Focus 101
DRCOG's Travel Demand Model

Presented to: DRCOG Staff

Presented by: Steve Cook

Transportation Planning & Operations Division

June 20, 2019

- **Basics**

- **Unique aspects of Focus Model**

- **Input data**

- **Outputs, queries, and uses of the model**

- **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)**
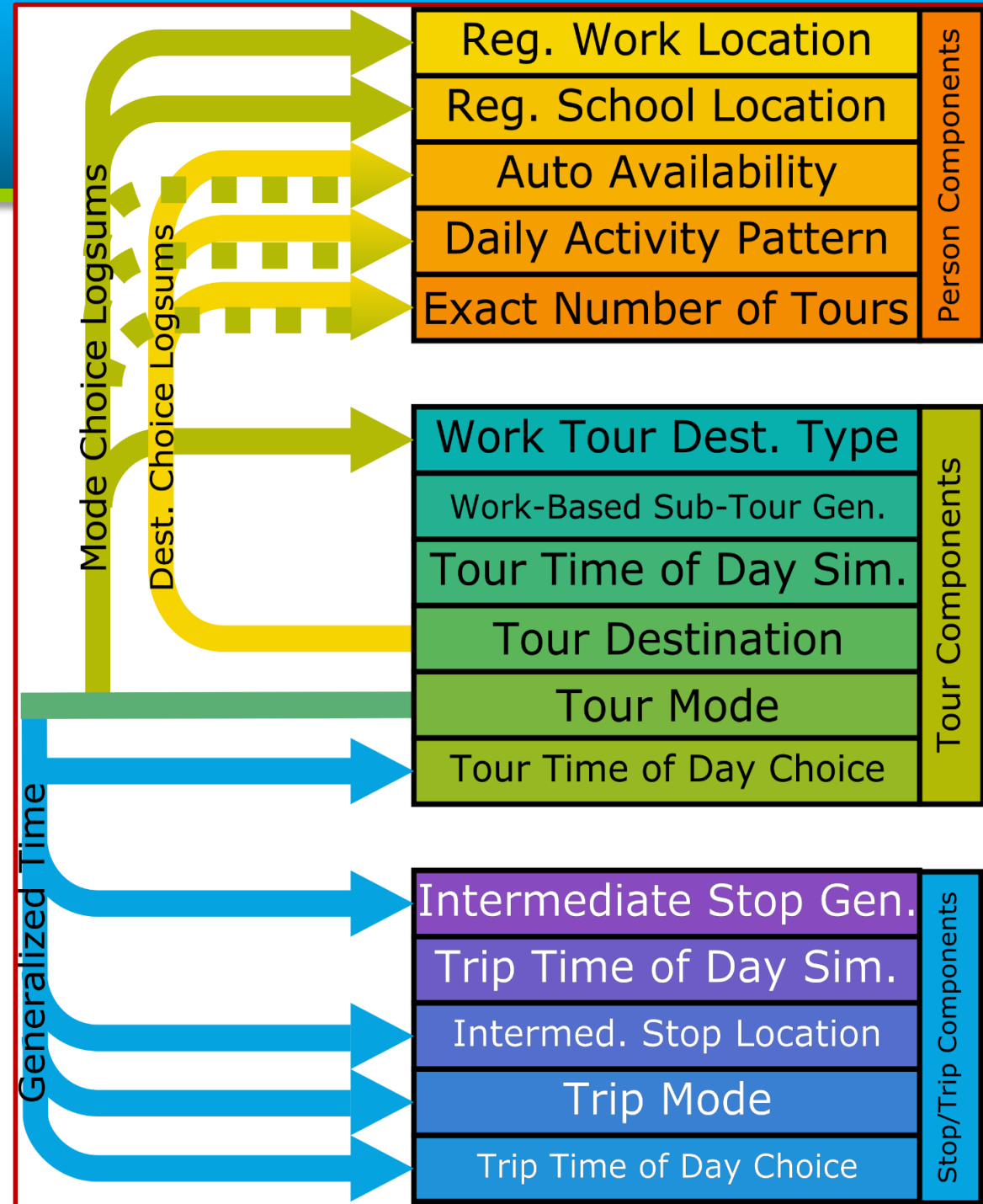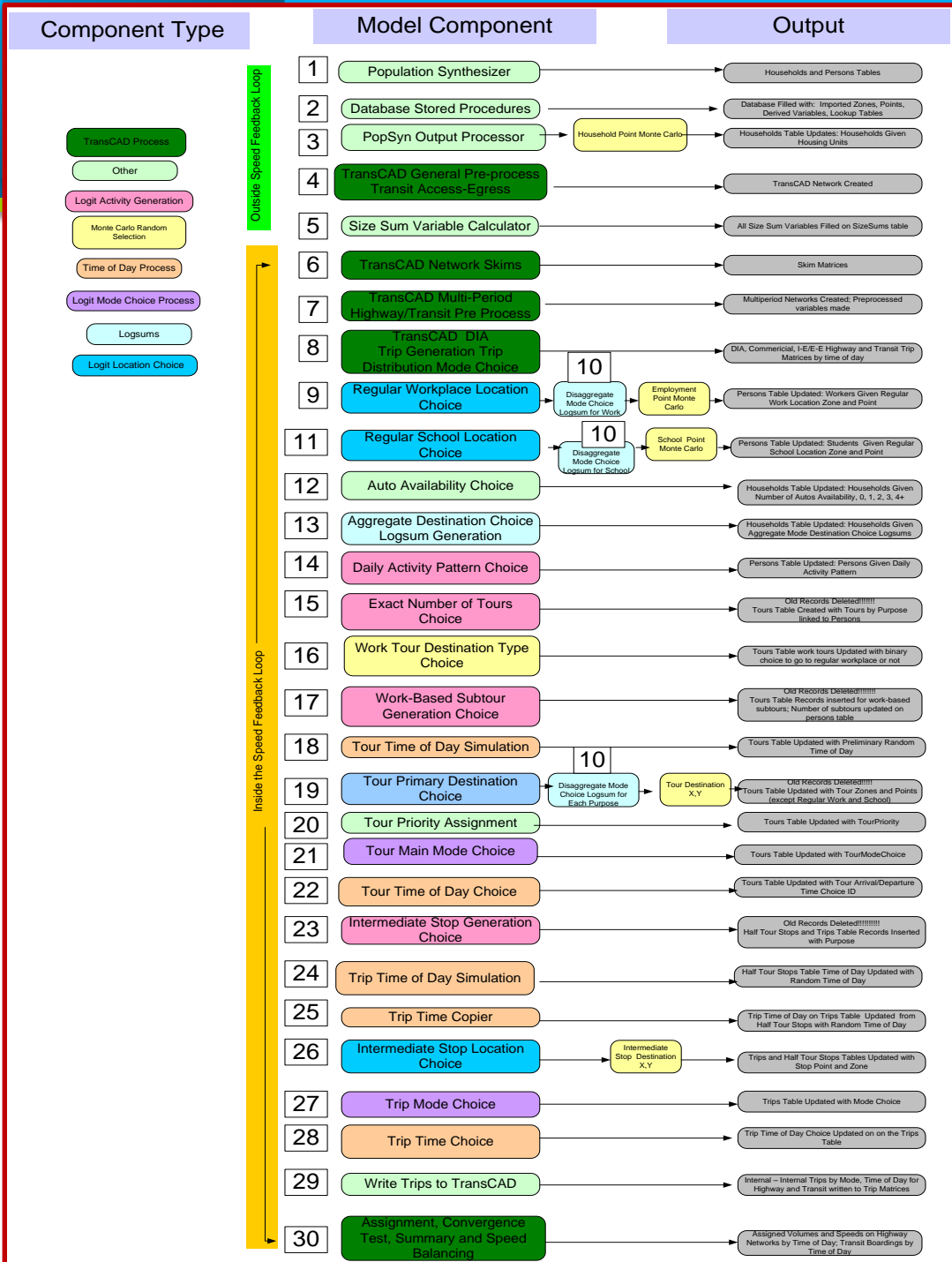 - **2.0 million by pedestrian & bicycle**
 - **0.5 million by transit and school bus**

Modeling Area

HOW IS FOCUS MODEL UNIQUE?

Component Type

- TransCAD Process
- Other
- Logit Activity Generation
- Monte Carlo Random Selection
- Time of Day Process
- Logit Mode Choice Process
- Logsums
- Logit Location Choice

Outside Speed Feedback Loop

Inside the Speed Feedback Loop

Model Component / Output

#	Model Component	Output
1	Population Synthesizer	Households and Persons Tables
2	Database Stored Procedures	Database Filled with: Imported Zones, Points, Derived Variables, Lookup Tables
3	PopSyn Output Processor → [Household Point Monte Carlo]	Households Table Updates: Households Given Housing Units
4	TransCAD General Pre-process Transit Access-Egress	TransCAD Network Created
5	Size Sum Variable Calculator	All Size Sum Variables Filled on SizeSums table
6	TransCAD Network Skims	Skim Matrices
7	TransCAD Multi-Period Highway/Transit Pre Process	Multiperiod Networks Created; Preprocessed variables made
8	TransCAD DIA Trip Generation Trip Distribution Mode Choice	DIA, Commericial, I-E/E-E Highway and Transit Trip Matrices by time of day
9	Regular Workplace Location Choice → [10 Disaggregate Mode Choice Logsum for Work] → [Employment Point Monte Carlo]	Persons Table Updated: Workers Given Regular Work Location Zone and Point
11	Regular School Location Choice → [10 Disaggregate Mode Choice Logsum for School] → [School Point Monte Carlo]	Persons Table Updated: Students Given Regular School Location Zone and Point
12	Auto Availability Choice	Households Table Updated: Households Given Number of Autos Availability, 0, 1, 2, 3, 4+
13	Aggregate Destination Choice Logsum Generation	Households Table Updated: Households Given Aggregate Mode Destination Choice Logsums
14	Daily Activity Pattern Choice	Persons Table Updated: Persons Given Daily Activity Pattern
15	Exact Number of Tours Choice	Old Records Deleted!!!!!!! Tours Table Created with Tours by Purpose linked to Persons
16	Work Tour Destination Type Choice	Tours Table work tours Updated with binary choice to go to regular workplace or not
17	Work-Based Subtour Generation Choice	Old Records Deleted!!!!!!! Tours Table Records inserted for work-based subtours; Number of subtours updated on persons table
18	Tour Time of Day Simulation	Tours Table Updated with Preliminary Random Time of Day
19	Tour Primary Destination Choice → [10 Disaggregate Mode Choice Logsum for Each Purpose] → [Tour Destination X,Y]	Old Records Deleted!!!!! Tours Table Updated with Tour Zones and Points (except Regular Work and School)
20	Tour Priority Assignment	Tours Table Updated with TourPriority
21	Tour Main Mode Choice	Tours Table Updated with TourModeChoice
22	Tour Time of Day Choice	Tours Table Updated with Tour Arrival/Departure Time Choice ID
23	Intermediate Stop Generation Choice	Old Records Deleted!!!!!!!! Half Tour Stops and Trips Table Records Inserted with Purpose
24	Trip Time of Day Simulation	Half Tour Stops Table Time of Day Updated with Random Time of Day
25	Trip Time Copier	Trip Time of Day on Trips Table Updated from Half Tour Stops with Random Time of Day
26	Intermediate Stop Location Choice → [Intermediate Stop Destination X,Y]	Trips and Half Tour Stops Tables Updated with Stop Point and Zone
27	Trip Mode Choice	Trips Table Updated with Mode Choice
28	Trip Time Choice	Trip Time of Day Choice Updated on the Trips Table
29	Write Trips to TransCAD	Internal – Internal Trips by Mode, Time of Day for Highway and Transit written to Trip Matrices
30	Assignment, Convergence Test, Summary and Speed Balancing	Assigned Volumes and Speeds on Highway Networks by Time of Day; Transit Boardings by Time of Day

Right-side Diagram

Mode Choice Logsums

Dest. Choice Logsums

Generalized Time

Person Components
- Reg. Work Location
- Reg. School Location
- Auto Availability
- Daily Activity Pattern
- Exact Number of Tours

Tour Components
- Work Tour Dest. Type
- Work-Based Sub-Tour Gen.
- Tour Time of Day Sim.
- Tour Destination
- Tour Mode
- Tour Time of Day Choice

Stop/Trip Components
- Intermediate Stop Gen.
- Trip Time of Day Sim.
- Intermed. Stop Location
- Trip Mode
- Trip Time of Day Choice

- **Individual person and household characteristics modeled**
  - <u>Every</u> 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?
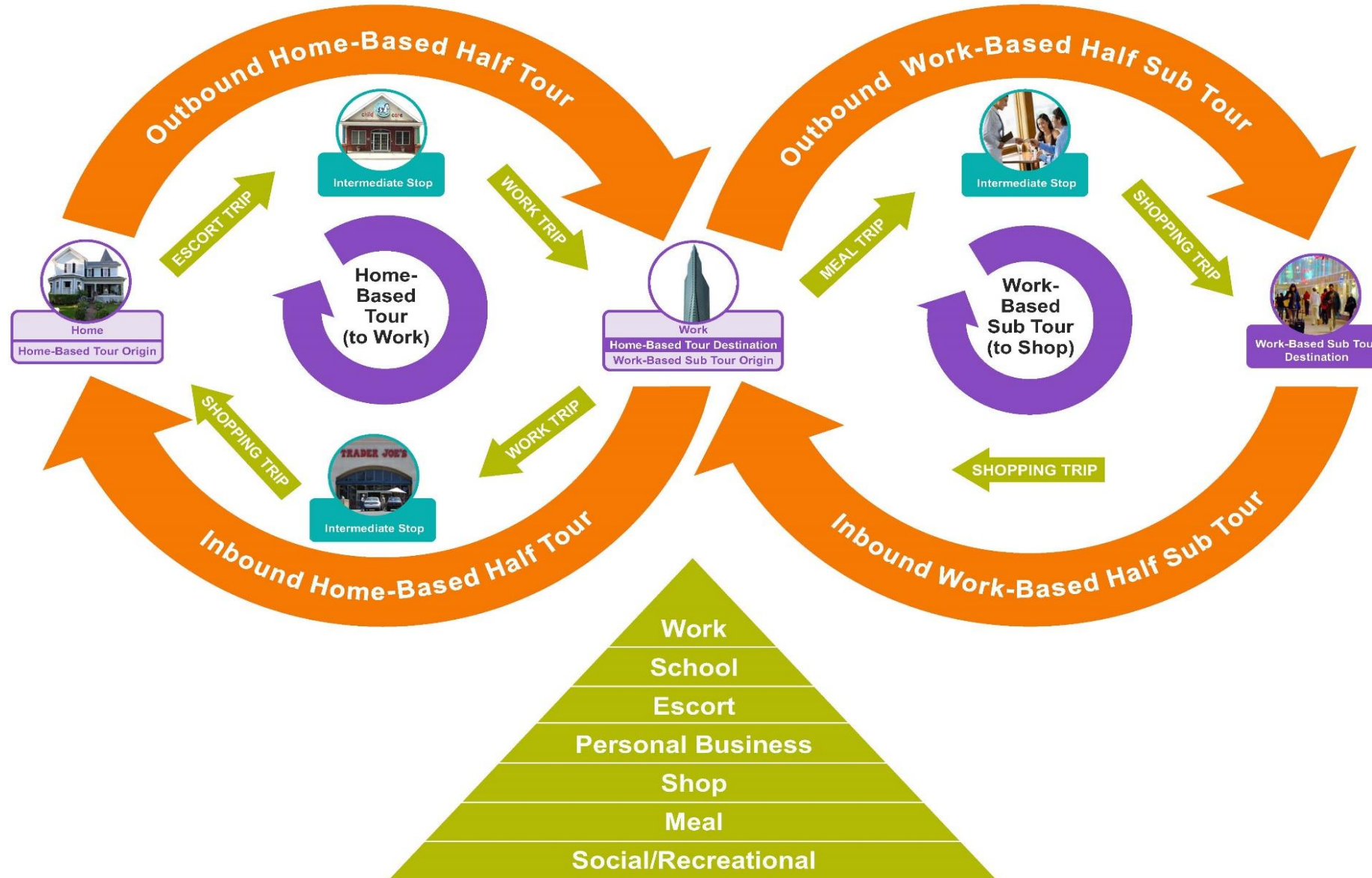
INPUT DATA

- **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

- **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
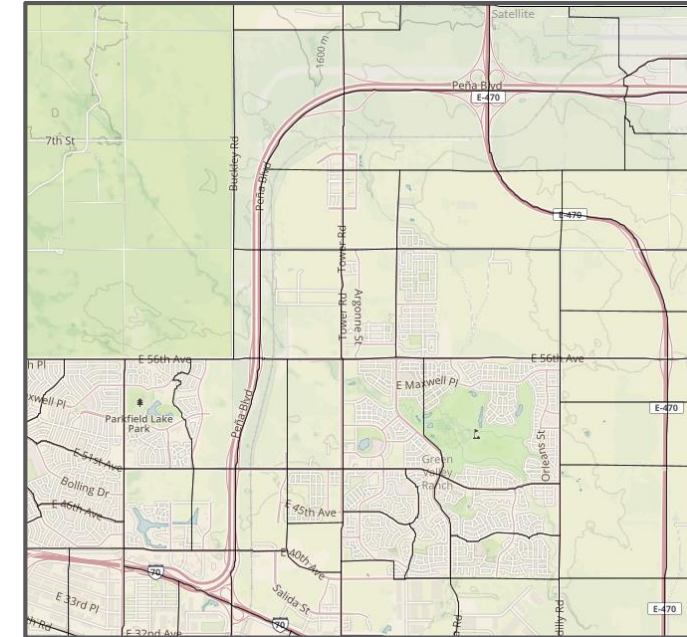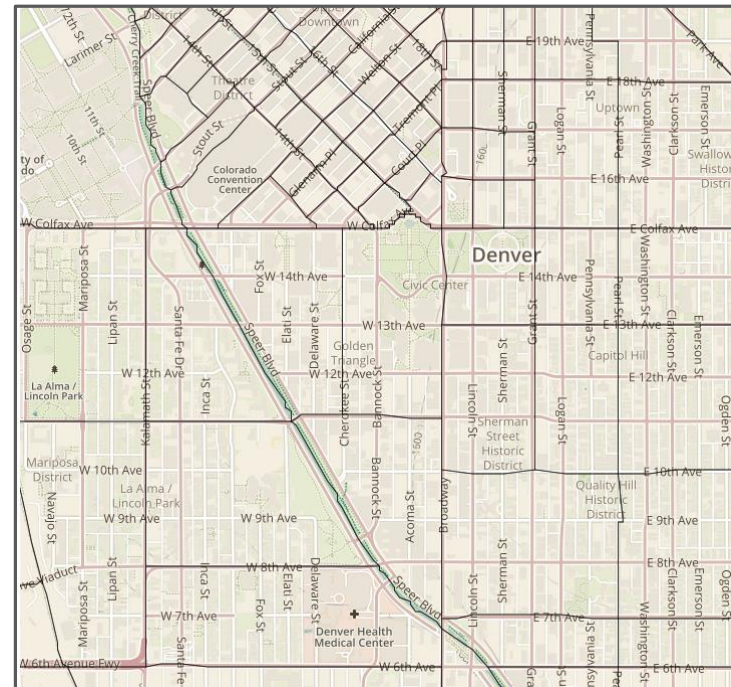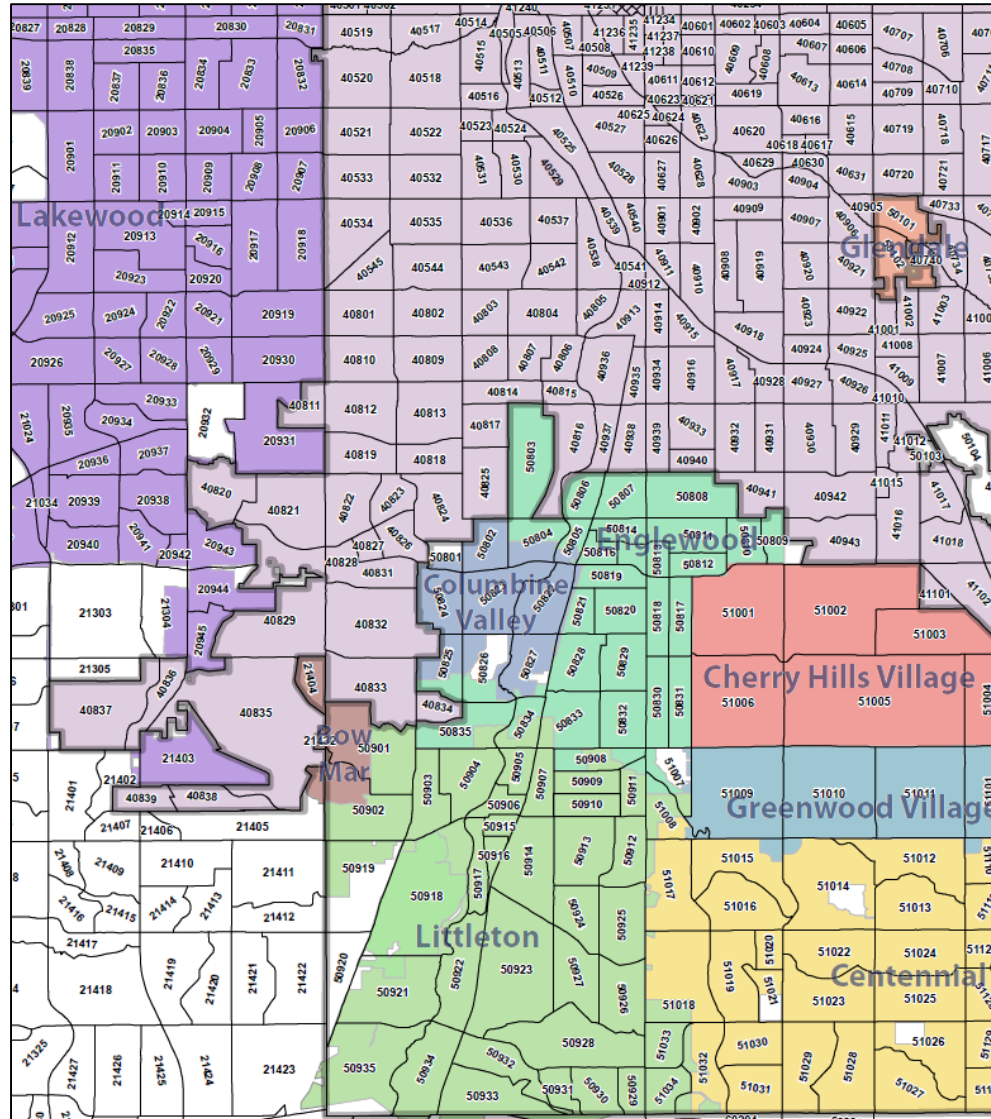
Roadway network link data

- **lanes**
- **fee-flow speed/time**
- **capacity – for final speed/time**
- **facility type**
- **operating cost / tolls**
- **TAZ centroid connectors**
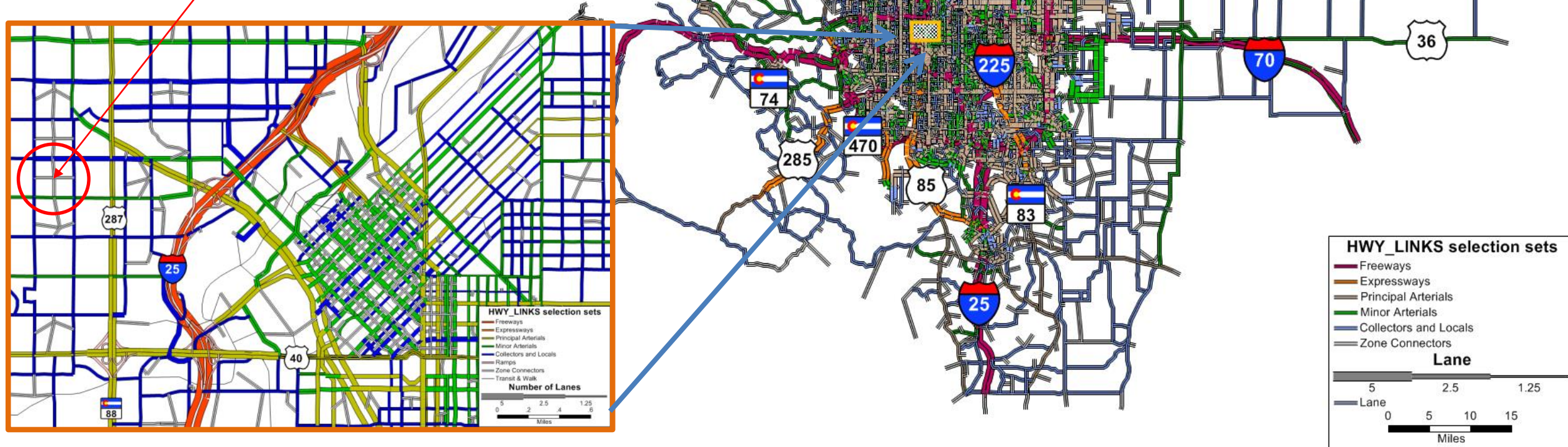
Transit network route information

- **stop locations and dwell time**
- **frequency by time of day**
- **mode and service type**
- **fare (vary by person)**
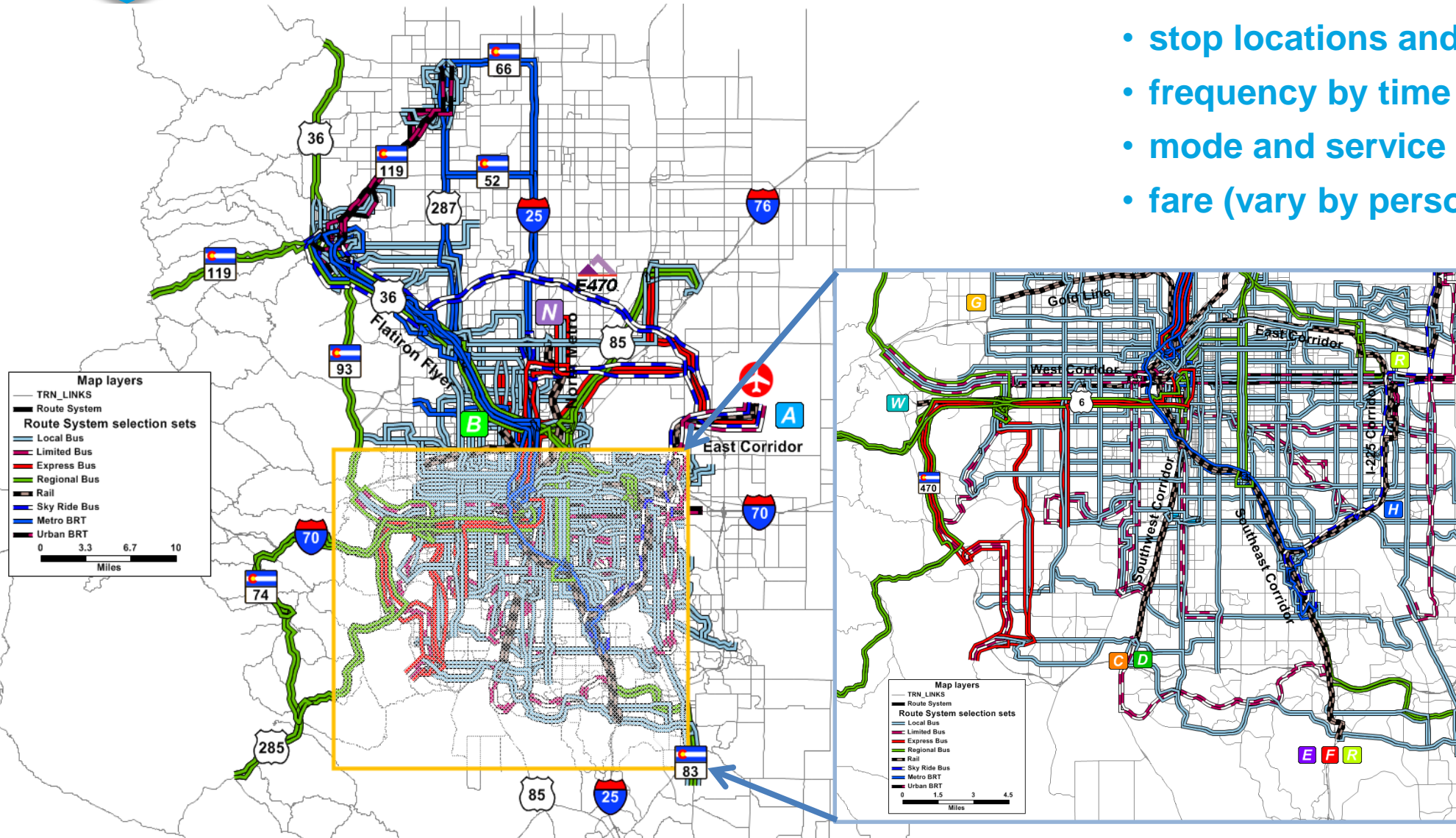
DECISIONS MODELED
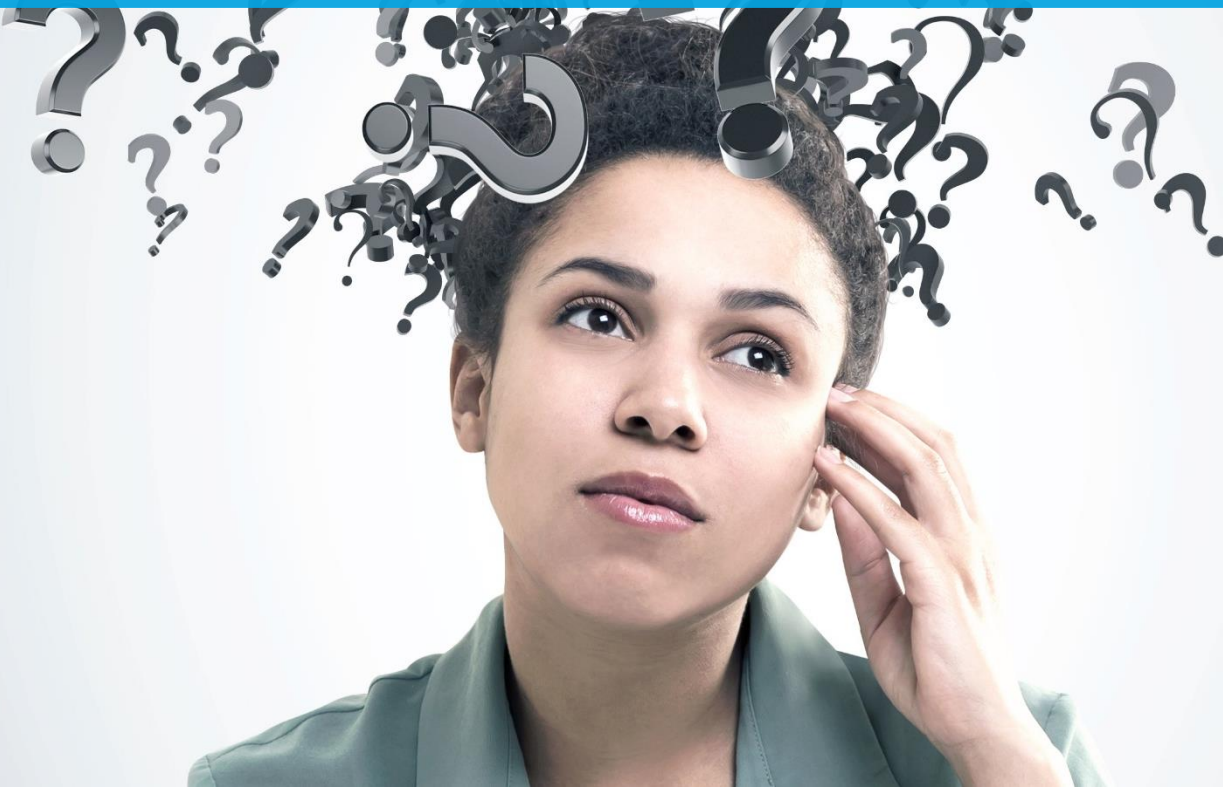
- **Regular workplace location**
  - At home or outside the home?
  - What type (sector) of employment
  - Which TAZ?
- **Regular school location – by grade/age**
- **Daily activity pattern**
  - For which purposes will tours, trips or stops be made?
- **Number of tours by purpose**

(!) **Choice model components are calibrated to 2010 household travel survey results**

- 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)*

35 MINUTES TO MARTHA'S VINEYARD
SORRY THE TRIP IS SO SHORT.
M.V. Island Queen
Falmouth, MA

Number of People that Work in Boulder
2006-2010 CTPP Census Data

City of Boulder
Residents that Work in Boulder
- 4 - 50
- 51 - 100
- 101 - 200
- 201 - 1155
- 0

Larimer County to Boulder: 2,520
Total Workers in Boulder: 93,750
# of Workers Who Are Residents of Boulder: 37,295; = 39.7%
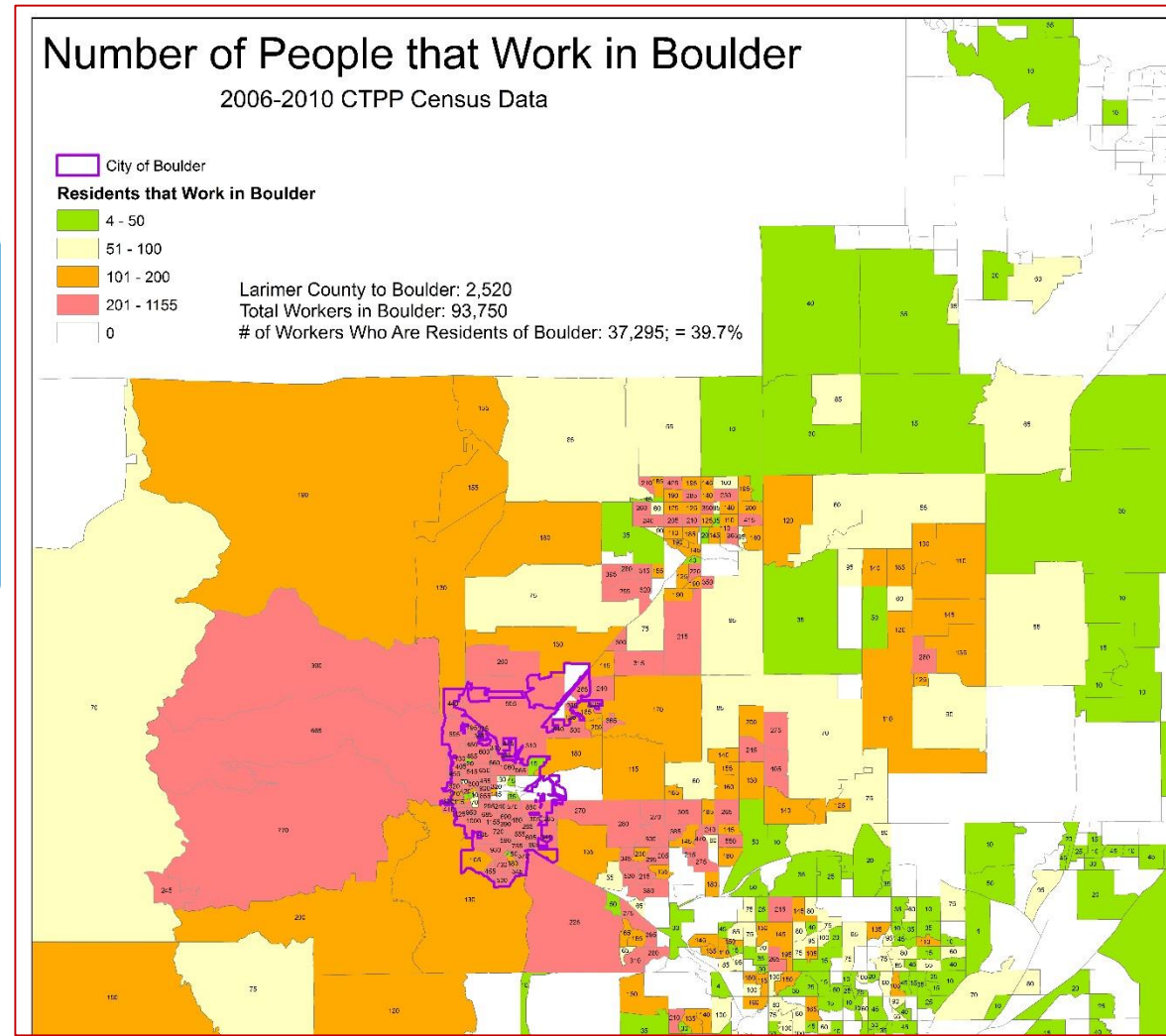
- **Destinations**
  - Regular workplace/school or somewhere else for work/school travel? (or stay home)
  - Specific locations

- **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 — Transit — Non-Motorized — School Bus

Auto: Drive Alone, Shared Ride 2, Shared Ride 3+

Transit: Walk to Transit, Drive to Transit

Non-Motorized: Walk, Bike

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

Not "Assigned"

- **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 <u>operating</u> speeds: Pedestrian – 3 mph;   Bicycle – 8 mph

    - Bicycle speed reflects legal cycling habits and terminal times at O & D
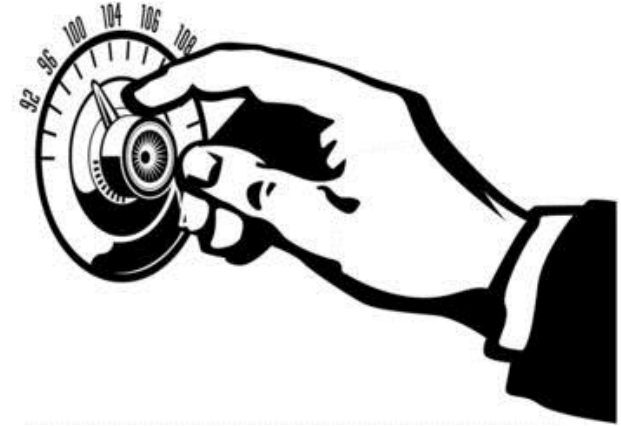
Note: Scooter trips are not calculated. Assumed to operate in either bicycle or pedestrian "mode."
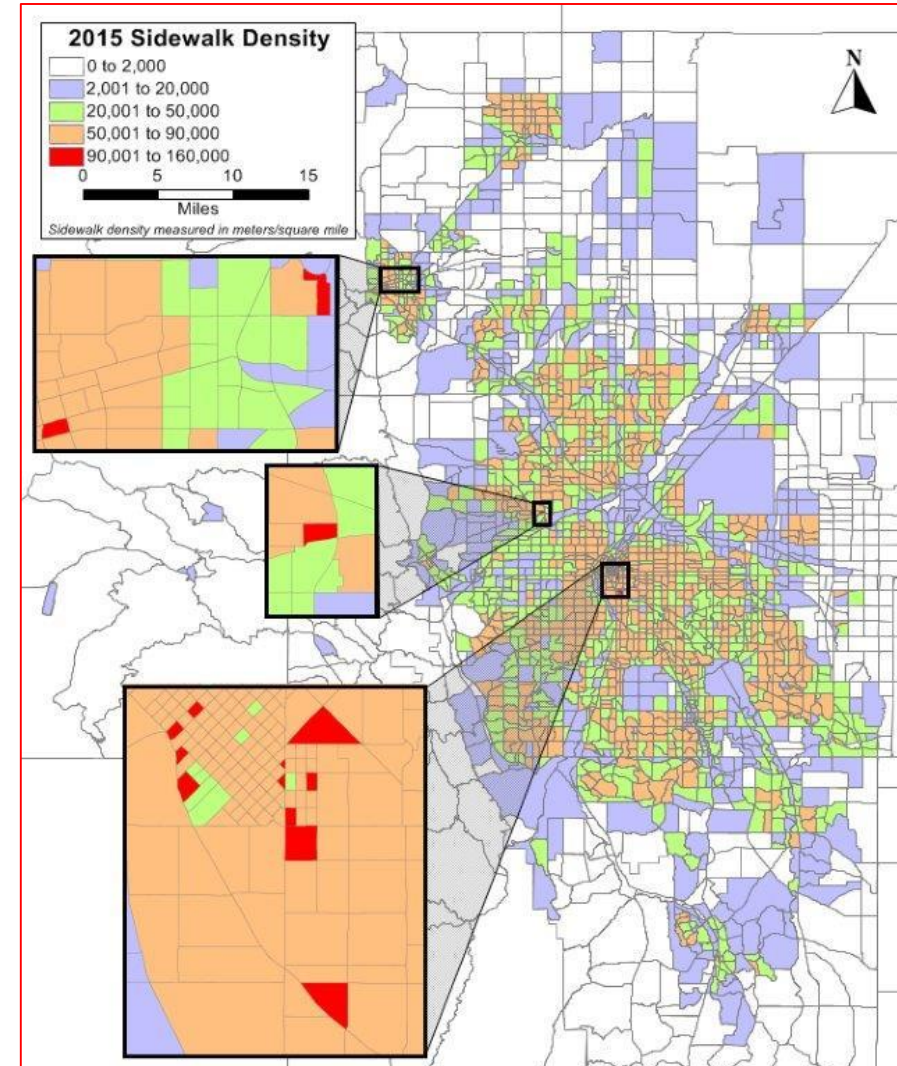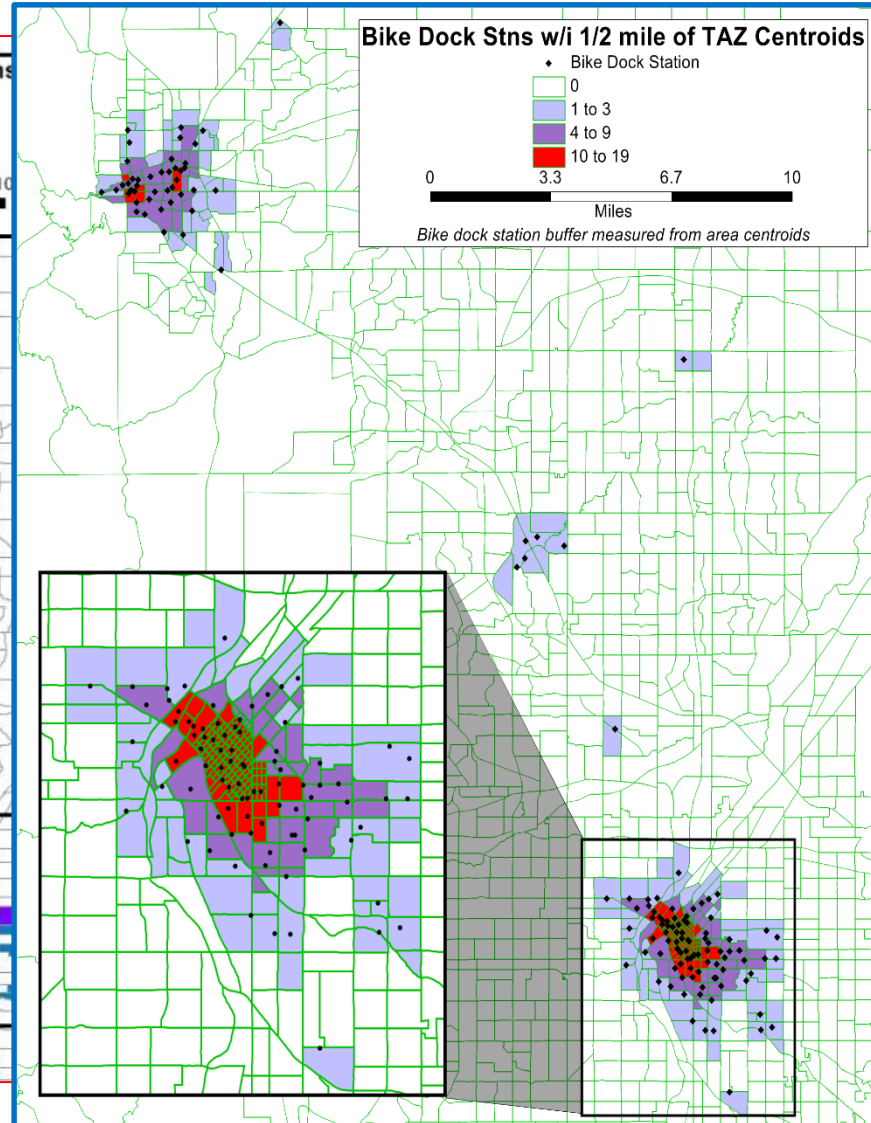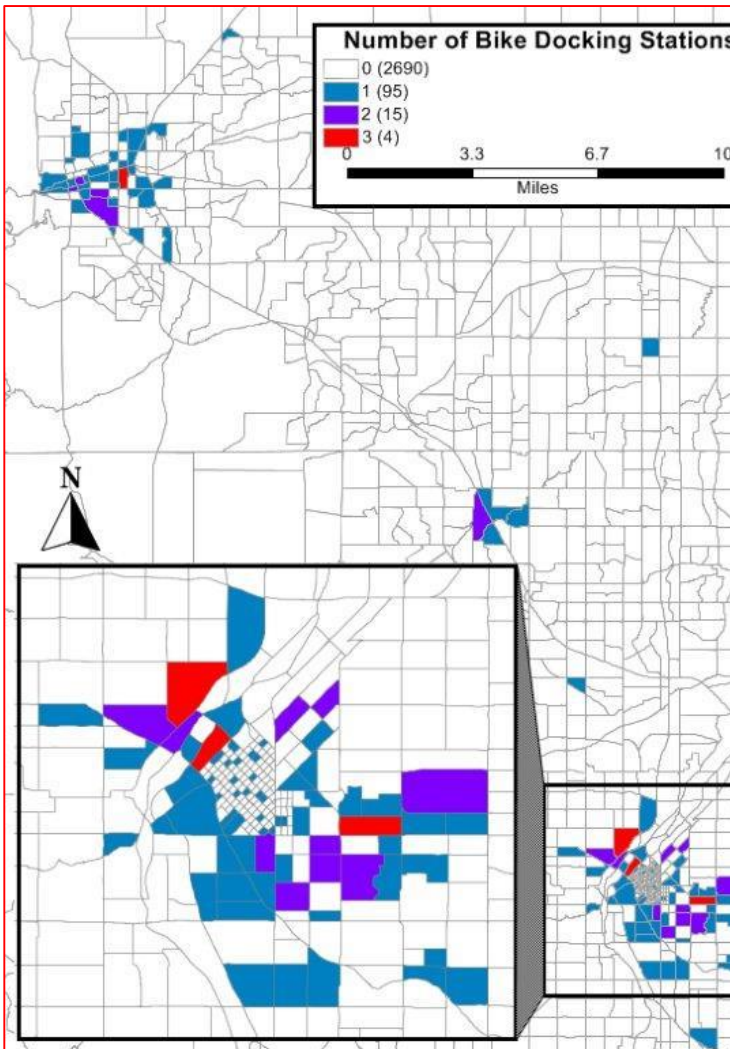
DRCOG Planimetrics

- **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

- **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

Littleton-Downtown
Park-n-Ride Patron Origins (Weekda

Legend
Major Roads
Highways
Park-n-Ride
Origin of PnR Patron
RTD Boundary
Drive Distance
Less than 1/2 mile
1/2 mile - 2 miles
2 - 5 miles
5 - 10 miles
10 - 20 miles
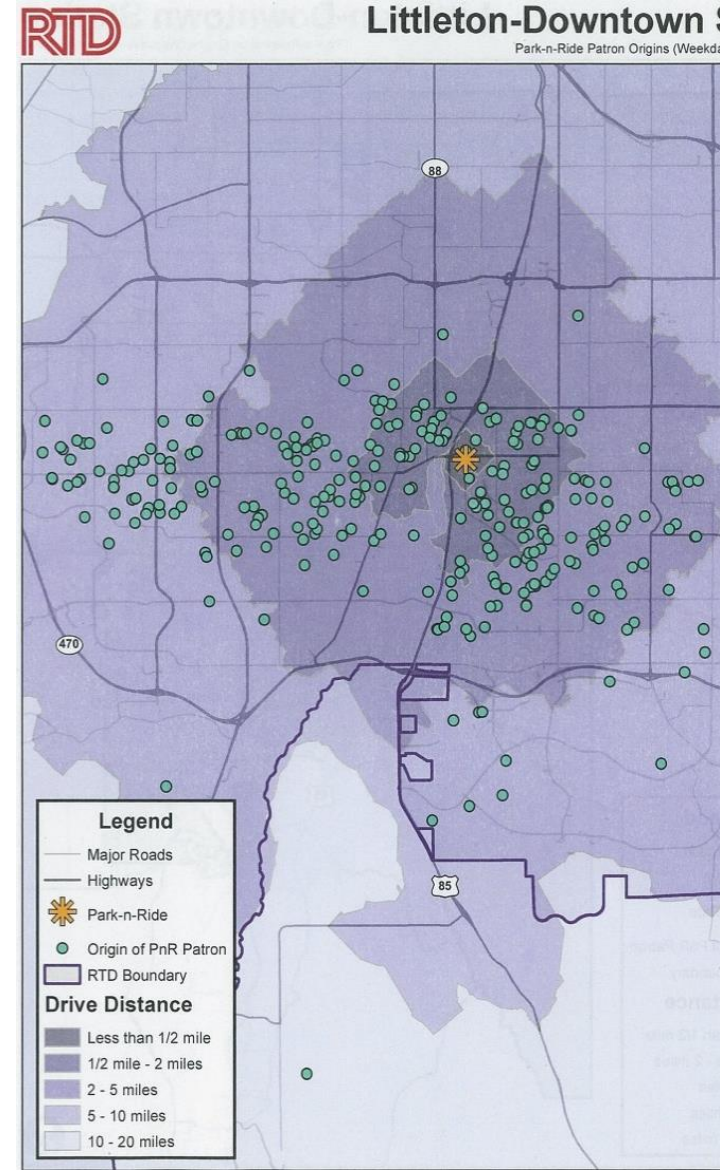
- **Os and Ds calculated with gravity model in TransCAD**

  - 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)

2015 CV Trip Origins
(Test - Iter18: 10/31/2018)

CV Trips
CV
0 - 500
501 - 1000
1001 - 2000
> 2001
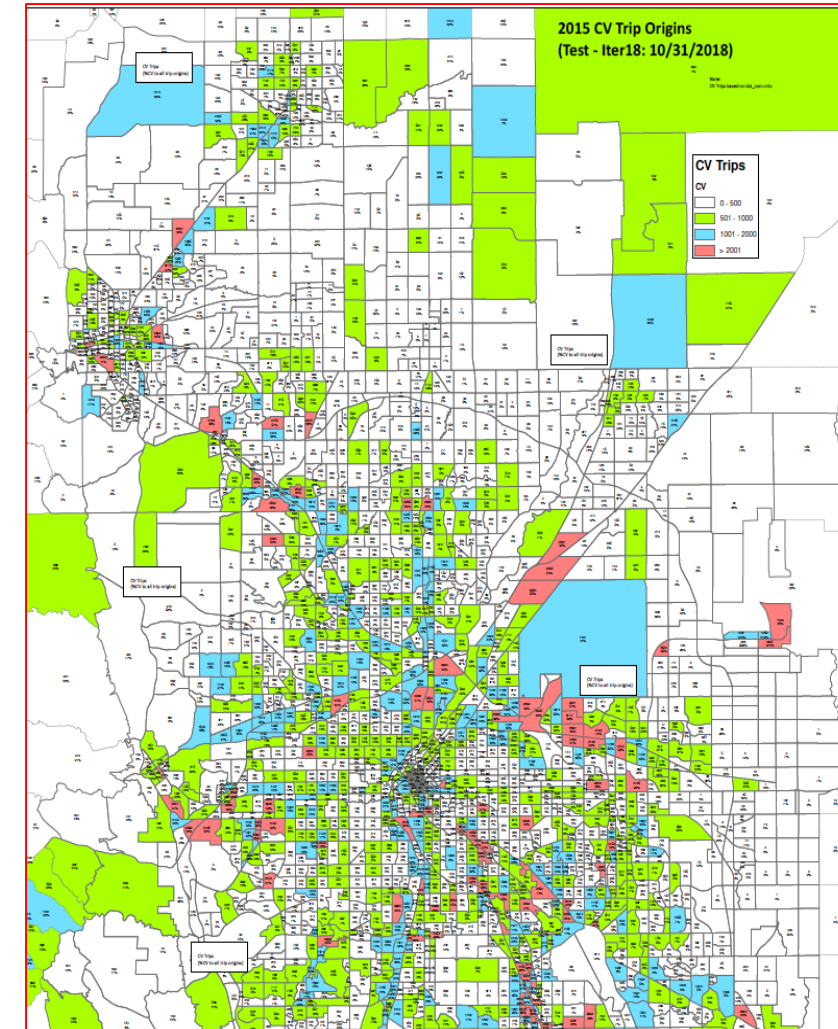
Sample O-D table: (auto, transit, walk, bicycle, CVs, external auto)

Sample Origin/Destination (O-D) Trip Table

"From" Origin TAZ #	"To" Destination TAZ #							Tot. Os
	1	**2**	**3**	**4**	**5**	**6-2831**	**2832**	
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

15,223

Intrazonal

- Trip Tables for each travel mode and time period
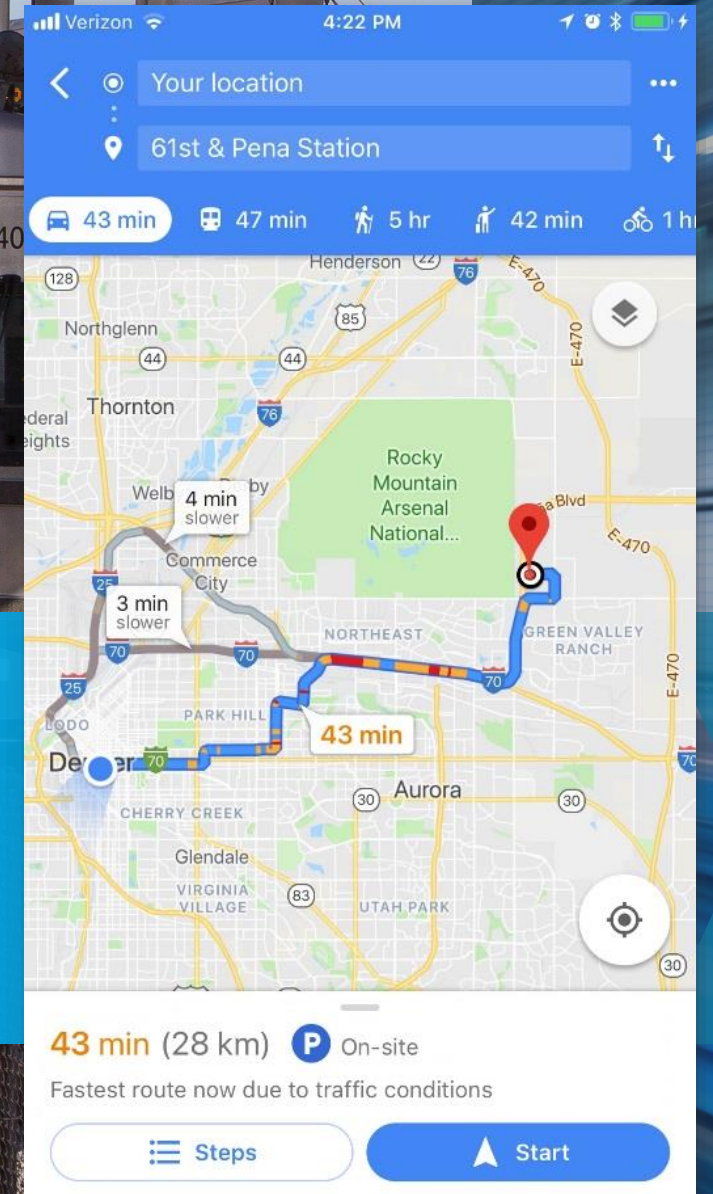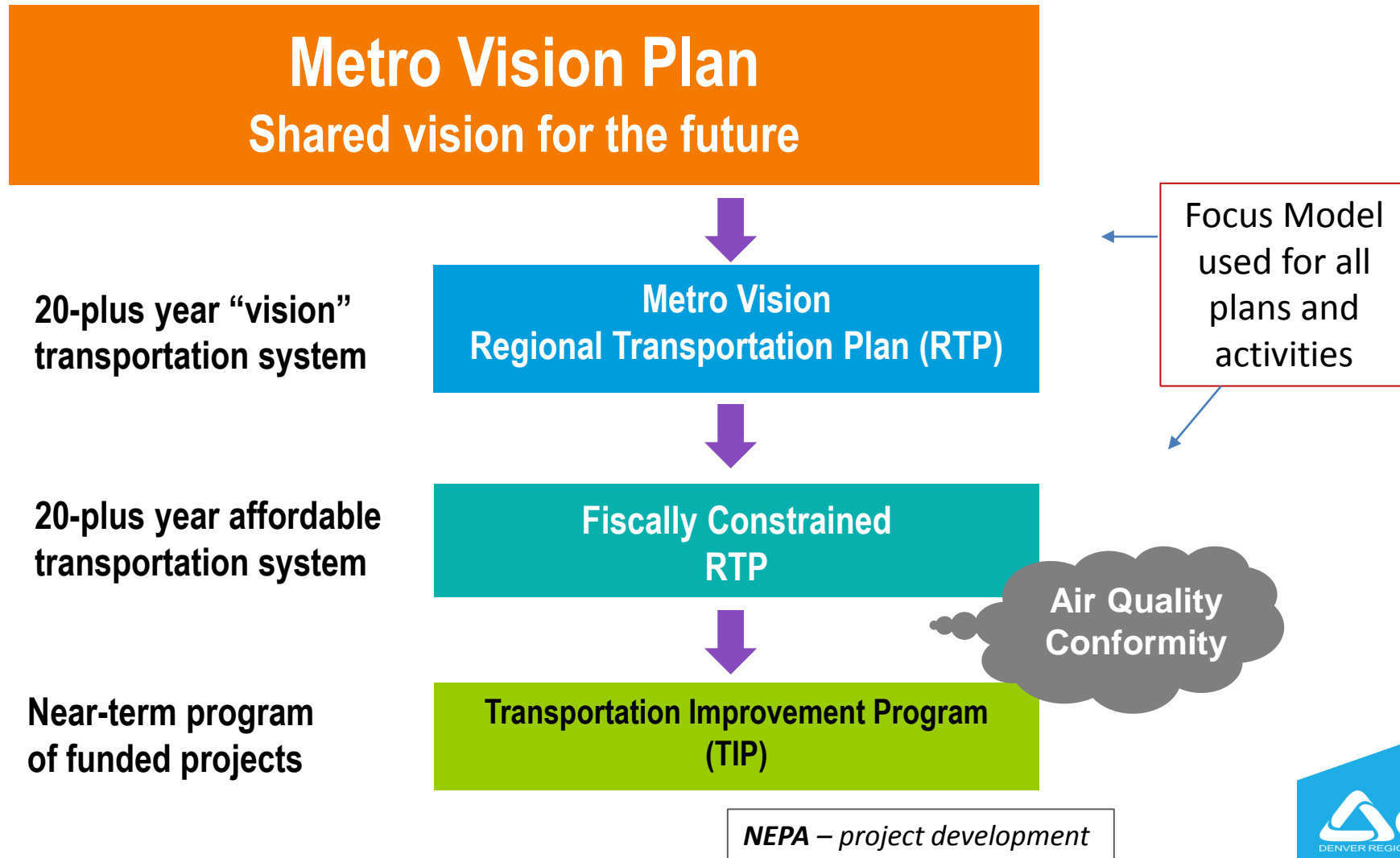
OUTPUTS & QUERIES

- **origins and destinations by TAZs (Int<u>ra</u>zonal and Int<u>er</u>zonal)**

- **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

Capital Hill/Cheeseman TAZ # 1503

- Pop. - 3,150, Jobs - 598
- Pop+Job density – 18,000/sq. mi.
- Avg./Median age – 38/31 (51% Age 18-34)
- Total Trip Os – 8,000
- Ped./Bicycle Trip Os – 2,800
- Transit Trip Os – 500
- Mot. Veh. Trip Os – 3,500
- CV Trip Os - 530

Littleton/Centennial TAZ # 2190

- Pop. - 3,190, Jobs - 500
- Pop+Job density – 5,000/sq. mi.
- Avg./Median age – 42/44 (13% Age 18-34)
- Total Trip Os – 8,000
- Ped./Bicycle Trip Os - 570
- Transit Trip Os – 180
- Mot. Veh. Trip Os – 5,000
- CV Trip Os - 651
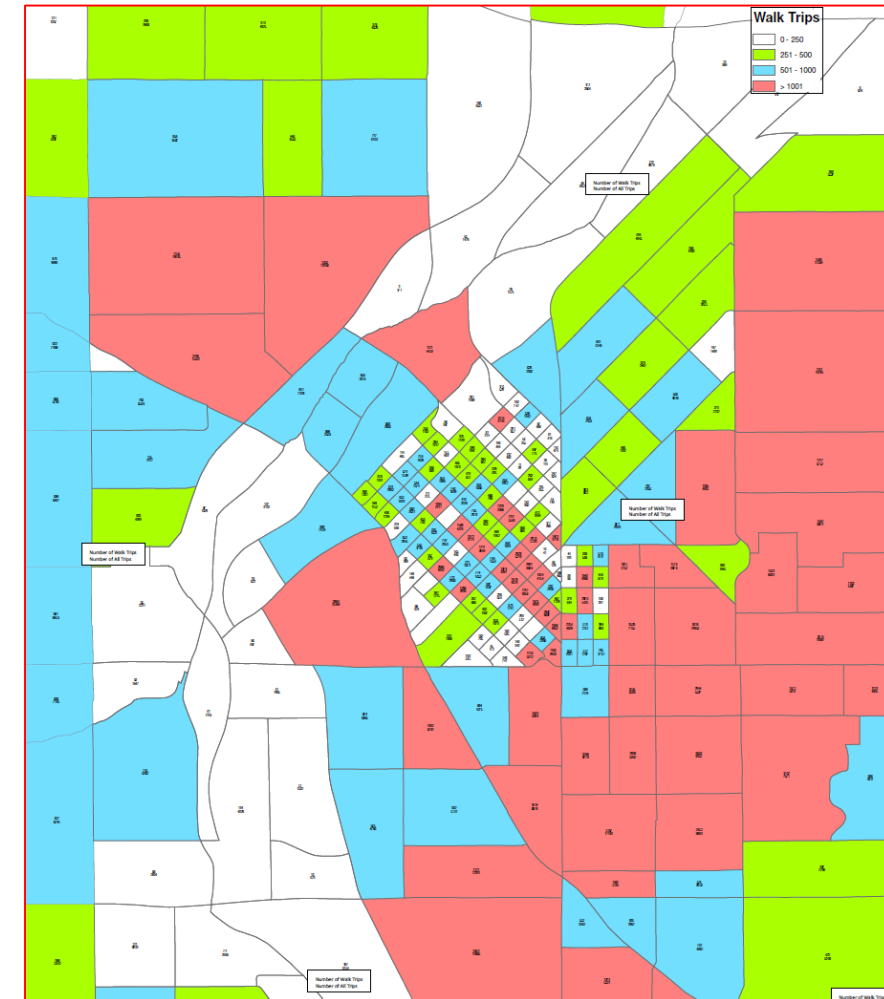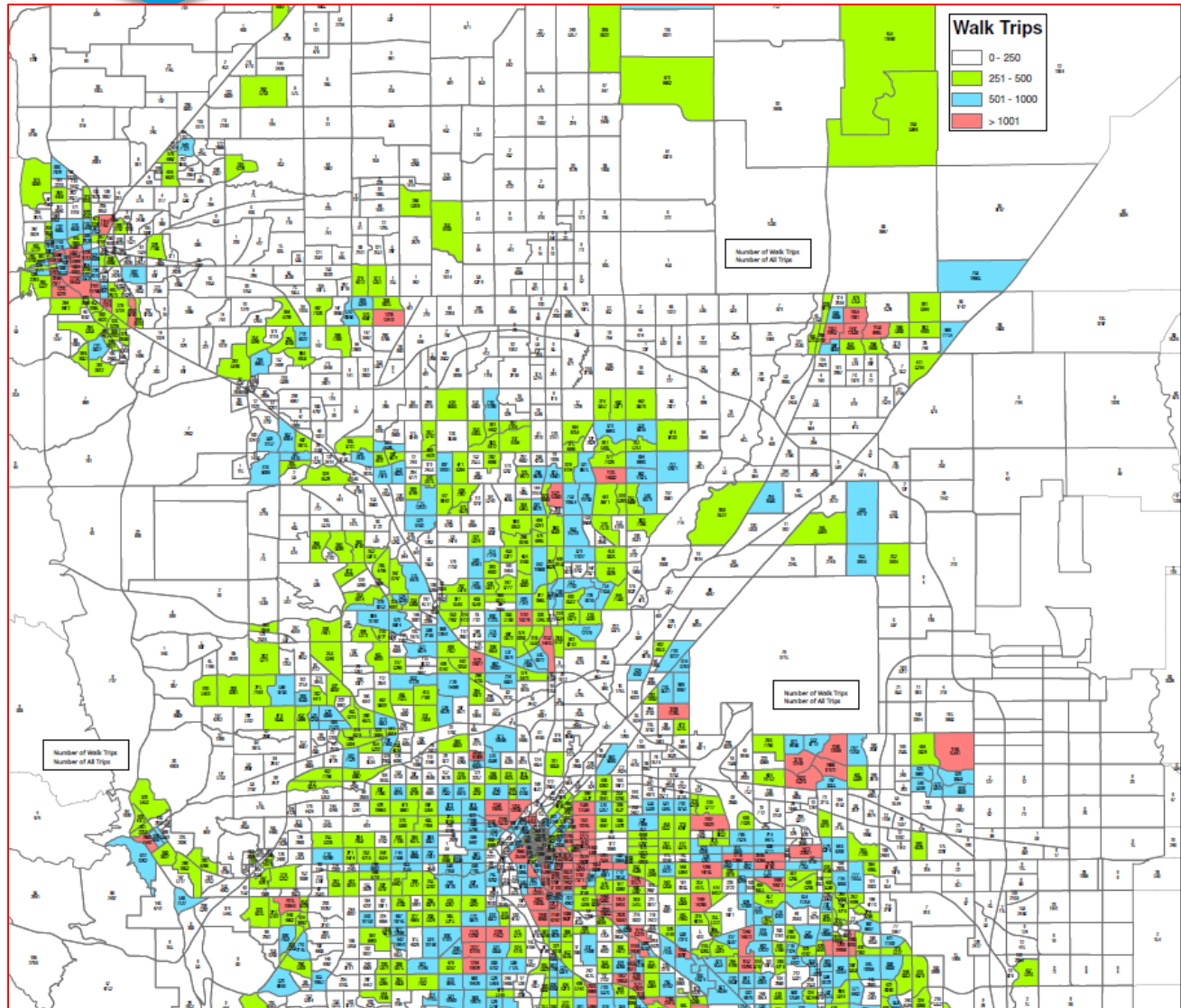
- **link <u>daily</u> traffic volumes (x)**
- **person/vehicle miles traveled (P/VMT)**
- **vehicle and person hours of delay**
- **who uses specific roads?**
  - "select link" analyses
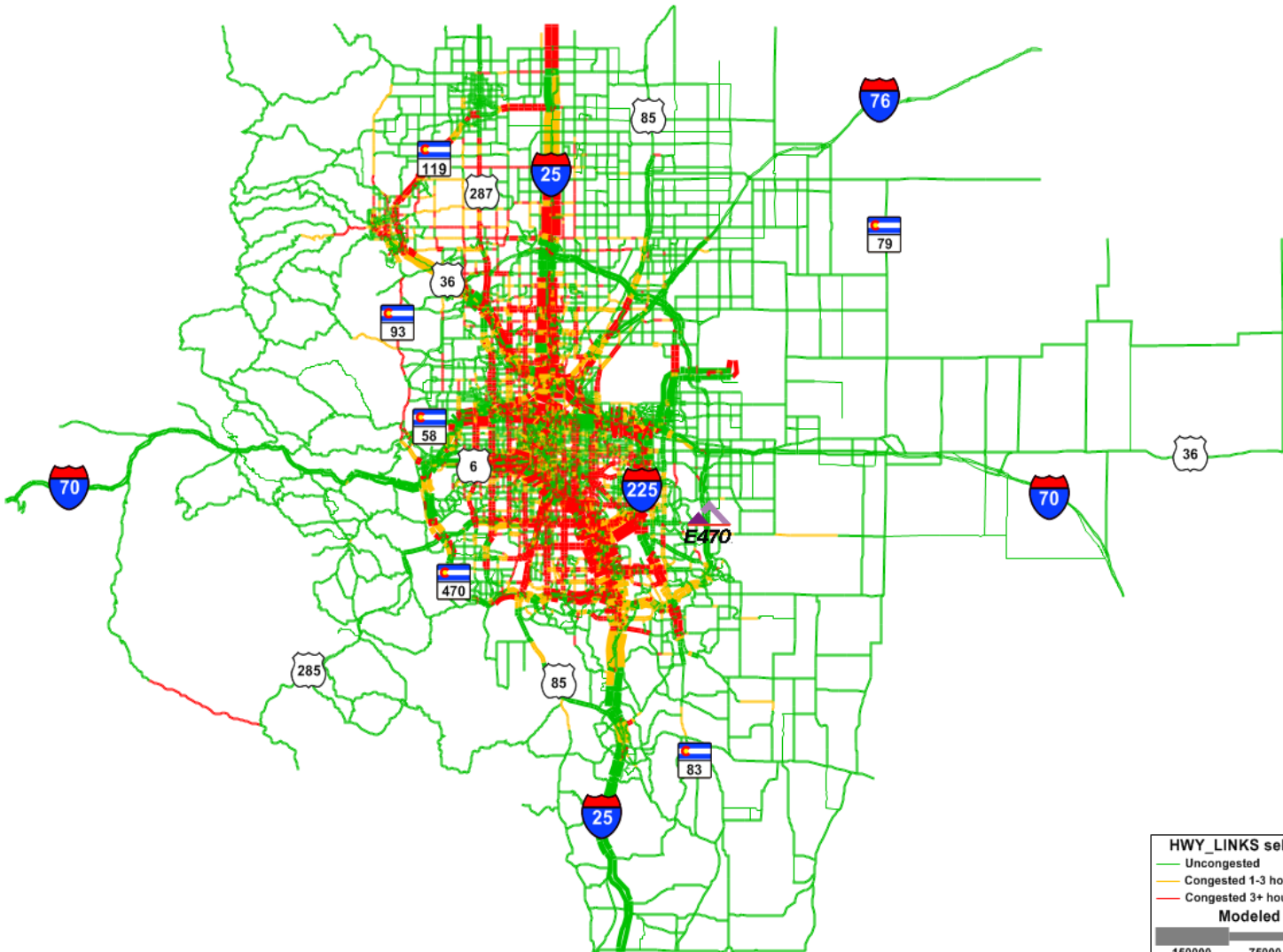
(x) - Example traffic volumes (pass by <u>one point</u>):
- **I-25:** 300,000 vehicles (= 420,000 people)
- **Colorado Blvd.:** 60,000 vehicles (= 84,000 people)
- **17th St**.: 10,000 vehicles (includes ~300 buses) (= 20,000 people)

HWY_LINKS selection sets
— Uncongested
— Congested 1-3 hours
— Congested 3+ hours
Modeled ADT

| 150000 | 75000 | 37500 |
| 0 | 5 | 10 | 15 |

Miles
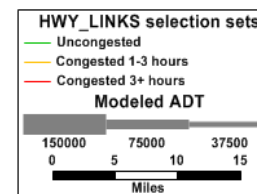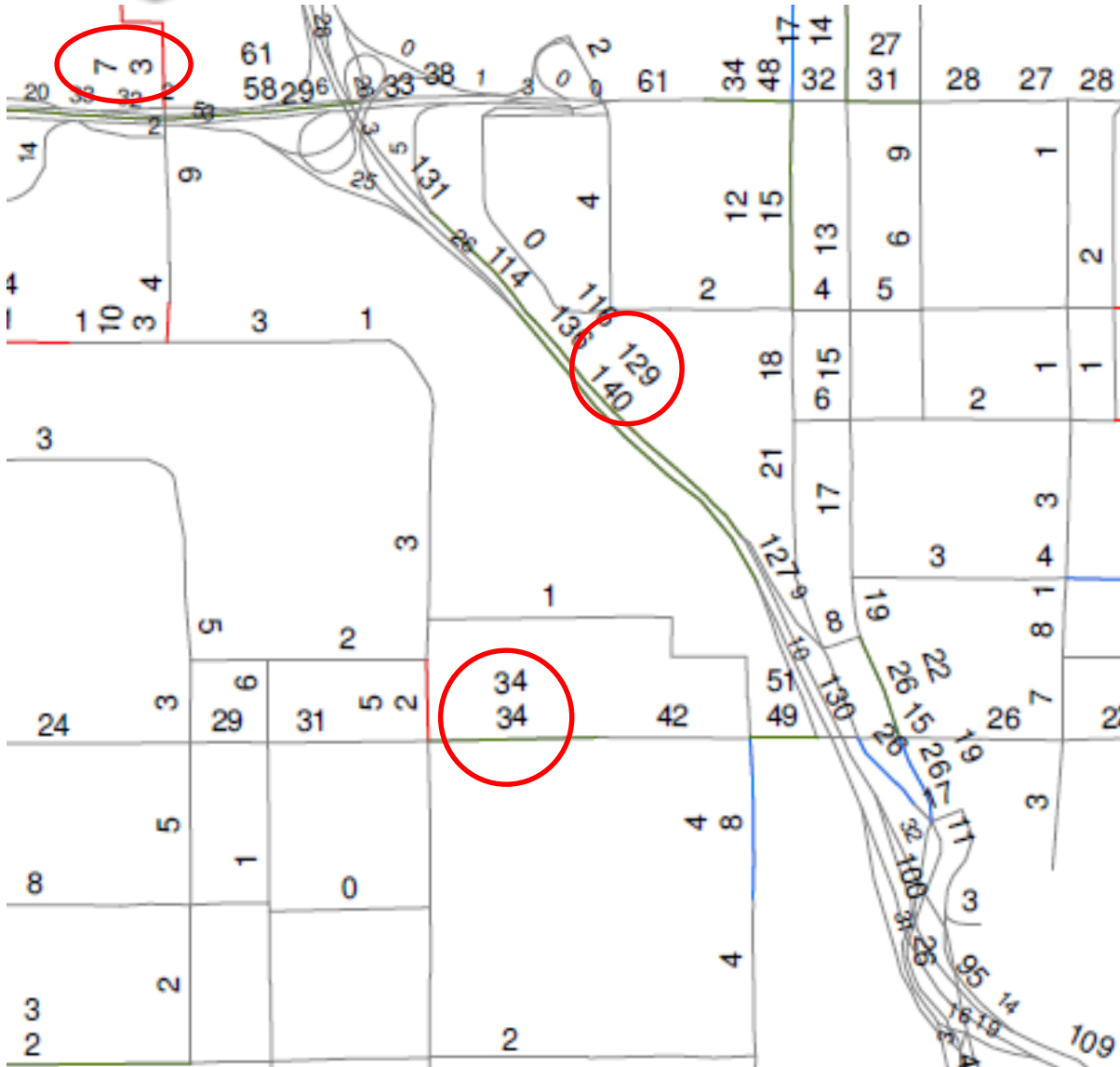
- Examples (1,000s/day):
  - Bryant St.: traffic count 7k; model 3k
  - I-25 nb: traffic count 129k; model 140k
  - Alameda Ave.: traffic count 34k; model 34k !
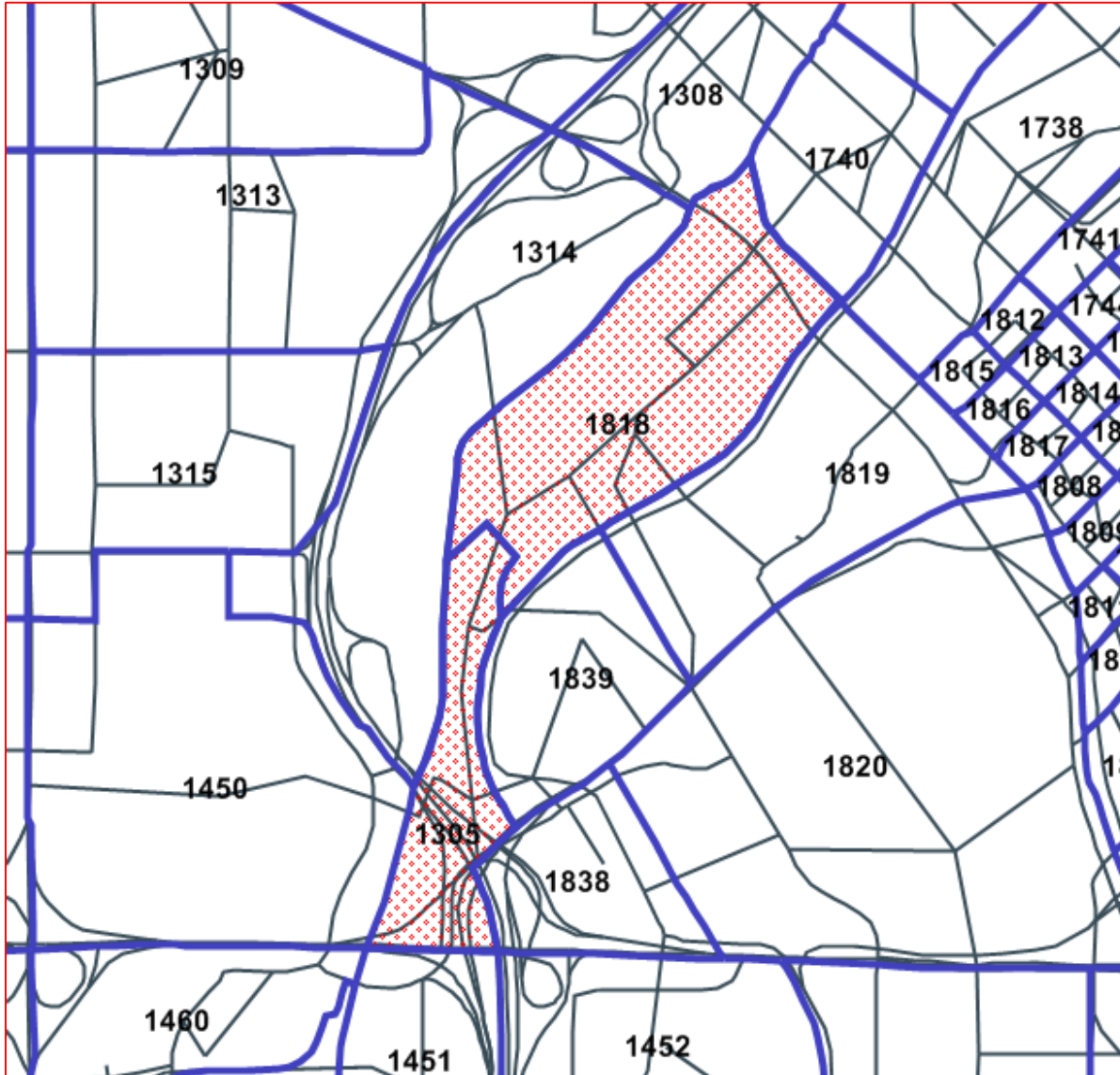
  (Average occupancy = 1.4 persons)
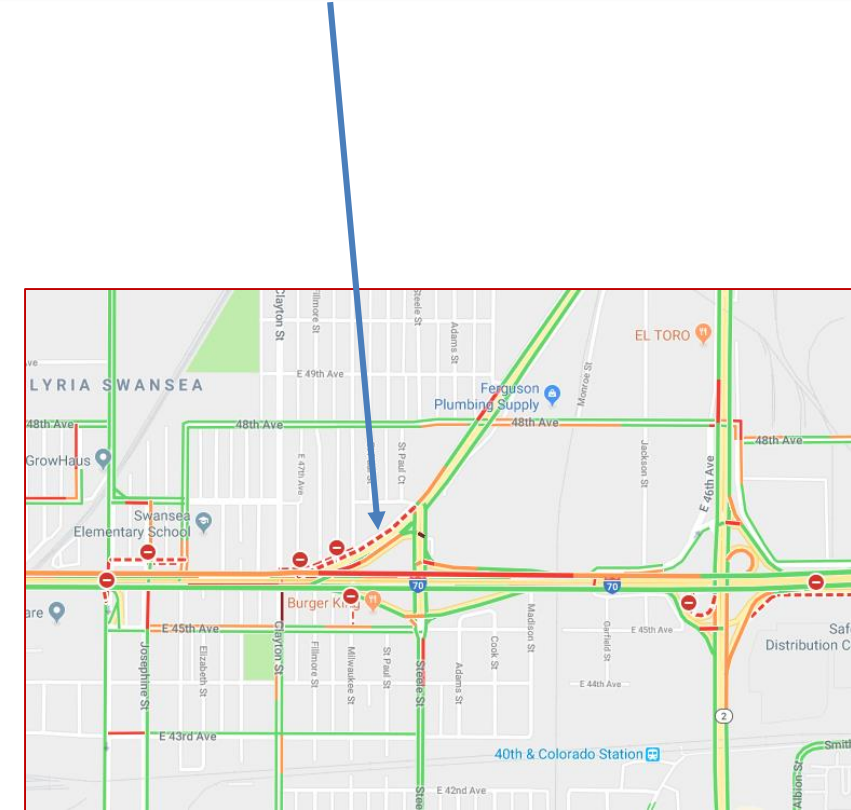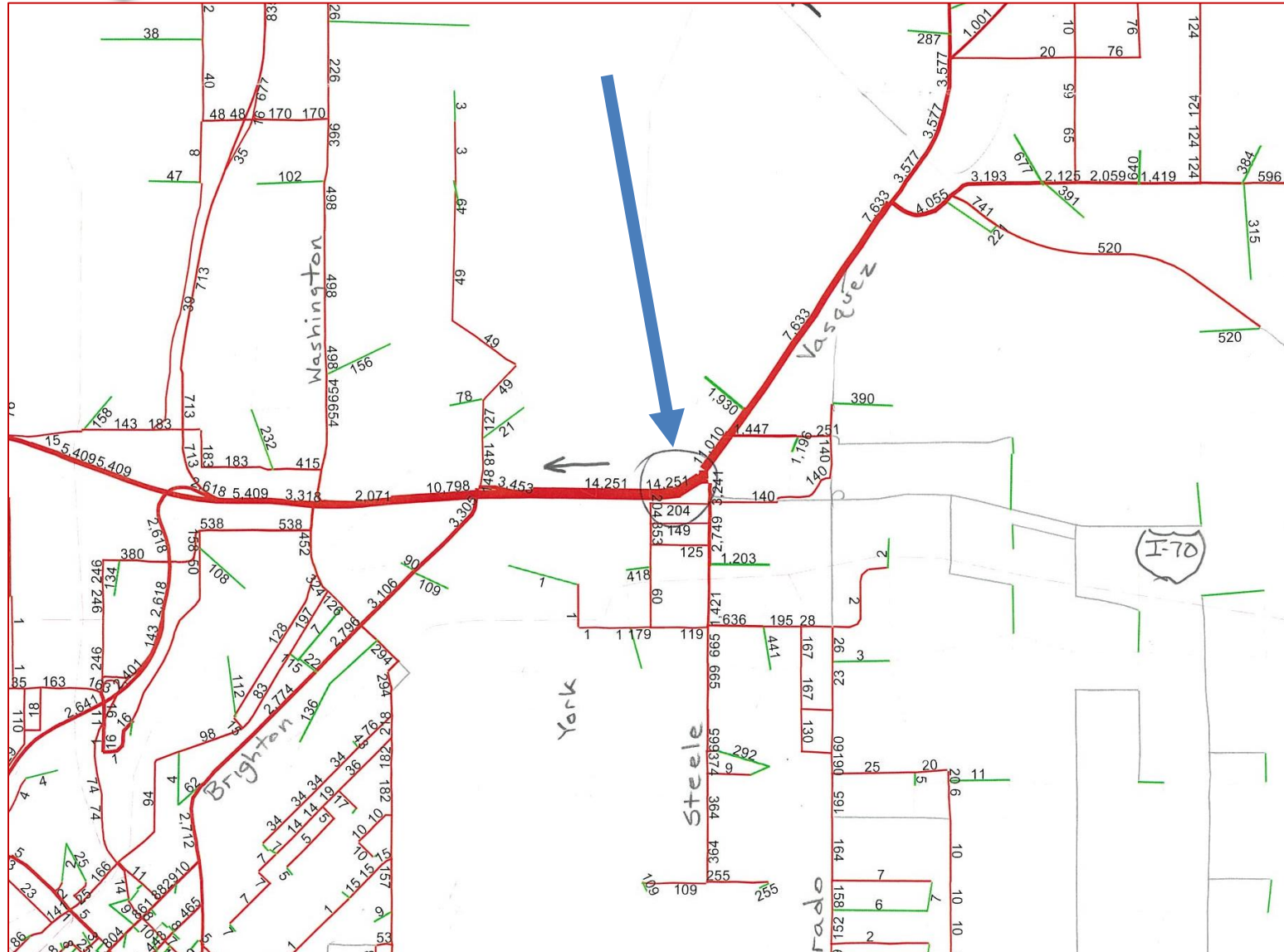
DRCOG 2040 RTP

Zone	HHs	Jobs
1818	0	991

River Mile Analysis – additional growth

Zone	HHs	Jobs
1818	7,654	37,819
1305	1,260	2,190
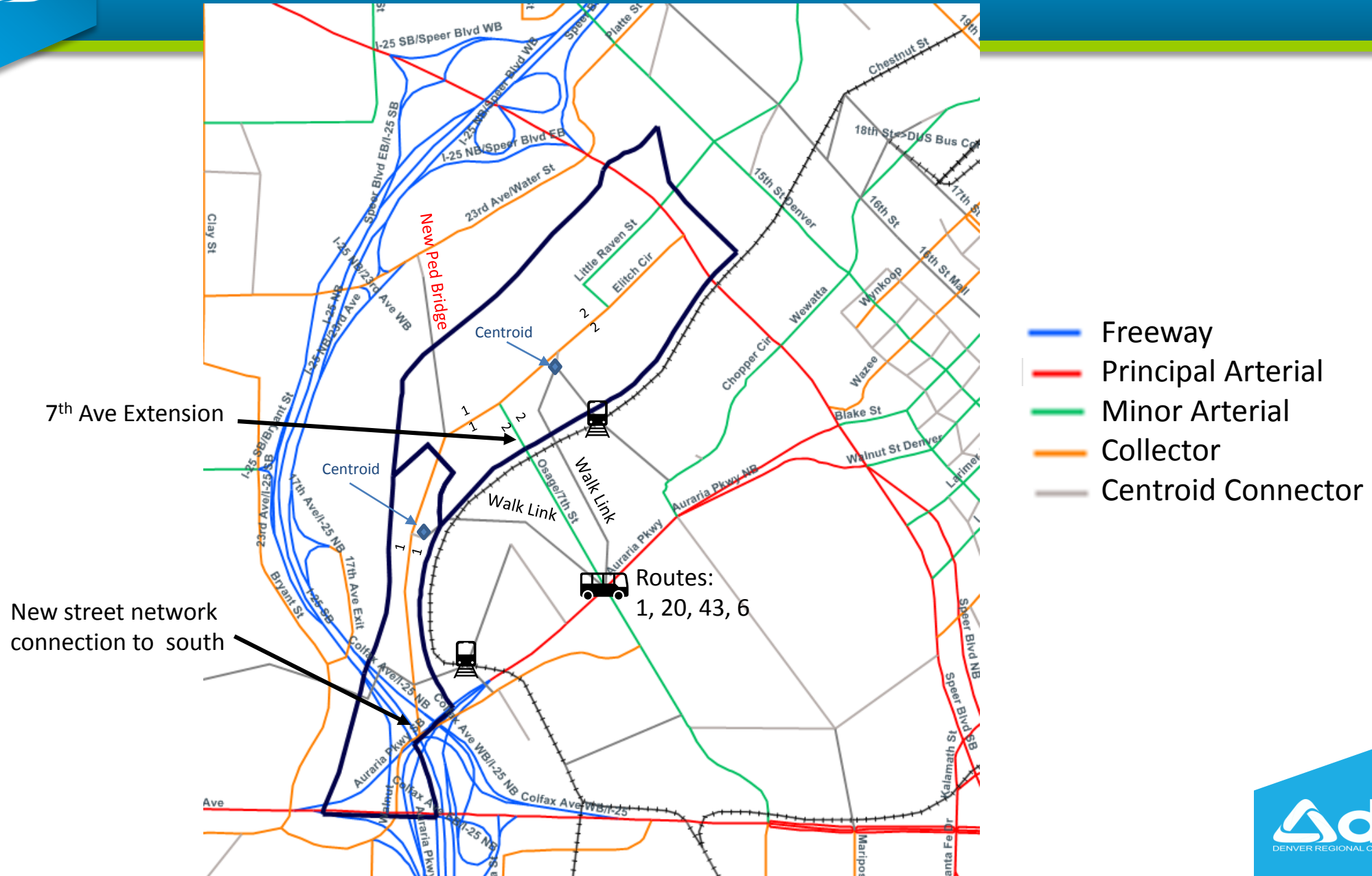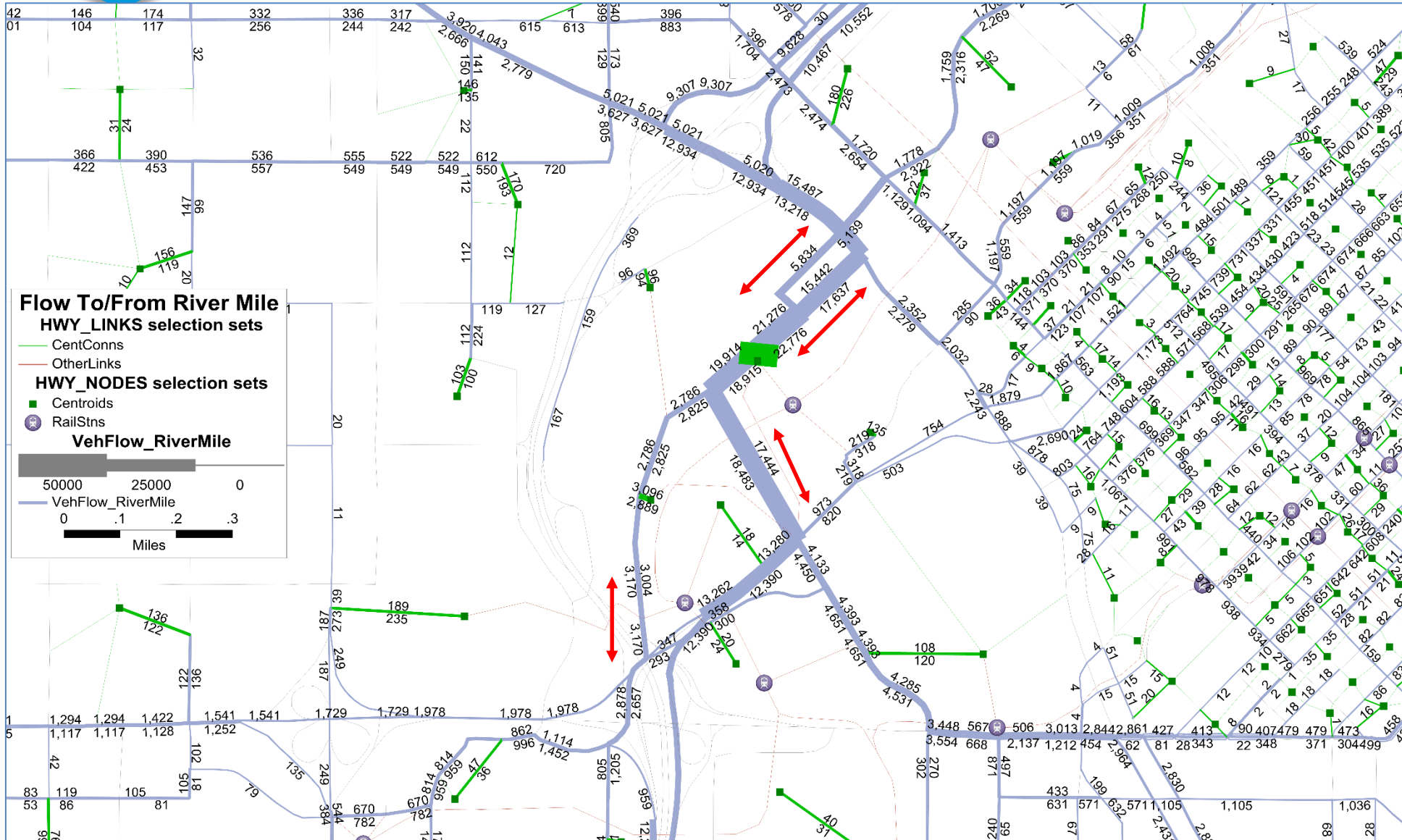
Traffic Changes:
- Diversion
- Regional Growth
- Induced
- Latent

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
    - 0/0L – 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

- How much will traffic volume, transit ridership, or bicycle & pedestrian travel modes <u>change</u> 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?

- 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)

- . . . .

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 <u>change</u> 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!

- 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?

drcog
DENVER REGIONAL COUNCIL OF GOVERNMENTS