CAMBRIDGE SYSTEMATICS

Think Forward

District Modeling Support

Kick-Off Meeting

presented to

District 8 Staff

presented by

Cambridge Systematics, Inc.

Ron West & Sean McAtee

January 28, 2016

Morning Agenda

- About our team
- Modeling basics
  - Opening the black box
  - Example applications
- Travel model 

- Modeling at District 8
  - Discussion with managers and modelers

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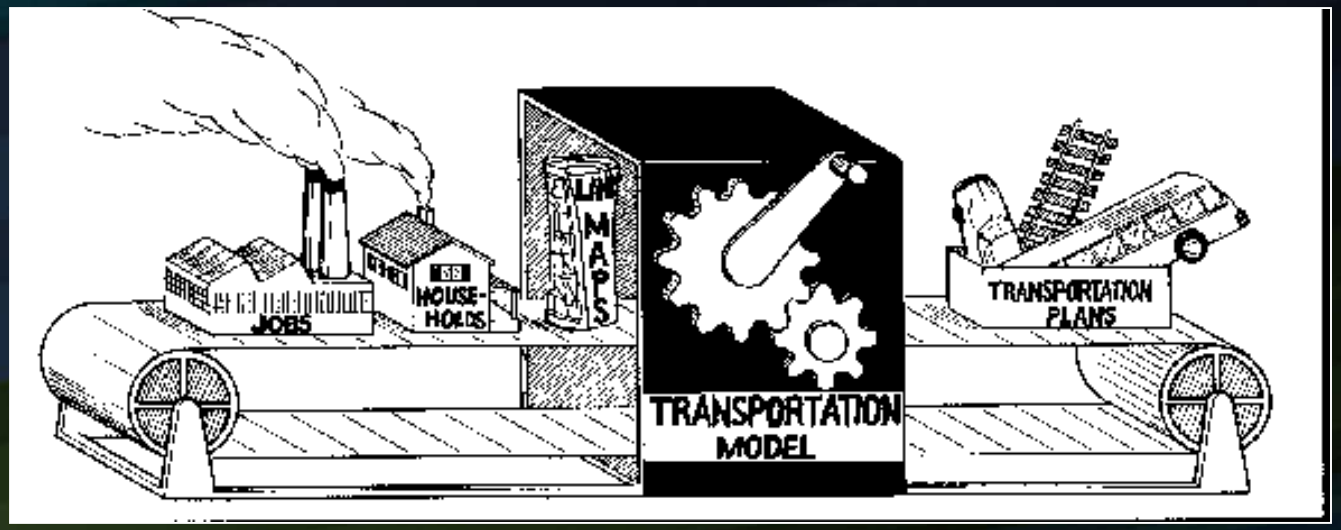
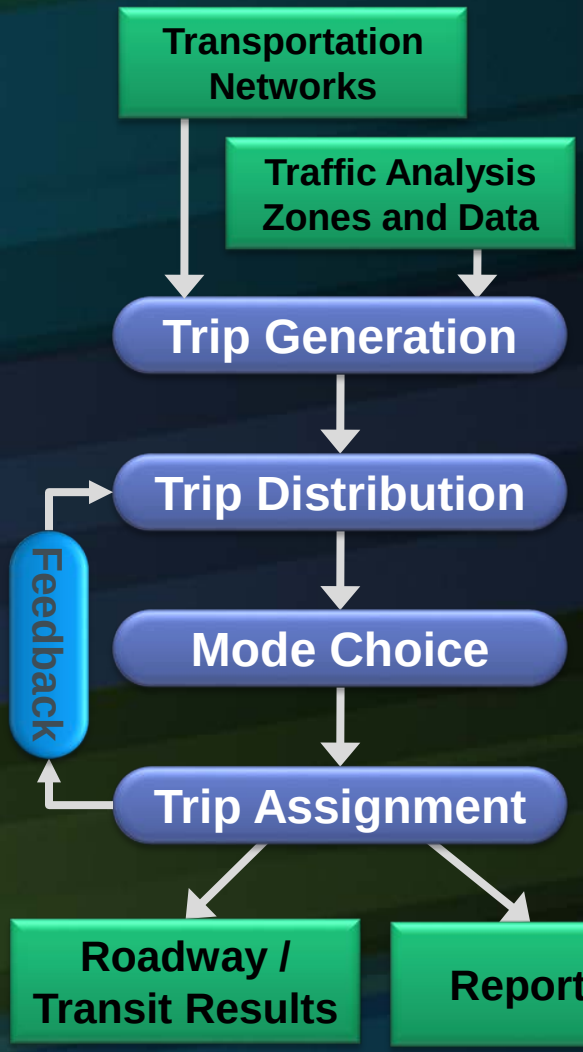
Task Order Team

Travel Modeling Basics

Opening the Black Box



The Four Steps



Transportation Supply

Transportation Demand

How many trips?

Where will they go?

What mode?

What route?

Forecasts

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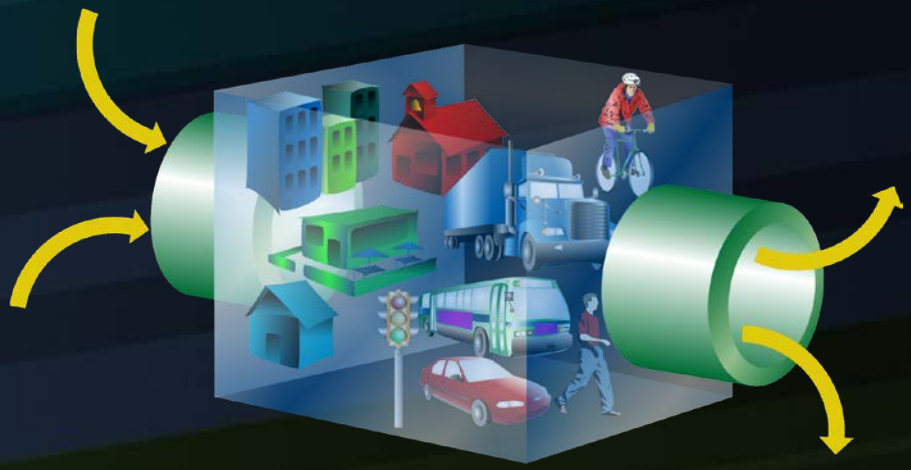
Model Inputs and Outputs

Inputs

- Transportation Networks
- Socioeconomic Data
- External Data
- Special Generators
- Model Parameters



Outputs

- Trips by Mode
- Traffic Volumes
- Congested Speeds
- Transit Volumes
- Summary Information

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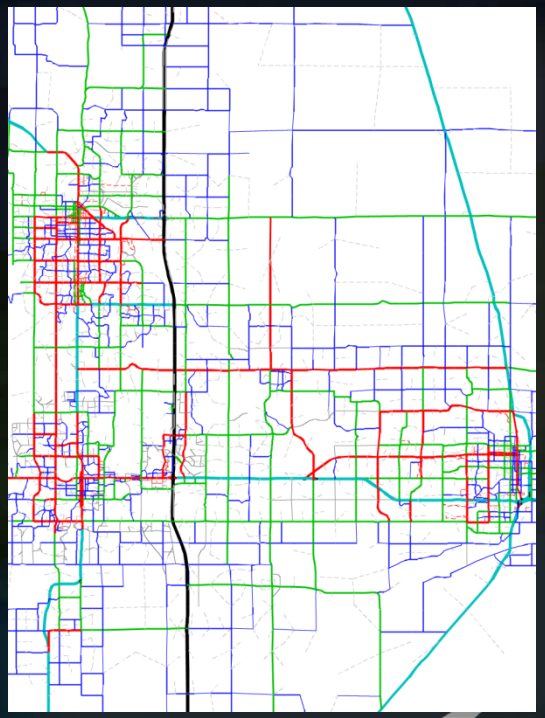
Model Inputs and Outputs

Inputs

- **Transportation Networks**
- Socioeconomic Data
- External Data
- Special Generators
- Model Parameters

- Roadway Networks
  - » Contains roadway characteristics
    - – Number of Lanes
    - – Roadway Type (Freeway, arterial, etc.)
    - – Area Type (CBD, Urban, Suburban, Rural)
- Transit Networks
  - » All fixed route transit service
  - » The model is sensitive to transit level of service (frequency, speed, coverage)
  - » Local/Express Bus, BRT, Rail



Model Inputs and Outputs

Inputs

- Transportation Networks
- **Socioeconomic Data**
- External Data
- Special Generators
- Model Parameters

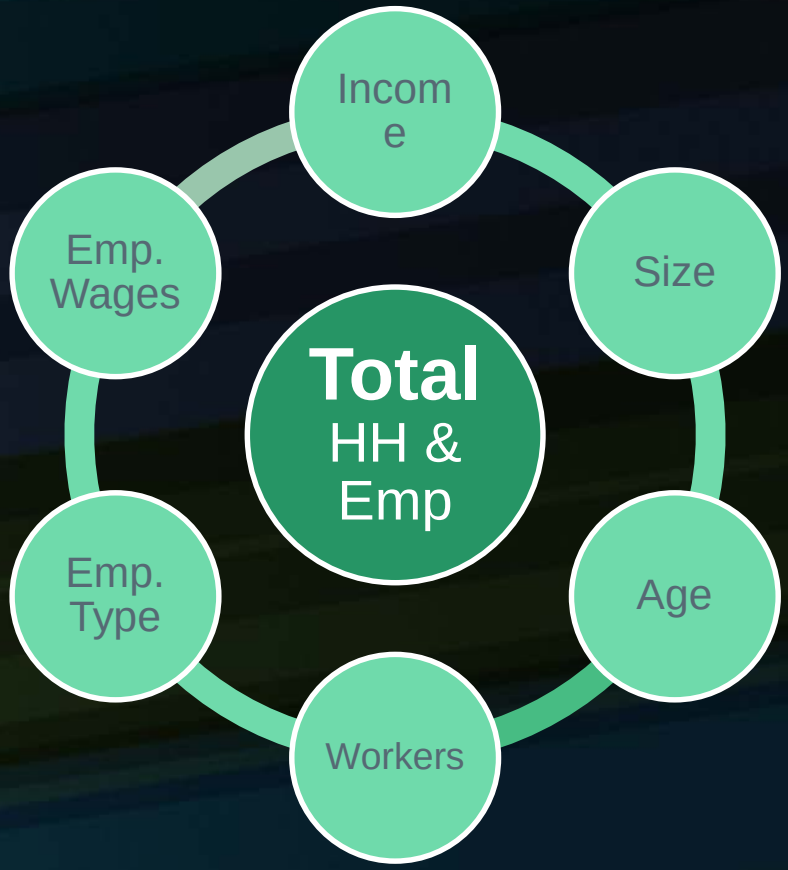
- Identifies **demand** for travel
- Household data
  - Average household **size**
  - Median household **income**
  - Number of resident **workers**
  - **Age** of household residents
  - And more…
- Employment data
  - By 13 industries
  - By Wage level

Model Inputs and Outputs

Inputs

- Transportation Networks
- **Socioeconomic Data**
- External Data
- Special Generators
- Model Parameters

- How Much Detail is Needed for scenario testing?
  - » Only totals are required



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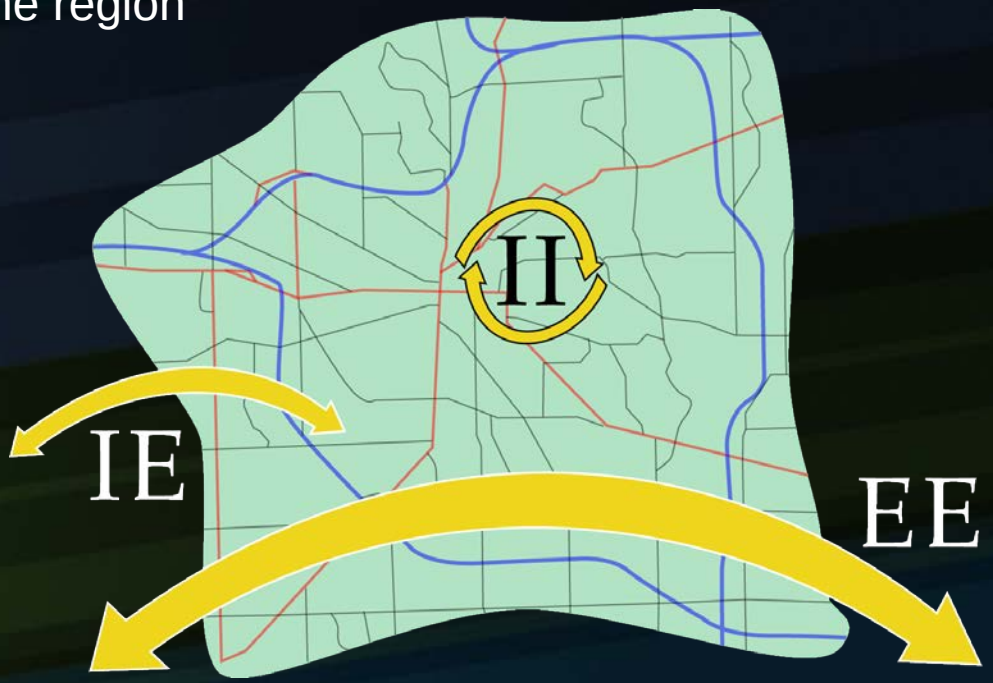
Model Inputs and Outputs

Inputs

- Transportation Networks
- Socioeconomic Data
- **External Data**
- Special Generators
- Model Parameters

- Model travel:
  - To/from the region
  - Through the region



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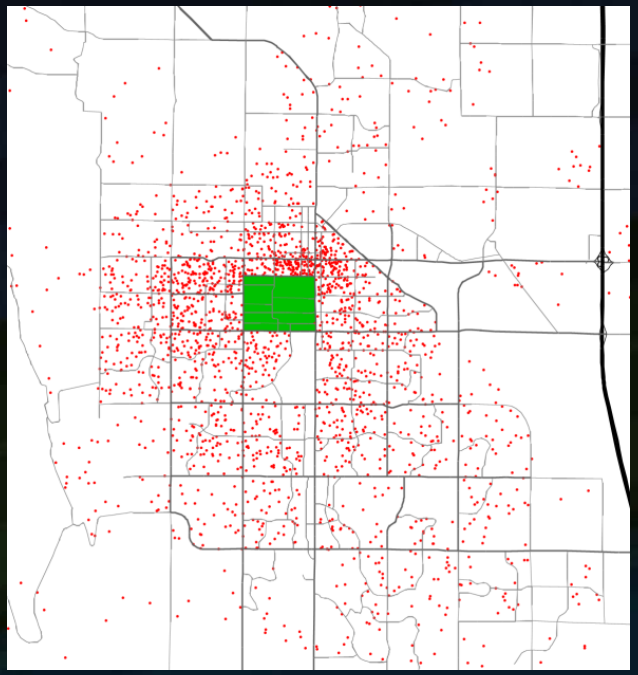
Model Inputs and Outputs

Inputs

- Transportation Networks
- Socioeconomic Data
- External Data
- **Special Generators**
- Model Parameters

- Unique locations not well represented by employment data
  - SCAG's Special Generators:
    - Ports
    - Airports
  - Potential Additional:
    - Large Warehouses
    - Specific study areas



Model Inputs and Outputs

Inputs

- Transportation Networks
- Socioeconomic Data
- External Data
- Special Generators
- **Model Parameters**

- Represent the way people behave
  - How many trips are made?
  - How far will people travel?
  - What impacts decisions about travel mode?
  - How does congestion impact travel?
- Source Data
  - SCAG / Caltrans Household Travel Survey
  - On-Board Transit Surveys
  - Speed Surveys
  - Big Data
  - Validated to traffic counts

Model Inputs and Outputs

- Information about each trip
  - » Start/end
  - » Time of day
  - » Mode of travel
  - » Purpose of trip
  - » Trip time and distance

Outputs

- **Trips by Mode**
- Traffic Volumes
- Congested Speeds
- Transit Volumes
- Summary Information

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Model Inputs and Outputs

- By Time of Day
  - » Daily
  - » AM, PM, Mid-Day, Evening, Night
  - » AM and PM Peak Hours
- Turn Movements
  - » Better estimated with assistance of base-year counts
- Congested speed based on volume

Outputs

- Trips by Mode
- **Traffic Volumes**
- **Congested Speeds**
- Transit Volumes
- Summary Information

Model Inputs and Outputs

- By Time of Day
  - » Peak and Off-Peak
  - » Daily sum
- By route or route group
  - » Also by stop, but with less accuracy
- Useful for Big-Picture transit analysis
  - » Detailed analysis requires localized model refinement
- Transit trips are removed from the highway network

Outputs

- Trips by Mode
- Traffic Volumes
- Congested Speeds
- **Transit Volumes**
- Summary Information

Model Inputs and Outputs

- Performance Report
  - » Summaries of model results
  - » Useful for planners and engineers
- Planning Tools
  - » Maps and charts
  - » Results presented for general understanding
    - – VMT, VHT, Delay
    - – Level of Service
    - – Trip Lengths
    - – Trip Patterns

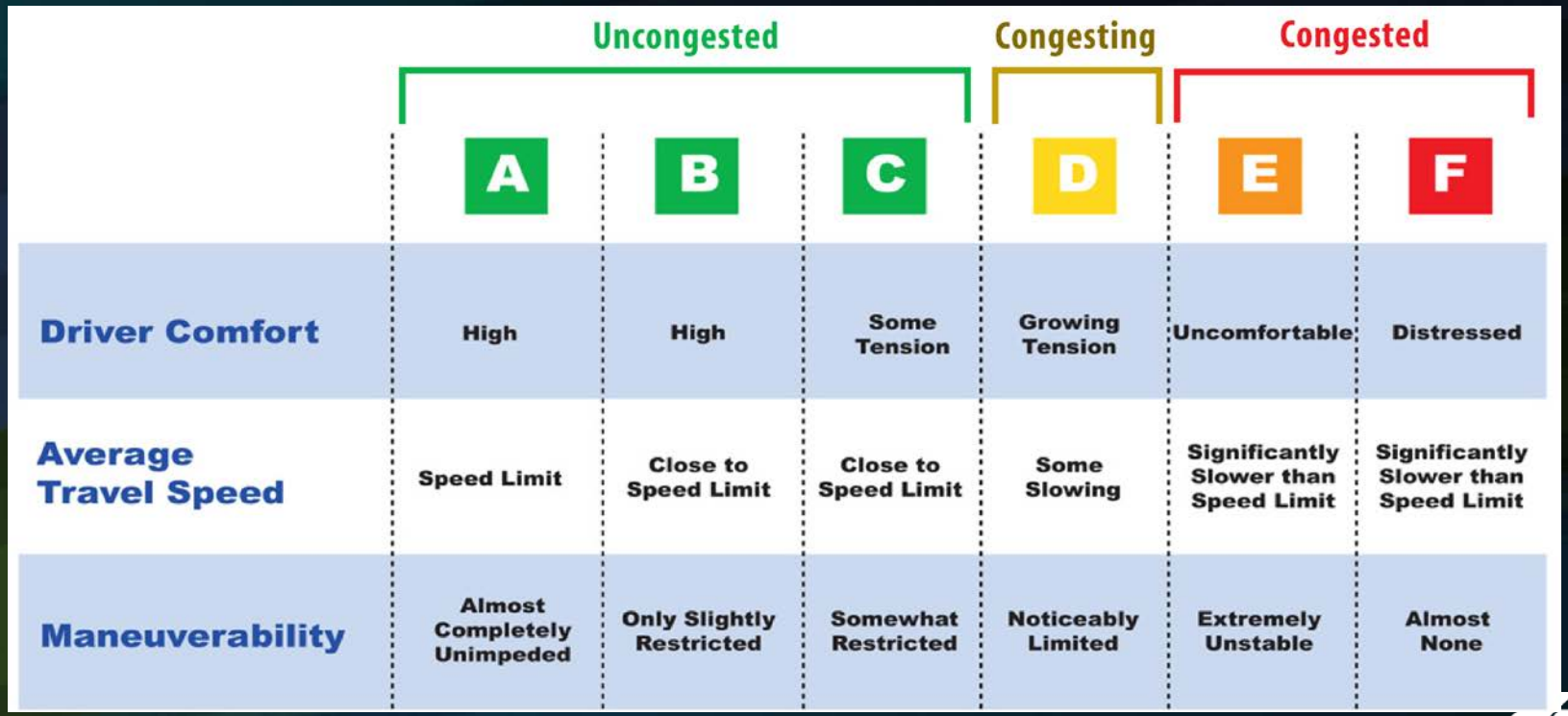
Outputs

- Trips by Mode
- Traffic Volumes
- Congested Speeds
- Transit Volumes
- **Summary Information**

Example Applications

Model Inputs and Outputs

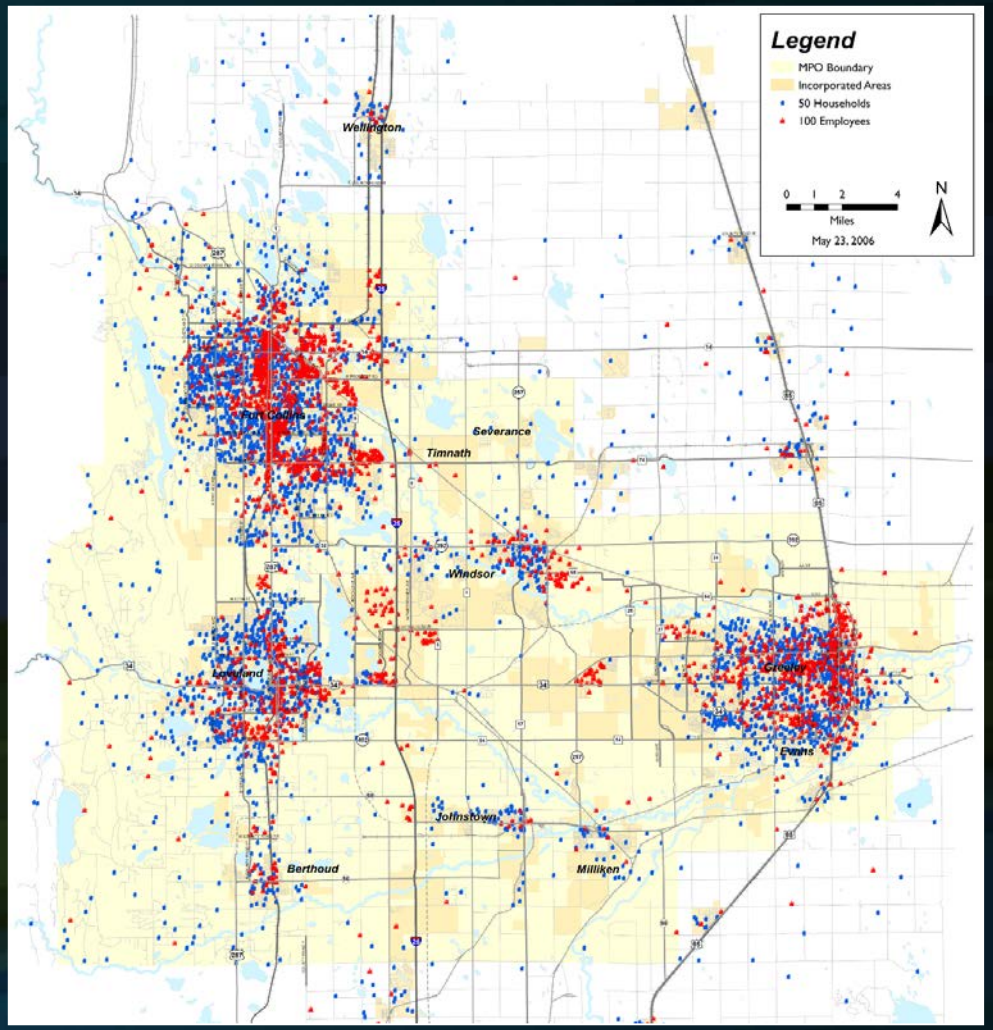
- The model can estimate level of service to help identify problem areas.



	Uncongested			Congesting	Congested	
	A	B	C	D	E	F
Driver Comfort	High	High	Some Tension	Growing Tension	Uncomfortable	Distressed
Average Travel Speed	Speed Limit	Close to Speed Limit	Close to Speed Limit	Some Slowing	Significantly Slower than Speed Limit	Significantly Slower than Speed Limit
Maneuverability	Almost Completely Unimpeded	Only Slightly Restricted	Somewhat Restricted	Noticeably Limited	Extremely Unstable	Almost None

Household And Employment Growth

Today



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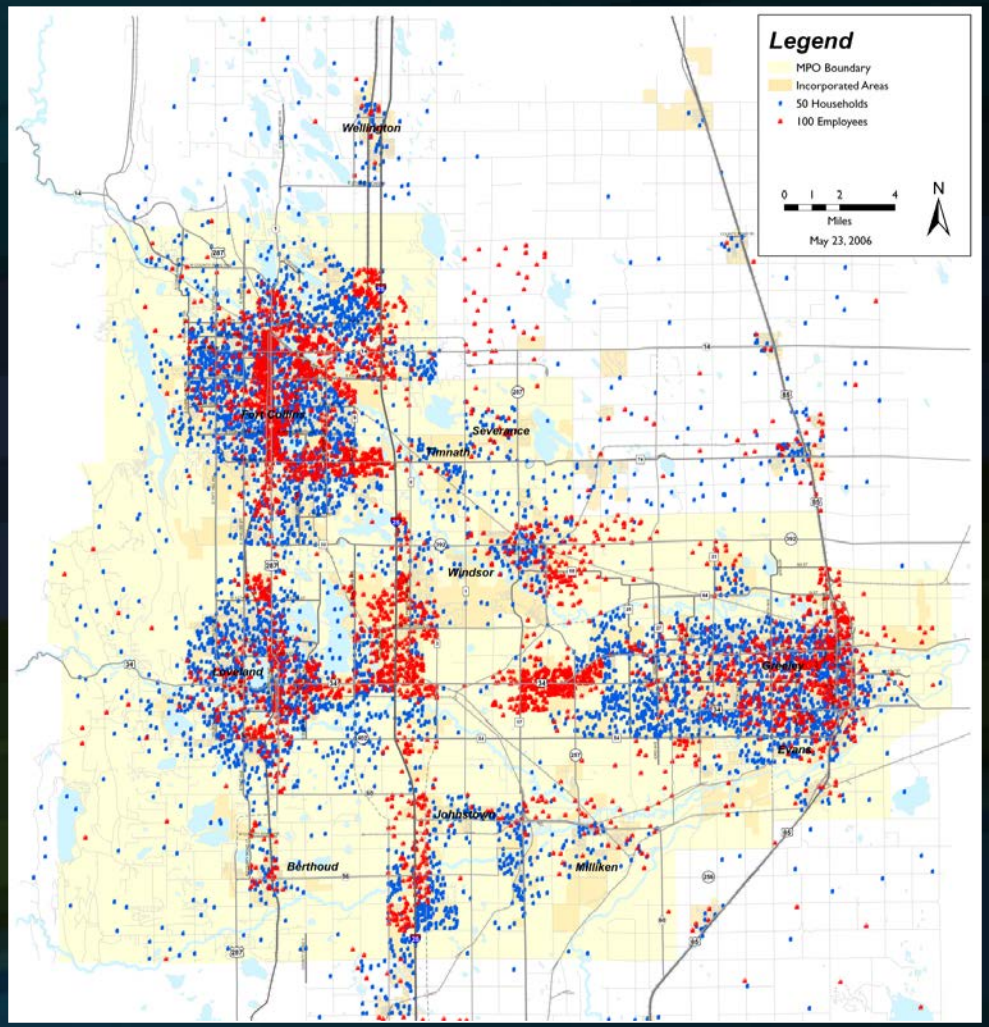
Household And Employment Growth

Future



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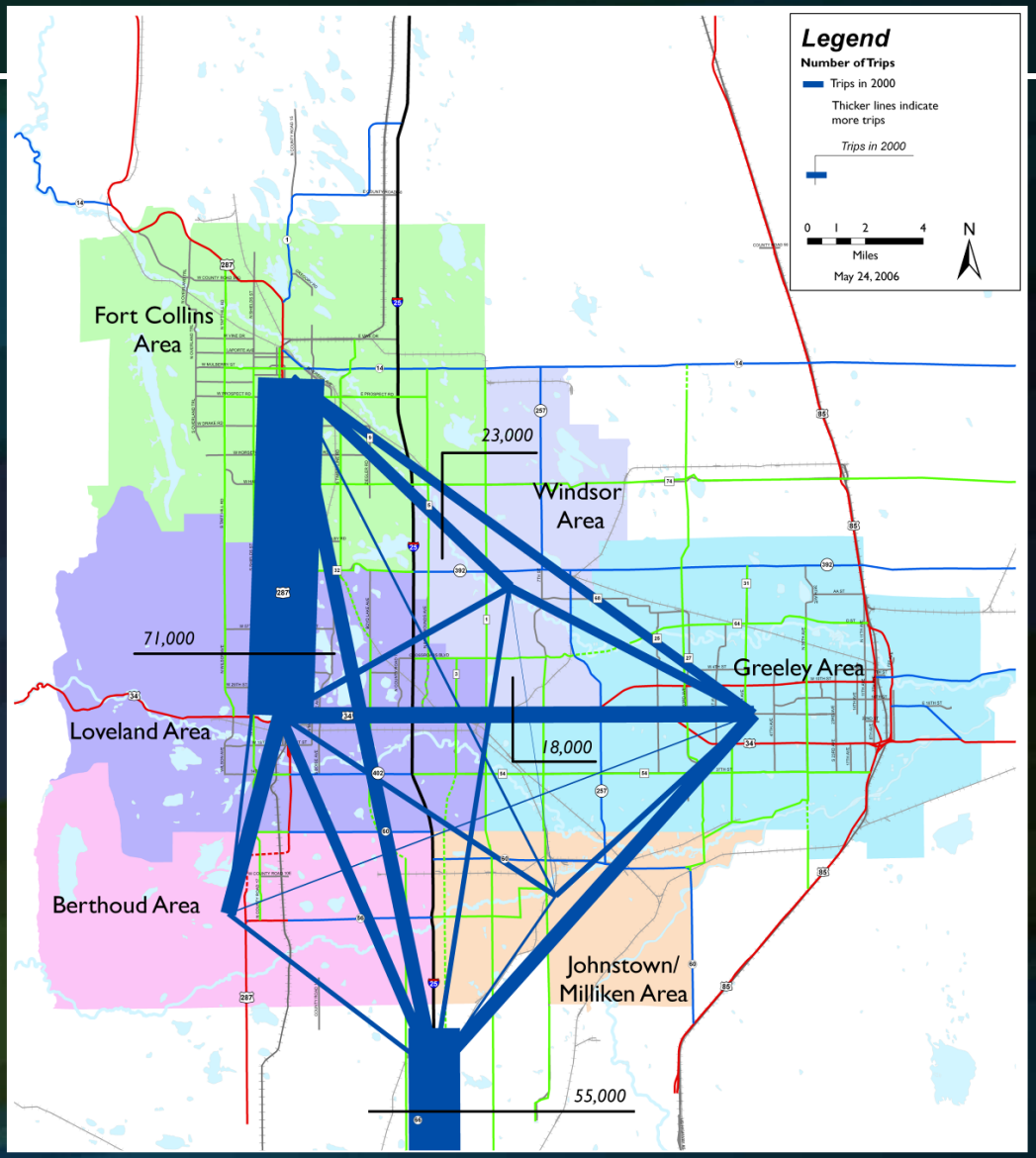
Travel Patterns

Today



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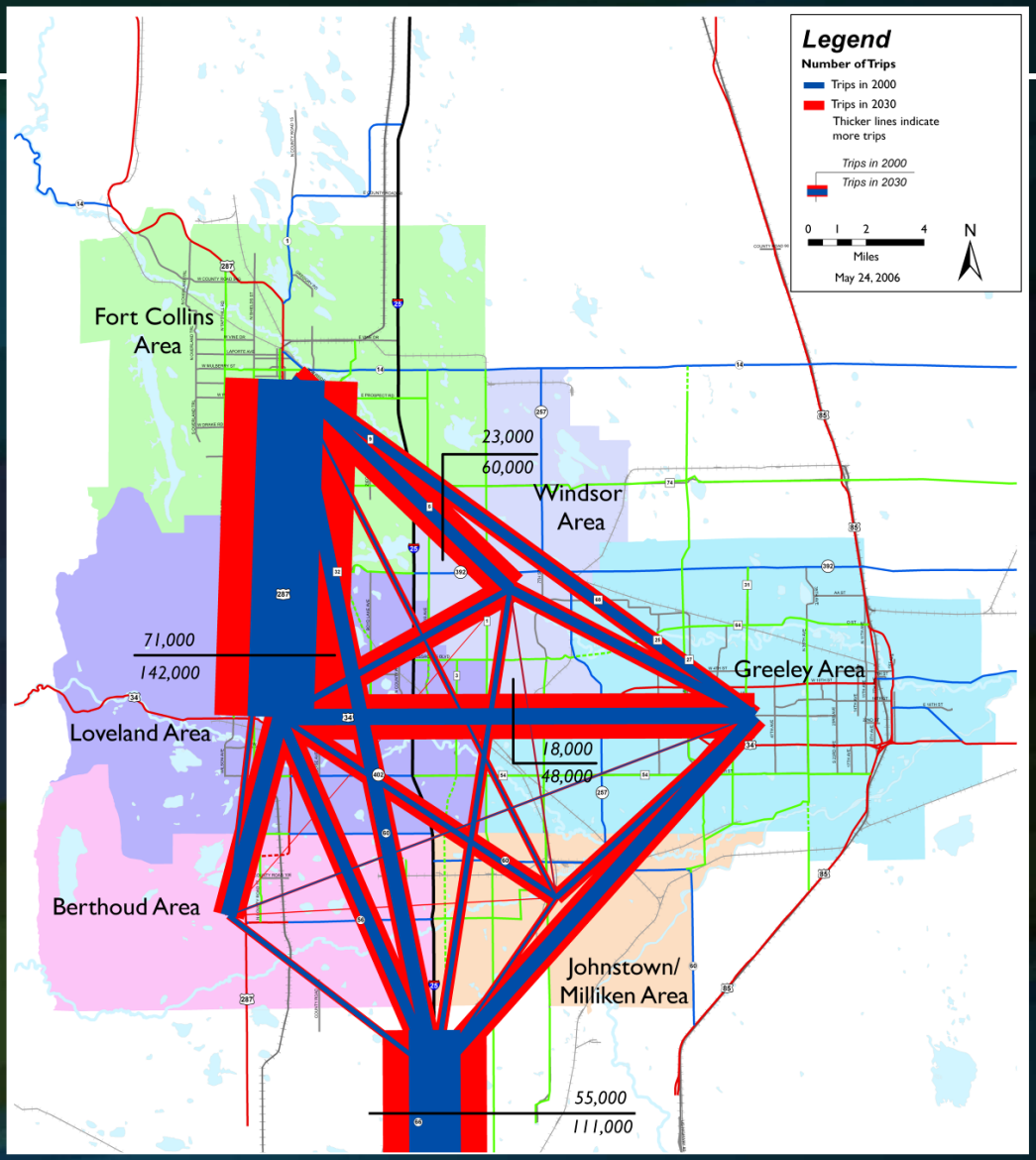
Travel Patterns

Future



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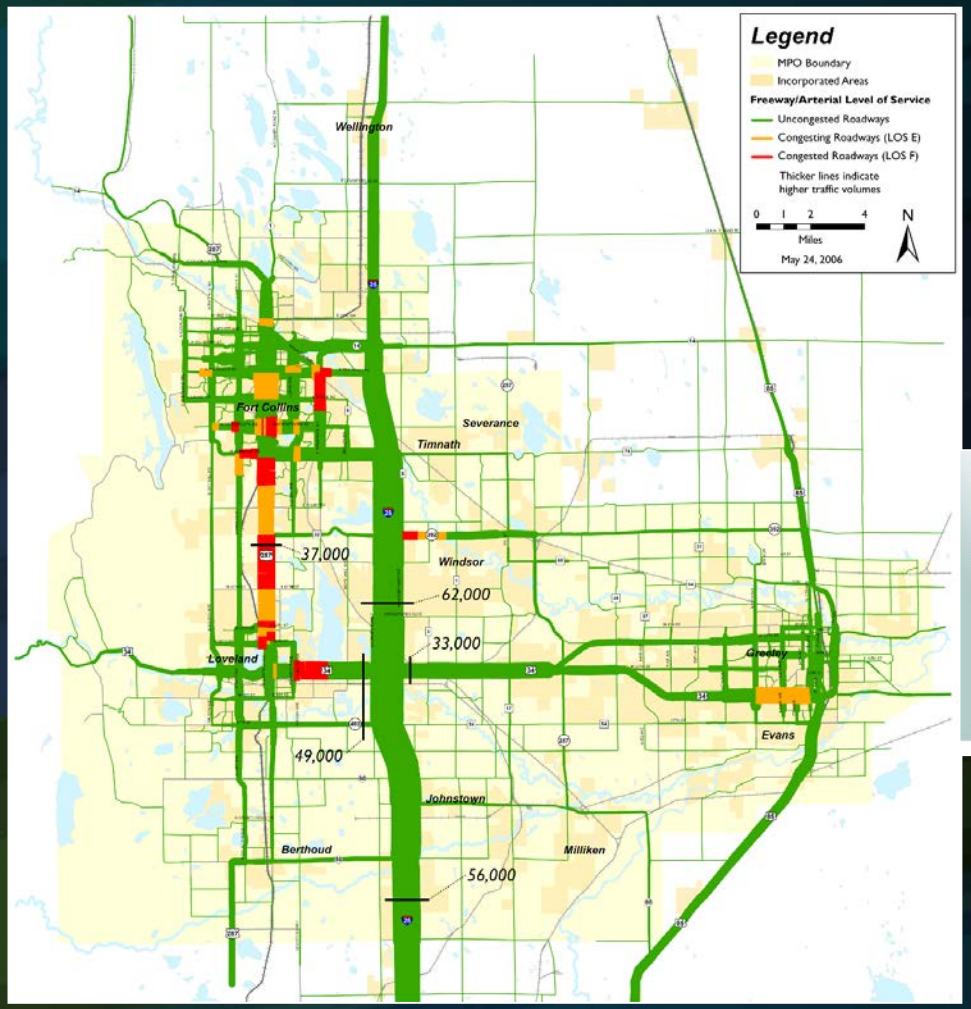
Traffic Volumes And Congestion



Today

Travel Times

From/To	Today	2030	Increase
Fort Collins to Denver	73 Minutes	119 Minutes	46 Minutes (63%)
Fort Collins to Greeley	37 Minutes	49 Minutes	12 Minutes (32%)
Greeley to Loveland	29 Minutes	39 Minutes	10 Minutes (34%)
Berthoud to Windsor	24 Minutes	37 Minutes	13 Minutes (54%)

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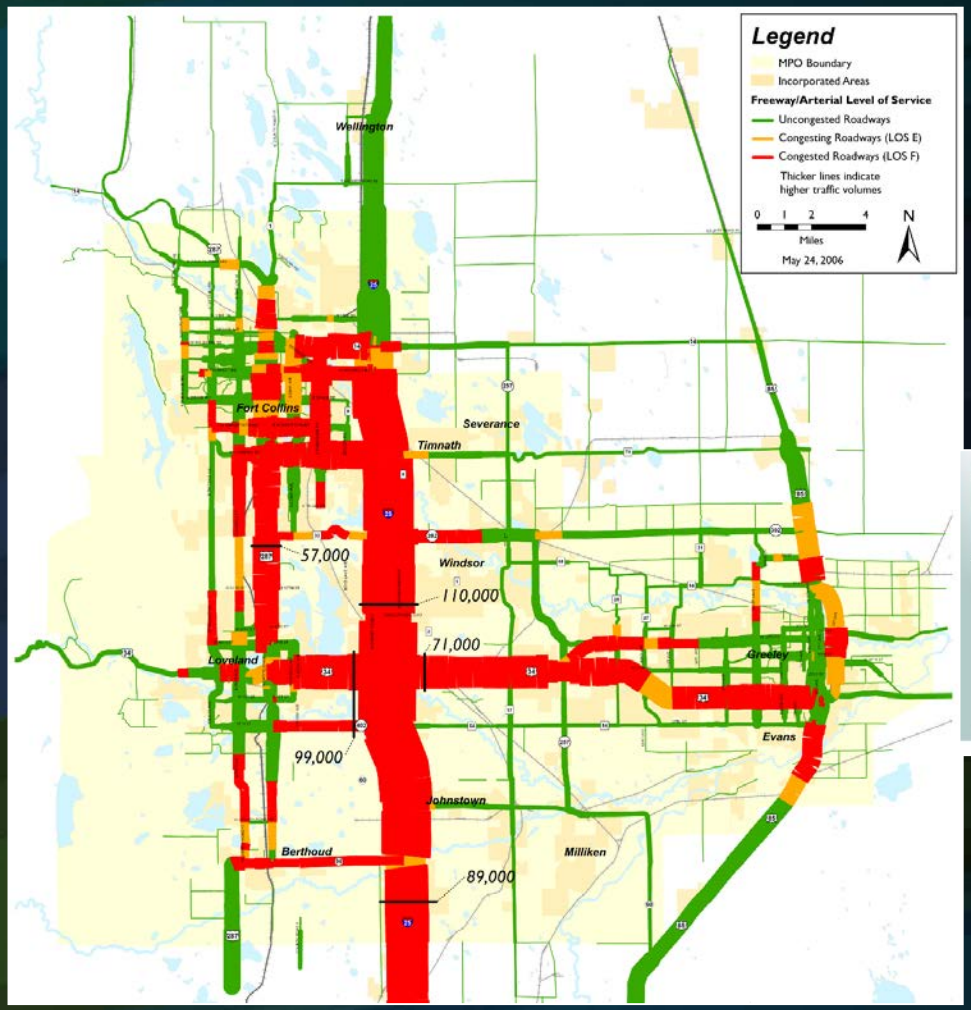
Traffic Volumes And Congestion



Future

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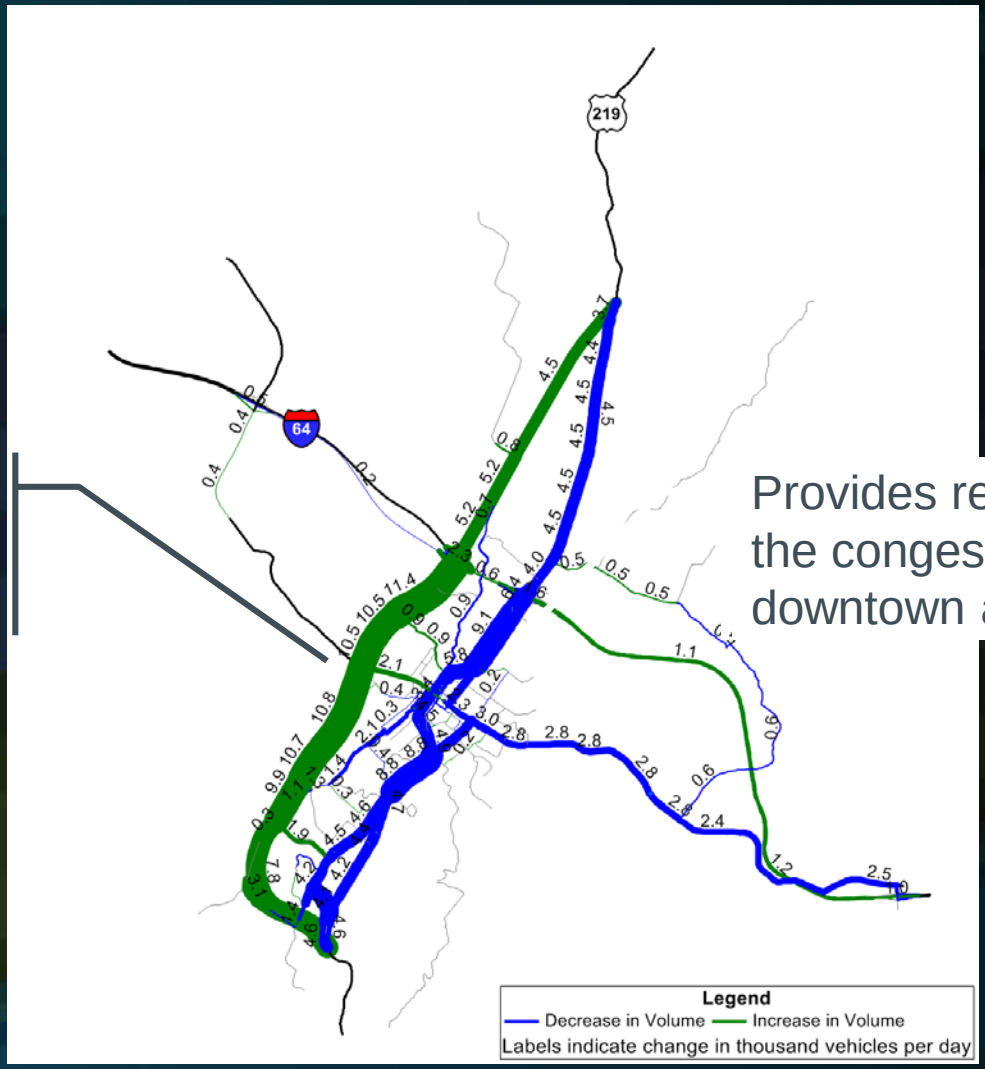
Where Does The Traffic Go?

A new parkway serves through traffic



Provides relief in the congested downtown area

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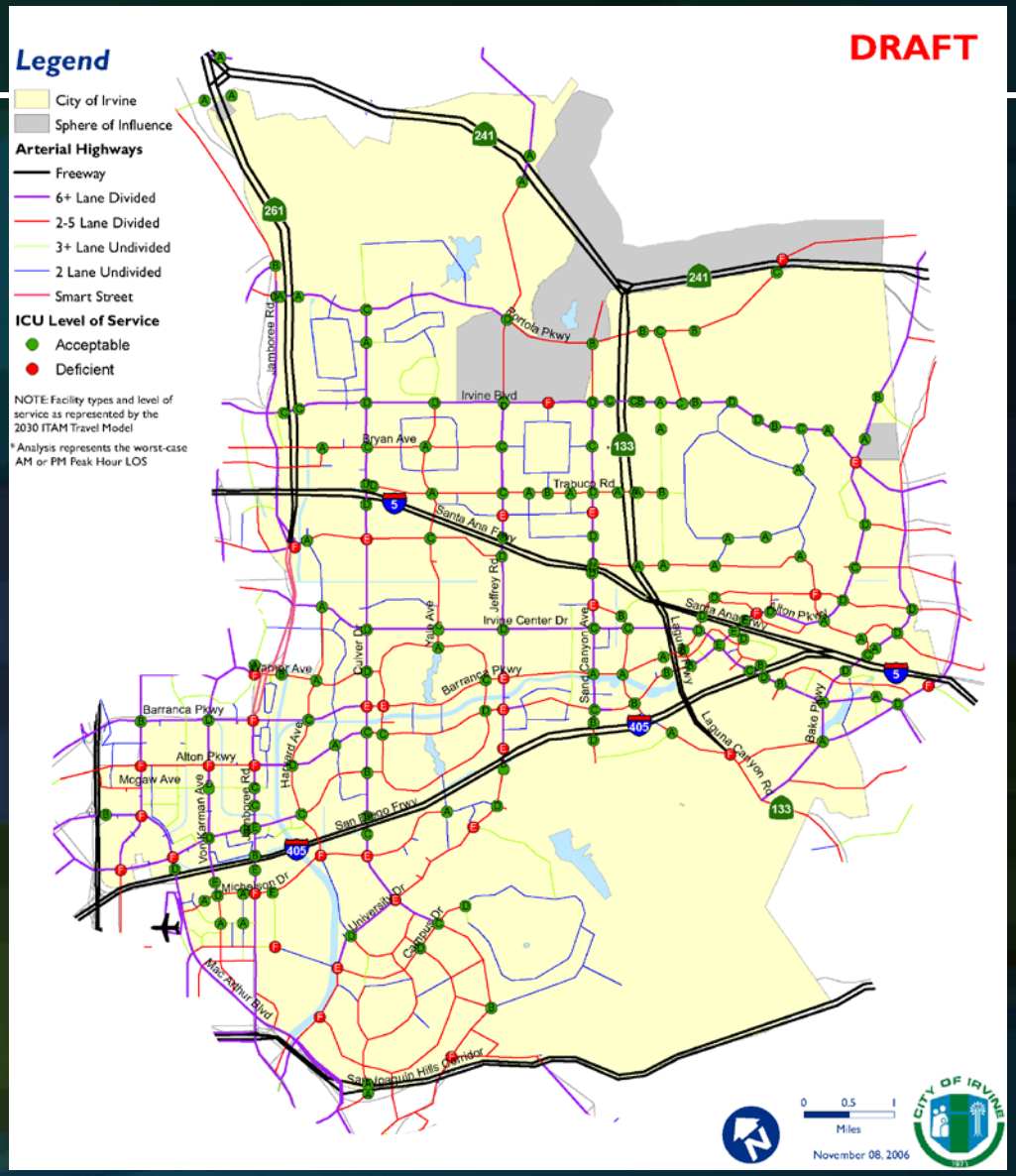
Intersection Los Reporting



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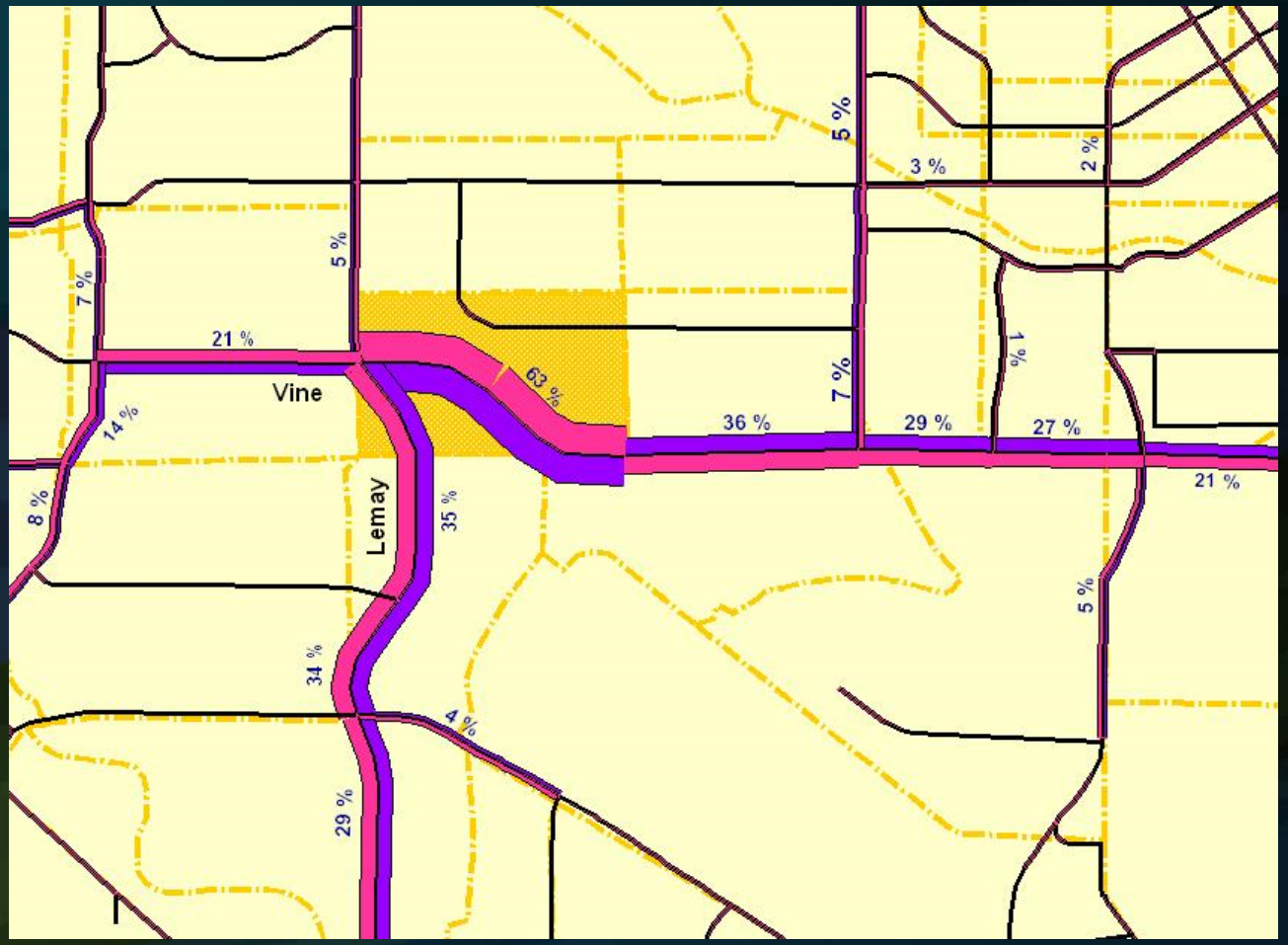
Traffic Impact Analysis



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Travel Model

Testing Demand Changes

- Evaluate base, interim, and forecast year datasets
- Consider testing large development proposals (e.g., over 200 households or employees)
  - Use the model's trip distribution to compare to traffic study assumptions
  - Cross-check development model runs with ITE-based traffic studies

- Use the model to test very small developments
- Test unreasonable changes to the jobs/housing balance

Testing Roadway Changes

- Test large and medium-scale capacity changes
- Test different roadway alternatives
- Test a comprehensive roadway plan
- Test various corridor configurations

- Test scenarios that do not impact system capacity
- Try to model very small capacity or speed changes
- Rely on the demand model to test interchange configurations

Non-motorized Results

- Focus on potential non-motorized demand
  - E.g., 1, 2, and 5 mile trip bandwidths
  - Identify good places for infrastructure improvements
- Consider non-motorized model results to be a rough estimate
  - The model is only one tool to aid in analysis

- Expect detailed numbers
  - YES: "There is a high demand for a new bike lane in this corridor"
  - NO: "This new bike lane will result in X new bike trips"

Transit Results

- Evaluate major system adjustments
- Test large route changes
- Focus on a system-wide results

- Test fine tuning of route alignments
- Expect detailed forecasts by transit route or transit stop
  - This information is available, but must be interpreted carefully by a transit professional

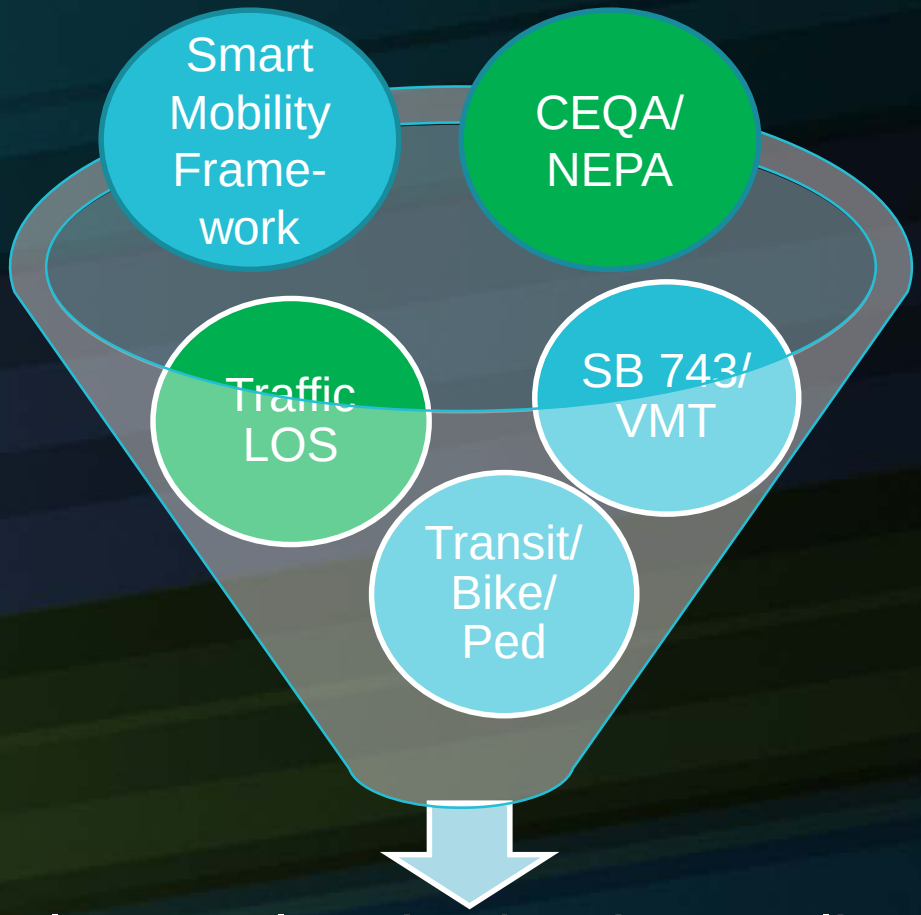
Traffic Results

- Post process traffic volumes based on counts
- Focus on forecast **growth** rather than values
- Consider corridors as a whole
- Use the model to plan freeways, expressways, and arterials

- Rely on raw model volumes
- Expect detailed collector and intersection forecasts
  - This information is available, but must be interpreted and may require additional post processing

District 8 Modeling Activities

A Changing Planning Framework



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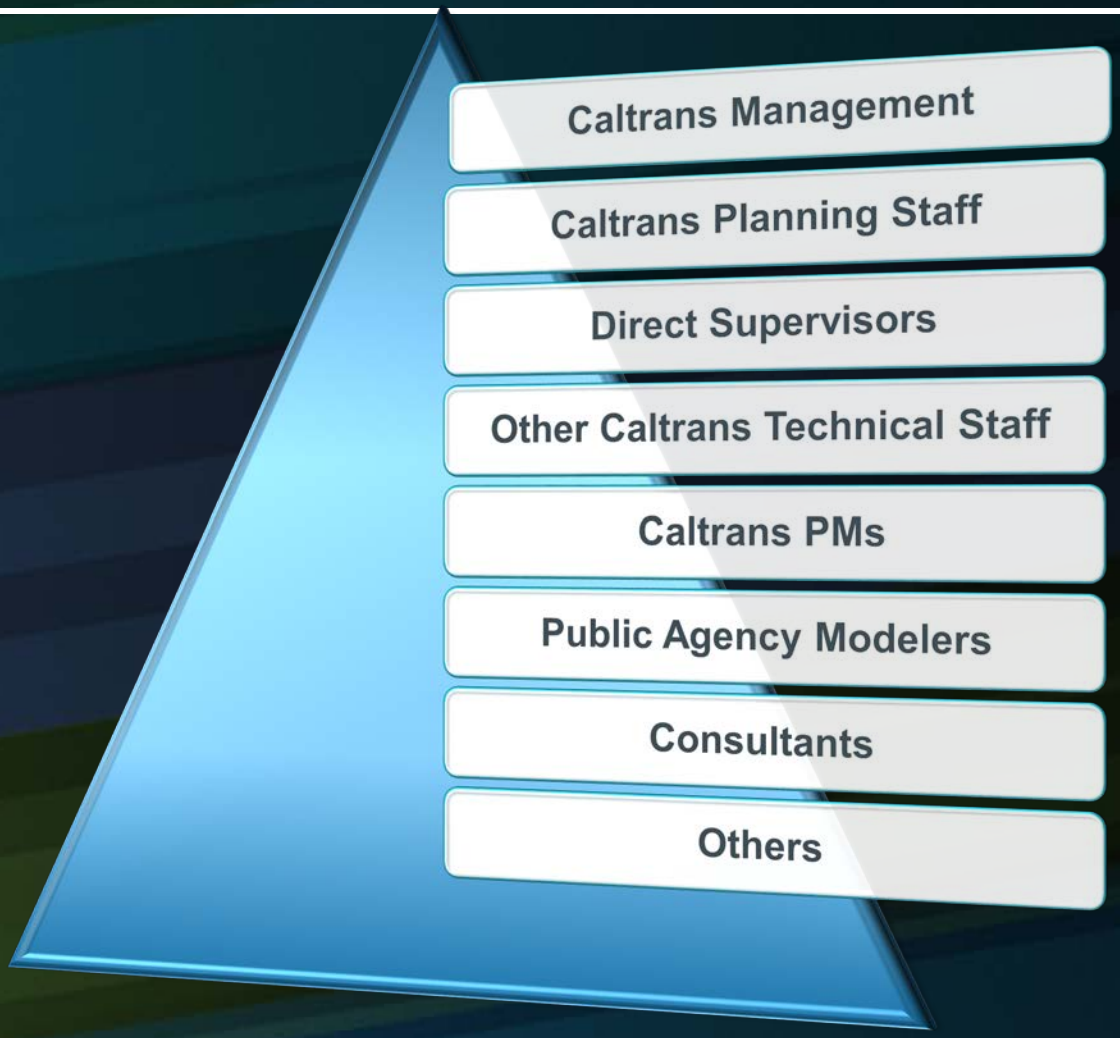
District 8 Modeling Context

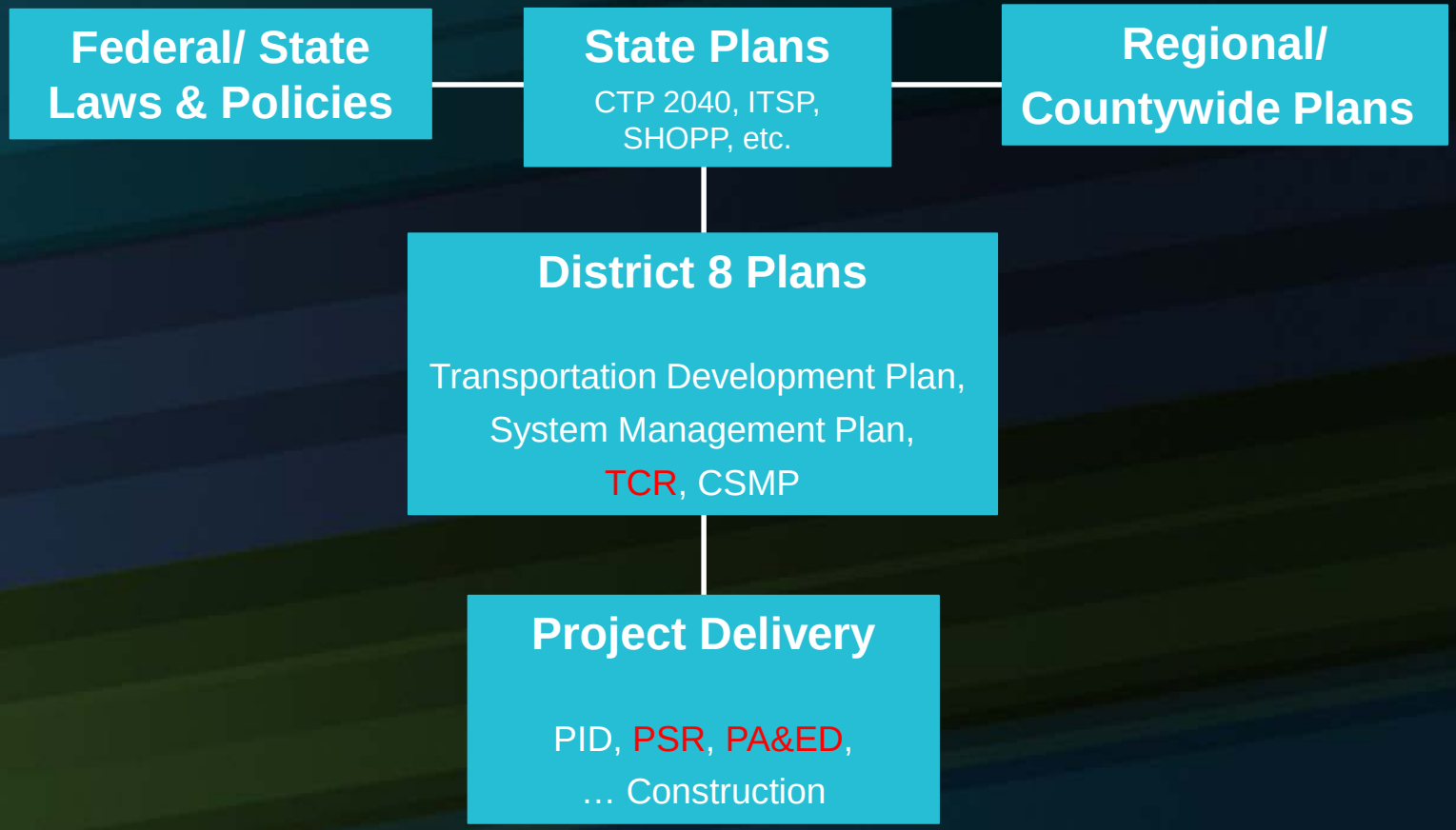
- Staff retention
- District modelers generally *apply* models (forecasting)
- MPO/County models increasingly complex
  - » SB 743, AB 32, SB 375
  - » Need to understand multiple models
    - – RivTAM
    - – SBTAM
    - – SCAG Model
  - » Model updates – SCAG 2016 RTP/SCS is coming soon

Modeling Group as Service Bureau



Time sensitive
Critical path
Credible

District Planning Process



Project Delivery

Modeling activities are generally front-loaded:
This applies for both project delivery and for planning activities

Transportation Concept Reports

- All State Highways
  - Updated periodically
- Generally straightforward data requirements – Except when they are not
  - CSMP
- Base year / Horizon year
- Auto / Truck splits
  - AADT
  - Peak hour splits
  - VMT
  - LOS, V/C
- Alternative modes

TCR Reporting – Example 1

SR-54 Corridor Performance

54-1 Location Description: I-5 IC to the I-805 IC

WESTBOUND

BASE YEAR (BY): 2010	HORIZON YEAR (HY): 2040
BY AADT: 58,000	HY AADT: *72,575*
BY LOS: C	HY LOS with RTP Improvements: C
	HY LOS with no RTP Improvements: D
BY VMT: 110,200	HY VMT: 137,892.5
BY Vehicle Occupancy Rate: Not available	HY Vehicle Occupancy Rate: *Not available*
BY Daily Vehicle Hours of Delay (35 MPH): Not available	HY Daily Vehicle Hours of Delay (35 MPH): *Not available*
BY Truck Traffic AADT: 1508	HY Truck Traffic AADT: *1887*
BY Total Trucks (% of AADT): 2.60%	HY Total Trucks (% of AADT): *2.60%*
BY 5+ Axle Truck Traffic AADT: 109	HY 5+ Axle Truck Traffic AADT: *136*
BY 5+ Axle Trucks (% of AADT): 0.19%	HY 5+ Axle Trucks (% of AADT): *0.19%*
BY Peak Hour Volume: 4,250	HY Peak Hour Volume: *5,443*
BY Peak Hour VMT: 8,075	HY Peak Hour VMT: *10,341.7*
BY Peak Hour V/C: 0.64	HY Peak Hour VC: *0.82*
BY Peak Hour Average Speed: >60 mph	HY Peak Hour Average Speed: *>60 mph*

Peak Period Length: 1 hour Peak Hour Time of Day: 0700-0 Peak Hour Directional Split: 65%

Bottlenecks: No reoccurring observed bottlenecks

District 12 SR 54

TCRs – Model Data

- Select roadway segments
- Observed Base Year Data
  - Traffic Counts, PeMS, Caltrans Count Book
- Travel Model
  - Base horizon + Horizon year
  - Horizon year: With and without projects
- Adjust future forecasts
  - Observed + model growth
- HCM
  - For LOS – may involve Traffic Ops

TCR Reporting – Example 2

			FUTURE 2020									2020 CONCEPT		
Seg.	*POST MILE*	*LIMIT*	*2020 NO BUILD*	*R/U UB*	*2020 ADT*	*PEAK Hr*	*2-WAY PEAK Hr Vol*	*TRUCK PEAK Hr*	*DIRECT SPLIT*	*2020 V/C*	*2020 LOS*	FACILITY	Lanes Added	LOS
1	0.0/R2.4	Jct I-15 to Main St./Montara Road	4 MF	U	30,000	10.8%	2,700	10%	65%	0.41	A	4 MF	0	A
2	R2.4/7.2	Main St/Montara Road to "A" St	4 MF	R	25,000	10.8%	2,700	10%	65%	0.41	A	4 MF	0	A
3	R7.2/107.2	"A" St to Goffs Road	4 MF	R	22,500	12.4%	2,800	12%	70%	0.46	B	4 MF	0	B
4	15.0/44.2	Goffs Road to Jct SR 95N	4 MF	R	20,000	12.5%	2,500	14%	70%	0.47	B	4 MF	0	B
5	44.2/49.5	Jct SR 95N to Jct SR 95S	4 MF	R	19,000	12.4%	2,350	14%	70.0%	0.44	B	4 MF	0	B
6	49.5/59.4	Jct SR 95S to Arizona State Line	4 MF	R	15,000	10.0%	1,500	12%	75.0%	0.37	B	4 MF	0	B

District 8 I-40

Project Study Report

- Early Project Delivery Document
  - » Inform Purpose and Need
- Travel Model Forecasts Required
  - » Traffic counts collected specifically for project (plus off the shelf data - HPMS)
  - » Big Data (Origin-Destination)
- Base Year / Opening Year / Horizon Year
  - » Mainline, ramps, intersections
  - » Detailed, link level analyses
- Auto, truck, multimodal
- Traffic assignment to inform HCM
  - » Changes in VMT/GHG?

PSR Example

Segment		Type	Balanced 2040 No-Project	
From	To		AM Peak Hour (vph)	PM Peak Hour (vph)
Santa Anita Ave On-Ramp	Peck Rd SB Off-Ramp	Mainline	0	0
		Express	214	1,885
Peck Rd SB Off-Ramp		Off-Ramp	0	0
Peck Rd SB Off-Ramp	Peck Rd NB Off-Ramp	Mainline	6,114	4,933
		Express	214	1,885
Peck Rd NB Off-Ramp		Off-Ramp	521	704
Peck Rd NB Off-Ramp	Valley Blvd On-Ramp	Mainline	5,593	4,229
		Express	214	1,885
Valley Blvd On-Ramp		On-Ramp	234	167
Valley Blvd On-Ramp	Stewart St On-Ramp	Mainline	5,827	4,396
		Express	214	1,885

SR 60/I-605/I-10 PSR

Project Approval and Environmental Document

- Purpose & Need
- Environmental document
  - CEQA, NEPA
    - Public review
- Travel model forecasts required – support traffic microsimulation
  - Traffic counts collected specifically for project
  - Big Data (Origin-Destination)
- Base year / Opening year / Horizon year
  - Primarily trip tables to inform traffic analysis
    - Traffic assignment may be conducted
- Auto, truck, multimodal
- SB 743 – VMT analysis

Other Areas Where Model Data Is/Can Be Used

- Discussion

Morning Wrap-Up

PM Agenda

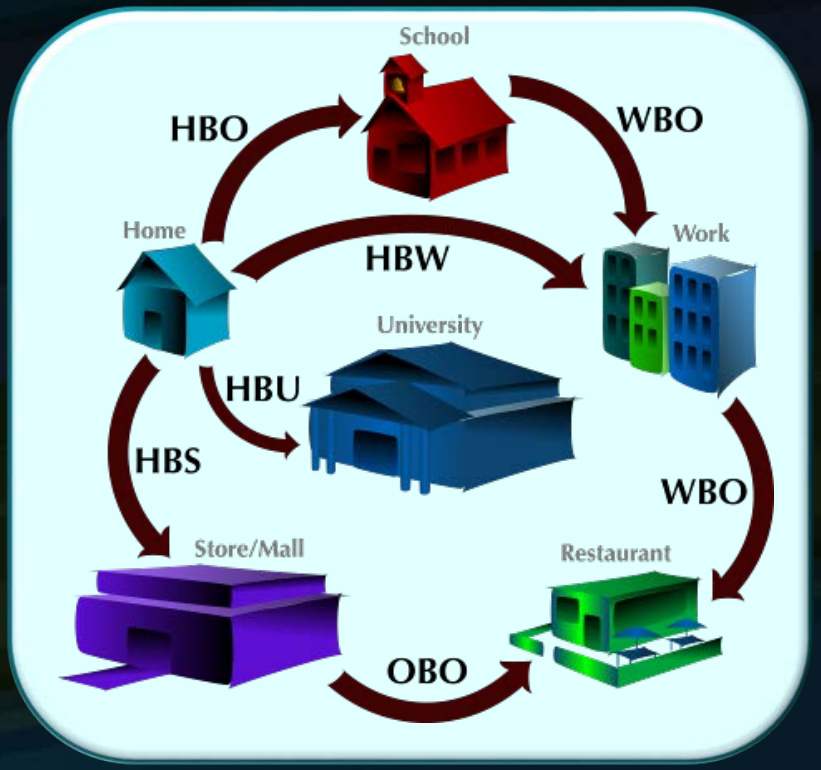
- Model steps
  - Basic model components
  - Recap of validation and post-processing
- SR 60 project
  - Work plan
  - Master schedule
- Review of homework
  - Separate presentation
- Next steps

Model Steps

Trip Generation: How Many Trips?

- Based on household survey
- Different trip purposes
- Generate all trips*
  - Walk
  - Bike
  - Transit
  - Auto

** This is different than ITE Trip Generation, which only considers vehicle trips*



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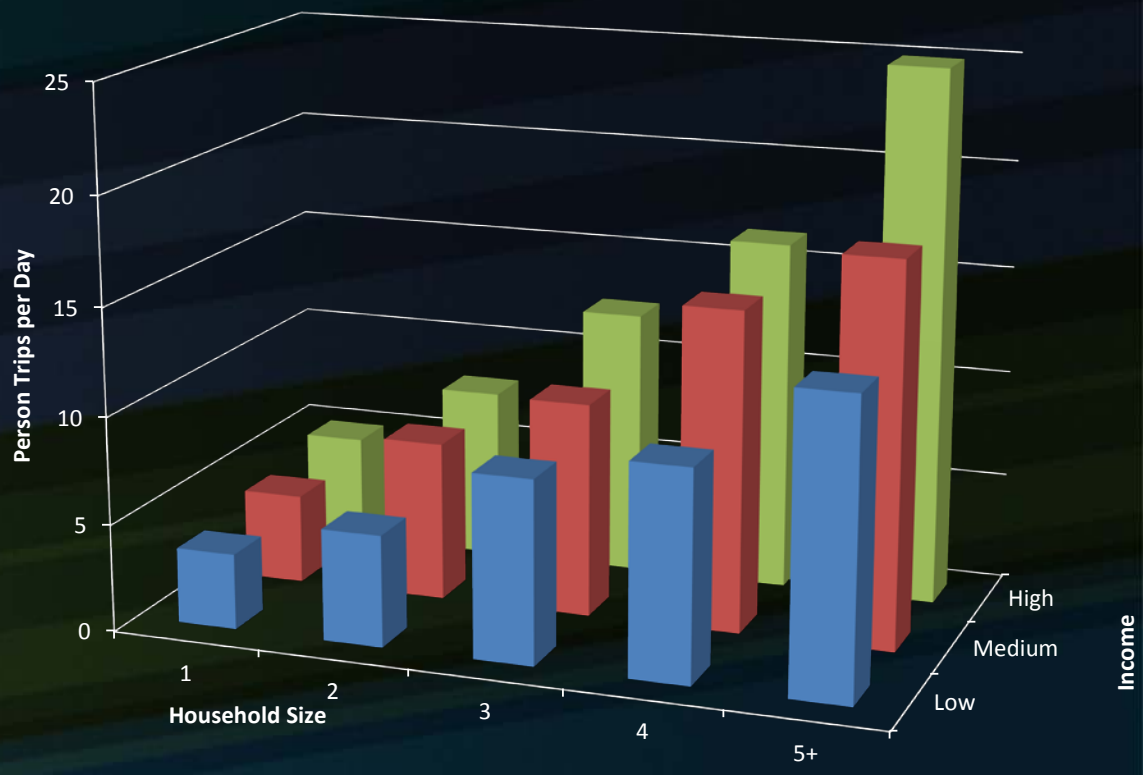
Trip Generation: How Many Trips?

- Cross-classified production rates
  - » Household size & income
  - » Household Workers & Income



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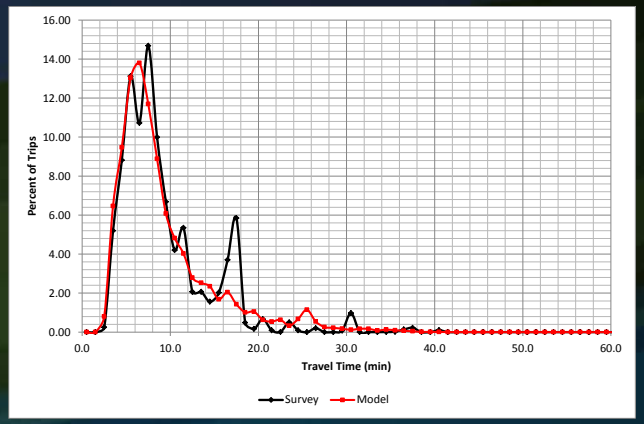
Trip Distribution: Where will they go?

- Match
  - » Productions & attractions
- Survey Data
  - » Trip length distributions
  - » Subregion to subregion patterns

The *Gravity* concept can be used to model travel!



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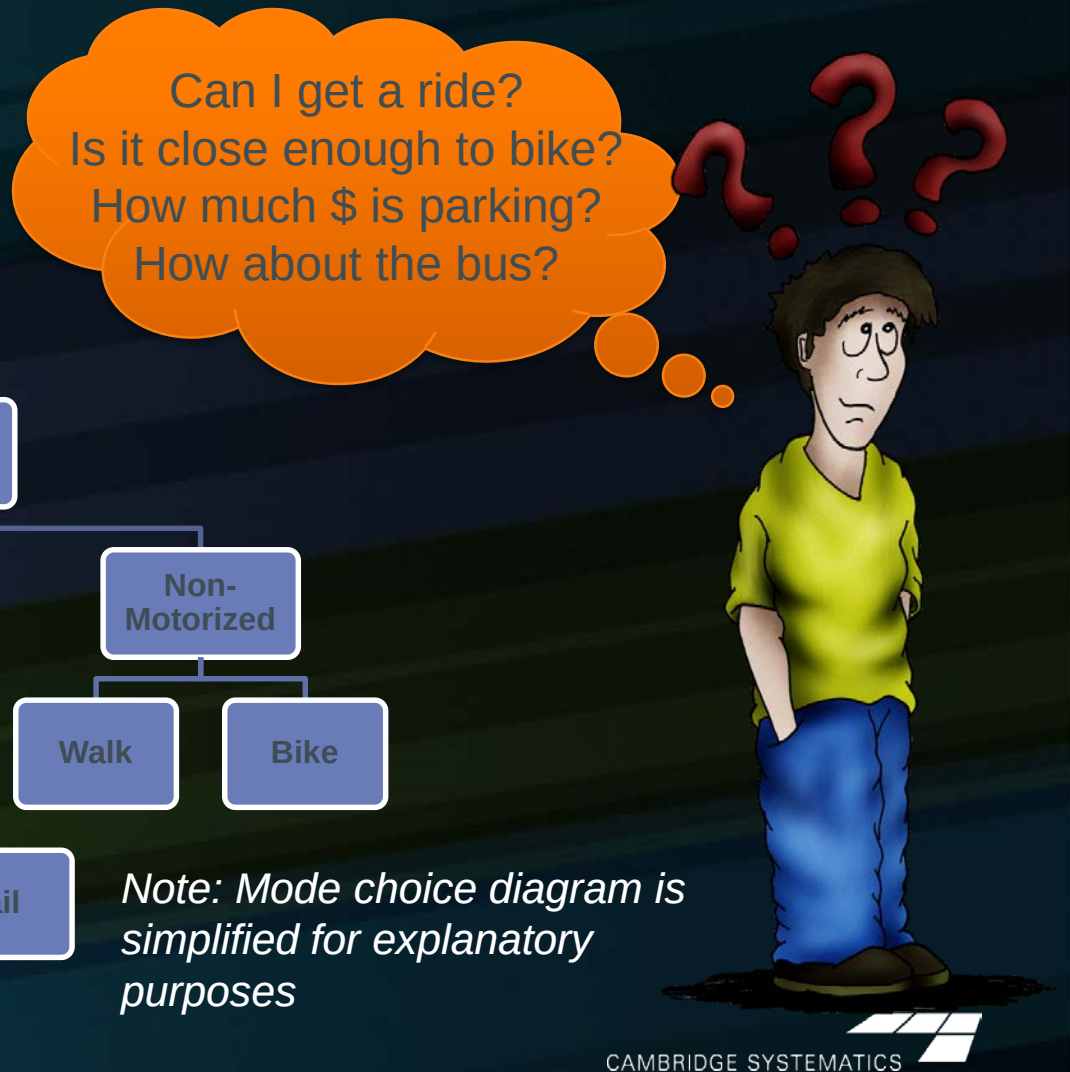
Mode Choice: What Mode?

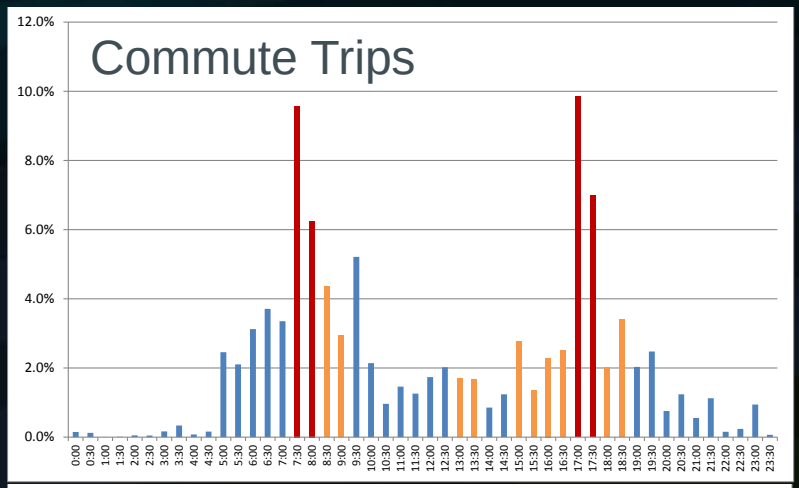
- Nested Logit Model
  - Consider all modes for each zone pair

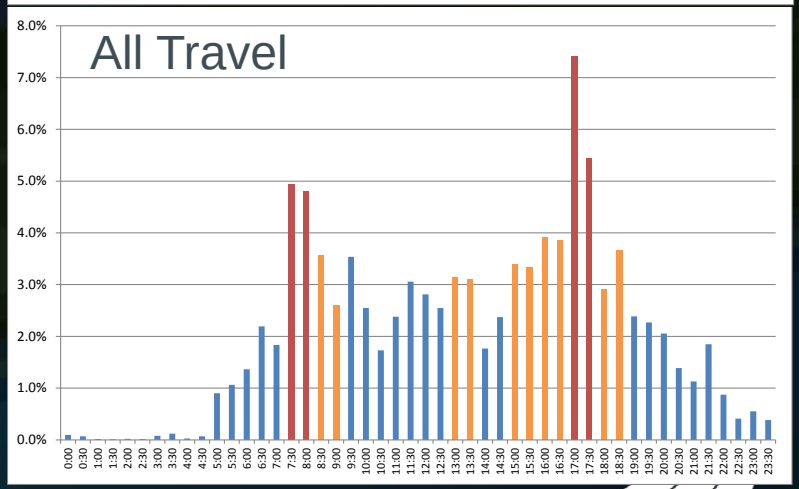


Note: Mode choice diagram is simplified for explanatory purposes

Traffic Assignment: What Route?

- 4 to 5 time periods (depending on model version)
- Account for localized and peak period congestion





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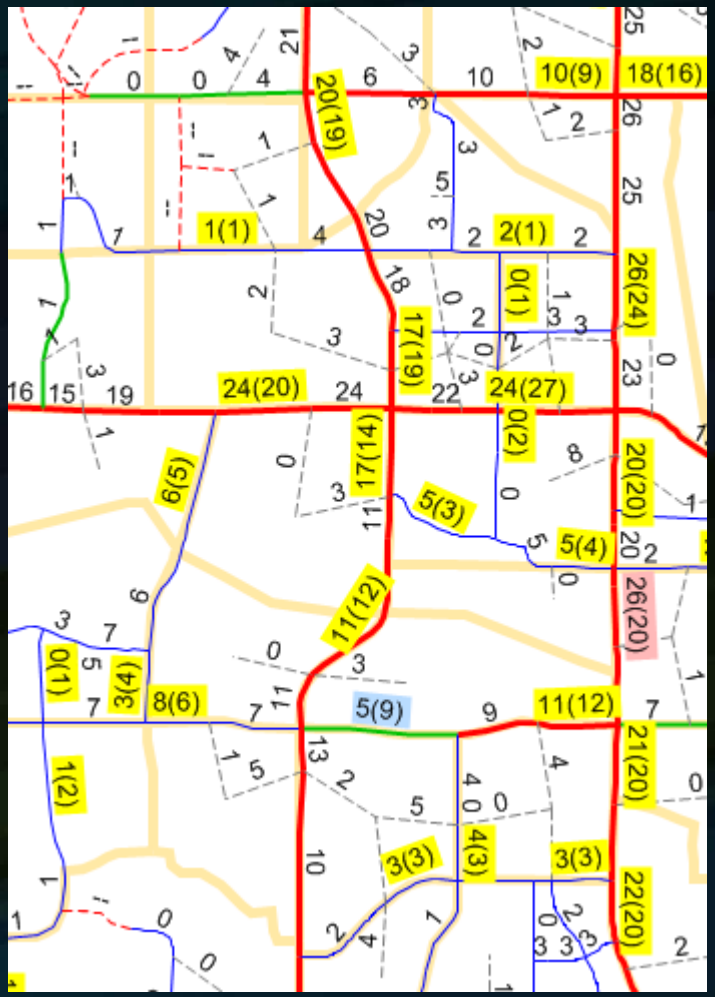
Model Validation / Post-Processing

Matching Local Data

- Surveys & reasonableness checks
  - » Final Trip Rates
  - » Travel Times
  - » District to District travel patterns
- Traffic count data
  - » VMT by subregion, facility type, and area type
  - » Corridor and localized review



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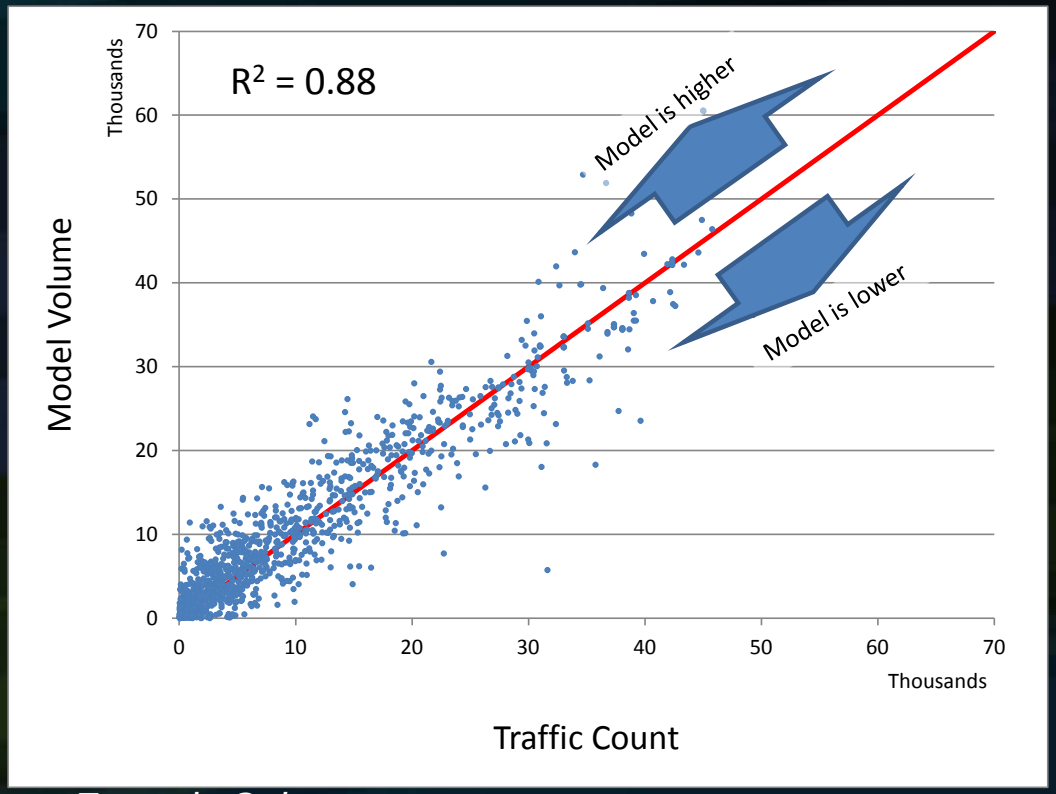
Matching Counts

- How does the model work for today
  - Statistics
    - R-Squared
    - % RMSE
    - Volume / Count Ratio
    - Etc…
  - Screenlines
  - Corridor Review
  - Highest Errors



Example Only

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Testing Sensitivity

- Dynamic validation
  - » Observe how the model reacts changes
    - – Test big and small changes
    - – Test the base and forecast year
  - » Do results make sense?

Post Processing: Reconciling to Counts

- Is the model too low in the base year?
  - » Then the forecast is increased by the same amount
- Is the model too high in the base year?
  - » Then the forecast is decreased by the same amount
- Both ***Post Processed*** and ***Raw*** volumes are available for analysis

Post Processing: Reconciling to Counts

Use % Growth *(e.g., traffic increases by 30%)*

$$Forecast_{ratio} = Raw\ Volume \cdot \frac{Count\ Volume}{Raw\ Base\ Year\ Volume}$$

Use Volume Growth *(e.g., traffic increases by 5,000 vehicles)*

$$Forecast_{diff} = Raw\ Volume + Count\ Volume - Raw\ Base\ Year\ Volume$$

Use the Average

$$Forecast_{avg} = \frac{Forecast_{ratio} + Forecast_{diff}}{2}$$

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SR 60 PROJECT

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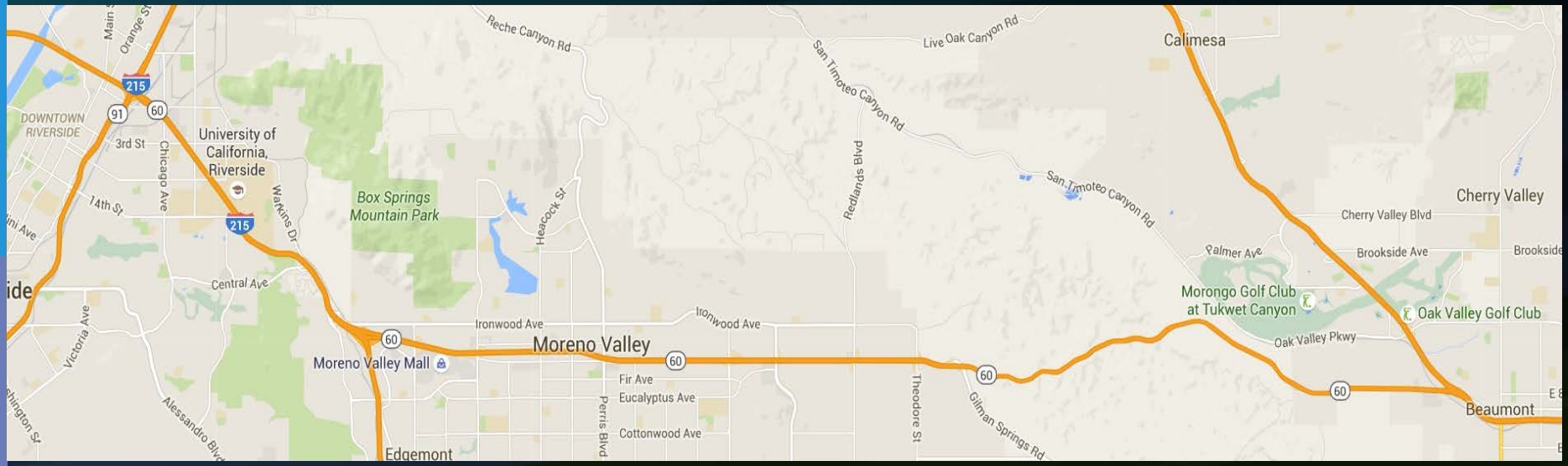
SR 60 Project Area



Google Maps

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SR 60 Feasibility Study

- 1) Existing Conditions (2014)
- 2) 2035 RTP Build Out Conditions
- 3) Alt 2 + Improvement Projects from TCR Concept build out
- 4) Alt 2 + 2-mixed flow lanes each direction segment 3, add 1-mixed flow lane each direction segment 4, add 1-HOV lane each direction segment 6, add 1-HOV lane W/B
- 5) Alt 2 + 1-Truck lane in W/B direction plus Transit/Park & Ride/Bicycle/Pedestrian
- 6) Alt 2 + Transit/Park & Ride/Bicycle/Pedestrian
- 7) Alt 2 + 1-Truck lane in W/B direction
- 8) Alt 2 + 1-HOV lane in W/B direction

Summary of Improvements by Scenario

Scenario	Year	Improvements by Vehicle Class/Mobe			
		Mixed Flow	HOV	Truck	Transit/ Bike/Ped
1. Base Year	2012				
2. RTP Build Out	2035				
3. TCR Build Out	2035	X	X		
4. Mixed Flow +	2035	X	X		
5. WB Truck & Transit	2035			X	X
6. Transit	2035				X
7. WB Truck	2035			X	
8. WB HOV	2035		X		

SR 60 Study

- Development of purpose and need
  - » Feasibility study has already documented deteriorating traffic LOS & other issues
- Forecasting decision points:
  - » TCR or PSR level of analysis
    - – Something in-between?
  - » Wait for SCAG 2016 RTP model?
    - – Updated population/employment projections
    - – Updated trip distribution patterns
    - – Updated model parameters
  - » Continue with existing model?
    - – RivTAM or 2012 SCAG RTP Model

Data Collection

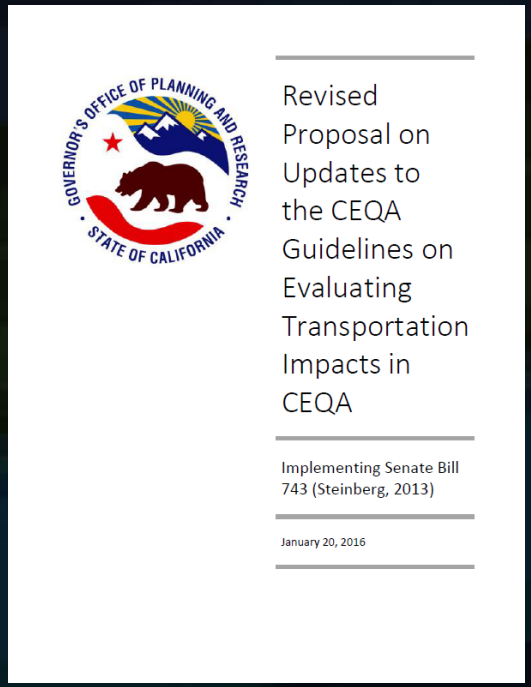
- Traffic data
  - Can new mainline traffic counts be collected?
  - Intersection counts
  - Ramp volumes
  - PeMS
  - Caltrans traffic reports
  - Other sources of data (example: SR 60 Truck Lanes EA)
- Transit ridership
  - Boardings
  - On-board surveys
- Big data
  - Origin-destination data

Performance Measures

- What are desired outcomes?\
- Traffic LOS
  - HCM-level analysis
  - SB 743 – VMT reductions
    - Induced travel
  - Travel patterns
    - Local
    - Intercounty – within SCAG Region
    - Interregional/Interstate
- Analysis years
  - Horizon year … current SCAG Model horizon (2035)
- Time periods
  - Peak hours, daily, AADT

Modes of Travel

- Multimodal analyses
  - » Transit potential
  - » Non-motorized
    - – Mobility options
- Truck movements
  - » Warehousing and industrial land uses
    - – Moreno Valley Logistics Center
- SB 743 Analyses
  - » New CEQA thresholds of significance – VMT reduction



Next Steps

- Refine/finalize work plan
- Master schedule
  - In-person meeting dates
- Immediate next steps

Morning Wrap-Up