted, as the selection of lanes that are over 500 miles in length, removes commodities with a shorter average length of haul.
- TRAFFIC GROWTH – as the FAF data was based on 2007 data, a 2% growth rate was used to grow freight to a 2017 total. This growth rate is based on the *National Transportation Statistics 2003*. Changes specific to commodities since 2007 have not been made, therefore products such as dried distillers grains or source verified grains do not show increases beyond the 2% growth up to 2017, thereby potentially underreporting a cornerstone business sector for the viability of the site by IANR.
- MOVEMENT ASSUMPTIONS – since not all containers entering Manly will be from full loads, an empty container factor was needed to account for the number of empty lifts performed. The

Cambridge Systematics and Association of American Railroads study *National Rail Freight Infrastructure Capacity and Investment Study* of 2007 employed a factor of 1.69 for empty loads over all equipment types, this has been used.

- LOAD SIZE – FAF data was broken down to 20 ton units, representing the roughly 40,000 pound load limit of a shipping container
- DIVERTED MILES – an important quantifiable factor of the analysis was the amount of diverted highway miles an intermodal shipment would net. Each county in the market area had a zip code selected for mileage calculation; this was usually the largest population center, or apparent center of industrial activity, if not the same. A similar spot selection was made for the FAF zone based lanes. A calculation of highway miles using Bing Maps for each county to each lane calculated. In addition, intermodal shipments shifting from other terminals would show diverted miles, so a mileage was calculated for each lane to Manly, as well as Chicago and Rochelle IL, as these were treated as the prior intermodal terminals for eastern railroads [CSX or Norfolk Southern railroads] and western railroads respectively [BNSF or Union Pacific]. The difference in shipment miles was then calculated, but assumed that the non-Manly end drayage movement would occur the same as before. The lanes with zip codes are included below.

County	State	Zip Code	County	State	Zip Code
ALLAMAKEE	IA	52172	**WINNEBAGO**	IA	50436
BLACK HAWK	IA	50702	**WINNESHIEK**	IA	52101
BOONE	IA	50036	**WORTH**	IA	50448
BREMER	IA	50677	**WRIGHT**	IA	50525
BUCHANAN	IA	50682	**ANOKA**	MN	55448
BUENA VISTA	IA	50588	**BLUE EARTH**	MN	56001
BUTLER	IA	50602	**BROWN**	MN	56073
CALHOUN	IA	50579	**CARVER**	MN	55387
CARROLL	IA	51401	**COTTONWOOD**	MN	56101
CERRO GORDO	IA	50401	**DAKOTA**	MN	55077
CHEROKEE	IA	51012	**DODGE**	MN	55927
CHICKASAW	IA	50659	**FARIBAULT**	MN	56013
CLAY	IA	51301	**FILLMORE**	MN	55965
CLAYTON	IA	52043	**FREEBORN**	MN	56007
DALLAS	IA	50263	**GOODHUE**	MN	55066
DICKINSON	IA	51360	**HENNEPIN**	MN	55428
EMMET	IA	51334	**HOUSTON**	MN	55921
FAYETTE	IA	52142	**JACKSON**	MN	56111
FLOYD	IA	50616	**LE SUEUR**	MN	56057
FRANKLIN	IA	50441	**MCLEOD**	MN	55350
GREENE	IA	50129	**MARTIN**	MN	56031
GRUNDY	IA	50638	**MOWER**	MN	55912
HAMILTON	IA	50595	**MURRAY**	MN	56172
HANCOCK	IA	50438	**NICOLLET**	MN	56074
HARDIN	IA	50126	**NOBLES**	MN	56187
HOWARD	IA	52136	**OLMSTED**	MN	55901

HUMBOLDT	IA	50529	**RAMSEY**	MN	55109
IDA	IA	51445	**REDWOOD**	MN	56283
JASPER	IA	50208	**RENVILLE**	MN	56277
KOSSUTH	IA	50511	**RICE**	MN	55021
MADISON	IA	50273	**SCOTT**	MN	55379
MAHASKA	IA	52577	**SIBLEY**	MN	55334
MARION	IA	50219	**STEELE**	MN	55060
MARSHALL	IA	50158	**WABASHA**	MN	55968
MITCHELL	IA	50461	**WASECA**	MN	56093
O'BRIEN	IA	51201	**WASHINGTON**	MN	55042
OSCEOLA	IA	51249	**WATONWAN**	MN	56081
PALO ALTO	IA	50536	**WINONA**	MN	55987
POCAHONTAS	IA	50574	**WRIGHT**	MN	55313
POLK	IA	50316	**BUFFALO**	WI	54755
POWESHIEK	IA	50112	**LA CROSSE**	WI	54601
SAC	IA	50583	**PEPIN**	WI	54736
STORY	IA	50011	**PIERCE**	WI	54022
TAMA	IA	52342	**ST. CROIX**	WI	54017
WARREN	IA	50125	**TREMPEALEAU**	WI	54612
WEBSTER	IA	50501			

FAF Zone	Zip Code	FAF Zone	Zip Code
Phoenix AZ	85302	**Columbus OH**	43201
Los Angeles CA	90293	**Portland OR**	97203
Sacramento CA	95814	**Philadelphia PA**	19124
San Francisco CA	94501	**Dallas-Fort Worth TX**	76117
Remainder of California	93706	**Houston TX**	77007
Jacksonville FL	32202	**San Antonio TX**	78056
Miami Florida	33142	**Remainder of TX**	79602
Remainder of Florida	32134	**Manly IA**	50456
Atlanta GA	30319	**Chicago IL**	60608
Savannah GA	31404	**Rochelle IL**	61068
Baltimore MD	21224		
Detroit MI	48205		
New York City NJ	07302		

ANALYSIS RESULTS

The results of the analysis are summarized in the tables below. The first report shows the diverted miles for the loaded trips as converted to the Intermodal at Manly in 2017. The second reports the total lifts for trips converted to the intermodal facility at Manly in 2017.

The results anticipate a market share that exceeds the estimated lifts for 2017 as compared to the primary demand projections for the application. It is a positive result in that taking a look at a limited set of lanes [top 20 lanes], sufficient traffic exists at reasonable levels of market capture to anticipate success for the UMTH. Additionally, if all intermodal valid lanes were analyzed and market share assumptions were reduced, sufficient traffic similar to or exceeding the 2017 traffic may be available. As UMTH and IANR will have significant marketing resources and service area reach with their connecting railroads and associated customer bases, the lanes identified in this analysis will be likely sources of traffic served by this project.

DIVERTED MILES	Outbound to:				Inbound from:		
	Domestic Truck	Domestic Intermodal	Export		Domestic Truck	Domestic Intermodal	Import
Phoenix AZ	1,096,557	130,819	-		496,374	14,906	228
Los Angeles CA	3,970,251	485,102	528,076		2,207,816	227,238	1,049,897
Sacramento CA	504,895	101,926	-		56,411	4,153	21,663
San Francisco CA	893,418	72,438	148,749		474,659	50,018	159,968
Remainder of California	1,902,128	510,485	2,246		2,032,058	357,914	154
Jacksonville FL	406,988	12,239	121,266		111,455	112,203	21,425
Miami FL	865,742	128,253	49,726		511,991	12,245	26,553
Remainder of Florida	1,082,413	59,383	101		389,929	6,033	2,771
Atlanta GA	1,899,330	367,132	-		634,969	77,985	-
Savannah GA	314,246	100,574	206,602		64,279	2,218	134,290
Baltimore MD	586,353	97,304	74,682		130,478	52,322	90,720
Detroit MI	822,816	209,872	123,938		677,259	153,706	76,539
New York City NJ	1,914,661	223,319	273,970		499,829	54,198	757,045
Columbus OH	501,694	60,212	-		570,236	6,653	-
Portland OR	307,907	14,845	1,610,384		472,169	138,598	22,155
Philadelphia PA	604,878	270,480	3,519		338,337	43,623	213,253
Dallas-Fort Worth TX	1,878,684	1,006,439	-		733,984	37,387	-
Houston TX	1,245,406	185,468	395,261		575,522	80,906	373,457
San Antonio TX	337,556	13,575	-		119,205	20,229	-
Remainder of TX	1,422,346	946,916	602		790,678	26,238	80
TOTALS	**22,558,271**	**4,996,780**	**3,539,120**		**11,887,637**	**1,478,772**	**2,950,199**

Directionally	31,094,172				16,316,609		
Overall	47,410,781						

DIVERTED LIFTS	Outbound to:				Inbound from:		
	Domestic Truck	Domestic Intermodal	Export		Domestic Truck	Domestic Intermodal	Import
Phoenix AZ	739	619	-		349	73	1
Los Angeles CA	2,289	2,470	2,571		1,279	1,081	5,558
Sacramento CA	294	502	-		33	22	97
San Francisco CA	497	377	806		262	237	754
Remainder of California	1,025	2,596	10		1,087	1,632	1
Jacksonville FL	328	48	462		90	469	71
Miami FL	561	512	182		318	65	98
Remainder of Florida	830	227	0		306	25	12
Atlanta GA	2,097	1,411	-		700	284	-
Savannah GA	262	360	741		58	9	490
Baltimore MD	610	348	287		136	190	355
Detroit MI	1,515	681	435		1,238	544	293
New York City NJ	1,810	928	1,028		477	212	2,790
Columbus OH	808	239	-		904	27	-
Portland OR	191	75	7,002		291	591	100
Philadelphia PA	592	966	13		332	159	778
Dallas-Fort Worth TX	2,384	5,637	-		953	195	-
Houston TX	1,243	818	1,721		582	477	1,706
San Antonio TX	320	62	-		107	106	-
Remainder of TX	1,572	4,013	3		910	153	0
TOTALS	19,965	22,890	15,261		10,412	6,553	13,105
Directionally	58,117				30,070		
Empty Container Factor	154,326						
Overall	154,326						