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*Haagen-Smit Symposium  
"Challenge to Change"*



# Measuring the Effects of Land Use on Travel Behavior and Climate Change

*Jerry Walters, Fehr & Peers*

*April 2008*



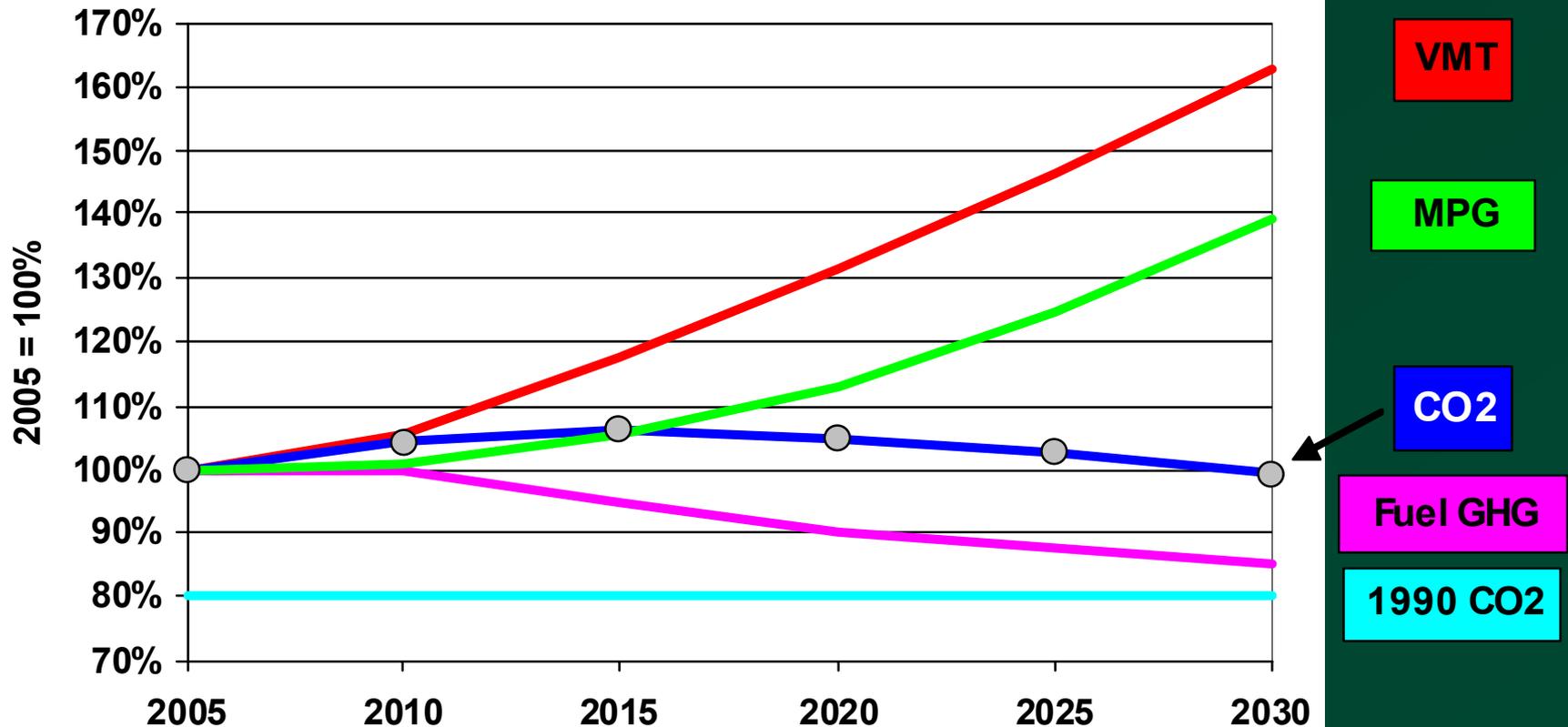
# Agenda

- 1. Smart Growth and Climate Change**
- 2. Measuring Effects of Smart Growth on Travel**
- 3. Getting the Models to Get it Right**
- 4. Focusing on Multi-Modalism and Mobility**



# Growth in CO<sub>2</sub> Emissions assuming more Stringent Vehicle and Fuel Standard

(45 mpg CAFE in 2030) + (-15% Fuel GHGs) = (24% above 1990 in 2030)



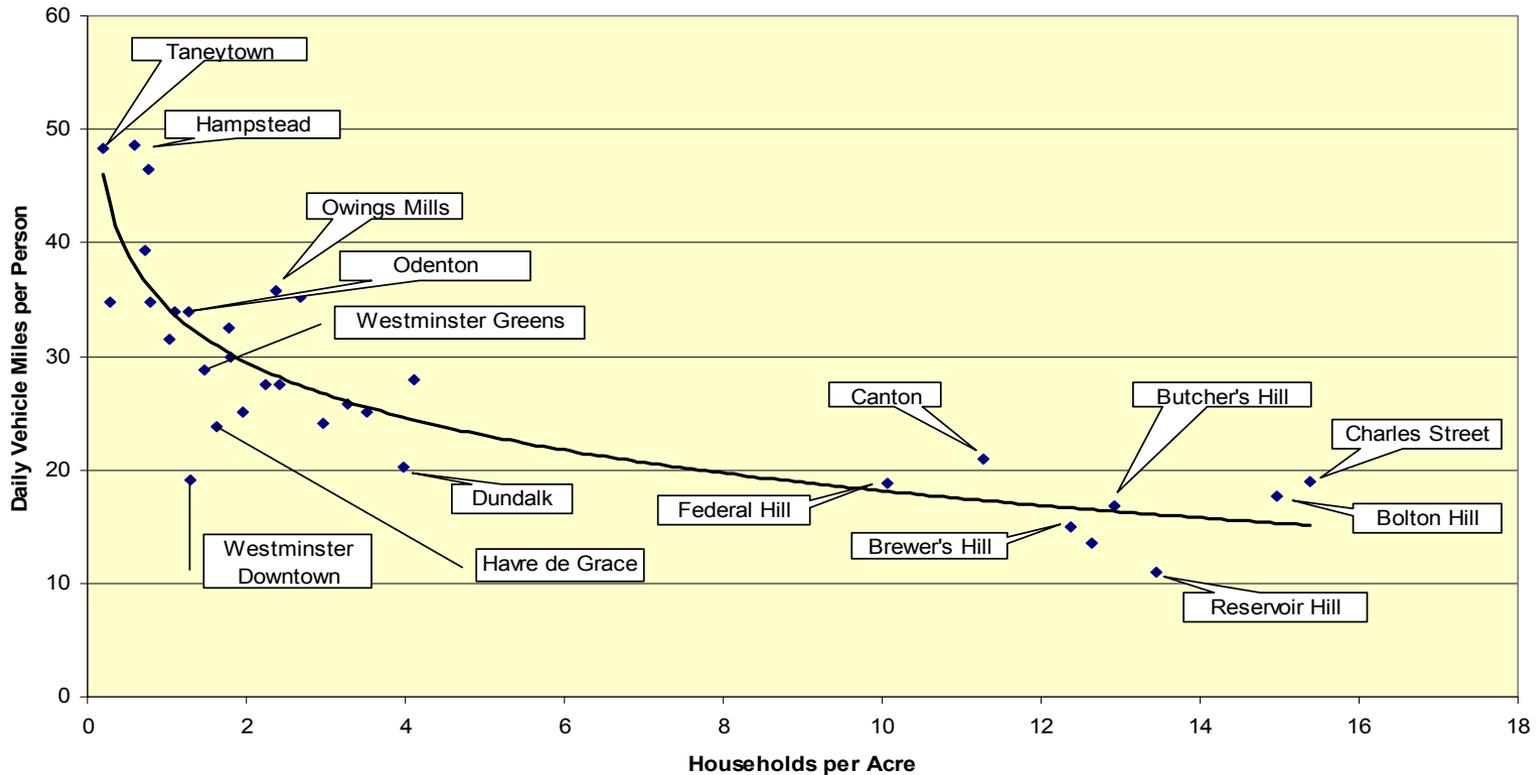
Sources: VMT: EIA with 10%rebound, MPG & Fuel: Trend Extrapolation



# Neighborhood comparison: 2/3rd VMT Reduction

## Daily Vehicle Miles per Person vs. Residential Density

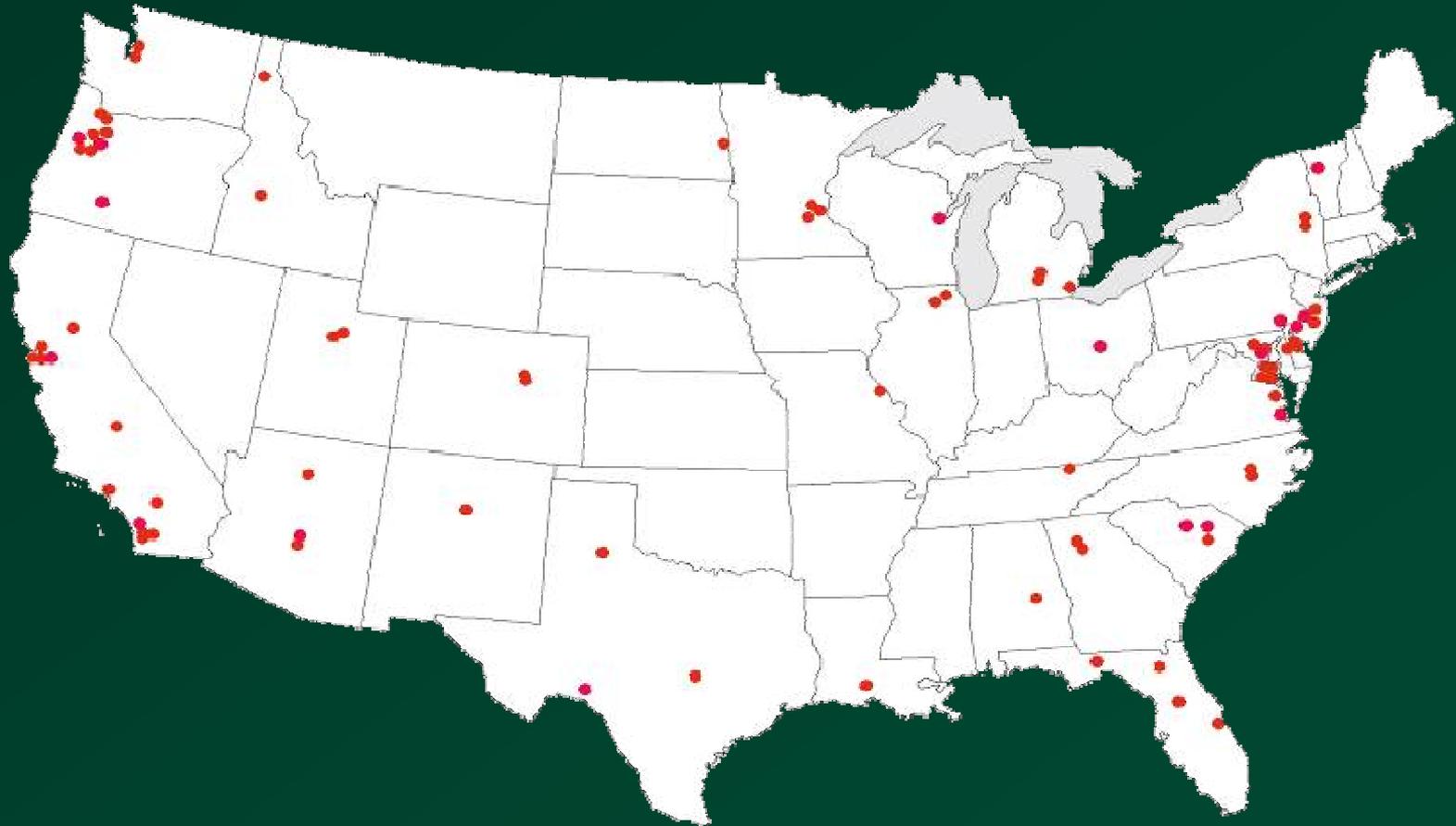
Source: Baltimore Metropolitan Council, 2001 Travel Survey





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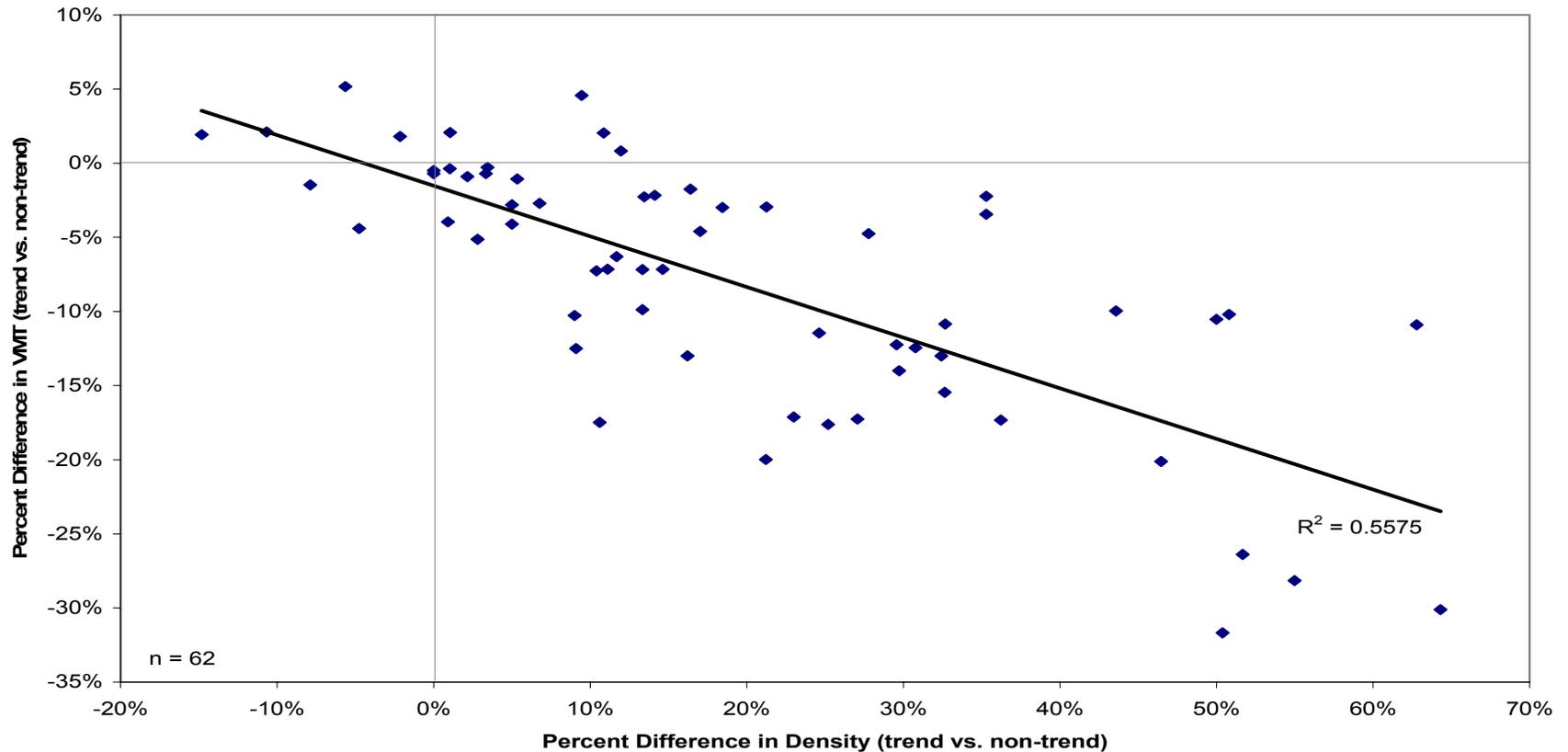
# Land use-transportation scenario planning studies in the U.S (Bartholomew 2007)





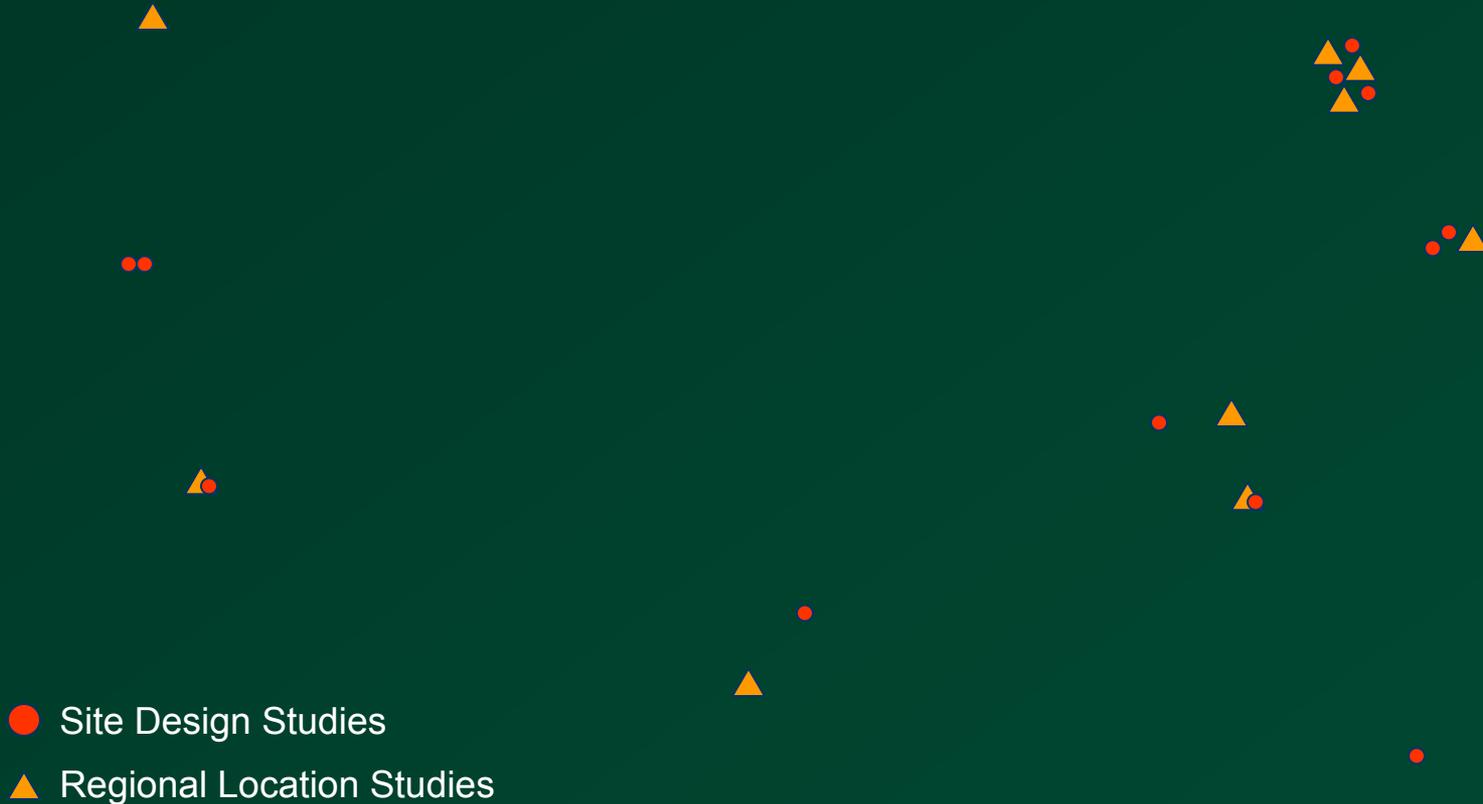
# VMT vs. Density for 62 Planning Scenarios Relative to Trend

Density & VMT





# Site Design & Location Studies in US and Canada

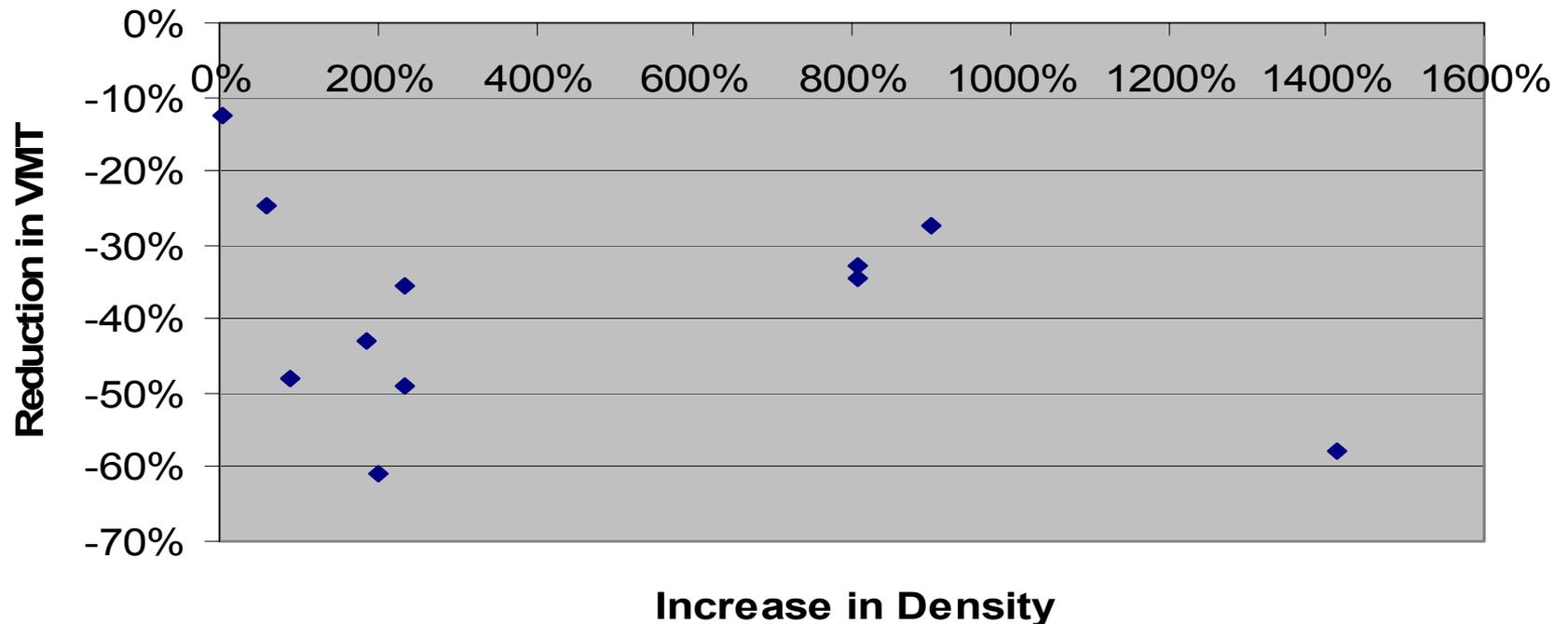




# % Reduction in Site Density vs % Change in VMT per Capita

(density reduction accompanied by relocation of development from infill to greenfield)

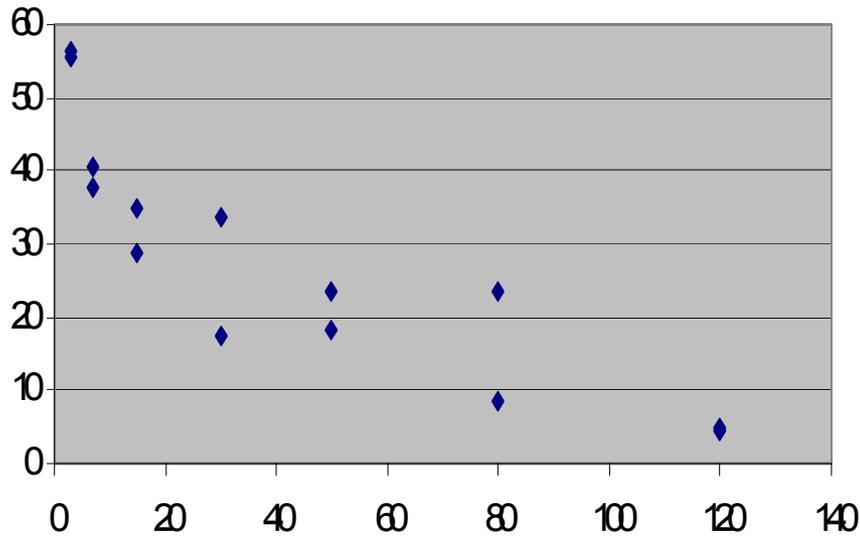
### Effect on VMT of Placing Development at Higher Density Infill Location



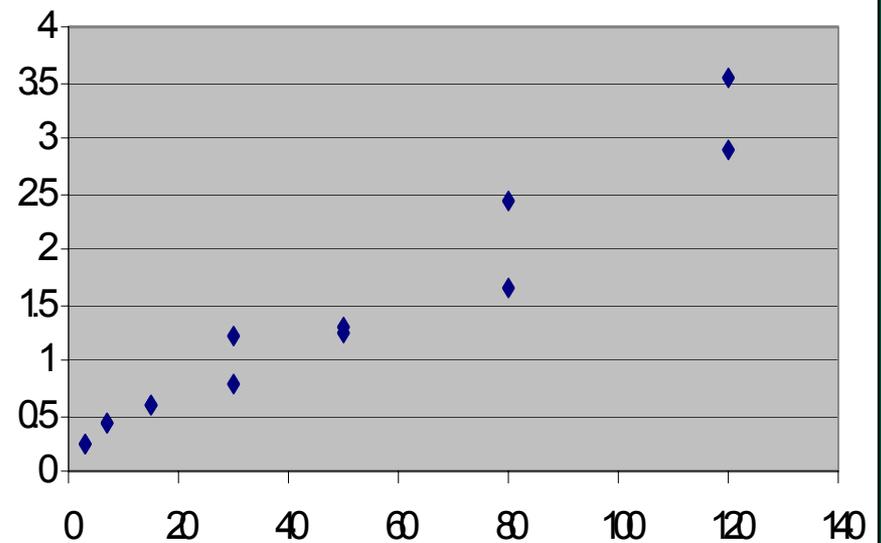


# SACOG Travel Generation by Density of Place

WT per Household



Transit+Walk+Bike Trips per HH



Jobs + Households within 1/4 Mile of Place of Residence

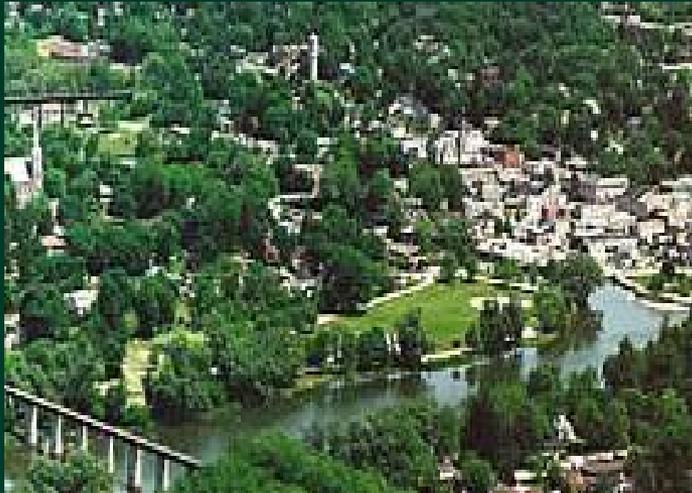


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# Trip generation is directly related to D's:



**Density** dwellings, jobs per acre

**Diversity** mix of housing, jobs, retail

**Design** connectivity, walkability

**Destinations** regional accessibility

**Distance to Transit** rail proximity





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# Density (jobs and dwellings per acre)

Shortens trip lengths

More walking/biking

Supports quality transit





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## **Diversity** (mix of housing, jobs, retail)

**Links trips, shortens distances**

**More walking/ biking**

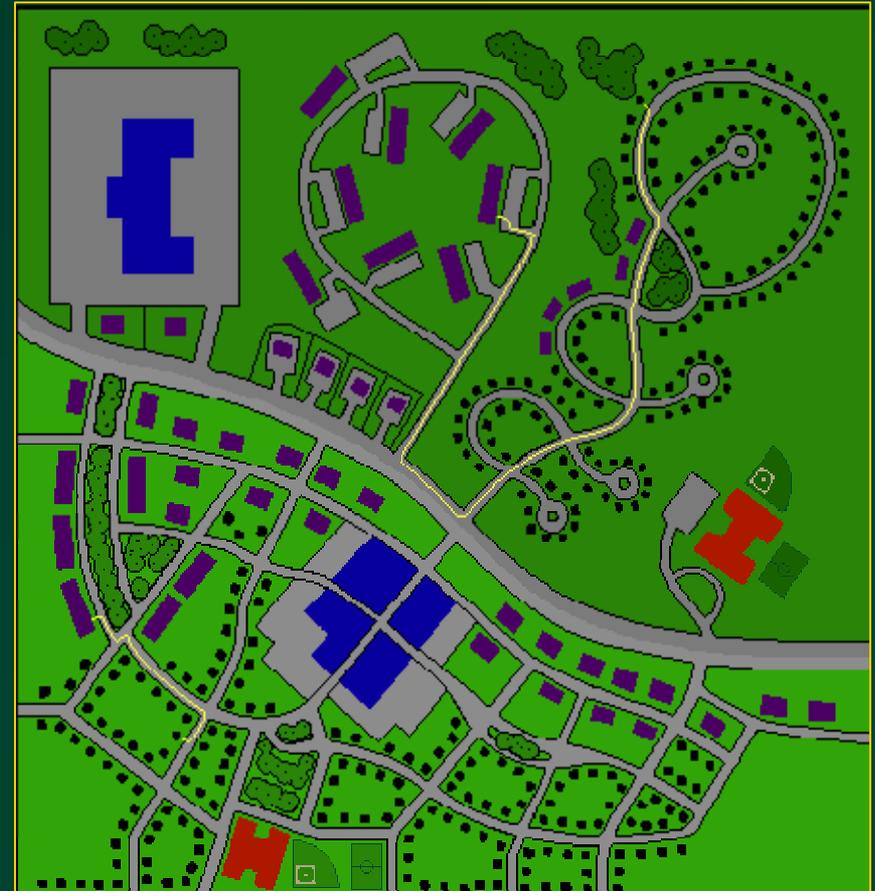
**Allows shared parking**





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# Design (connectivity, walkability)





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## Destinations (accessibility to regional activities)



**Development at infill or close-in locations reduces vehicle trips and miles**



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# Distance to Transit



**Transit shares higher within  $\frac{1}{4}$  mile and  $\frac{1}{2}$  mile of station**

## **4D's** (Land Use Clustering, Mixing, Traditional Design) — **All Reduce Travel**

	<b>Reductions in VMT per 100% increase in 4D's</b>
<b>1. Density</b>	<b>1% to 17%</b>
<b>2. Diversity</b>	<b>1% to 13%</b>
<b>3. Design</b>	<b>2% to 13%</b>
<b>4. Destinations</b>	<b>20% to 51%</b>

*Sources: National Syntheses, Twin Cities, Sacramento, Holtzclaw*



## 5<sup>th</sup> D - Distance from Transit

Vehicle-miles traveled, compared with regional average:

- 42% reduction for households within ½ mile of transit
- 21% reduction for households between ½ and 1 mile





## Emerging research: Other “D” factors that affect VMT

6. Development scale
7. Demographics
8. Demand management
  - parking management
  - pricing policies
  - traveler information
  - neighborhood electric vehicles





## Effects of Other “D” Factors

	Reduction in VMT per 100% increase in “D”
<b>6. Development Scale</b>	<b>15% +/-</b>
<b>7. Demographics</b>	<b>11% to 23%</b>
<b>8. Demand Management</b>	<b>varies</b>

*Source: EPA study on effects of mixed use development – Portland case study*



## Smart Growth Trip Generation



**National studies of Mixed Use,  
TOD and Infill development**

**Statistical analysis, empirical  
validation**



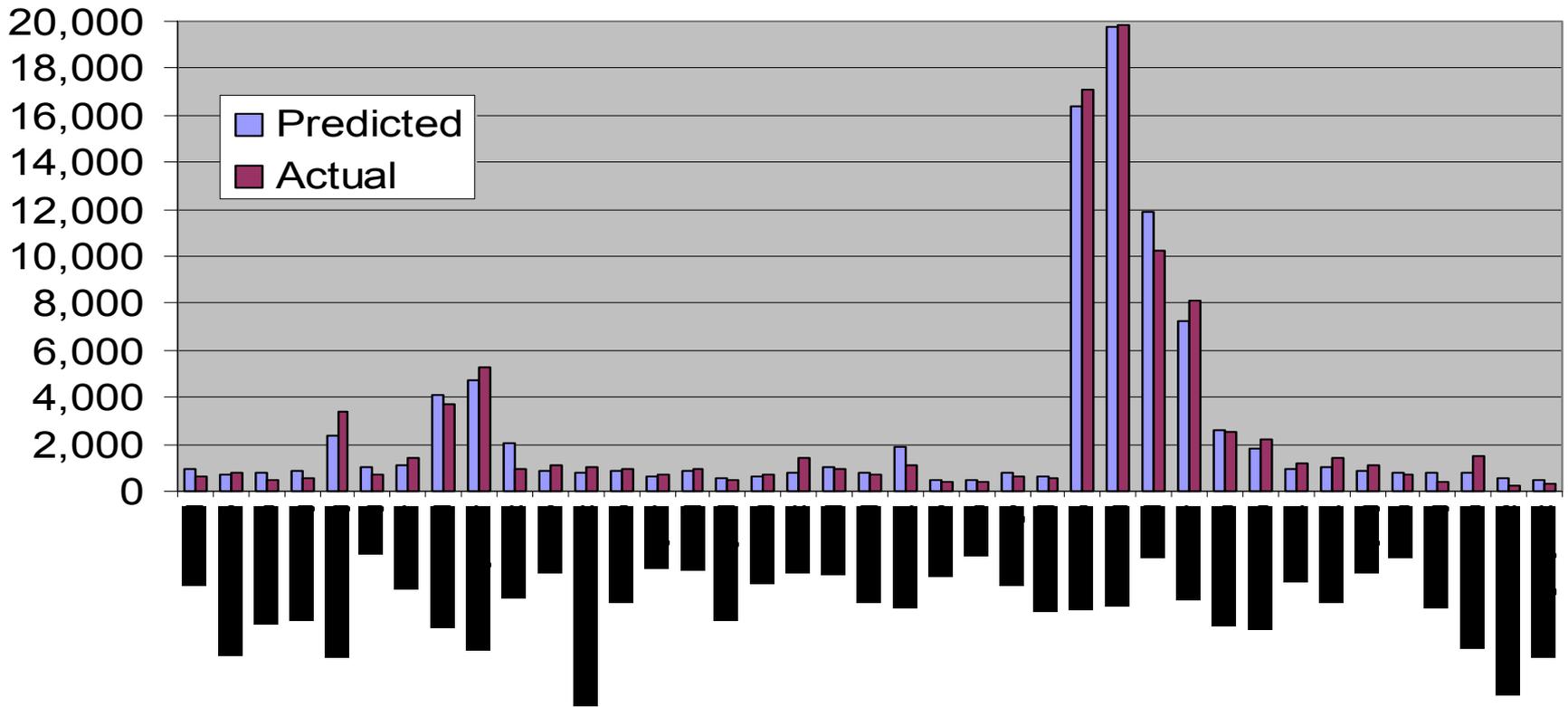
	MXD	TOD	Infill
Trip Discount	35%	44%	36%

**Examples: San Diego, Seattle, Portland, Sacramento, Houston, Atlanta, Boston**



# Direct Transit Ridership Models

Model 1- Relationship Between PM Peak Boardings and 1/2 mile Non-Retail Employment, 1/2 mile Population, and Downtown SF Indicator, R2=.985



Examples: BART, Caltrain, Sacramento LRT, Salt Lake LRT, Denver RTD



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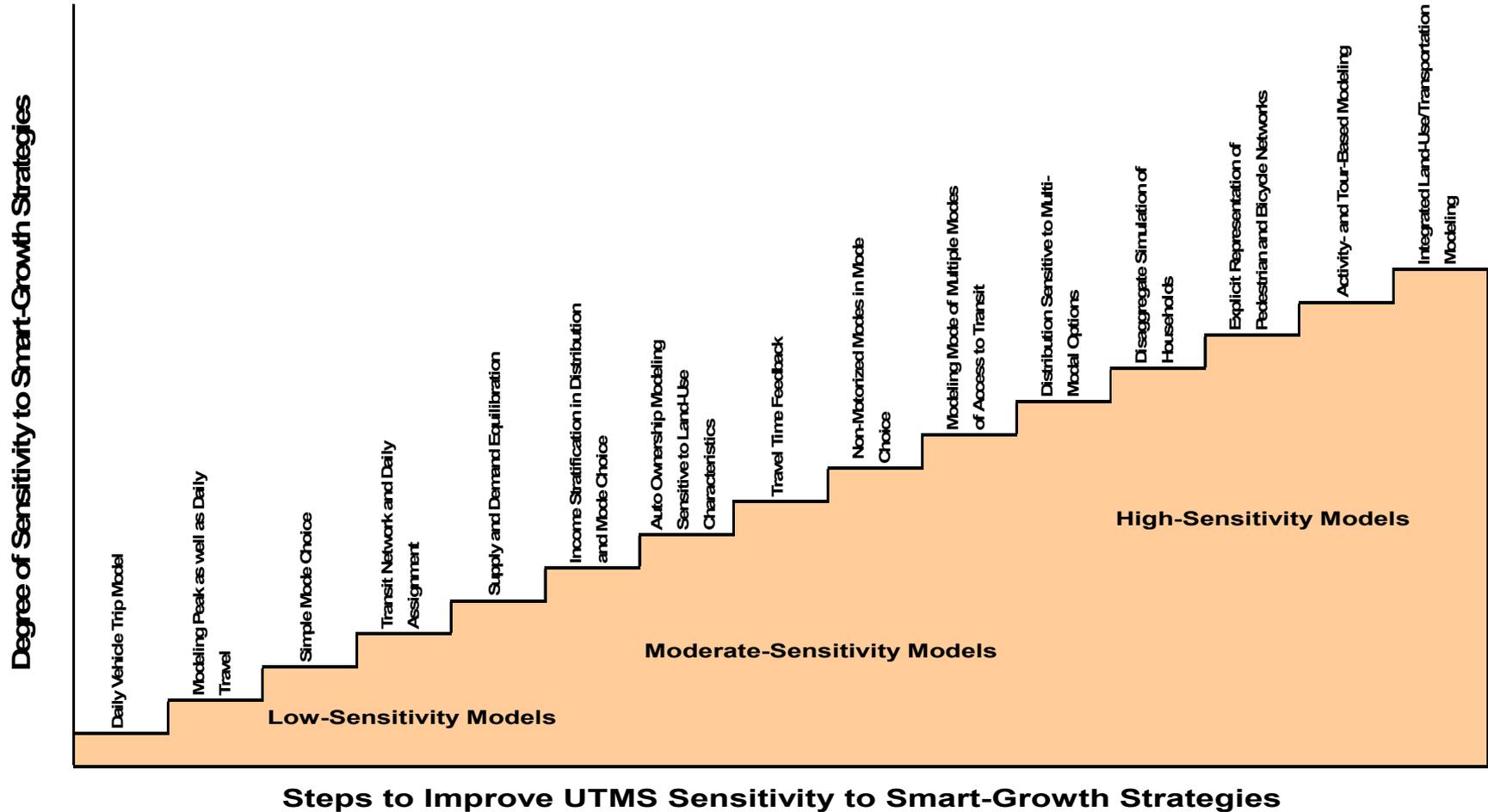
4. Focusing on Multi-Modalism and Quality of Life



## **Shortcomings of Conventional Travel Models in Assessing Smart Growth**

- **Primary use is to forecast long-distance auto travel on freeways and major roads**
- **Secondary use is to forecast system-level transit use**
- **Short-distance travel, local roads, non-motorized travel modes are not addressed in model validation**

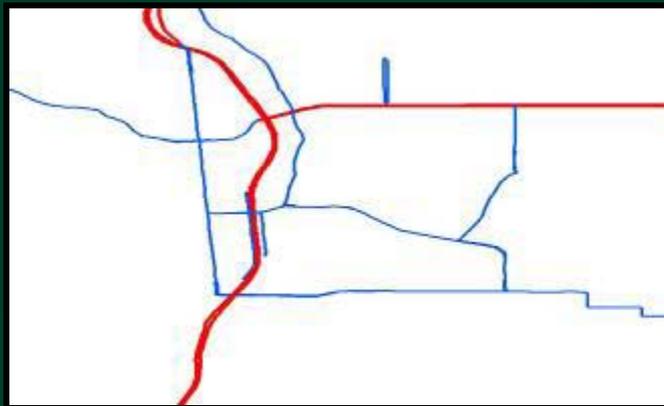
# Levels of Model Sophistication





## Typical Model “Blind Spots”

- Abstract consideration of distances between land uses within a given TAZ or among neighboring TAZ's
- Limited or no consideration intra-zonal or neighbor-zone transit connections



Network in Model



Network in Field



## Typical Model “Blind Spots”

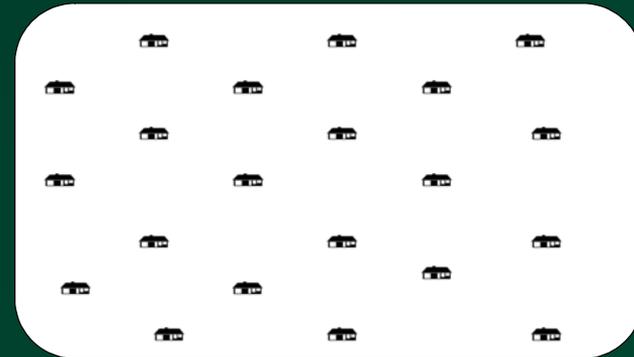
- Sidewalk completeness, route directness, block size generally not considered.





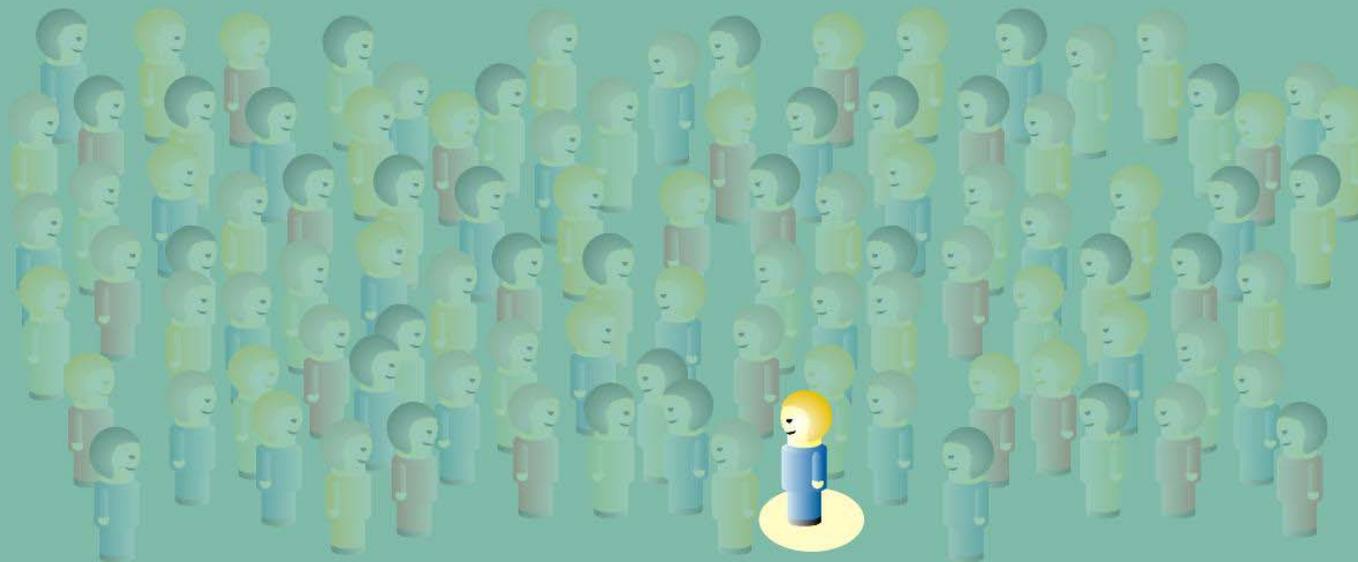
## Typical Model “Blind Spots”

- Little consideration is given to spatial relationship between land uses within a given TAZ (density)



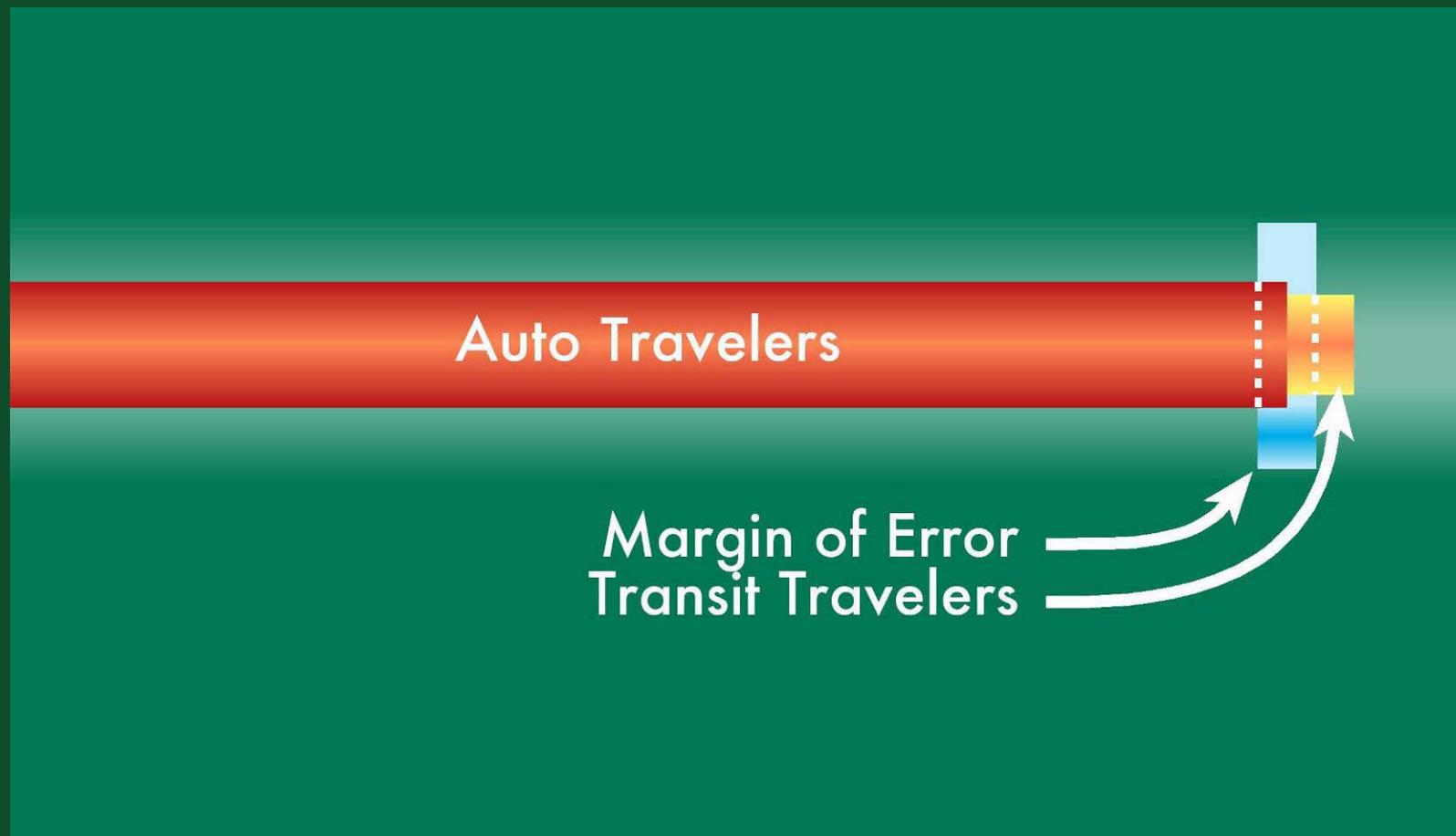
- Interactions between different non-residential land uses (e.g. offices and restaurants) not well represented

# Conventional Ridership Modeling



**Screen for Mode**

## Law of Small Numbers



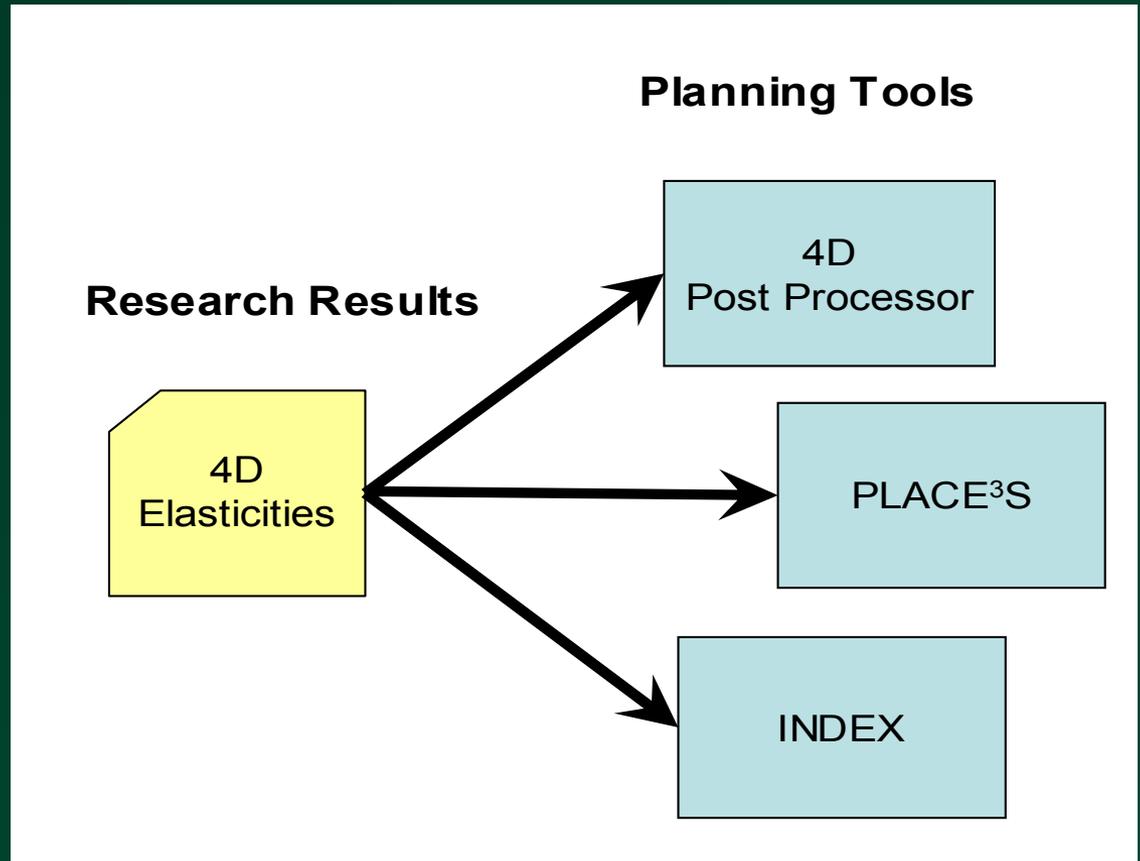


## FTA Report on Conventional Forecasting

- “... ridership projections for New Starts are often highly inaccurate in terms of both total ridership and the characteristics of the markets that are actually served.”

# Caltrans Study Recommendation

Use 4D's to compensate for any lack of sensitivity in travel models





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## Traffic LOS → Person Mobility

- **Person accessibility and safety**
- **Travel time mobility for all modes**
- **Comfort and convenience for all users**

# Van Ness Ave BRT Alternatives



Alternative	Person Delay (sec per person at avg intersection)	BRT Rider Delay (sec per person at avg intersection)	Vehicle Delay (sec per vehicle at avg intersection)
1, No Project 	20.8	20.9	19.3
2, Curb BRT Lanes 	19.1	10.6	19.3
3, Center-Side w/ two medians 	19.7	10.2	20.9

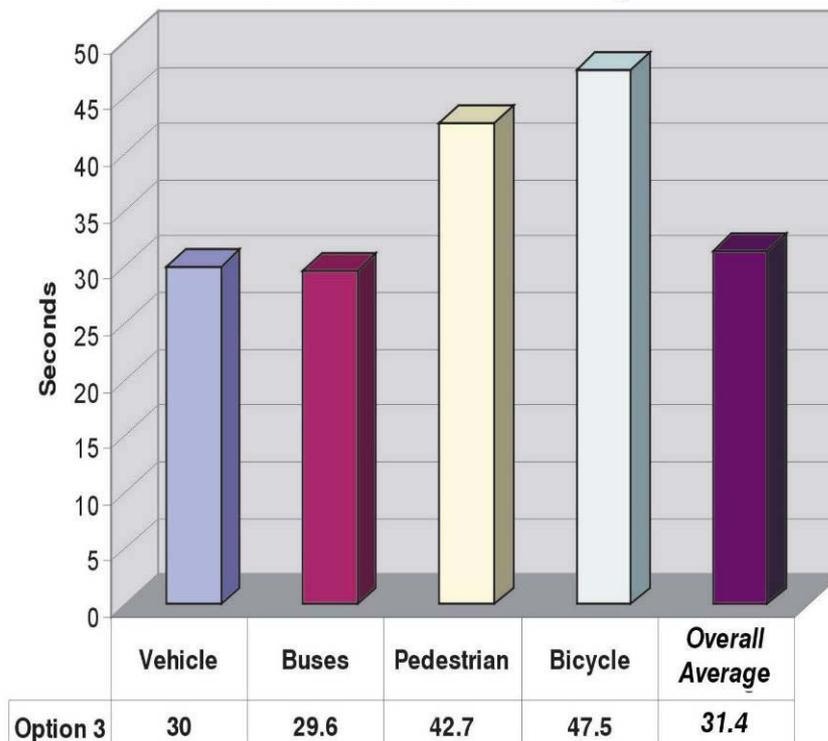
Alt. 2 reduces total traveler delay by 8% with no increase in vehicle delay.

Alt. 3 increases vehicle delay by 8% but reduces delay for all travelers 5%.

# Intersection LOS Improvement Study Alternative 1 -- Conventional Treatment

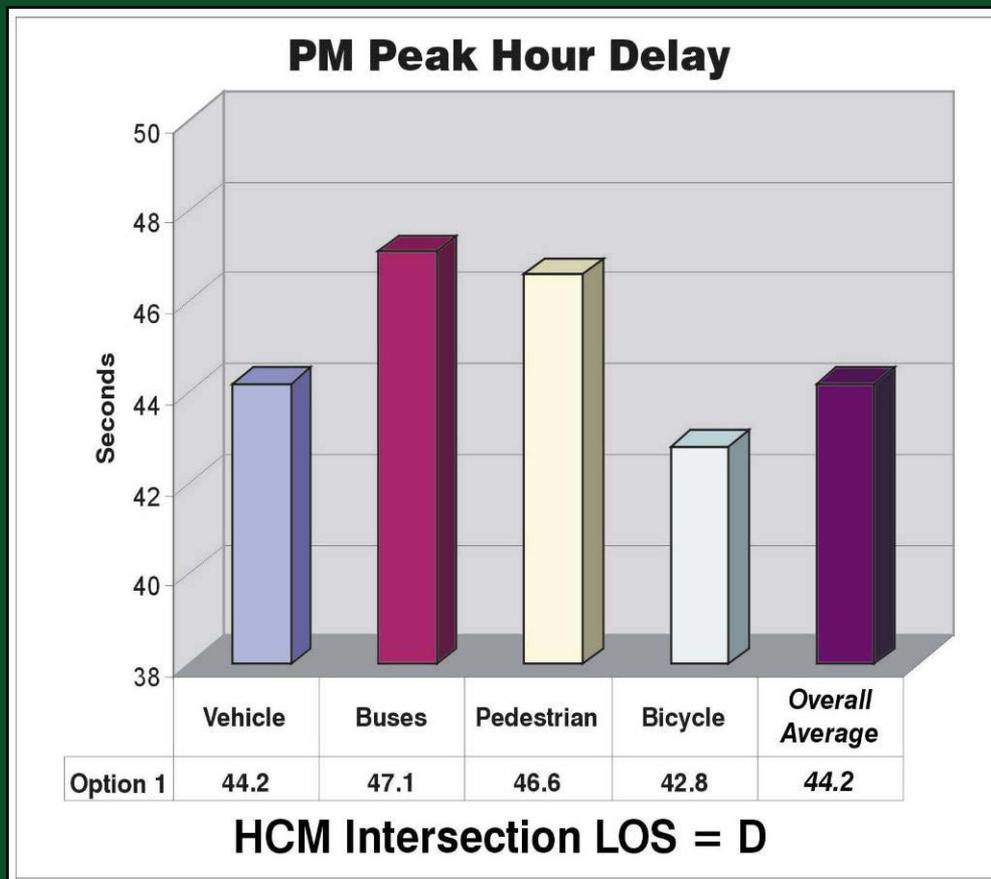


**PM Peak Hour Delay**

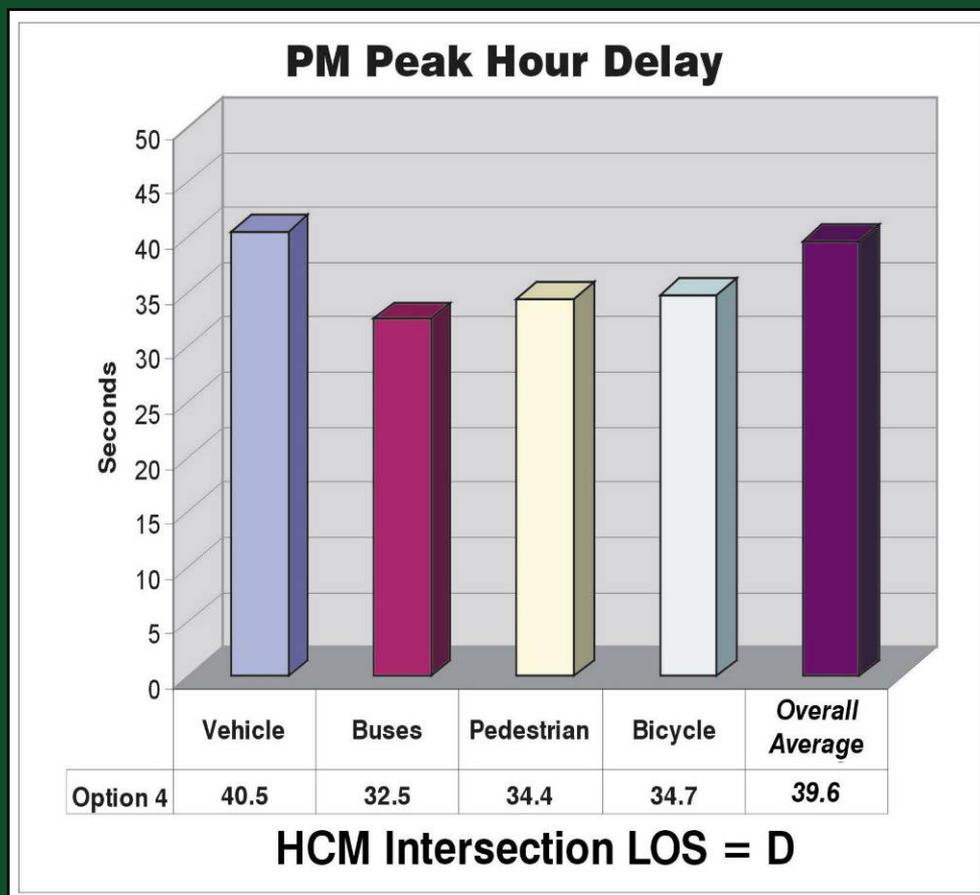


**HCM Intersection LOS = C**

# Alternative 2 – All Bike/Pedestrian Phase



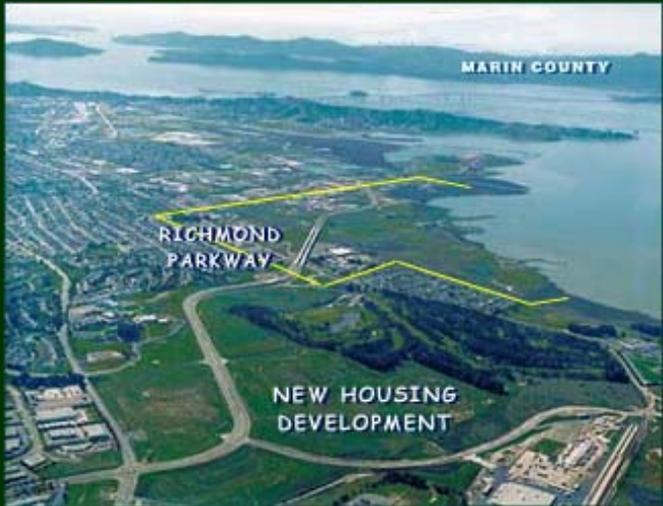
## Alternative 3 – Ped/ Bike Head-Start Phase (balanced LOS for all modes)





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5. Case Study



**CONTRA COSTA**  
SHAPING OUR FUTURE

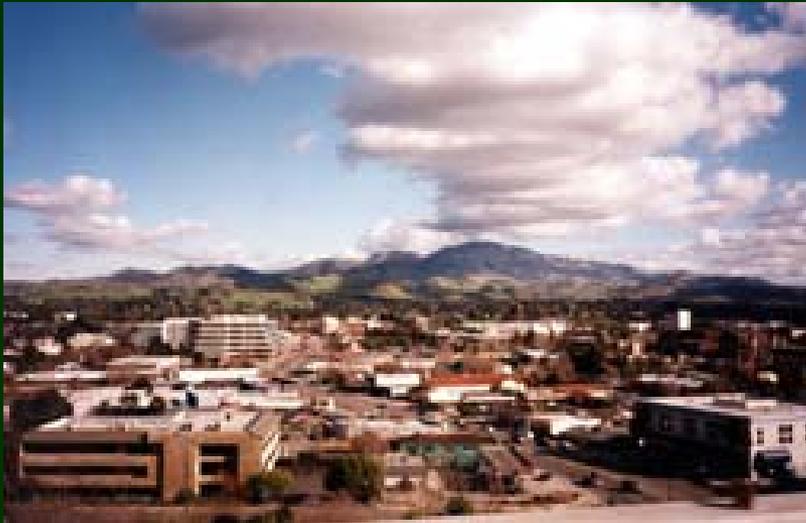
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**H**ousing is a key issue for Contra Costa County. The county is currently facing a housing shortage of approximately 20,000 units. The county is currently facing a housing shortage of approximately 20,000 units. The county is currently facing a housing shortage of approximately 20,000 units.

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# Contra Costa: Shaping Our Future



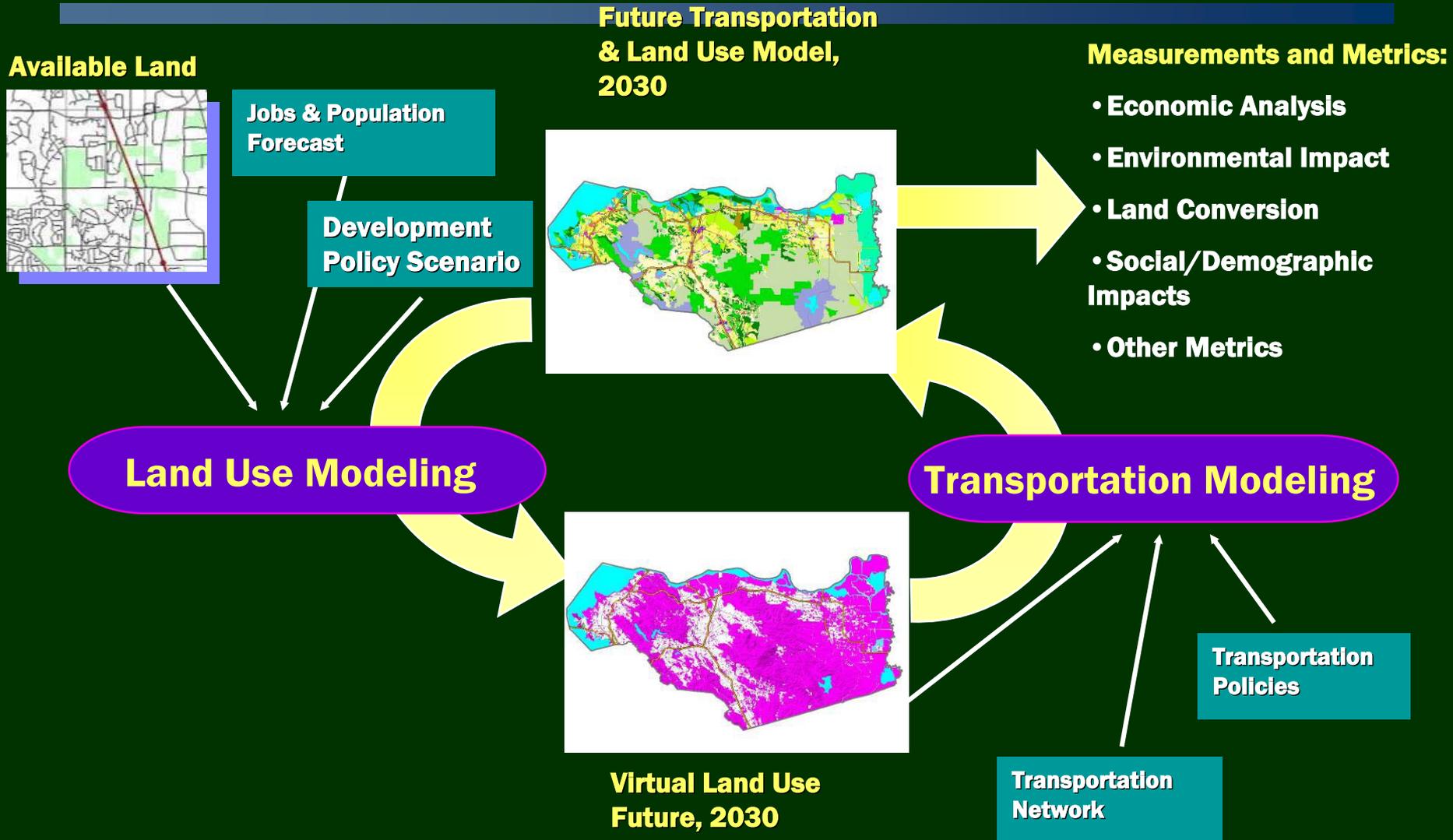
# Integrated Land Use/ Transportation Visioning and Planning Strategy

- ❖ **Emphasize development forms known to reduce travel per capita: density, mix, transit-oriented design, infill and close-in locations**
- ❖ **Concentrate land use around potential transit nodes**
- ❖ **Prioritize transportation system expansions that work best with compact, transit oriented development.**





# Modeling Future Development Scenarios



# “Vision Scenario” Smart Growth Scorecard



	<b>Vision Scenario improvements over Trend</b>
<b>Density</b>	11% increase for new growth
<b>Diversity</b>	23% increase in mixing at local level
<b>Design</b>	25% greater potential for traditional design
<b>Destinations</b>	Increased development at infill locations



# The Smart Growth Scenario reduces VMT and improves levels of congestion on major roads

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- ❖ **Countywide VMT** -7%
- ❖ **% of Arterial Miles Congested** - 42%  
(Peak hour LOS E or F)
- ❖ **% of Freeway Miles Congested** - 15%  
(Peak hr LOS E or F in at least 1 direction)



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Questions?

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