SH7 BUS RAPID TRANSIT STUDY

Travel Forecasting Methodology

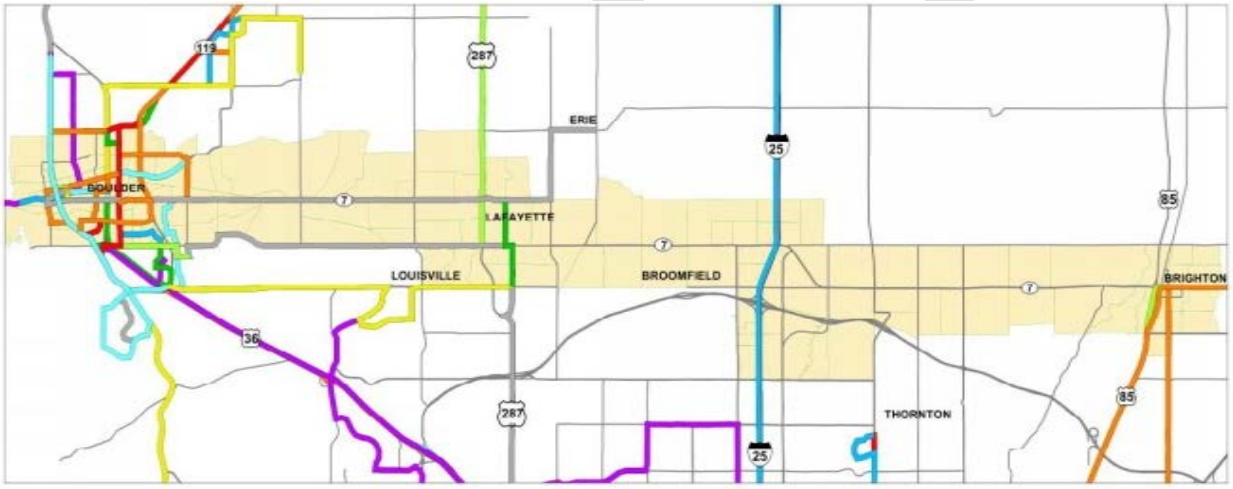
Introduction

This technical memorandum documents the travel demand forecasting methodology used for the SH7 BRT Study. This memorandum includes discussion of the following:

- Overview of DRCOG TransCAD travel demand model
- Pre-model run operational preparation
- Land use, transit and roadway review and adjustments
- Model scenario descriptions
- Results analysis

The general study area and transit routes in the region are illustrated in **Figure 1**.

Figure 1 – Study Area and Regional Transit Routes



Source: HDR, 2017

DRCOG Travel Demand Model Overview

Travel forecasts were developed for the SH7 BRT Study using the Denver Regional Council of Governments' (DRCOG's) and RTD's 2040 regional travel demand forecasting model known as Compass. A travel demand model is a planning tool for assessing alternative improvements to a transportation system and provides various transportation system outputs including estimated traffic volumes along roadways. The DRCOG/RTD model reflects the planned network of the 2040 Fiscally-Constrained Regional Transportation Plan. The Compass model is a trip-based model that follows the traditional four-step model procedure of trip generation, trip distribution, mode choice, and route assignment. The Compass model was used rather than DRCOG's activity-based Focus model, as approval of the Focus model is still pending for transit forecasting.

The Compass travel demand forecasting model is run on the TransCAD software platform. The latest version of the model, Compass 5.0 (Cycle 2, 2015), was utilized for the SH7 BRT Study. The 2015 and 2040 Compass models were used as the base year and the horizon year models.

The roadway and transit networks were converted from DRCOG's Focus model to Compass model for this project.

Pre-Model Run Operations and Quality Check

In order to perform model runs in Compass, several changes were made to the transit and roadway networks from Focus in order to properly convert the inputs for use in Compass. Edits included:

- Changed the highway geographic file link and node layer names to "PK_Links" and "PK_Nodes," respectively.
- Added "LRT_Stop" attribute field to the route layer.
- Renamed period speed fields in the highway geographic file dataview.
- Converted transit routes with Focus transit modes 13, 15, and 16 to equivalent modes in Compass.
- Deleted attribute fields from highway and transit base files of type "Date" or "Time."

Multiple tests were performed for years 2015 and 2040 in Compass until both models ran successfully, including reaching speed balance conversion. Statistics from the Model Summary files were reviewed to verify successful model runs.

Model Input Review

The travel demand model's roadway network, transit network, traffic analysis zone (TAZ) system, and land use assumptions within the study area and surrounding region were reviewed for accuracy in both the base year and horizon year. This review was performed in an effort to identify any obvious issues within the model networks or land use that could dramatically skew model results.

The model's TAZ system was found to provide adequate definition within the region and no changes were deemed necessary. Existing and future year land use assumptions from DRCOG's Cycle 2, 2015 travel demand model were checked for reasonableness for the area generally within one mile of the proposed SH7 BRT corridor alignments. Existing year household and employment totals at the TAZ level were compared to aerials and community data. Future year land use totals for each TAZ were compared to estimates from local community forecasts. Land use totals by TAZ were consequently adjusted to reflect the community plans. The 2040 transit forecasts for SH 7 BRT used these adjusted numbers.

Initial travel demand model runs were performed using the land use totals from above. In October 2016, DRCOG provided draft land use from the fall update of the Focus travel demand model. This land use was converted to Compass, assumptions reviewed, and adjustments made per the methodology described above for adjusting the Cycle 2, 2015 land use. The second round of SH7 BRT model runs were performed using these land use assumptions. Revised land use totals are included in **Appendix C**.

Table 1 illustrates the adjusted household and employment totals from within approximately one mile of the SH7 BRT corridor that were assumed in the second round of travel demand model

runs. **Figure 2** illustrates the area roadway network and TAZs included in the land use review.

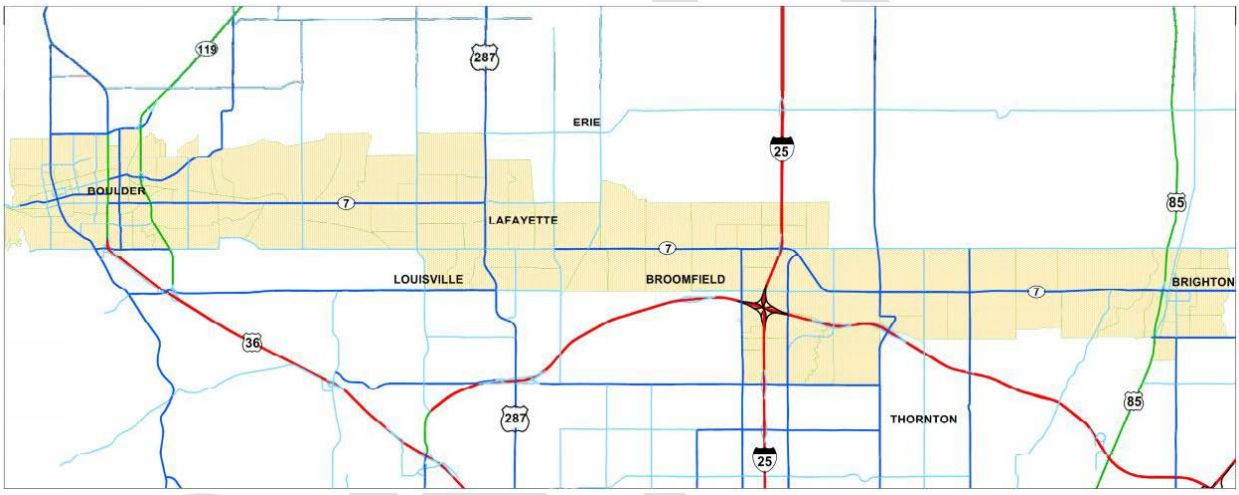
Table 1 – Travel Demand Forecasting Land Use Totals

Land Use	Year 2015	Year 2040	Change
Households	50,210	87,420	+37,210 (+74%)
Employment	74,170	128,220	+54,050 (+73%)

Source: DRCOG Compass Model, 2016

Growth in both household and employment totals is projected to be high along the corridor at over 2% annually.

Figure 2 – Traffic Analysis Zones



Source: HDR, 2017

The travel demand model roadway networks were reviewed within the study area and immediate vicinity for year 2015 and 2040. The 2015 model was compared to the real-world roadway network and the following edits made:

- SH 7 – laneage adjustments from City of Boulder to Brighton, where necessary
- Yosemite Street – crossing of E-470 removed
- Other minor adjustments as needed

No transit adjustments were necessary in the 2015 model within the study area.

Edits made to the 2015 roadway network were carried forward to the 2040 roadway network. Additionally, the 2040 roadway and transit networks were reviewed for improvements identified in the DRCOG *2040 Fiscally Constrained Regional Transportation Plan* (RTP), adopted in February, 2015, and the *Summary Document of the 2015 Cycle 2 Amendments to the 2040 Fiscally Constrained RTP*, adopted in March, 2016. No edits to the 2040 roadway or transit networks based on this project level review were necessary.

Model Run Operation and Scenarios

Two series of model runs were performed during the SH7 BRT analysis. The first series provided an initial assessment of stop locations, route headways, and dedicated transit lanes. Eleven model runs were performed, comprised of the following:

Year 2015 Model:

- Run 1: 2015 Base Model – No SH7 BRT
- Run 2: 2015 "Build" Model – SH7 BRT from Boulder to Brighton with 15/30 minute peak/off-peak headways

Series 1 Year 2040 Base Model:

- Run 3: 2040 Base Model – No SH7 BRT

Series 1 Year 2040 "Build" Models:

- Run 4: SH7 BRT from Boulder to Brighton with 15/30 minute headways
- Run 5: SH7 BRT with improved headways (7.5/15 minute headways)
- Run 6: SH7 BRT with improved headways and maximum stops
- Run 7: SH7 BRT with dedicated lanes and improved headways
- Run 8: SH7 BRT with dedicated lanes at free flow speed
- Run 9: SH7 BRT with Jump B and Erie/Lafayette feeder route
- Run 10: SH7 BRT with maximum frequency (5/10 minute headways)
- Run 11: SH7 BRT with dedicated lanes less one general purpose lane

All Series 1 2040 SH7 BRT model runs included the following improvements to the transit route system:

- North Metro line – The 2040 transit route system includes the North Metro line ending at the 124th Ave/Eastlake station in Thornton. For this study, the line was extended to SH7/Colorado Blvd where it shares a station with SH7 BRT.
- Jump A, B, and C removed (except in run 9 where Jump B was included)

The second series of model runs provided a more detailed analysis of various BRT alignments, stop locations, route headways, and dedicated transit lanes. Additionally, the model runs were performed with an updated 2040 land use data set provided by DRCOG. As with Series 1, future year land use totals for each TAZ were compared to estimates from local community forecasts. Land use totals by TAZ were consequently adjusted to reflect the community plans. The 2040 transit forecasts for SH 7 BRT used these updated and adjusted numbers.

Nine "Build" model runs were performed, with individual runs for testing of additional potential stations. This allows for a clear understanding of the effect of each individual station on ridership, without ridership "interference" of other new stations. The series of runs were comprised of the following:

Series 2 Year 2040 "Build" Models:

- Run 1: Operating Scenario 1-0 – Basic with stop at Boulder Junction
- Run 2: Operating Scenario 1-1 – Basic plus stops at 48th St and 63rd St
- Run 3: Operating Scenario 1-2 – Basic plus stop at new 75th St Park-n-Ride
- Run 4: Operating Scenario 1-3 – Basic plus stop at Huron St
- Run 5: Operating Scenario 1-4 – Basic plus stop at Quebec St
- Run 6: Operating Scenario 2 – Direct (no stop at Boulder Junction)
- Run 7: Operating Scenario 3 – Basic plus Lafayette Park-n-Ride
- Run 8: Operating Scenario 4 – Basic plus Lafayette service route pattern
- Run 9: Operation Scenario 5 – Basic with dedicated BRT lanes

All Series 2 SH7 BRT "Build" model runs in the second series included the following improvements to the transit route system:

- North Metro – The 2040 transit route system includes the North Metro line ending at the 124th Ave/Eastlake station in Thornton. For this study, the line was extended to SH7/Colorado Blvd where it shares a station with SH7 BRT.
- NATE BRT – BRT was added along SH 2 between Denver and Brighton based on the preferred route alignment identified in the Draft NATE II study, dated December, 2015.
- Feeder Routes – Feeder routes were included to provide improved accessibility to the SH7 BRT to/from Erie, Lafayette, Broomfield, Thornton, and Brighton. See **Element A**.
- Jump B – Included from Downtown Boulder to 63rd Street with adjusted headways. Jump A and C were removed.

In order to provide the best comparison of transit results between the different SH7 BRT models, set trip tables were utilized during the second series of model runs. Each SH7 BRT "Build" model run began with the trip tables from Build model run #1. Speed balancing was performed only in this first build model run. This method reduces any "noise" that speed balancing may cause in the model. The relatively minor edits to the transit system in the subsequent "Build" models would result in very minimal changes to the trip tables. An additional "set trip tables" model run with no speed balancing was also performed for Build model run #1 in order to provide a direct apples-to-apples comparison with the other models.

Results

As with all travel demand forecasting models, the DRCOG Compass model cannot be expected to provide precise transit utilization forecasts due to the complexity of the real world. Per industry practice, the model's outputs were reviewed and, where necessary, adjusted using engineering judgment.

Below are results from the second series of Compass 2040 model runs with the SH7 BRT. BRT daily ridership is illustrated in **Table 2**.

Table 2 – SH 7 BRT Daily Ridership Totals

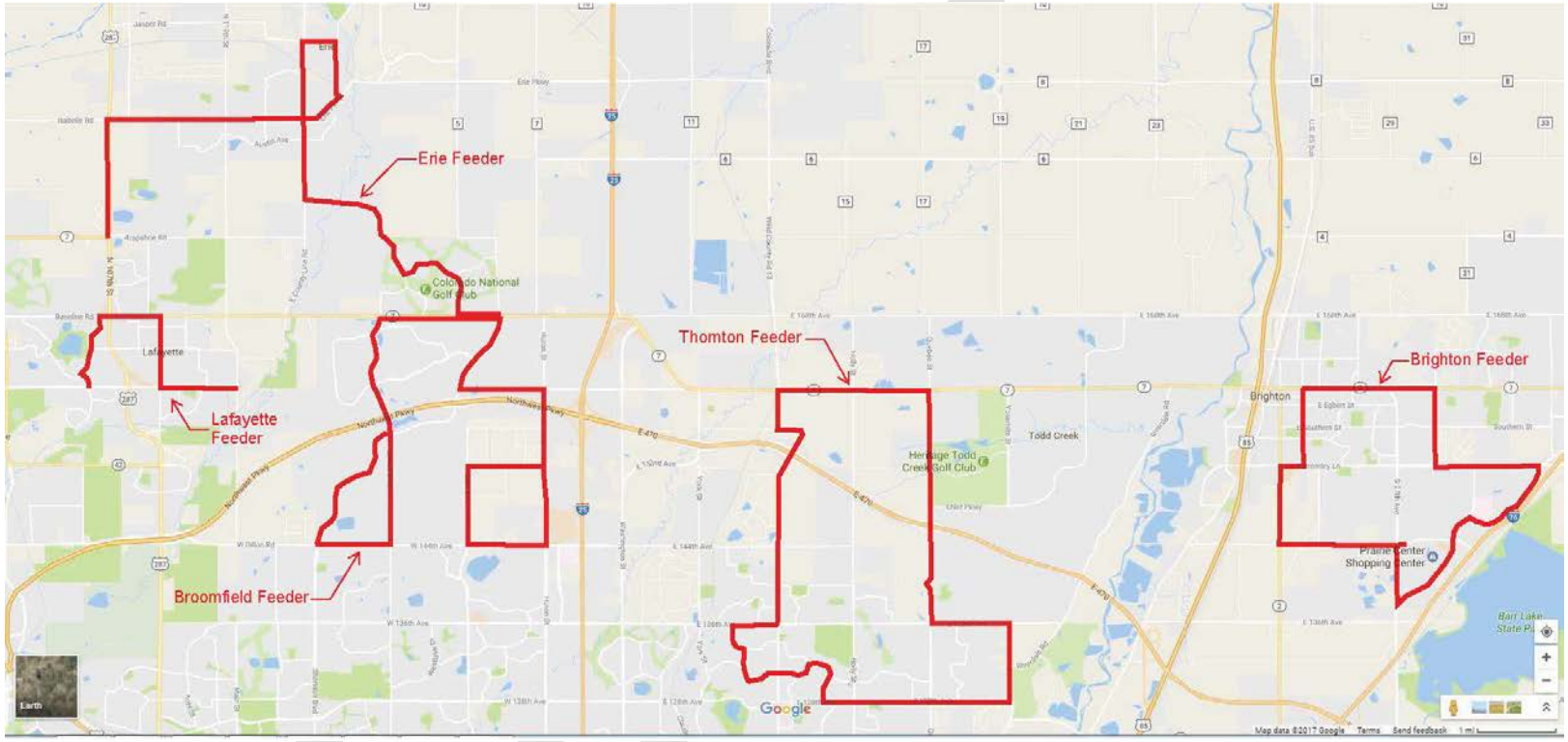
Operating Scenario	Total Ridership
Operating Scenario 1-0	6,498
Operating Scenario 1-1	6,137
Operating Scenario 1-2	6,548
Operating Scenario 1-3	7,374
Operating Scenario 1-4	6,853
Operating Scenario 2	6,642
Operating Scenario 3	6,747
Operating Scenario 4	6,389
Operating Scenario 5	8,630

Source: HDR, 2017

Further details of ridership results are included in **Element B**.

ELEMENT A

FEEDER ROUTES


Erie Feeder
Thornton Feeder
Brighton Feeder
Lafayette Feeder
Broomfield Feeder
Colorado National Golf Club
Heritage Todd Creek Golf Club
Todd Creek
Brighton
Prairie Center Shopping Center
Lafayette
Google

ELEMENT B

TRAVEL DEMAND MODEL TRANSIT RESULTS

SERIES 1 TRANSIT RESULTS

	1 2015 Base	2 2015 BRT	3 2040 No Action	4 2040 BRT Hdwy15/30	5 2040 BRT Hdwy7.5/15	6 2040 BRT Max Stops Hdwy7.5/15	7 2040 BRT Ddctd Lns Hdwy7.5/15	8 2040 BRT Ddctd Ln FF Hdwy7.5/15	9 2040 BRT JmpB+Feedr Hdwy7.5/15	10 2040 BRT Hdwy 5/10	11 2040 BRT DdLn-1GPLn Hdwy7.5/15
Jump A EB	672	-	835	-	-	-	-	-	-	-	-
Jump A WB	747	-	995	-	-	-	-	-	-	-	-
Jump B EB	548	-	651	-	-	-	-	-	193	-	-
Jump B WB	477	-	607	-	-	-	-	-	495	-	-
Jump C EB	208	-	301	-	-	-	-	-	-	-	-
Jump C WB	237	-	328	-	-	-	-	-	-	-	-
Jump EB	1,428	-	1,787	-	-	-	-	-	193	-	-
Jump WB	1,461	-	1,930	-	-	-	-	-	495	-	-
Erie/Laf Fdr NB	-	-	-	-	-	-	-	-	391	-	-
Erie/Laf Fdr SB	-	-	-	-	-	-	-	-	436	-	-
SH119 BRT EB	-	689		769	1,812	2,443	1,720	1,876	1,122	2,393	2,362
SH119 BRT WB	-	1,701		1,488	2,794	3,726	3,104	3,290	2,740	3,429	3,708
Total BRT+Jump Ridership	2,889	2,390	3,717	2,257	4,606	6,168	4,824	5,166	4,550	5,822	6,070
				-51%		34%	5%	12%	-1%	26%	32%

SERIES 2 TRANSIT RESULTS

	Downtown Boulder Station	28th Street & Canyon Boulevard	Boulder Junction	48th Street & Arapahoe Avenue	55th Street & Arapahoe Avenue	63rd Street & Arapahoe Avenue	75th Street & Arapahoe Avenue	US 287 & Arapahoe Road	Public Road & Baseline Road	Lafayette Park-n-Ride	119th Street & Baseline Road	Sheridan Parkway & Baseline Road	Huron Street & Baseline Road	I-25 & Baseline Road	Colorado Boulevard North Metro terminus	Quebec Street & 160th Avenue	US 85 & Bridge Street	27th Avenue & Bridge Street	**TOTAL RIDERSHIP - Mixed Traffic**	**TOTAL RIDERSHIP - Dedicated Lane**
Operating Scenario 1-0 Total	463	0	608	0	511	0	0	630	332	0	0	607	0	810	1,590	0	484	462	6,498	8,630
Operating Scenario 1-1 Total	488	0	670	208	307	219	0	653	344	0	0	609	0	812	1,597	0	485	463	6,853	9,101
Operating Scenario 1-2 Total	477	0	612	0	540	0	135	599	330	0	0	607	0	809	1,587	0	484	461	6,642	8,821
Operating Scenario 1-3 Total	462	0	607	0	510	0	0	627	332	0	0	454	404	809	1,593	0	485	463	6,747	8,961
Operating Scenario 1-4 Total	462	0	611	0	512	0	0	630	333	0	0	608	0	825	1,394	165	426	423	6,389	8,485
Operating Scenario 2 Total	355	413	0	0	430	0	0	648	334	0	0	608	0	810	1,593	0	485	462	6,137	8,151
Operating Scenario 3 Total	449	0	592	0	507	0	0	533	0	431	89	605	0	791	1,608	0	482	460	6,548	8,696
Operating Scenario 4 Total - B to B	386	0	517	0	407	0	0	434	285	0	0	601	0	783	1,588	0	484	462	5,948	7,900
Operating Scenario 4 Total - B to L	292	0	396	0	309	0	0	312	0	117	0	50	0	-50	0	0	0	0	1,426	1,893
Operating Scenario 4 Total	678	0	913	0	716	0	0	746	285	117	0	601	0	783	1,588	0	484	462	7,374	9,793

Note: this spreadsheet tab reflects two-way station activity divided by two to show ridership.