

Central Omaha Transit Alternatives Analysis

Ridership Projections Forecasting Methodology and Results Report

**Prepared for:
METRO
City of Omaha
Metropolitan Area Planning Agency (MAPA)**

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INTRODUCTION

OVERVIEW

This report documents the methodology that was used to develop travel demand forecasts to assist in the evaluation of two Bus Rapid Transit (BRT) and one Streetcar alternative for the Central Omaha Transit Alternatives Analysis (AA). The goal of the AA is to identify and compare the costs, benefits, and impacts of a range of transportation alternatives as a means of providing local decision makers with the information necessary to implement the most appropriate transportation solutions in the study area. The intent of the travel demand forecasting procedure was to provide a basis for comparing the ridership of each alternative through the use of regional socioeconomic data, a complementary transit network, and defensible forecasting method.

The AA study is Phase 1 of the overall transit planning process. Phase 2 will include environmental documentation and conceptual engineering, and possibly entry into Federal Transit Administration (FTA) Project Development if the project pursues funding as part of the FTA Small Starts program.

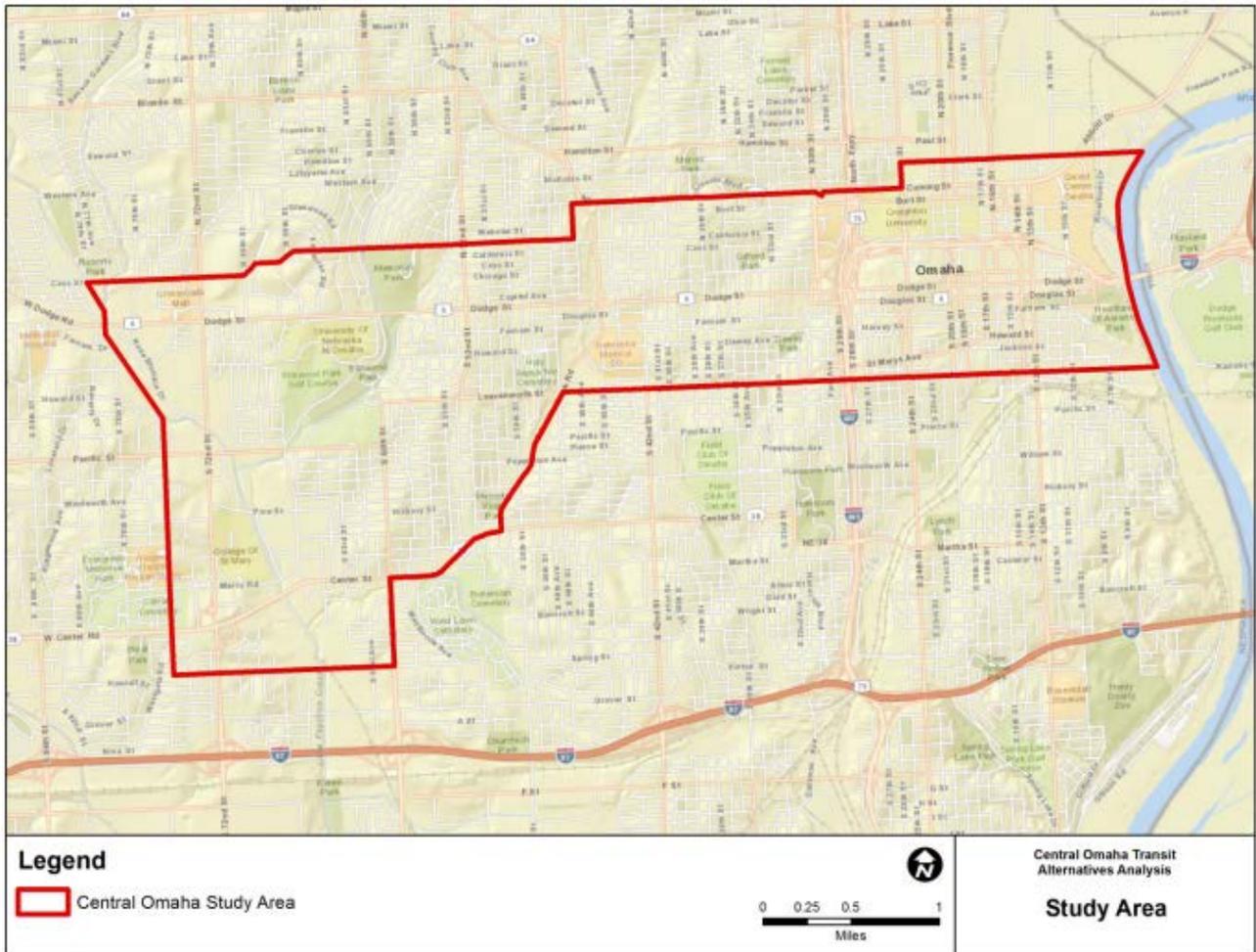
A small area direct-demand regression model was used to initially screen the transit alternatives in this study, because at the time, the regional travel demand model did not contain a transit component. During later stages of the study, the Metropolitan Area Planning Agency (MAPA) travel demand model with new transit modeling capabilities was released and utilized to provide a supplemental set of transit alternative forecasts. This transit model runs concurrently with the vehicular highway network model in TransCAD software, and thus has the capability to estimate transit ridership. Transit routes are modeled individually such that ridership estimates were able to be obtained using the TransCAD model to assess individual alternatives.

STUDY AREA DEFINITION

The study area includes Downtown, Midtown, the University of Nebraska Medical Center (UNMC), the University of Nebraska at Omaha (UNO), and the Crossroads and Aksarben Village areas.

Figure 1 identifies the study area boundaries.

FIGURE 1: CENTRAL OMAHA STUDY AREA



Source: HDR, 2013.

FINAL SCREENING USING SMALL AREA/ REGRESSION MODEL

The small area model is based on a customized regression methodology in which the transit ridership at the stop level (the dependent variable) is related to key independent variables such as population density, employment density, number of buses operating daily, and other important level-of-service variables that are known to influence transit ridership.

Though direct demand regression models have several advantages such as quick turnaround time in model application, ability to test the sensitivity of independent variables, and relatively short time needed for model estimation, they also have several limitations. For example, the direct demand models are not network based. Therefore, they are not capable of capturing the impact of transit service on competing non-transit modes. They do not provide any data to capture the air quality or highway congestion impacts. ***For these reasons, the results of direct demand models should generally be used to make high level planning decisions only.***

SMALL AREA MODEL DEVELOPMENT

The first step in the small area model development process is to compile a data base containing the stop level boardings, socio-economic and land use data in the primary catchment area and transit level-of-service data in the study area. Once the database is compiled, the next step is to use a statistical software to estimate regression equations to connect the dependent variable (ridership) to a number of key independent variables that are known to influence ridership.

The small area model was estimated using the combination of ride check data as well as the results of the 2012 On-Board Survey conducted by Metro. Historically, on board surveys include origin and destination information, as well as boarding and alighting data for each person surveyed. The boarding and alighting data are, by far, the most important data needed for small area model estimation. However, the 2012 On-Board survey collected only the origin and destination information. ***Stop level data was not available.*** Therefore, a decision was made to use the 2012 Ride Check data to obtain stop level activity.

The ride check data was extracted for the following routes that operate within the study area.

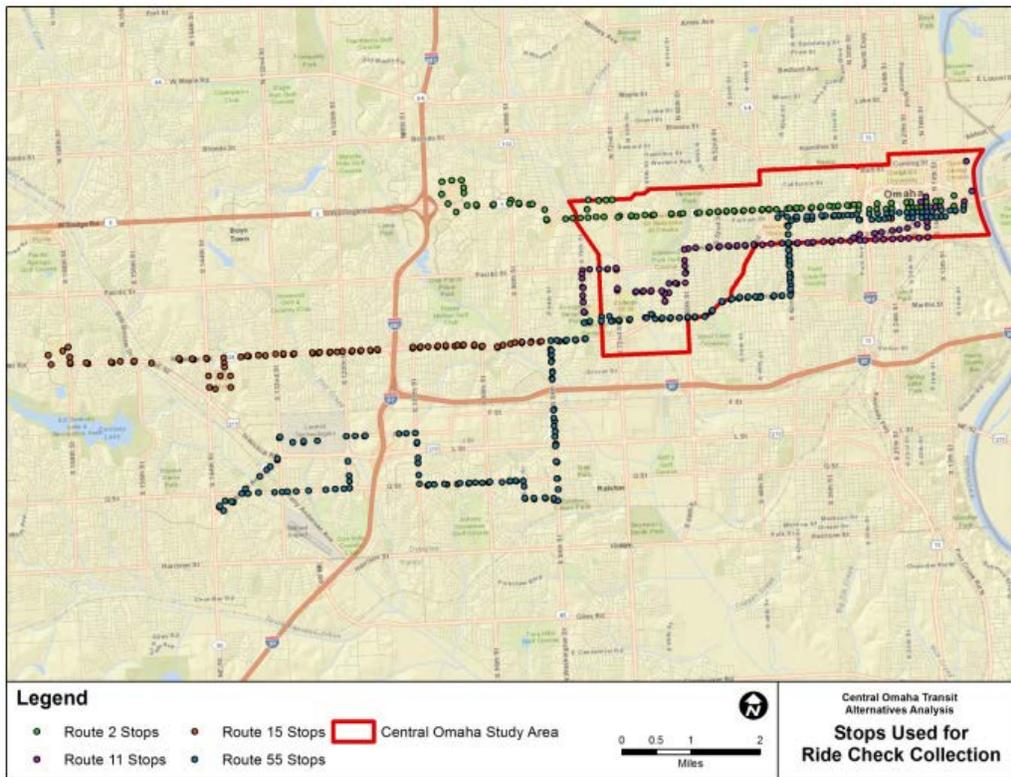
- Route 2 – Dodge
- Route 11 – Leavenworth
- Route 15 – West Center
- Route 55 – Q Street

Because ride check data is only a sample of daily boardings, they needed to be factored to reflect daily boardings. This was done by collecting the factored boarding data by route and direction (eastbound and westbound) from the 2012 Metro On-Board Survey and applying the factored boardings to the ride check data based on the number of boardings that was observed during the ride checks. **Table 1** shows the factored daily ridership from the onboard survey. **Figure 2** shows the stops from the ride check data for routes 2, 11, 15, and 55.

TABLE 1: FACTORED DAILY RIDERSHIP (OCTOBER 2012)

Route	Eastbound	Westbound	Total
2	845	904	1,749
11	324	216	540
15	354	389	743
55	367	388	755

FIGURE 2: STOPS USED FOR RIDE CHECK COLLECTION



Source: HDR, 2013.

Once the ride check data was converted to daily boardings, stops that were outside of the study area for routes 15 and 55 were removed, because those stops have different characteristics, than study area. All stops for routes 2 and 11 were included. Next, the stops were grouped within 1,000 feet to reflect the station spacing of the BRT and streetcar alternatives. Google Transit data, provided by Metro, was used to calculate the number of bus operating daily for each of the four routes as well as competing and complementary service.

Quarter mile and half mile buffers were also created around each stop for estimating population and employment densities. The population and employment numbers used to calculate densities were collected from MAPA for 2010. It is important to note that when calculating densities, population and employment was assumed to be evenly distributed across the transportation analysis zones (TAZ).

A series of model estimations (regressions) were then conducted at the stop level in order to relate key variables such as population density, employment density, number of buses operating daily,

number of competing buses operating daily, number of complementary buses daily, and the availability of a transit center to the number of estimated boardings occurring on each route by stop by direction.

The most significant variables determining ridership in the eastbound direction included the availability of a transit center, the number of buses operating daily, the number of competing buses operating daily, the number of complementary buses operating daily, population density within a quarter mile, and retail employment density within a half mile.

As for the westbound direction, the most significant variables determining ridership included the availability of a transit center, the number of buses operating daily, the number of competing buses operating daily, the number of complementary buses operating daily, and total employment density within a quarter mile.

Based on the regression analysis, two equations were created for estimating ridership. The equations are based on two independent calibrations using different variables. The final equations for estimating the stop-level boardings by direction are as follows:

Eastbound Boarding Equation

$$\begin{aligned} \text{Boardings} = & (34.70265229 \times \text{Transit Center}) \\ & + (0.567869392 \times \text{No. of Buses Operating Daily}) \\ & + (-0.169769306 \times \text{No. of Competing Buses Operating Daily}) \\ & + (0.016797492 \times \text{No. of Complementary Buses Operating Daily}) \\ & + (2.15094E - 05 \times \text{Population Density within a quarter mile}) \\ & + (0.000982543 \times \text{Retail Employment Density within a half mile}) \end{aligned}$$

Westbound Boarding Equation

$$\begin{aligned} \text{Boardings} = & (43.10886479 \times \text{Transit Center}) \\ & + (0.221095104 \times \text{No. of Buses Operating Daily}) \\ & + (-0.034449993 \times \text{No. of Competing Buses Operating Daily}) \\ & + (0.012205144 \times \text{No. of Complementary Buses Operating Daily}) \\ & + (0.003707533 \times \text{Total Employment Density within quarter mile}) \end{aligned}$$

The values used for these equations were based on a goodness-of-fit and analysis-of-variance statistics resulting from numerous regression analyses. The R-squared values were around 0.5 for the eastbound direction and nearly 0.7 for the westbound direction, which suggests that there is more variation in the survey data than what can be easily modeled using the variables (availability of a transit center, the number of buses operating daily, the number of competing buses operating daily, the number of complementary buses operating daily, population density and employment density).

For the eastbound equation, the three main variables chosen (availability of a transit center, the number of buses operating daily, and the number of competing buses operating daily,) were those which had t-statistics over 2.0. Furthermore, this formulation yielded the highest F-statistic (ratio

of explained variance to unexplained variance) of the formulations tested, around 15, on a basis of 99 total degrees of freedom (data points representing surveyed bus stops).

The number of complementary buses operating daily, population density and retail employment density was not seen by any of the regressions as statistically significant enough to warrant inclusion (it never experienced a t-statistic higher than 1.0, for example, significantly less than the commonly-used 95% critical value of 1.98). Nevertheless, these variables were included to give added flexibility to the small area model. **Table 2** identifies the eastbound regression analysis results.

TABLE 2: EASTBOUND REGRESSION ANALYSIS RESULTS

	Eastbound Direction
R Squared (coefficient of determination)	0.49
F Statistic	14.25
Degrees of Freedom	99
<i>Individual Variable T-Statistics</i>	
Transit Center	4.097
No. of Buses Operating Daily	3.468
No. of Competing Bus Operating Daily	-2.756
No. of Complementary Buses Operating Daily	0.411
Population Density within a quarter mile	0.006
Retail Employment Density within a half mile	0.208

Source: HDR, 2013.

For the westbound equation, the three main variables chosen (availability of a transit center, the number of buses operating daily and total employment density within a quarter mile) were those which had t-statistics over 2.0. This formulation yielded the highest F-statistic (ratio of explained variance to unexplained variance) of the formulations tested, around 39, on a basis of 94 total degrees of freedom (data points representing surveyed bus stops).

The number of competing buses operating daily and the number of complementary buses operating daily were not seen by any of the regressions as statistically significant enough to warrant inclusion (it never experienced a t-statistic higher than 1.0, for example, significantly less than the commonly-used 95% critical value of 1.98). Nevertheless, these variables were included to give added flexibility to the small area model. **Table 3** identifies the westbound regression analysis results.

The estimated regression model was validated by applying the model to all the four routes that operate in the study area. Overall, when comparing the observed data to the estimated ridership on routes 2, 11, 15, and 55 combined, the model projects ridership to be 9 percent higher in the eastbound direction and 15 percent higher in the westbound direction.

TABLE 3: WESTBOUND REGRESSION ANALYSIS RESULTS

	Westbound Direction
R Squared (coefficient of determination)	0.67
F Statistic	38.94
Degrees of Freedom	94
<i>Individual Variable T-Statistics</i>	
Transit Center	5.225
No. of Buses Operating Daily	2.301
No. of Competing Bus Operating Daily	-0.338
No. of Complementary Buses Operating Daily	0.305
Total Employment Density within a quarter mile	3.722

Source: HDR, 2013.

Given that the margin of error in most travel models, whether it is network based or otherwise, is usually about 10 to 15 percent, the regression model is reasonably validated for the study area.

FINAL SCREENING ALTERNATIVES TESTED

A total of three final screening alternatives were proposed for the Central Omaha Transit Alternatives Analysis. Of the three alternatives, two would utilize BRT technology and one would utilize streetcar technology. **Figure 3** identifies each of the three alternatives.

FIGURE 3: CENTRAL OMAHA ALTERNATIVES



Each of the three alternatives assumes the same number of daily buses operating in each corridor. Based on the Draft Operating Plan from May 2013, approximately 85 buses would operate daily in each alternative.

The underlying bus network would remain unchanged from the current operation. This network was used to determine competing and complementary service for each alternative.

RESULTS FROM SMALL AREA MODEL

The forecast results are presented in four sections in order to compare the ridership across all alternatives. **Figure 4** shows the aggregation of the ridership data.

FIGURE 4: AGGREGATION OF RIDERSHIP DATA



Table 4 presents the forecast results for the three proposed alternatives. The ridership was estimated based on the current model year (2010). It should be noted that the regression model estimated in this study is based on bus ridership data. This data does not reflect the ridership characteristics associated with BRT or Streetcar technologies. Research in the travel modeling field indicate premium modes such as rail, BRT and Streetcar tend to attract more ridership than a comparable bus mode with exactly similar operating characteristics. This phenomenon is known as the “Bias Factor” and is due to the fact that premium modes offer better ride quality, safety and reliability of service. Even the very appearance of the vehicle can have a positive bias on ridership.

Past experience in Houston and Phoenix indicates the light rail bias factor is between 15 and 20 percent. For this study, for Streetcar technology, the Bias factor was reduced to 15 percent and for BRT, to 10 percent.

TABLE 4: CENTRAL OMAHA SMALL AREA MODEL RIDERSHIP RESULTS

	Alternative		
	1 BRT Dodge/Douglas	2 BRT Farnam/Harney	3 Streetcar
Section 1 - 72nd Street to 50th Street	180	180	0
Section 2 - 42nd Street to 36th Street	120	200	220
Section 3 - 33rd Street to 11th Street	480	620	680
Section 4 - 10th Street to Mike Fahey Street	300	300	300
Total Ridership - No BRT/Rail Preference	1,080	1,300	1,200
Total Ridership - With Preference	1,180	1,430	1,380

Source: HDR, 2013.

LIMITATIONS/UNCERTAINTIES IN USING THE SMALL AREA MODEL

The Central Omaha Small Area Model was estimated using the 2012 Ride Check Data and the OD survey data. This data was a snapshot of a particular moment, and therefore, like most models, do not fully reflect changing factors, such as: an increase in fuel prices; reduction in transit services; changes in parking policies, etc. Therefore, this type of model is suitable for short term application only.

It is important to point out that as with all direct demand models, there is always a margin of error associated with using demographic and land use forecasts. Because we are comparing more than two alternatives, these margins of error are irrelevant because the same margins of error exist in each alternative, and therefore, cancel each other out.

The following items are recommended for further refining the Central Omaha Small Area Model:

- The ridership coefficients were calibrated based on ride check data that was done in coordination from the 2012 On-Board Survey. Future on-board surveys should contain boardings and alighting information, along with origin and destination information to improve the calibration process.
- Data collection for transit riders traveling short distances can be challenging, given the limited amount of time the transit rider is on a transit vehicle. The development of a survey instrument specifically designed to quickly survey transit riders taking short trips would help to better understand that particular market.
- A special event factor could be developed and applied to the daily ridership by using person trip tables and event data provided from a variety of sources, including but not limited to, Convention and Visitors Bureau, City data, County data.
- Fare assumptions are not included in the small area model. This variable should be considered in future phases of study.

FINAL SCREENING USING MAPA TRAVEL DEMAND MODEL

Nearing the end of the final screening process, the MAPA TransCAD travel demand model with transit component became available and a second ridership forecast was produced. Ultimately, this estimate was not utilized during final screening to determine the Locally Preferred Alternative (LPA) due to known limitations and uncertainties as described on page 18. As planned, a final ridership estimate will be developed for the final LPA based upon more accurate and complete information in the study area.

MAPA MODEL BACKGROUND AND CAPABILITIES

The current MAPA TransCAD travel demand model reflects a base year of 2010, meaning the roadway network, transit network, and socioeconomic data reflect year 2010 conditions. This model and its inputs were reviewed and approved by Iowa DOT and NDOR in the spring of 2013. Any modifications to the TransCAD model were conducted for purposes of this Alternatives Analysis project only, and are documented in the next section.

The transit model includes the ability to model separate modes, including bus, express bus, BRT and streetcar. Characteristics of each of the modes are summarized in **Table 5**.

TABLE 5. TRANSIT MODEL CHARACTERISTICS BY MODE

Mode	Impedance Field	Fare
Bus	Bus Time	\$1.25
Express Bus	Express Time	\$1.50
BRT	Express Time	\$1.25
Streetcar	Bus Time	\$0.50
Walk	Walk Time	n/a

Travel time is a key variable in the travel demand modeling process. In a basic sense, the model iterates through a feedback loop in which trips are distributed throughout the transportation system based on congested travel times, as trips seek the path with shortest travel times. Vehicular travel times are computed based on congested speeds, such that as the roadway segment approaches capacity, its congested speeds will decrease, and vehicular travel times increase.

Similarly, the transit model utilizes an impedance field, which varies by mode. The in-vehicle bus time (“Bus Time”) is equal to three times the free-flow driving time for local routes. “Express Time” represents a service that is faster than local bus, but slower than an average vehicular speed. The original travel demand model contained Express Times that were equivalent to the “Bus Time” field. As part of this assessment, the “Express Time” was modified to twice the free-flow driving time, as discussed in the next section.

Transit fares are converted to an equivalent value of time, using \$12/hour. Thus, in terms of the travel demand model, \$1.00 “costs” 5 minutes.

The MAPA model derives transit trips in two ways, as described below.

Walk-access trips:

- trips with walk access on both trip ends.
- made via any link that is designated as a walkable link.
- Impedance based on fare, walk access time, initial wait time, in-vehicle time, transfer walk time and transfer wait time (if appropriate), and egress walk time.

Drive-access trips:

- primarily based on locations with designated Park n Ride facilities.
- have drive access on the home or production end of the trip, and walk access on the attraction end.
- Impedance based on drive access time and drive time, initial wait time, in-vehicle time, transfer walk time and transfer wait time (if appropriate), and egress walk time.

The results of the transit assignment include transit boardings and alightings at each route stop location, by walk access and drive access.

ADJUSTMENTS TO THE TRANSIT MODEL

The following modifications were made to the original 2010 base year TransCAD model, for purposes of completing this analysis.

- Updated walkable links
 - Previously several corridors in the downtown Omaha area were not designated as walkable links. These corridors included one-way roadways such as Dodge, Douglas, Farnam and Harney Streets. The WalkLink attribute was changed to “9” along these corridors in order to represent a walkable link. Walk times were re-calculated to reflect this change.
- Updated “Express Time”
 - Previously, bus time and express time were equivalent (3 times free-flow vehicular speed). The “Express Time” was changed to 2 times the free-flow vehicular travel time, per the provided travel demand model documentation.
- Added turn penalty
 - Added left-turn prohibitors at 96th Street/W Dodge Road (from link ID 2681 to 5808 and from 3099 to 5809) to reflect an existing median break at this location.
- Added Walk-Access connectors
 - Walk-access connectors represent the means for walking to transit service. In the study area, this provides a means for walking to and from large travel analysis zones (TAZs).

- Decrease the walk time in the study area
 - 36 study area TAZs were modified for walk access time. This was done because the TAZs are geographically large, with corresponding walk-access connectors covering fairly long distances. Since much of the walkable development in the study area is close to the study corridors, walk time on all TAZ connectors in study area TAZs was changed to 2.0 minutes to represent a reasonable average walk time from these more densely-developed TAZs. Previously, the walk time was calculated based on a walk speed of 3mph and the distance from the centroid of the zone to the street network. This change provided a better representation of the average walk time to the study corridors.
- Removed inaccurate Park n Ride location
 - The original travel demand model network included a Park n Ride location at 96th/Dodge Streets. Since this location is not a designated Park n Ride, it was removed.

FINAL SCREENING ALTERNATIVES TESTED

A total of three alternatives were under evaluation for the Central Omaha Transit Alternatives Analysis. Of the three alternatives, two would utilize BRT technology and one would utilize streetcar technology. The three final screening alternatives were shown in the previous section, Figure 3. **Table 6** summarizes key assumptions for the three alternatives, including headway, fare, and representative Park n Ride locations.

TABLE 6. FINAL SCREENING ALTERNATIVE CHARACTERISTICS

Alternative	AM/PM Headway	Off-Peak Headway	Fare	Park n Ride Location
1 (BRT)	10 min	15 min	\$1.25	72 nd /Dodge
2 (BRT)	10 min	15 min	\$1.25	72 nd /Dodge
3 (Streetcar)	10 min	15 min	\$0.50	42 nd /Dodge

Note: Park n Ride lots are not a part of the Alternative Analysis projects and were assumed for travel demand modeling purposes only.

The BRT and Streetcar projects do not include Park n Ride lots as a part of the project. However, Park n Ride locations were assumed in the model for each of the alternatives in order to represent transit trips that would access the new service by driving their personal vehicle to a parking lot and getting on the BRT or Streetcar. Although determining Park n Ride locations is not a component of this study, these assumptions were made in order to allow the travel demand model to generate this type of commuter trip. As previously noted, Park n Ride locations are a necessary input for the travel demand model to permit drive-access transit trips. For each alternative, Park n Ride locations were established at the western terminus of the alternative alignment. Actual parking lot capacity and availability was not taken into consideration when coding these Park n Ride locations.

Streetcars are not typically associated with Park n Ride lots. However, the concept of driving a personal vehicle and “parking once” to use the Streetcar for short, linked trips in the study corridor is likely. Thus, providing a Park n Ride location at the western terminus of the Streetcar alignment (42nd/Dodge) allows representation of this type of drive access trip in the travel demand model.

RESULTS FROM TRAVEL DEMAND MODEL

A ridership summary of the total boardings (combined for both walk access and drive access) is shown in **Table 7**. The results show the highest ridership for BRT Alternative 1. The representative Park and Ride location at 72nd/Dodge attracts commuter trips (in the form of drive-access trips) for each of the BRT alternatives, more notably for Alternative 1 compared to Alternative 2. No drive-access trips are attracted to the Streetcar alternative, which suggests that the western terminus at 42nd Street is not at a location attractive to commuters along the corridor.

TABLE 7. FINAL SCREENING ALTERNATIVE RIDERSHIP ESTIMATES FROM THE TRAVEL DEMAND MODEL

Alternative	New Service Ridership			Total Transit System Ridership
	Walk Access	Drive Access	Total	
1 (BRT)	980	380	1,360	13,000
2 (BRT)	820	160	980	12,700
3 (Streetcar)	520	0	520 *	12,500
No-Build	0	0	0	12,500

*Refer to Limitations/Uncertainties in using the MAPA Travel Demand Model on Page 18 for considerations in this methodology for forecasting Streetcar ridership.

Notes:

No-Build alternative includes the adjustments to the 2010 base year model as described on Page 11 of this document.

The total transit system ridership for Metro for average weekday service in April 2012 was 14,877.

The total Metro transit unlinked passenger trip count was 14,090 on an average weekday in 2010 (the MAPA model base year) according to the National Transit Database.

Ridership estimates at the stop-level are shown in **Table 8**, **Table 9**, and **Table 10**. These tables are reporting the transit assignment results in Origin-Destination format.

TABLE 8. RIDERSHIP RESULTS BY STOP- ALTERNATIVE 1 (BRT ON DODGE/DOUGLAS)

Eastbound on Douglas

<i>Intersection</i>	Walk Access		Drive Access	
	Boardings	Alightings	Boardings	Alightings
<i>72nd/Dodge</i>	99	0	187	0
<i>62nd/Dodge</i>	55	6	0	0
<i>50th/Dodge</i>	92	20	0	0
<i>42nd/Dodge</i>	103	30	0	1
<i>36th/Dodge</i>	50	38	0	4
<i>33rd/Dodge</i>	36	19	2	1
<i>31st/Dodge</i>	40	40	0	2
<i>24th/Douglas</i>	12	56	0	8
<i>20th/Douglas</i>	3	119	0	98
<i>16th/Douglas</i>	1	76	0	48
<i>13th/Douglas</i>	1	54	0	13
<i>11th/Douglas</i>	0	16	0	7
<i>10th/Capitol</i>	0	1	0	0
<i>10th/Cass</i>	0	7	0	5
<i>12th/Fahey</i>	1	7	0	2
<i>16th/Fahey</i>	0	3	0	0
	491	491	189	189

Westbound on Dodge

<i>Intersection</i>	Walk Access		Drive Access	
	Boardings	Alightings	Boardings	Alightings
<i>16th/Fahey</i>	3	0	0	0
<i>12th/Fahey</i>	7	1	2	0
<i>10th/Cass</i>	7	0	5	0
<i>10th/Capitol</i>	1	0	0	0
<i>11th/Dodge</i>	16	0	7	0
<i>13th/Dodge</i>	54	1	13	0
<i>16th/Dodge</i>	76	1	48	0
<i>20th/Dodge</i>	119	3	98	0
<i>24th/Dodge</i>	56	12	8	0
<i>31st/Dodge</i>	40	40	2	0
<i>33rd/Dodge</i>	19	36	1	2
<i>36th/Dodge</i>	38	50	4	0
<i>42nd/Dodge</i>	30	103	1	0
<i>50th/Dodge</i>	20	92	0	0
<i>62nd/Dodge</i>	6	55	0	0
<i>72nd/Dodge</i>	0	99	0	187
	491	491	189	189

Total Daily Riders =	1361	(combined directions)
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TABLE 9. RIDERSHIP RESULTS BY STOP- ALTERNATIVE 2 (BRT ON FARNAM/HARNEY)

Eastbound on Harney

Intersection	Walk Access		Drive Access	
	Boardings	Alightings	Boardings	Alightings
72nd/Dodge	86	0	79	0
62nd/Dodge	51	7	0	0
50th/Dodge	84	21	0	0
42nd/Farnam	75	35	0	1
36th/Farnam	50	12	0	0
33rd/Farnam	24	15	0	3
31st/Farnam	23	36	0	1
24th/Harney	8	39	0	4
20th/Harney	1	52	0	2
16th/Harney	5	111	0	42
13th/Harney	0	28	0	7
11th/Harney	1	31	0	12
10th/Capitol	0	1	0	1
10th/Cass	1	9	0	4
12th/Fahey	0	8	0	1
16th/Fahey	0	2	0	0
	408	408	80	80

Westbound on Farnam

Intersection	Walk Access		Drive Access	
	Boardings	Alightings	Boardings	Alightings
16th/Fahey	2	0	0	0
12th/Fahey	8	0	1	0
10th/Cass	9	1	4	0
10th/Capitol	1	0	1	0
11th/Farnam	31	1	12	0
13th/Farnam	28	0	7	0
16th/Farnam	111	5	42	0
20th/Farnam	52	1	2	0
24th/Farnam	39	8	4	0
31st/Farnam	36	23	1	0
33rd/Farnam	15	24	3	0
36th/Farnam	12	50	0	0
42nd/Farnam	35	75	1	0
50th/Dodge	21	84	0	0
62nd/Dodge	7	51	0	0
72nd/Dodge	0	86	0	79
	408	408	80	80

Total Daily Riders = 977 (combined directions)

TABLE 10. RIDERSHIP RESULTS BY STOP – ALTERNATIVE 3 (STREETCAR)

Eastbound on Harney

Intersection	Walk Access		Drive Access	
	Boardings	Alightings	Boardings	Alightings
42nd/Harney	106	0	1	0
40th/Harney	10	6	0	0
36th/Harney	37	14	0	0
33rd/Harney	45	6	0	0
31st/Harney	27	19	0	0
26th/Harney	1	18	0	0
24th/Harney	18	9	0	0
20th/Harney	2	56	0	0
16th/Harney	5	66	0	1
13th/Harney	1	24	0	0
11th/Harney	2	25	0	0
10th/Capitol	2	0	0	0
10th/Cass	1	11	0	0
12th/Fahey	1	0	0	0
16th/Fahey	0	2	0	0
	258	258	1	1

Westbound on Farnam

Intersection	Walk Access		Drive Access	
	Boardings	Alightings	Boardings	Alightings
16th/Fahey	2	0	0	0
12th/Fahey	0	1	0	0
10th/Cass	11	1	0	0
10th/Capitol	0	2	0	0
11th/Farnam	25	2	0	0
13th/Farnam	24	1	0	0
16th/Farnam	66	5	1	0
20th/Farnam	56	2	0	0
24th/Farnam	9	18	0	0
26th/Farnam	18	1	0	0
31st/Farnam	19	27	0	0
33rd/Farnam	6	45	0	0
36th/Farnam	14	37	0	0
40th/Farnam	6	10	0	0
42nd/Farnam	0	106	0	1
	258	258	1	1

Total Daily Riders = 518 (combined directions)

During the course of the modeling work conducted for the final screening phase of this study, the MAPA model methodology for estimating Drive Access travel time skims was updated to incorporate congested travel time, rather than free-flow travel time. To test the sensitivity of ridership results with the two different drive access travel skim approaches, a scenario test was conducted that found drive access ridership results along the project corridor vary by about 20% when using congested travel times instead of free flow travel times. Since the 2010 base year model was validated using the free-flow travel time, and earlier project results were reported using the previous drive access skim methodology, the updated version of the model script file was not used for any of the modeling in this project analysis. All modeling work, and thus all ridership forecasts, for this study's analysis are based on the same version of the script.

METRO LOCAL BUS ROUTE 2

- Route 2 currently provides local bus service along Dodge/Douglas, accessing the CBD, UNMC, Midtown, UNO, and Crossroads. It is likely that the addition of any new transit service included in this assessment would cause Metro to modify Route 2, either in its stop locations or frequency of service.
- Through discussions with MAPA, Metro, and the City of Omaha, it was determined that Route 2 would not be adjusted. Rather, the background local bus network was left as it was originally coded in the MAPA model.
- **Table 11** highlights the ridership for the tested alternatives, shown along with Metro Route 2.
- Based on actual Metro ridership from April 2012, average weekday ridership was 1,700 average weekday trips on Route 2. These 1,700 actual trips can be compared to 1,300 model trips for Route 2 in the No-Build MAPA travel model. Thus, the 2010 No-Build model used as a baseline in this study slightly underrepresents the existing Route 2 ridership.

TABLE 11. RIDERSHIP RESULTS FOR NEW SERVICE AND METRO BUS ROUTE 2

Alternative	New Service Ridership Total	Metro Local Bus Route 2	Combined New Service and Metro Local Bus Route 2
1 (BRT)	1,360	830	2,190
2 (BRT)	980	820	1,800
3 (Streetcar)	520	1,000	1,520
No-Build	0	1,300	1,300

Note: ridership reflects combined Walk Access and Drive Access.

- *Potential for Additional Sensitivity:*
 - The coding of Route 2 in the transit model may be modified in later phases of study to better support and provide feeder service to the enhanced BRT and / or Streetcar service.

LIMITATIONS/UNCERTAINTIES IN USING THE MAPA TRAVEL DEMAND MODEL

The goal of this assessment was to test the alternatives using the MAPA travel demand model in order to compare each of the options relative to each other, and not necessarily on the magnitude of the ridership forecasts. Additional discussion about the limitations and uncertainties and potential adjustments to the MAPA travel demand model are highlighted below.

LAND USE

- The socioeconomic data input into the travel demand model for this assessment reflect year 2010 levels of households and employment. Typical ridership forecasting analysis would utilize a land use data set reflective of the year the transit service could potentially open. The MAPA TransCAD travel demand model was not available for the horizon year of 2040 at the time of this final screening analysis (did not become available until Fall 2013).
- *Potential for Additional Sensitivity Tests:*
 - Land use sensitivity could be completed using a land use data set for an interim year. MAPA is currently developing interim year data sets for the years 2020 and 2030. In the meantime, interim year socioeconomic data could be estimated using 2010 and 2040 socioeconomic datasets, with the existing 2010 base year TransCAD network.
 - A brief comparison of the MAPA model socioeconomic data in the study area shows a projected 15% increase in households and an 8% increase in total jobs between years 2010 and 2040. This comparison was made using the 36 study area TAZs (those adjacent to any of the alternative alignments).
 - The SB Friedman “Forecast of Development Impacts” memorandum, dated September 2013, should be further consulted in future phases of the project. The study area growth noted in this memo is significantly higher from the socioeconomic data input used in the 2010 MAPA travel model.

OTHER RIDERSHIP CONSIDERATIONS

- “Modal bias” refers to increased attractiveness for premium transit service (e.g., streetcar or BRT) that is not reflected in measurable attributes like travel time and cost. The MAPA travel demand model does not incorporate any modal bias consideration for “premium” transit services that would reflect a perceived higher quality of transit compared to current local bus service.
- The MAPA travel demand model does not consider the new travel markets that would likely spur from economic development along a corridor where a premium transit service was present.
- The MAPA travel demand model is based on average weekday travel patterns, and was calibrated and validated based on peak hour traffic volume data. The model is not designed to generate the “non-home-based” trips that would occur on evenings and weekends, or for special event activities.
- The travel market related to a BRT is generally commuter trips, which the travel demand model is designed to capture. The Streetcar travel market, however, is related to a travel market that is not well captured using a traditional four-step travel demand model. The

travel market for a Streetcar is more likely to include trip making characteristics outside of the average weekday commuting time periods.

- *Potential for Additional Sensitivity Tests:*
 - Modal bias sensitivity could be incorporated by factoring the ridership projections for each BRT and Streetcar.
 - A land use scenario could be incorporated that reflects intensified land development/ economic development in the project corridor.

MAPA TRANSIT MODEL ENHANCEMENTS

- The MAPA travel demand model includes only limited validation at the system level for the transit model in its original form.
- *Potential for Additional Sensitivity:*
 - Future enhancements to the transit model would be based on a thorough review of current bus service on a route by route basis. Model parameters would be modified as needed.
 - The alternatives tested in this analysis (both BRT and Streetcar) could be further refined by route, to exhibit faster travel times outside of the CBD. The modified travel times would reflect reasonable operations assumptions related to implementing transit signal priority, potential dedicated transitways, and lower station dwell times with longer station spacing.
 - FTA has developed a travel forecasting tool in response to MAP-21 directives to develop a more simplified model for project sponsors, referred to as STOPS, Simplified Trips-on-Project Software. This stand-alone software was developed for predicting transit trips and the automobile change in VMT related to major transit projects, especially localized transit circulator projects. STOPS Version 1.0 Beta has been calibrated nationally, and is available for local use. The STOPS model uses Census data (CTPP worker flows), coded transit network data (General Transit Feed Specification, developed by local transit providers), and regional travel demand model as key inputs, FTA's intended application for STOPS is for New Starts and Small Starts projects. The STOPS model could be used as an additional source of ridership forecasts in later phases of the project development process for this assessment.

PEER CITY PREMIUM TRANSIT RIDERSHIP

- *Potential for Additional Sensitivity:*
 - To provide some context on ridership ranges for similar BRT or Streetcar routes in other US cities, a brief review of existing system ridership for premium transit services across the country could be conducted.

PRELIMINARY LOCALLY PREFERRED ALTERNATIVE FORECAST USING MAPA TRAVEL DEMAND MODEL

A preliminary LPA ridership estimate assuming dual technologies was completed using the MAPA TransCAD travel demand model; see Table 13 on page 21. Ultimately, this estimate was not utilized due to known limitations and uncertainties as described on page 18. A final ridership estimate will be developed for the final LPA based upon more accurate and complete information in the study area during preliminary design.

DESCRIPTION OF LPA ALTERNATIVE

The LPA includes a combination of BRT and Streetcar services. The Streetcar route has been shortened from the alignment tested in the Final Screenings phase, with new limits for Streetcar services at 12th/Fahey and 42nd /Farnam (UNMC). The BRT alignment has also been adjusted, with new limits at 10th/Farnam/Harney and 102nd/Nicholas (Westroads). BRT and Streetcar would overlap in the segments between 10th/Farnam/Harney and 42nd /Farnam. The LPA with stop locations for this “hybrid” option is shown in **Figure 5**.

FIGURE 5. LPA WITH STOP LOCATIONS

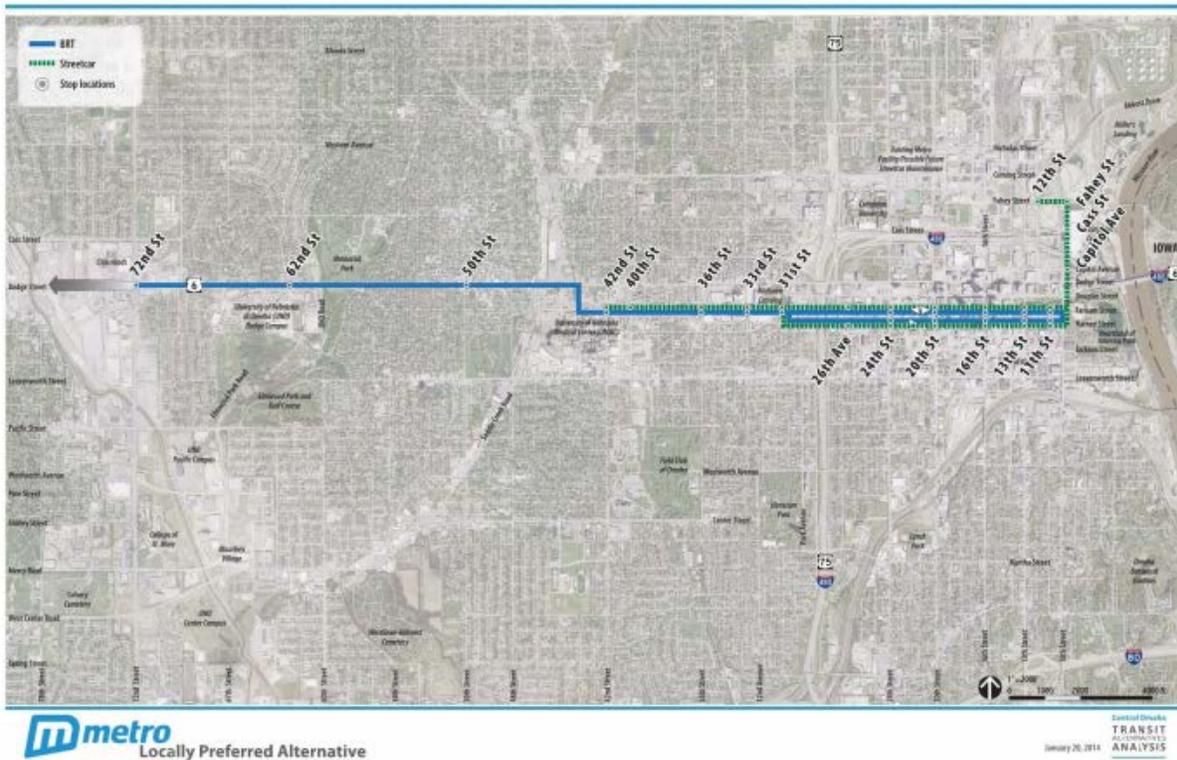


Table 12 summarizes key assumptions for the three alternatives, including headway, fare, and representative Park n Ride locations.

TABLE 12. PRELIMINARY LPA CHARACTERISTICS

Hybrid LPA Component	AM/PM Headway	Off-Peak Headway	Fare	Park n Ride Location
BRT	10 min	15 min	\$1.25	42 nd /Farnam (UNMC) 102 nd /Nicholas (Westroads)
Streetcar	10 min	15 min	\$0.50	

Note:

Park n Ride lots are not a part of the Alternative Analysis projects and were assumed for travel demand modeling purposes only.

For the Hybrid LPA scenario, Park n Ride locations are shared between the BRT and Streetcar.

RIDERSHIP RESULTS FROM THE TRAVEL DEMAND MODEL

A ridership summary of the total boardings (combined for both walk access and drive access) is shown in **Table 13**.

TABLE 13. PRELIMINARY LPA RIDERSHIP ESTIMATE FROM THE TRAVEL DEMAND MODEL

Alternative	New Service Ridership				Total	Total Transit System Ridership
	BRT Component		Streetcar Component			
	Walk Access	Drive Access	Walk Access	Drive Access		
LPA (BRT/Streetcar Hybrid)	1530	1460	360*	10*	3,360	14,500
No-Build	*	*	*	*	0	12,500

*Refer to Limitations/Uncertainties Using the MAPA Travel Demand Model on Page 18 for considerations in this methodology for forecasting streetcar ridership.

LPA ridership estimates at the stop-level are shown in **Table 14** and **Table 15**. These tables are reporting the transit assignment results in Origin-Destination format.

The goal of this assessment was to test the alternatives using the MAPA travel demand model in order to compare each of the options relative to each other, and not necessarily on the magnitude of the ridership forecasts. Additional discussion about the limitations and uncertainties and potential adjustments to the MAPA travel demand model for is highlighted on page 18.

TABLE 14. PRELIMINARY LPA RIDERSHIP RESULTS BY STOP- BRT PORTION

Eastbound on Harney

<i>Intersection</i>	Walk Access		Drive Access	
	Boardings	Alightings	Boardings	Alightings
<i>102nd/Nicholas</i>	169	0	728	0
<i>90th/Dodge</i>	153	15	0	0
<i>84th/Dodge</i>	86	13	0	0
<i>72nd/Dodge</i>	89	74	0	23
<i>62nd/Dodge</i>	39	4	0	0
<i>50th/Dodge</i>	68	60	0	13
<i>42nd/Farnam</i>	41	91	0	32
<i>36th/Farnam</i>	52	19	0	1
<i>33rd/Farnam</i>	20	30	0	79
<i>31st/Farnam</i>	24	71	0	14
<i>24th/Farnam</i>	19	65	0	35
<i>20th/Farnam</i>	5	78	0	27
<i>16th/Farnam</i>	2	169	0	346
<i>13th/Farnam</i>	0	35	0	66
<i>11th/Farnam</i>	0	44	0	91
	767	767	729	729

Westbound on Farnam

<i>Intersection</i>	Walk Access		Drive Access	
	Boardings	Alightings	Boardings	Alightings
<i>11th/Farnam</i>	44	0	91	0
<i>13th/Farnam</i>	35	0	66	0
<i>16th/Farnam</i>	169	2	346	0
<i>20th/Farnam</i>	78	5	27	0
<i>24th/Farnam</i>	65	19	35	0
<i>31st/Farnam</i>	71	24	14	0
<i>33rd/Farnam</i>	30	20	79	0
<i>36th/Farnam</i>	19	52	1	0
<i>42nd/Farnam</i>	91	41	32	0
<i>50th/Dodge</i>	60	68	13	0
<i>62nd/Dodge</i>	4	39	0	0
<i>72nd/Dodge</i>	74	89	23	0
<i>84th/Dodge</i>	13	86	0	0
<i>90th/Dodge</i>	15	153	0	0
<i>102nd/Nicholas</i>	0	169	0	728
	767	767	729	729

Total Daily Riders =	2991	(combined directions)
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TABLE 15. PRELIMINARY LPA RIDERSHIP RESULTS BY STOP- STREETCAR PORTION

Eastbound on Harney

Intersection	Walk Access		Drive Access	
	Boardings	Alightings	Boardings	Alightings
42nd/Farnam	42	0	0	0
40th/Farnam	5	3	0	0
36th/Farnam	35	5	0	0
33rd/Farnam	38	5	0	0
31st/Farnam	24	14	0	0
26th/Harney	1	6	0	0
24th/Harney	20	11	0	0
20th/Harney	6	47	0	0
16th/Harney	5	42	0	0
13th/Harney	1	16	0	0
11th/Harney	2	17	3	0
10th/Capitol	2	0	0	0
10th/Cass	1	12	0	2
12th/Fahey	0	1	0	1
	180	180	3	3

Westbound on Farnam

Intersection	Walk Access		Drive Access	
	Boardings	Alightings	Boardings	Alightings
12th/Fahey	1	0	1	0
10th/Cass	12	1	2	0
10th/Capitol	0	2	0	0
11th/Farnam	17	2	0	3
13th/Farnam	16	1	0	0
16th/Farnam	42	5	0	0
20th/Farnam	47	6	0	0
24th/Farnam	11	20	0	0
26th/Farnam	6	1	0	0
31st/Farnam	14	24	0	0
33rd/Farnam	5	38	0	0
36th/Farnam	5	35	0	0
40th/Farnam	3	5	0	0
42nd/Farnam	0	42	0	0
	180	180	3	3

Total Daily Riders =	367	(combined directions)
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FINAL COMBINED LOCALLY PREFERRED ALTERNATIVE

The final ridership forecasts for the Locally Preferred Alternative include a combination of methodologies, with the BRT ridership estimate based on the MAPA travel model conducted in April, 2014, and the Streetcar ridership estimate based on the small area regression model, conducted in June 2013. This combination allows for appropriate use of the capabilities of the travel model to predict ridership on BRT that would predominantly serve weekday commuters, which is the foundation of the travel model. This combination of methodologies also accommodated a recommended phased LPA and became a necessity due an immediate funding opportunity to implement, if funded, the BRT portion well ahead of schedule. The Streetcar ridership forecast will require further adjustments, as noted on pages 18-19, during preliminary design in order to use the travel model as a forecasting tool for this premium transit service.

The LPA includes a combination of BRT and Streetcar services. The Streetcar route runs between 12th/Fahey and 42nd /Farnam (UNMC), and the BRT between 10th/Farnam/Harney and 102nd/Nicholas (Westroads), with overlap between 10th/Farnam/Harney and 42nd /Farnam.

BRT-PORTION OF THE LPA IN MAPA TRAVEL DEMAND MODEL

A supplemental model scenario was assessed utilizing the MAPA travel demand model. This supplemental scenario included the BRT portion of the LPA, as was shown in **Figure 5**. Results from this analysis are shown in **Table 16**. The modeling work for this scenario was conducted with the following key modifications compared to the previous (Final Screening) stage of the study:

- Updated version of the MAPA travel model script, which became available in November 2013, where the drive-access travel time skim was calculated based on congested, rather than free-flow, travel times.
Increased Route 2 headways to 30 minutes for the AM, PM, and Off-Peak. This modification reflects a modified background bus network, with a focus on the BRT route (with 10 minute AM and PM headways, and 15 minute Off-Peak headway).

TABLE 16. BRT RIDERSHIP RESULTS FOR LPA IN SUPPLEMENTAL TRAVEL DEMAND MODEL SCENARIO

	2010 Existing	2010 + BRT
New Service Ridership	n/a	2,740
<i>Drive Access</i>		1,012
<i>Walk Access</i>		1,728
System Transit Ridership	11,705	13,538
<i>Drive Access</i>	781	1,576
<i>Walk Access</i>	10,923	11,962

Note: Results as reported directly from the MAPA TransCAD Travel Demand Model, no modal bias factors assumed

This analysis shows a total of 2,740 BRT riders, comprised of the following:

- 1,012 of the BRT Riders drive a vehicle to a park and ride, then board the BRT. (“Drive Access”)
 - 795 of the drive-access trips are new Metro riders
 - 217 shift from existing routes
- 1,728 of the BRT Riders walk to board the BRT. (“Walk Access”)
 - 1,039 of the walk-access trips are new Metro riders
 - 689 shift from existing routes

STREETCAR-PORTION OF THE LPA IN THE SMALL AREA MODEL

Streetcar may be considered a premium transit service, where the majority of Streetcar trips would come from short walk trips. The “unmeasured attributes” (visibility, reliability, flexibility, safety, comfort) of this type of premium transit service are not components of a travel demand model. Regional travel models, including the MAPA travel demand model, were originally developed for highway modeling purposes during average weekday commuting time periods and were not designed to understand transit and other factors that are critical for estimating transit system patronage.

The ability to forecast Streetcar service is limited based on the lack of available industry tools that can adequately predict ridership estimates for a premium transit service. Subsequent phases of study will need to include additional forecasting efforts or alternative methodologies to adequately forecast streetcar ridership.

For this planning-level assessment of the Streetcar service, the forecast from the Small Area model (with a 15% bias factor included) was deemed the best prediction of ridership. This Streetcar service forecast was 1,380 daily riders. (See **Table 4**).

The Modern Streetcar ridership estimate for the LPA uses the Small Area Model since the current MAPA Model does not modify future development and land use assumptions. It is recommended that the BRT / Modern Streetcar ridership estimates in later phases (Environmental Documentation and Conceptual Engineering) be made using the MAPA Model which will consider changes to the background bus network, development, and land use assumptions.

LPA RIDERSHIP SUMMARY

The final ridership results for the two transit services are based on each service operating independently of one another, and not combined. Existing conditions (year 2010) daily ridership forecasts included in the LPA are as follows:

- 1,380 Streetcar
- 2,740 BRT

The ridership forecasts conducted are preliminary in nature due to the issues noted with the various models. As planned, during later phases of the project, a more accurate dual technology ridership forecast will be conducted representing true study area conditions. A well informed decision to fully implement the final LPA will be made with a complete representation of the project's impact including; a refined forecast along with other pertinent findings of the preliminary design phase.