DTA Simulation Model

Project Experience:

TRPC – Smart Corridors Project

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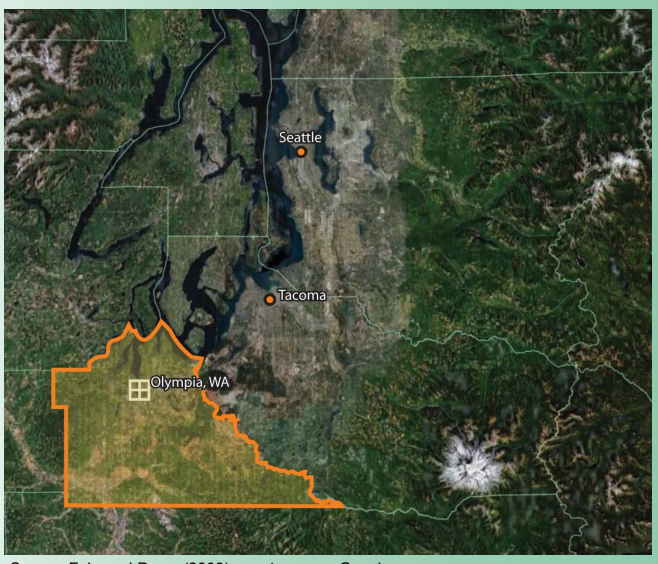
Outline

- Project Overview and Background
- Model Development
- Model Validation and Calibration
- DTA Simulation
  - Density / Outflow
  - Queuing
  - Incident
  - VMT / Emission Calculation
- Q&A

Overview

- Thurston Regional Planning Council (TRPC) is an intergovernmental board made up of local government jurisdictions within Thurston County in Washington State
- County has an area of 727 sq miles and a population of 245,300
- The county is the home of the State's Capitol, City of Olympia
- The county's population is expected to be 373,000 in 2030

Geography



Source: Fehr and Peers (2009); courtesy map Google

Project Background

- Congestion Mitigation and Air Quality (CMAQ) grant
- TRPC policy makers decided to focus on two strategic corridors
- Best options to reduce PM10 in support of their ITS architecture
  - coordinated signal timing and optimization
  - transit signal priority (TSP)
- Two strategic corridors were chosen from the Regional Transportation Plan (RTP) that are problematic for Intercity Transit's on-time performance goals

Study Corridors

Project Objectives

- To improve multi-modal transportation operations on the two corridors
- To evaluate signal coordination and optimization
- To evaluate transit signal priority
- To integrate arterial/freeway management
- To reduce PM10 (particulate matter) emissions in the corridors.

Why DTA Model?

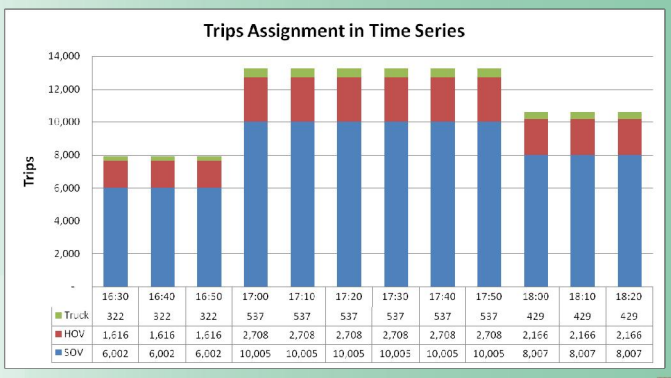
- TRPC's Travel Demand Model has limitations as any other 4-step model
- Micro-simulation models can not be practically applied for a network of this size
- TRPC wants a tool that will help them evaluate ITS options and study operational characteristics
- Regional concept of traffic operations and to develop a model for the county with DTA for the benefit of jurisdictions

DTA Model Development

- NETWORK
  - Entire network brought into DTA model from Travel Demand Model
  - Refined the network to add missing intersections on the corridors
  - Added network detail (turning pockets)
  - Added signal data / intersection controls
  - Modified all centroid connectors for the zones around two corridors to reflect field conditions
  - Verified link attributes
  - Network properties in DTA model:
    - 800 centroids
    - 2500 regular nodes
    - 8000 links
    - 20 transit lines (study corridors only)

DTA Model Development

- TRIP TABLES
  - PM peak hour trip tables brought from Travel Demand Model
  - 30-mimute Pre-peak and post-peak loading applied
  - The modes are SOV, HOV & Truck

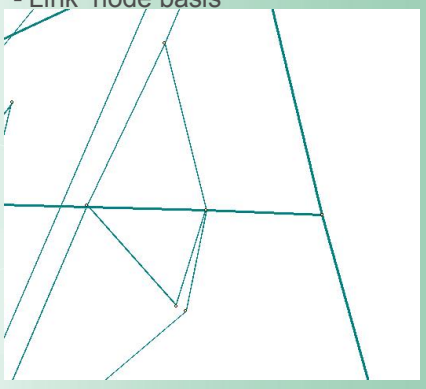


	16:30	16:40	16:50	17:00	17:10	17:20	17:30	17:40	17:50	18:00	18:10	18:20
Truck	322	322	322	537	537	537	537	537	537	429	429	429
HOV	1,616	1,616	1,616	2,708	2,708	2,708	2,708	2,708	2,708	2,166	2,166	2,166
SOV	6,002	6,002	6,002	10,005	10,005	10,005	10,005	10,005	10,005	8,007	8,007	8,007

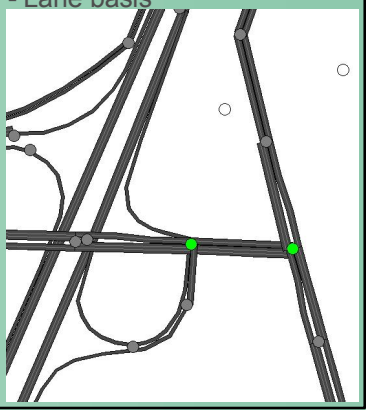
DTA Model Development

- INTERSECTION GEOMETRY
  - Approaches to the intersections were modified to reflect field conditions
  - Added right and left turn lane pockets where needed

Travel Demand Model
- Link node basis

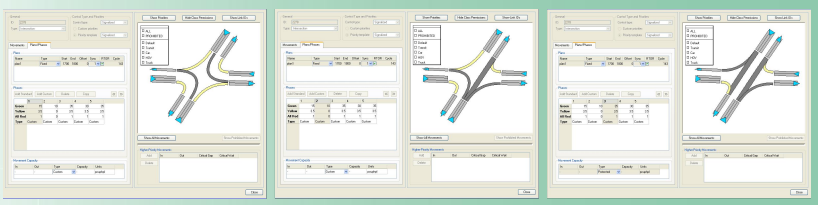


DTA Model
- Lane basis



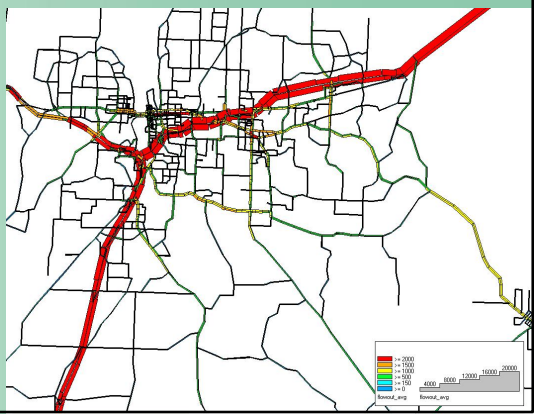
DTA Model Development

- INTERSECTION CONTROLS
  - Coded on two study corridors first
  - For all the intersections within the buffer zone of a few blocks from the corridors
  - 81 signals & 67 stopped controls



DTA Model Development

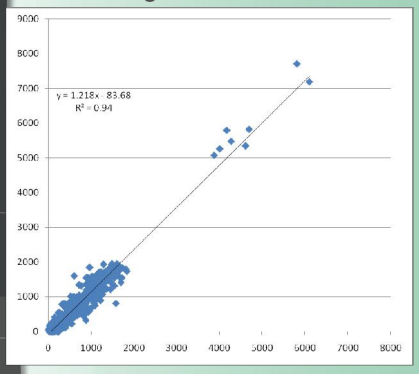
- First run after bringing the network and demand matrices from travel demand model into DTA model – without any intersection controls and validation / calibration
  - network check
  - Flow blockage check
  - Convergence check



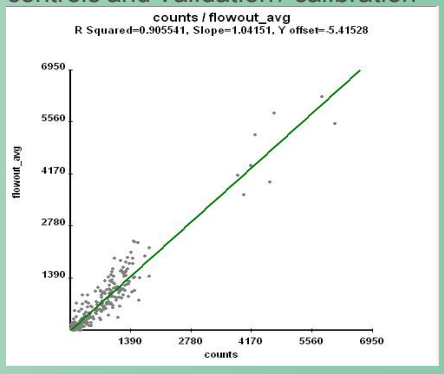
DTA Model Development

Link Volume Comparison

Static assignment model

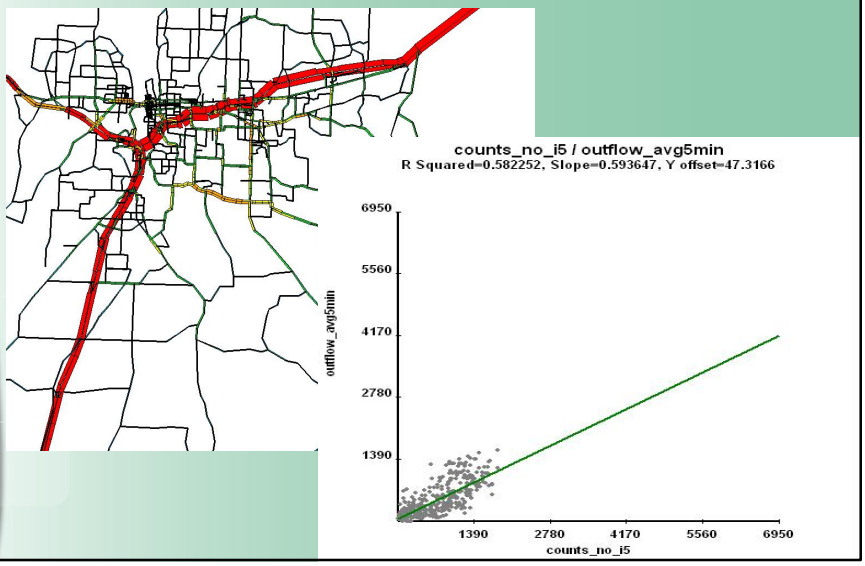


DTA model without intersection controls and validation / calibration



DTA Model Development

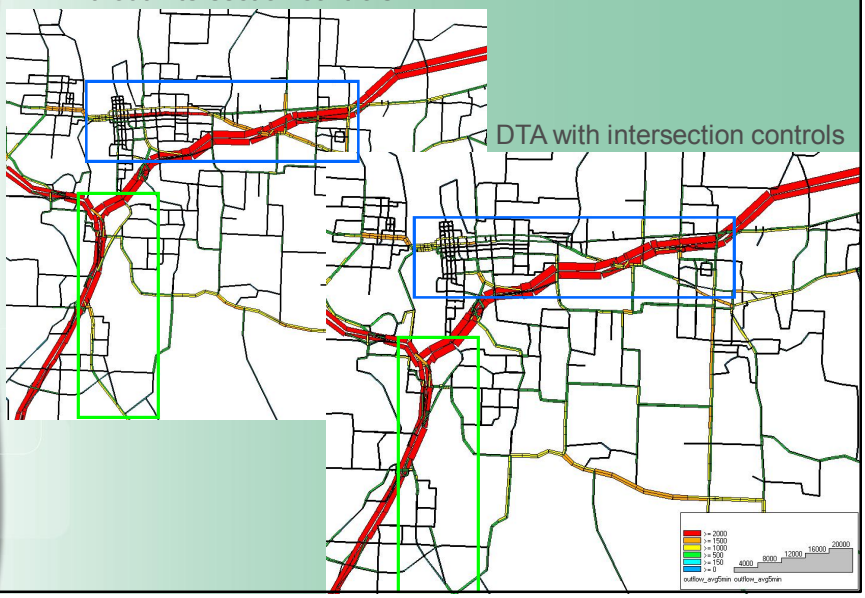
Run DTA with intersection controls without any validation / calibration



DTA Model Development

DTA without intersection controls

DTA with intersection controls



DTA Model Development

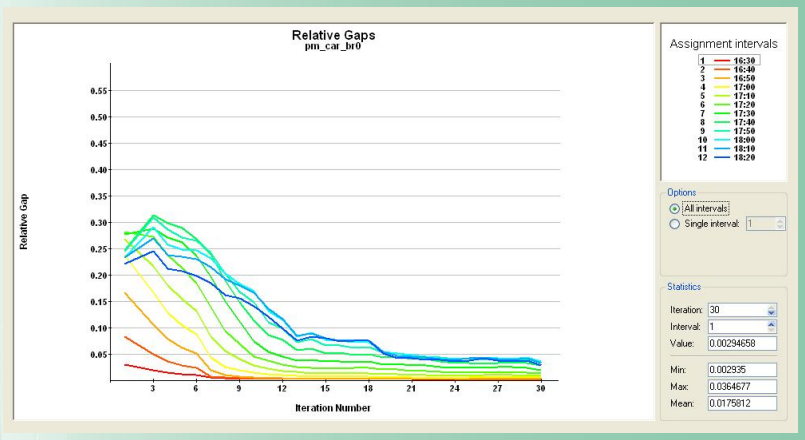
- Validation / Calibration
  - Validated and calibrated the existing year model (study corridors and I-5 primarily)
    - Based on link counts
    - Based on turn move counts
    - Based on travel time on corridors
    - Queuing at hot spots

DTA Model Development

General Approaches to Validate / Calibrate the models

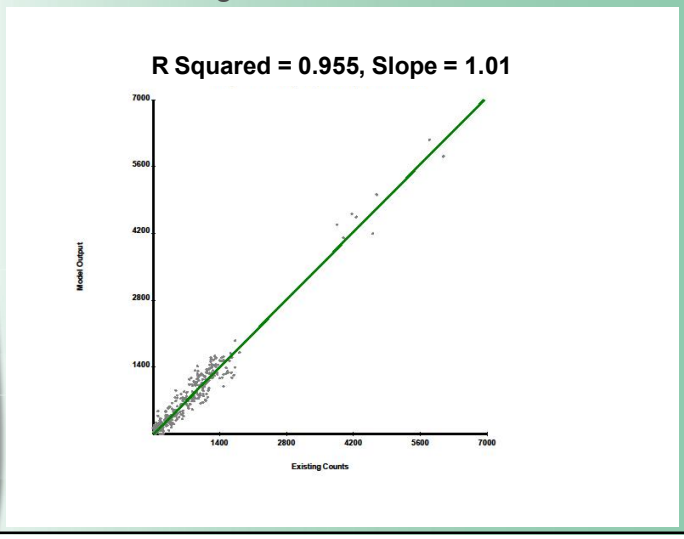
	Static Assignment Model	Dynamic Assignment Model
Validation	Counts	Counts
		Travel times / speeds /queues
	Network measures (VMT, VHT etc)	Network measures (VMT, VHT etc)
	Traveling paths	Traveling paths
Calibration	Link/node properties	Link/node/**movement** properties
	Turn penalties	**Driver behavior properties (response time, follow up time, gap acceptance)**
		Intersection control properties
	Demand adjustment	Demand adjustment

Model Convergence



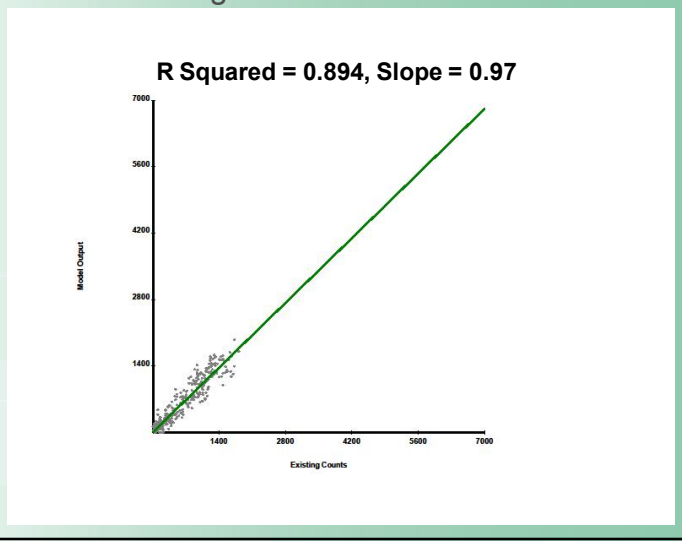
Existing Model Validation / Calibration – Link Volume

Including I-5

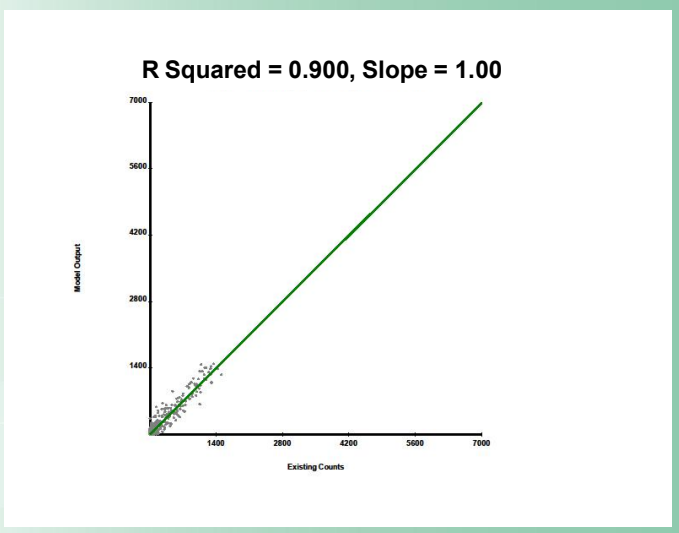


Existing Model Validation / Calibration – Link Volume

Excluding I-5

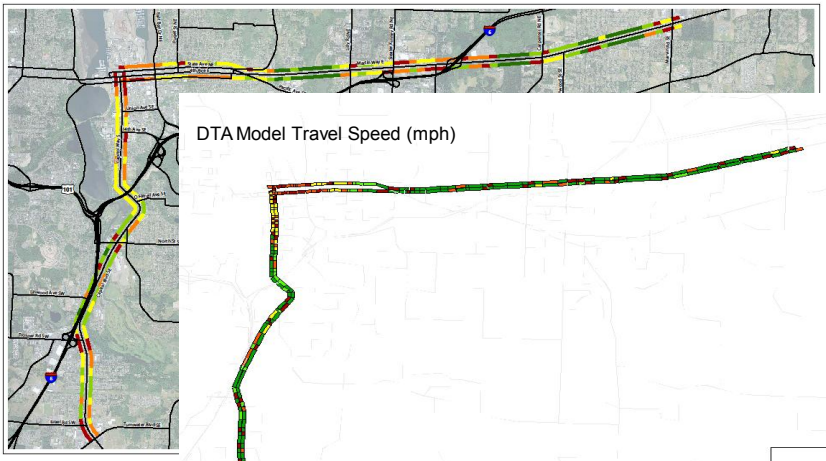


Existing Model Validation / Calibration – Turn Movement



Comparison of Travel Speed

Weekday Observed Travel Speed (mph)



DTA Model Travel Speed (mph)

Existing Model Validation / Calibration – Travel Time

Observed Travel Time (sec)

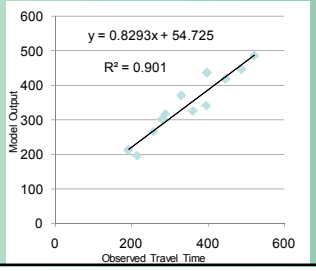
Martin Way SE	WB	EB
500 Ft. E of Marvin Rd NE - I-5 SB Ramps	521	488
I-5 SB Ramps - Pacific Ave SE	397	446
State Ave NE		
Pacific Ave SE - Capitol Way S	257	N/A
4th Ave S		
Capitol Way S - Pacific Ave SE	N/A	280
Capitol Way S/Capitol Blvd S	**NB**	**SB**
State Ave NE - Carlyon Ave SE	395	330
Carlyon Ave SE - Linwood Ave SW	214	192
Linwood Ave SW - Tumwater Blvd SW	289	360

Model Travel Time (sec)

Martin Way SE	WB	EB
500 Ft. E of Marvin Rd NE - I-5 SB Ramps	485	447
I-5 SB Ramps - Pacific Ave SE	437	418
State Ave NE		
Pacific Ave SE - Capitol Way S	265	N/A
4th Ave S		
Capitol Way S - Pacific Ave SE	N/A	301
Capitol Way S/Capitol Blvd S	**NB**	**SB**
State Ave NE - Carlyon Ave SE	341	370
Carlyon Ave SE - Linwood Ave SW	196	212
Linwood Ave SW - Tumwater Blvd SW	317	325

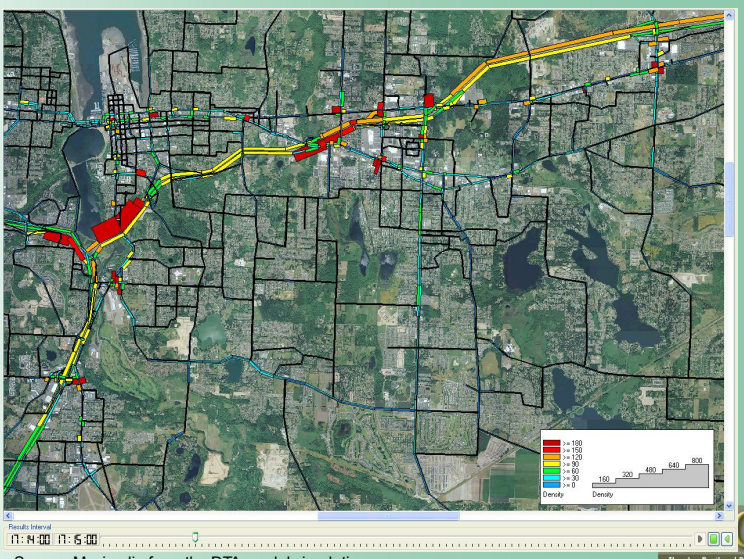
Travel Time Comparison (Model-Observed) /Observed

Martin Way SE	WB	EB
500 Ft. E of Marvin Rd NE - I-5 SB Ramps	-6.9%	-8.4%
I-5 SB Ramps - Pacific Ave SE	10.1%	-6.3%
State Ave NE		
Pacific Ave SE - Capitol Way S	3.1%	N/A
4th Ave S		
Capitol Way S - Pacific Ave SE	N/A	7.5%
Capitol Way S/Capitol Blvd S	**NB**	**SB**
State Ave NE - Carlyon Ave SE	-13.7%	12.1%
Carlyon Ave SE - Linwood Ave SW	-8.4%	10.4%
Linwood Ave SW - Tumwater Blvd SW	9.7%	-9.7%



Existing Model Simulation

• Density

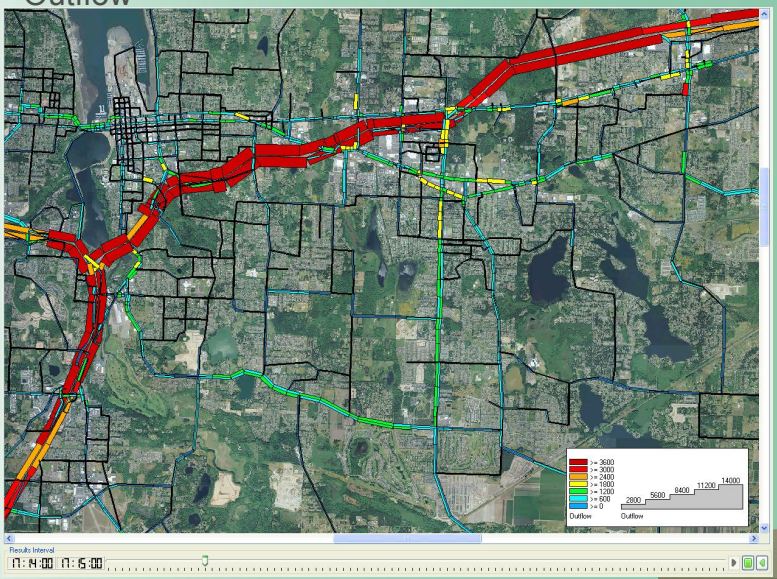


Source: Movie clip from the DTA model simulation

Thurston Regional Planning Council

Existing Model Simulation

• Outflow

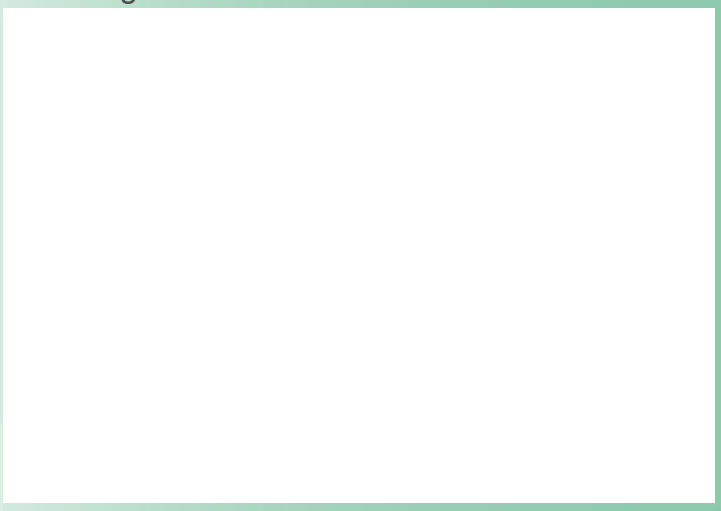


Source: Movie clip from the DTA model simulation

Thurston Regional Planning Council

Existing Model Simulation

- Queuing



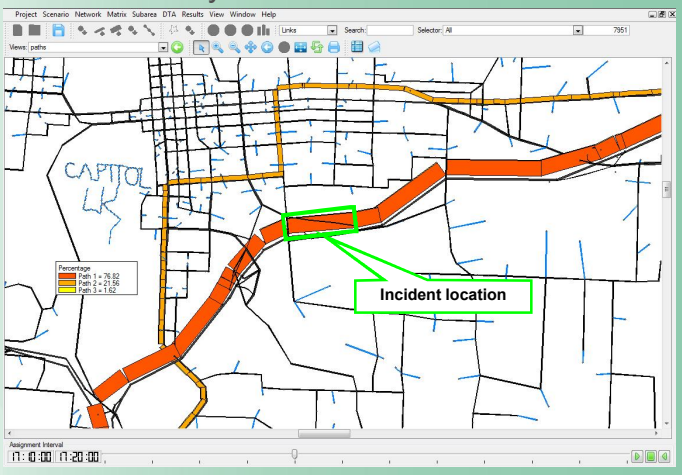
Source: Movie clip from the DTA model simulation

Existing Model Simulation

- Incident Analysis
  - Tested on I-5 SB in the vicinity with two-lane closure
  - Separated car and truck demands into two
    - -- external-external trips
    - -- others
  - Run 10 more iterations with incident lane closure.

Existing Model Simulation

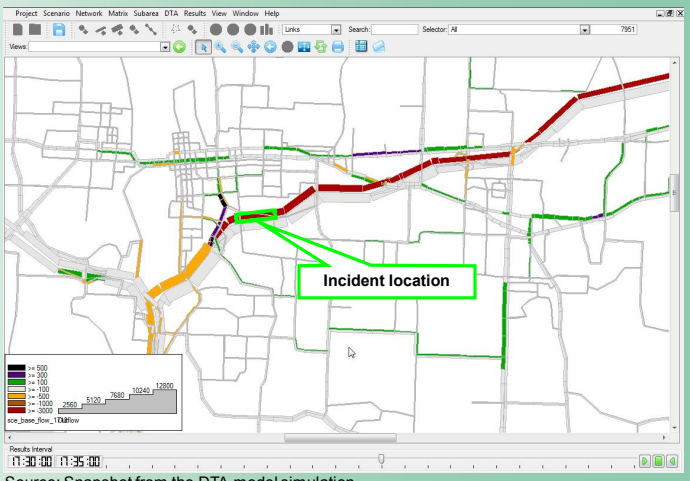
- Incident Analysis – Paths



Source: Snapshot from the DTA model simulation

Existing Model Simulation

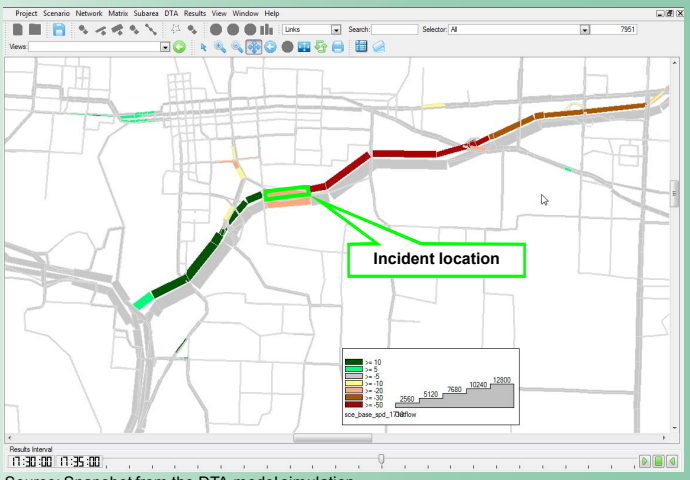
- Incident Analysis – Flow change



Source: Snapshot from the DTA model simulation

Existing Model Simulation

- Incident Analysis – Speed change



Source: Snapshot from the DTA model simulation

Emission Calculation

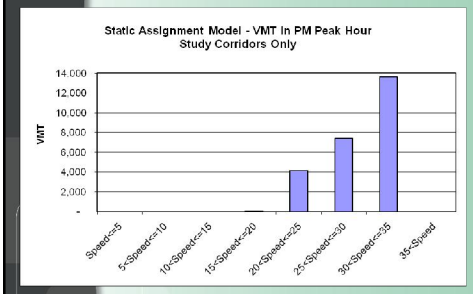
EMFAC2007 Running Emissions Factors in Grams per Mile for Year 2009 Conditions in North Coast

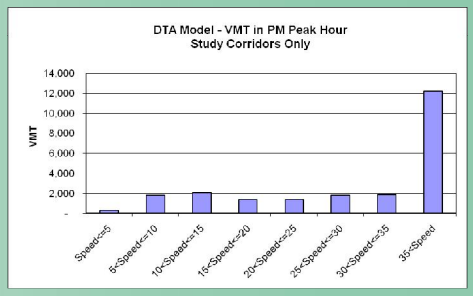
Speed Bin (MPH)	Total Organic Gasses (TOG)	Sulfur Dioxide (SO2)	Diesel Particulate Matter (Diesel PM)	Particulate Matter < 2.5 microns (PM 2.5)	Particulate Matter < 10 microns (PM10)	Oxides of Nitrogen (NOx)	Carbon Dioxide (CO2)	Carbon Monoxide (CO)
0-5	2.074	0.013	0.15755	0.212	0.231	3.776	1,279.87	14.878
5-10	1.35	0.01	0.109135	0.145	0.158	2.87	984.068	11.86
10-15	0.891	0.008	0.073715	0.099	0.108	2.295	782.681	9.8
15-20	0.639	0.006	0.053015	0.072	0.078	2.029	646.1	8.372
20-25	0.511	0.005	0.044505	0.059	0.064	1.915	561.297	7.383
25-30	0.425	0.005	0.038065	0.049	0.054	1.838	503.436	6.673
30-35	0.37	0.005	0.033695	0.043	0.047	1.793	465.449	6.177
35-40	0.337	0.004	0.03128	0.04	0.043	1.778	443.148	5.865
40-45	0.323	0.004	0.03082	0.039	0.042	1.793	434.315	5.727
45-50	0.326	0.004	0.0322	0.04	0.043	1.84	438.243	5.779
50-55	0.347	0.004	0.035535	0.043	0.047	1.924	455.592	6.062
55-60	0.388	0.005	0.040595	0.049	0.053	2.051	488.528	6.664
60-65	0.456	0.005	0.047495	0.057	0.062	2.234	541.17	7.742
60-70	0.502	0.005	0.05612	0.065	0.071	2.41	551.148	8.576
70-75	0.572	0.006	0.0667	0.075	0.082	2.663	566.512	10.013

Note: EMFAC has unusual emissions factors for CO2 for speeds above 65 MPH, modify or use with caution.

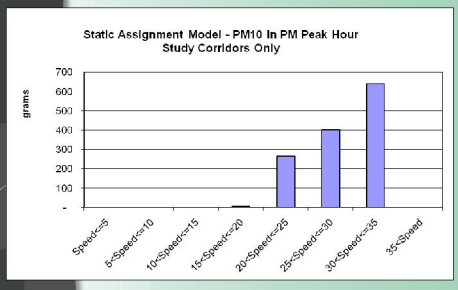
Source: CTEMFAC 2.6, UC Davis and Caltrans, Sept 21, 2009. Model Run By: Fehr & Peers, 2009

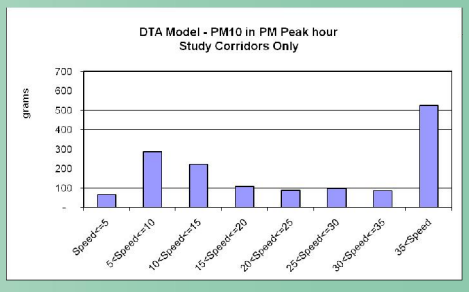
Comparison of VMT Output





Comparison of PM10 Calculation



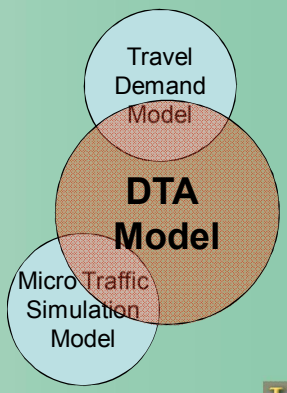


Benefits of DTA Model

- More realistic traffic simulation
  - Lane based simulation
  - Traffic congestion / queuing
  - Intersection delays
- Region-wide traffic operation model
- Hot spot identification
- Corridor analysis
- Incident management
- Work zone analysis
- Evacuation plan
- Emission Calculation

Lessons Learned

- Data needs
- Network resolution
- Validation/Calibration
- MOEs



Do you have any questions on this presentation or related issues?

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