Peer Review
Transportation Models

SANDAG

June 23, 2005

MODEL OVERVIEW

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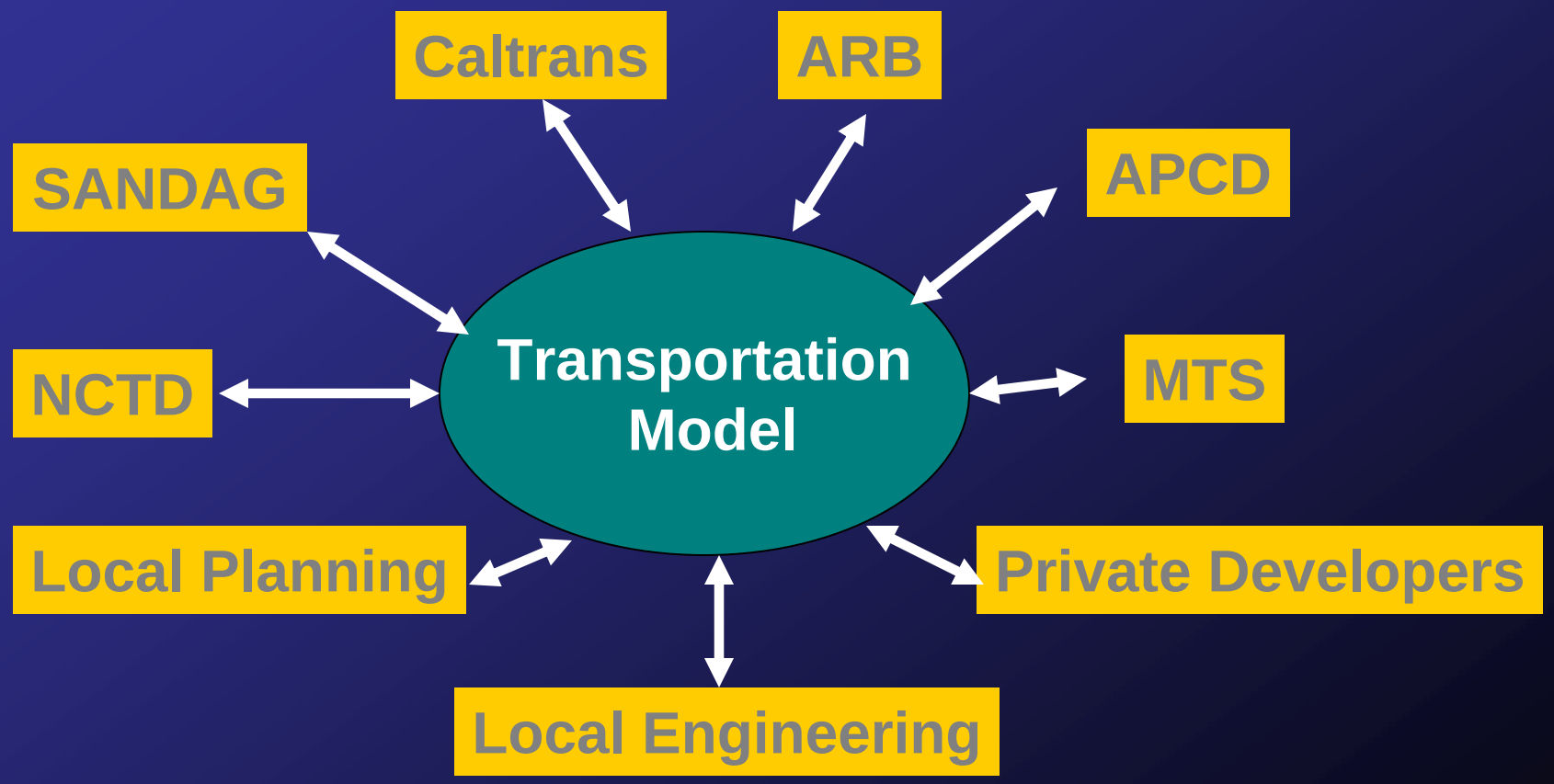
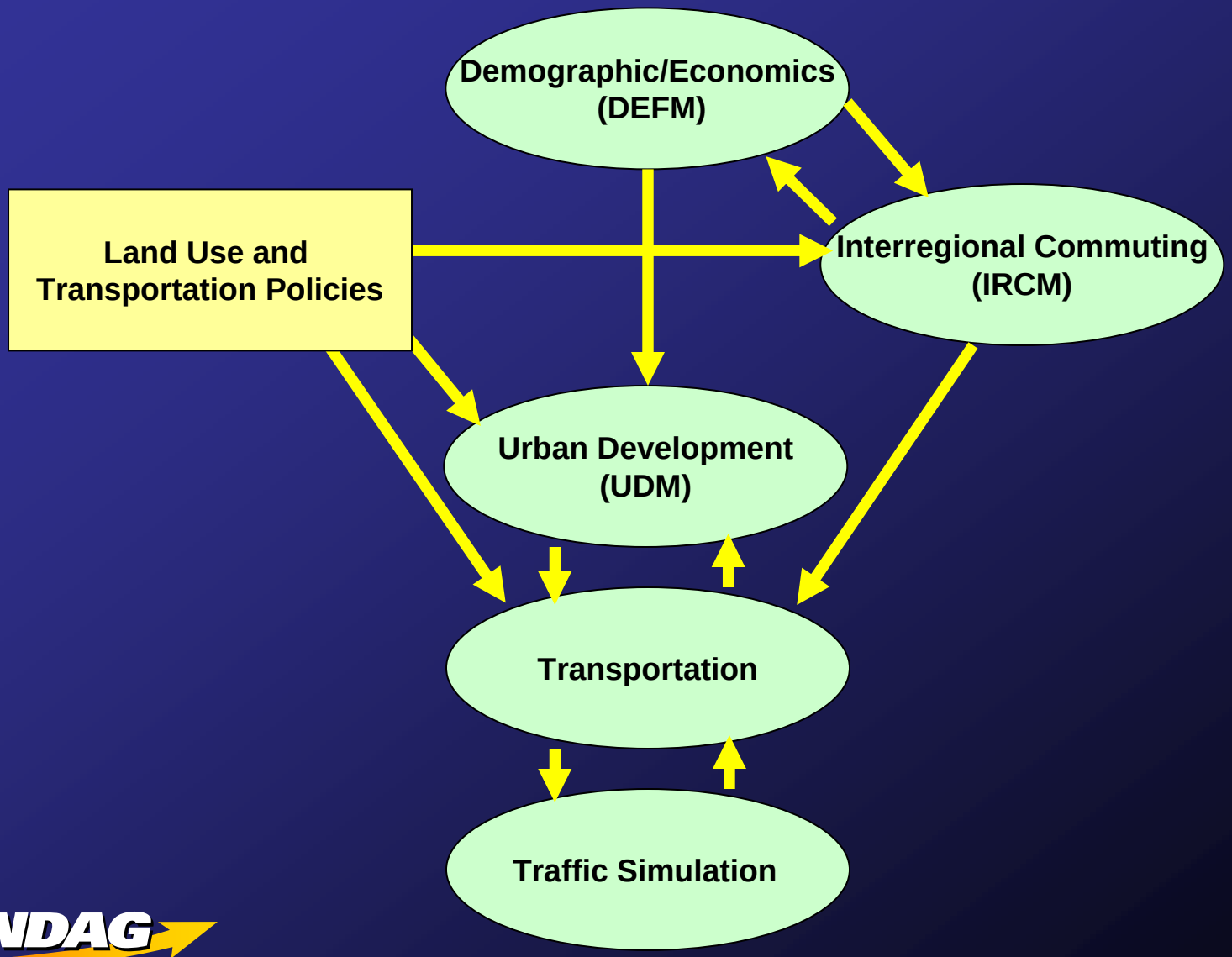
Model Users and Data Sources



Model Components



SANDAG FOCUS

- Base year accuracy
- Detail-oriented
- Consistency of results
- Efficiency
- Effective reports and graphics

Major Planning Milestones

April,2000	2020 Regional Transportation Plan
August,2002	TransitWorks Strategy
March,2003	2030 Regional Transportation Plan
July, 2004	Regional Comprehensive Plan
November,2004	TransNet Extension
April,2007?	2030 Regional Transportation Plan

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Current Model Improvements

Urban Development Model

Parcel-based forecasts

Trip Distribution

Multiple feedback loops

Multi-modal impedances

Mode Choice

Interim "New Starts" model

Estimation of new model with SANDAG data

Surveys

2006 Home Interview Survey

2006 Vehicle Classification Survey

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Model Execution Time

Model Steps	Execution Time	
Initial Processing	**Minutes**	**Hours**
Trip Generation	1	0.02
Highway Network & Skimming	7	0.12
Transit Network	7	0.12
Total	15	0.25
Feedback Loop Processing		
Trip Distribution (1 period/10 purposes/TDZ)	2	0.03
Vehicle Trip Factoring (3 periods/3 modes/TDZ)	1	0.02
Highway Assignment (3 periods/3 modes/convergence 0.01/TDZ)	90	1.50
Post Processing & Skimming (3 periods/3 modes//TDZ)	16	0.27
Total	107	1.78
Final Iteration Processing		
Highway Network & Skimming (2 periods/8 modes/TAZ)	30	0.50
Transit Network & Skimming (2 periods/2 ride modes/2 access modes/TAP)	27	0.45
Mode Choice (2 periods/6 purposes/3 incomes/19 modes/TAZ)	48	0.80
Transit Assignment (2 periods/2 ride modes/2 access modes/TAP)	28	0.47
Highway Assignment (3 periods/8 modes/convergence 0.01/TAZ)	290	4.83
Total	366	6.10
Grand Total	488	8.13

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2030 RTP
Travel Model Forecasts

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Travel Changes

Year	Population	Vehicle Miles	VMT/Person	Change From Previous Decade		
				Population	Vehicle Miles	VMT/Person
1980	1,861,846	36,700,064	19.7			
1990	2,498,016	62,767,139	25.1	34.2%	71.0%	27.5%
2000	2,813,833	74,690,159	26.5	12.6%	19.0%	5.6%
2010	3,211,721	89,177,342	27.8	14.1%	19.4%	4.6%
2020	3,528,605	101,977,580	28.9	9.9%	14.4%	4.1%
2030	3,855,085	112,181,590	29.1	9.3%	10.0%	0.7%

Sources:

1980, 1990, 2000 Census	1980, 1990, 2000 ADT Flow Maps
2030 Regional Growth Forecasts	2030 Regional Transportation Plan

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Highway Lane Miles

Facility Type	2000	2030	Change
Freeways-Main Lanes	2,173	2,553	17%
Freeways-HOV/ML	25	468	1772%
Freeways-Total	2,197	3,021	38%
Arterials	9,579	12,085	26%
Total	11,776	15,106	28%

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Highway VMT (Millions)

Facility Type	2000	2030	Change
Freeways	37.34	57.73	55%
Arterials	33.69	47.46	41%
Total	71.04	105.19	48%

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Highway Vehicles/Lane

Facility Type	2000	2030	Change
Freeways	16,997	19,110	12%
Arterials	3,517	3,927	12%
Total	6,032	6,963	15%

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Congested Freeway Miles

LOS	2000	2030	Change
E	97	236	43%
F	142	147	3%
E&F	238	317	25%

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Transit System

Ride Mode	Route Miles			Vehicle Miles		
	2000	2030	Change	2000	2030	Change
Commuter Rail	41	38	-9%	955	2,569	169%
Light Rail	46	96	108%	7,245	20,088	177%
Regional BRT	0	199	N/A	0	22,643	N/A
Corridor BRT	0	148	N/A	0	30,800	N/A
Limited Bus	145	91	-37%	2,470	1,285	-48%
Express Bus	236	14	-94%	9,666	2,921	-70%
Local Bus	971	1073	10%	72,325	137,285	90%
System Total	1439	1657	15%	92,661	217,591	135%

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Trips by Mode

Mode	Home-Work			Total Trips		
	2000	2030	Change	2000	2030	Change
Total Auto	1,513,378	1,929,737	28%	13,333,911	18,791,470	41%
- Drive Alone	1,313,198	1,666,365	27%	8,616,178	12,006,830	39%
- 2 Person Carpool	149,140	200,978	35%	2,319,674	3,326,603	43%
- 3+ Person Carpool	51,040	62,394	22%	2,398,059	3,458,038	44%
Total Transit	79,306	212,214	168%	206,966	543,871	163%
- Local Bus	33,619	37,286	11%	108,215	128,247	19%
- Rail/BRT	36,836	173,063	370%	82,385	411,665	400%
- Express Bus	8,851	1,865	-79%	16,366	3,959	-76%
- Walk Access	57,035	131,287	130%	168,676	407,847	142%
- Drive Access	13,916	51,971	273%	20,503	77,105	276%
- Drop-off Access	8,355	28,956	247%	17,787	58,919	231%
School Bus	-	-	N/A	254,166	322,708	27%
Non-motorized	77,155	88,700	15%	1,901,477	2,393,579	26%
Total	1,669,839	2,230,651	34%	15,696,521	22,051,628	40%

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SANDAG Modeling Issues

- Accommodating future population growth
- Travel impacts of smart growth
- Transit ridership expectations
- Representing BRT service
- Managing increasingly complex models

Balancing Act

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Model Overview

Discussion

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By Mike Calandra, Senior Research Analyst

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Service Means

- Local Technical Assistance (LTA)
  - Public sector clientele
- SourcePoint
  - Private sector Clientele

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Service Types

- Survey Design and Analysis
- Demographic and Economic Analysis
- Custom Mapping and GIS Applications
- Other Services
- **Transportation Modeling**

SANDAG Services

Transportation Model Service Staff

Mike Calandra

Senior Research Analyst

Limeng Yu

Associate Transportation Planner

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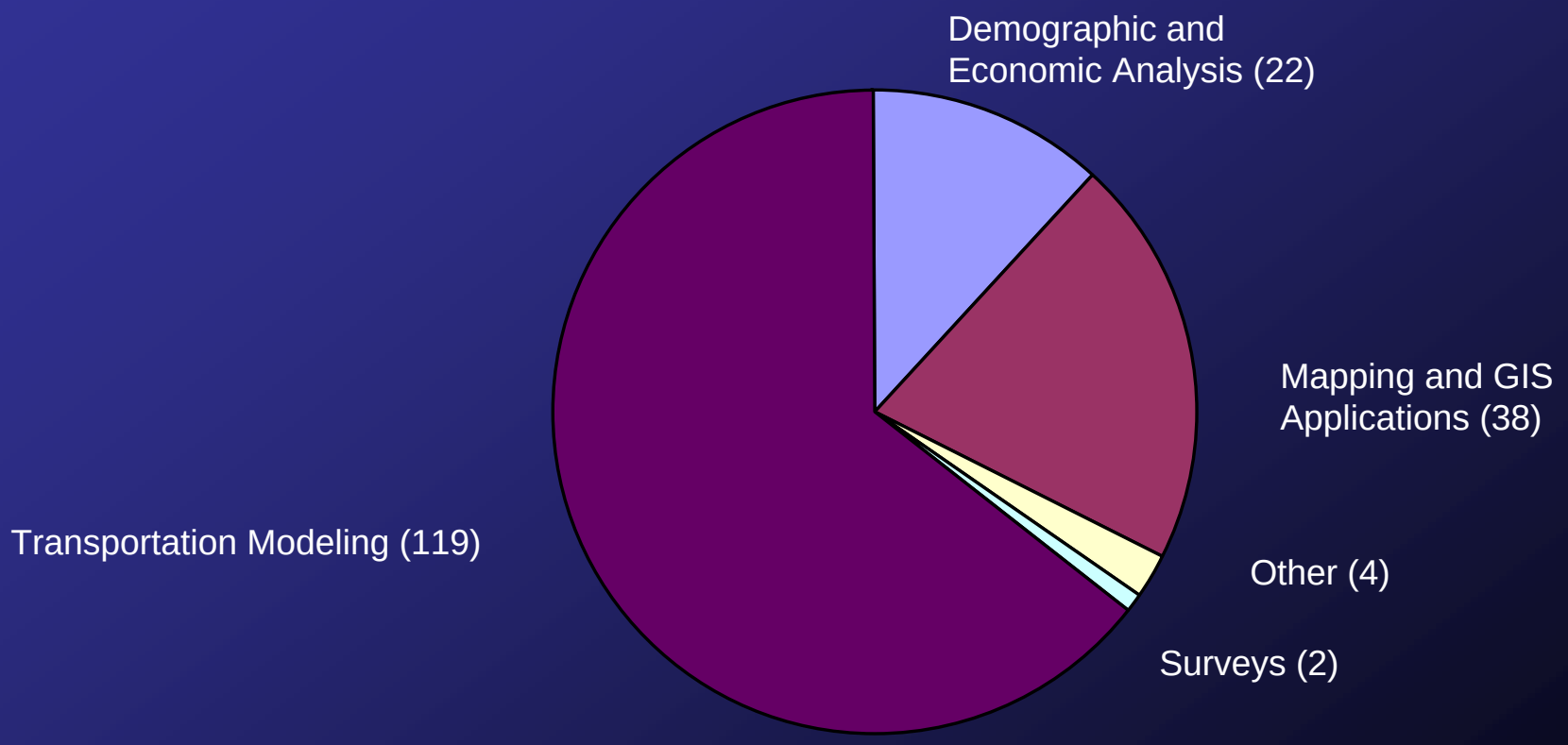
Calendar Year 2004 Jobs (185)



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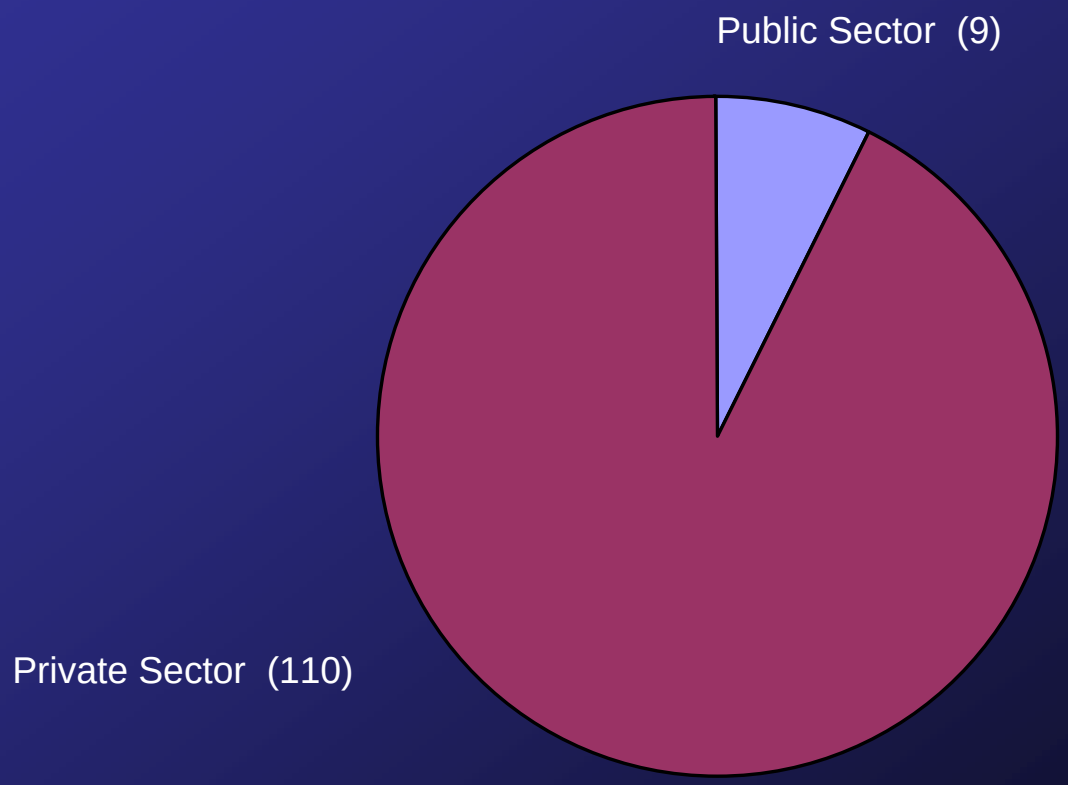
Calendar Year 2004 Transportation Jobs (119)



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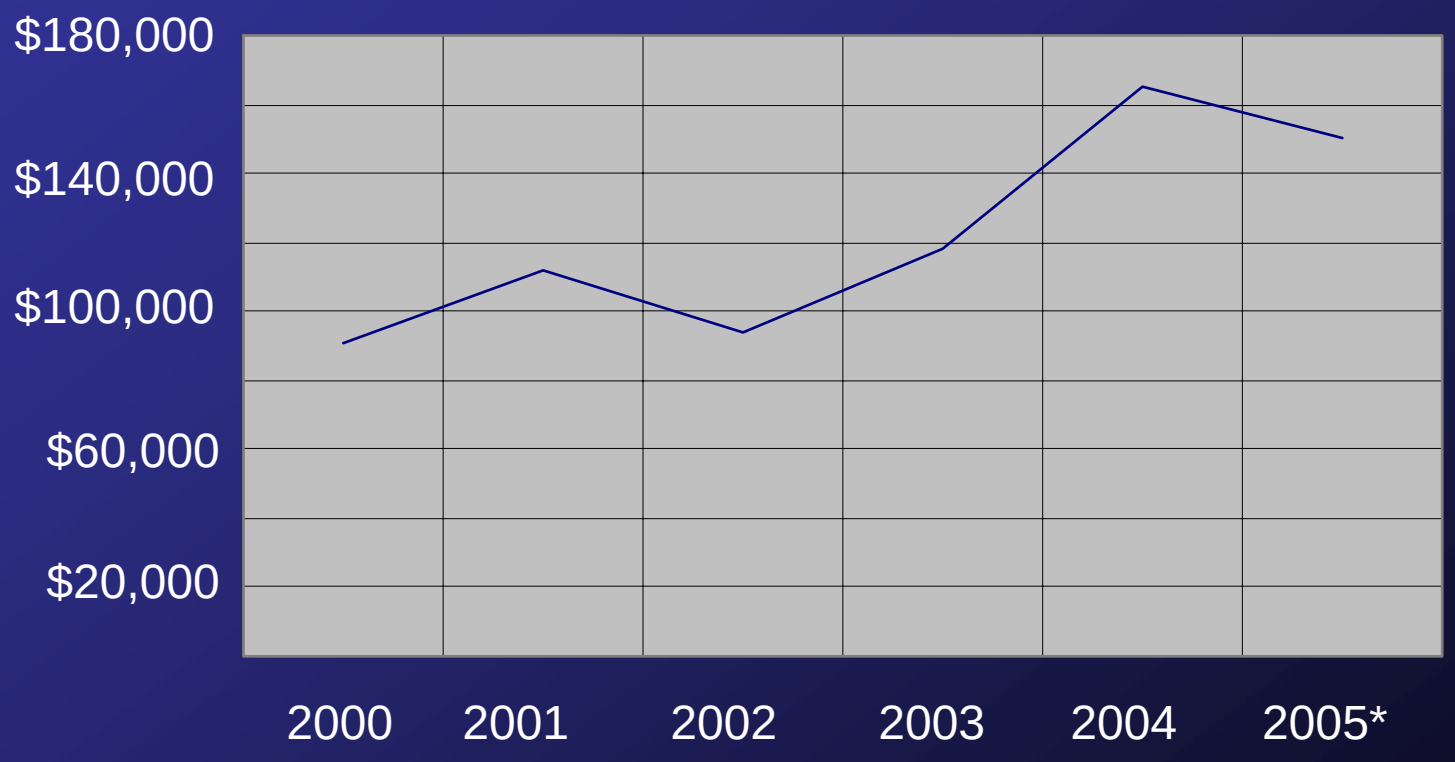
Transportation Modeling Revenue



* Projected

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Transportation Modeling Products

- Subarea Transportation Forecasts (Volume Plots)
- Land Use Distribution (Select Zones)
- Network Distribution (Select Links)
- Intersection Analysis (Turn Reports)
- Travel Time Contour Maps
- Traffic Simulation

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Subarea Transportation Modeling

- Land Use Projects
  - Isolate the project into it's own TAZ
  - Override regional land use assumptions with project-specific land use trip generation
  - Update network to reflect new TAZ
  - Update network to reflect proposed circulation element changes
  - Project select zone assignment and/or turn reports

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Subarea Transportation Modeling

- Network Projects
  - Define network alternatives (usually ‘Build’ Vs. a ‘No Build’ scenarios)
  - Update network to reflect defined alternatives
  - Project select link assignment and/or turn reports

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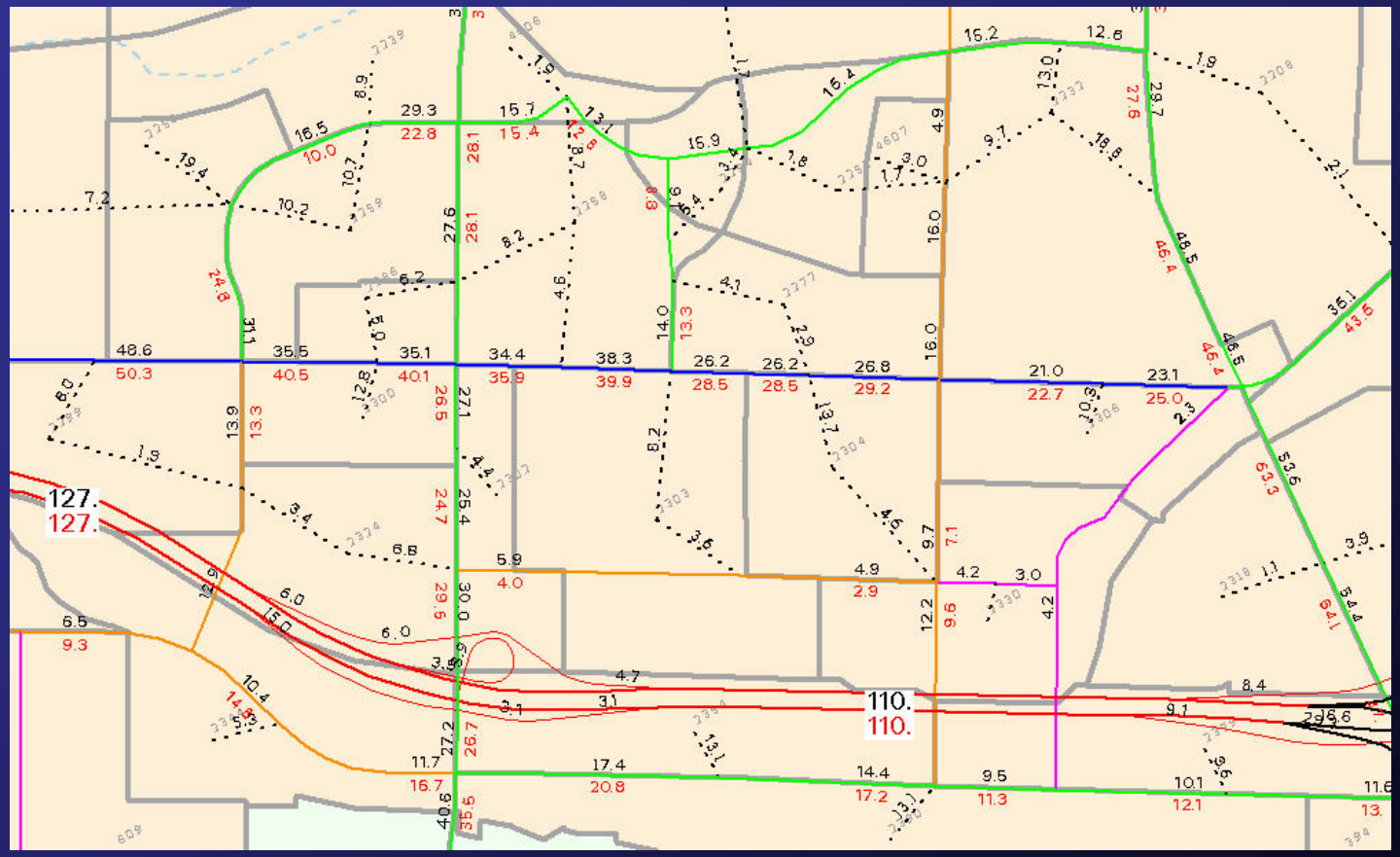
Traffic Volume Map



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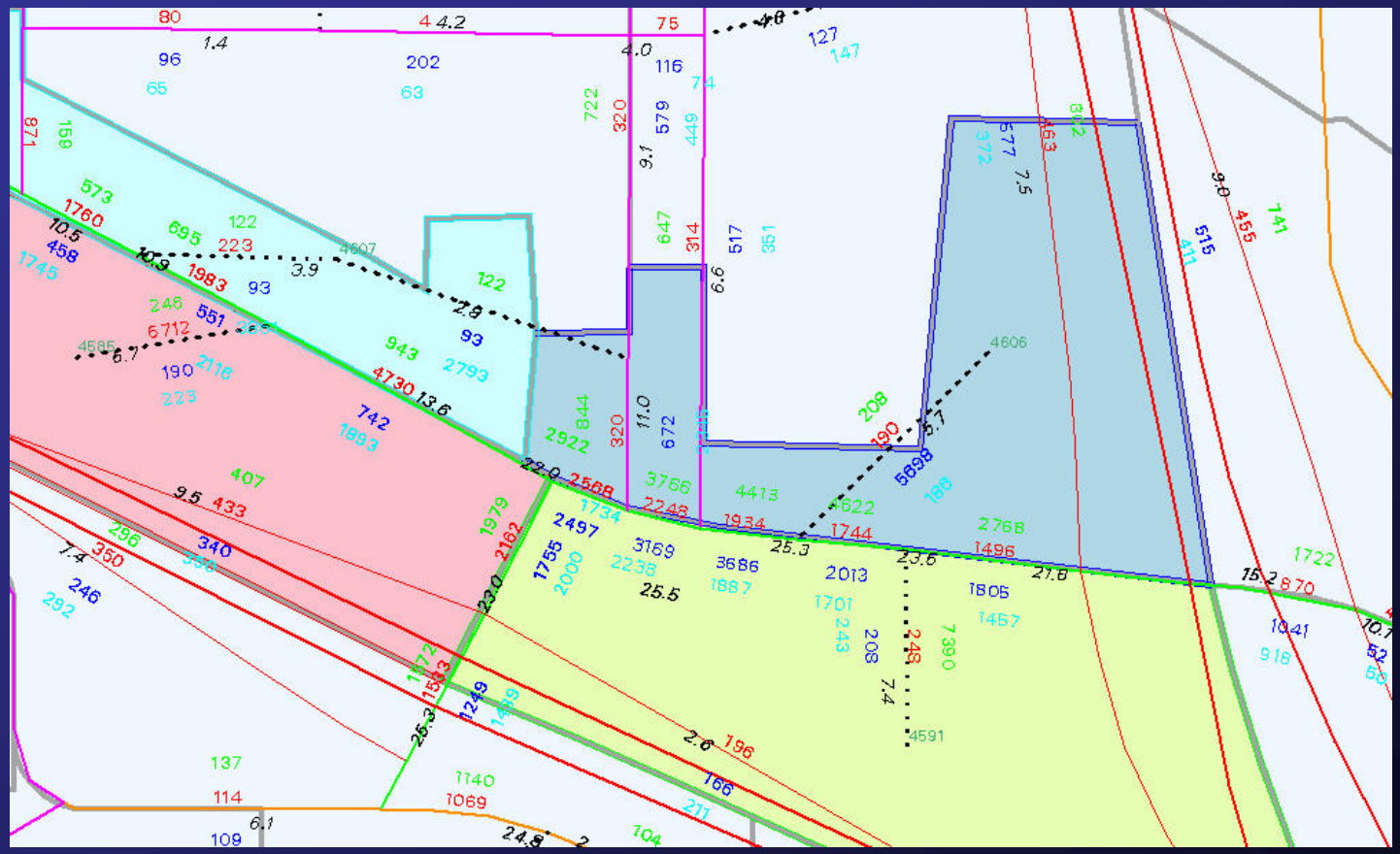
Select Zone Map



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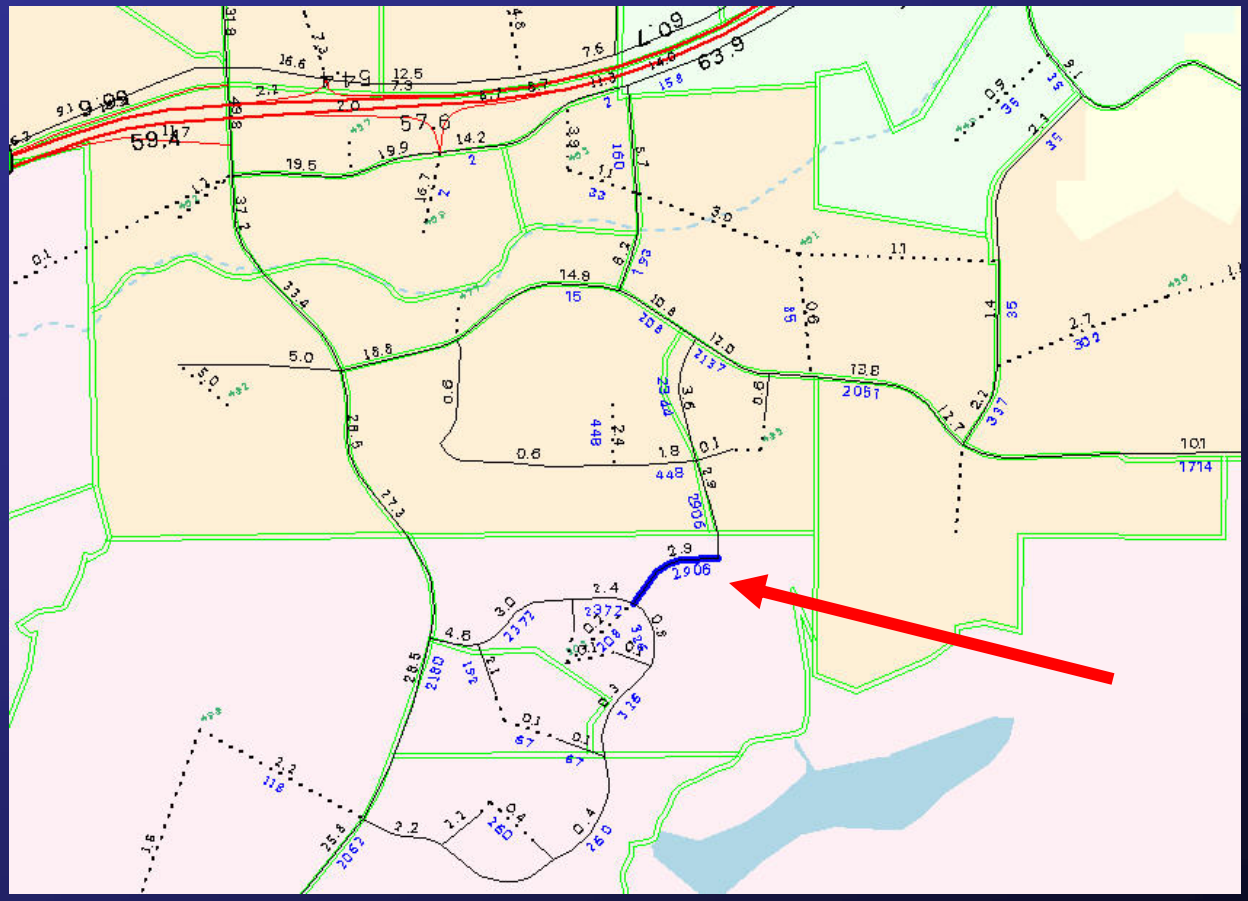
Select Link Map



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Travel Time Contour Map

- To or from any TAZ
- Zone-based analysis uses model skim files for travel times
- Any time period: AM, PM or Off Peak
- Client-defined contour intervals
- Multiple zones can be combined for overlap analysis

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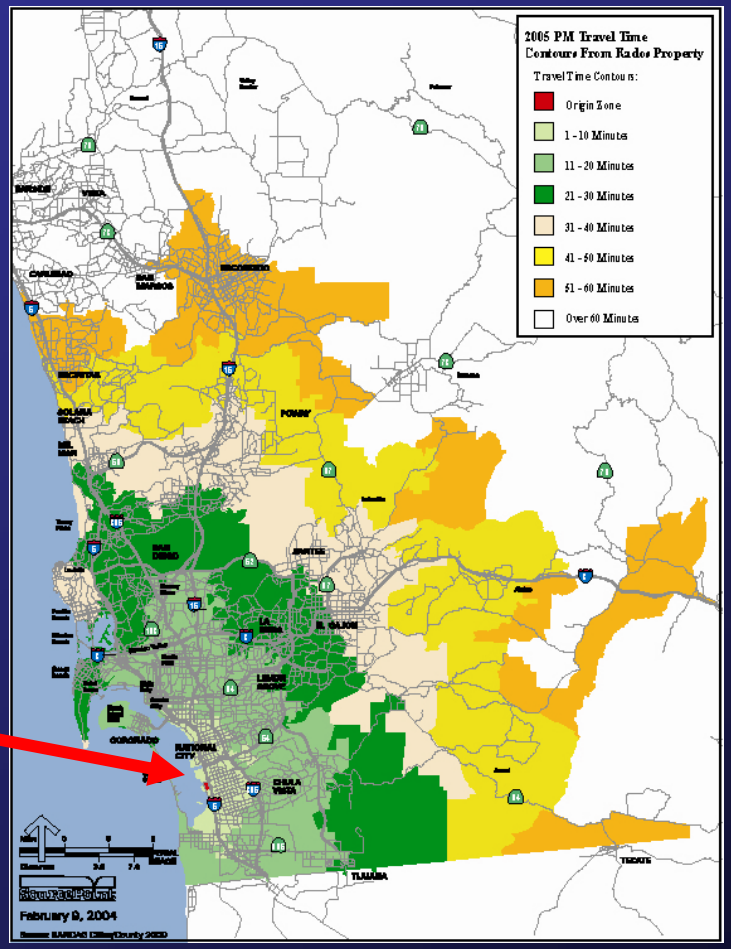
Travel Time Contour Map



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Traffic Simulation Modeling

- When the planning model does not supply adequate detail
- Operations tool applied to planning
- SANDAG's traffic simulation software:
  - Corsim
  - Dynasim

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Traffic Simulation Modeling

FHWA's Corsim

Citilab's Dynasim

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Transportation Modeling Products

- Product Delivery
  - Hard copy maps and print outs
  - Electronic (Email and/or FTP)
    - PDF maps
    - Spread Sheets
    - Arcview/ArcGIS Shape Files
    - Interactive Mapping Applications

DATA SOURCES

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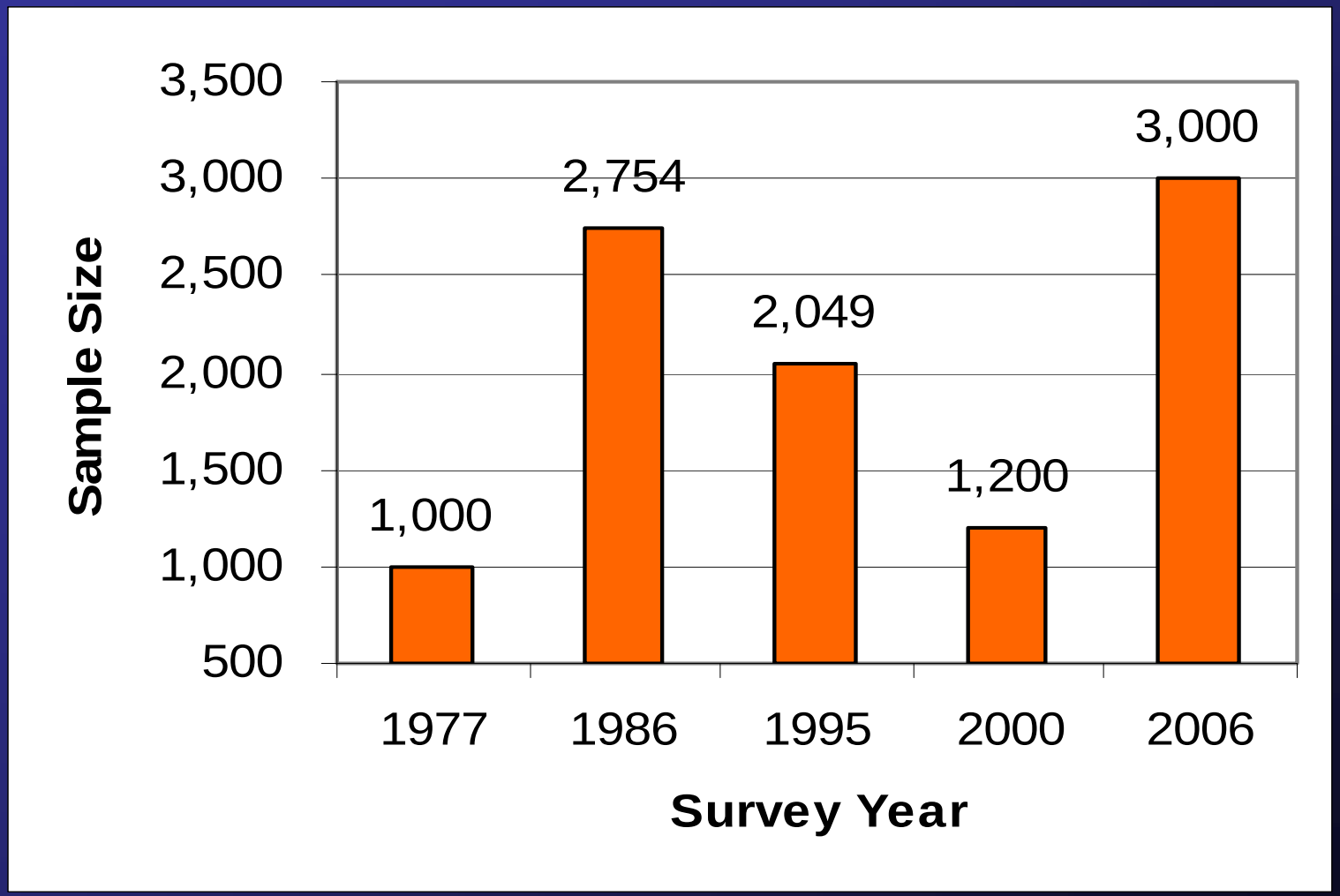
Travel Behavior Surveys



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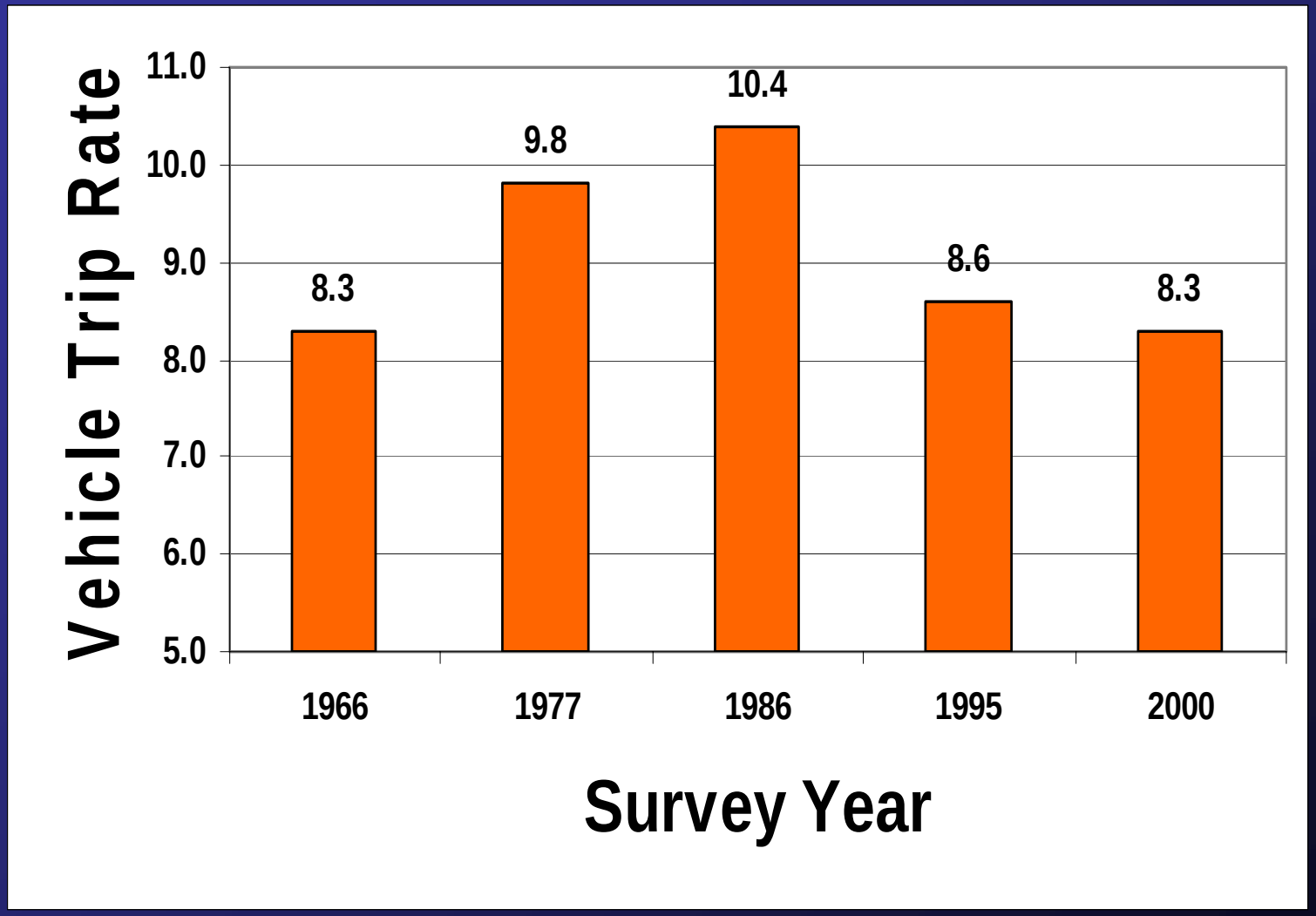
Historical Survey Trip Rates



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California Statewide Travel Survey

- 1,200 San Diego County households
- 104 households with GPS-equipped vehicles
- 1,000 GPS trips out of 4,700 total survey trips
- February-October 2001
- GeoStats

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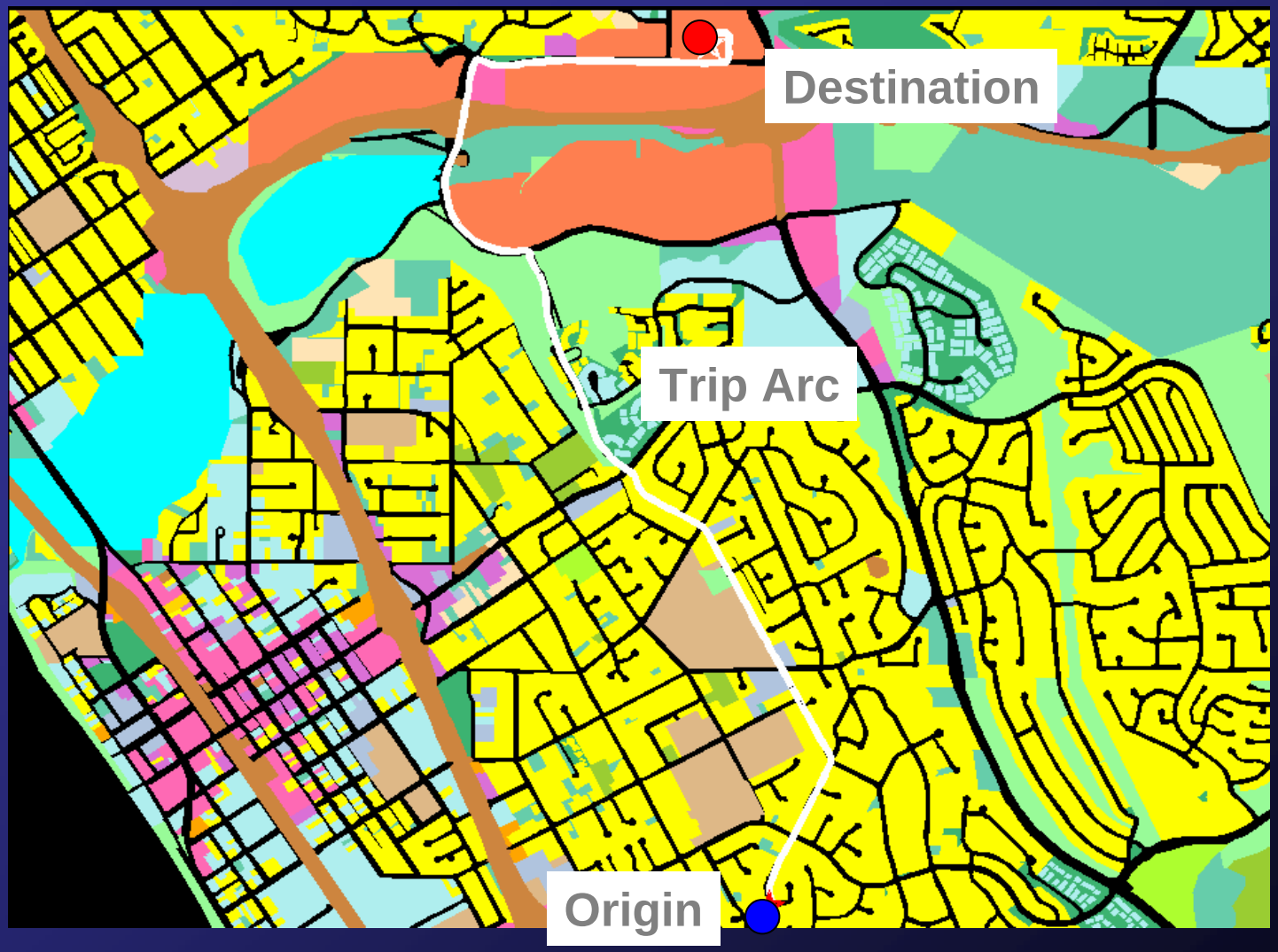
GPS Trip Features



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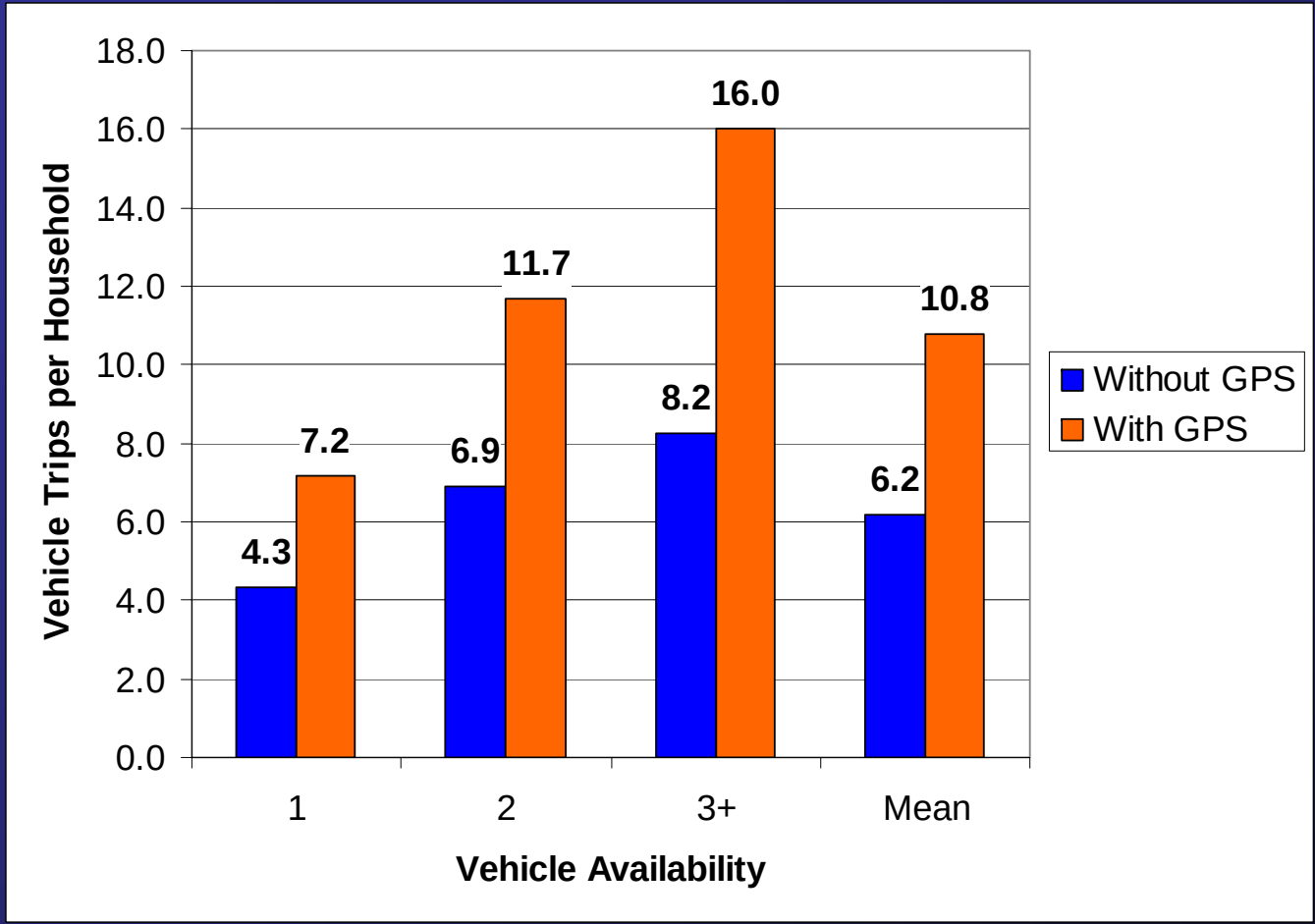
Trip Rate Comparison



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GPS Correction Factors

Trip Purpose	Trip Length	Time Period	Correction Factor
HBW	Short	Off-Peak	1.46
HBW	Short	AM Peak	1.00
HBW	Short	PM Peak	0.91
HBW	Long	Off-Peak	1.06
HBW	Long	AM Peak	0.75
HBW	Long	PM Peak	0.92
HBO	Short	Off-Peak	1.73
HBO	Short	AM Peak	1.58
HBO	Short	PM Peak	1.64
HBO	Long	Off-Peak	1.22
HBO	Long	AM Peak	1.19
HBO	Long	PM Peak	1.05
NHB	Short	Off-Peak	2.56
NHB	Short	AM Peak	2.72
NHB	Short	PM Peak	1.99
NHB	Long	Off-Peak	1.47
NHB	Long	AM Peak	1.72
NHB	Long	PM Peak	1.75

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2006 Travel Behavior Survey

- Spring 2006
- Current budget $350,000 for 3,000 samples
- Seeking additional funding
- GPS sample
- Over sample key travel markets:
  - Regular transit users
  - CBD households/workers
  - Inter-regional commuters
  - Smart growth households

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2001 Transit Ridership Survey

- Basis for mode choice model estimation
- 12,000 of 51,000 forms complete
- Automated procedures to increase sample size

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Potential Data Improvements

- Fill in data gaps
- More rigorous traffic count program
- Automated transit passenger counts
- Integration of PeMS

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Data Sources

Discussion

Highway Networks

By Ziying Ouyang, Associate Analyst

Integrated Multi-Year Management System

- Components
  - Master transportation network database
  - Customized editing menus
  - Series of programs and procedures
  - Spreadsheet of highway projects by scenarios

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Integrated Multi-Year Management System

- Benefits
  - Minimizes coding time
  - Eliminates unintended discrepancies between alternatives
  - Allows comparison of network characteristics
  - Allows model run comparison

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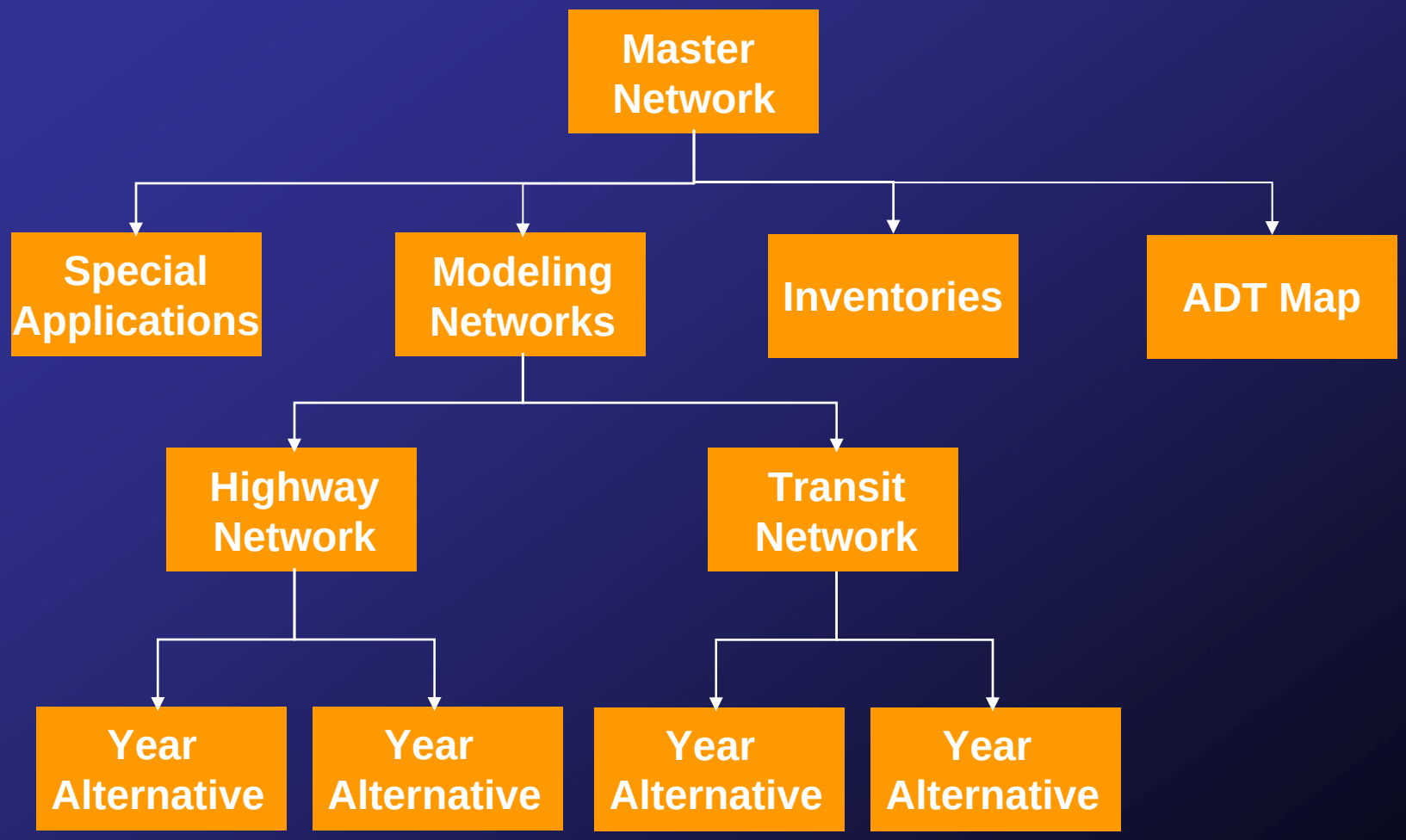
Transportation Database



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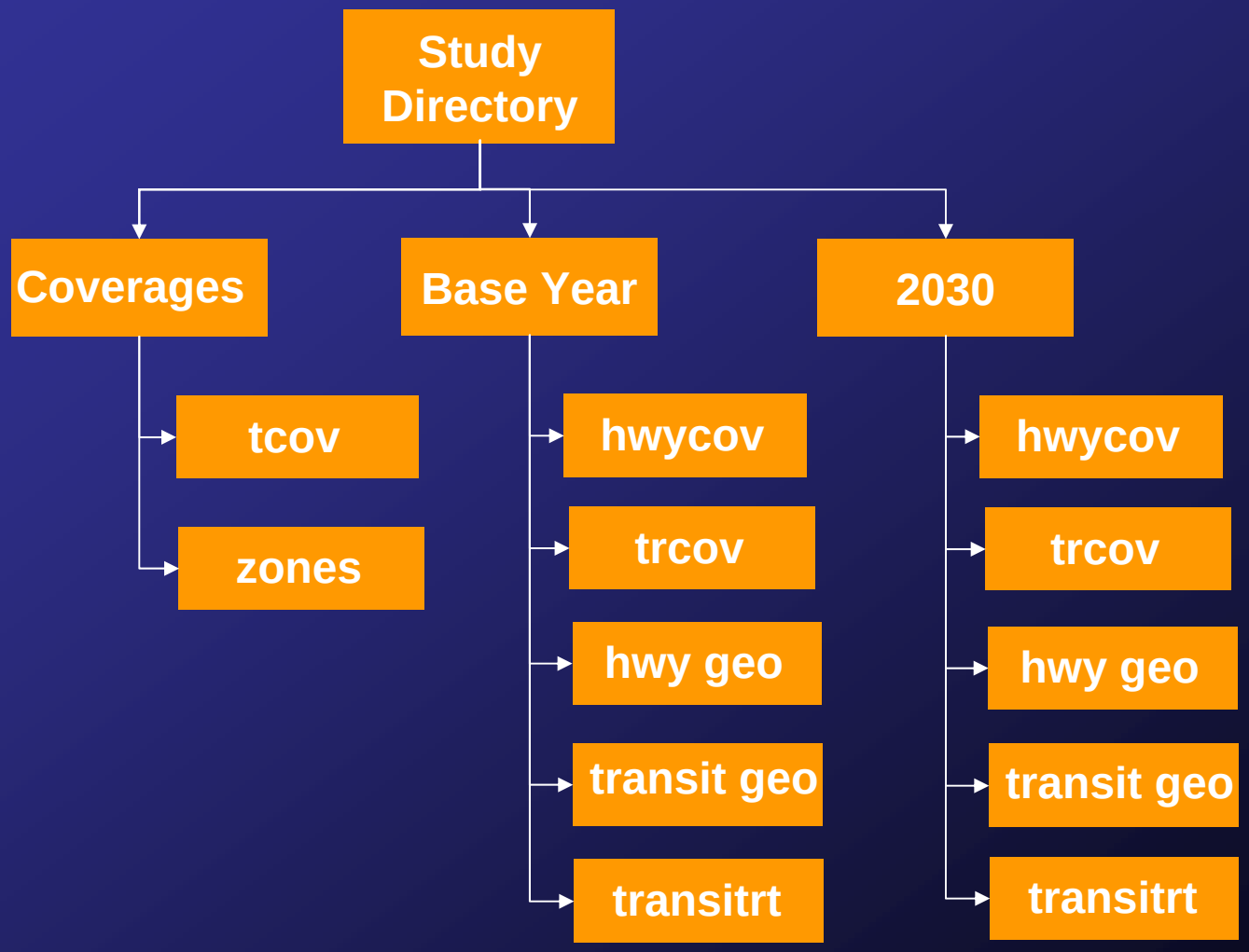
Model Directory Structure



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Transportation Network Facilities

- Freeways
- Freeway ramps
- HOV lanes
- Circulation element streets
- Selected local streets
- Access links
- Commuter and light rail lines
- Bus route streets
- Existing and planned facilities

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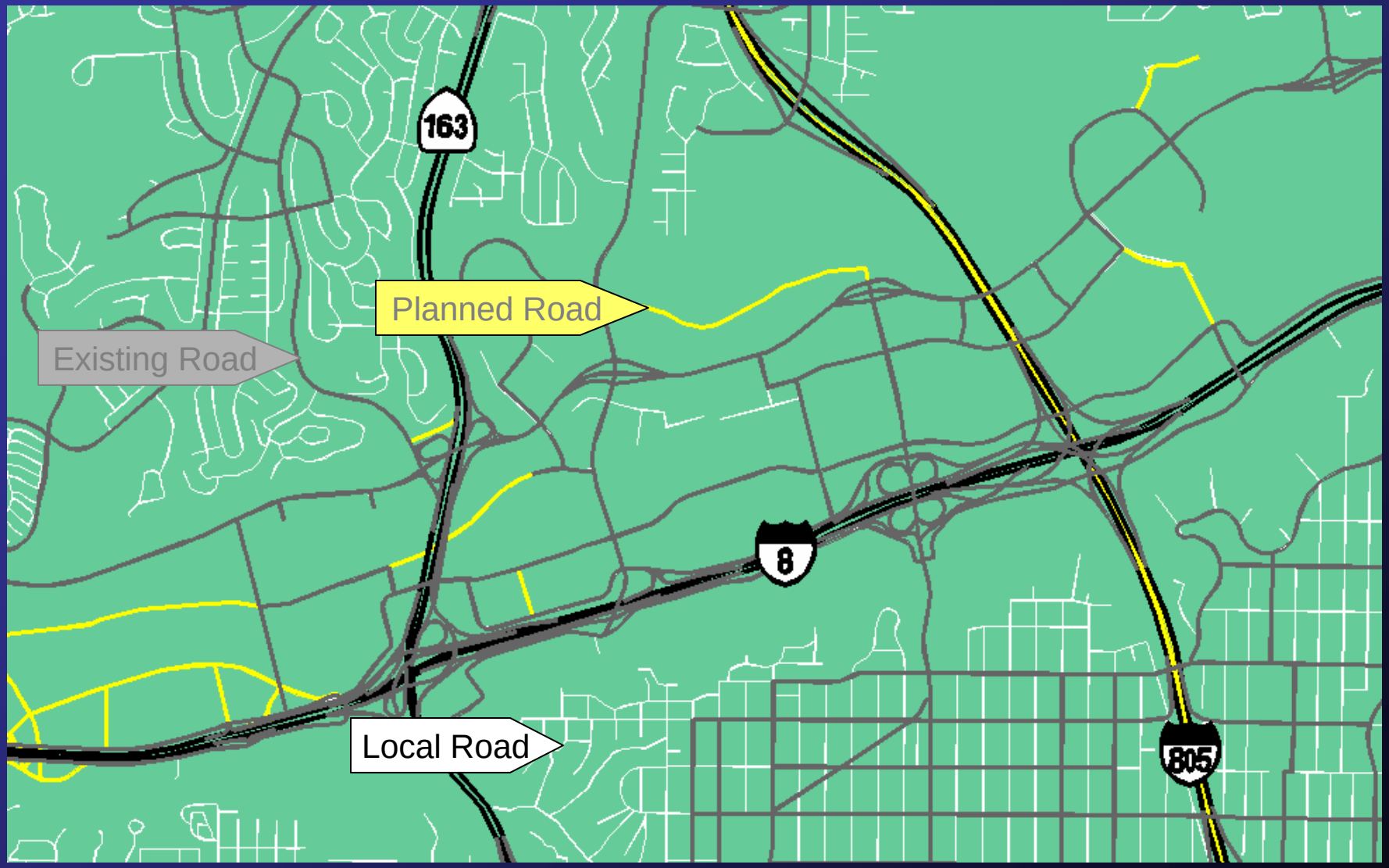
Highway Network



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Network Attributes

- Functional classification
- Lanes
- Median
- Posted speed
- One/two-way
- Phasing
- Intersection controls
- Intersection geometrics
- Turn prohibitions

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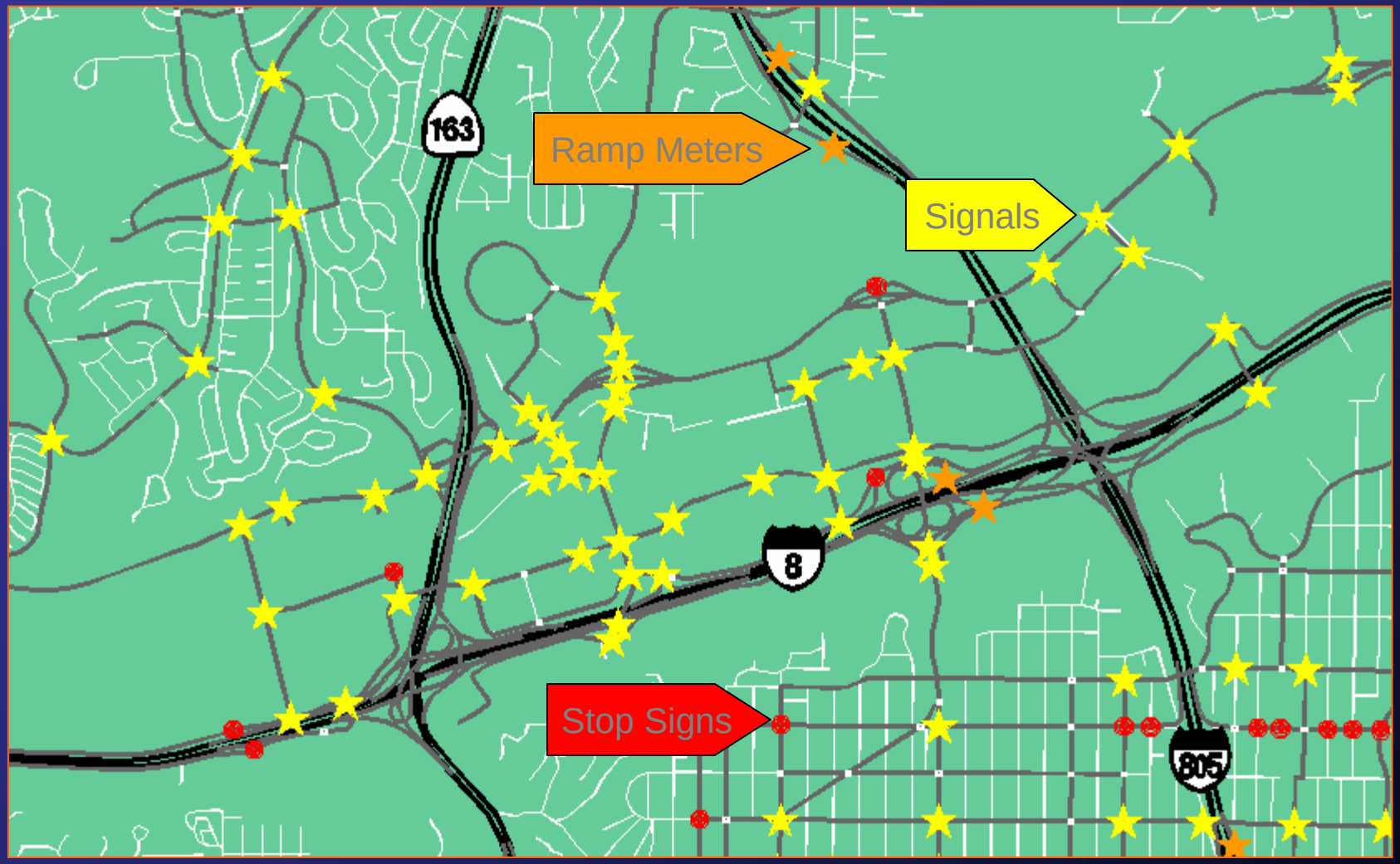
Intersection Controls



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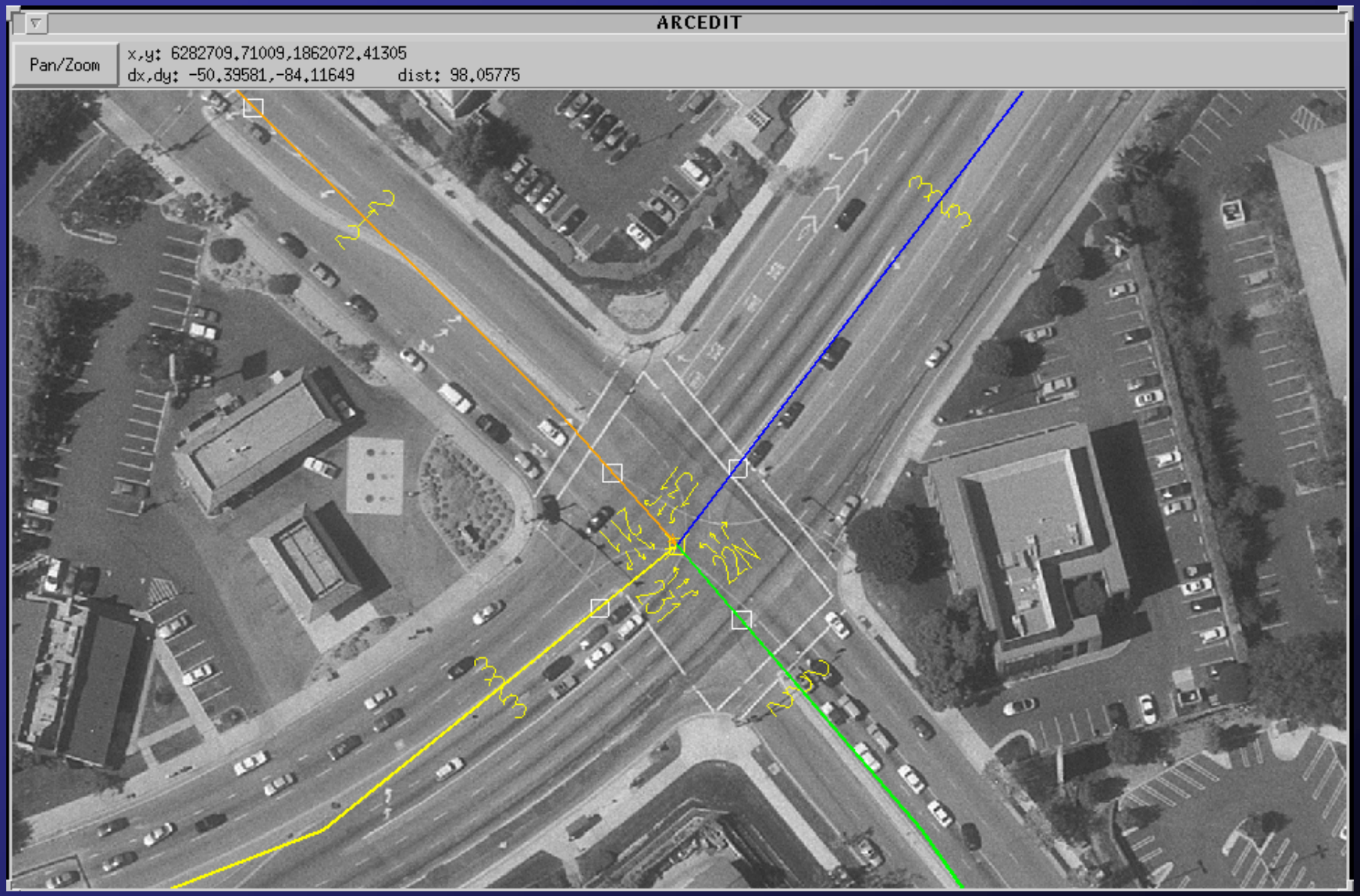
Intersection Editing



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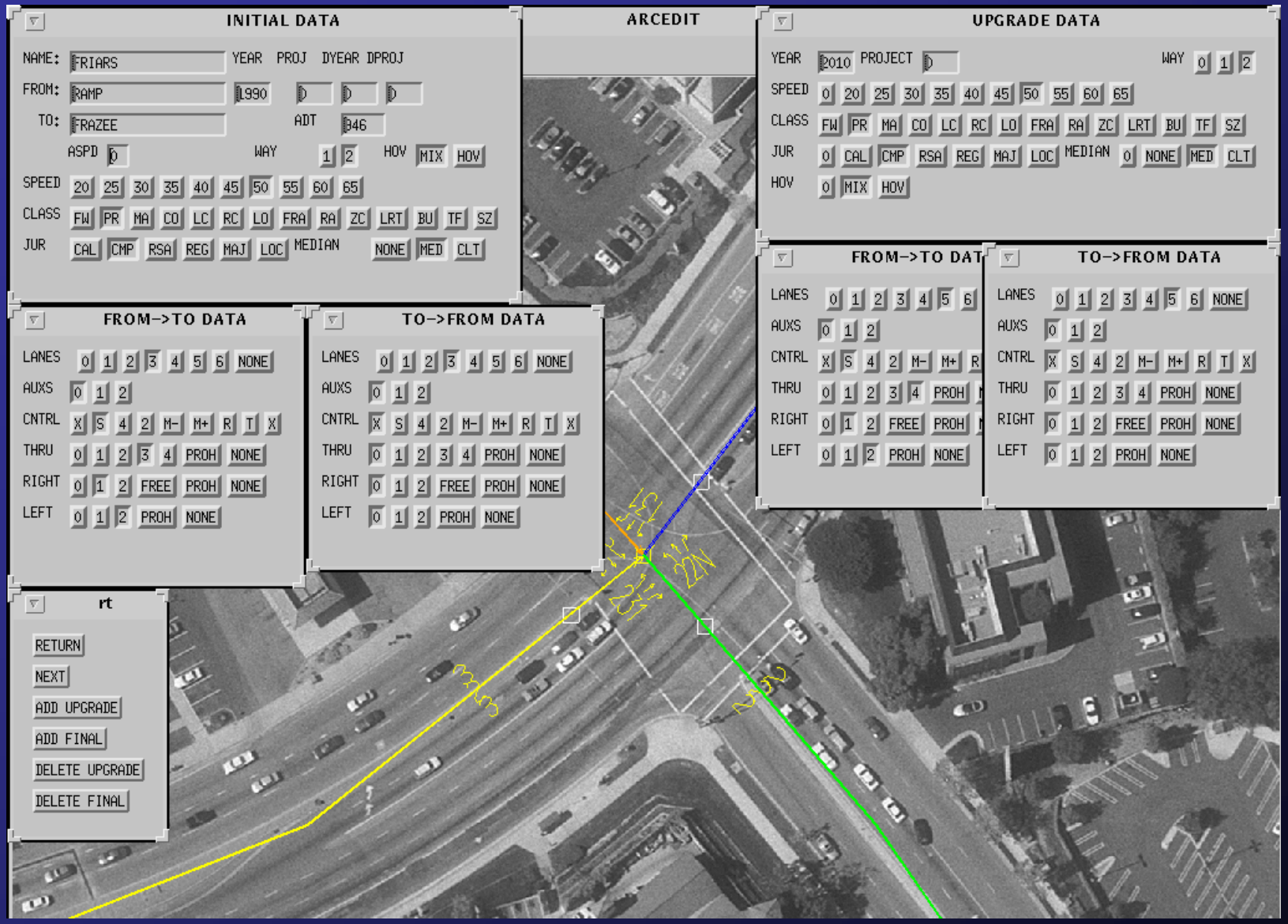
Link Attribute Menu



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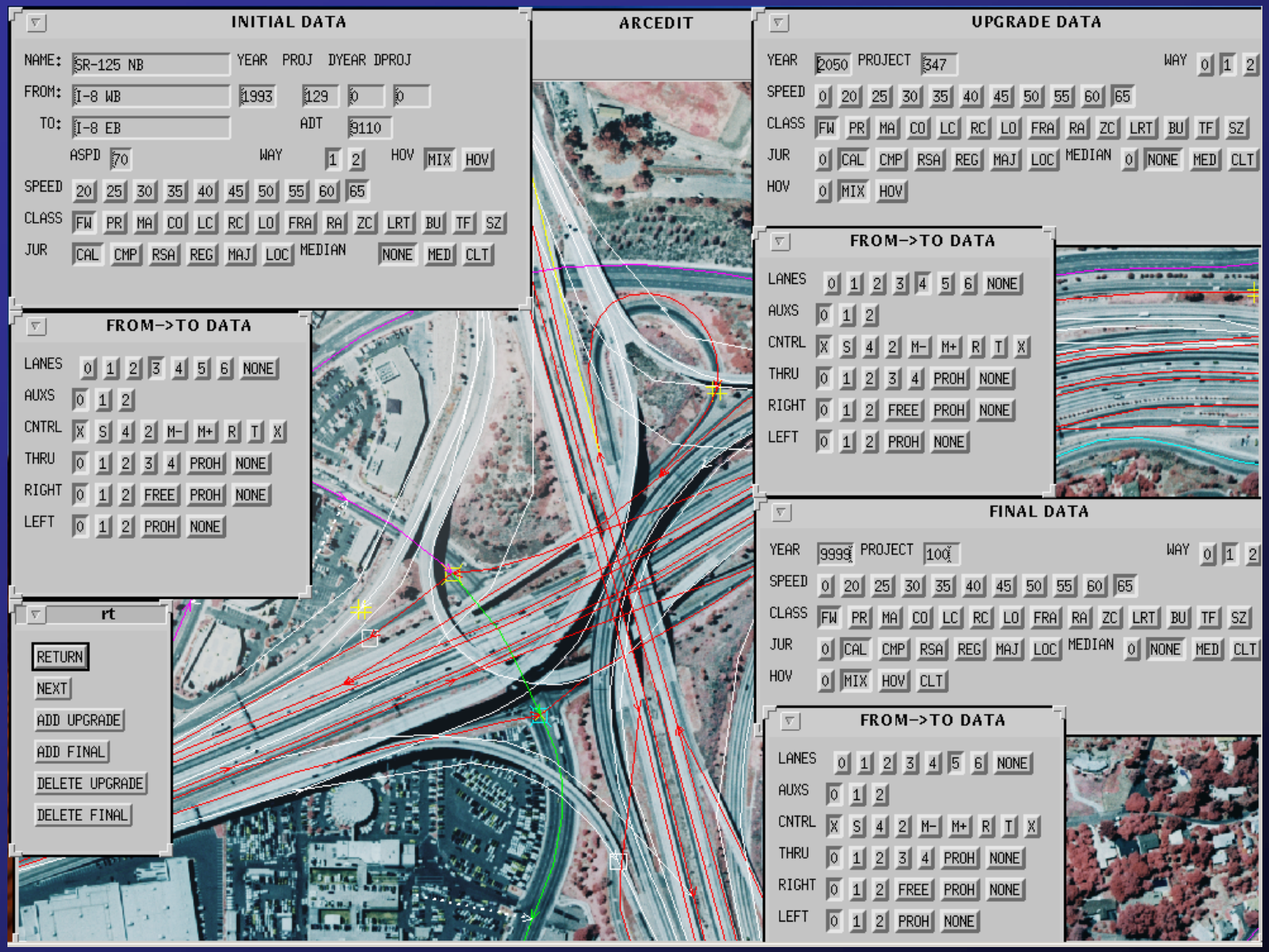
Link Attribute Menu



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Highway Projects

Project	Description	2030bl	2030he	2030te	2030hx	2030hov	2030tx	2030me	2030rc	2030uncs
1	I5: SR54-I15, 10F	9999	2030	2030	2030	9999	9999	9999	9999	2030
2	I5: I8-I805(N), 2HOV	9999	2030	9999	9999	2030	9999	2020	2040	2030
3	I5: SR52-Mission Bay Dr OC, SB AUX	1994	1994	1994	1994	1994	1994	1994	1994	1994
4	I5: Eastgate Mall SBoff/NBon	9999	9999	9999	9999	9999	9999	9999	9999	9999
5	I5: NB Aux: Mission Bay Dr - SR52	2001	2001	2001	2001	2001	2001	2001	2001	2001
6	I5: I805-Del Mar Heights, 2HOV	2000	2000	2000	2000	2000	2000	2000	2000	2000
7	I5/I805/SR56: Stages 2b&3	2005	2005	2005	2005	2005	2005	2010	2010	2005
8	I5/I805: aux. lane	2000	2000	2000	2000	2000	2000	2000	2000	2000
9	I5/I805/SR56: Stage 1	1998	1998	1998	1998	1998	1998	1998	1998	1998
10	I5: SR56 S-E & W-N Direct Connectors	9999	2030	2030	2030	2030	9999	2010	2014	2030
11	I5: Via dl Valle-Del Mar Hgts Rd, SB Trk Ln	1995	1995	1995	1995	1995	1995	1995	1995	1995
12	I5: Del Mar Hgts-Leucadia, 10F	9999	2010	2010	2010	2010	9999	2020	9999	2010
13	I5: Leucadia-La Costa, 10F	9999	9999	9999	2030	9999	9999	9999	9999	9999
14	I5: La Costa-Palomar Airport, 10F	9999	9999	9999	2030	9999	9999	9999	9999	2030
15	I5: Palomar Airport-Vandegrift Bld, 10F	9999	9999	9999	2030	9999	9999	9999	9999	9999
16	I5: At SR78, SB-EB Direct Connector	9999	2030	2030	2030	2030	9999	2020	2030	2030
17	I5: At SR78, WB-SB Direct Connector	9999	2030	2030	2030	2030	9999	2020	2030	2030
18	I5: SB ramp meters in Oceanside	2000	2000	2000	2000	2000	2000	2000	2000	2000
19	I5: At SR78, NB-EB Widen Connector and Aux	2001	2001	2001	2001	2001	2001	2001	2001	2001
20	I5: Vandegrift Bld-Orange Co, 2HOV	9999	2030	9999	9999	2030	9999	9999	9999	2030
21	I8: At Sunset Cliffs Bl, Revise IC	9999	9999	9999	9999	9999	9999	9999	9999	9999
22	I8: I5-Morena BL, Widen EB connector	9999	9999	9999	9999	9999	9999	9999	9999	9999

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Data Sources

- Existing
  - Digital Aerial Photo
  - Local Review
  - SanGIS
  - Highway Capacity Manual
- Planned - Near Term
  - RTIP and Local CIPs
  - Caltrans
  - EIRs and Site Plans
- Planned - Long Range
  - RTP
  - Local General Plans

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Highway Link Capacity

Freeways

- Main lanes & HOV lanes : 1800 to 2200 VPHPL
- Auxiliary lanes: 1200 VPHPL

C = 1800+2000*(ML-1) +1200*AL +2000*HL+ 200 (if AL>0)

Surface Streets

- Travel lanes: 1800 VPHPL
- Median adjustment

C = 1800*L - 300 - 200 (if M<2)

Rural Two Lane Roadways

C = 950 VPH

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Highway Intersection Capacity

Traffic Signals

- Through and right turn lanes: 1800 VPHPL
- Left turn lanes: 100 to 250 VPHPL
- GC ratio: Intersecting classification
  Number of approaches

C = 1800*TL*GC + RL*TC + LL*TC

Two-Way Stop Signs

- Approach lanes: 250 to 750 VPHPL

Ramp Meters

- 750-1000 VPHPL

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Highway Travel Time

Link Time

- Link distance
- Posted speed
- Congestion delay

Intersection Time

- Initial delay: 10 Seconds per signal
  1 Minute per ramp meter
- Congestion delay

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Potential Improvements

- Better project tracking
- Signal inter-connection

Highway Networks

Discussion

TRANSIT NETWORKS

By Tom King, Associate Research Analyst

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Topics

- Transit Network Coding
- Transit Travel Time Computations
- Transit Walk Access Procedures
- Transit Drive Access Procedures
- Fares

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Transit Network Coding

Ride Modes

- Commuter Rail
- Light Rail
- Regional BRT
- Corridor BRT
- Limited Express
- Express
- Local

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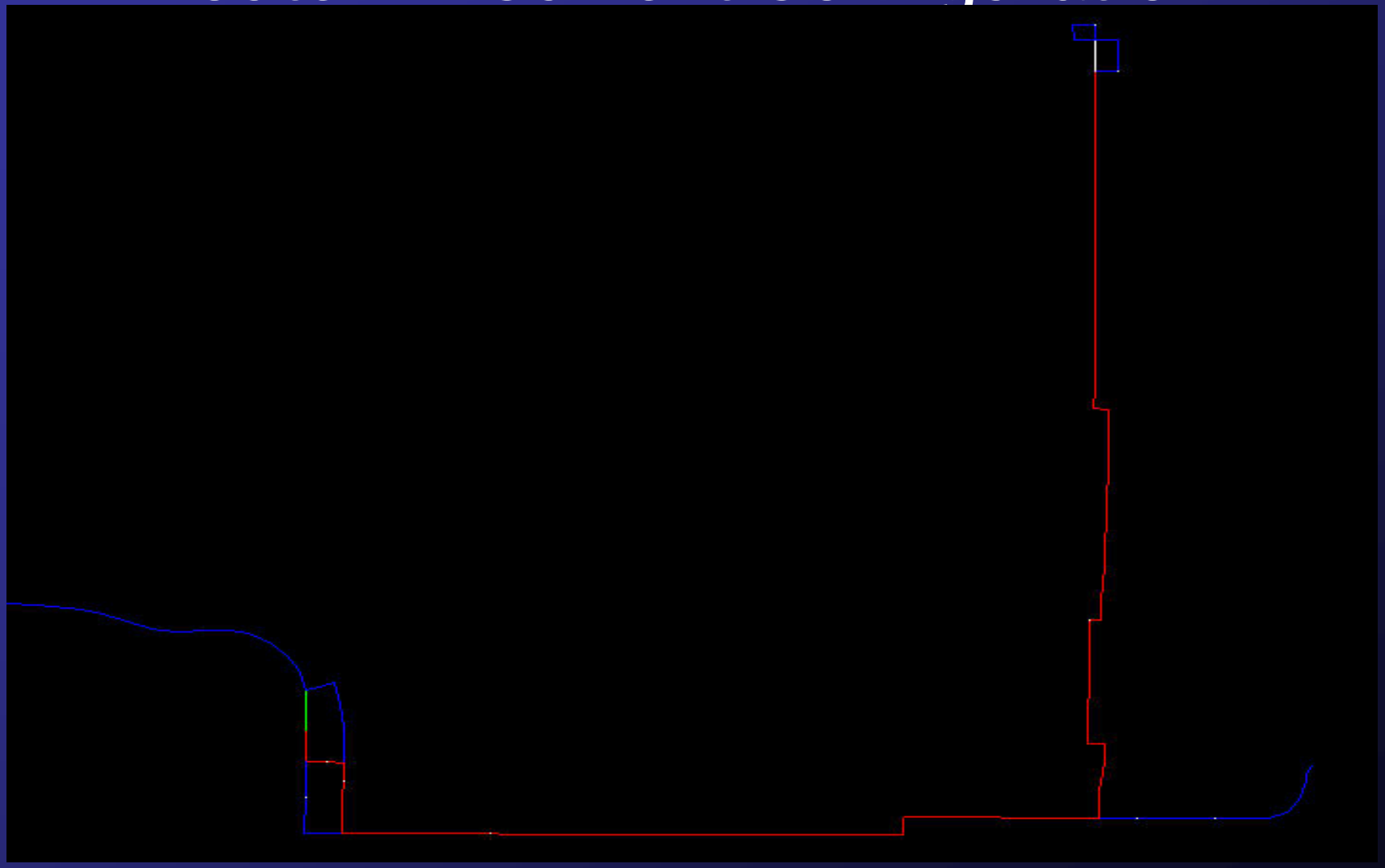
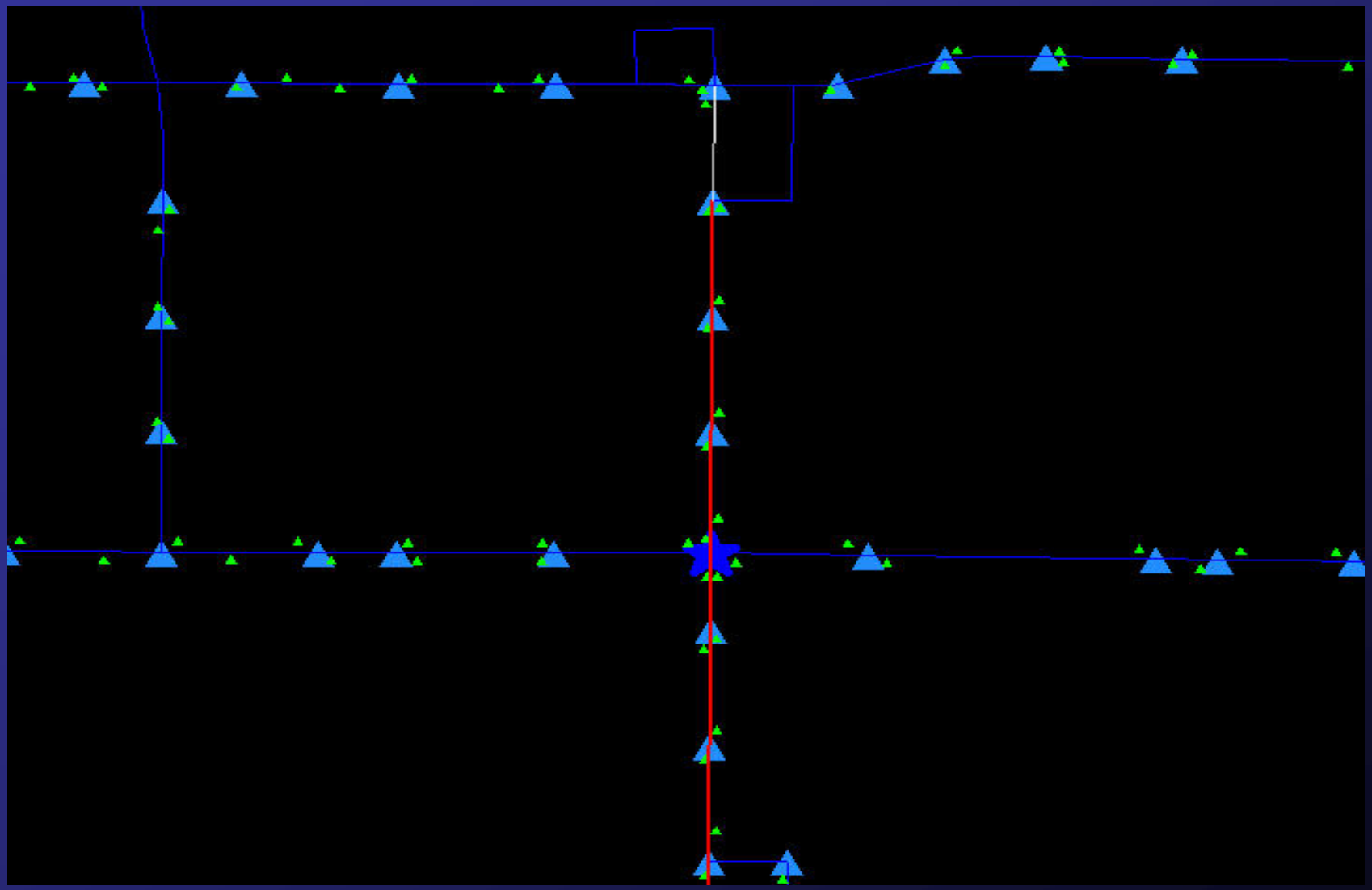
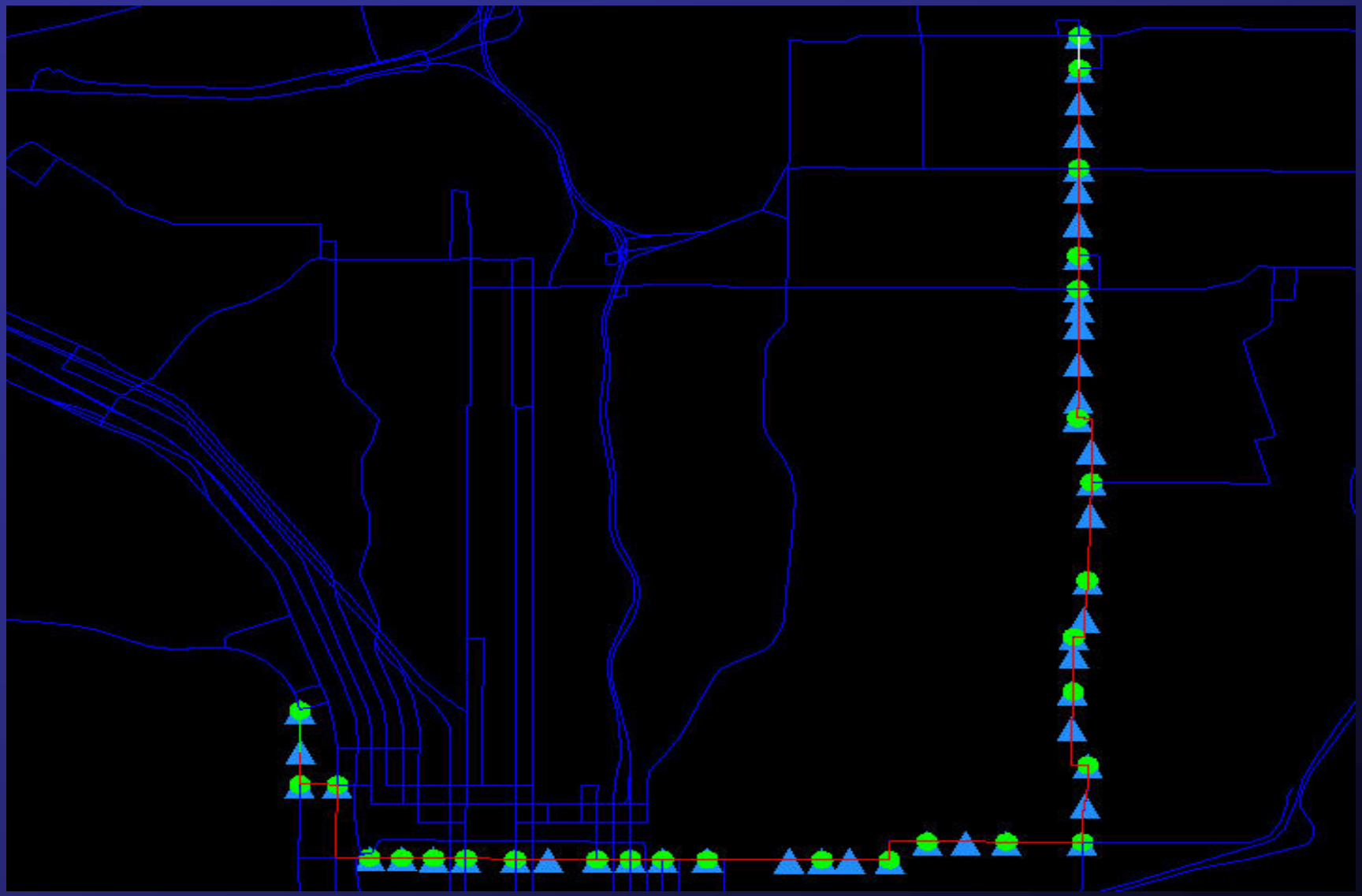
Route 2 – Current Configuration



Stop Coding



TAP Coding



Transit Travel Times

Transit In-Vehicle Travel Times

Buses

- Highway Link Time
- Intersection Time
- Congestion Delay Time
- 18 Seconds per Bus Stop

Rail

- Scheduled Station-to-Station Time
- Link Distance / Top Speed
- 20 Second Station Dwell Time
- Acceleration/Deceleration Time

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Base Year Transit Travel Speeds

		AM Peak				Midday Off-Peak			
				Difference				Difference	
Route	**Ride Mode**	**Observed**	**Estimated**	**Absolute**	**Percent**	**Observed**	**Estimated**	**Absolute**	**Percent**
Coaster	Commuter Rail	59	55	-4	-7%	60	55	-5	-8%
Blue Line	Light Rail	71	66	-5	-7%	70	66	-4	-6%
Orange Line	Light Rail	63	63	0	0%	62	63	1	2%
810	Limited Express	64	84	20	31%				
860	Limited Express	71	86	15	21%				
20	Express	125	147	22	18%	121	107	-14	-12%
30	Express	109	107	-2	-2%	117	103	-14	-12%
320	Express	79	95	16	20%	82	60	-22	-27%
2	Local Bus	39	39	0	0%	41	38	-3	-7%
3	Local Bus	58	59	1	2%	62	59	-3	-5%
5	Local Bus	101	111	10	10%	108	113	5	5%
7	Local Bus	68	63	-5	-7%	73	62	-11	-15%
11	Local Bus	90	109	19	21%	100	109	9	9%
15	Local Bus	103	101	-2	-2%	107	97	-10	-9%
34	Local Bus	104	87	-17	-16%	118	86	-32	-27%
302	Local Bus	93	78	-15	-16%	93	76	-17	-18%
929	Local Bus	81	75	-6	-7%	89	73	-16	-18%
932	Local Bus	103	91	-12	-12%	105	89	-16	-15%
TOTAL		**1481**	**1516**	**35**	**2%**	**1408**	**1256**	**-152**	**-11%**
		Absolute % Difference = 11%				**Absolute % Difference = 12%**			

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Transit Access Procedures

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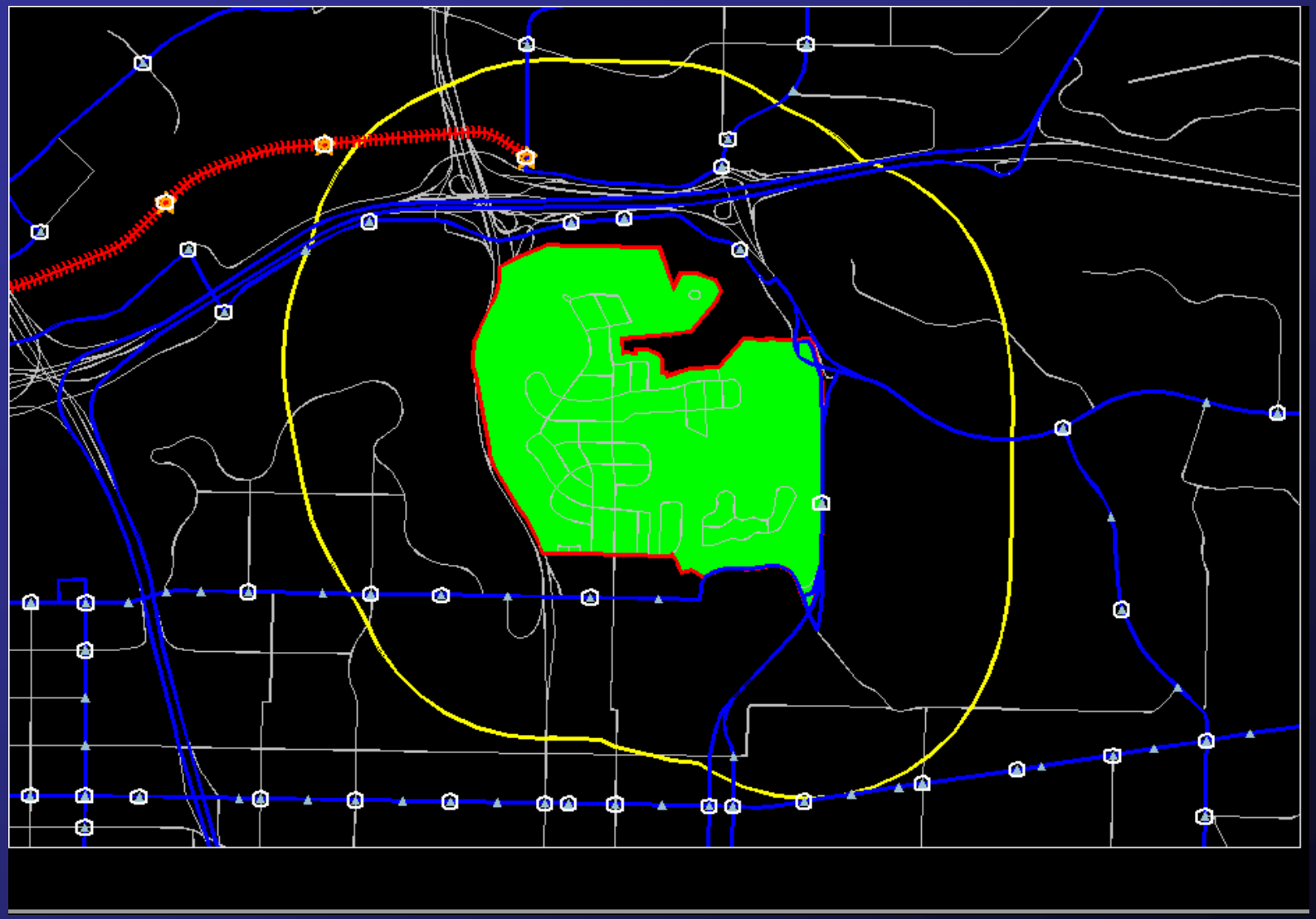
½ Mile Walk Distance



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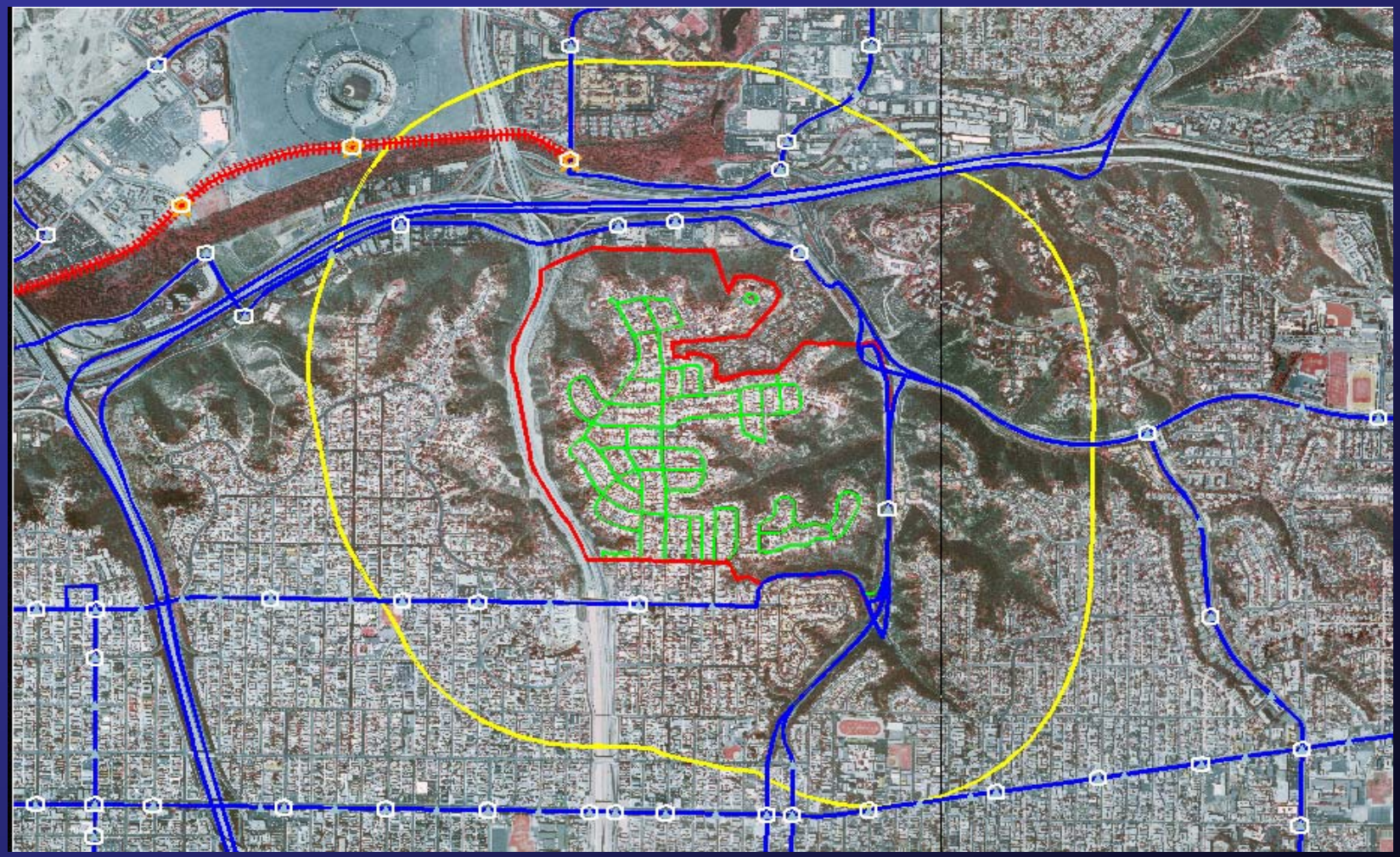
½ Mile Walk Distance



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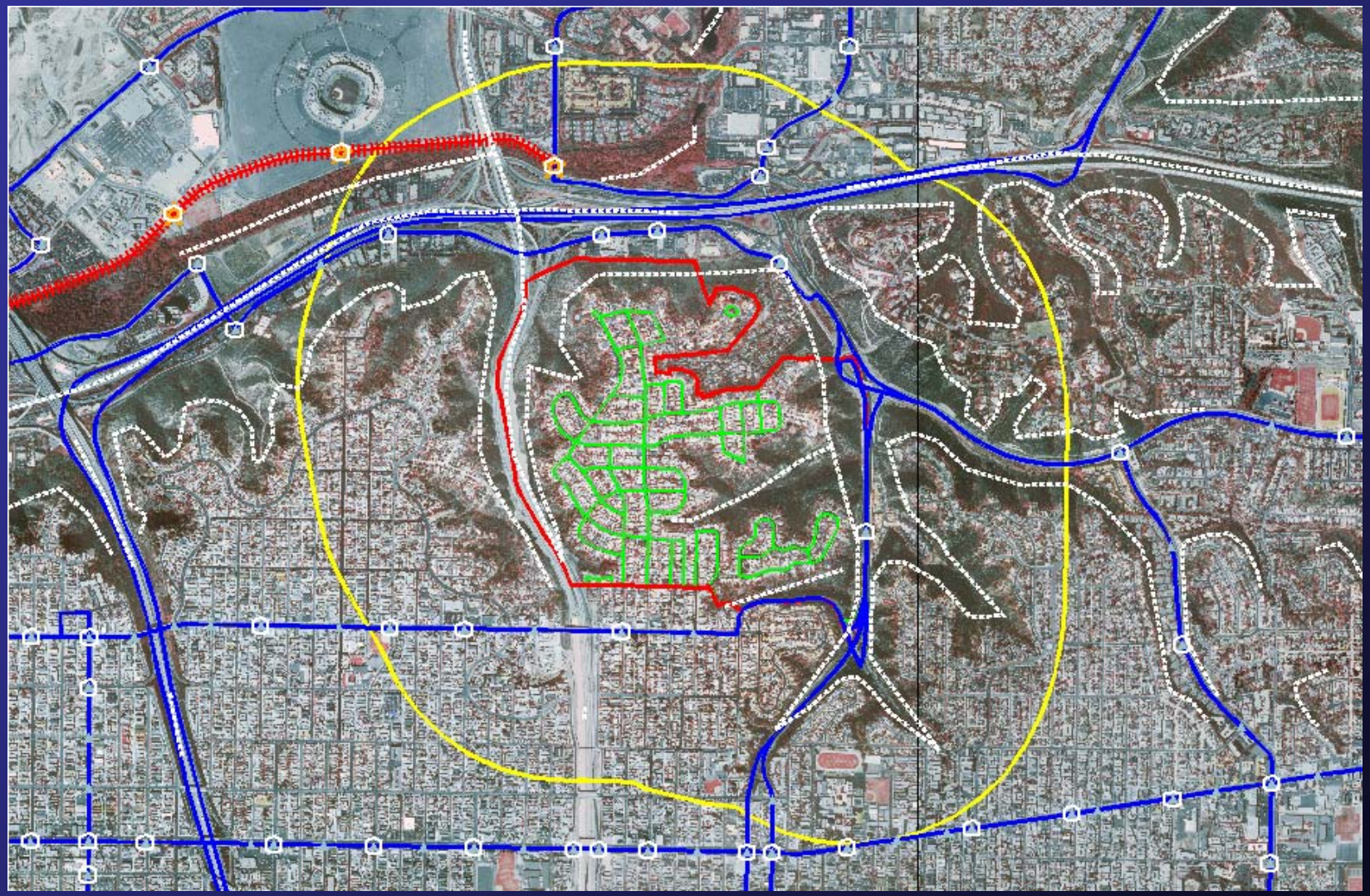
Walk Barriers



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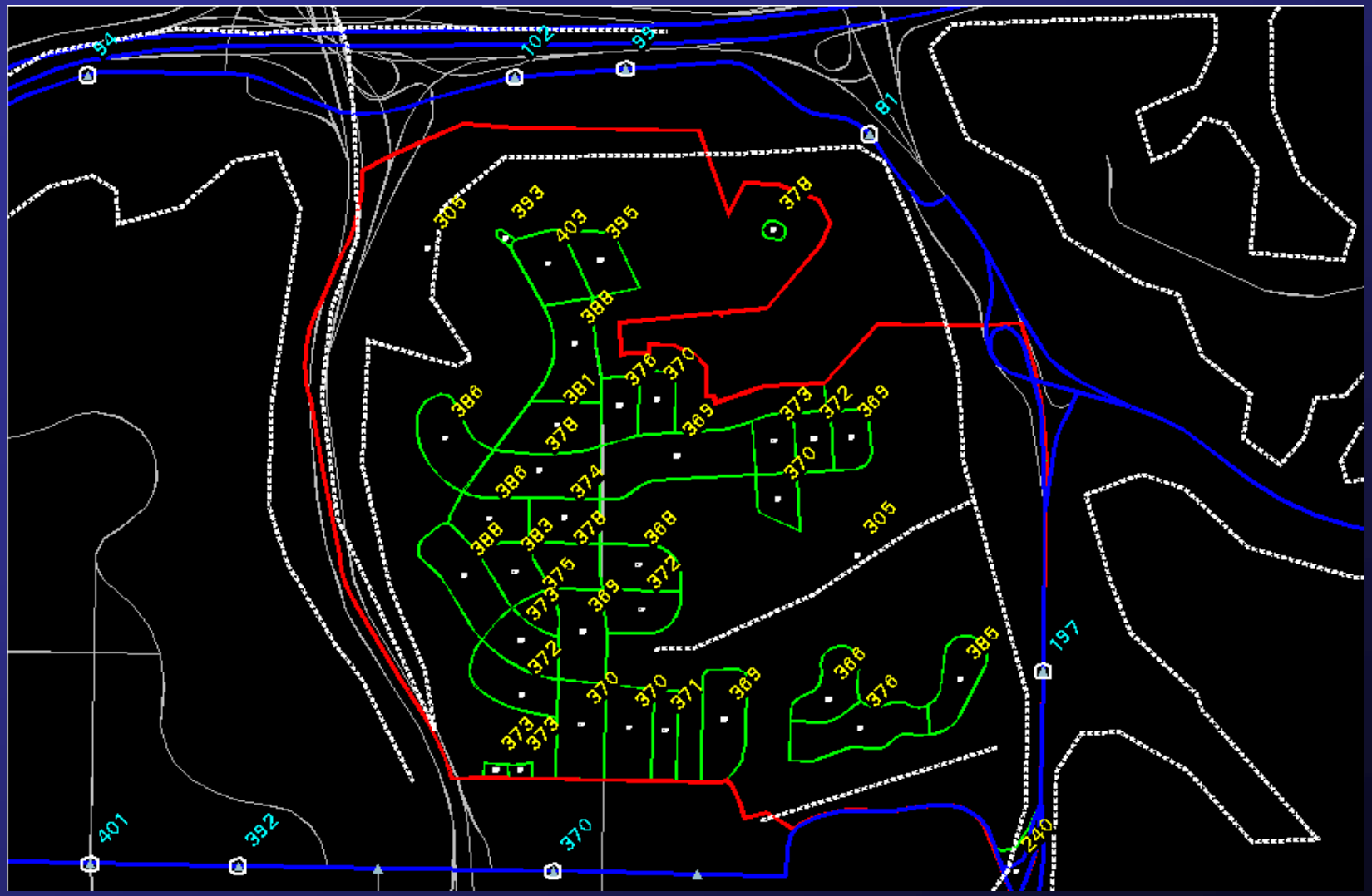
MGRA and TAP Elevations



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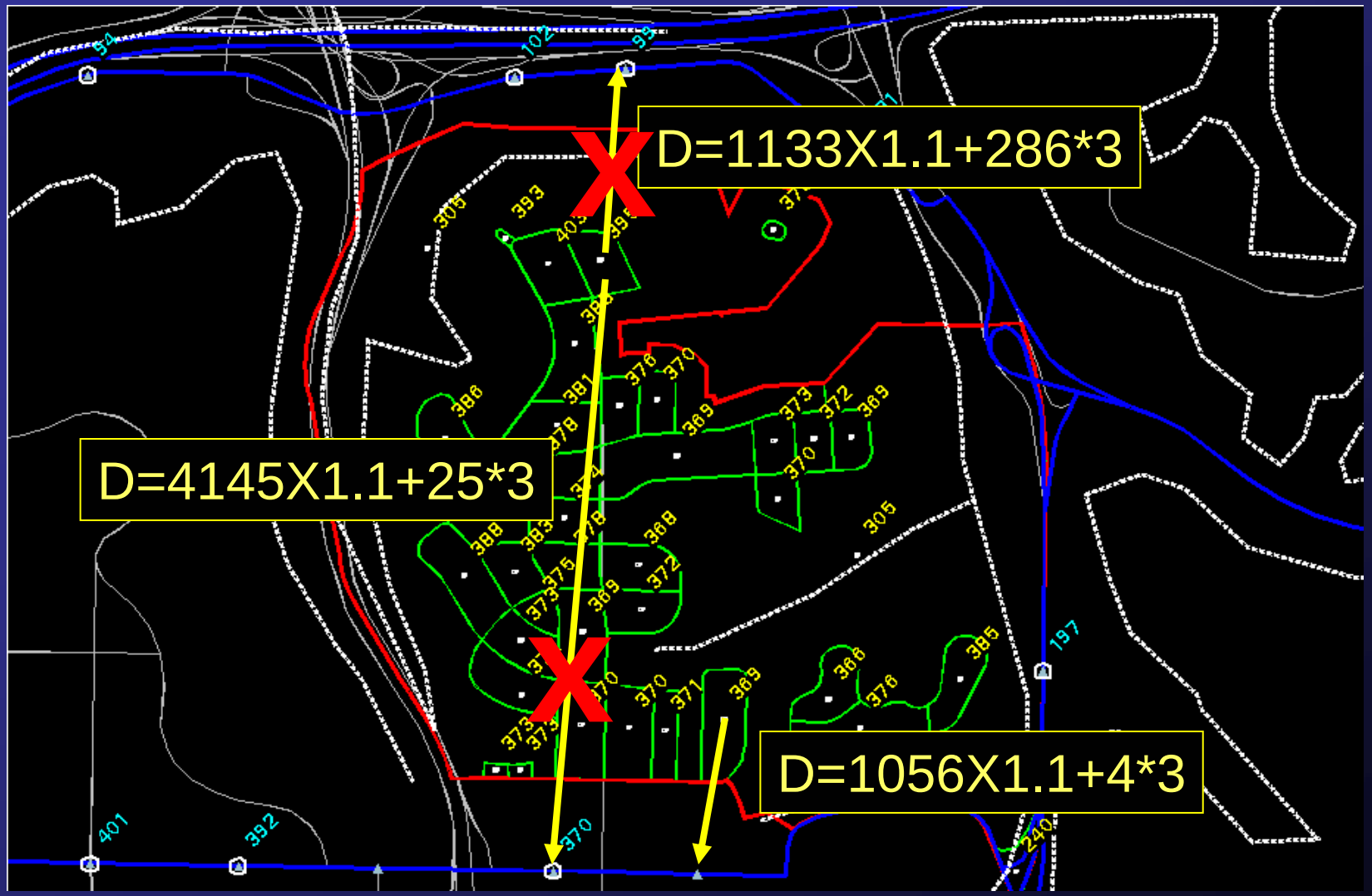
MGRA and TAP Elevations



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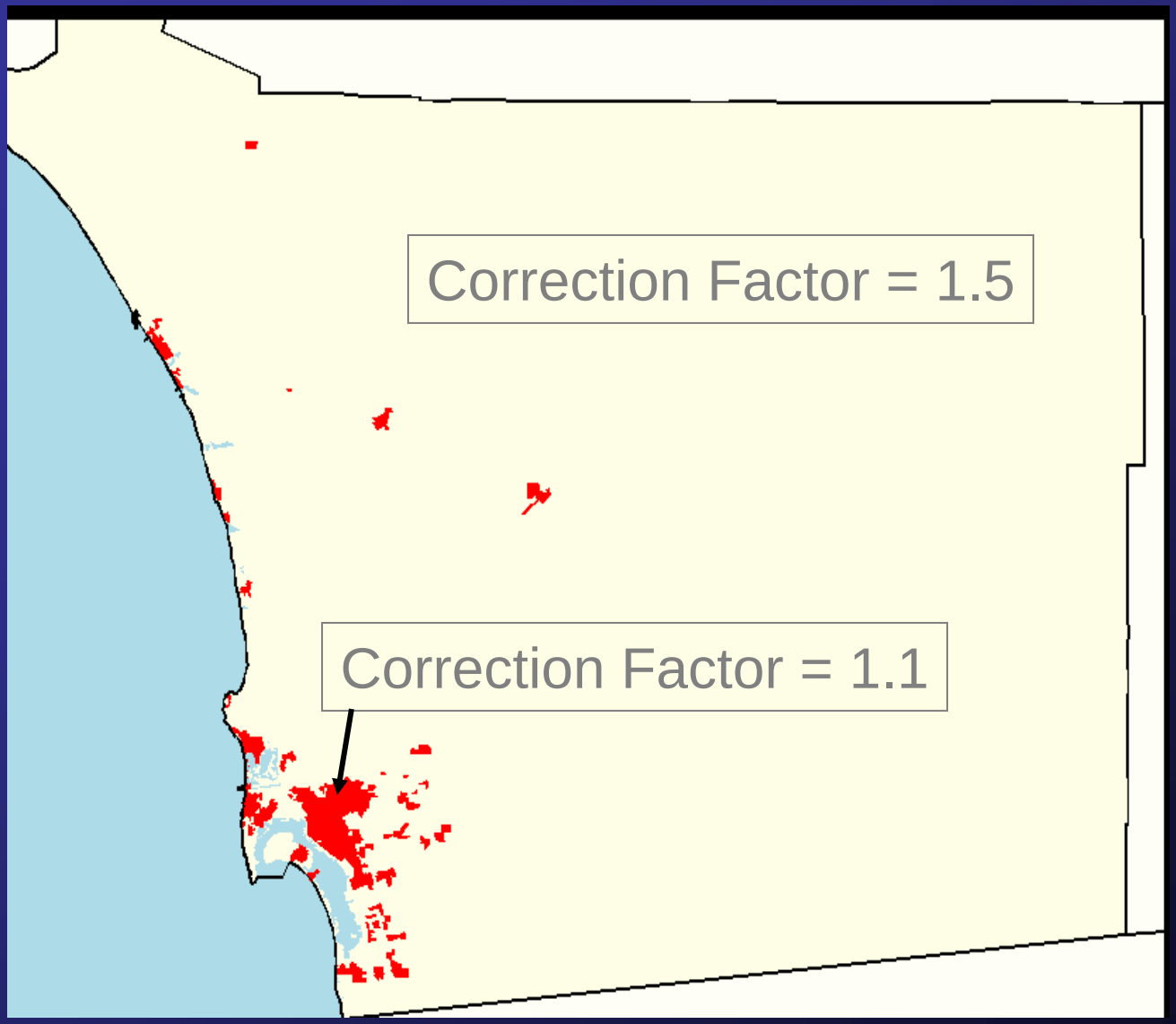
Grid Pattern Street Areas



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Drive Access Connections

- Connect TAZ to closest lot within 30 minutes
- Connect TAZ to other lots within 30 minutes, if:
  - Provides access to different rail/BRT route or to different mode
  - Within 15 minutes of closest lot
  - Up to two connections per rail/BRT route or mode

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Outputs

- Walk Access – MGRA to TAP travel time and distance
- Drive Access – TAZ to TAP peak period travel time and distance

Fare Structure

Fare Structure by Ride Mode

Ride Mode	Fare Structure	Price Range (2000 Dollars)
Commuter Rail	By Zone	$3.00 - $3.75
Light Rail	By Station	$1.25 - $2.50
Regional BRT	By Route	$3.50
Corridor BRT	By Route	$3.00
Limited Express	By Route	$2.75 - $3.25
Express	By Route	$1.50 - $2.25
Local	By Route	$0.50 - $2.00

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Transit Network Parameters

MODE	Local Weights			Premium Weights		
	IVT	IWT	XWT	IVT	IWT	XWT
Walk Access	1.50	N/A	N/A	1.50	N/A	N/A
Commuter Rail	N/A	N/A	N/A	0.67	1.50	2.50
Light Rail	N/A	N/A	N/A	0.67	1.50	2.50
Regional BRT	N/A	N/A	N/A	0.67	1.50	2.50
Corridor BRT	N/A	N/A	N/A	0.67	1.50	2.50
Limited Express	N/A	N/A	N/A	0.67	1.50	2.50
Express	N/A	N/A	N/A	0.67	1.50	2.50
Local	1.00	1.50	2.50	1.30	1.50	2.50

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Potential Improvements

- Street based walk distances
- Use automated passenger counting systems to improve bus speeds
- Represent BRT operation

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Transit Networks

Discussion

GROWTH FORECASTS

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Long-Range Forecasts Are:

- Best assessment of what to expect
- Based on most recent data and policies
- Produced collaboratively
  - Local jurisdictions
  - Technical and policy committees
  - Extensive public outreach and review
- A tool for elected officials and others

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Data Management and Statistical Tools

- Enterprise-Scale Relational Data Base Manager
- Graphical User Interfaces
- GIS
- Input-Output Model
- Linear and Nonlinear Calibration Algorithms
- Probabilistic, N-Dimensional Controlling Routines

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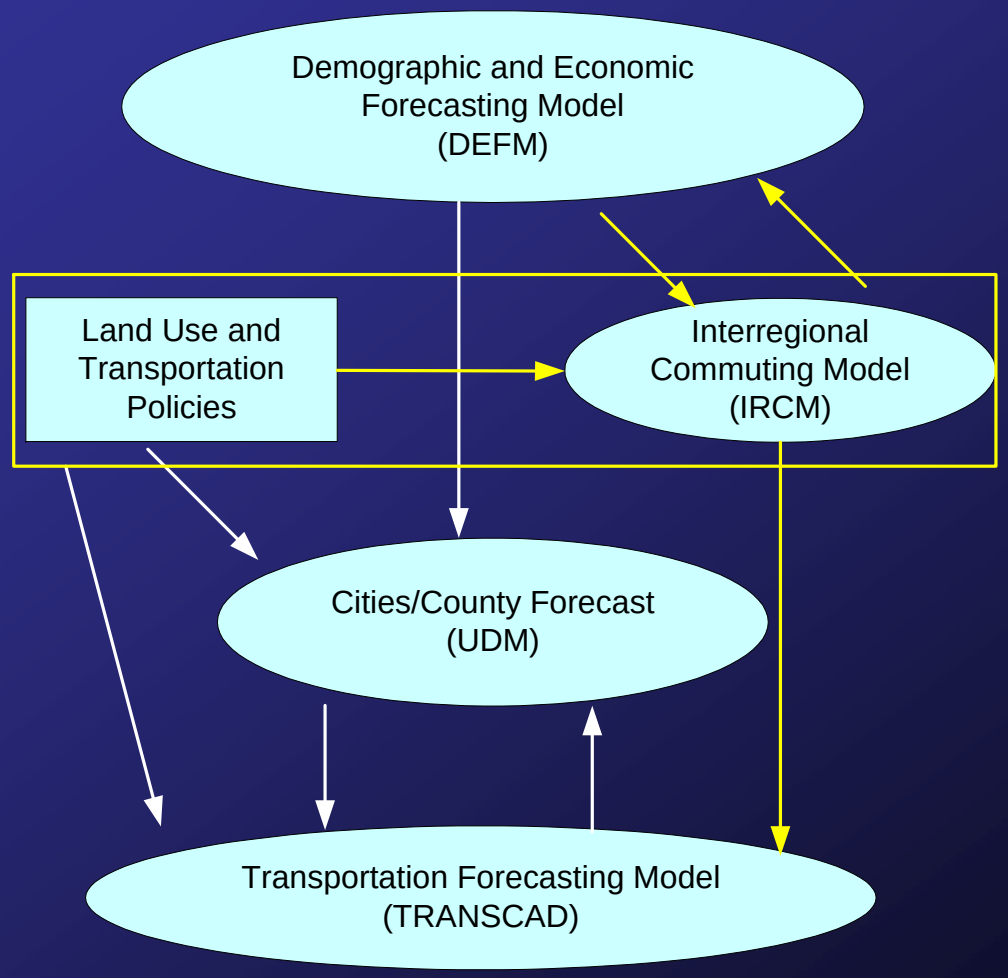
Forecasting Modeling System



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Current Modeling Geography

220 Zones for Urban Modeling

↑

4,605 Transportation Analysis Zones

↑

33,000 Master Geographic Reference Areas

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Proposed Modeling Geography

120 Zones for Urban Modeling

↑

2,000 Trip Distribution Zones

↑

5,000 Traffic Assignment Zones

↑

20,000 Walk Access Zones

↑

800,000 Split Parcels

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Regional Forecast

- Demographic Component
  - Births, Deaths
  - Age, Sex, Ethnicity
  - Migration Patterns
  - Labor Force
- Economic Component
  - Employment, Output
  - Prices, Wages, Costs
  - Housing Supply/Demand
  - Public Finance

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Urban Development Model (UDM)

- Spatial Interaction Gravity Models
- Links between Employment, Shopping and Residential Locations
- Commute Patterns
- Travel Times
- Development Opportunities

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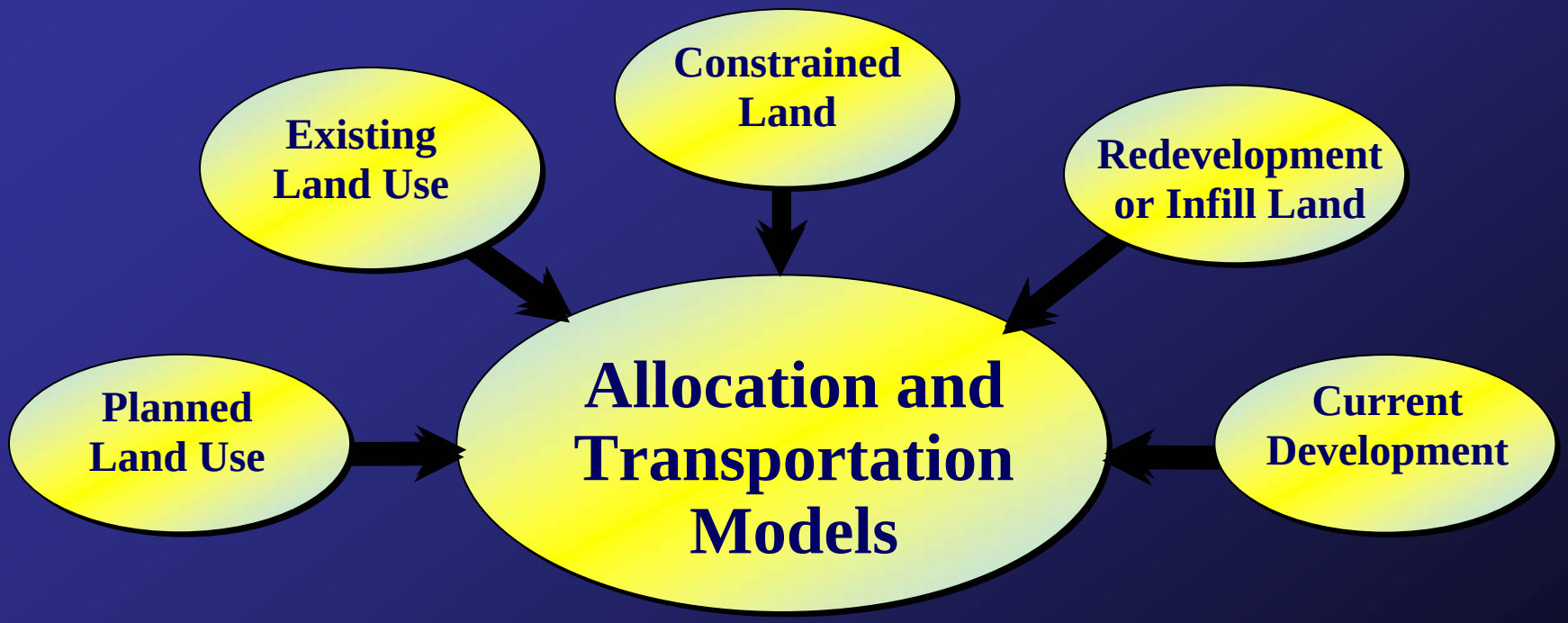
Land Use Inputs



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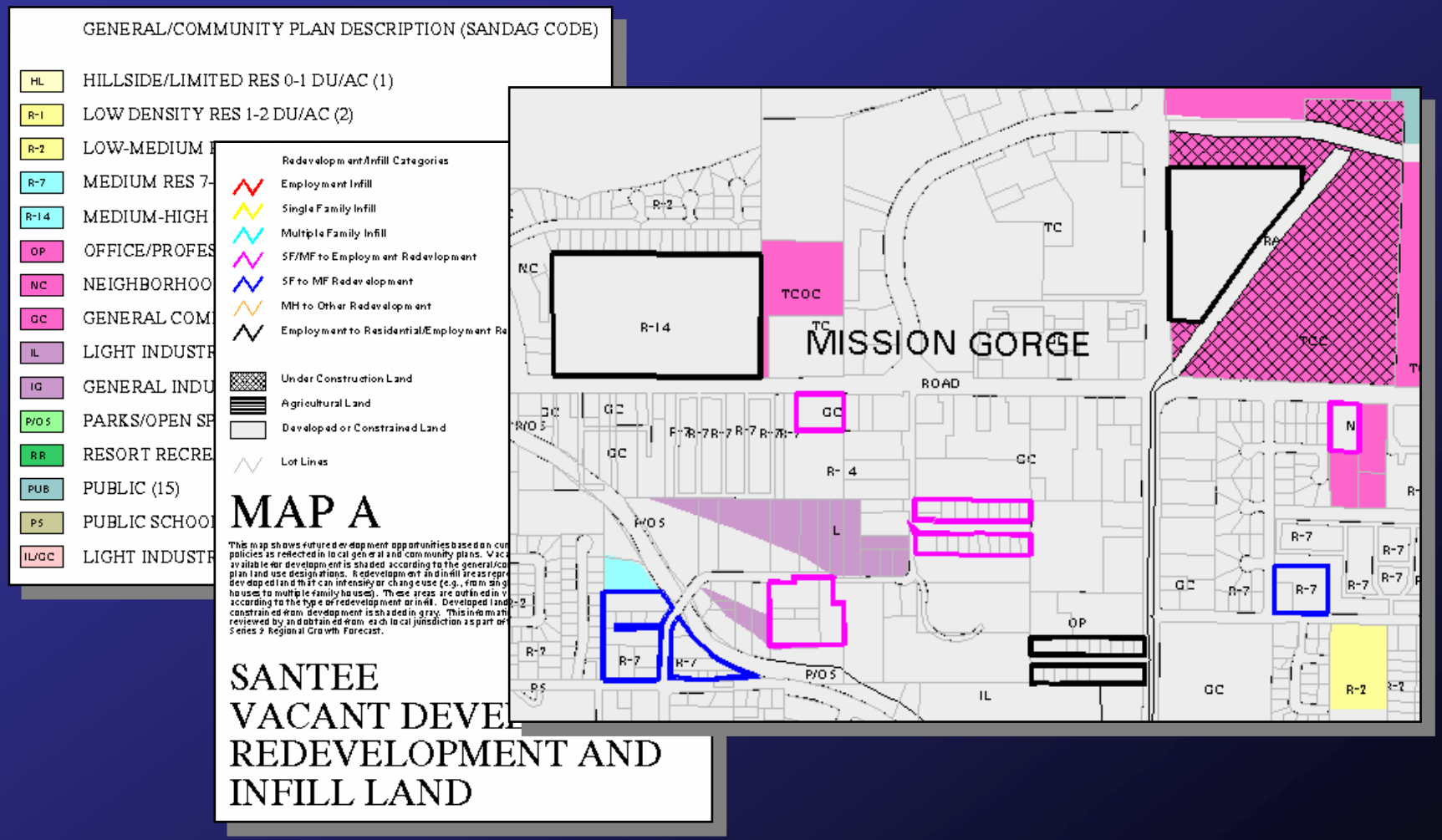
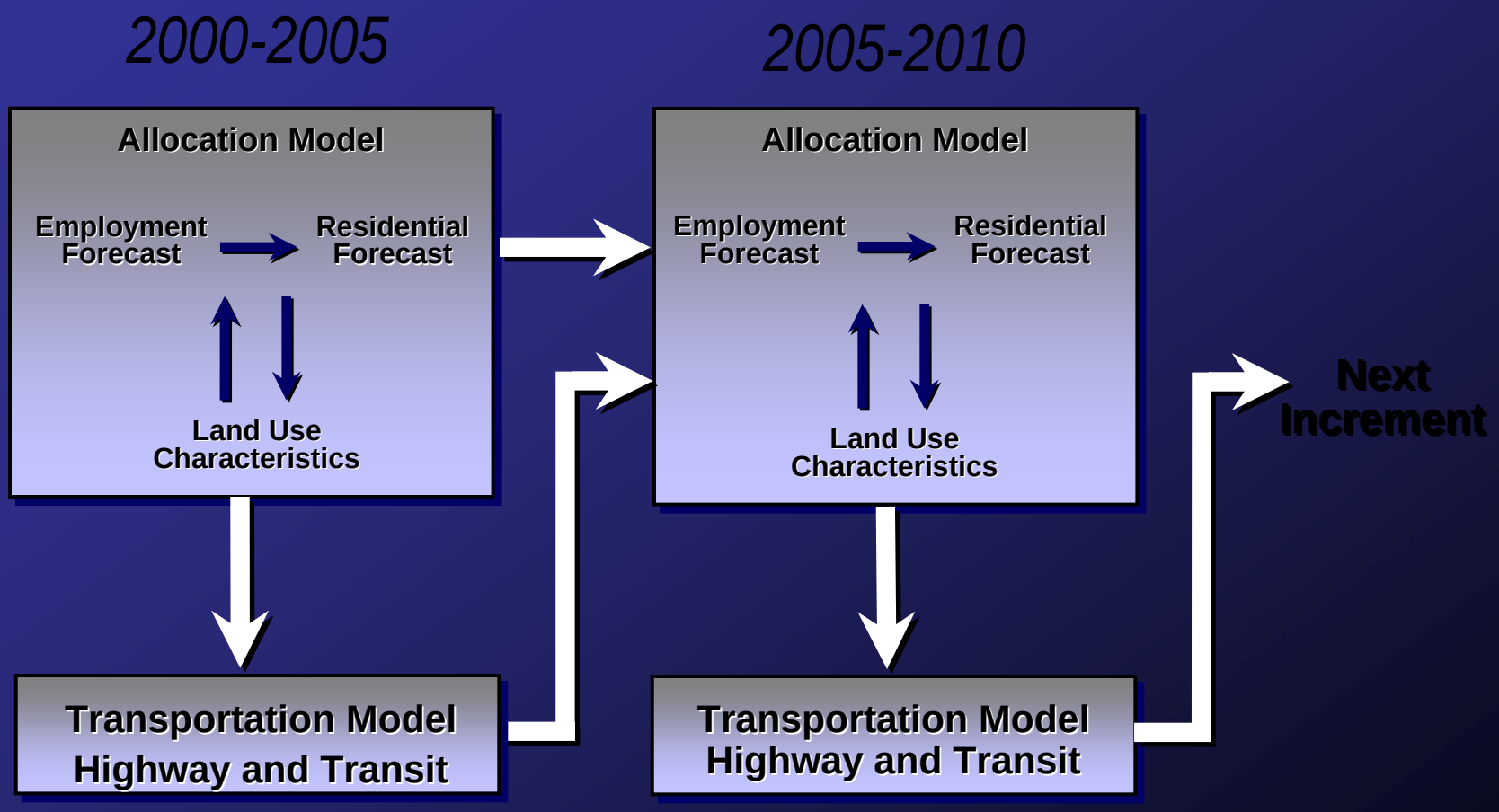
Developable Land



Linking the Land Use and Transportation Models



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Keys to Success

- Providing a tool for effective decision-making
- Committing to update and maintain models and databases
- Establishing credibility of models and process
- Taking the models out of the “Black Box”
- Balancing theoretical elegance with practical application

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Growth Forecasts

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Questions and Answers

TRIP GENERATION

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Trip Types

- Home-Work
- Home-College
- Home-School
- Home-Shop
- Home-Other
- Work-Other
- Other-Other
- Serve Passenger
- Visitor
- Airport

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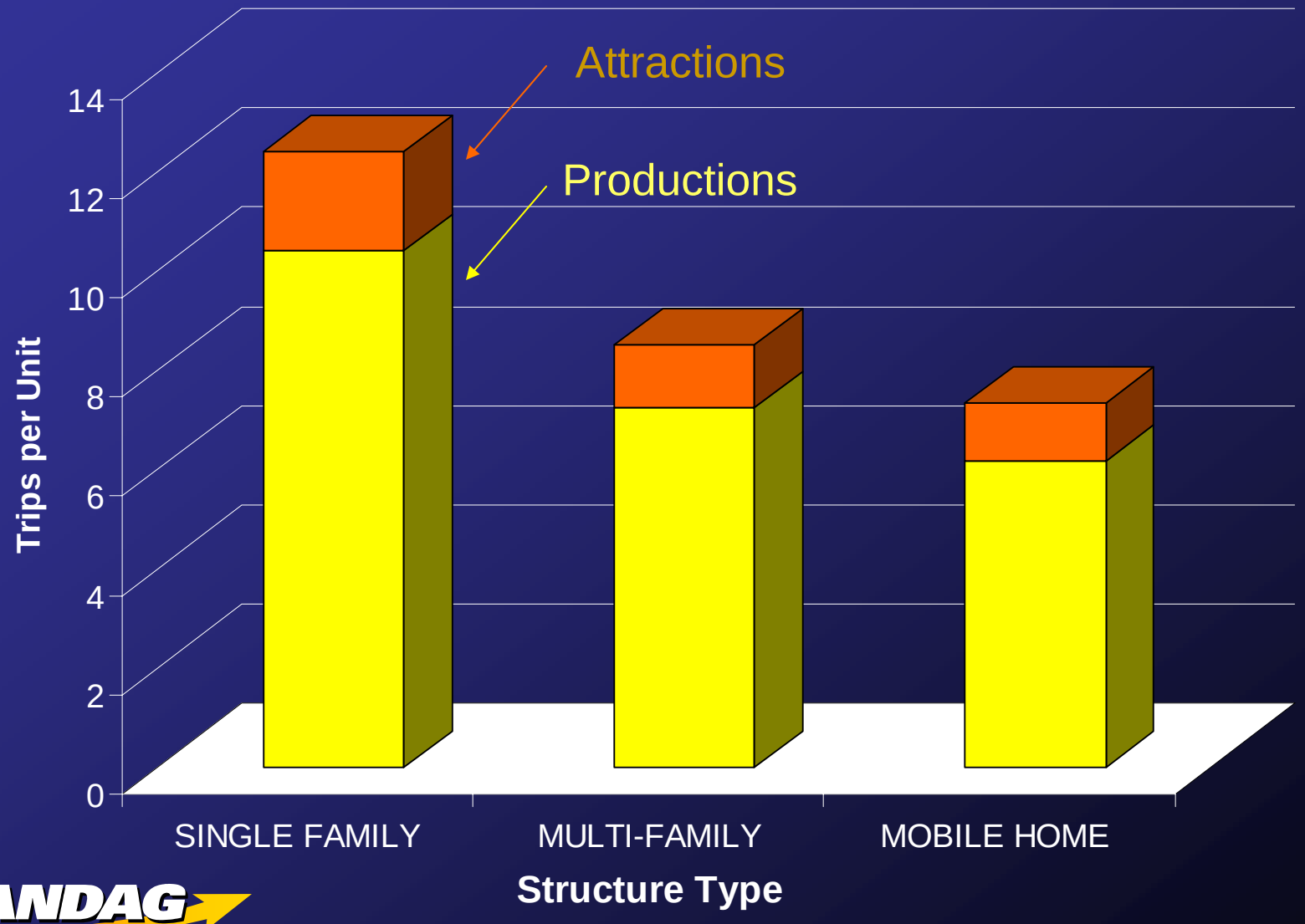
Person Trip Rates Residential



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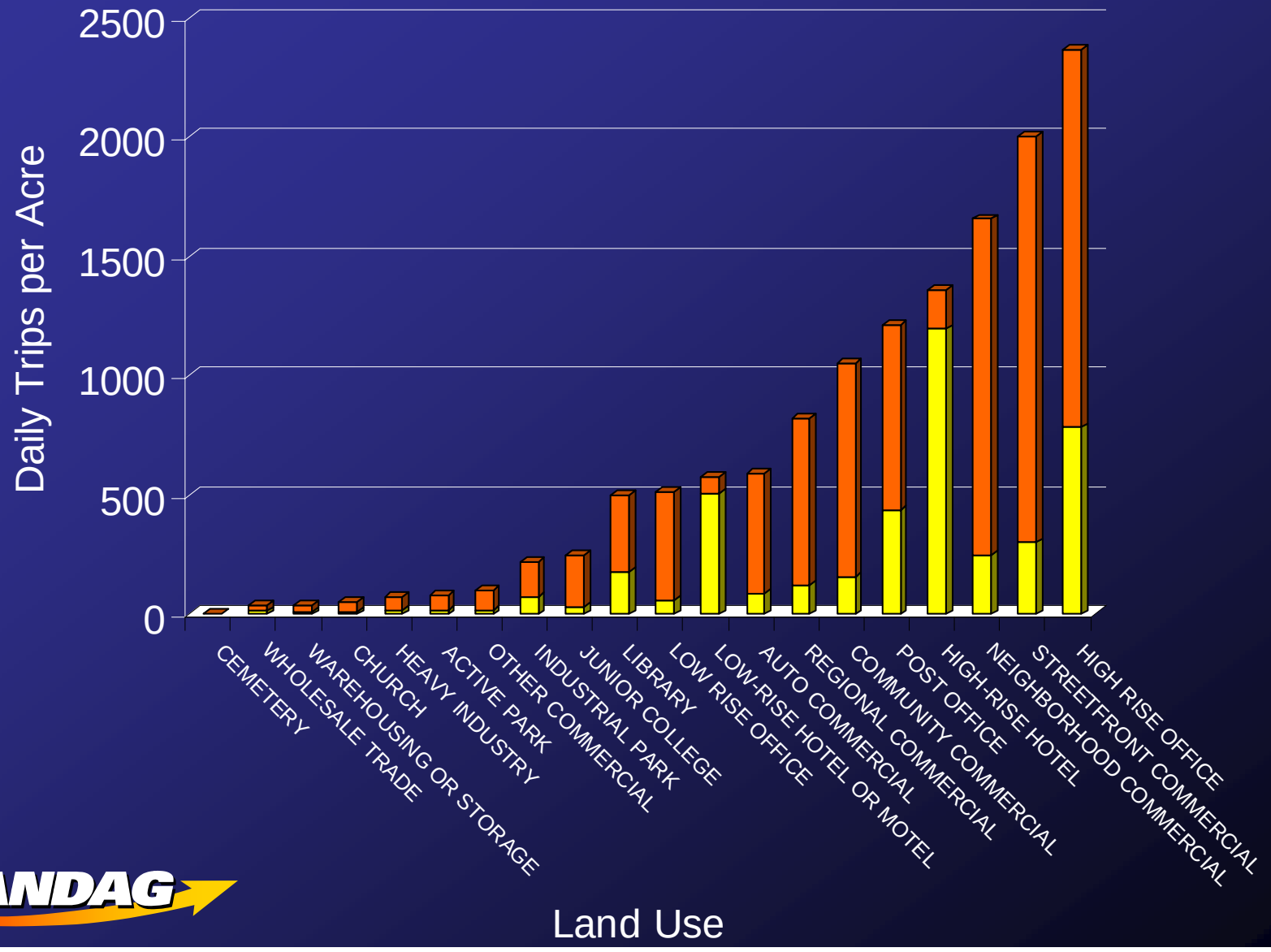
Person Trip Rates
Non-Residential Uses



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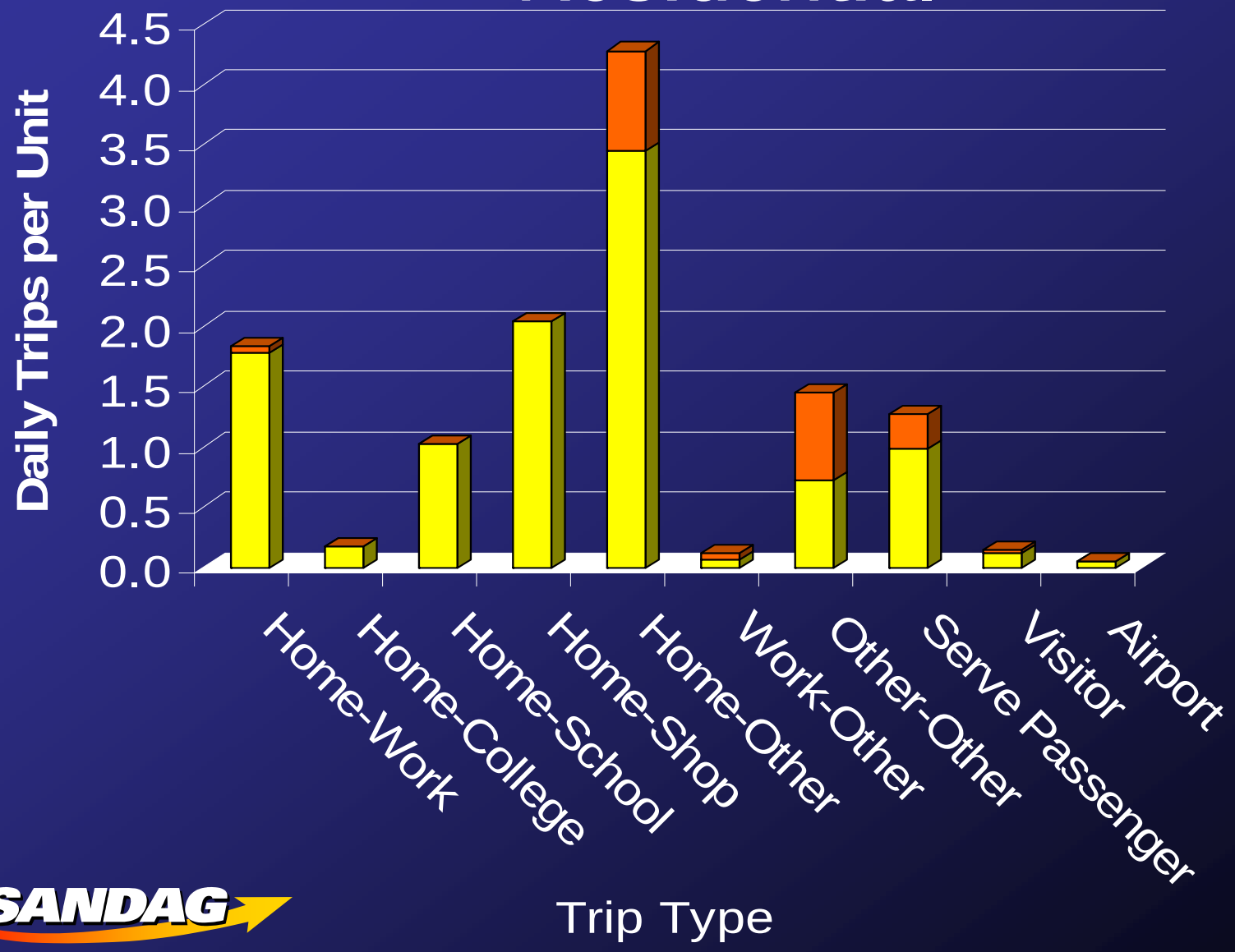
Person Trip Rates Residential



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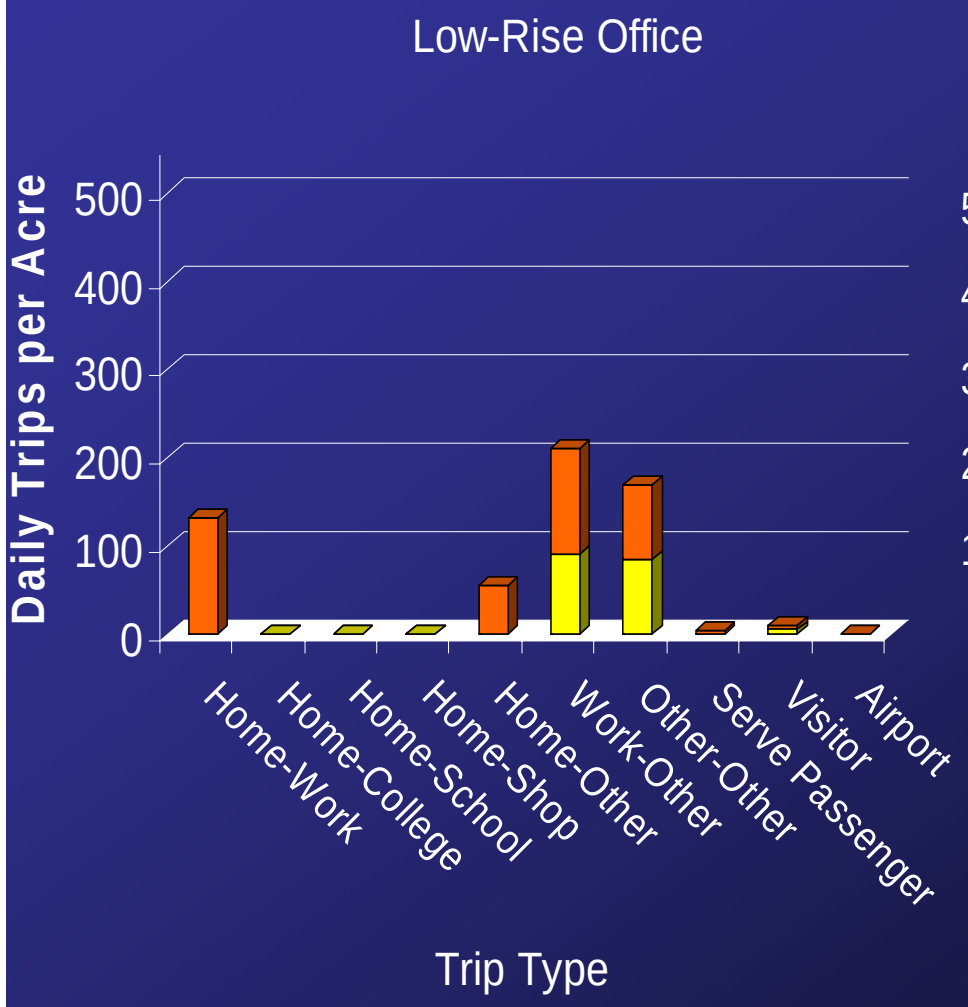
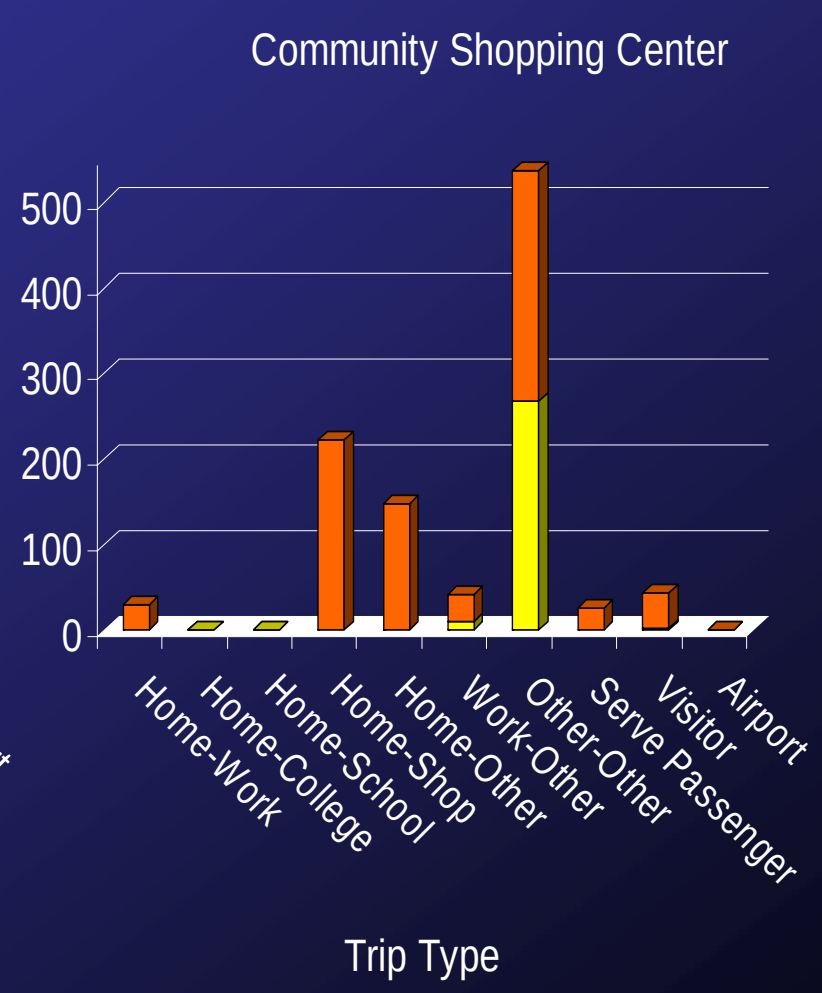
Person Trip Rates
Non-Residential





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Unique Generators

- Regional Airport (1)
- Military Bases (15)
- Universities (3)
- Tourist Attractrions(8)
- Casinos (14)
- Beaches (38)

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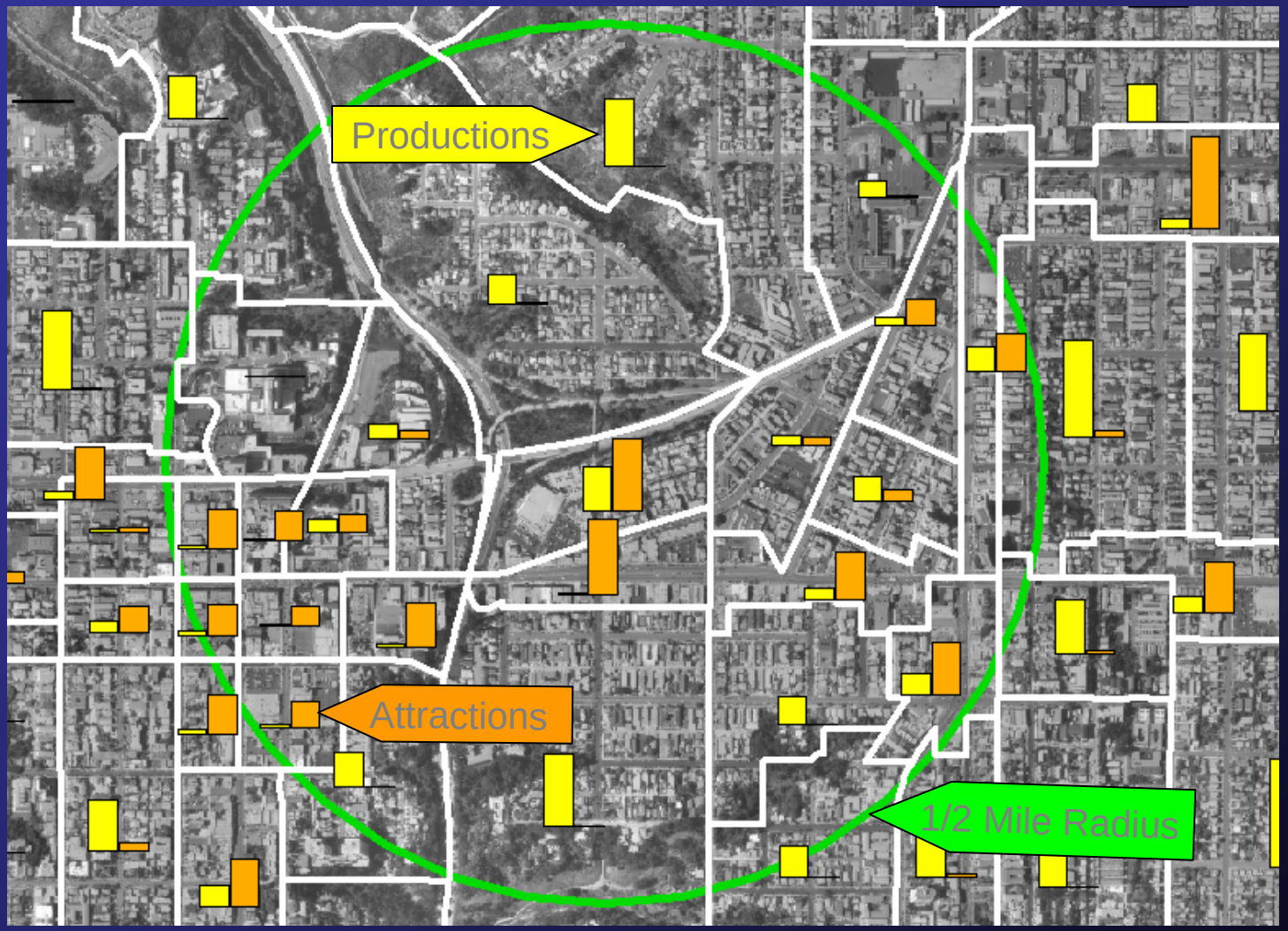
Home-Shop Trips - Hillcrest



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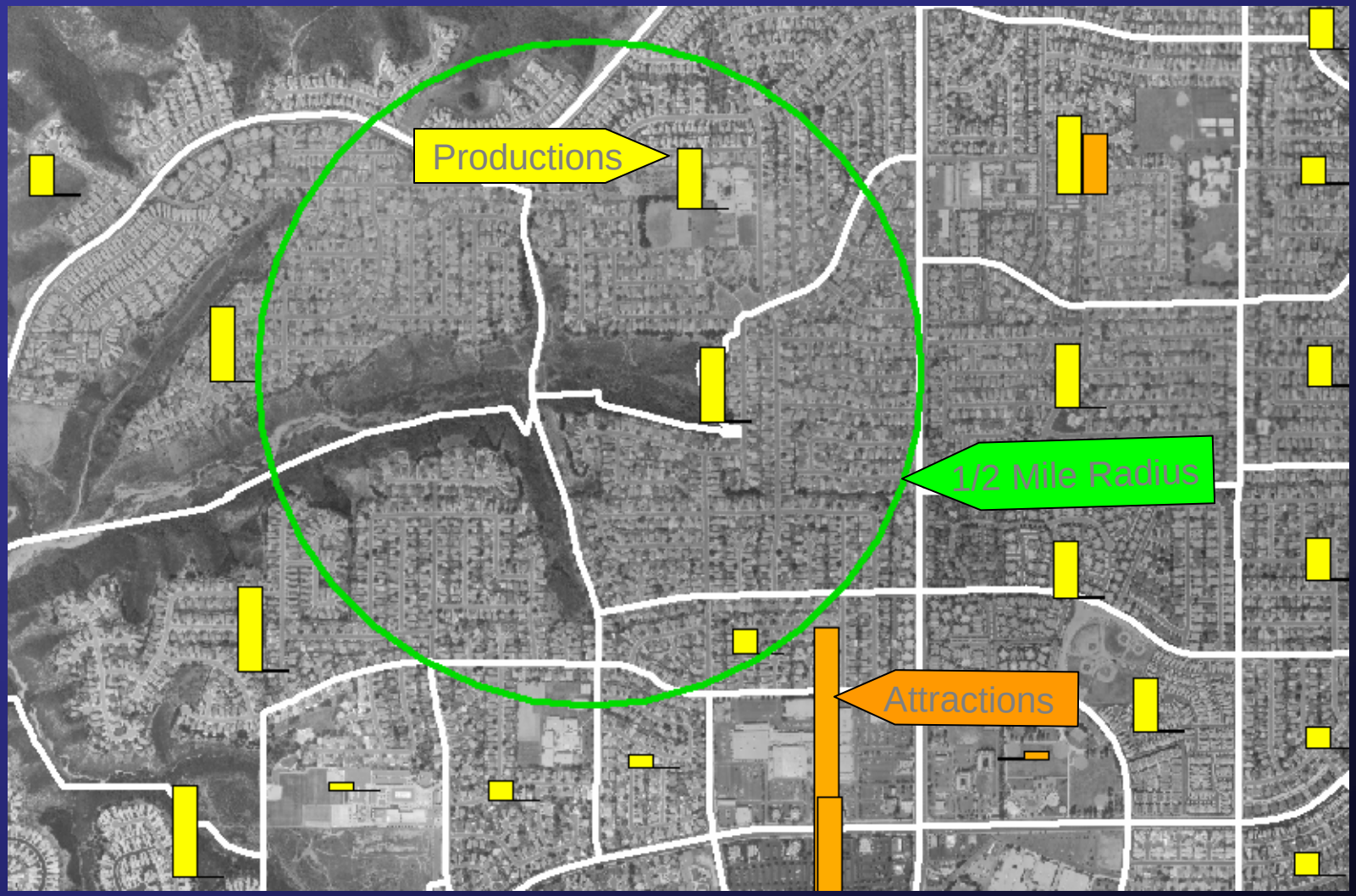
Home-Shop Trips - Mira Mesa



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Regional Control Totals

Trip Type	Factor
• Home-Work	• Total Employment
• Home-College	• Population (19-24)
• Home-School	• Population (6-18)
• Home-Shop	• Retail Sales
• Home-Other	• Service Sectors Output
• Work-Other	• Total Employment
• Other-Other	• Total Trips
• Serve Passenger	• Auto Passenger Trips
• Visitor	• Visitor Sector Output
• Airport	• Air Passenger Trips

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Tele-Commuting
E-Commerce Reductions

- Office Land Uses
  - 5% reduction in work trips
- Commercial Uses
  - 0 to 5% reduction in shop trips

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Potential Improvements

- Person trip rates by age group and household income level
- Non-residential trip rates by building square footage
- School trip rates by enrollment
- Add commercial vehicle trip type(s)
- Disaggregate work trips by income level
- Link trips into half-tours
- Add accessibility variable

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Trip Generation

Discussion

TRIP DISTRIBUTION

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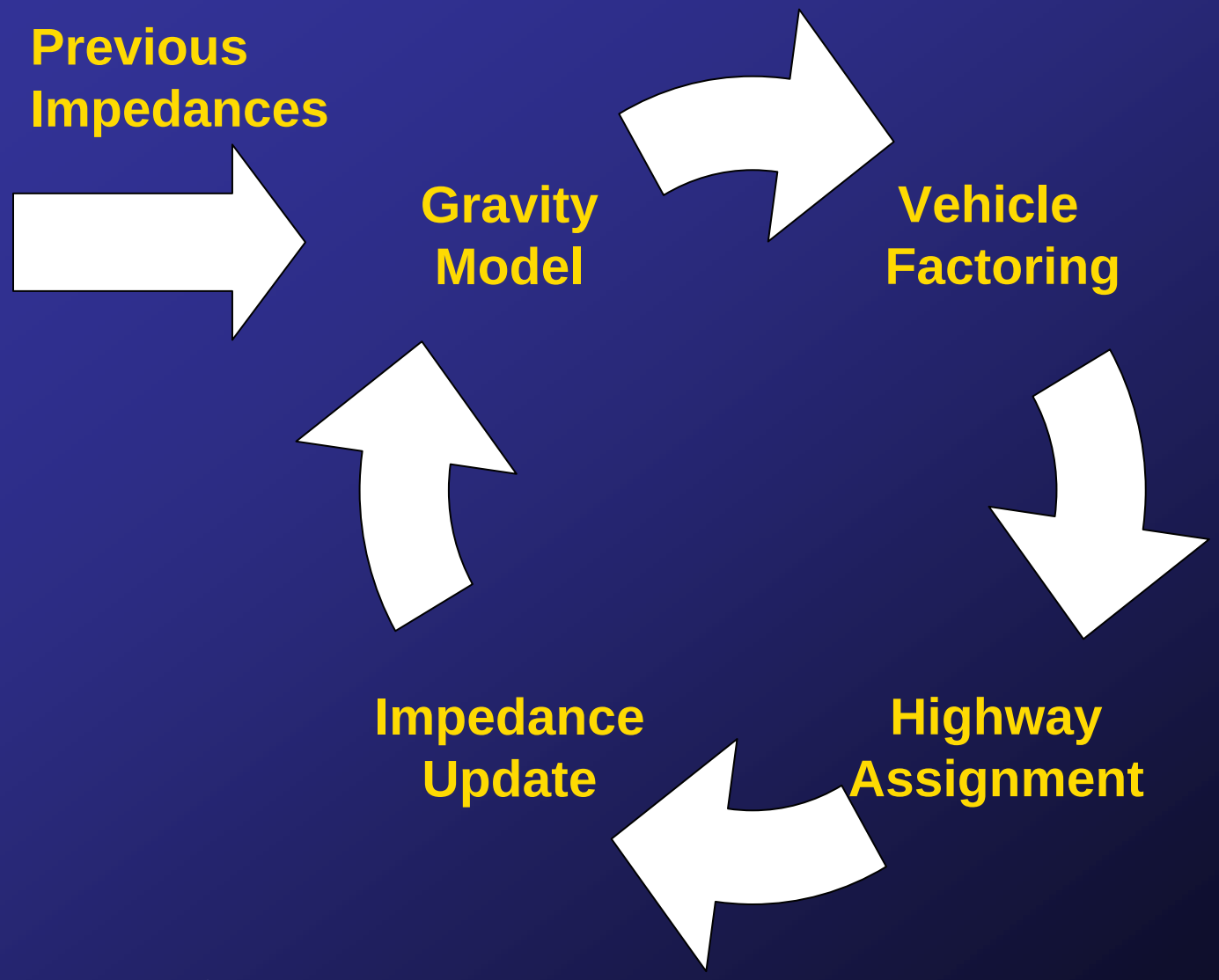
Procedures

- Daily gravity model
- Gamma function
- Doubly constrained
- Composite impedances from mode choice
- Multiple feedback loops

Feedback Loop



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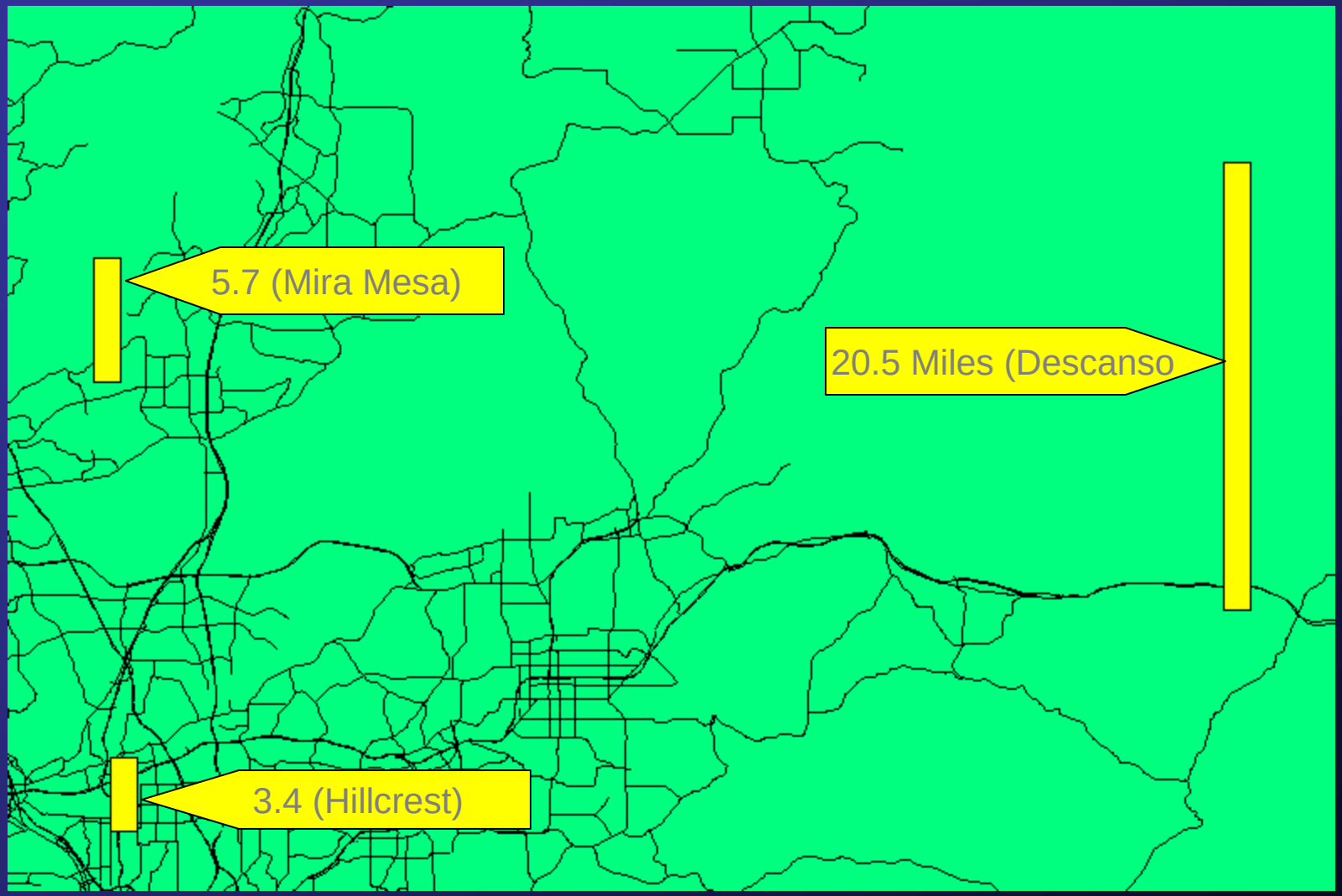
Average Home-Shop Trip Length



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Data Sources

- Travel Behavior Survey
- Census Transportation Planning Package

Trip Distribution

Discussion

MODE CHOICE

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Alternative Models

- Mode Choice Improvement Project
- Interim Model
- Market Research Model

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Interim Model

- Use asserted industry standard coefficients
- Calibrate modal constants using FTA guidelines
- Remove thresholds
- Add toll/managed lane capability
- Use for Mid-coast New Starts submittal
- Focus of today's presentation

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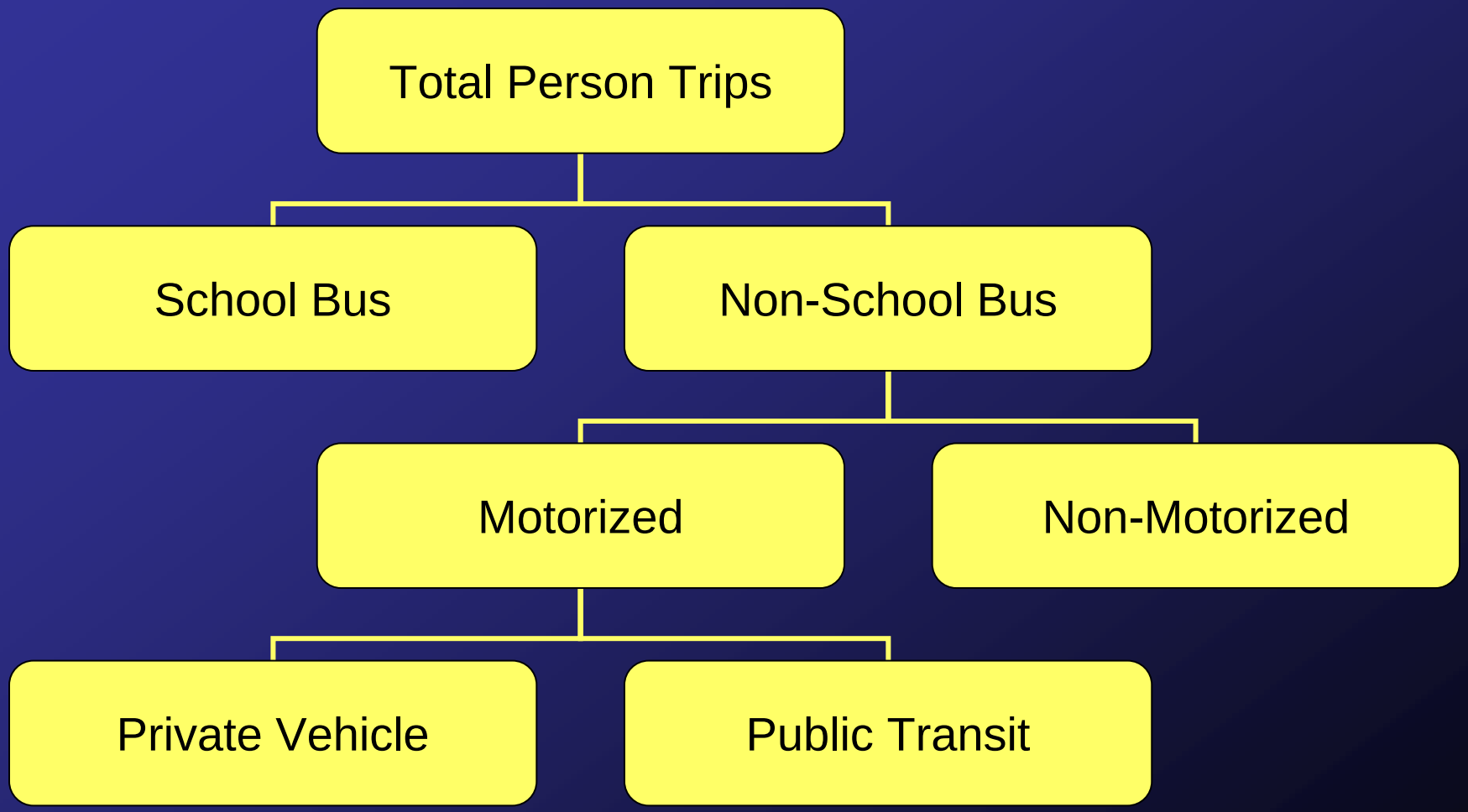
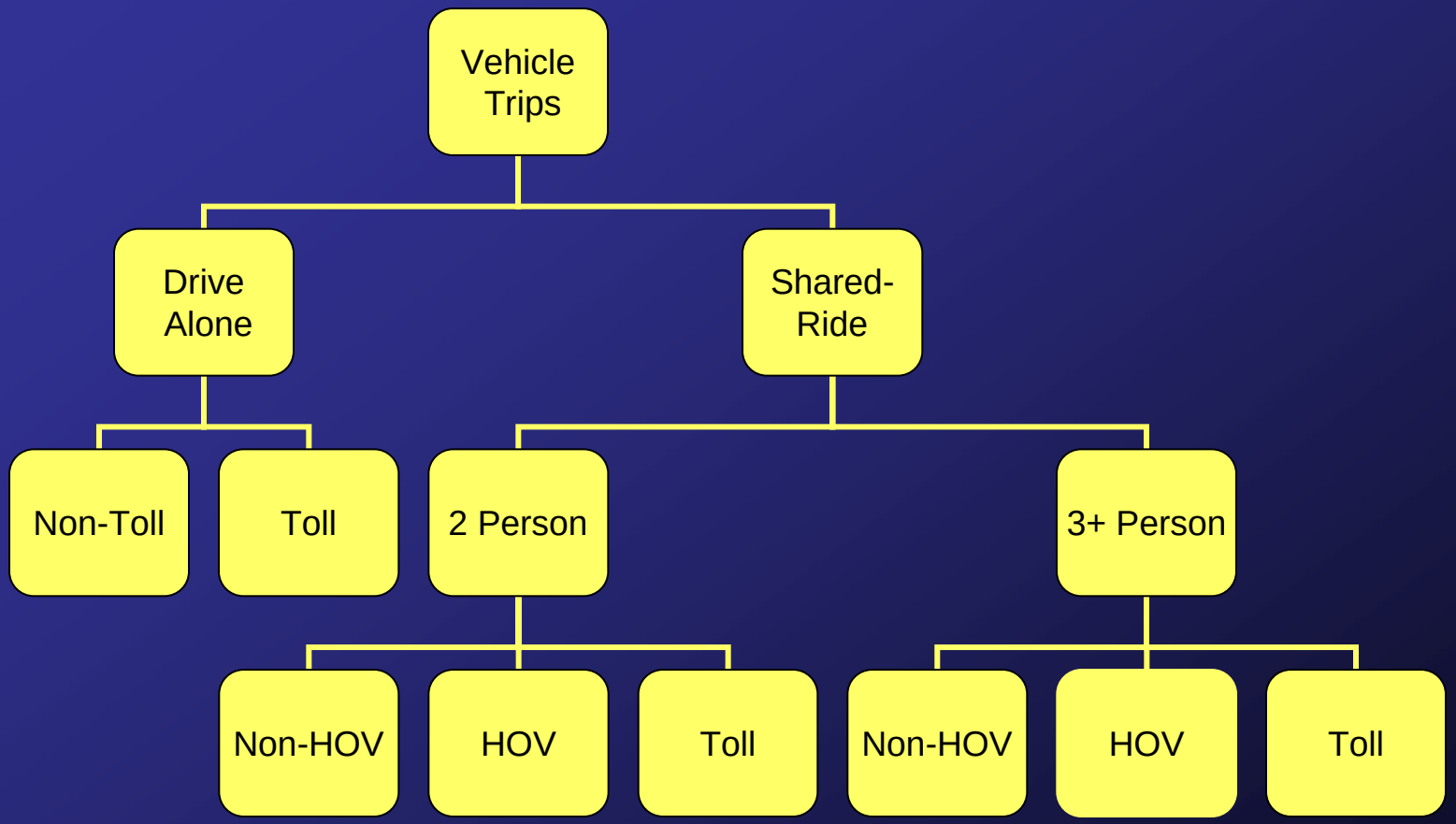
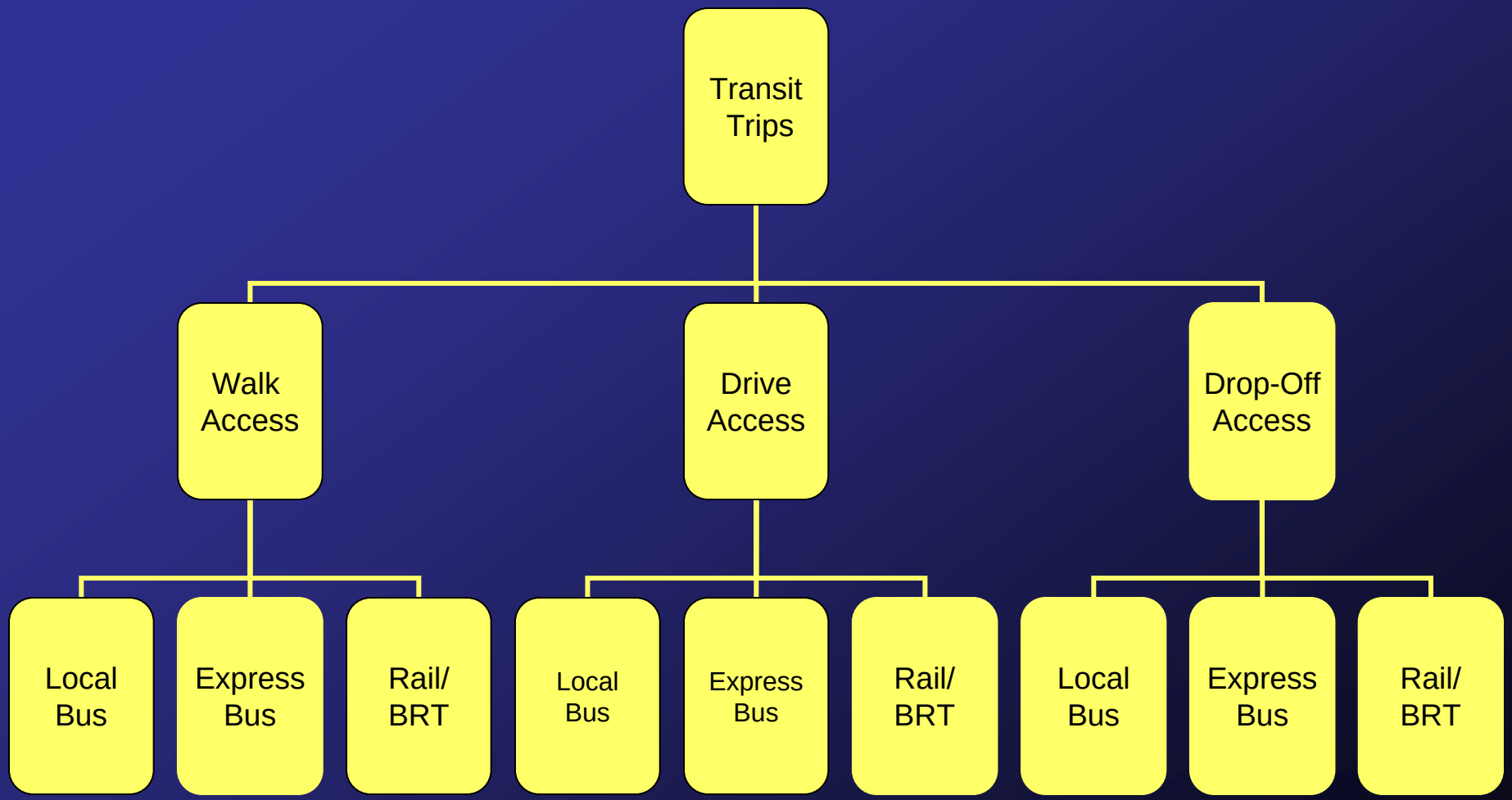
Nested Mode Choice Structure



Private Vehicle Structure



Public Transit Structure



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Transit Ride Modes

Transit Network	Mode Choice	Assignment
• Commuter Rail • Light Rail • Regional BRT • Corridor BRT	• Rail/BRT	•Premium
• Limited Express Bus • Express Bus	• Express Bus	
• Local Bus	• Local Bus	• Local Bus

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Trip Types

Generation/Distribution

- Home-Work
- Home-College
- Home-School
- Home-Shop
- Home-Other
- Other-Other
- Work-Other
- Visitor
- Airport
- Serve Passenger

Mode Choice

- Home-Work
- Home-College
- Home-School
- Home-Other
- Other-Other
- Serve Passenger

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Market Segments

- Income Level (Home-Based Only)
  - Low ($0 – $24,999)
  - Medium ($25,000 – $49,999)
  - High ($50,000 or more)
- Time of Day
  - Peak Period (6-9 AM, 3-6 PM)
  - Off-Peak Period

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Utilities - Auto Modes

Component	Coefficient	Source
In-vehicle time	-0.0250 (Work) -0.0125 (Non-work)	Highway network times
Terminal Time	-0.0500 (Work) -0.0250 (Non-work)	Land use
Auto operating costs	-0.0070 (Low) -0.0028 (Mid) -0.0010 (High)	Highway network distances Cost per mile
Parking costs	-0.0070 (Low) -0.0028 (Mid) -0.0010 (High)	Local knowledge Escalation factor
Tolls	-0.0070 (Low) -0.0028 (Mid) -0.0010 (High)	Toll distances $0.10-$0.26/mile

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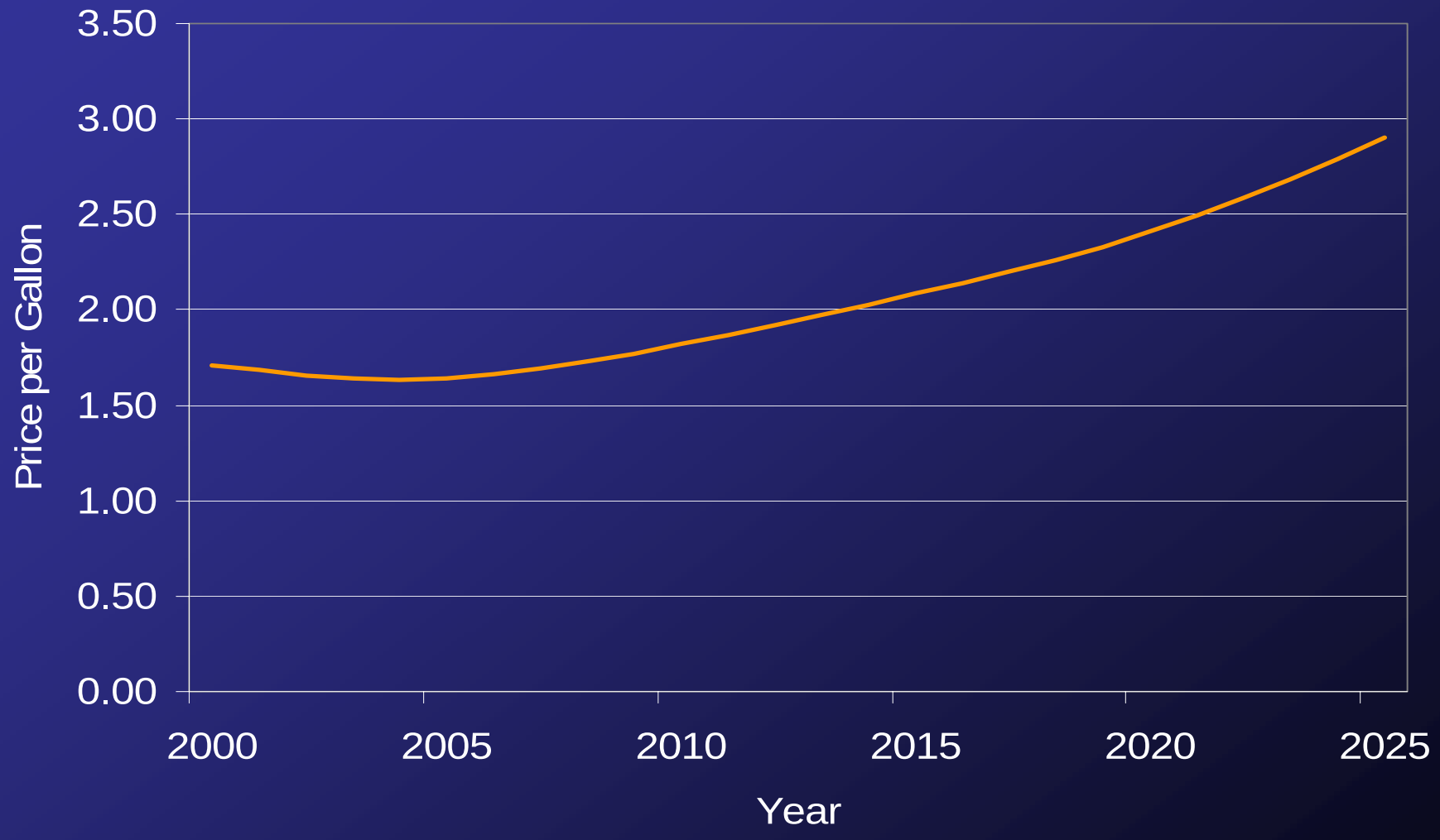
Gas Price Forecast



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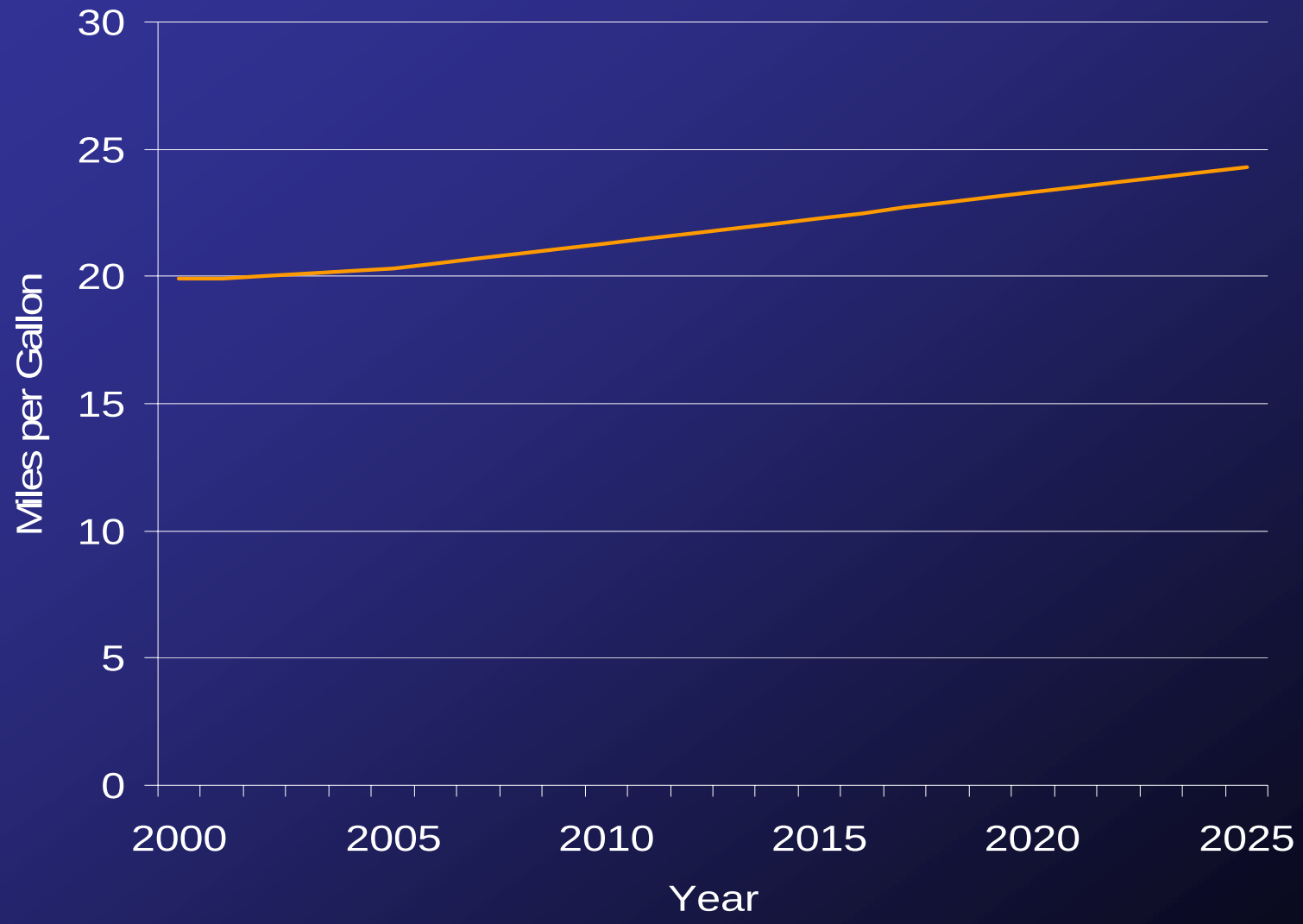
Fuel Economy Forecast



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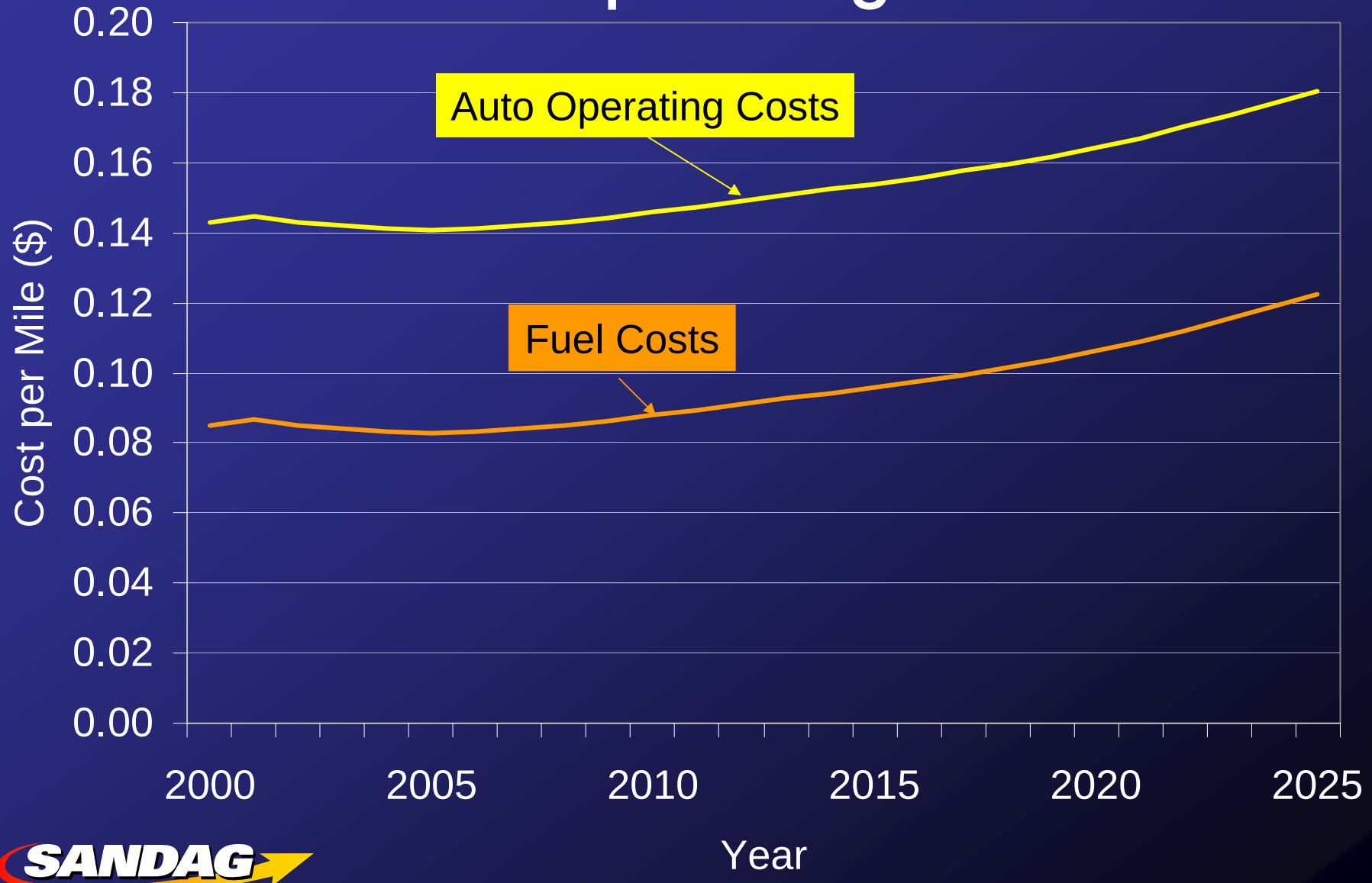
Auto Operating Cost



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Parking Costs

	Area 1	Area 2	Area 3	Area 4
Work				
Daily Rate	$15.00	$8.00	$5.00	$5.00
Rate/Trip	$7.50	$4.00	$2.50	$2.50
Vehicle Occupancy	1.20	1.20	1.20	1.20
Rate/Occupant	$6.25	$3.33	$2.08	$2.08
Pay Percent	50%	50%	50%	25%
Weighted by Payers	$3.13	$1.67	$1.04	$0.52
Non-Work				
Hourly Rate	$1.50	$1.50	$1.50	$1.50
Duration	50%	50%	50%	50%
Rate/Trip	$0.38	$0.38	$0.38	$0.38
Vehicle Occupancy	1.33	1.33	1.33	1.33
Rate/Occupant	$0.28	$0.28	$0.28	$0.28
Pay Percent	50%	50%	50%	50%
Weighted by Payers	$0.14	$0.14	$0.14	$0.14

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Utilities – Non-Motorized

Component	Coefficient	Source
Time	-0.0500 (Work) -0.0250 (Non-work)	MGRA distances (<1 Mile) Arterial network

Threshold: Maximum six mile length

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Utilities – Transit Auto

Component	Coefficient	Source
Drive time from production zone	-0.0500 (Work) -0.0250 (Non-work)	Transit access time
Drive operating cost	-0.0070 (Low) -0.0028 (Mid) -0.0010 (High)	Transit access link distance Cost per Mile
Terminal times at home and parking lot	-0.0500 (Work) -0.0250 (Non-work)	1 minute/location
Transit in-vehicle time	-0.0250 (Work -0.0125 (Non-work)	Transit networks
Transit first wait time	-0.0375 (Work -0.0188(Non-work)	Transit networks
Transit transfer time	-0.0625(Work -0.0313 (Non-work)	Transit networks + 10 minutes/transfer
Transit Fare	-0.0070 (Low) -0.0028 (Mid) -0.0010 (High)	Transit networks
Walk time to attraction MGRA	-0.0500 (Work) -0.0250 (Non-work)	Transit access links

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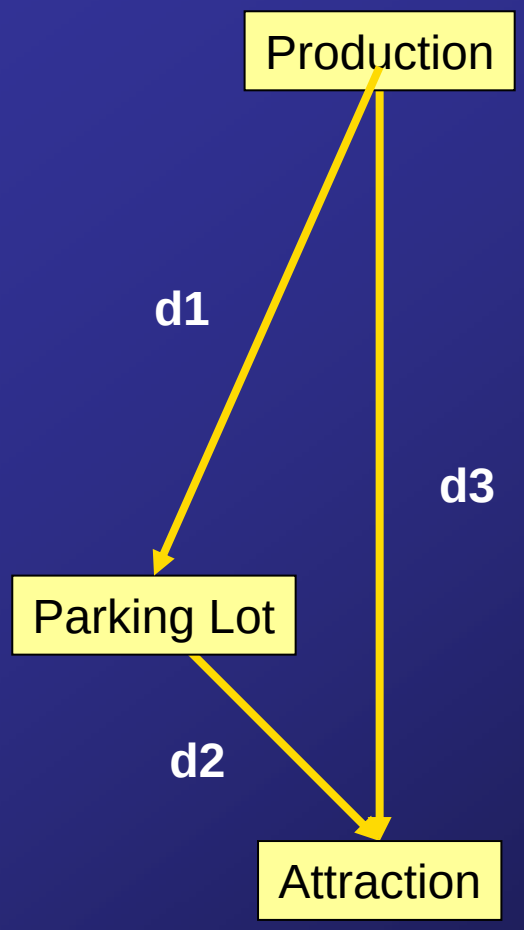
Thresholds – Transit Auto



Existing

- d1/d3 < 33%
- (d1+d2)/d3 <125%

Removed

- d3 > 2.5 Miles
- Transit in-vehicle > 5 minutes

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Utilities – Transit Walk

Component	Coefficient	Source
Walk time from production MGRA	-0.0500 (Work) -0.0250 (Non-work)	Transit access links
Transit in-vehicle time	-0.0250 (Work -0.0125 (Non-work)	Transit networks
Transit first wait time	-0.0375 (Work -0.0188(Non-work)	Transit networks
Transit transfer time	-0.0625(Work -0.0313 (Non-work)	Transit networks
Transit Fare	-0.0070 (Low) -0.0028 (Mid) -0.0010 (High)	Transit networks
Walk time to attraction MGRA	-0.0500 (Work) -0.0250 (Non-work)	Transit access links

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Market Research Model

- Developed from 2000 Stated Preference Survey
- Market segmentation approach
- Initial spreadsheet application
- Preliminary application mode choice program
- Not yet calibrated

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Rail Trips by Income Level

Mode/Income	Linked Trips		Difference	
	Observed	Estimated	Absolute	Percent
Light Rail				
Low	37,135	40,899	3,764	10%
Mid	29,014	23,602	-5,412	-19%
High	8,722	13,309	4,587	53%
Total	74,871	77,810	2,939	4%
Commuter Rail				
Low	295	1,574	1,279	434%
Mid	1,220	1,372	152	12%
High	3,026	1,930	-1,096	-36%
Total	4,542	4,876	334	7%

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Market Research Model

- Multinomial Logit
- Purposes
  - Commute
  - Non-commute
- Market Segments
  - Road Runners
  - Cautious Runabouts
  - Intrepid Trekkers
  - Flexible Flyers
  - Conventional Cruisers
  - Easy Goers

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Utilities – Auto

Component		Coefficients					
		Road Runners	Cautious Runabouts	Intrepid Trekkers	Flexible Flyers	Conventional Cruisers	Easy Goers
In-vehicle time	W	-0.073	-0.051	-0.043	-0.043	-0.040	-0.040
	NW	-0.057	-0.024	-0.016	-0.016	-0.017	-0.017
Search time	W	-0.072	-0.072	-0.072	-0.072	-0.072	-0.072
	NW	-0.041	-0.041	-0.041	-0.041	-0.041	-0.041
Park cost/ log(income)	W	-0.978	-0.978	-0.978	-0.978	-0.978	-0.978
	NW	-0.854	-0.854	-0.854	-0.854	-0.854	-0.854
Walk time		-0.056	-0.056	-0.056	-0.056	-0.056	-0.056
Cars/Adult	DA	0.440	0.440	0.440	0.440	0.440	0.440
	SR	0.267	0.267	0.267	0.267	0.267	0.267

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Utilities – Transit

Component		Coefficients					
		Road Runners	Cautious Runabouts	Intrepid Trekkers	Flexible Flyers	Conventional Cruisers	Easy Goers
In-vehicle time	W	-0.067	-0.035	-0.034	-0.034	-0.022	-0.022
	NW	-0.047	-0.020	-0.012	-0.012	-0.016	-0.016
First & transfer wait time	W	-0.138	-0.138	-0.044	-0.044	-0.097	-0.097
	NW	-0.031	-0.031	-0.011	-0.011	-0.016	-0.016
Transit Fare	W	-0.150	-0.150	-0.150	-0.150	-0.150	-0.150
	NW	-0.091	-0.091	-0.091	-0.091	-0.091	-0.091
Walk time		-0.062	-0.062	-0.062	-0.062	-0.062	-0.025
Transfers		-0.142	-0.142	-0.142	-0.142	-0.142	-0.142
Seat Availability		+0.001	+0.001	+0.001	+0.001	+0.001	+0.001

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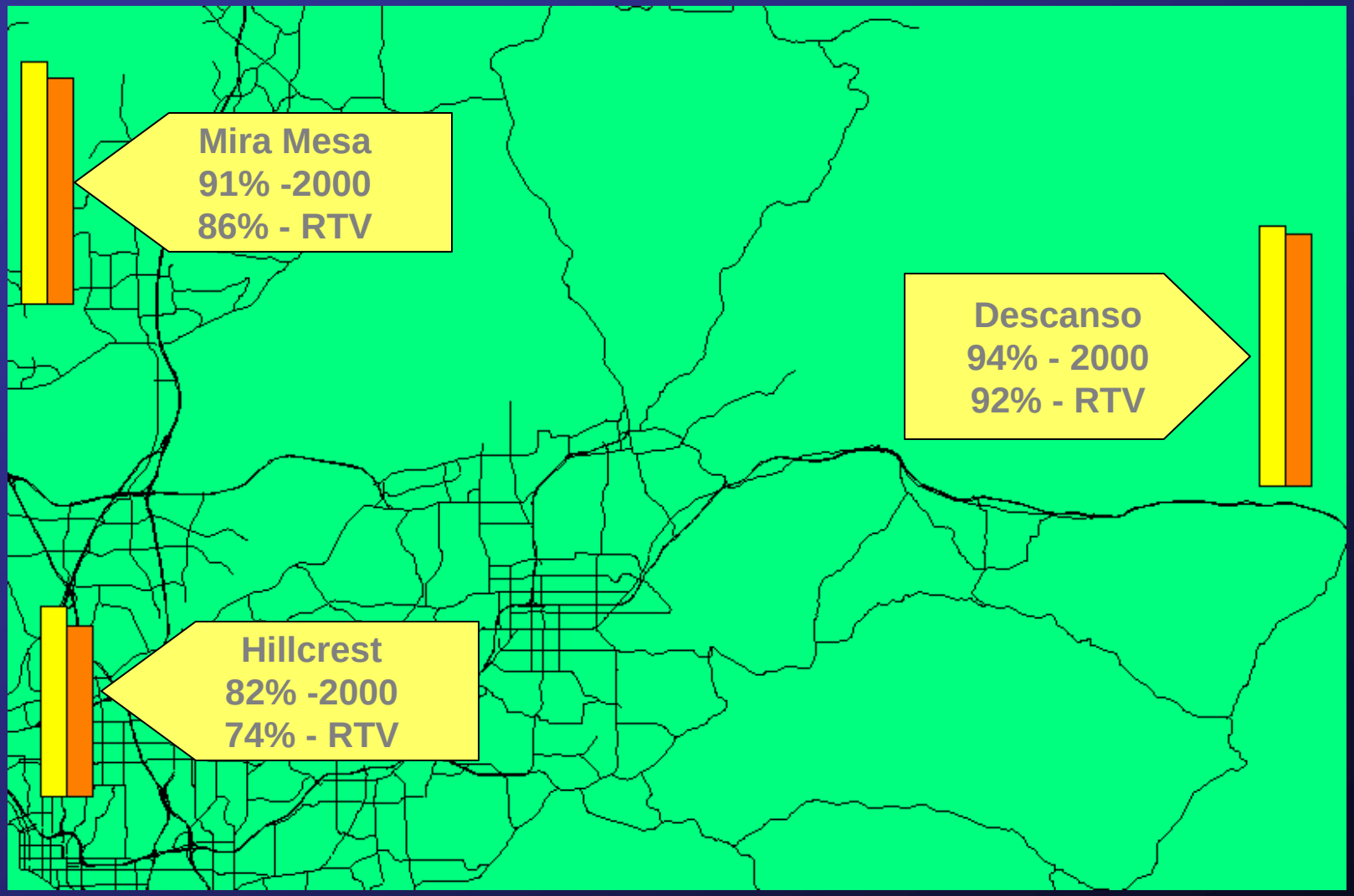
Vehicle % of Total Work Trips



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Mode Choice

Discussion

HIGHWAY AND TRANSIT ASSIGNMENT

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Highway Assignment

- TransCAD Multi-Modal Multi-Class Assignment
- Logit Delay Function
- Convergence: 0.01
- Time Periods:
  - AM (6:00-9:00)
  - PM (3:00-6:00)
  - Off Peak
- Modes:
  - Drive Alone Non Toll/Toll
  - 2 Person Shared-ride Non-HOV/HOV/Toll
  - 3+ Person Shared-ride Non-HOV/HOV/Toll

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Market Segmentation Methodology

- Factor analysis to identify traveler attitudes
- Structural equation model (SEM) to link traveler attitudes to demographic characteristics
- Cluster analysis to segment traveler market
- Application of SEM and market segmentation to general population

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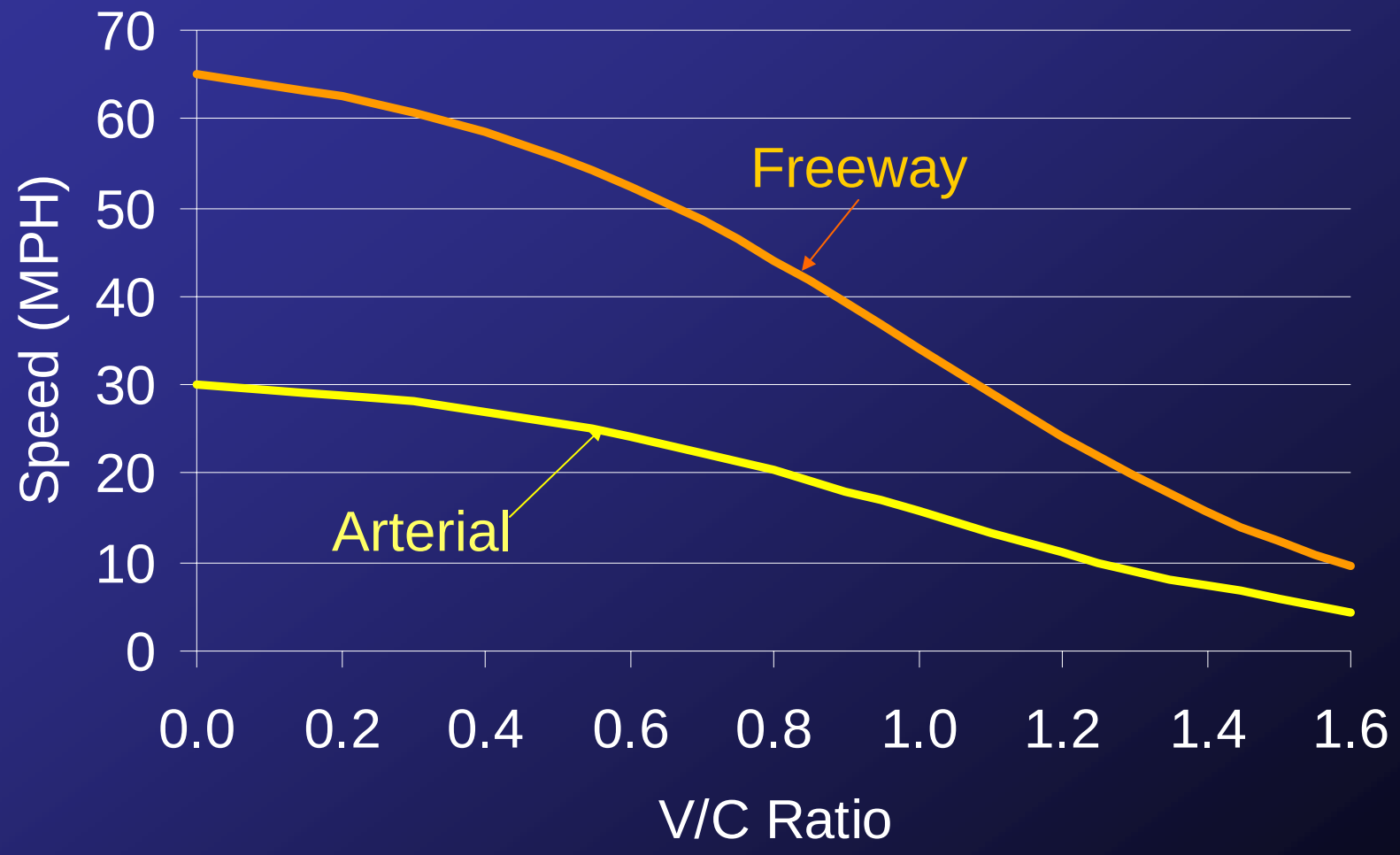
Volume Delay Function



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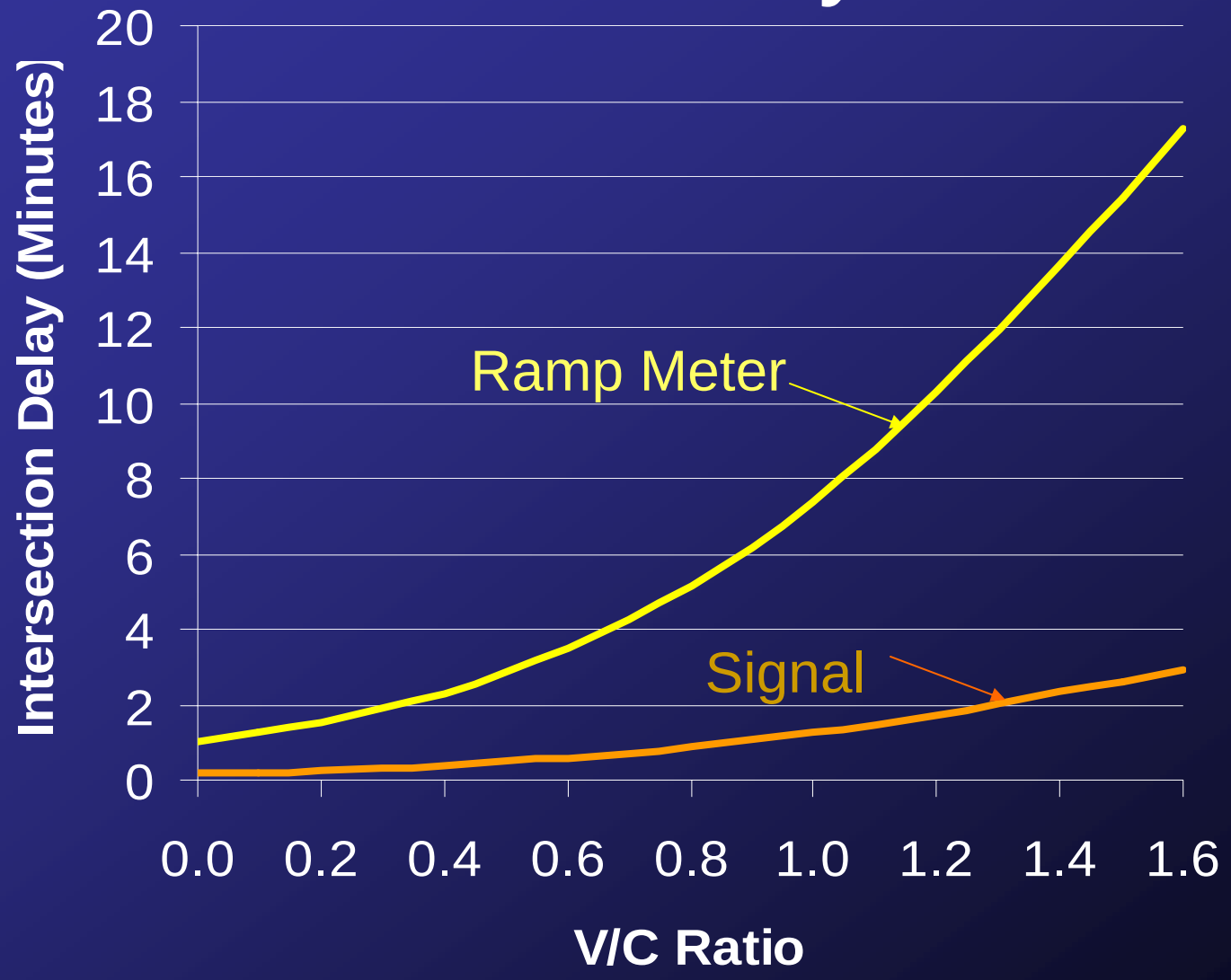
Intersection Delay Function



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Post Processing – Volume Adjustment

		(0.57)		
		(-6,537)		
Base Year	12,314	8,700 15,237	16,111	Count Model
2005	20,145 26,682	16,080 22,617	19,302 25,839	Adjusted Model
2030	4,874 8,684	5,318 9,128	7,175 10,985	Adjusted Model
	109	109	109	BRT

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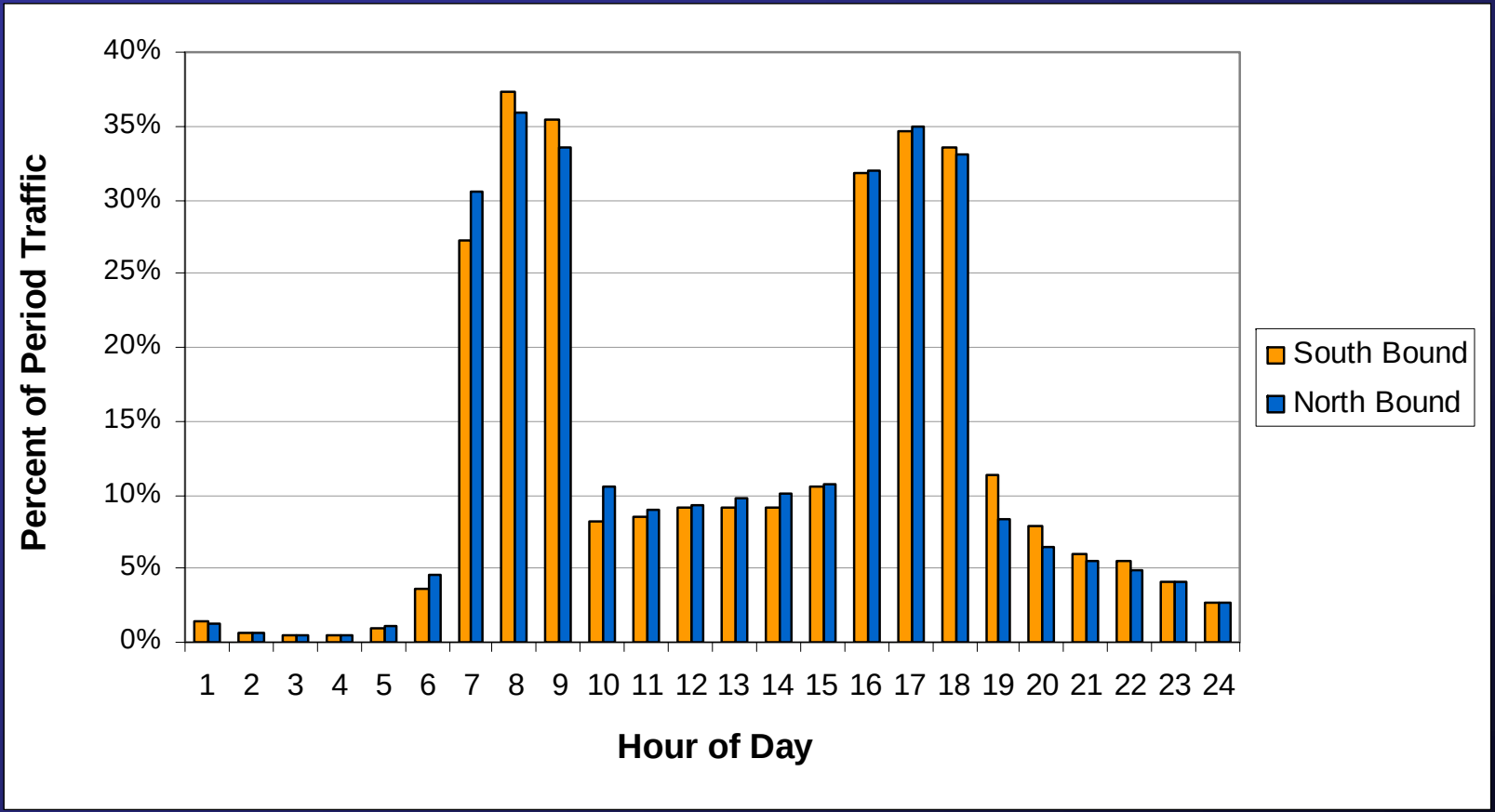
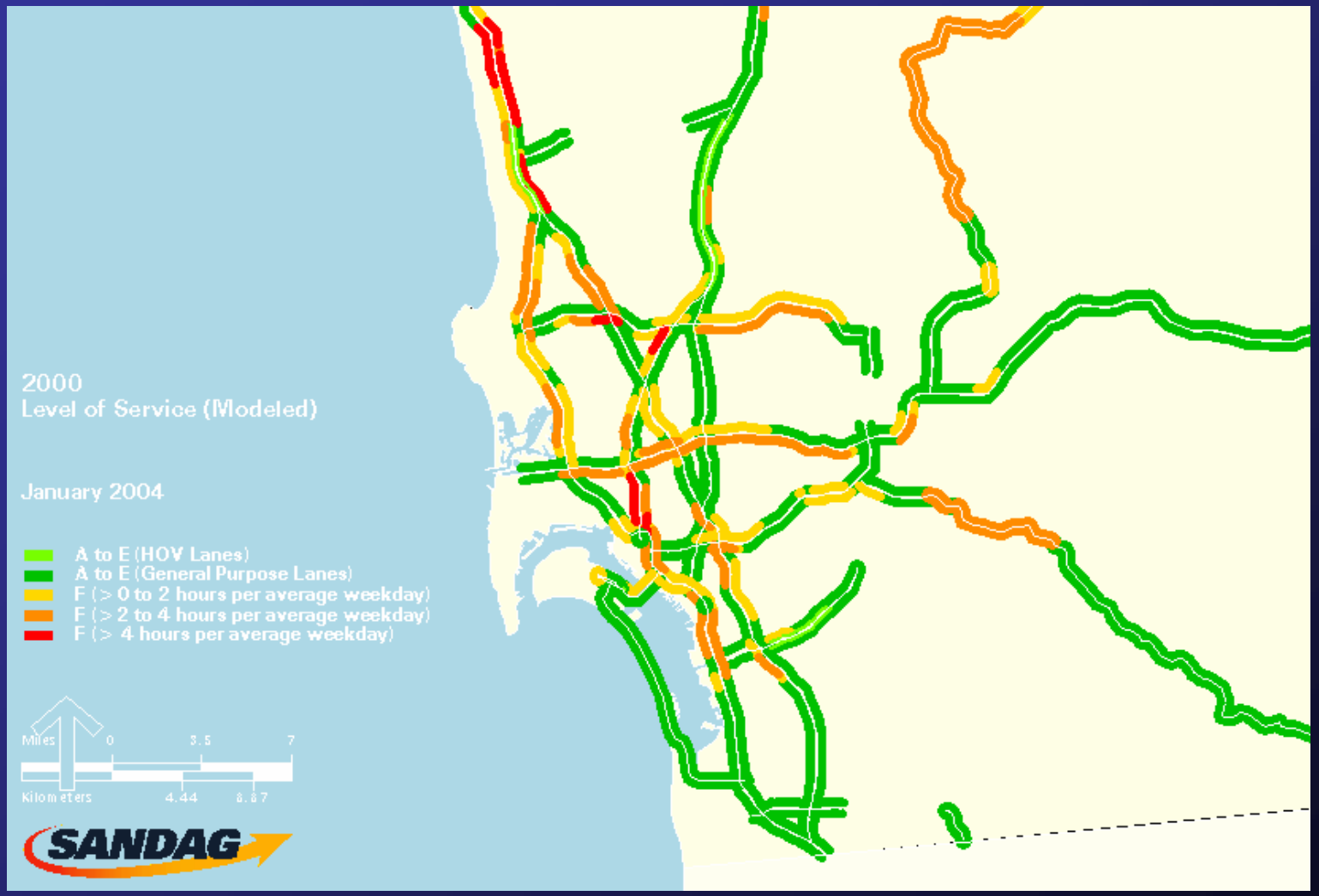
Post Processing- Travel Time



Post Processing - Level of Service



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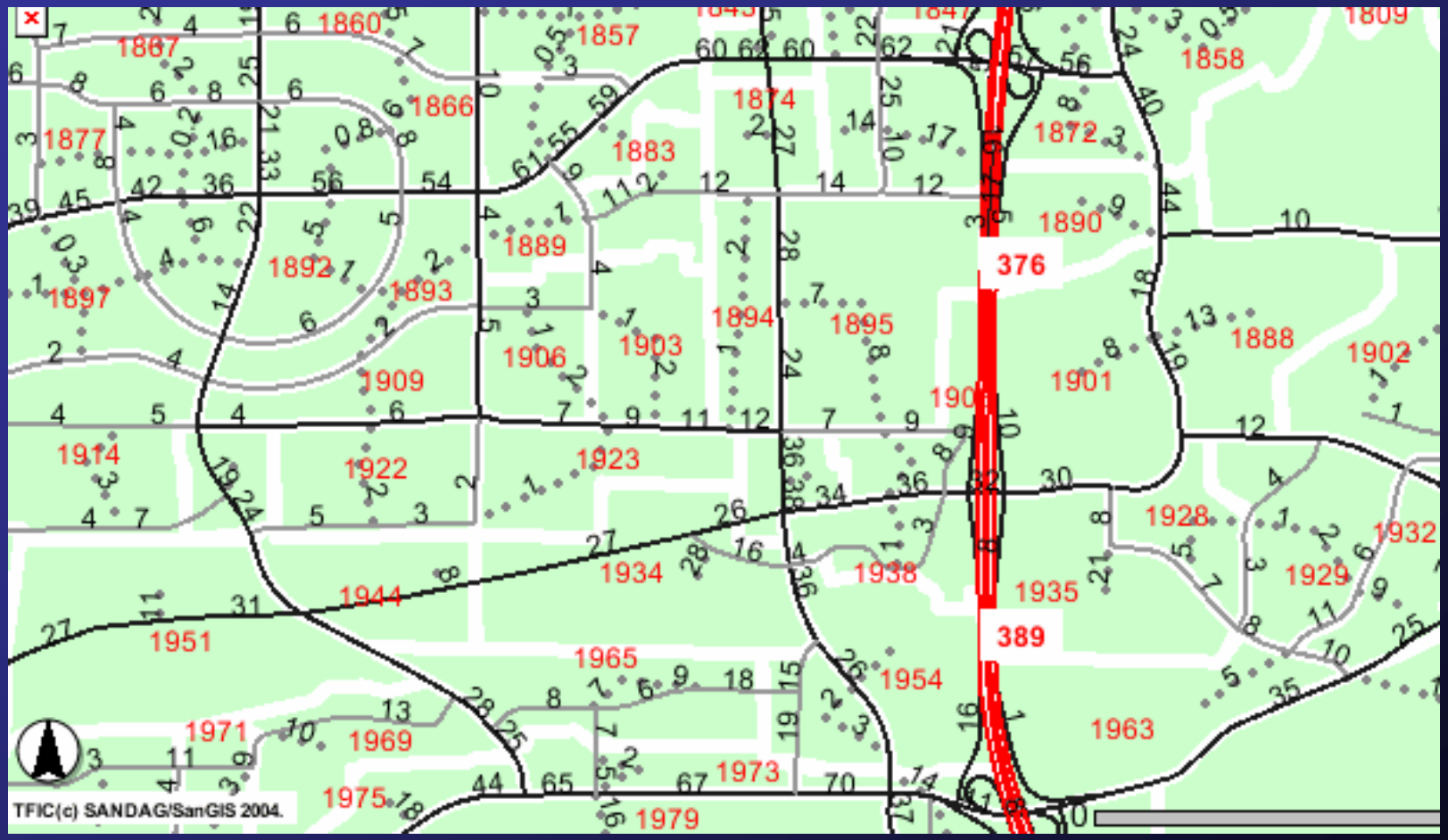
Post Processing – Freeway Volumes



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Validation Procedures

- Total VMT
- VMT by Functional Classification
- Screenline Counts
- Subarea VMT
- Adjacent Land Use VMT
- Problem Links

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Vehicle Miles Traveled Comparison

Facility Type	Observed VMT	Estimated VMT	Difference	Percent	Number of Counts
Freeway	37,512,611	37,604,056	91,445	0%	84
Prime	5,961,573	5,602,280	-359,293	-6%	349
Major	12,858,134	12,372,028	-486,106	-4%	1,715
Collector	5,139,022	5,258,954	119,932	2%	1,245
Local Collector	3,633,059	3,688,351	55,292	2%	1,399
Rural Collector	811,381	1,169,206	357,825	44%	76
Local	1,104,307	1,089,476	-14,831	-1%	338
Freeway Ramp	1,394,422	1,469,156	74,734	5%	166
On/Off Ramp	2,374,705	2,013,225	-361,480	-15%	972
Total	70,789,214	70,266,732	-522,482	-1%	6,344

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Average link Volume Comparison

Facility Type	Average Link Volumes				Absolute Difference		Number of Counts
	Observed	Estimated	Difference	Percent	Difference	Percent	
Freeway	148,045	148,338	293	0%	15,031	10%	84
Prime	32,088	30,269	-1,819	-6%	6,319	20%	349
Major	18,219	16,638	-1,581	-9%	4,527	25%	1,715
Collector	9,359	8,692	-667	-7%	3,168	34%	1,245
Local Collector	5,531	5,300	-231	-4%	2,151	39%	1,399
Rural Collector	3,696	4,534	838	23%	2,100	57%	76
Local	4,452	4,297	-155	-4%	1,759	40%	338
Freeway Ramp	21,845	22,341	496	2%	4,753	22%	166
On/Off Ramp	7,813	6,688	-1,125	-14%	2,508	32%	972
Total	13,757	12,894	-863	-6%	3,494	25%	6,344

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Highway Travel Time Surveys

Route	AM				PM			
	Observed	Modeled	Difference		Observed	Modeled	Difference	
Calsbad-Escondido	26	30	4	15%	26	27	1	4%
Chula Vista-Sorrento Mesa	54	54	0	0%	66	71	5	8%
Downtown-Sorrento Mesa	29	32	3	10%	29	35	6	21%
El Cajon-Downtown	28	29	1	4%	25	30	5	20%
Escondido-Calsbad	39	35	-4	-10%	43	40	-3	-7%
Escondido-Downtown	62	64	2	3%	59	64	5	8%
Escondido-Kearny Mesa	55	47	-8	-15%	44	46	2	5%
MidCity-Kearny Mesa	15	16	1	7%	20	16	-4	-20%
Mid City-Sorrento Mesa	26	31	5	19%	42	42	0	0%
Oceanside-Downtown	63	62	-1	-2%	65	62	-3	-5%
Rancho Bernado-Sorrento Mesa	33	35	2	6%	51	50	-1	-2%
Sorrento Mesa-Downtown	29	27	-2	-7%	25	28	3	12%
SanYsidro-Downtown	27	32	9	19%	20	28	8	40%
Total	486	494	8	2%	515	539	24	5%

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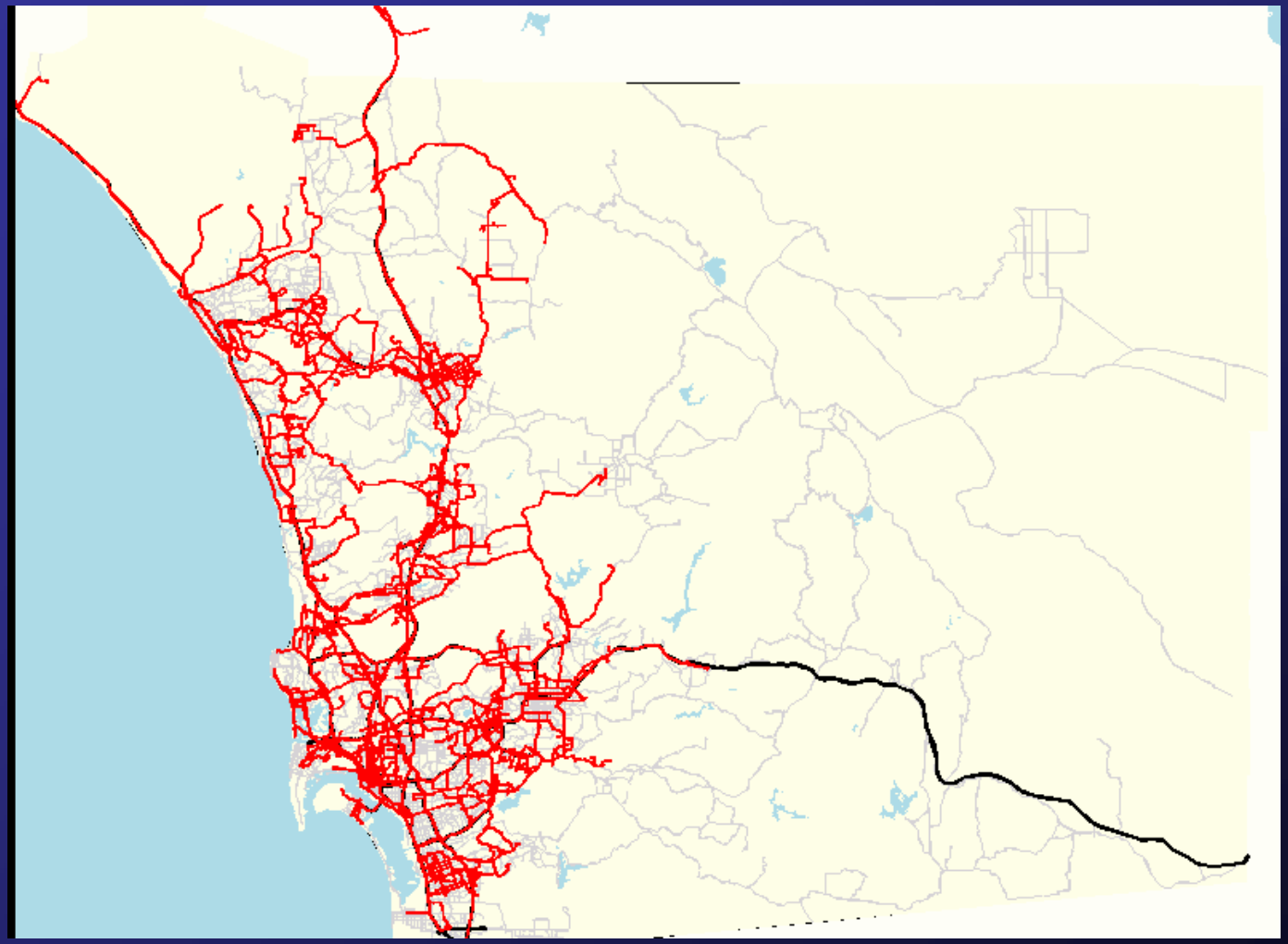
GPS Coverage



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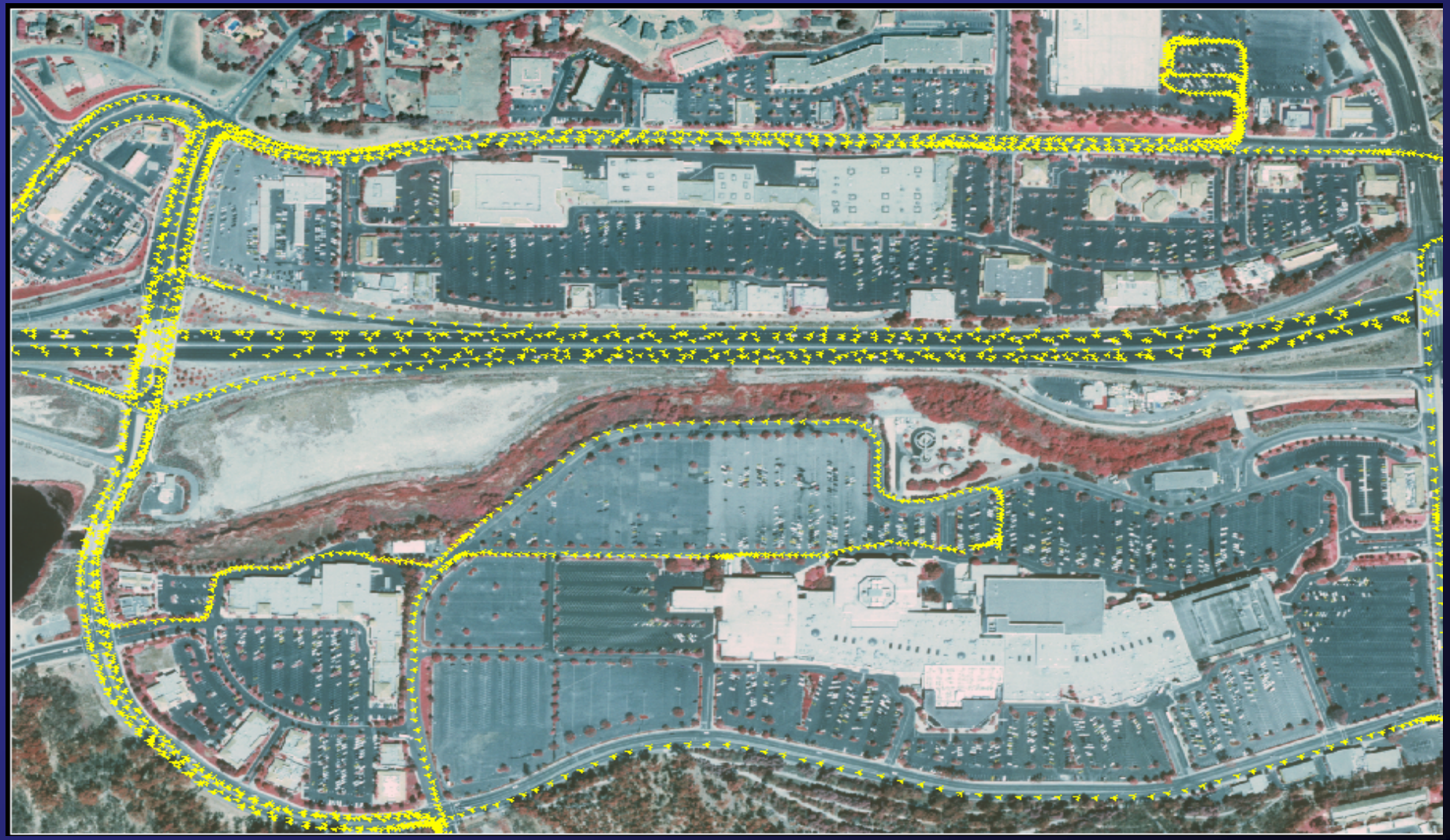
GPS Points and Aerial Photos



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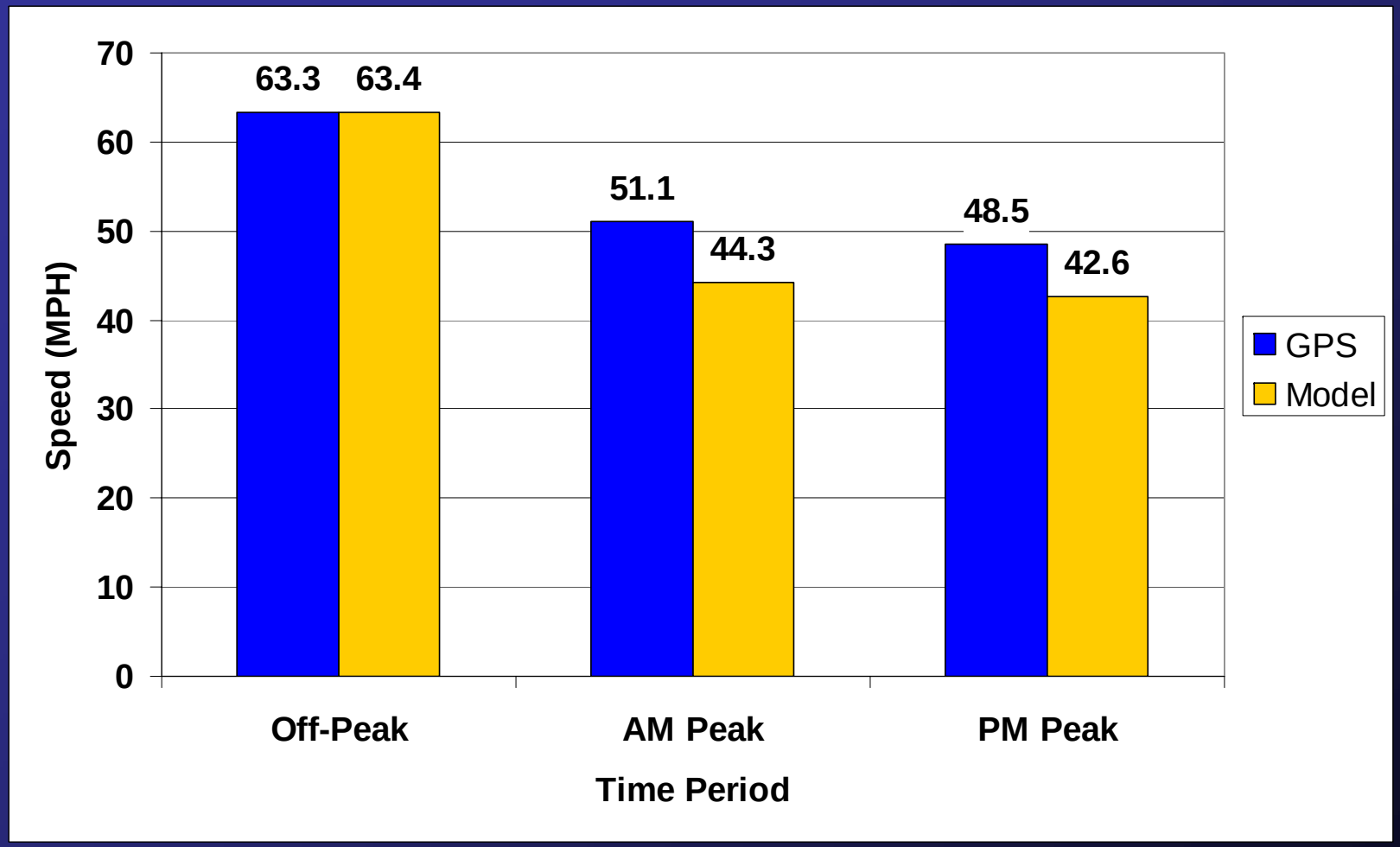
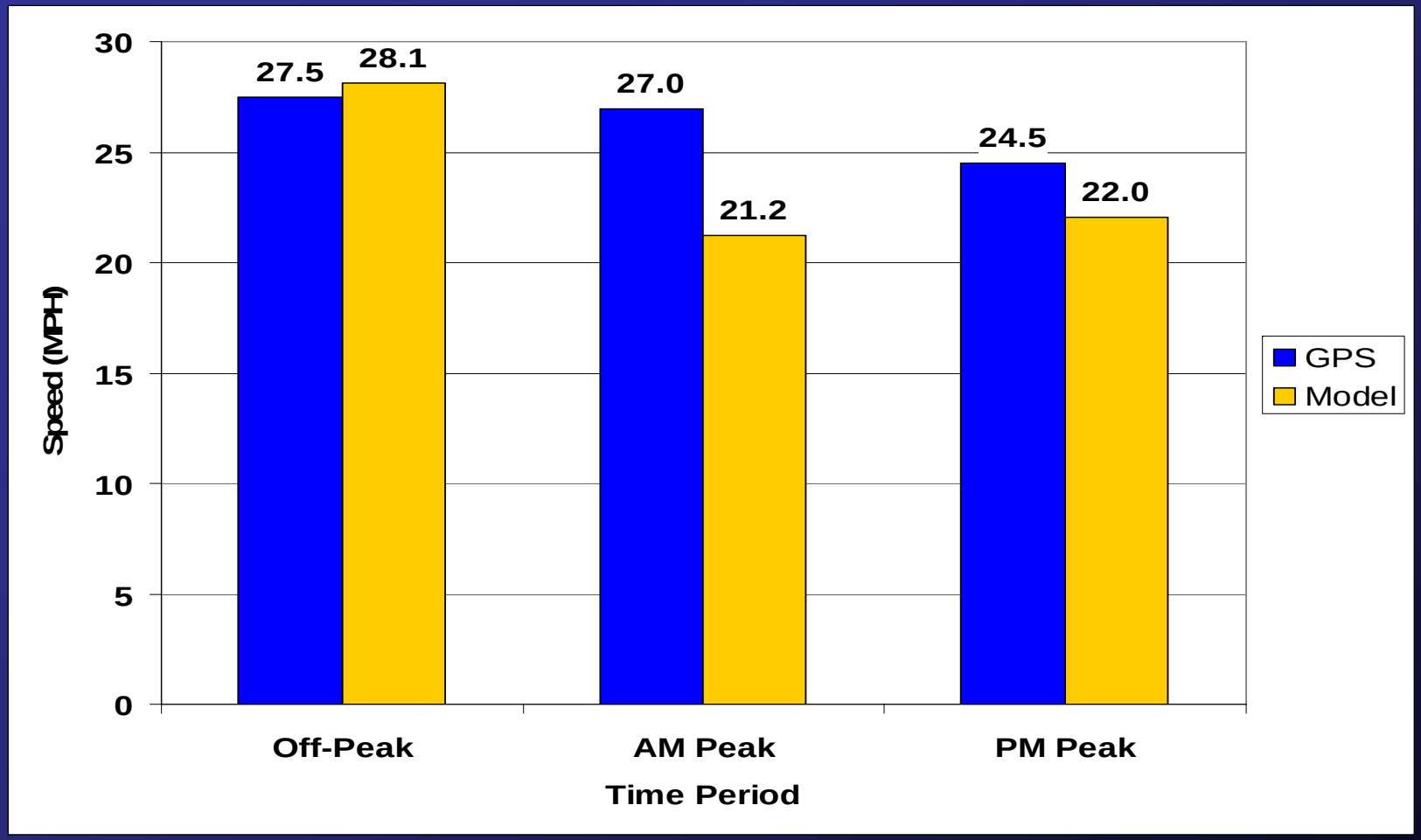
Freeway Speed Comparison



Arterial Speed Comparison



Potential Improvements

- Incorporate PeMS speeds and counts
- Analyze GPS further
- Improve time-of-day procedures
- Refine ramp meter algorithms
- Rationalize toll modes

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Transit Assignment

- TransCAD Pathfinder Method
- Time Periods:
  - Peak
  - Off Peak
- Ride Modes:
  - Premium Service
  - Local Service
- Access Modes:
  - Auto Access
  - Walk Access

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Validation Procedures

- Total Boardings per Linked Trip
- Boardings by Mode
- Boardings by Sub areas
- Screenline Counts
- Individual Routes

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Boardings Comparison by Mode

	Modeled Boardings			Observed	Difference	
Mode	**Peak**	**Off Peak**	**Daily**	**Boardings**	**Absolute**	**Percent**
Commuter Rail	4,771	174	4,944	4,544	400	8.80%
Light Rail	59,874	37,234	97,108	95,362	1,746	1.80%
Limited Bus	1,361	0	1,361	1,038	323	31.10%
Express Bus	14,735	5,675	20,410	17,259	3,151	18.30%
Local Bus	119,213	83,177	202,390	211,072	-8,682	-4.10%
System Total	199,954	126,260	326,214	329,275	-3,061	-0.90%

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Boardings Comparison by Area Type

	Boardings		Difference	
Location	**Observed**	**Estimated**	**Absolute**	**Percent**
Centre City	126,738	111,876	-14862	-11.70%
Central Area	161,191	122,227	-38964	-24.20%
Suburban	354,275	395,087	40812	11.50%
Rural	20,122	23,236	3114	15.50%

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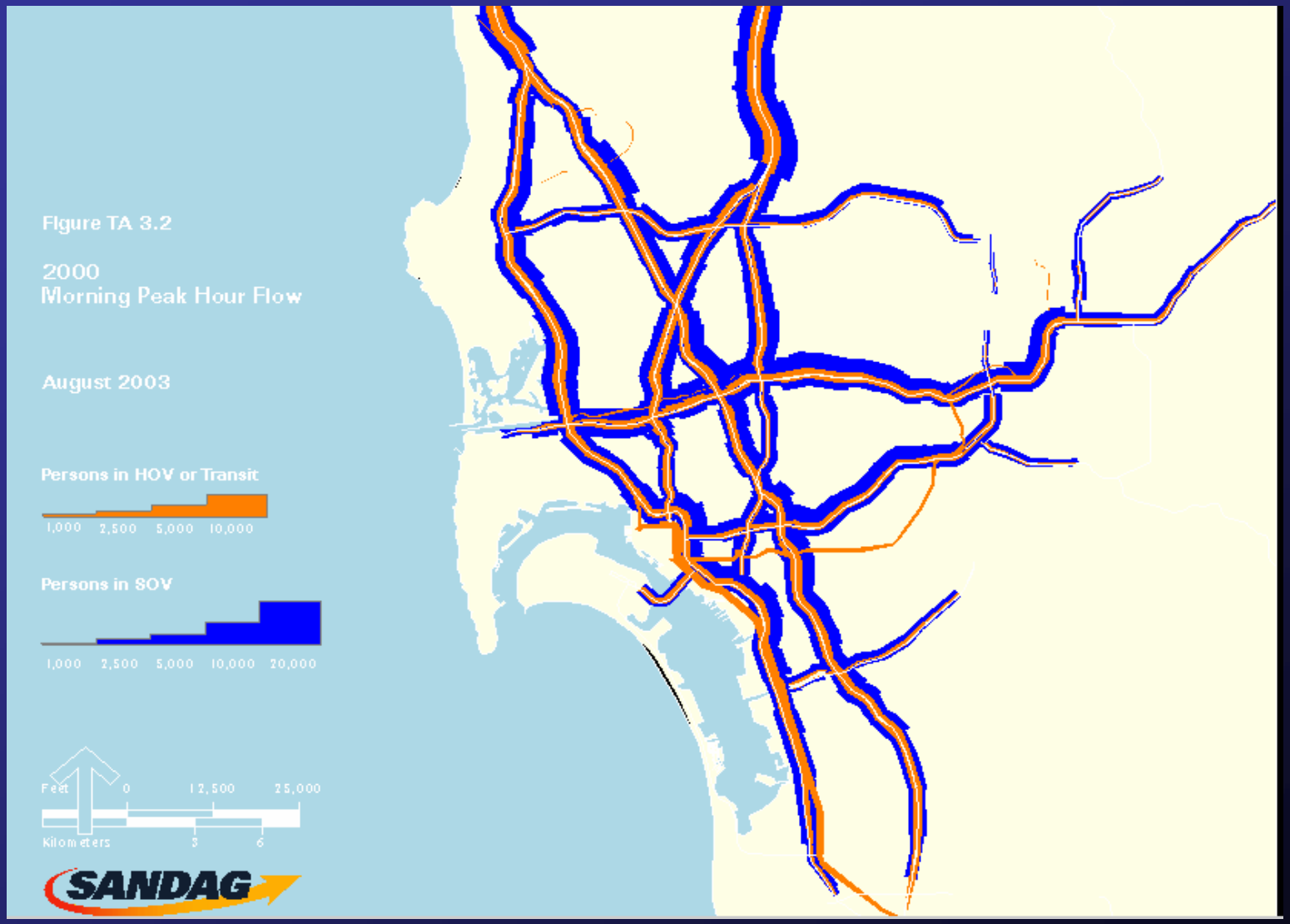
Potential Improvements

- Split peak period into AM and PM

Post Processing – Transit and Highway



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TFIC - Homepage

File Edit View Favorites Tools Help

Back Search Favorites Media

Address http://maximus.sandag.org/tfic/trfic30.html

Google Search Web 119 blocked AutoFill Options

SANDAG Transportation Forecast Information Center

2030 Traffic Volume Forecast
February 2005 Update

The Transportation Forecast Information Center (TFIC) gives you quick access to transportation forecasts. You may use this tool to look at the forecasts on screen as well as print maps or tables. Click on a button below to select the type of information and forecast year you want to view, or click "help" to see detailed instructions on how to use the application.

TYPE OF INFORMATION	FORECAST YEAR					
Basic Traffic Volumes:	2000	2010	2020	2030	All Years	Help
Enhanced Traffic Volumes:	2000	2010	2020	2030	All Years	Help

Basic Traffic Volumes. Forecasted average weekday traffic (AWT) volumes in thousands are displayed for freeways, ramps, and major and minor roads. Individual roadway segments can be selected to obtain additional information including street name, type of roadway, number of lanes, and posted speed.

Enhanced Traffic Volumes. The enhanced information shows traffic analysis zone (TAZ) zone connector volumes and enables you to obtain TAZ-level trip generation and land use forecasts in addition to the information from the basic version.

Forecast Year. Select an individual year (2000, 2010, 2020, or 2030) to obtain traffic forecasts for that year. Select "All Years" to obtain traffic volume forecasts for years 2000 through 2030.

Source. SANDAG uses a regional transportation model to produce highway and transit forecasts for individual forecast years between 2000 and 2030. These forecasts are updated periodically to incorporate the most recent planning assumptions. Traffic forecasts shown here were completed in **April 2004** using the 2030 Regional Transportation Plan (Mobility 2030) and the Final 2030 Regional Growth Forecast. Forecasts differ from the previous version of TFIC, which was based on the older 2020 Regional Transportation Plan (RTP) and 2020 Regional Growth Forecasts. TFIC traffic volumes also differ from those published in the 2030 RTP. The 2030 RTP was based on the Preliminary 2030 Regional Growth Forecast, which has since been updated and finalized.

Disclaimer. We make every effort to produce accurate forecasts. If you find a traffic volume that appears to be in error, e-mail us at tfic@sandag.org with the location and description of the problem. We will make corrections to our databases and produce revised forecasts in the next update cycle.

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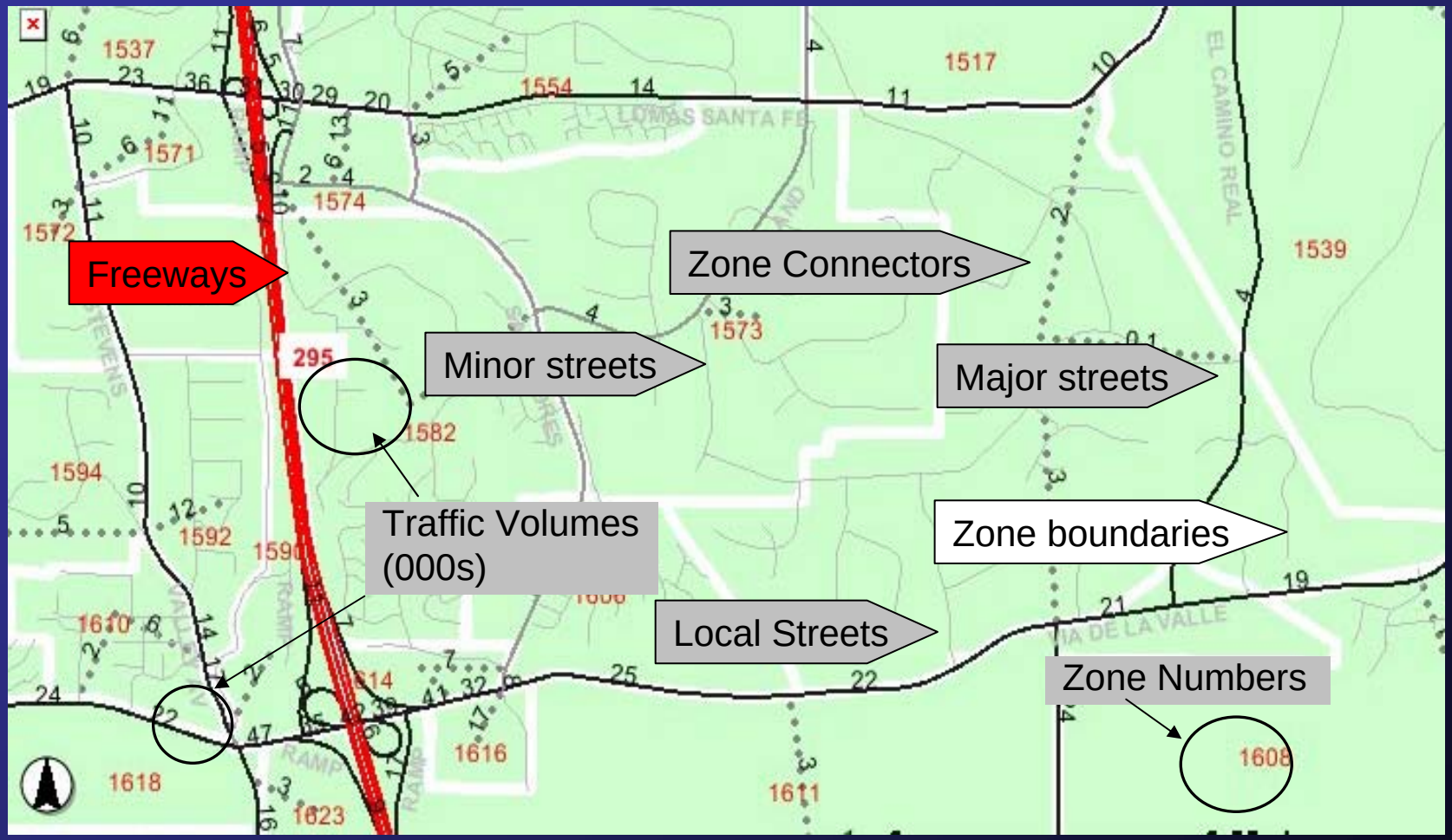
TFIC – Map Layers



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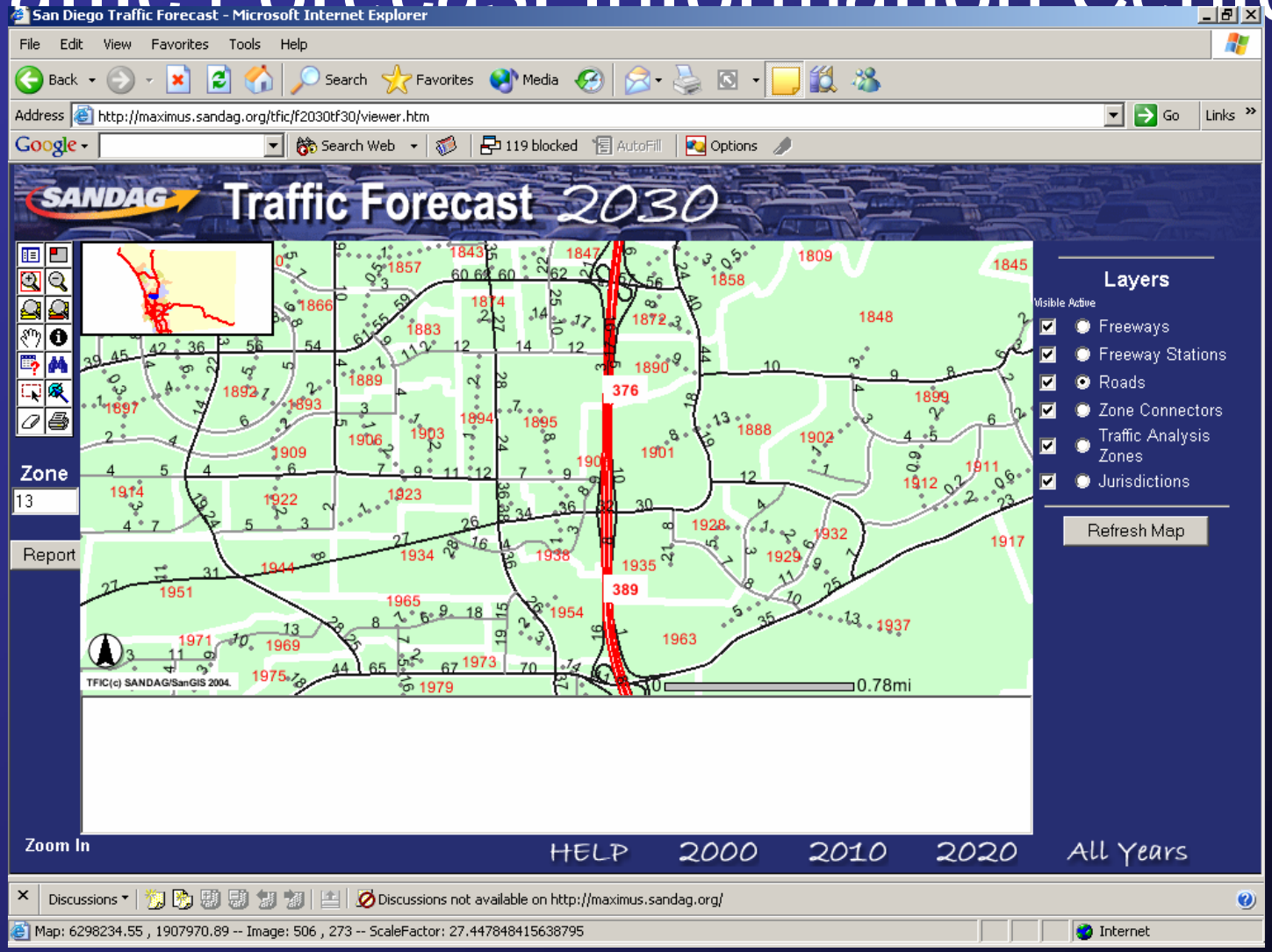
Traffic Forecast Information Center



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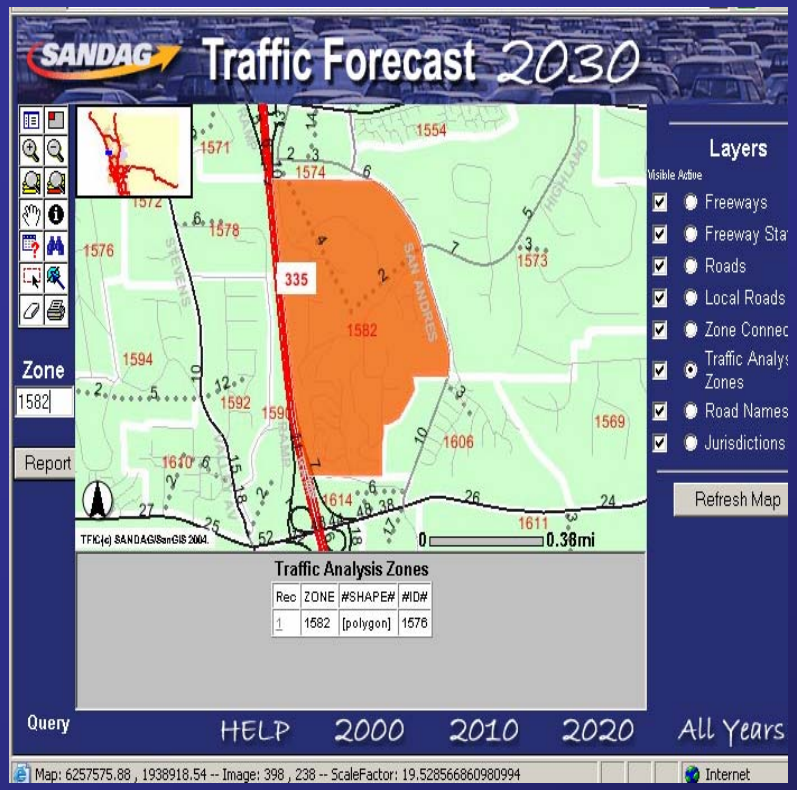
http://maximus.sandag.org/trfic.html

TFIC – Trip Generation Report



Tables include:

- Different years
- Land use
- Vehicle trips

SAN DIEGO REGIONAL TRAFFIC FORECAST
VEHICLE TRIP GENERATION AND LAND USE BY ZONE - YEAR: 2030
TRAFFIC ANALYSIS ZONE : 1582

LU Code	Description	Type	Amount	Trips
101	SINGLE FAMILY	DU	360	3187
102	MULTI-FAMILY	DU	16	98
4112	RIGHT-OF-WAY	ACRE	28.9	0
5004	NEIGHBORHOOD COMMERCIAL	ACRE	0.4	457
6002	LOW RISE OFFICE	ACRE	1.8	412
6102	CHURCH	ACRE	6.6	265
6806	ELEMENTARY SCHOOL	SITE	1	812
9101	INACTIVE USE	ACRE	9.7	0
	TOTAL		0	5231

Source: San Diego Association of Governments Traffic Forecast, April 2004

Query on zone 1582

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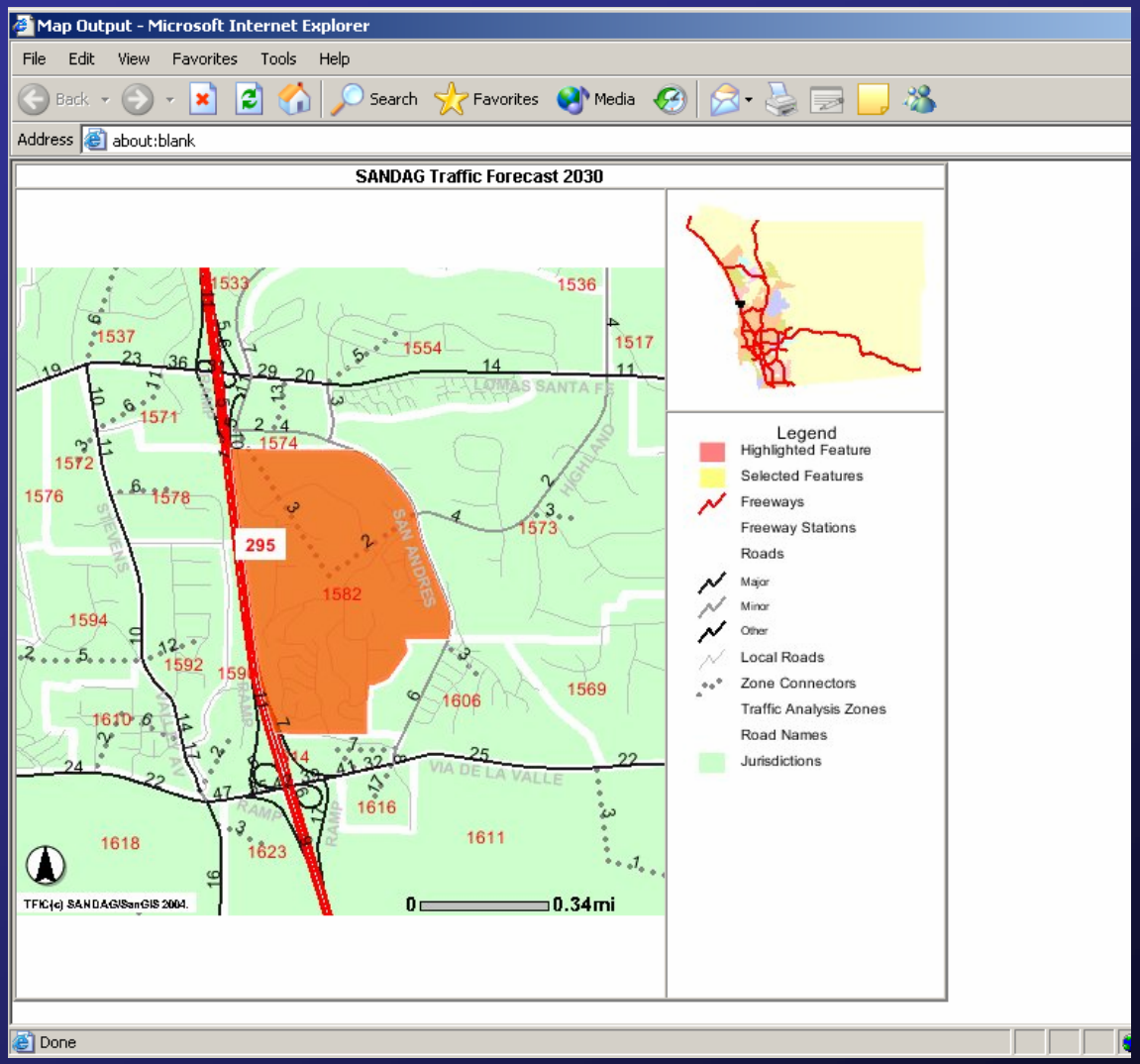
TFIC – Print Tool



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Highway and Transit Assignment

Discussion

EMISSIONS MODELING

By Limeng Yu, Associate Planner

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SANDAG Air Quality Modeling Procedures

Agency Collaboration

- ✓ San Diego County and 18 Cities
- ✓ SANDAG
- ✓ San Diego Air Pollution Control District (SDAPCD)
- ✓ The California Air Resources Board (ARB)
- ✓ California Department of Transportation (Caltrans)
- ✓ The U.S. Department of Transportation (DOT)
- ✓ The U.S. Environmental Protection Agency (EPA)

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SANDAG Air Quality Modeling Procedures

Major Pollutants

- **ROG (Reactive Organic Gases)**
- **CO (Carbon Monoxide)**
- **NOx (Oxide of Nitrogen)**
- **PM (Particulate Matter)**

SANDAG Air Quality Modeling Procedures

Nonattainment Area

- **OZONE**
  - ✓ **Before 2004:** **1-Hour Serious**
  - ✓ **Since 2004:** **8-Hour Basic**
- **PM 2.5**

SANDAG Air Quality Modeling Procedures

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SANDAG Air Quality Modeling Procedures

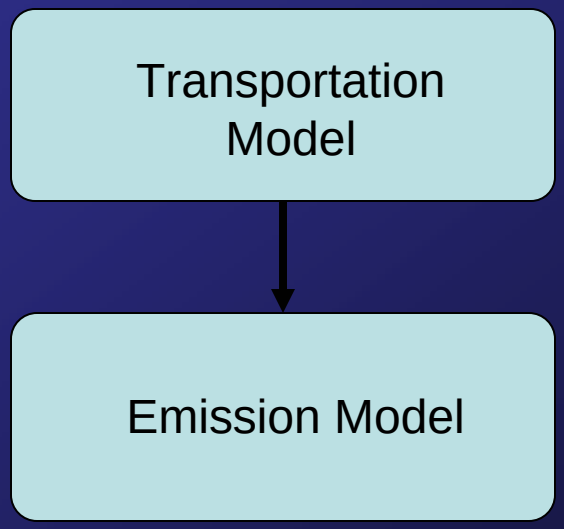
SANDAG Air Quality Modeling Procedures

Conformity Analysis

- Transportation plan/strategies/control vehicle emission not to exceed SIP budget
- Conformity links to FHWA and FTA funding

SANDAG Air Quality Modeling Procedures

Inputs and Outputs



SANDAG Air Quality Modeling Procedures

Two Emission Modeling Packages

DTIM
(Caltrans)

Inputs:

- Emission Factors
- Loaded Network Data
- Trip Ends and IZ Data
- SPS File

Outputs:

- Regional Total Emission
- Time Period Emission
- Grid Cell Emission
- Fuel Consumption

EMFAC/BURDEN
(ARB)

Inputs:

- Emission Factors
- VMT
- Trip Ends
- Hourly Speed Fractions

Outputs:

- Regional Total Emission
- Fuel Consumption

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SANDAG Air Quality Modeling Procedures

Reasons for using EMFAC

- Simplicity
- Consistency
- EPA approved

SANDAG Air Quality Modeling Procedures

Common Equation in Two Packages

Emission Factors * Transportation Activities = Emissions

SANDAG Air Quality Modeling Procedures

Typical Emission Modeling Projects

- 2030 RTP
- 2004 RTIP
- CO Maintenance Plan
- ARB Transportation Activity Data

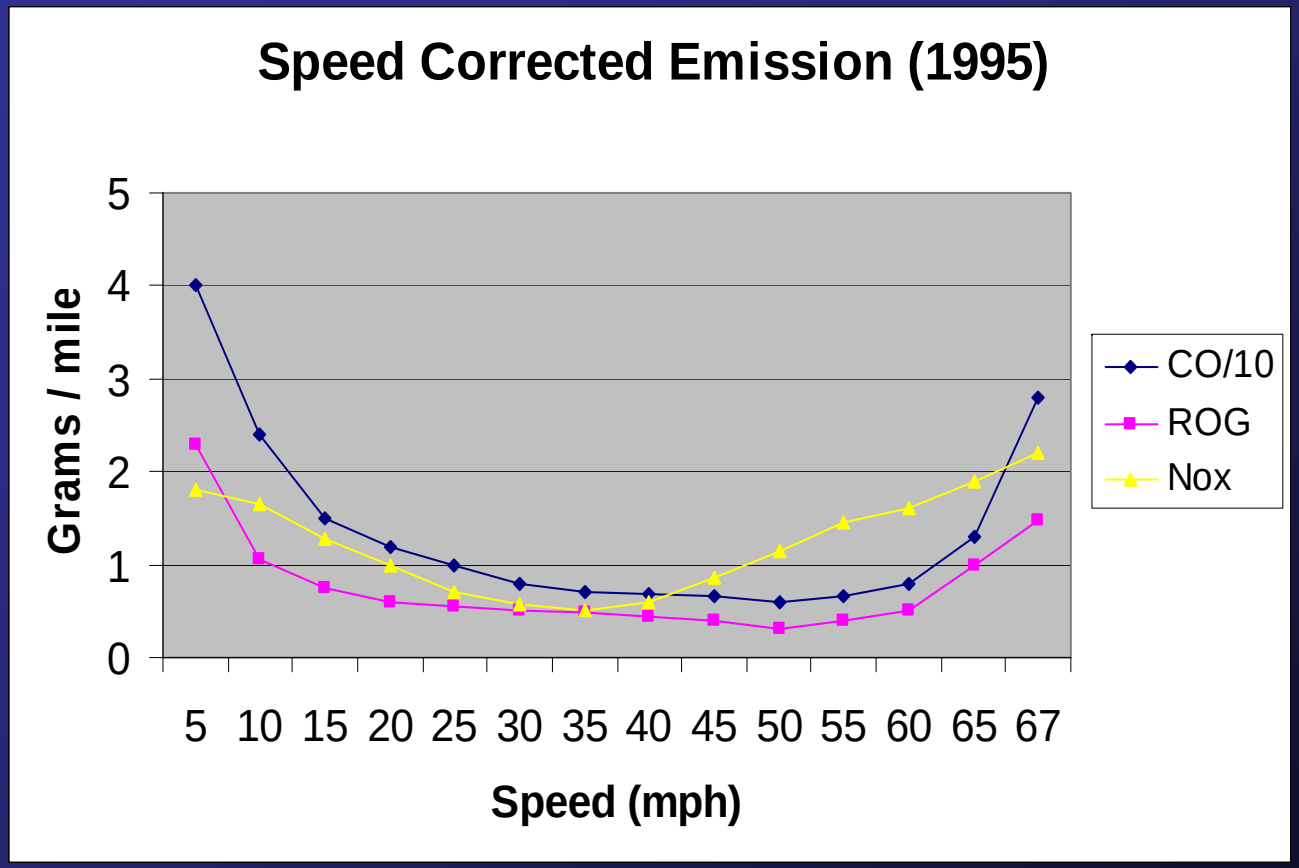
SANDAG Air Quality Modeling Procedures

- Start
- Parking
- Stable

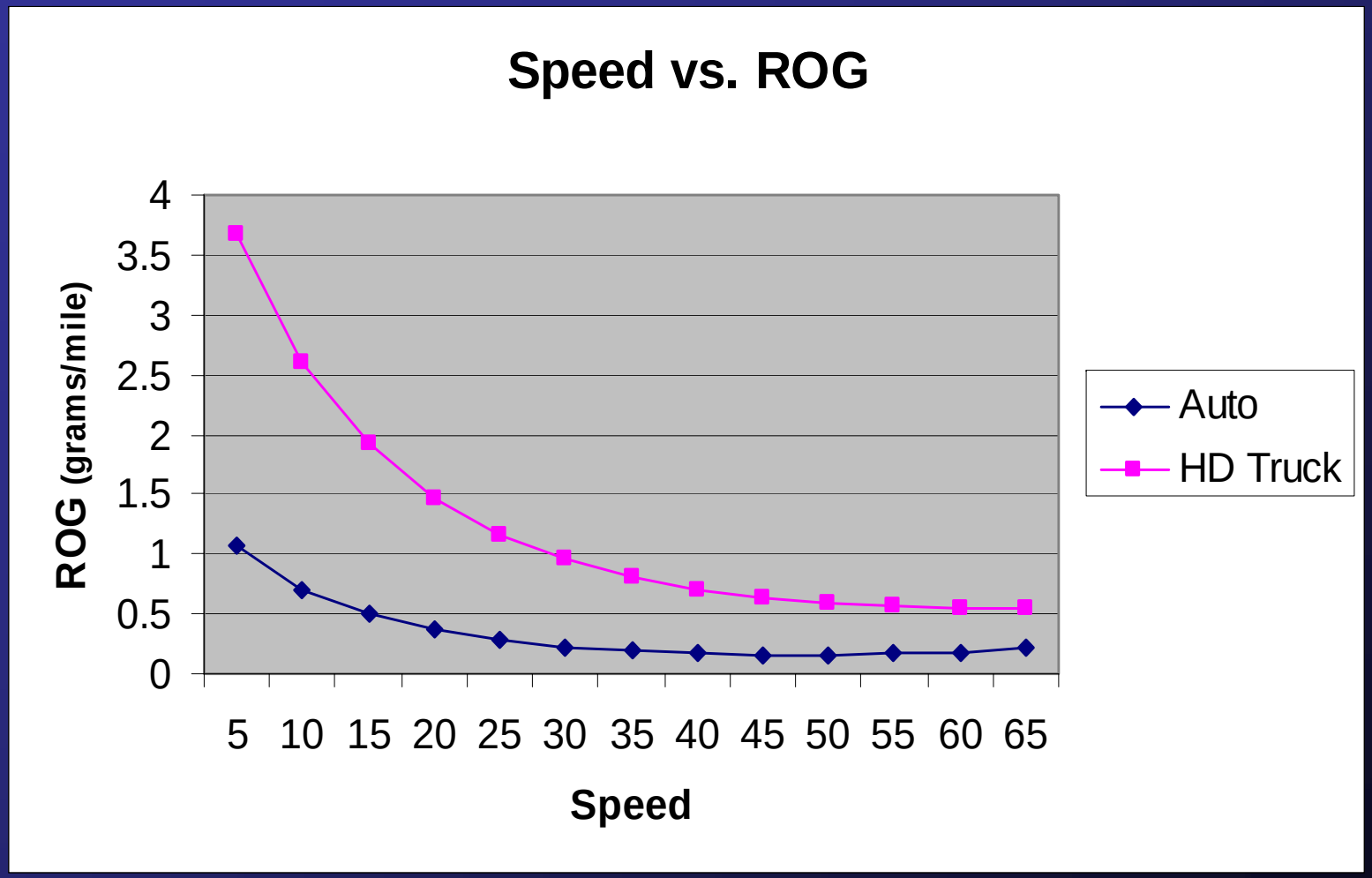
SANDAG Air Quality Modeling Procedures

- Vehicle Type
- Travel Speeds
- Temperature
- Fuel Type

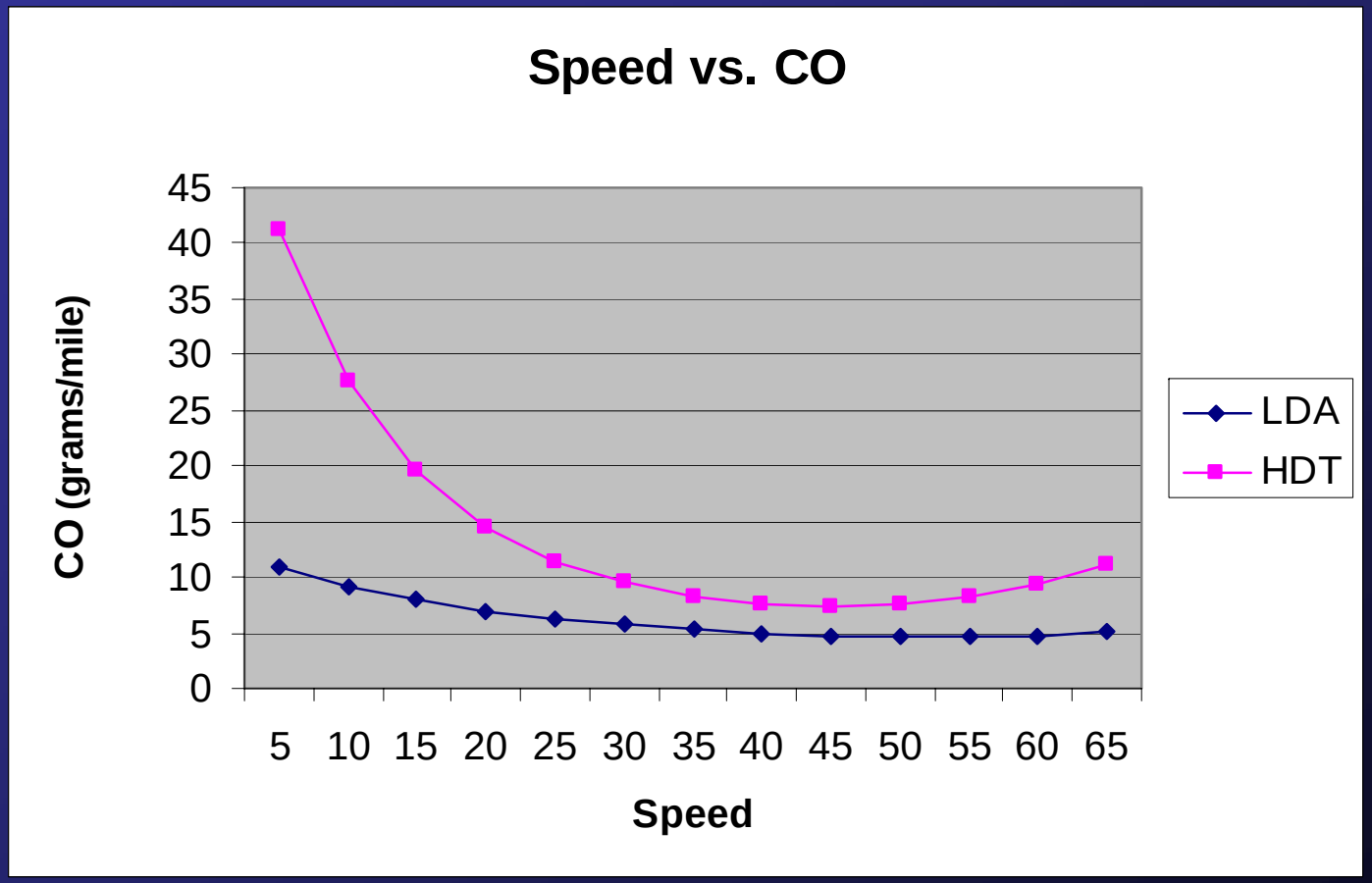
SANDAG Air Quality Modeling Procedures



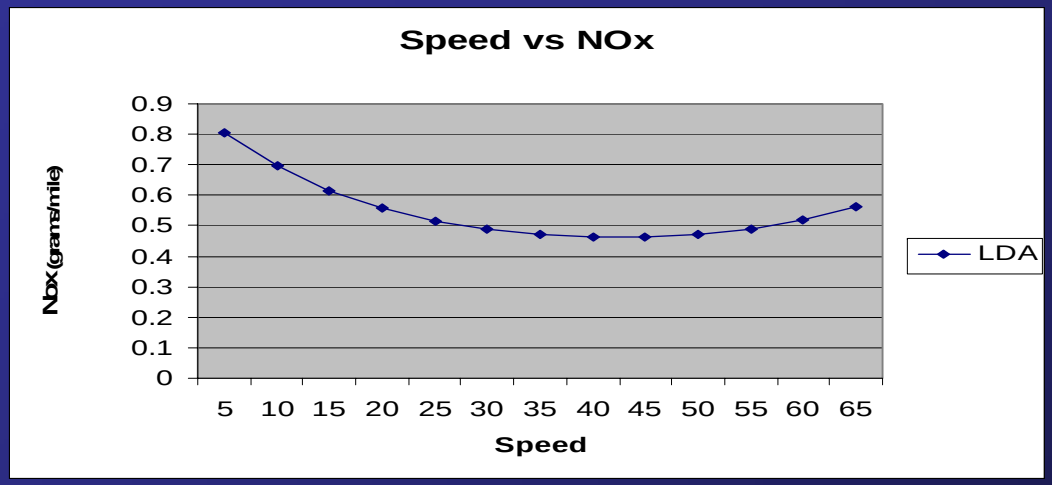
SANDAG Air Quality Modeling Procedures

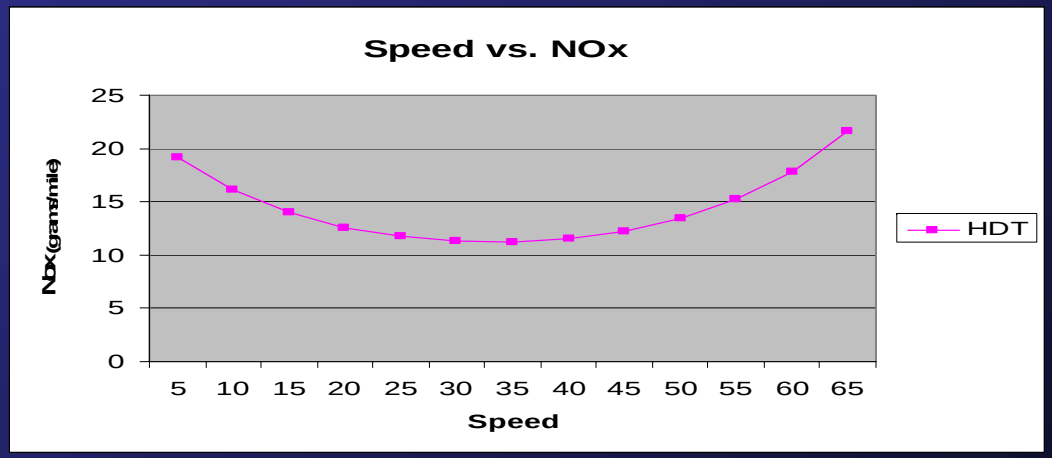


SANDAG Air Quality Modeling Procedures



SANDAG Air Quality Modeling Procedures



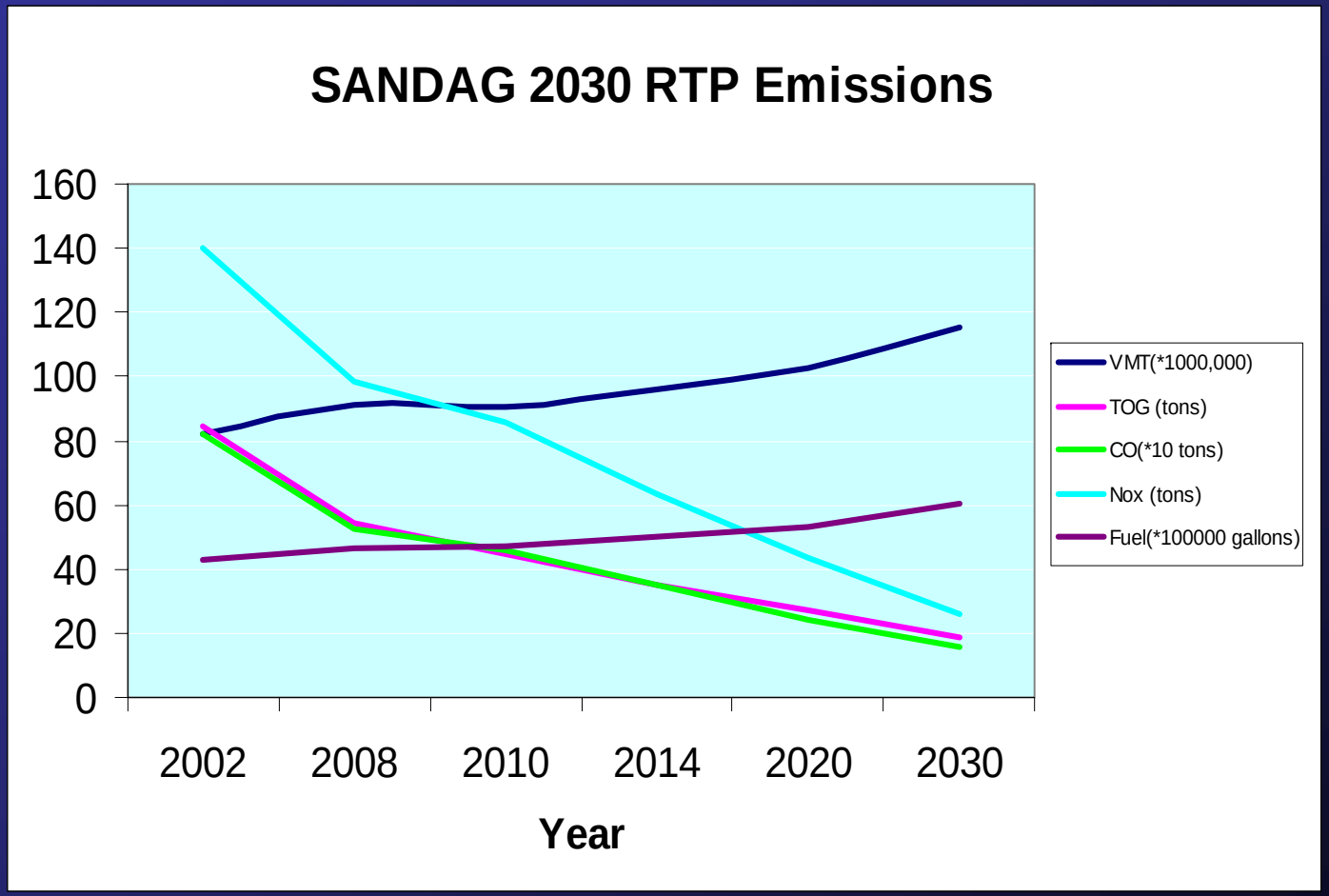


SANDAG Air Quality Modeling Procedures

Future Trends

- **Emission reduction due to new technologies in car-making and fuel production industry**

SANDAG Air Quality Modeling Procedures



SANDAG Air Quality Modeling Procedures

Conclusion

- **Best solution comes from the integration of land use, transportation, and air quality planning**
- **Balancing and compromising conflicting goals -- clean air, improving mobility and economic vitality**

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SANDAG Air Quality Modeling Procedures

Emissions Modeling

Discussion

Historical Accuracy
Year 2000 Daily VMT Estimates

Forecast	Base Year	Estimated	Observed	Error
Series 6	1980	65.2	72.5	-11.2%
Series 7	1985	79.7	72.5	9.0%
Series 8	1990	74.2	72.5	2.3%
Series 9	1995	74.3	72.5	2.4%

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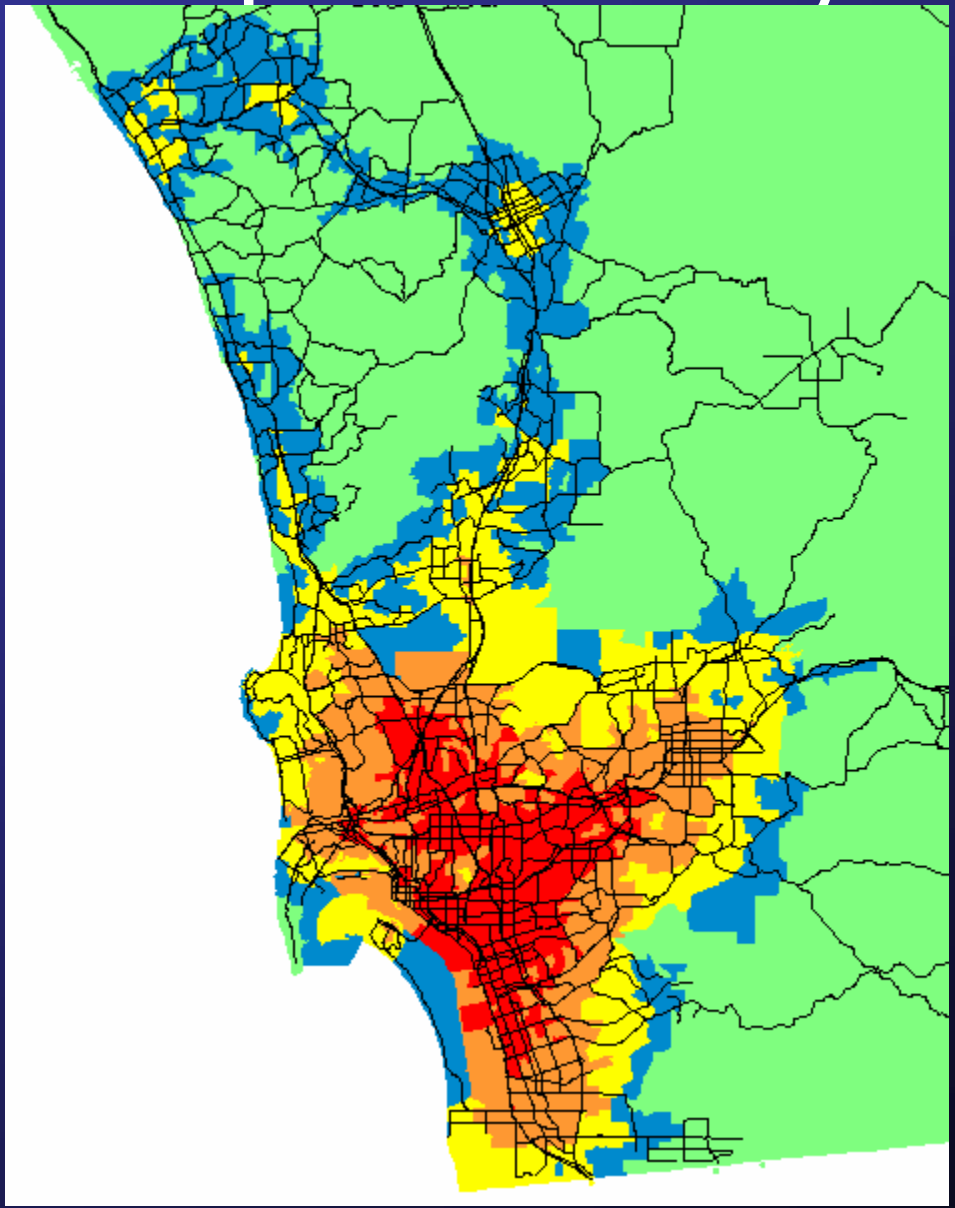
Home-Shop Accessibility



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