



Focus 101

DRCOG's Travel Demand Model

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Transportation Planning &
Operations Division

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Travel demand modeling at DRCOG

- **Basics**
- **Unique aspects of Focus Model**
- **Input data**
- **Outputs, queries, and uses of the model**



Travel demand modeling - basics

- Did you make a trip from your house this morning?
- Where did you go?
- What mode of travel did you use to get there?
- What driving path or transit route(s) did you take?

- **15 million “person trips” typical weekday!**

- **12.5 million in cars/trucks (9 million vehicle trips)**



- **2.0 million by pedestrian & bicycle**

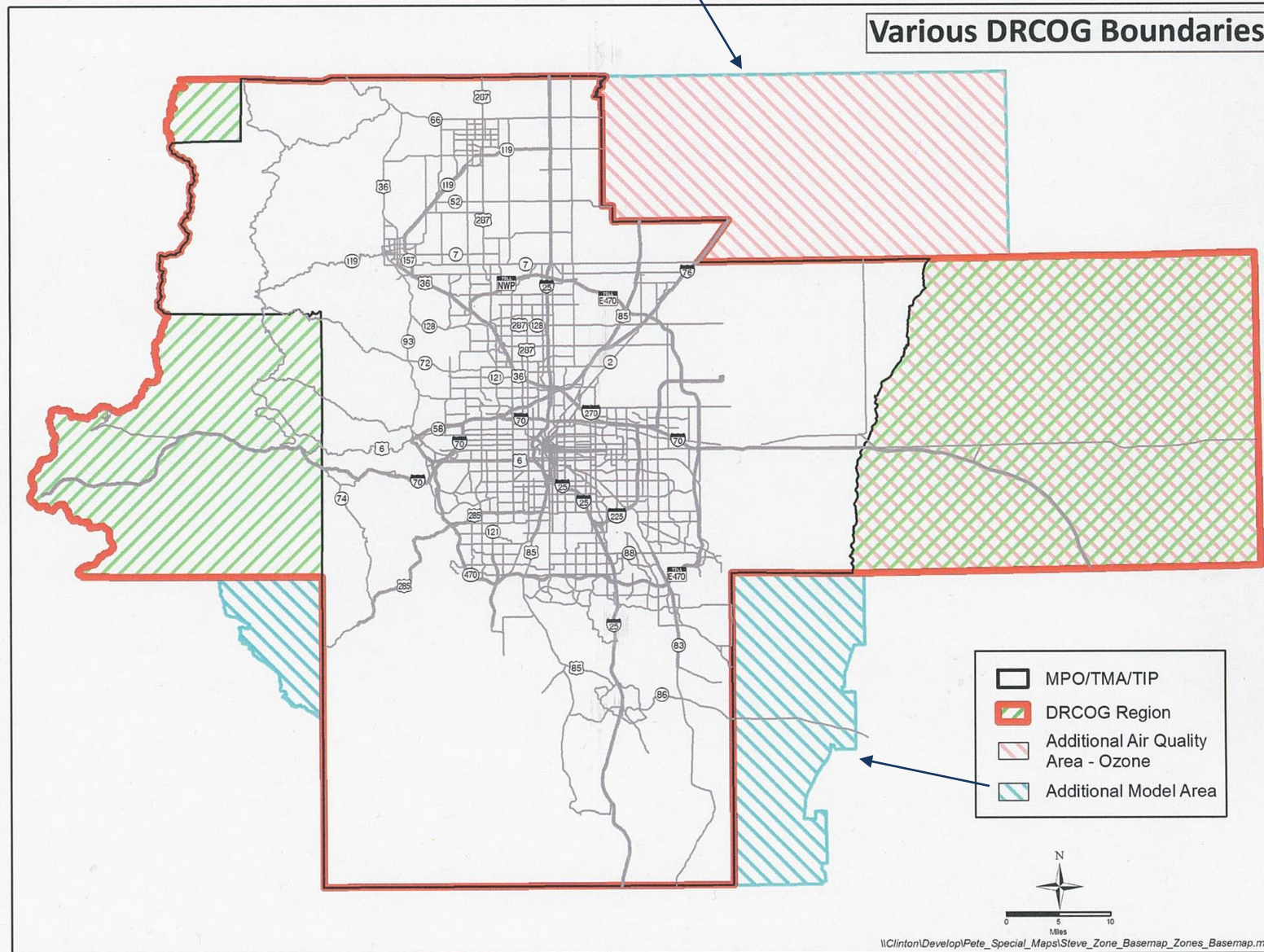


- **0.5 million by transit and school bus**



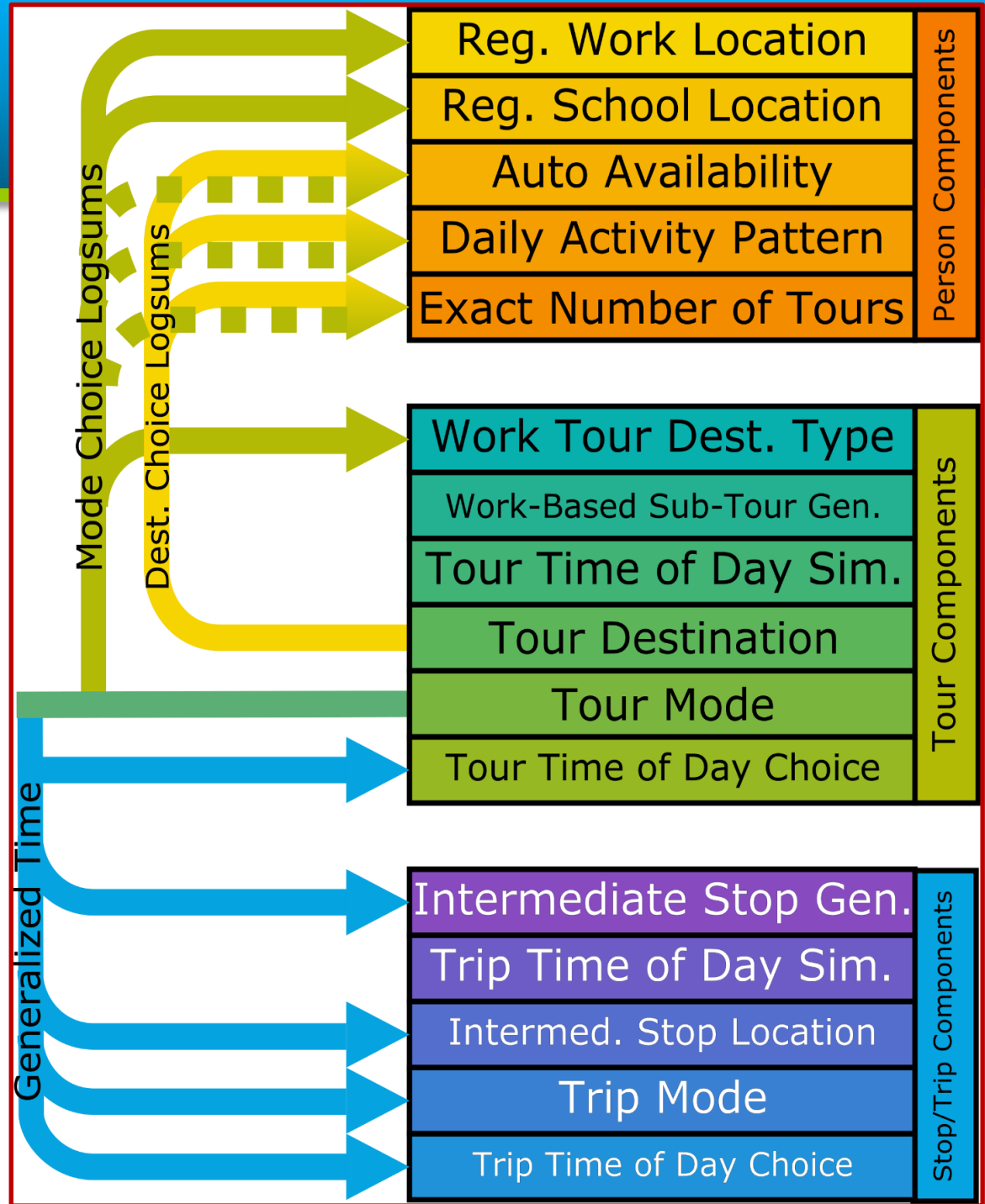
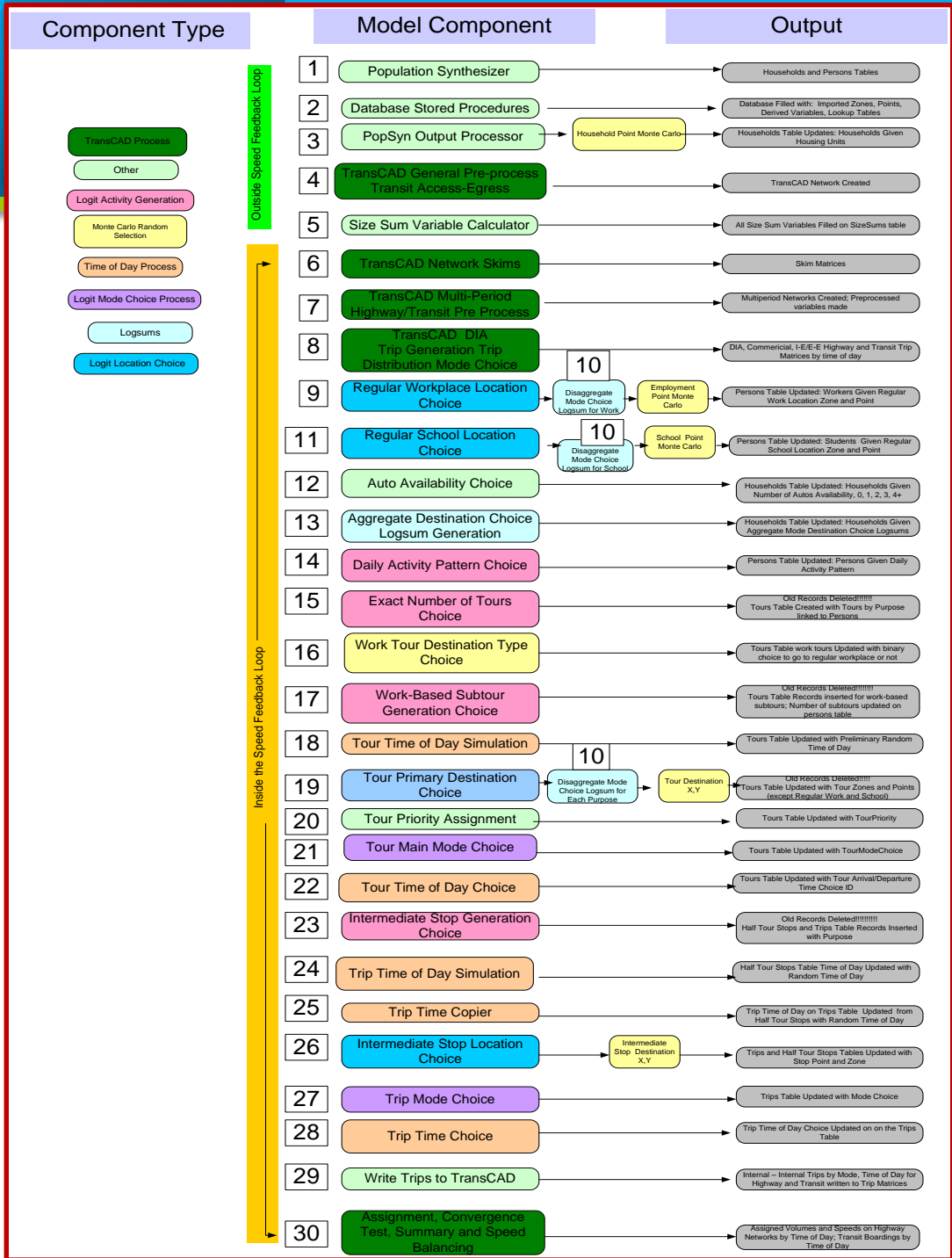


Modeling Area





HOW IS FOCUS MODEL UNIQUE?



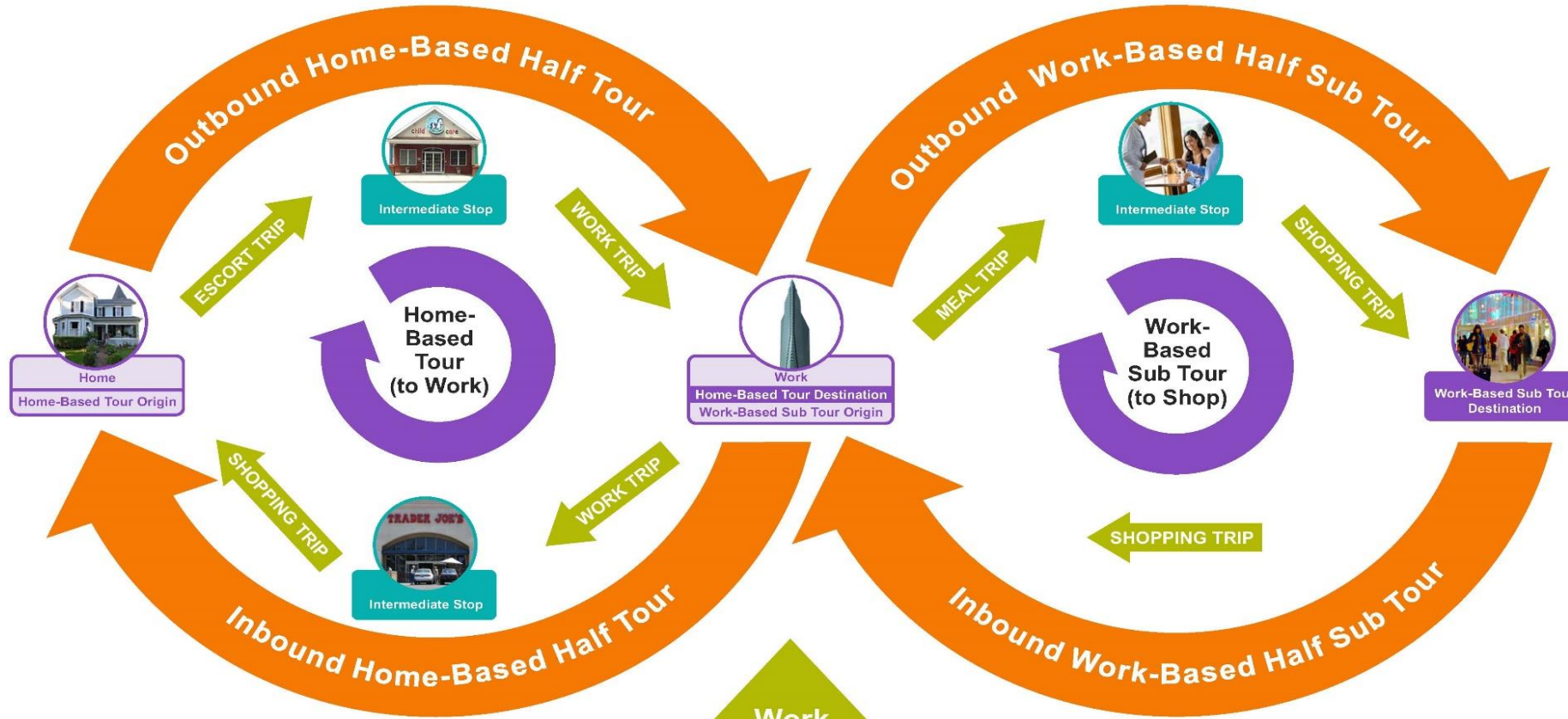


Focus includes an activity-based-trip model (ABM)

- **Individual person and household characteristics modeled**
 - Every person in the DRCOG region
 - Where people “choose” to work and go to school
 - How many “autos” a household has
- **Tour-based**
 - Full tour includes all travel between leaving from and returning home
 - A round trip tour may include intermediate stops
- **Individual component travel choices**
 - Time-of-day; Duration at destination; Intermediate stops
 - Mode of travel for tour (primary) and sub-trips (any mode)



What is a tour?





INPUT DATA





Model represented population (with RP&D Division land use team)

- **Households**

- Housing unit location
- Annual income
- Number of persons

- **Individual persons**

- Age & gender
- Student status and “grade”
- Worker status and occupation
- Relationship with other household members
- Added dormitory student residents



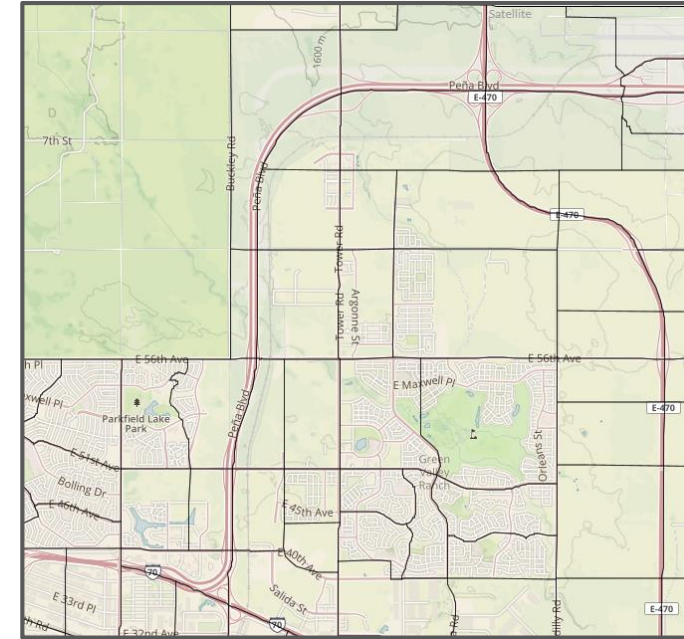
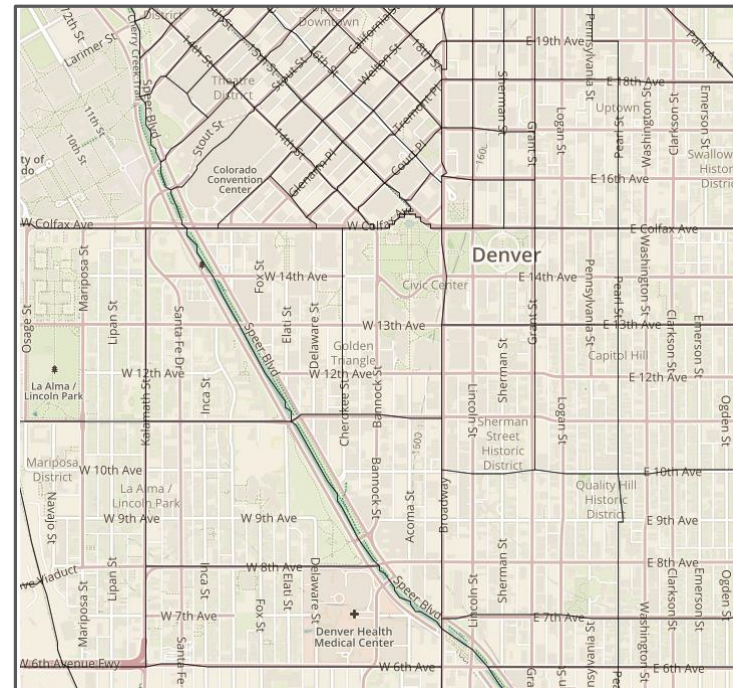
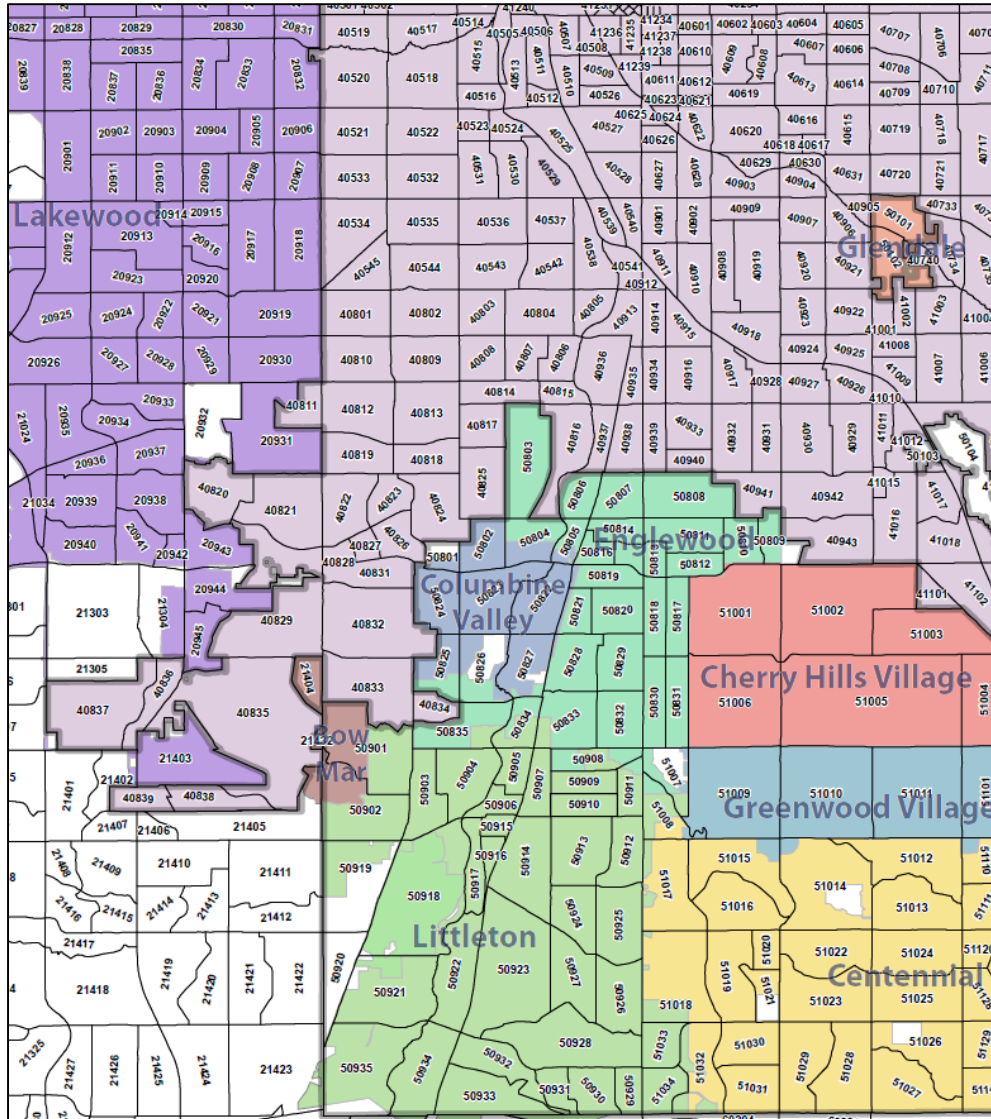
Socioeconomic data (with land use team and UrbanSim)

- **Housing unit points**
 - distance to transit
- **Employment establishment points**
 - industry sector
 - number of jobs
- **School points**
 - public or private, grade, K-8, high school or university
 - enrollment
- **Zone (TAZ) data**
 - points – households and employment establishments
 - centroid coordinates – start/end of assignment trips

And Future Year
Forecasts
2020 – 2040 - 2050



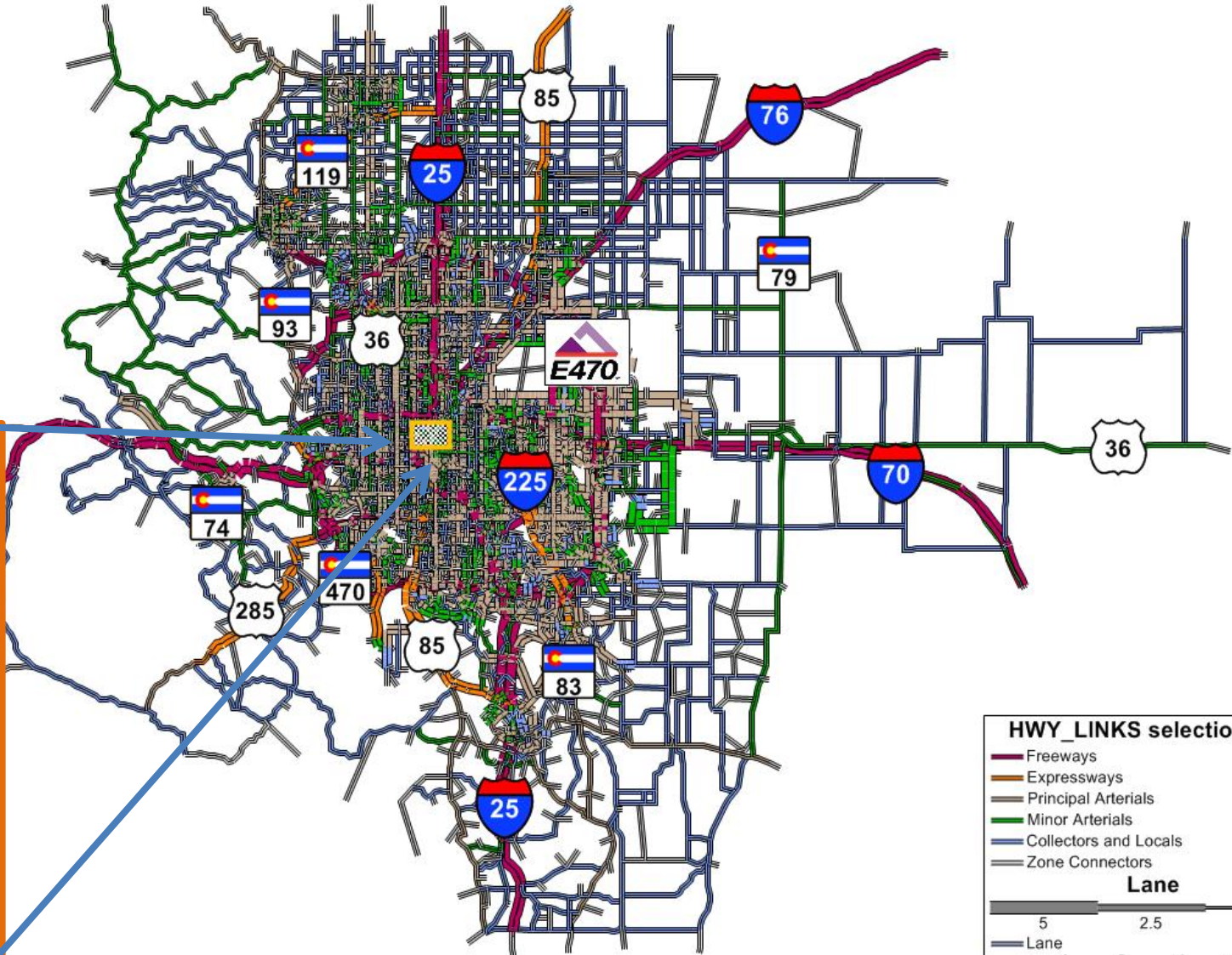
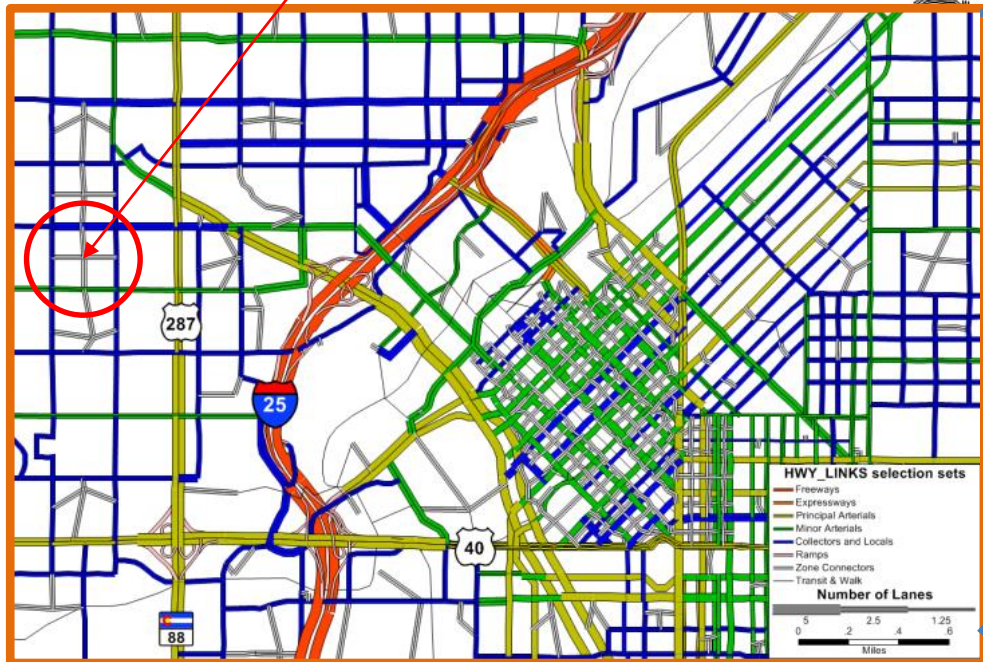
Transportation analysis zones (2,832 TAZs)





Roadway network link data

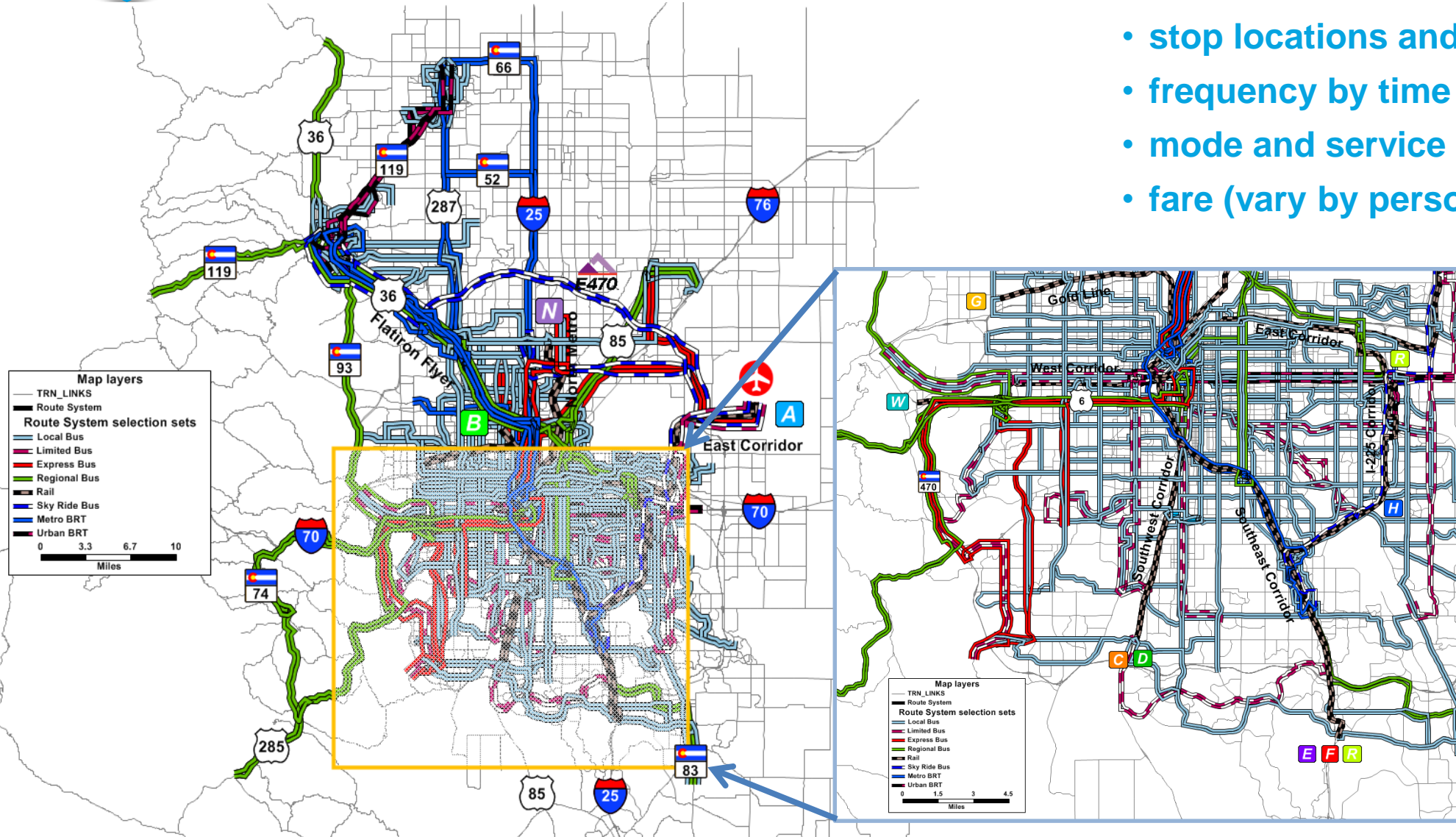
- lanes
- fee-flow speed/time
- capacity – for final speed/time
- facility type
- operating cost / tolls
- TAZ centroid connectors



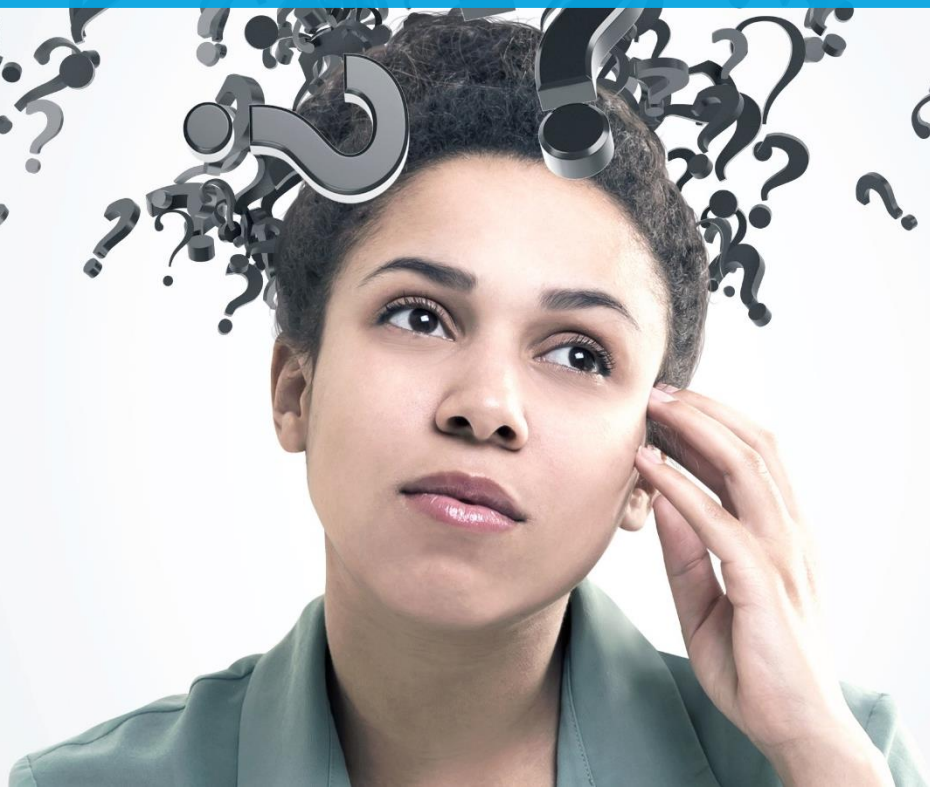


Transit network route information

- stop locations and dwell time
- frequency by time of day
- mode and service type
- fare (vary by person)



DECISIONS MODELED





Person decision/choice factors (utility functions)

- **Regular workplace location**
 - At home or outside the home?
 - What type (sector) of employment
 - Which TAZ?
- **Regular school location – by grade/age**
- **Daily activity pattern**
 - For which purposes will tours, trips or stops be made?
- **Number of tours by purpose**



Choice model components are calibrated to 2010 household travel survey results

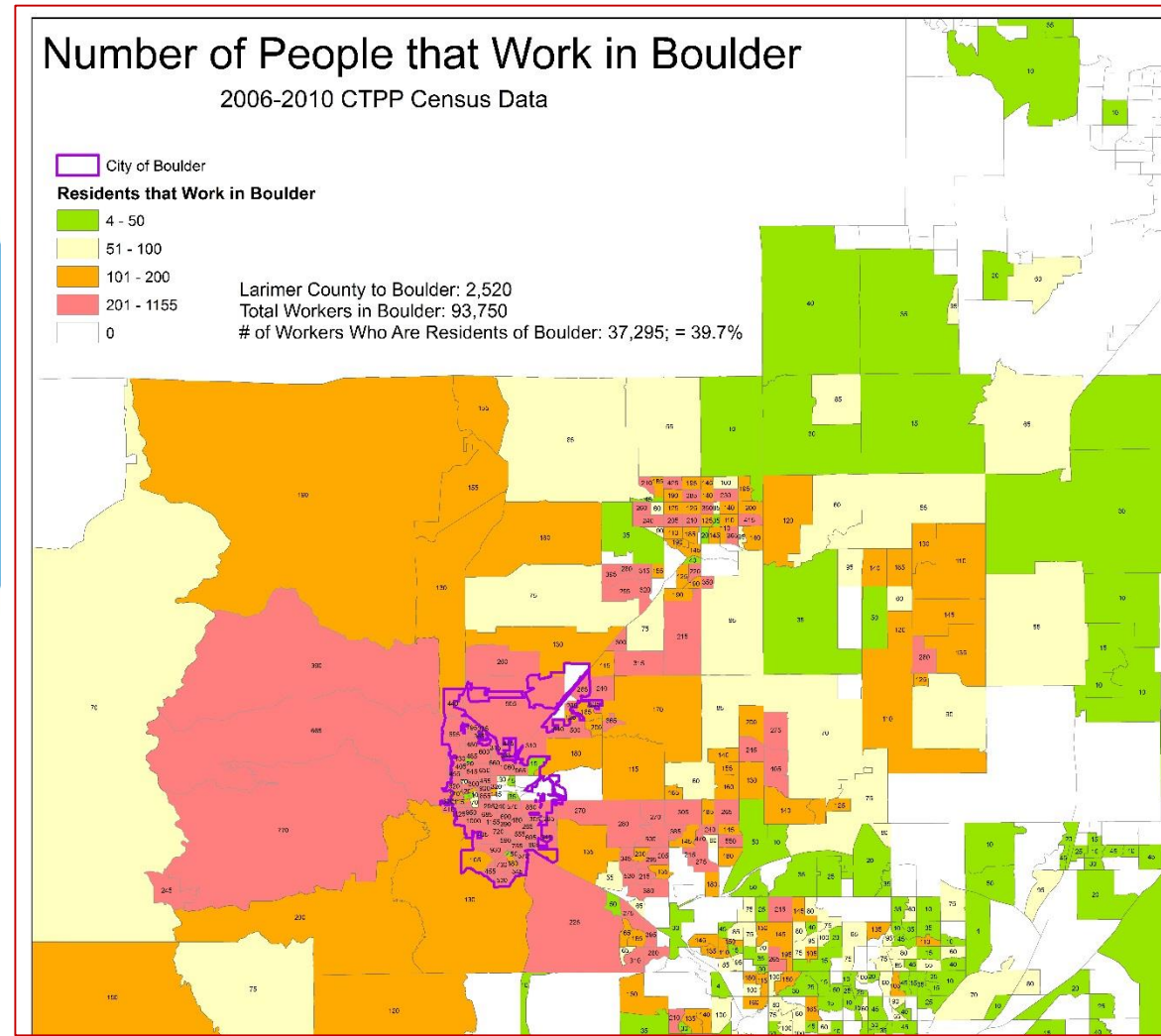


US Census data – place of work by residence compare to Focus

- ACS – tallied by place of residence
 - How did you usually get to work last week?
 - Region values:
 - 82% in autos (74% drive alone: 8% carpool)
 - 4.5% transit
 - 5% walk/bicycle/other
 - 8.5% work at home
 - 0.001% by ferry



- CTPP – tallied by residence and workplace
 - 2010 down to TAZ (2,800)
 - 2020 down to block group (2,100)





Tour and trip decisions - weekday

- **Destinations**
 - Regular workplace/school or somewhere else for work/school travel? (or stay home)
 - Specific locations
- **Departure, arrival, and duration times**
- **Mode of travel**
- **ABM creates origin-destination (O-D) trip tables** (5 modes x 10 time periods)
- **Path or route of travel (assignment)**
 - By roadways (auto/truck)
 - By transit (bus/rail)



Mode of travel choices

Tour or Trip

Auto

Drive Alone

Shared Ride 2

Shared Ride 3+

Transit

Walk to Transit

Drive to Transit

Non-Motorized

Walk

Bike

School Bus

Trip Tables "Assigned" to routes/paths by time period of day.

Not "Assigned"





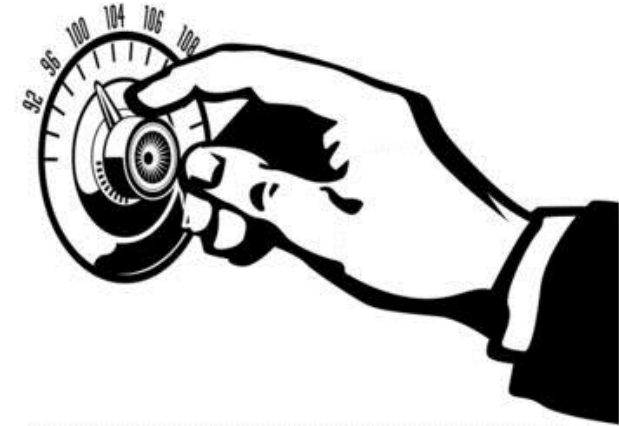
Mode of travel factors for personal trip mode choice

- **General**

- Demographic: Income, household size, ages, auto availability
- Auto operating cost, value of time, cost of transit, travel time,
- Travel time by modes

- **Bicycle and pedestrian calculation factors (“utility functions”)**

- Density of population & employment; Mixed use measure
- Type of development activities (retail, entertainment, etc.)
- Age, student status, other demographic,
- Sidewalk + shared use path “density”
- Bikeshare stations
- Avg operating speeds: Pedestrian – 3 mph; Bicycle – 8 mph
 - Bicycle speed reflects legal cycling habits and terminal times at O & D

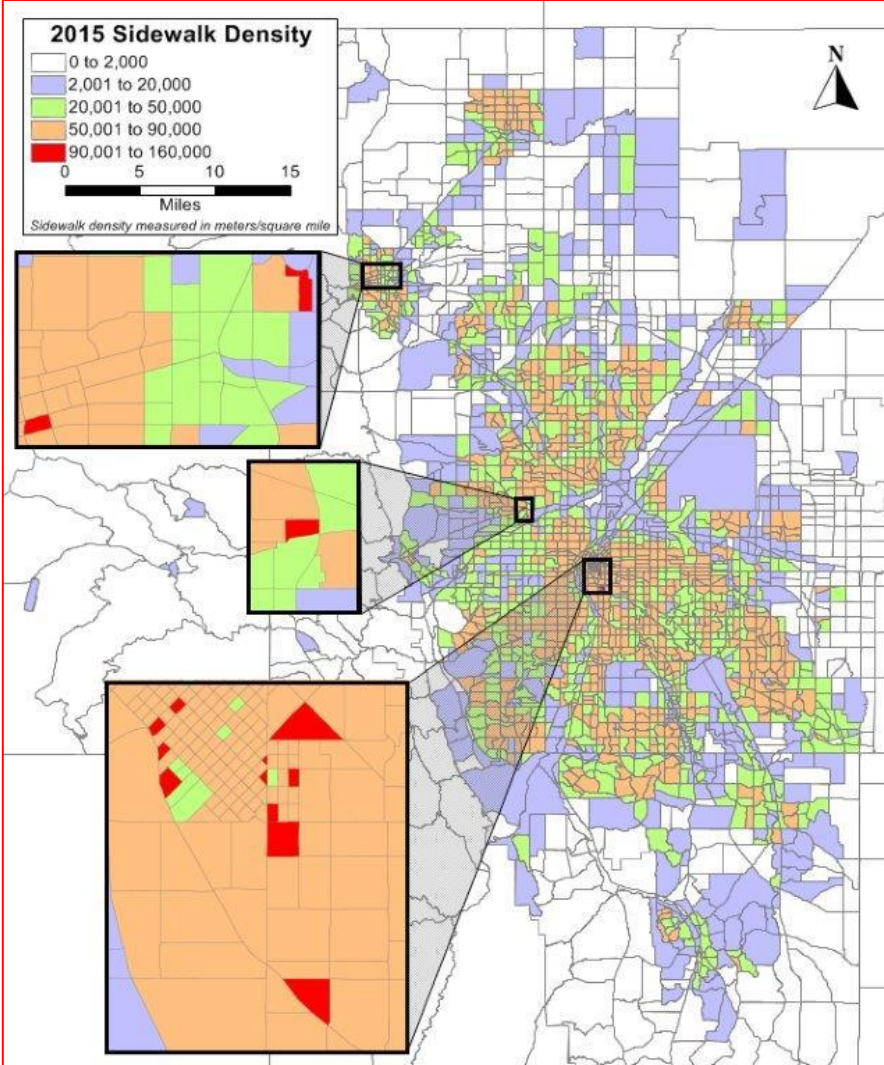
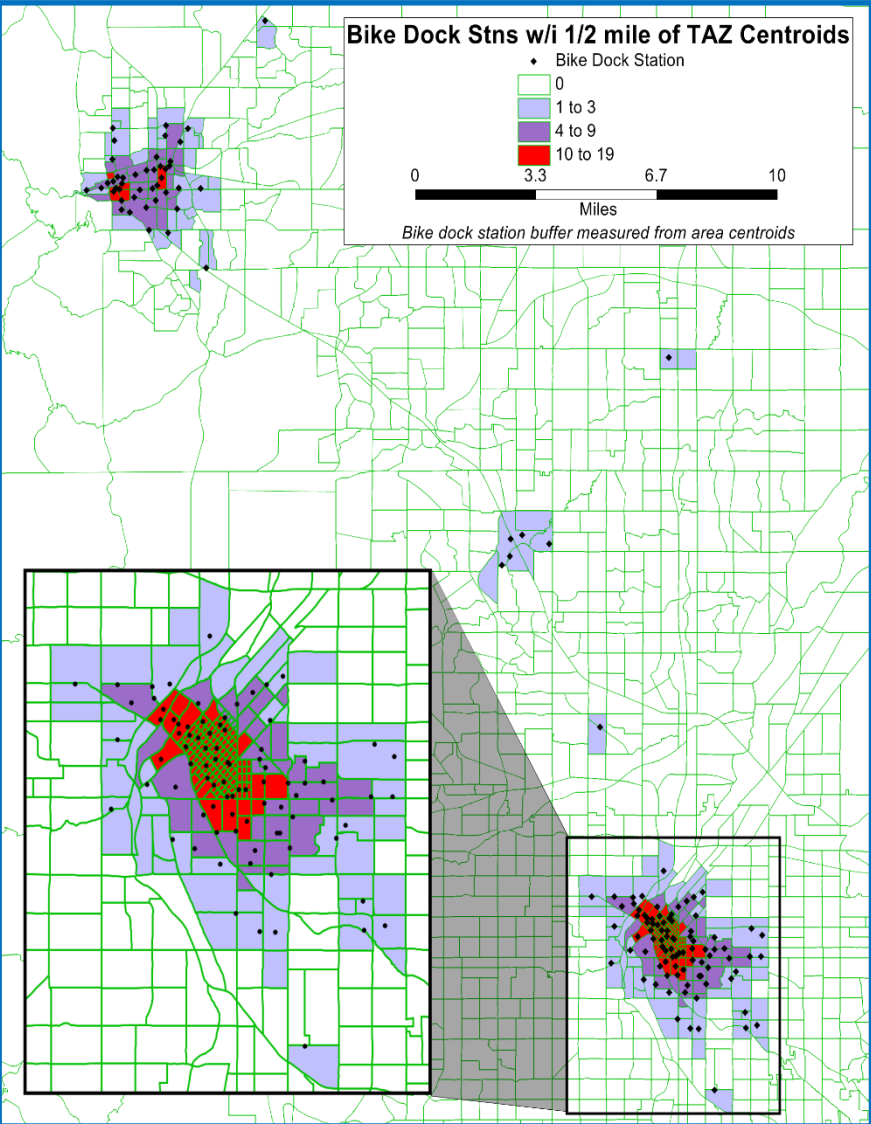
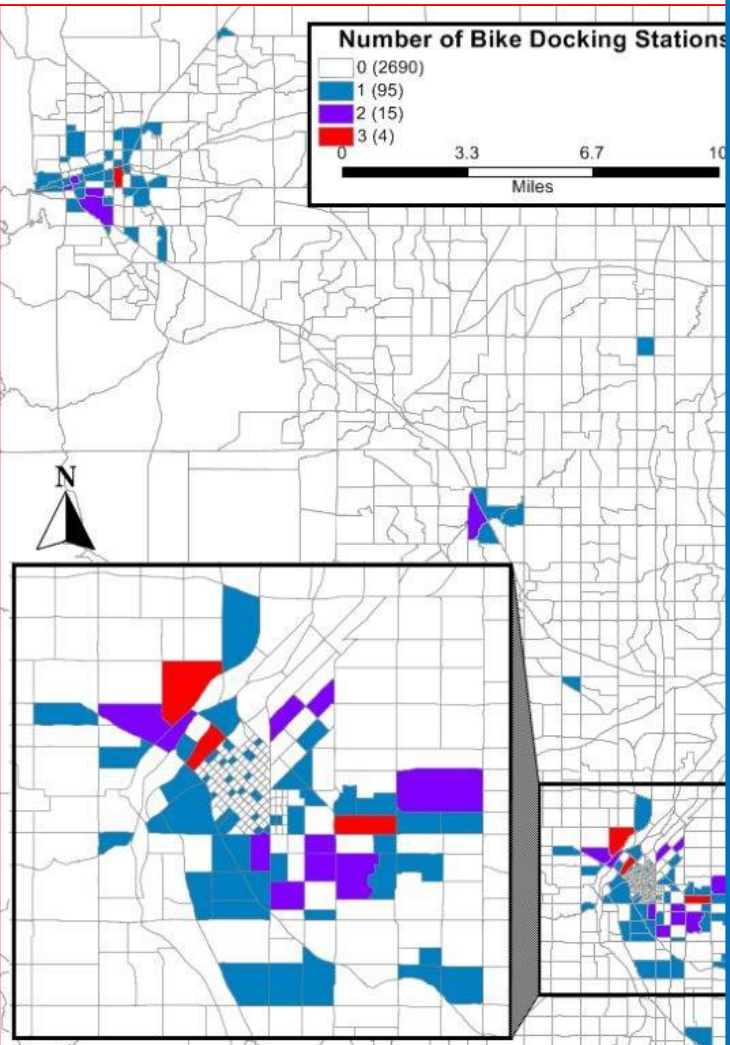


Note: Scooter trips are not calculated. Assumed to operate in either bicycle or pedestrian “mode.”



Bike stations and sidewalk/path density by TAZs

DRCOG Planimetrics





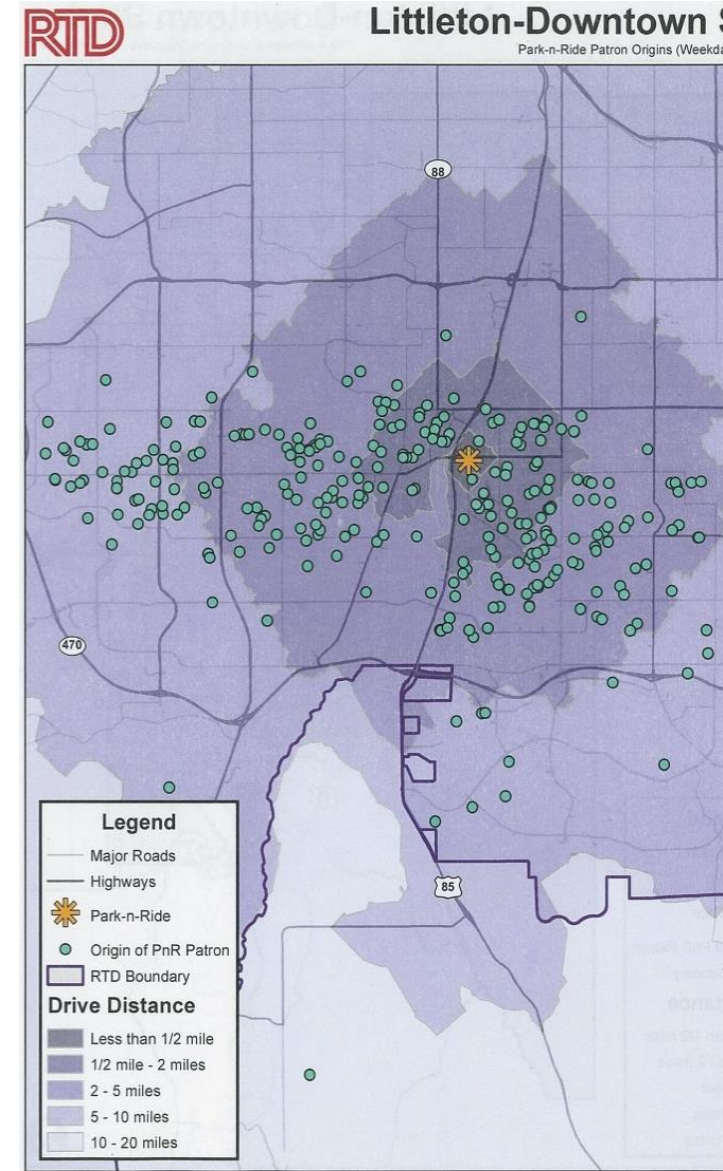
Assignment of auto/truck motor vehicle trips - roadway path factors

- **TransCAD assigns trips for 10 time periods during weekday**
- **Departure, arrival, and duration at destination**
- **Mode: Drive Alone; Shared Ride 2; Shared Ride 3+**
- **Roadway travel times**
 - operating speeds by time period;
 - terminal time at origin/destination ends of trip
- **Path of travel (assignment)**
 - by roadways between TAZs



Assignment of transit trips - route choice factors

- **TransCAD transit assignment**
- **Travel Time**
 - Walk to bus stop or station, drive to PnR, wait time, in-vehicle time, transfer time (penalty), final walk (or applicable mode) to destination
- **Bus versus Rail**
 - Rail and BRT attractiveness factors
- **Drive access/PnR transit trips (driver, passenger, or drop-off)**
 - Drive to the PnR lot not assigned in the model
 - Walk links from car to platform (larger lots, overpasses, etc.)
 - PnRs have no capacity
 - Fee for out-of-district residents





Other special vehicle trips – DIA, commercial vehicles, External

- **Os and Ds calculated with gravity model in TransCAD**

- TAZ based (not individual persons)

- **1) DIA trips (3% of VMT)**

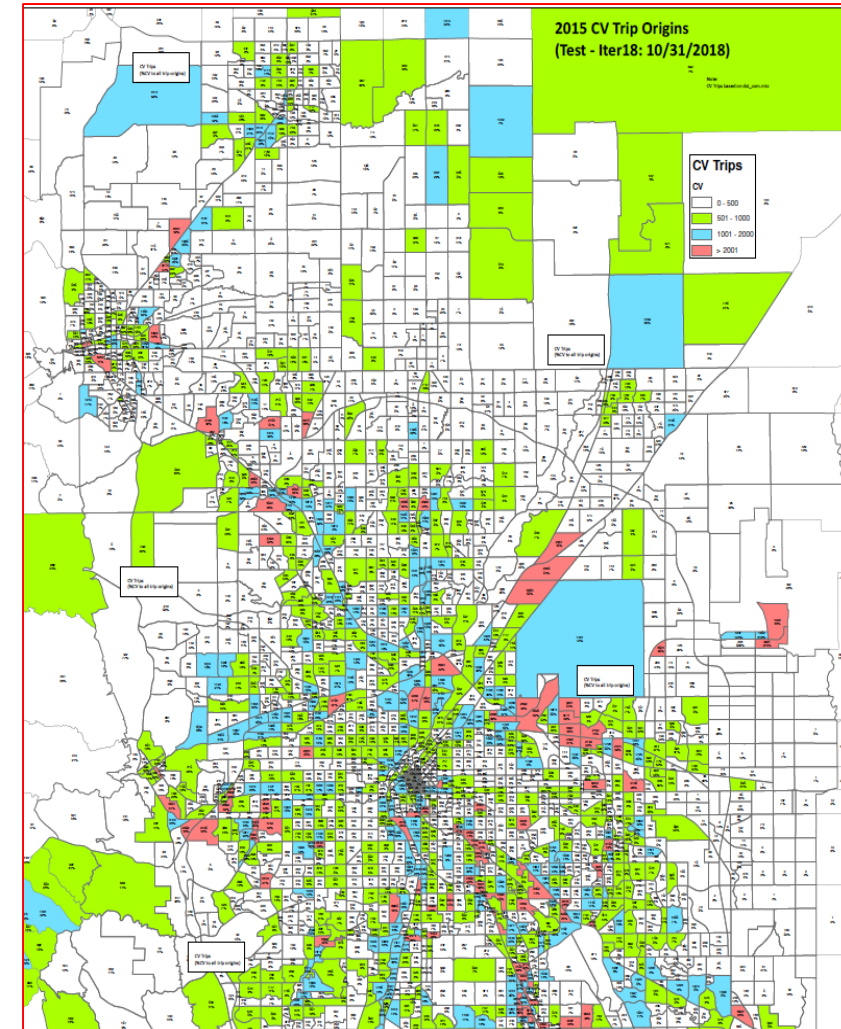
- Work, drop-offs/pick-ups, long-term parking, rental cars, deliveries, etc.

- **2) Commercial vehicles (CVs) (13% of VMT)**

- Light duty cars, trucks, vans & medium/heavy trucks
- Services, package deliveries, freight shipments, food deliveries

- **3) External trips at border (18% of VMT)**

- To, from, and through the DRCOG region (28 roadways)





Sample O-D table: (auto, transit, walk, bicycle, CVs, external auto)

Sample Origin/Destination (O-D) Trip Table											
		"To" Destination TAZ #									
		1	2	3	4	5	6-2831	2832	Tot. Os		
"From" Origin TAZ #	1	6	2	0	5	7	500	7	527		
	2	2	5	8	11	5	900	2	933		
	3	0	9	3	4	2	600	5	623		
	4	5	10	4	3	8	1,000	8	1,038		
	5	8	6	2	7	12	900	2	937		
	6-2831	500	900	600	1,000	900	3,000	600	7,500		
	2832	7	3	4	8	2	600	6	630		
Total Ds		528	935	621	1,038	936	7,500	630	3,035	15,223	
		Intrazonal								15,223	
- Trip Tables for each travel mode and time period											



Verizon 4:22 PM

Your location

61st & Pena Station

43 min 47 min 5 hr 42 min 1 hr

43 min

43 min (28 km) P On-site

Fastest route now due to traffic conditions

Steps Start

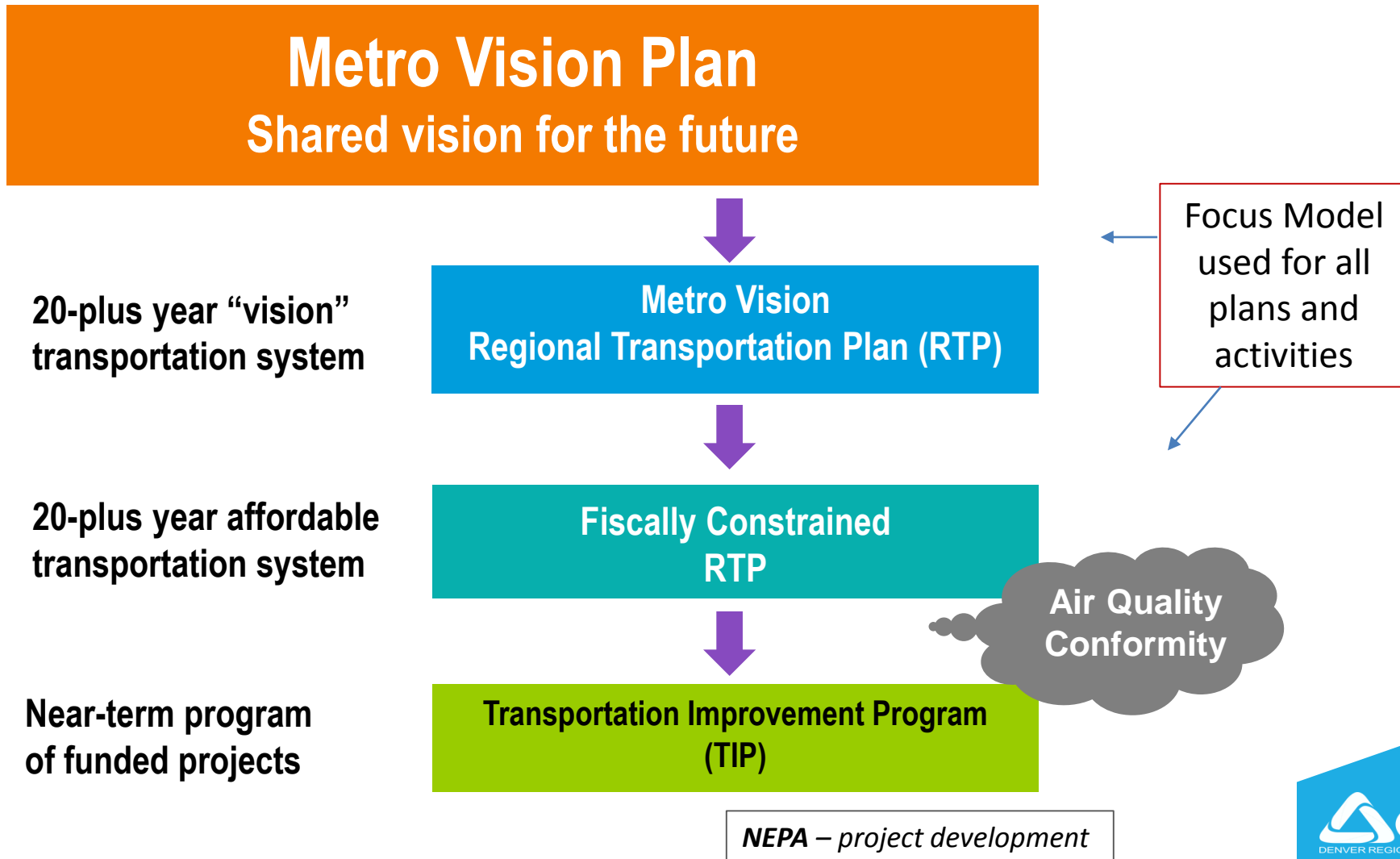
The image shows a Google Maps interface on a mobile device. At the top, it displays the carrier 'Verizon' and the time '4:22 PM'. Below that, there are search bars for 'Your location' and '61st & Pena Station'. A navigation bar shows different travel modes: car (43 min), transit (47 min), walking (5 hr), wheelchair (42 min), and bicycle (1 hr). The main map area shows a route from Denver to Aurora, with a highlighted segment in red and blue. A callout box indicates a '43 min' travel time. Below the map, it shows '43 min (28 km) P On-site' and a note: 'Fastest route now due to traffic conditions'. At the bottom, there are buttons for 'Steps' and 'Start'.

OUTPUTS & QUERIES





DRCOG Plans and transportation activities use Focus





Trip outputs

- **origins and destinations by TAZs (Intrazonal and Interzonal)**
- **trip purpose**
- **mode of travel**
- **Average/median trip length**
- **regional 2015 weekday values:**

vehicle miles traveled (VMT)	77 million
person trips	14.5 million
vehicle trips	9 million



Focus output examples: tour purpose and primary mode

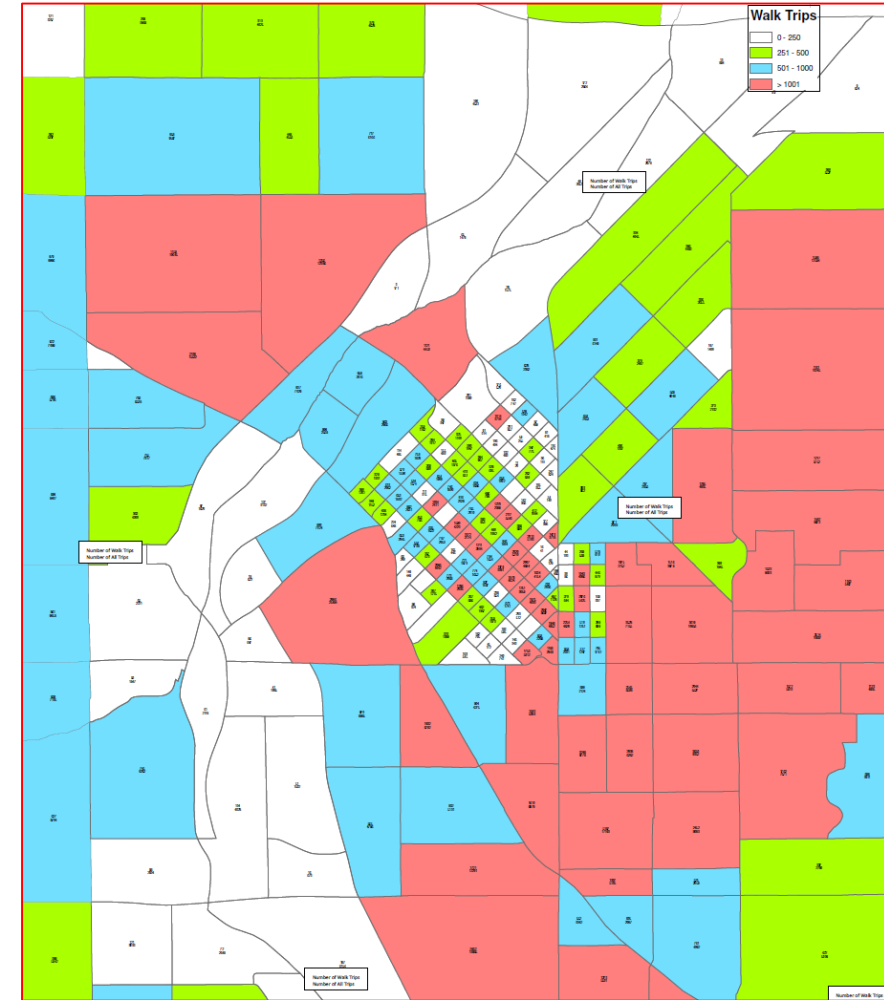
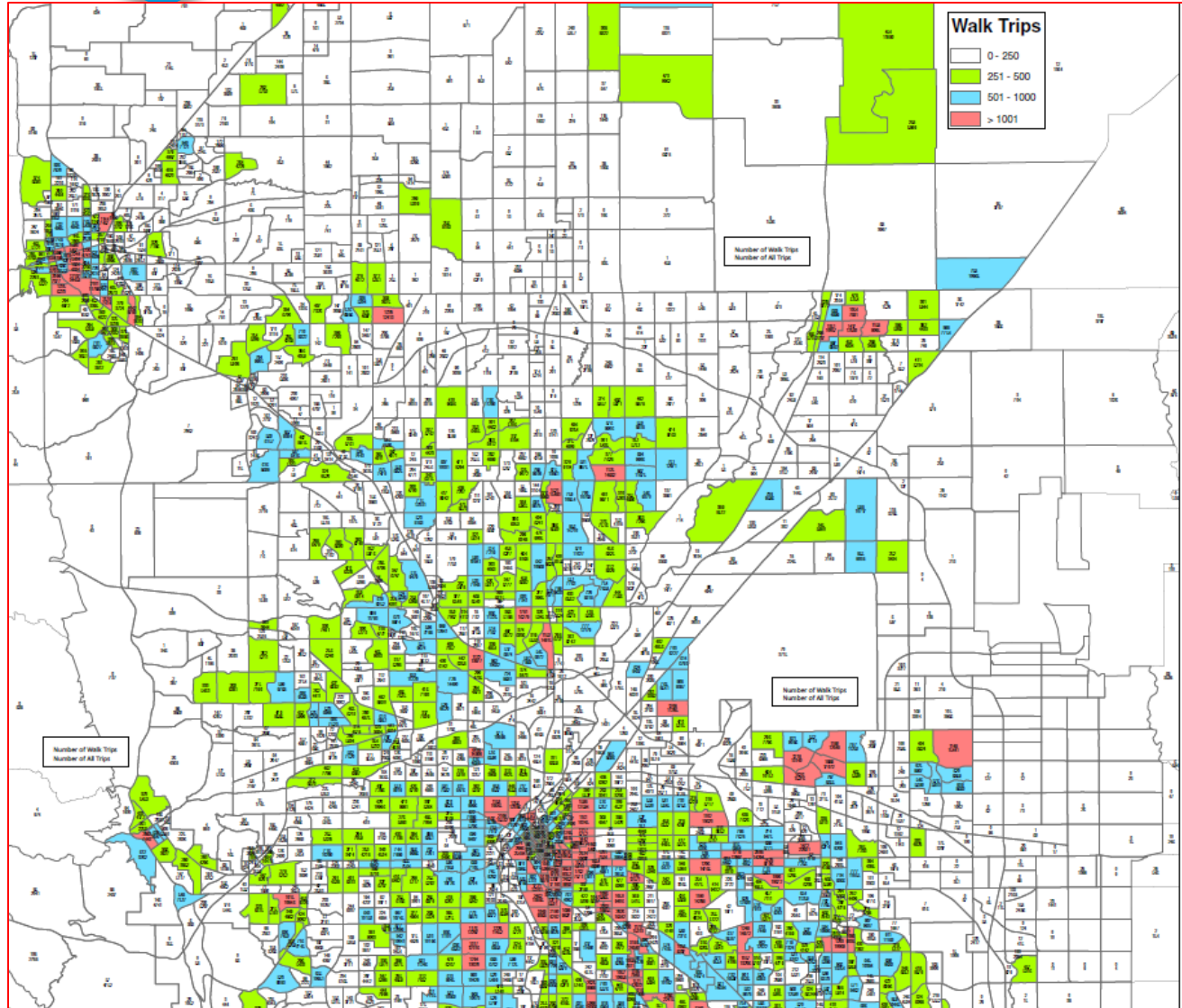
Tour Purpose	Total
Work	1,670,155
School	901,746
Escort	718,650
Personal business	740,072
Shopping	717,832
Meal	308,277
Social recreation	752,710
Total	5,809,442

Tour mode	Total	Mode share
Bike	42,278	0.73%
Drive alone	2,480,314	42.69%
Drive to transit	51,994	0.89%
School bus	119,654	2.06%
Shared ride 2	1,466,384	25.24%
Shared ride 3+	1,009,056	17.37%
Walk	481,525	8.29%
Walk to transit	158,236	2.72%
Total	5,809,442	

Trips = 14.5 million

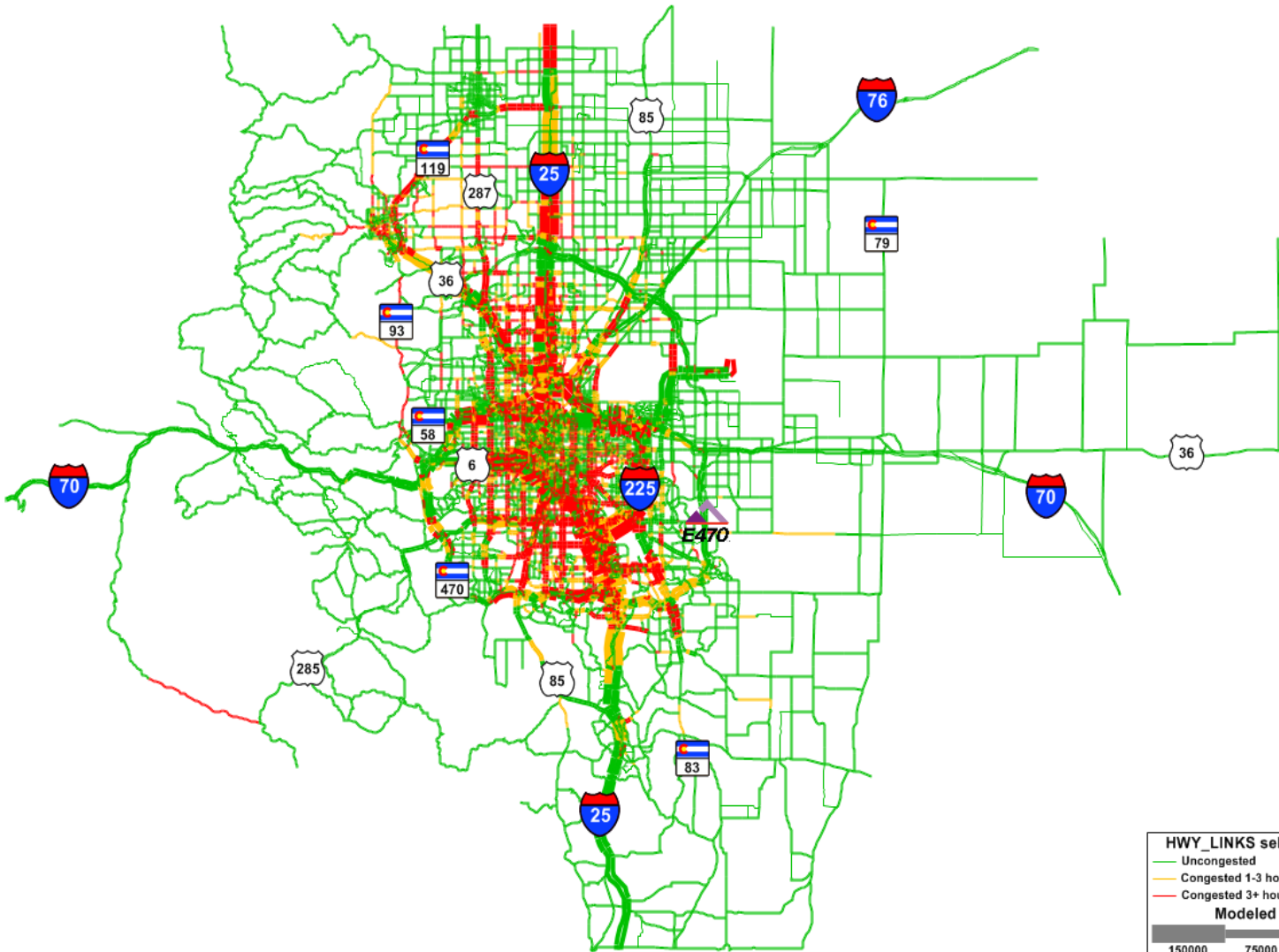


Model Output - Walk trips by TAZ





“Highway” assignment outputs

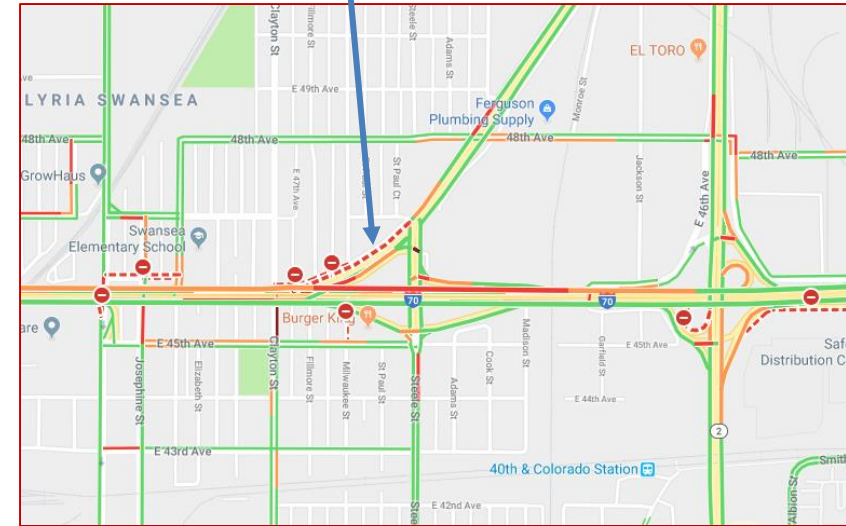
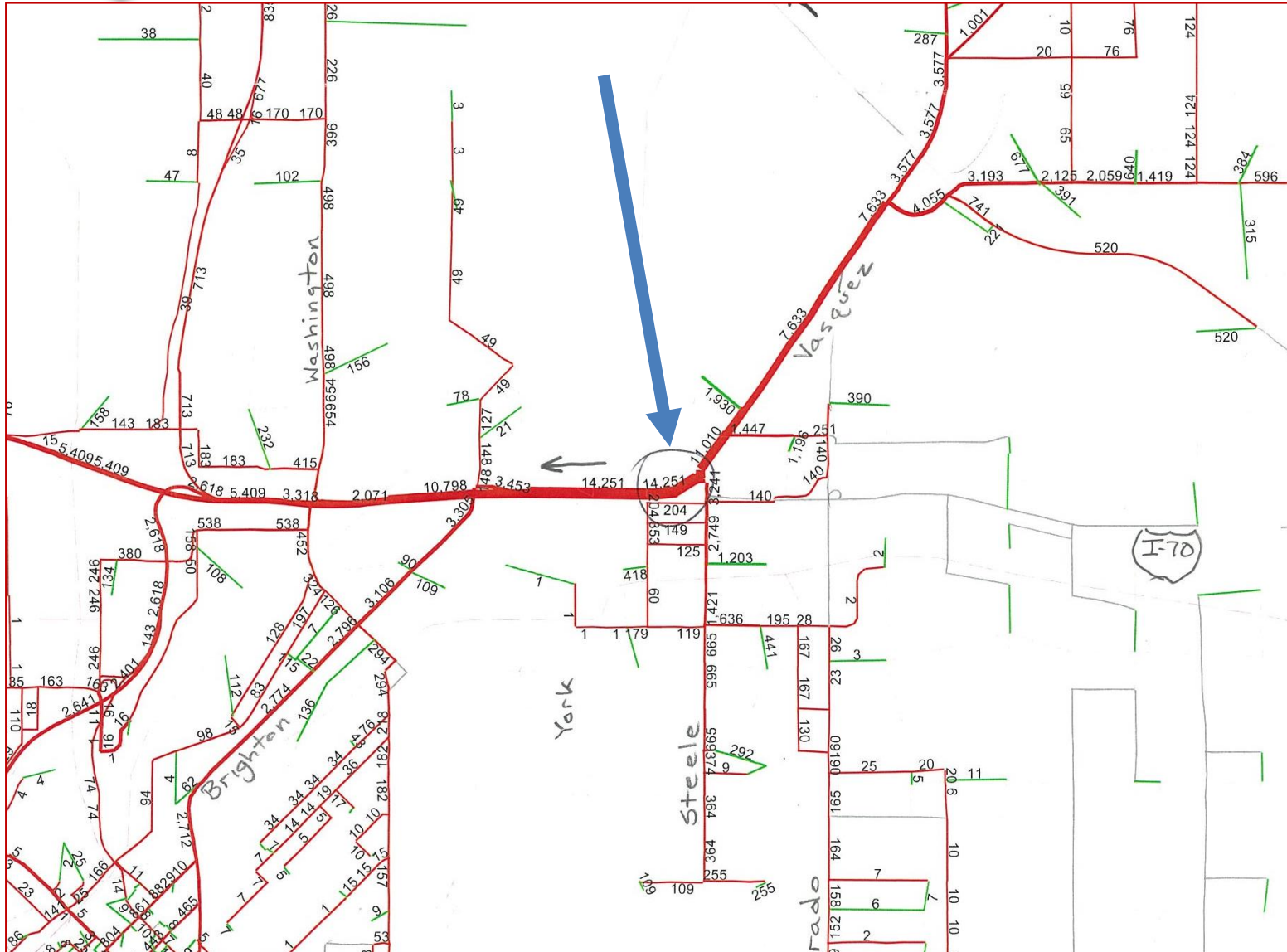


- link daily traffic volumes (x)
- person/vehicle miles traveled (P/VMT)
- vehicle and person hours of delay
- who uses specific roads?
 - “select link” analyses

- (x) - Example traffic volumes (pass by one point):
- **I-25:** 300,000 vehicles (= 420,000 people)
 - **Colorado Blvd.:** 60,000 vehicles (= 84,000 people)
 - **17th St.:** 10,000 vehicles (includes ~300 buses) (= 20,000 people)

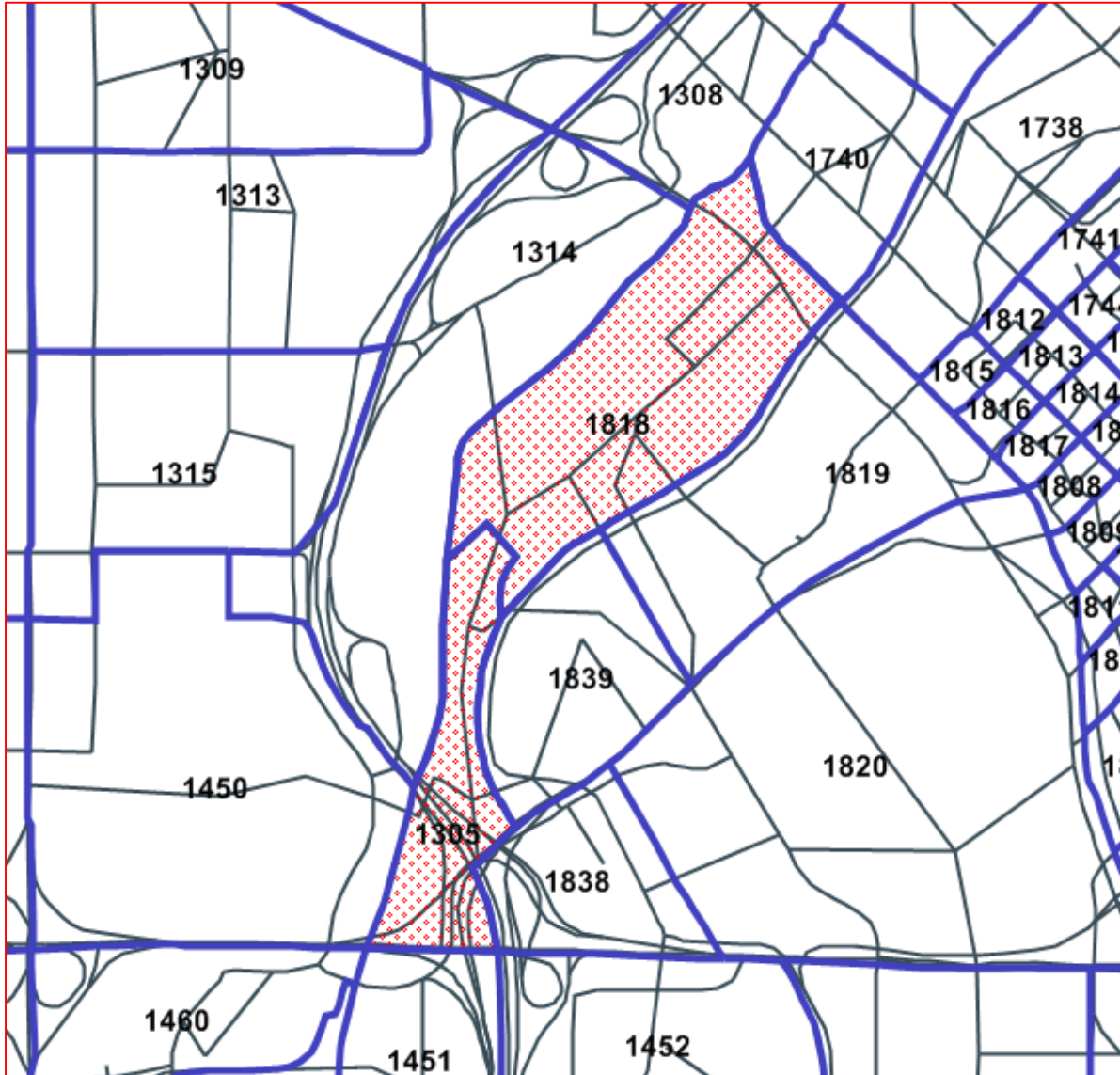


Select Link analysis – on-ramp from Vasquez/Steele to I-70





River Mile Development Proposal Analysis – TAZ split 2040



DRCOG 2040 RTP

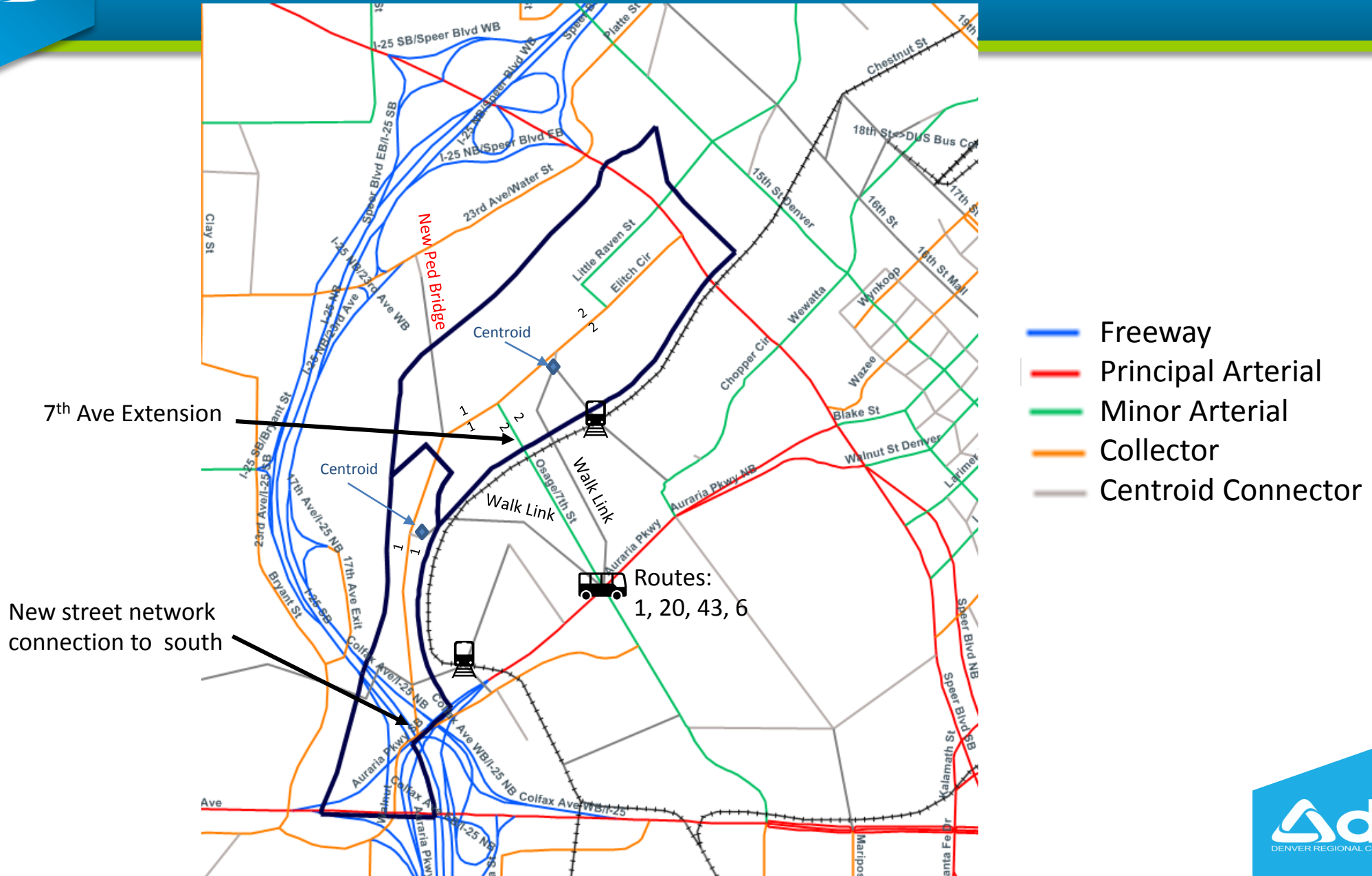
Zone	HHs	Jobs
1818	0	991

River Mile Analysis – additional growth

Zone	HHs	Jobs
1818	7,654	37,819
1305	1,260	2,190

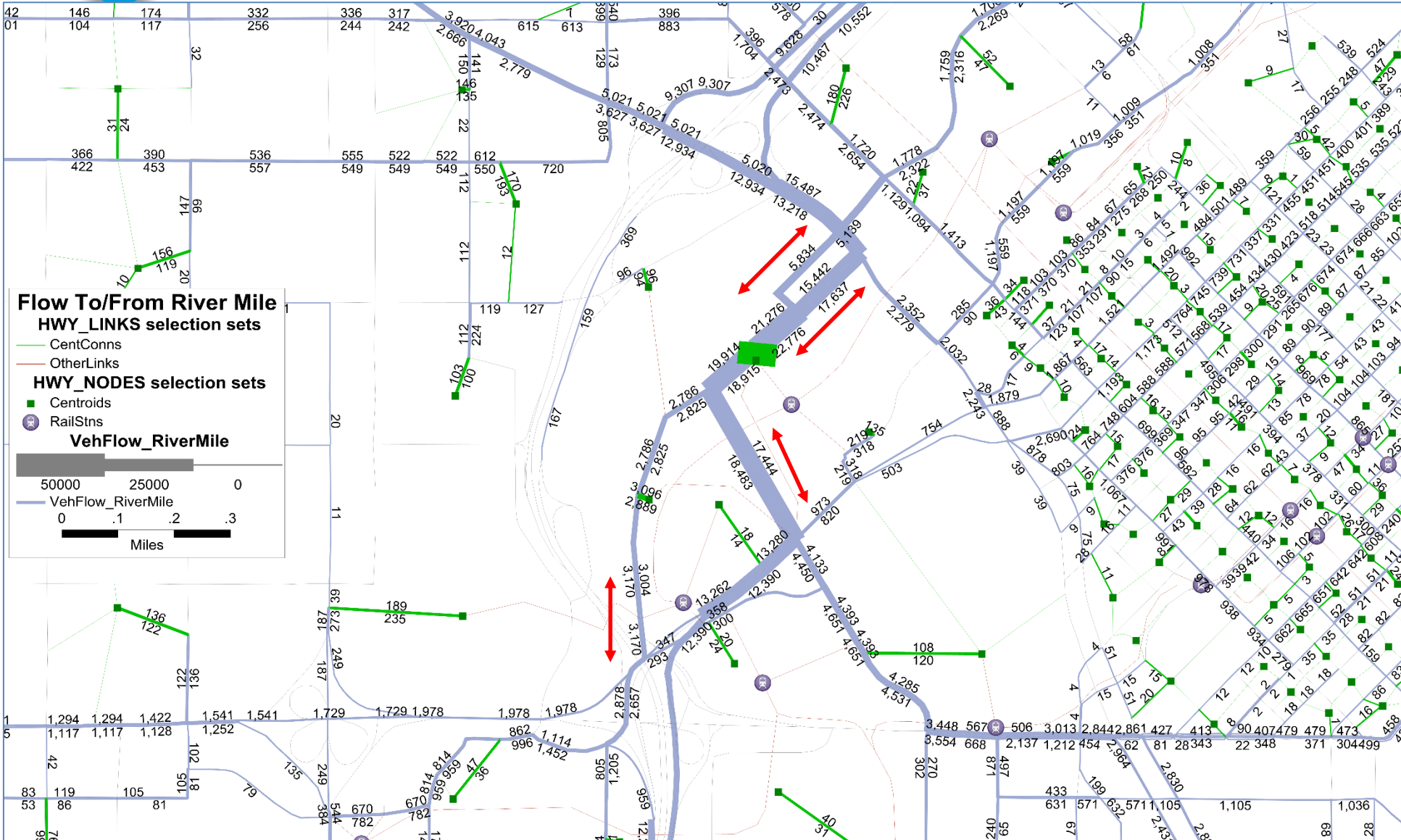


River Mile - Network Changes





Select TAZ Analysis – vehicle trips to and from



Traffic Changes:

- Diversion
- Regional Growth
- Induced
- Latent



Transit assignment outputs

Boardings	Modeled 2015
Free shuttles	49,100
Local bus	149,000
Limited bus	35,100
Express bus	9,300
Regional bus	12,300
SkyRide bus	7,500
Rail	98,500
Total	361,000

Daily value estimates:

- **Station and PnR** Boardings
 - DUS-14,000; Englewood-2,500; Lamar-400
- Route-by-route comparisons
 - **Ridership (boardings)**, along entire route
 - Colfax 15/15L – 22,000
 - O/Ol – 9,000
 - W-Line – 12,500
 - P (Parker) - 500
 - **“Volume”** of riders per day, at one point
 - Colfax Ave. E/of Grant – 8,000
 - Broadway S/of Littleton Blvd – 700
 - W-Line E/of JeffCo Ctr. – 2,350
 - Parker Road S/of Main St - 60



Example queries / “what ifs”

- How much will traffic volume, transit ridership, or bicycle & pedestrian travel modes change due to:
 - regional population & employment growth (e.g. through 2040)?
 - Specific proposed large-scale development
 - a new (or closed down!) road or transit line?
 - change in auto operating and fuel costs?
 - change in roadway capacity or mobility services – new technology?
- What are the travel characteristics of zero-car households?



Example queries / “what ifs” (continued)

- What modes of travel are used to get to/from workplaces or TAZs?
- What roadway paths or transit routes are used to get from A to B
- What if transit fares double? What if free?
- How will operating speeds and VMT affect “mobile source pollutant emissions?”
 - Air quality conformity
 - Emission inventories for nonattainment area Ozone Plans (SIPs)
-



Caution on use of model outputs

DO NOT use direct model outputs to predict:

- Precise mode shares on individual roadway segments
- Bicyclists or pedestrians using a specific facility
- Exact intersection turning movements in the future
 - Model predicts levels of change for the future
- Socioeconomic changes in TAZ HH incomes over time
 - Model synthesizes these attributes for use within the model, but they are not “predictions”
- Other overly precise data outputs – *“how many transit riders on Main Street are heading to the new brewpub?”* – **NO!**



Terminology pitfalls

- Transit trips **vs.** boardings/ridership **vs.** riders (persons) **vs.** volume
- Tour **vs.** trip
- Commute trips **vs.** work trip **vs.** all trips
- “In and around” a TAZ **vs.** to and from a TAZ
- Modeled **vs.** surveyed (sample) **vs.** counted (observed)
- Average (mean) **vs.** median
- VMT in a TAZ or community by residents **vs.** by all roadway travelers

Any questions?