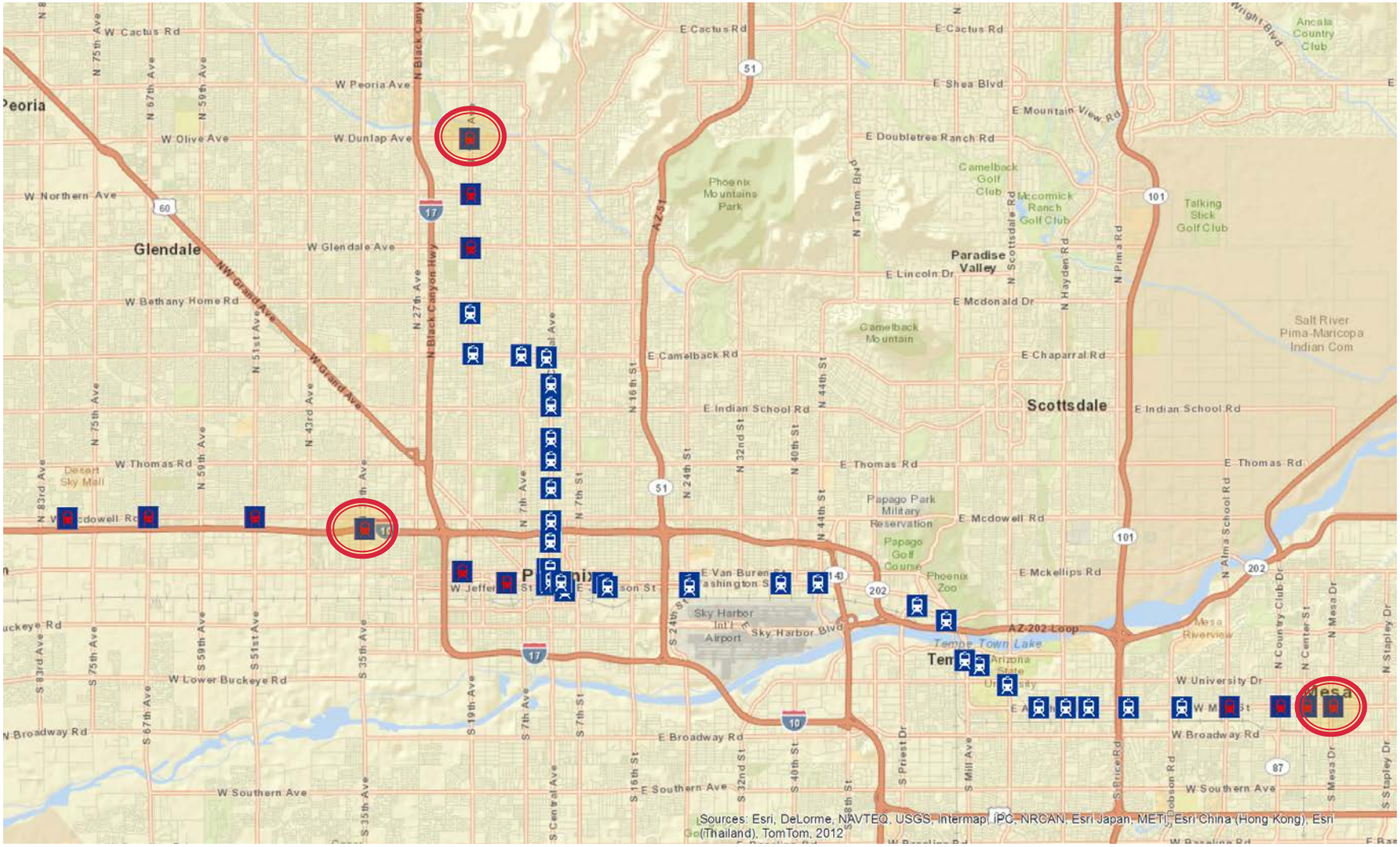
Smart Growth Along the Proposed Phoenix Light Rail Expansions Can Reduce Future Urban Energy Consumption and Environmental Impacts

Final Presentation
CEE/SOS 598: Urban Infrastructure Anatomy and Sustainable Development

December 4, 2012
Noon, Wrigley 481, ASU Tempe Campus

Extensions


W Cactus Rd
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W Peoria Ave
W Olive Ave
W Dunlap Ave
W Northern Ave
Glendale
W Glendale Ave
W Bethany Home Rd
NW Grand Ave
W Grand Ave
W Thomas Rd
E Thomas Rd
E Shea Blvd
E Mountain View Rd
E Doubletree Ranch Rd
Phoenix Mountains Park
Camelback Golf Club
McCormick Ranch Golf Club
Talking Stick Golf Club
Paradise Valley
E Lincoln Dr
E Mcdonald Dr
Camelback Mountain
E Camelback Rd
E Chaparral Rd
Salt River Pima-Maricopa Indian Com
Scottsdale
E Indian School Rd
Papago Park Military Reservation
E Mcdowell Rd
Papago Golf Course
Phoenix Zoo
E Mckellips Rd
Sky Harbor Int'l Airport
Sky Harbor Blvd
AZ-202 Loop
Tempe Town Lake
W University Dr
W Broadway Rd
E Broadway Rd
W Southern Ave
W Lower Buckeye Rd
Desert Sky Mall
Ancala Country Club
Sources: Esri, DeLorme, NAVTEQ, USGS, Intermap, iPC, NRCAN, Esri Japan, METI, Esri China (Hong Kong), Esri (Thailand), TomTom, 2012

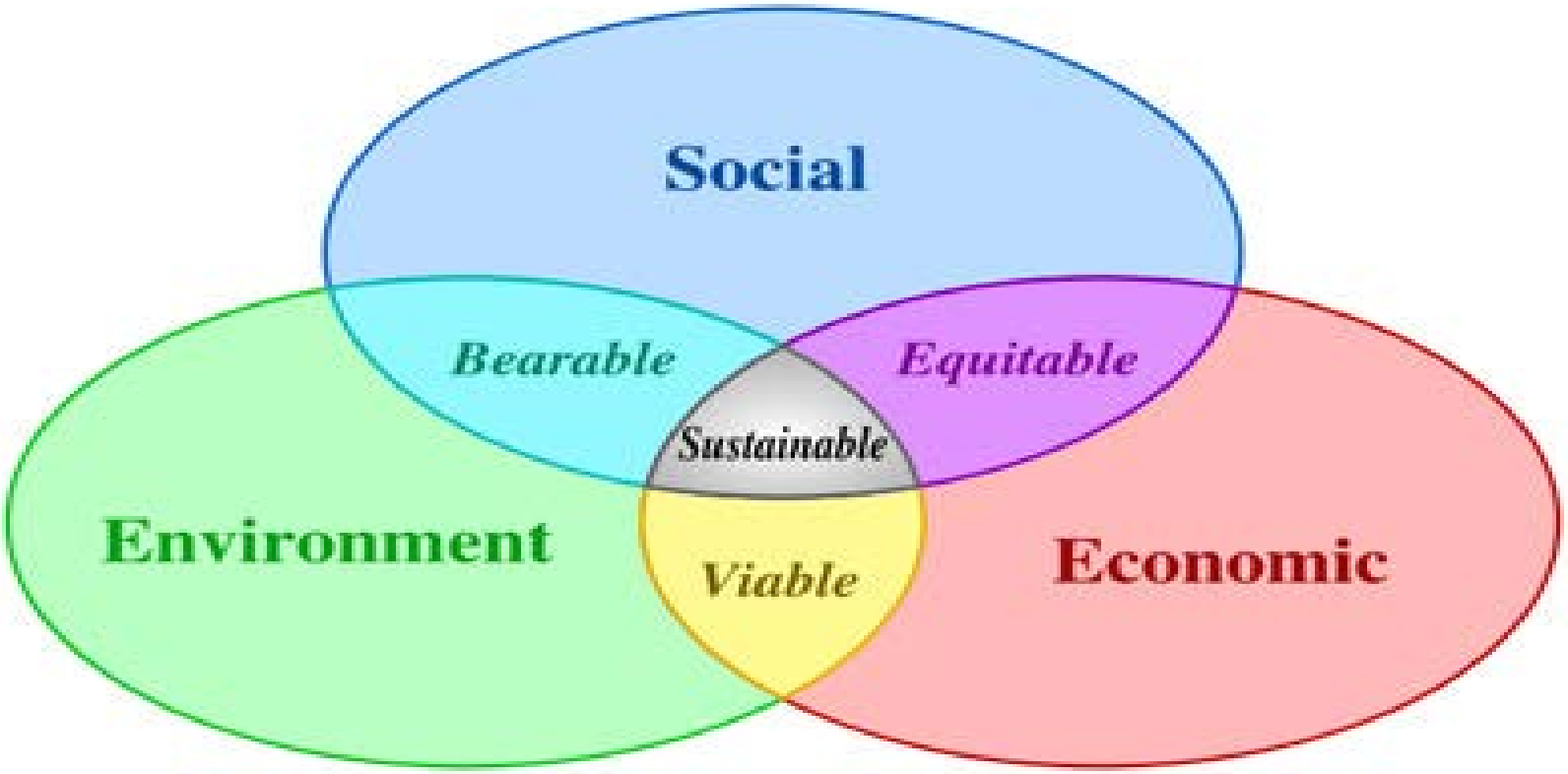
Project Goals

- Different scenarios
  - Transit-Oriented Development (TOD) vs. Business as Usual (BAU)
  - Scenario 1 – TOD as single-family homes
  - Scenario 2 – TOD as high density apartments, mixed-use commercial/residential
  - Land use at each station
    - Conservative – vacant lots
    - Aggressive – vacant lots and parcels that could be acquired for TODs
- Diverse locations
  - Mesa (E. Main St and Mesa Dr) – Heavy Commercial/Office + Residential
  - I-10 corridor, Phoenix (I-10 and 35th Ave) – Smaller Apartment Mixed Use
  - North Phoenix (N 19th Ave and Dunlap Ave) – Smaller Apartment Mixed Use
- Comprehensive analysis of energy and environmental effects, barriers, and transition strategies

Life Cycle Assessment

- Buildings
  - Building Construction
  - Electricity Feedstock Production
  - → Building Use
- Transportation
  - Vehicle Manufacturing
  - Gasoline Feedstock Production
  - → Automobile Use
- Environmental Indicators
  - Energy Use
  - Greenhouse Gas Emissions
  - Criteria Air Pollutant Emissions (CO, VOCs, NOx, SOx, PM_{10}, $PM_{2.5}$)

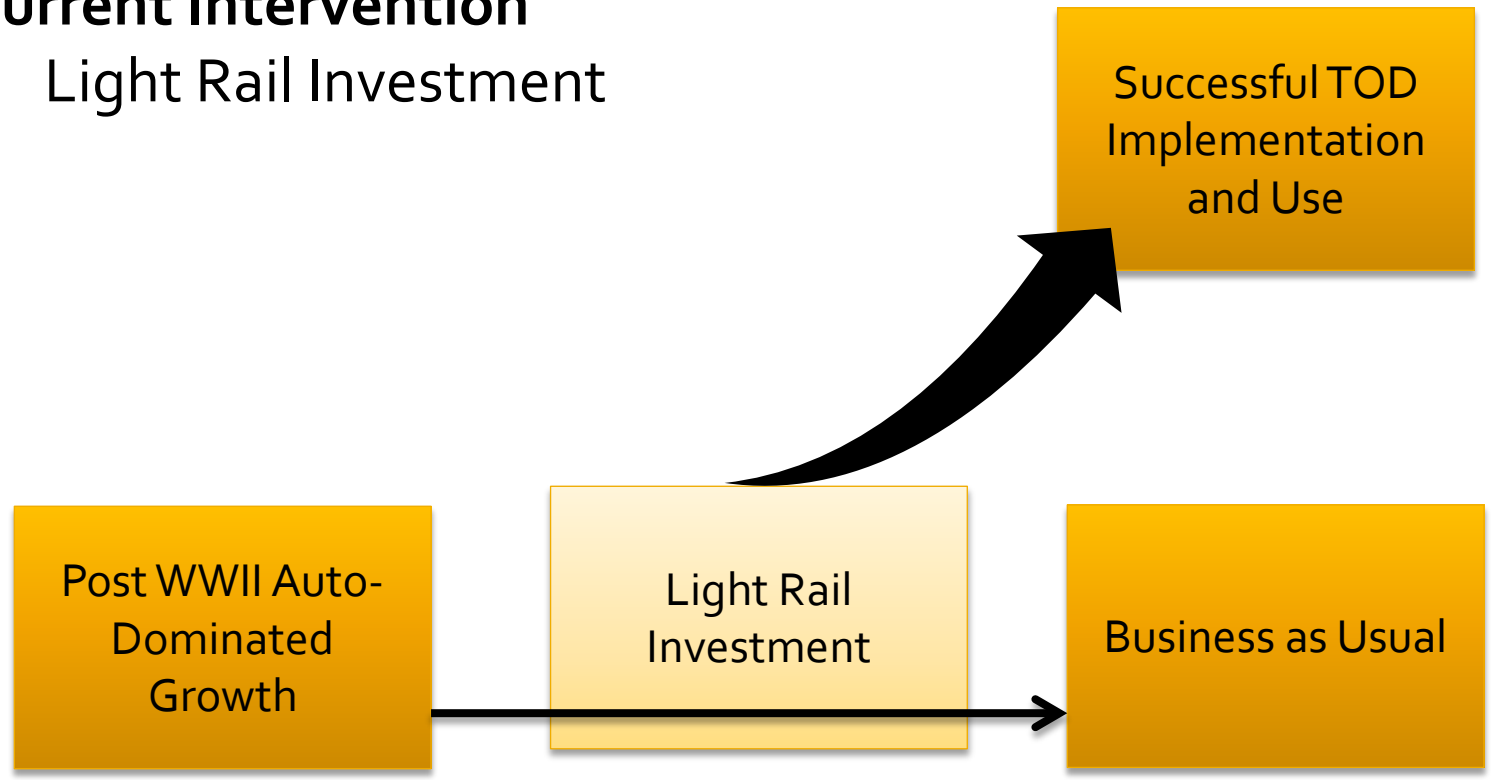
Sustainability Approach



Transition Intervention

Current Intervention

- Light Rail Investment



Barriers

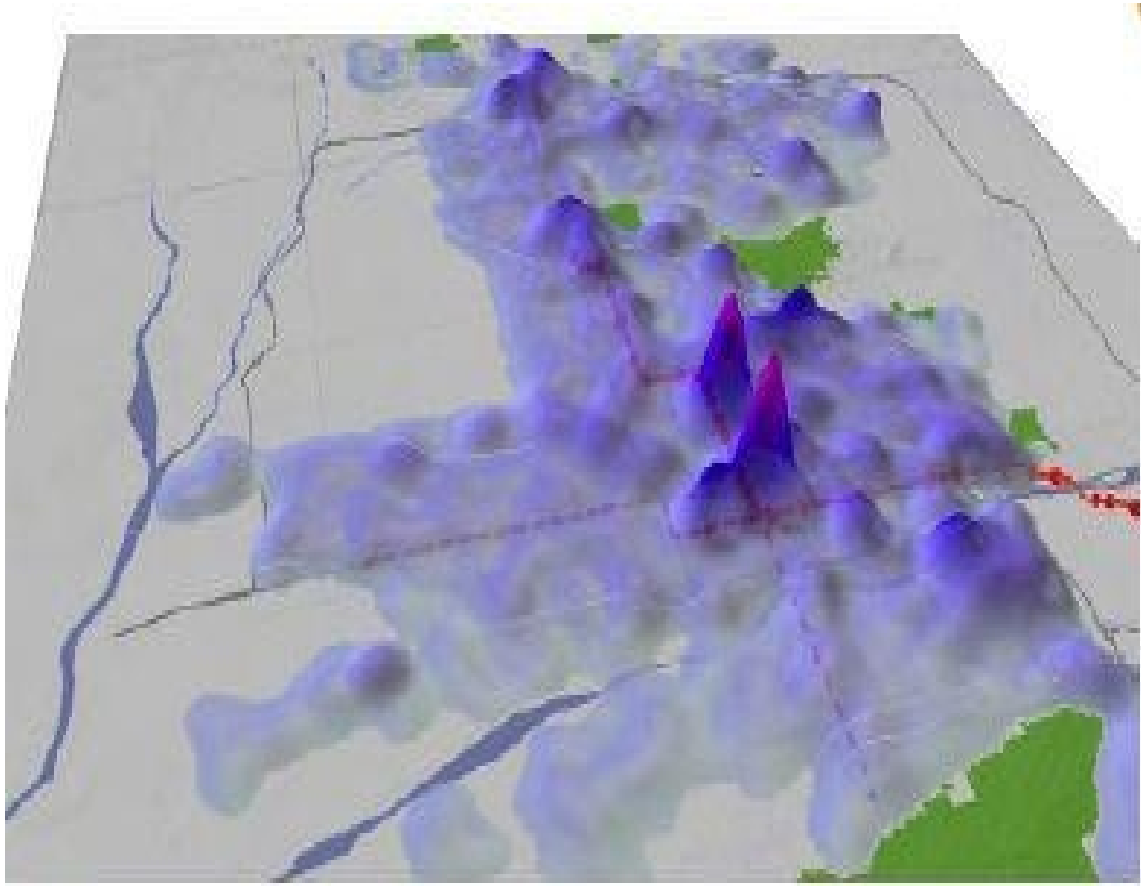
Conditions/Challenges	Resulting Barriers
▪ Rapid Growth, 30 years	▪ Weak Urban Core

▪ Urban Sprawl
  ▪ Housing Industry Reliance
	▪ Uniform Mindset
	  ▪ Housing Types
	  ▪ Highway Infrastructure Dependence

▪ Council-Manager Government	▪ Competing Development Priorities
▪ Private Property Rights Protection Act (Proposition 207; 2006)	▪ Inefficient Land Assembly

TOD Best Practices

- Walkable Neighborhoods
  - Walkscore
- Efficient Resident / Workers Ratio
  - Job Density
  - TOD Typologies
- Social Resident Interaction
  - Place Making



Low Density — High Density

Project for Public Spaces

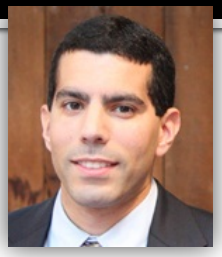
Place Making and Power of 10

Project for Public Spaces. (n.d.). What Makes A Successful Place? Retrieved 10 29, 2012, from Project for Public Spaces:

Solutions

- Walkable Neighborhoods
  - Encourage Place Making
- Flexible Form Base Code
  - Commercial/Resident Mix
- Market Light Rail Vision
  - Share Light Rail Vision
  - Relay TOD Benefits
  - Promote Transit-Oriented Choices
    - User Incentives

Research Teams



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Assistant Professor

Mindy Kimball
Ph.D. Candidate

Transitions

- Conditions
- Barriers
- Solutions

Roberta Bosfield

Nick Francis

Amelia Celoza
Gilbert Flores
Ryan Furcini

Buildings

- Construction
- Energy Production
- Energy Use

Andrew Fraser

Sam Johnson
Andrew Kaehr
Valentina Prado

Drew Rostain
Minghao Xu

Transportation

- Vehicle Manufacturing
- Energy Production
- Gasoline Combustion

Matt Nahlik

Kieth Christian
Madhav Garikapati
Andy Yu

Buildings

What are the energy and environmental effects of residential and commercial building densification around light rail stations?

Option 1 ▽

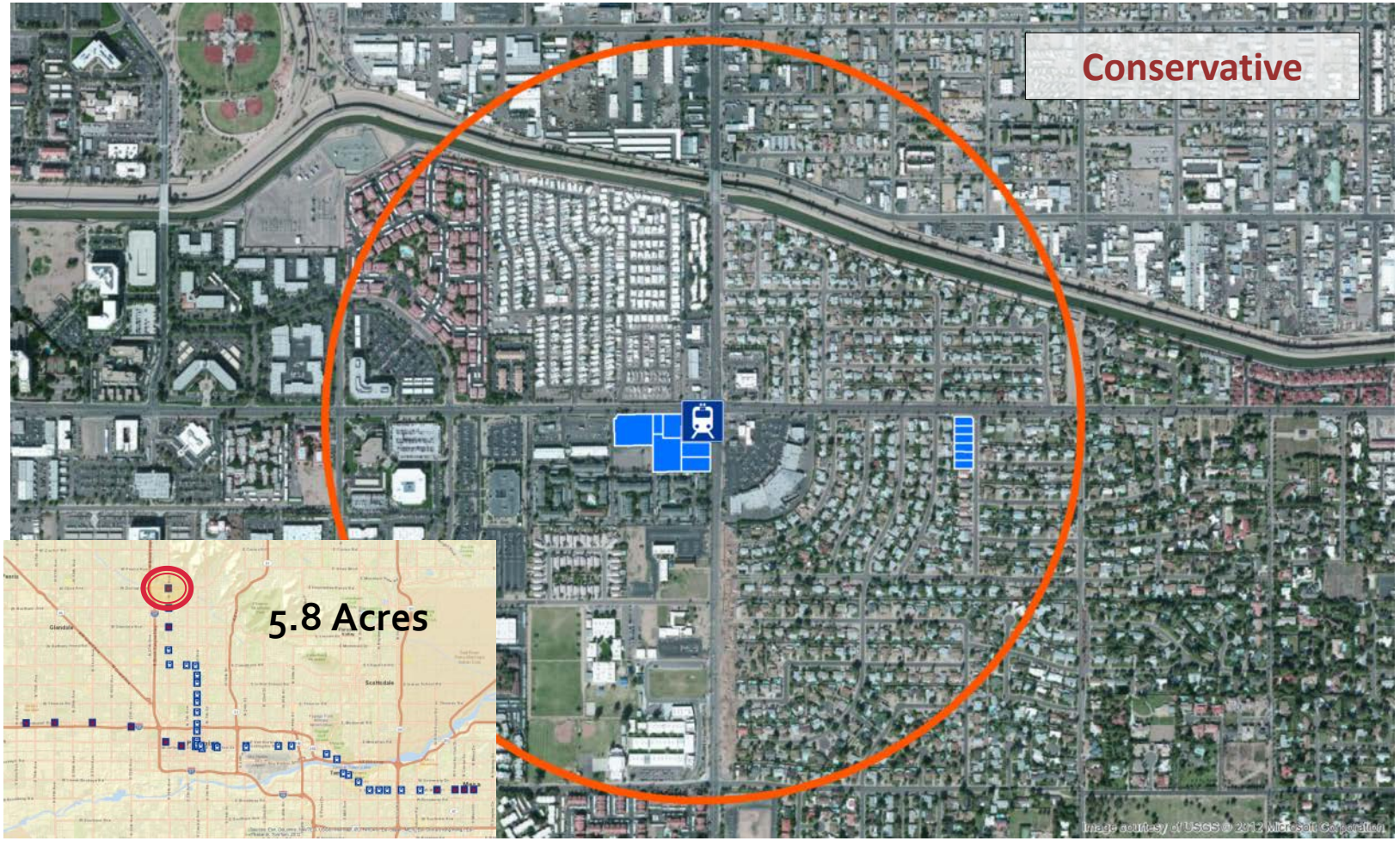
Option 2 ▽

Option 3 ▷

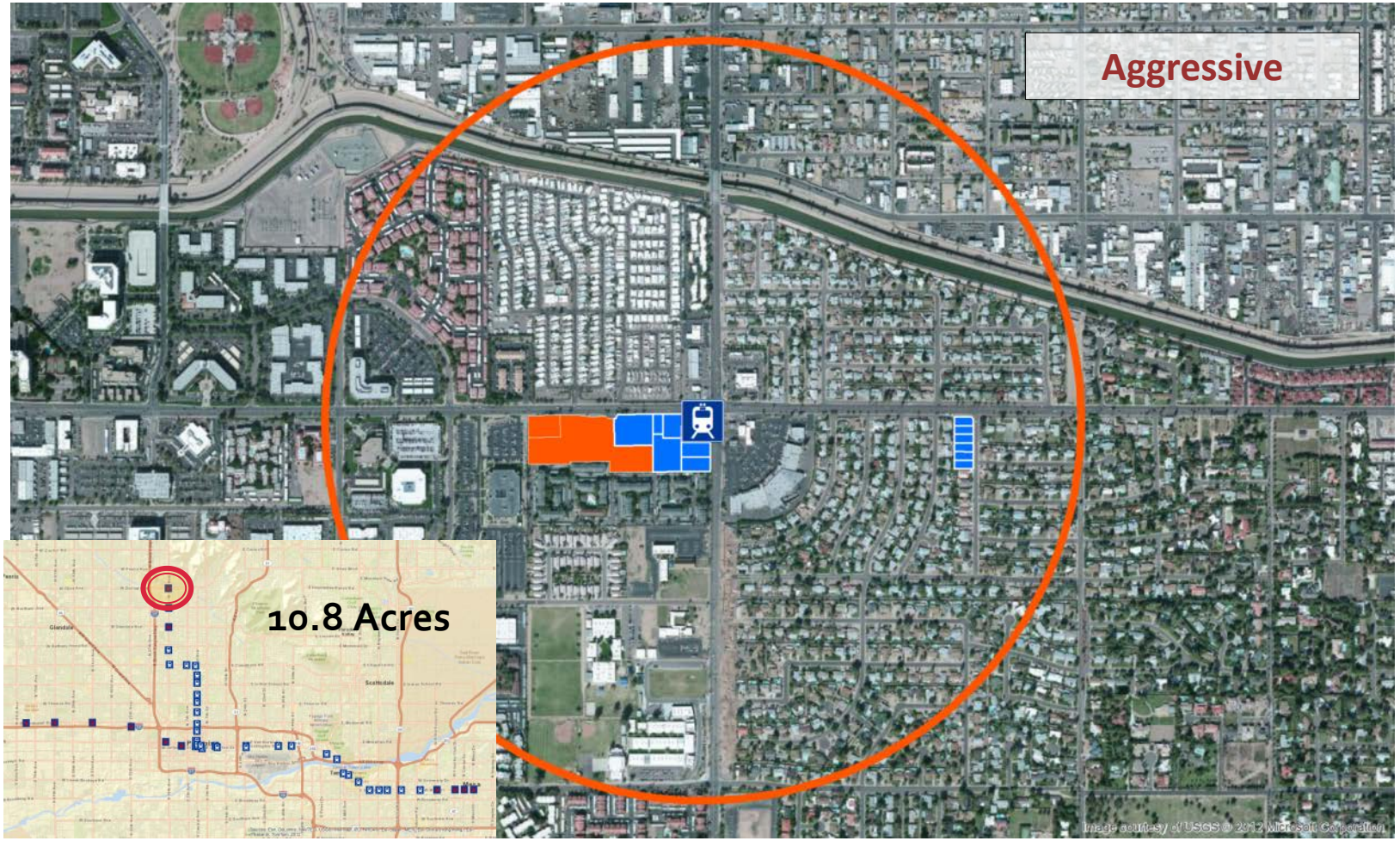
Land Selection Methodology

- Light rail extension plan (Valley Metro)
- Land parcel selection (Maricopa County Assessor, Google Maps)
- Conservative strategy
  - Vacant lots within ½ mile radius
- Aggressive strategy
  - Vacant lots + currently occupied land that could be repurposed within ½ mile radius

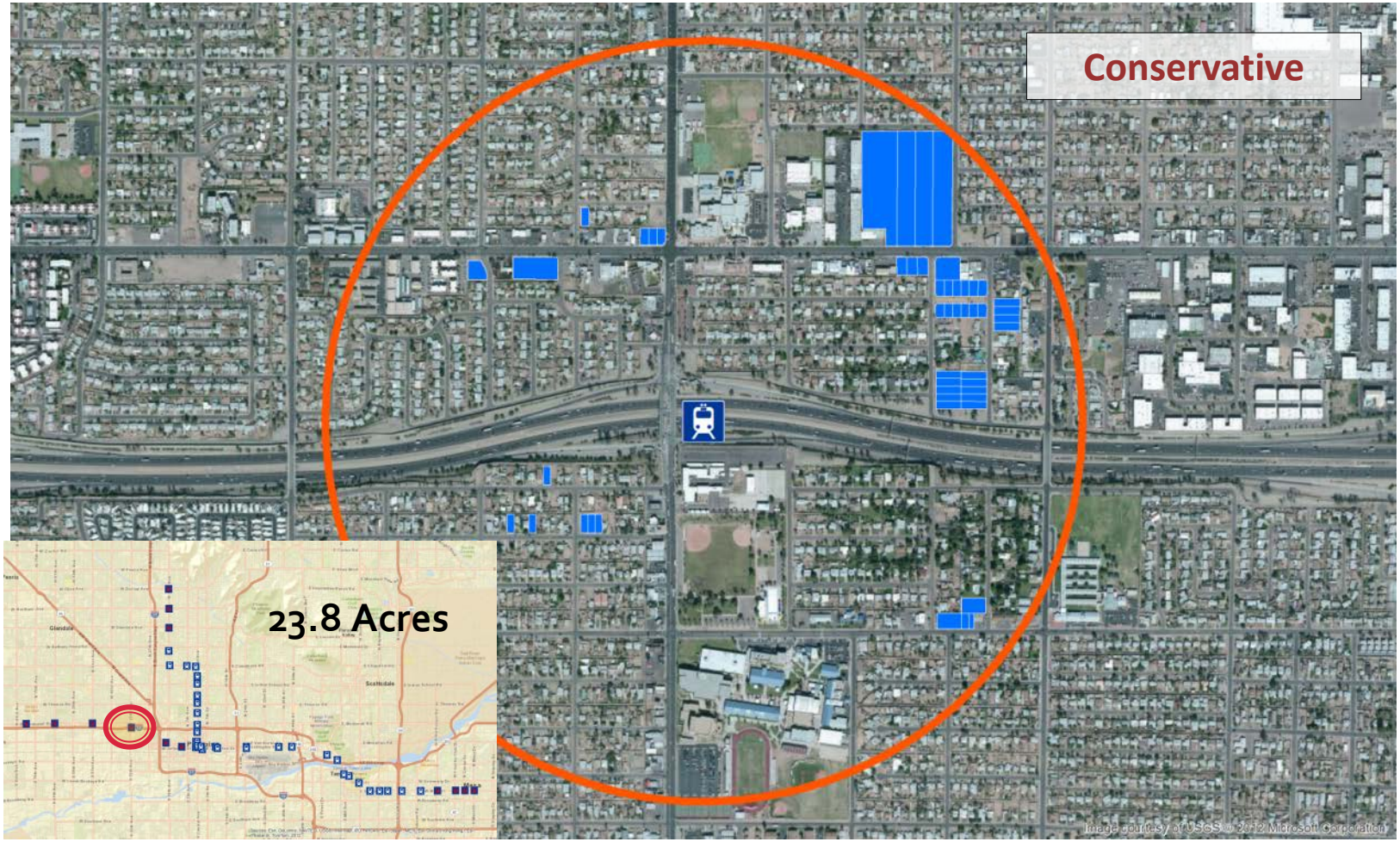
19th Ave & Dunlap



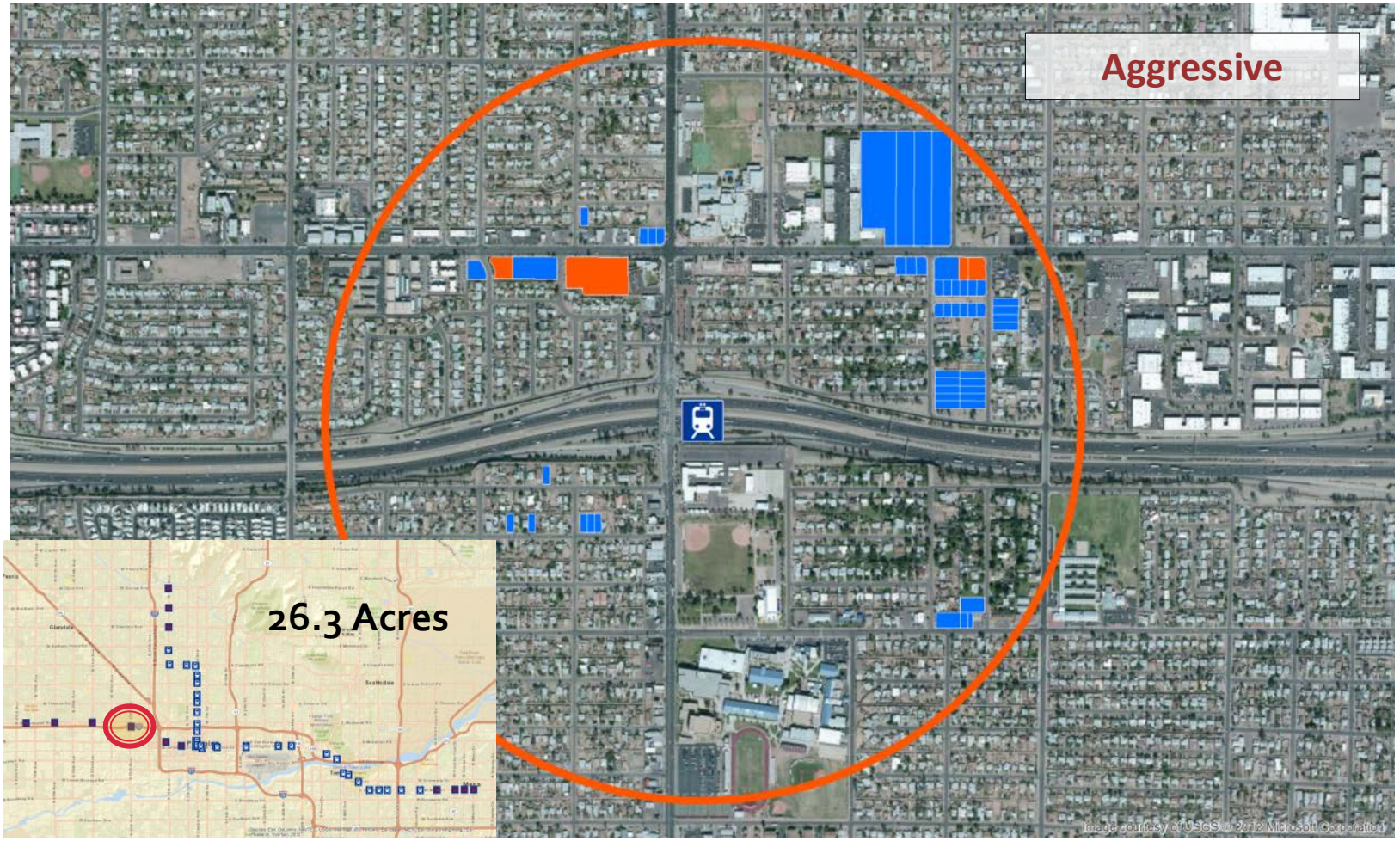
19th Ave & Dunlap



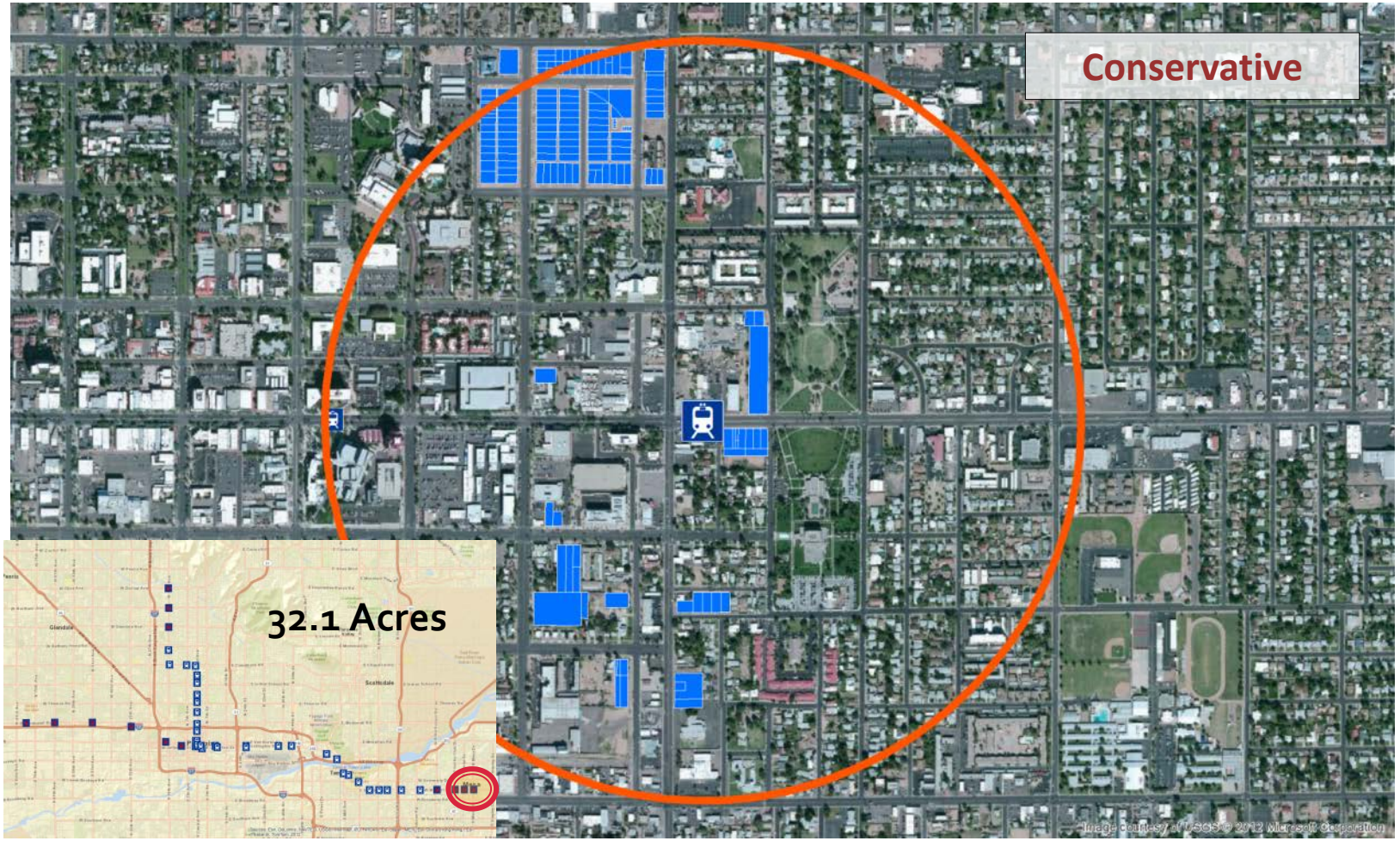
I-10 & 35th Ave


Conservative
23.8 Acres
Image courtesy of USGS © 2012 Microsoft Corporation

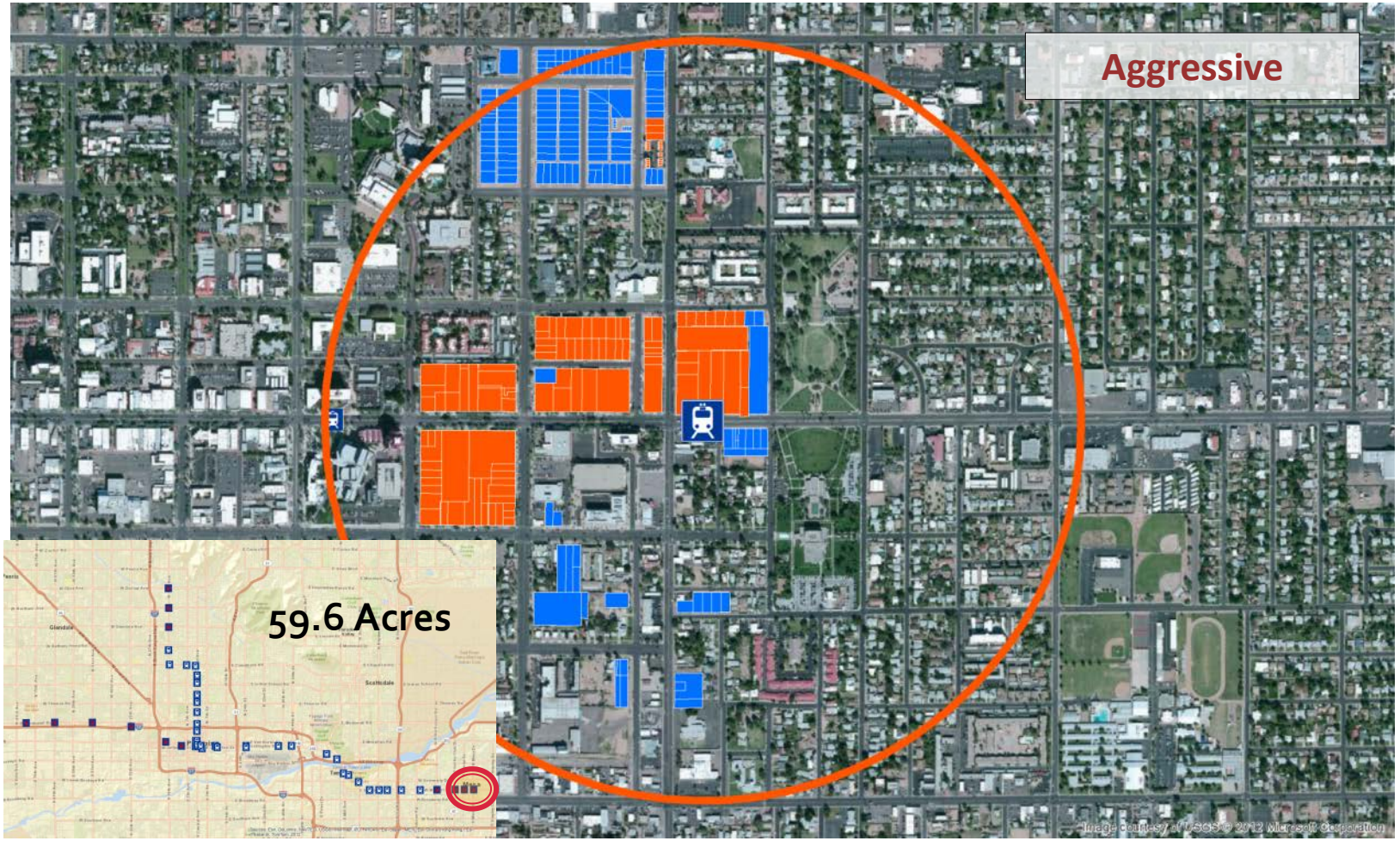
I-10 & 35th Ave



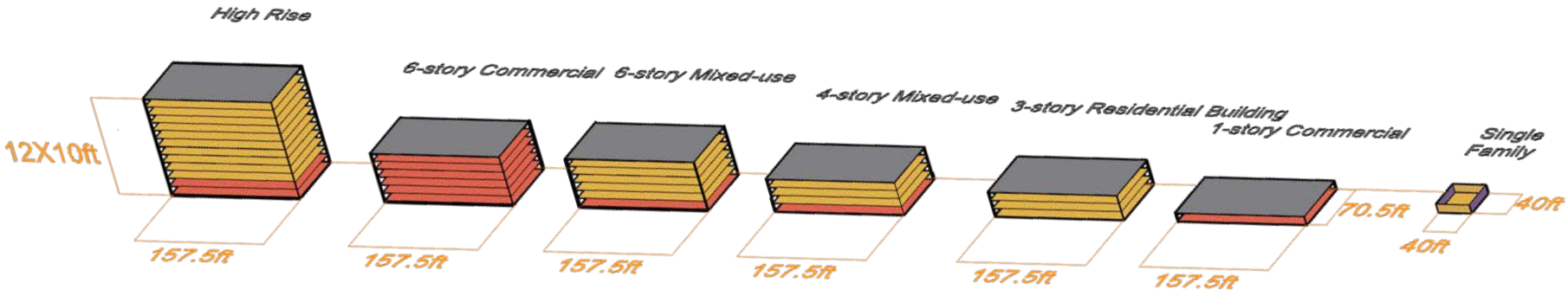
Mesa



Mesa



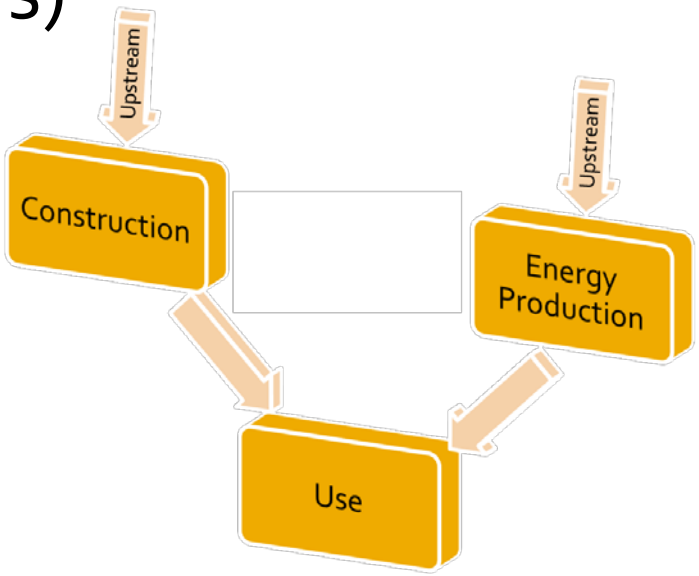
Building Models & Allocation



	TOD		BAU	
Type	Conservative	Aggressive	Conservative	Aggressive
Single Family Home	38	42	2494	3906
4 Floor(3R, 1C)	50	97	-	-
6 Floor(5R, 1C)	-	7	-	-
12 Floor(10R, 2C)	10	10	-	-
3 Floor(3R)	19	19	-	-
Commercial Space(1C)	3	3	169	277
Medium Commercial(6C)	16	25	-	-
Parking Spots	5808	1004	2028	3324

Building Life-cycle Modeling

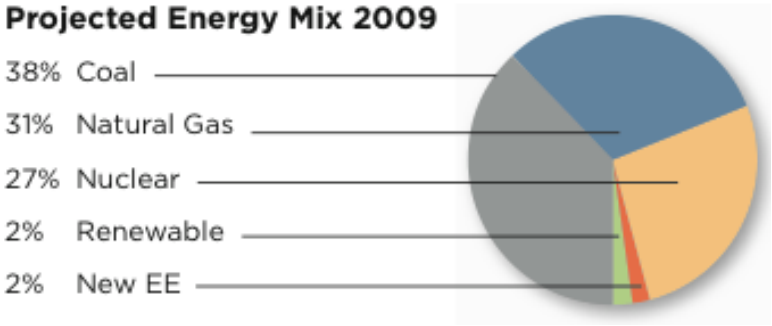
- Building Construction
  - RS Means: Materials and Construction Processes
  - Athena: Energy use and emissions
- Building Use Phase (60 years)
  - Energy Plus:
    Electricity Consumption
  - GREET:
    Emissions

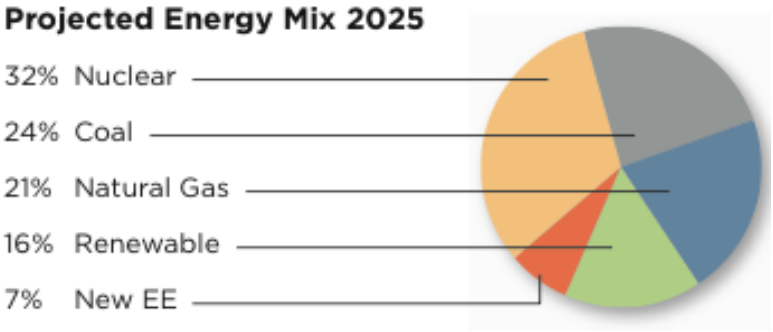


Arizona's Energy Future

In 2006, Arizona Corporation Commission set a goal for increasing renewable energy use:

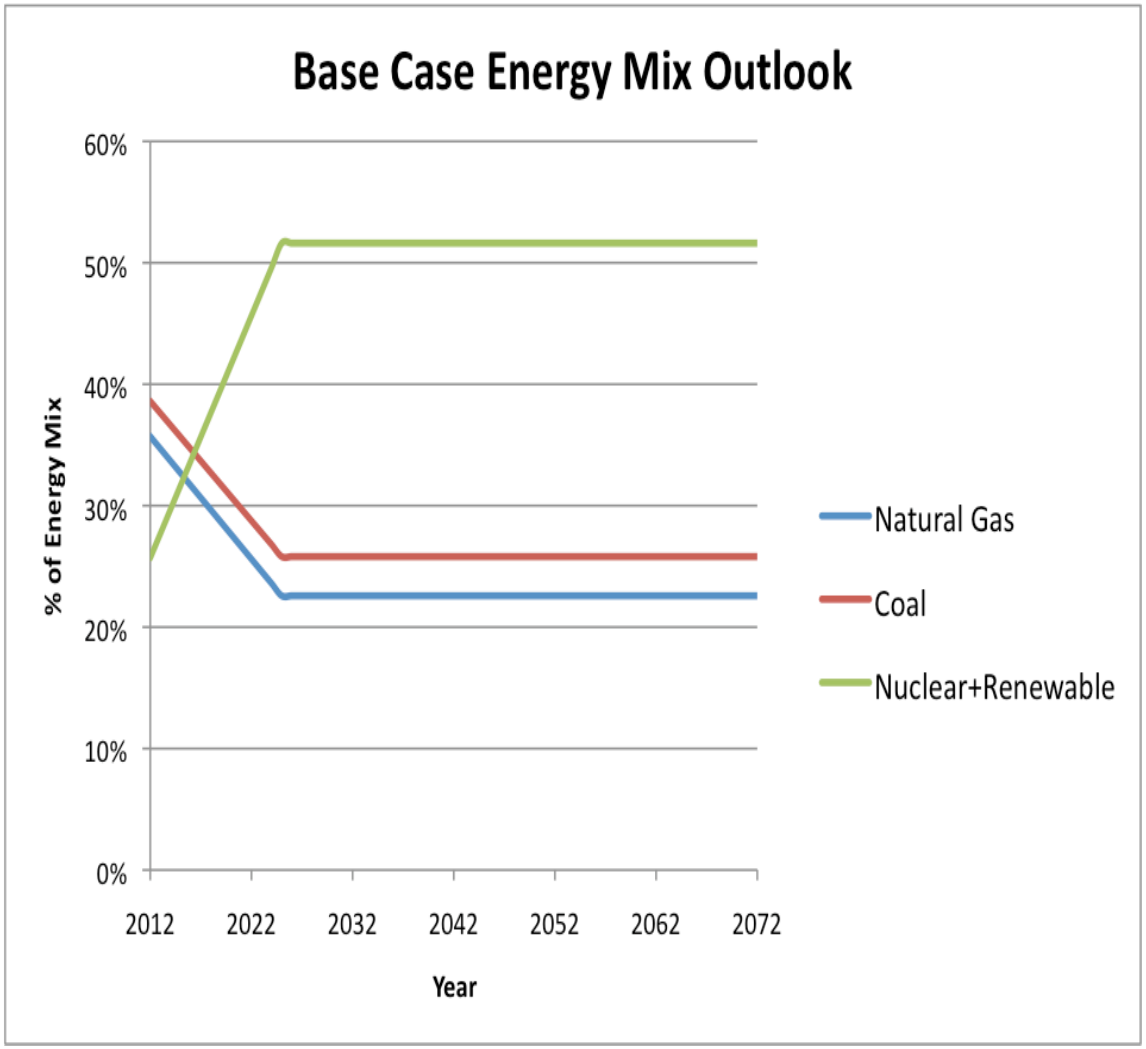
- 2006 – **1.25%**
- 2012
  - Projected – 3.5%
  - Actual – 3.1% Non-Hydro, 6.1% Hydro
- 2025 – **15%**

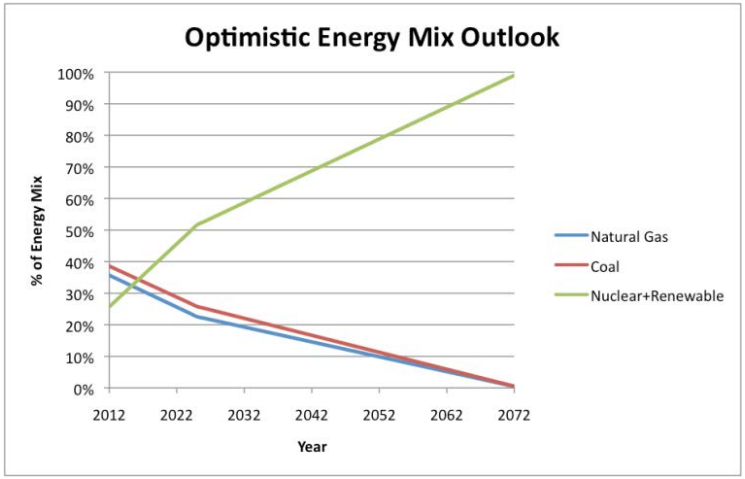


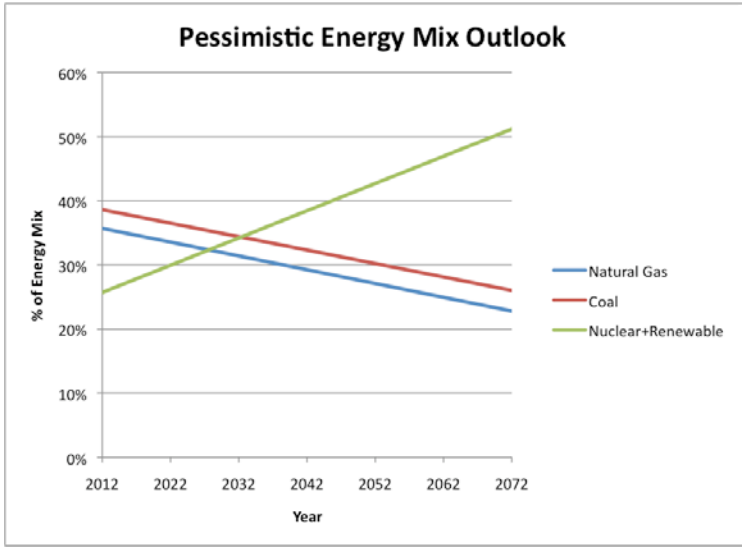


Arizona's Uncertain Energy Future

PRELIMINARY RESULTS. PLEASE VISIT urbansustainability.lab.asu.edu FOR INFORMATION ABOUT FINAL RESULTS.







Buildings Life Cycle GHG Emissions

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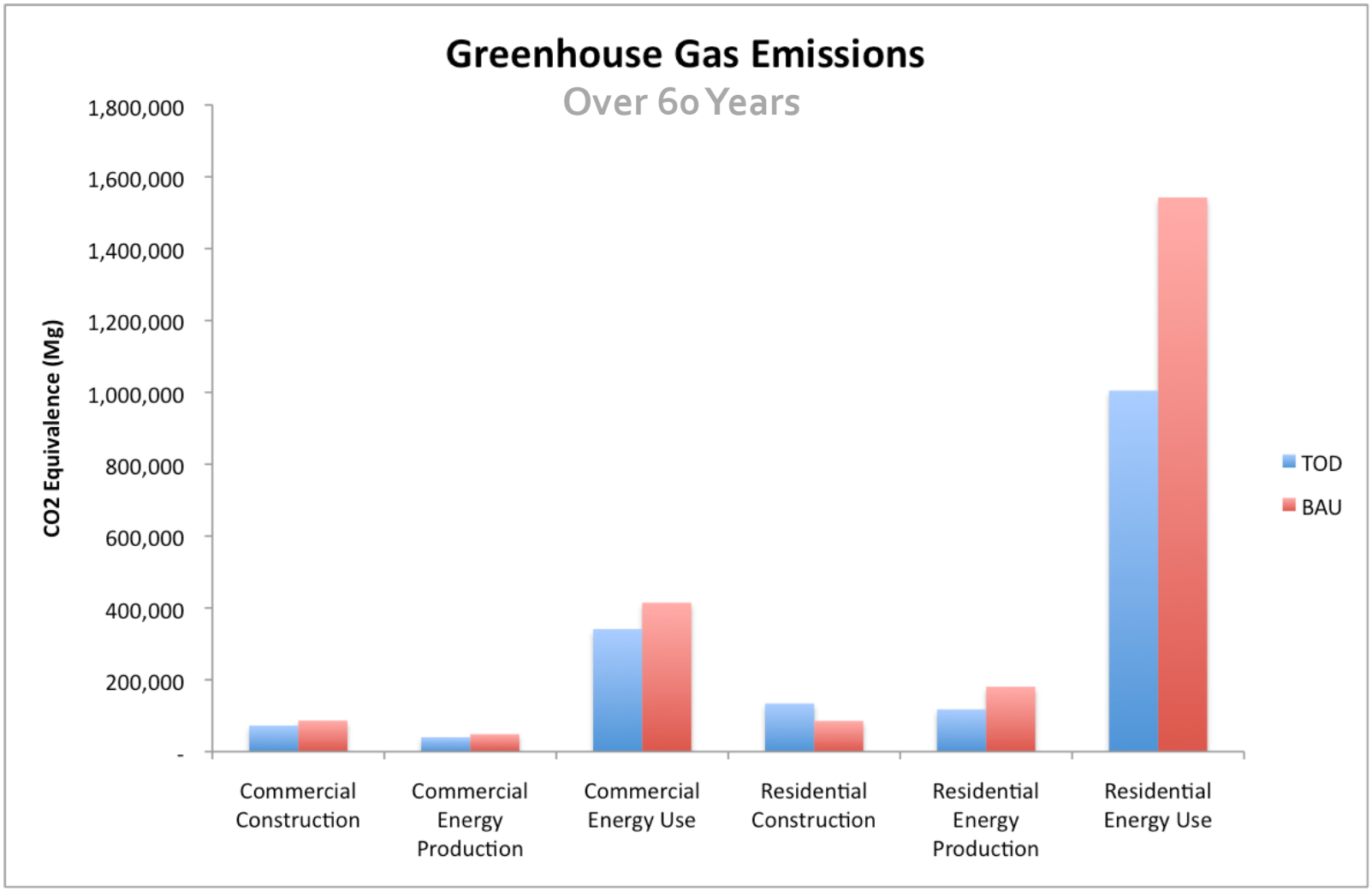

Building Life Cycle NOx Emissions

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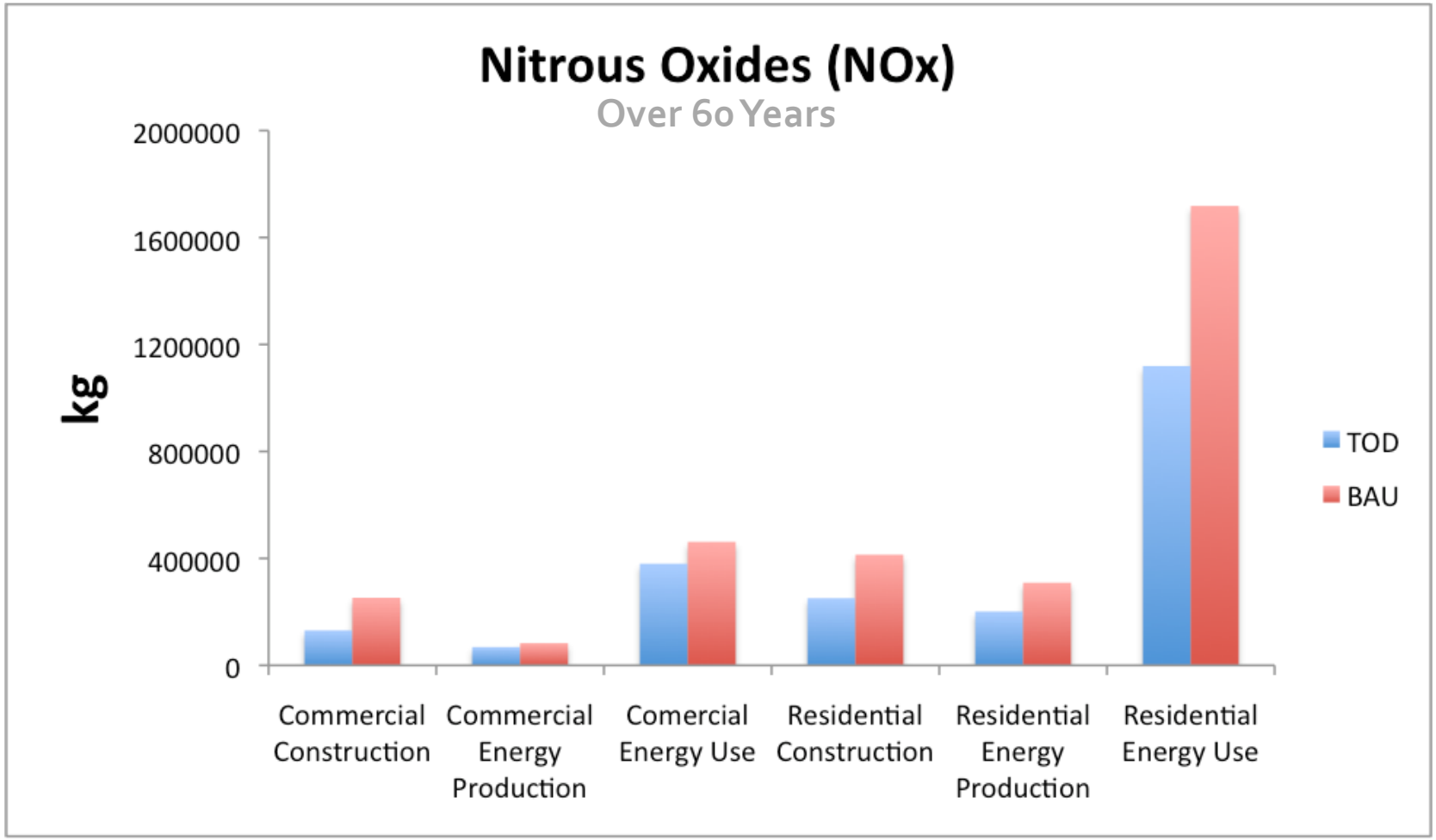
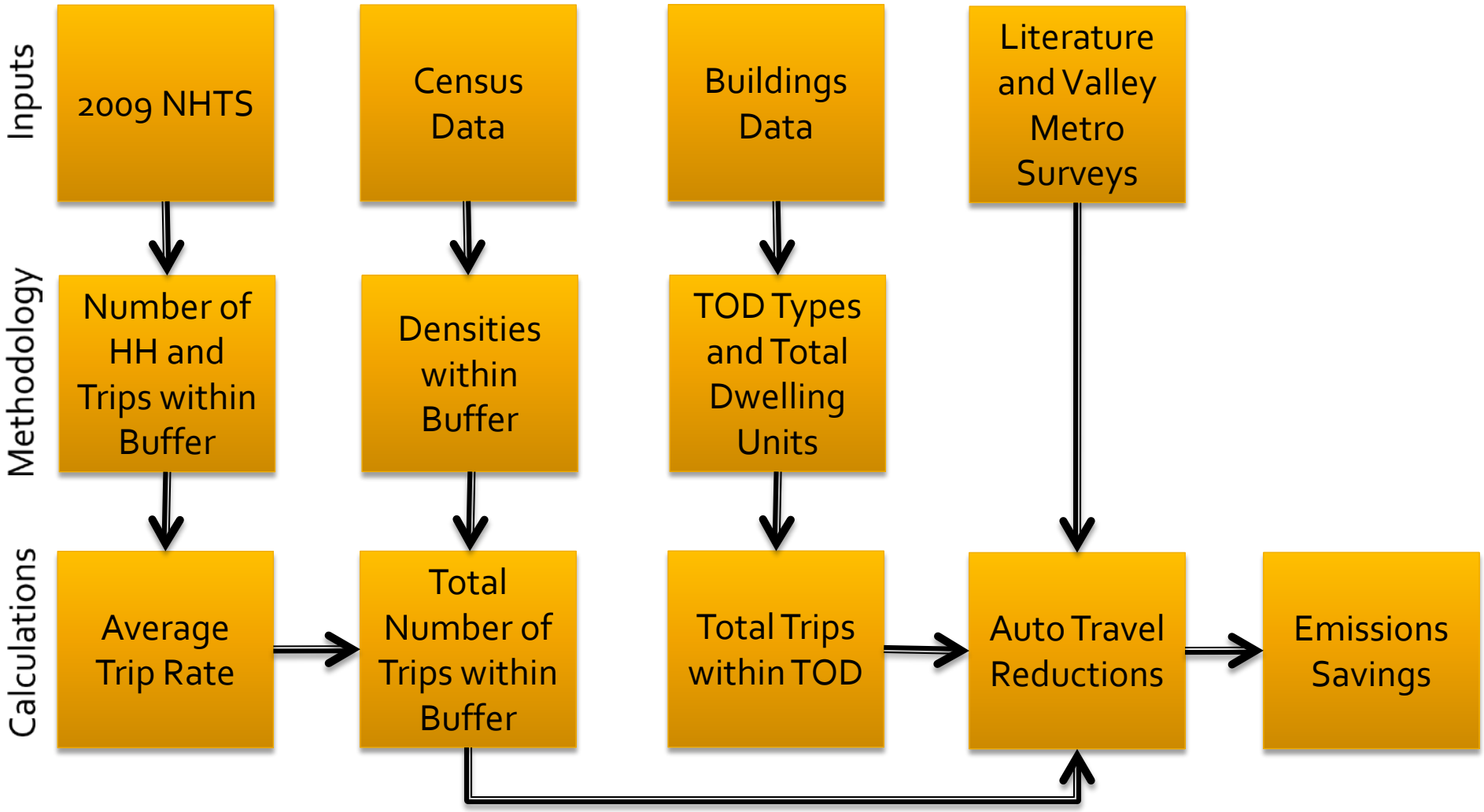


Transportation

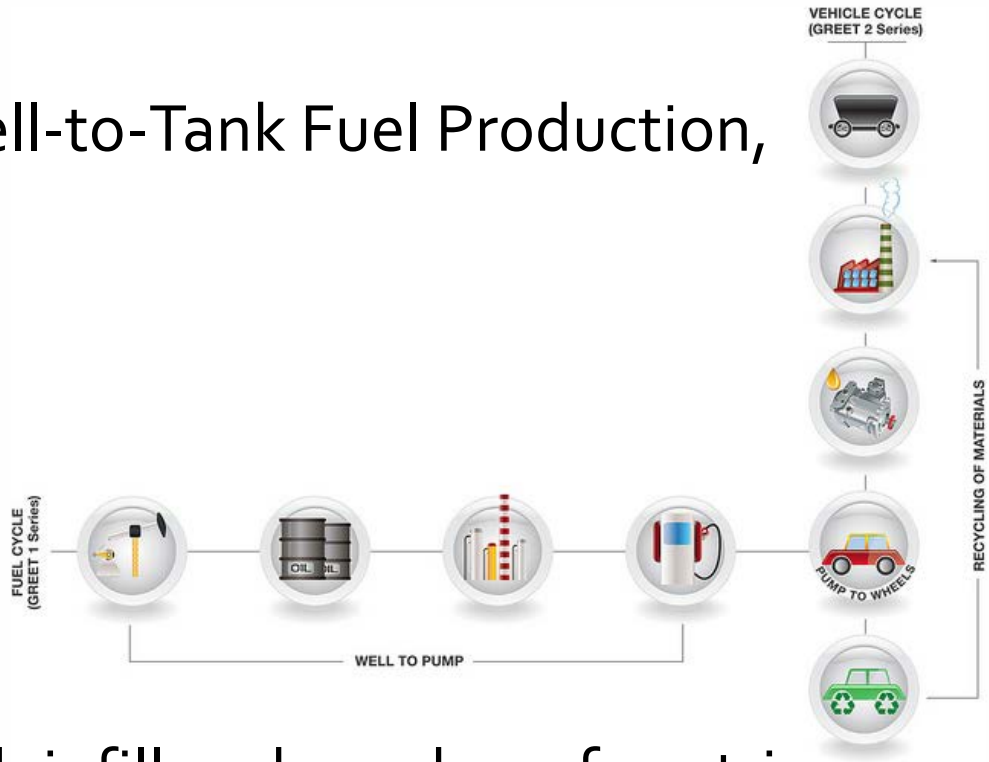
What are the transportation energy and air emissions changes that occur from urban infill around light rail?

Transportation Methodology



Environmental Approach

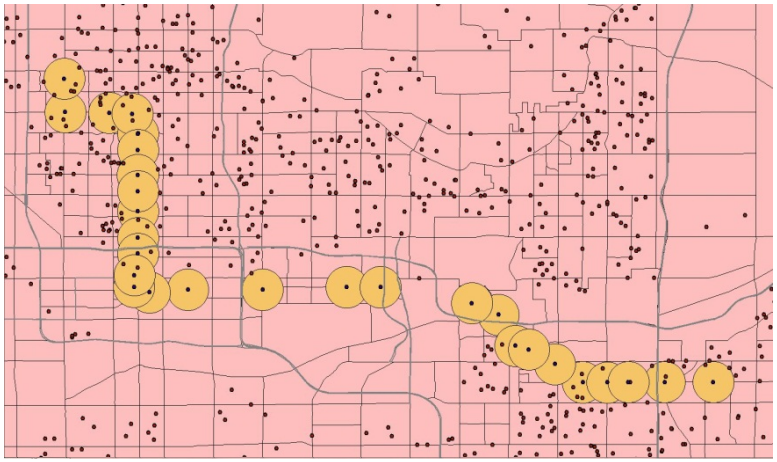
- Quantify Vehicle Miles Traveled (VMT) for each scenario
- Life-Cycle Approach
- Vehicle Manufacturing, Well-to-Tank Fuel Production, Vehicle Operation
- GREET model by the EPA
- Examine Energy Use, Greenhouse Gas Emissions, and Criteria Pollutant Emissions



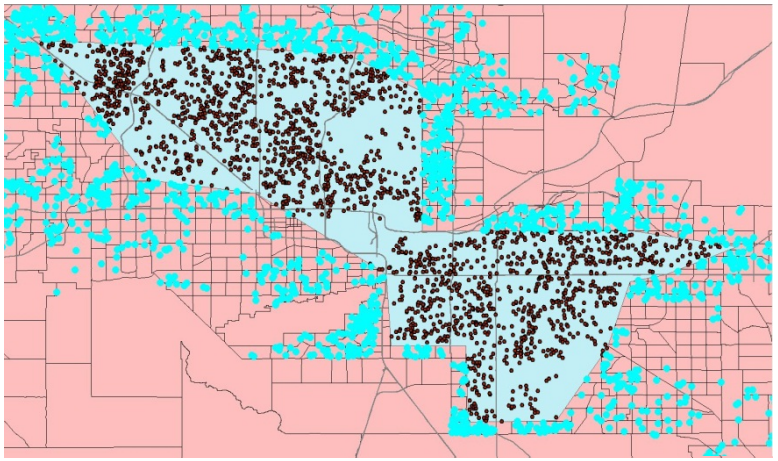
- Reduce travel distance with infill and number of car trips with mode-shift to light rail

Average Trip Rates and Densities

Residential-induced Travel



Urban Infill Travel Characteristics



Fringe Travel Characteristics

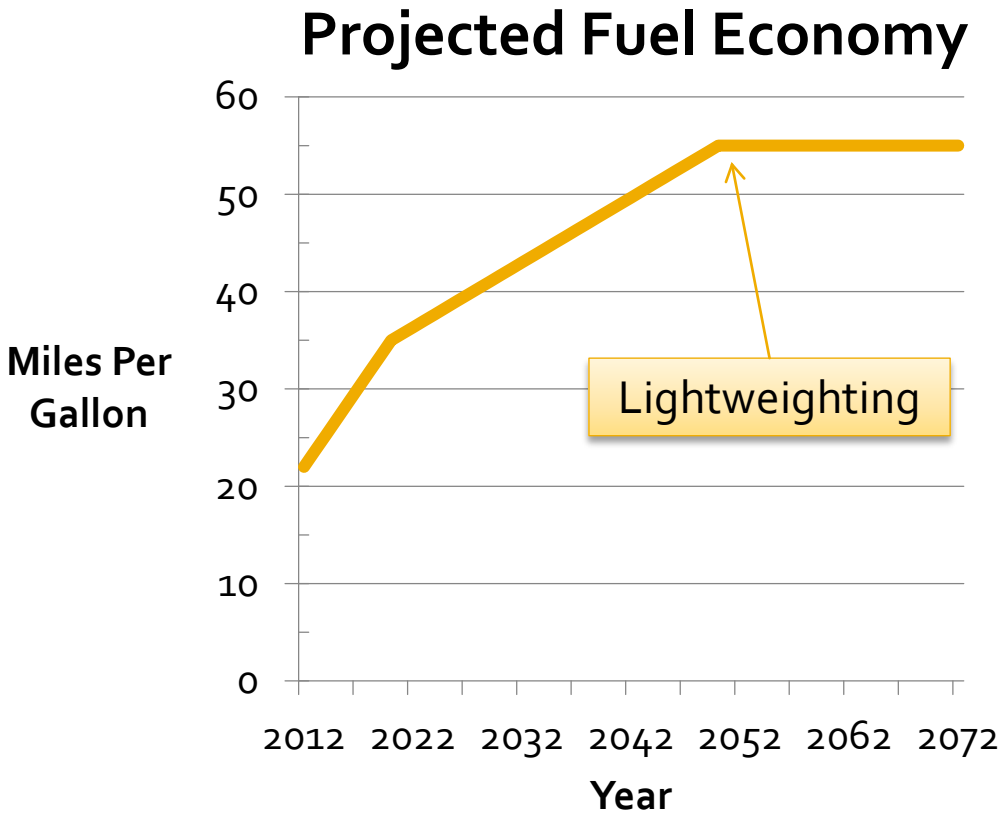
Commercial-induced Travel

- Institute of Transportation Engineers' Trip Generation Manual
- Commercial real estate area from the buildings team
- Characteristic shopping travel from NHTS

Vehicle Analysis

	Use % From NHTS	Characteristic Travel Use
Cars	49.1%	51.4%
Vans	7.8%	8.2%
SUVs	19%	19.9%
Pick-Up Trucks	19.6%	20.5%
Totals:	**95.5%**	**100.0%**

Commute travel assumed to be characterized by four categories of vehicles shown.



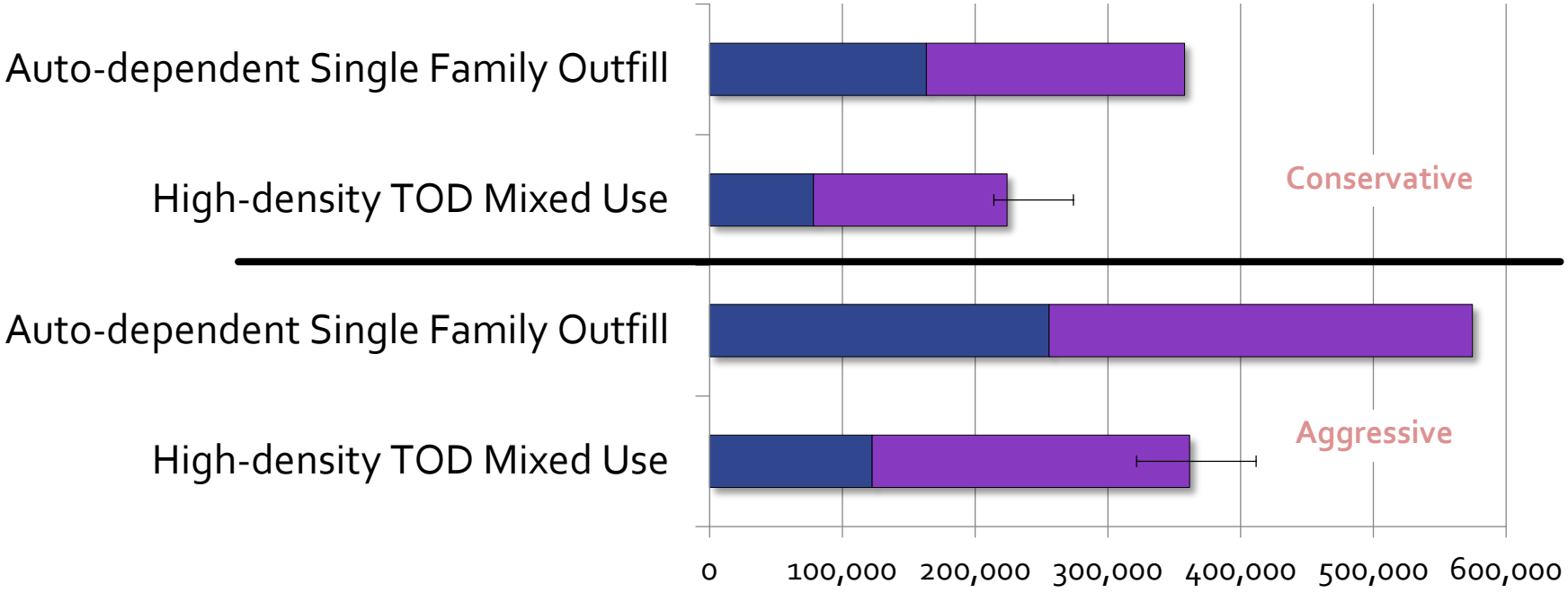
Projected fuel economy of cars: 22 mpg in 2012, 35 mpg in 2020, 55 mpg in 2050.

Possible VMT Savings

High-density Mixed Use

PRELIMINARY RESULTS. PLEASE VISIT urbansustainability.lab.asu.edu FOR INFORMATION ABOUT FINAL RESULTS.

Residential-induced and Commercial-induced Daily Vehicle Miles Traveled (VMT) Totals



- Conservative savings between 100,000-150,000 miles per day
- Aggressive savings between 160,000-240,000 miles per day

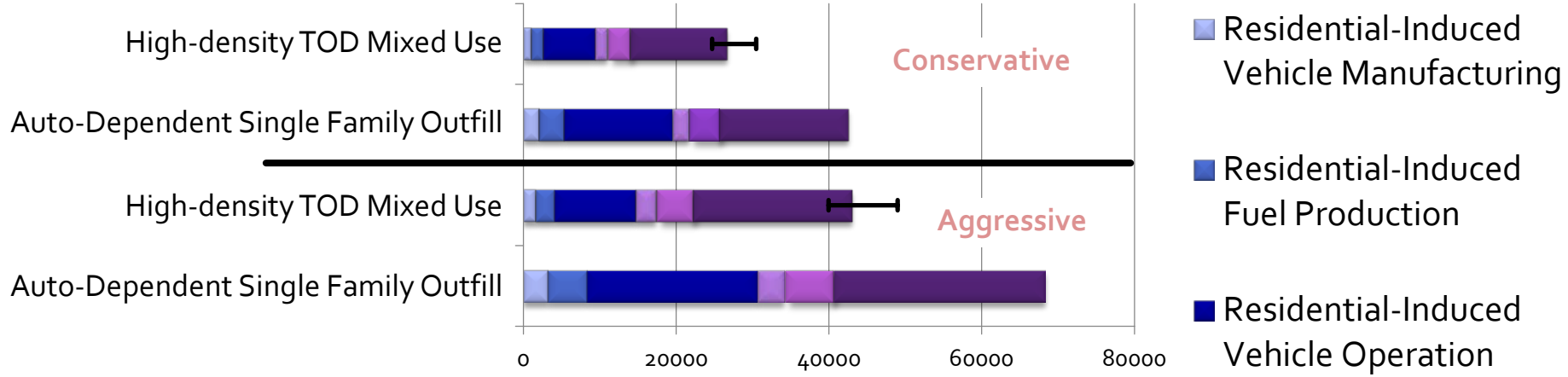
Critical Considerations

- Travel characteristics of TOD residents
- Maximum and minimum mode shift percentages
- Percentage of shopping trips per household
- Percentage of shopping trips generated from the TOD's
- Commercial trip generation
- Light weighting of vehicles to reach 55mpg

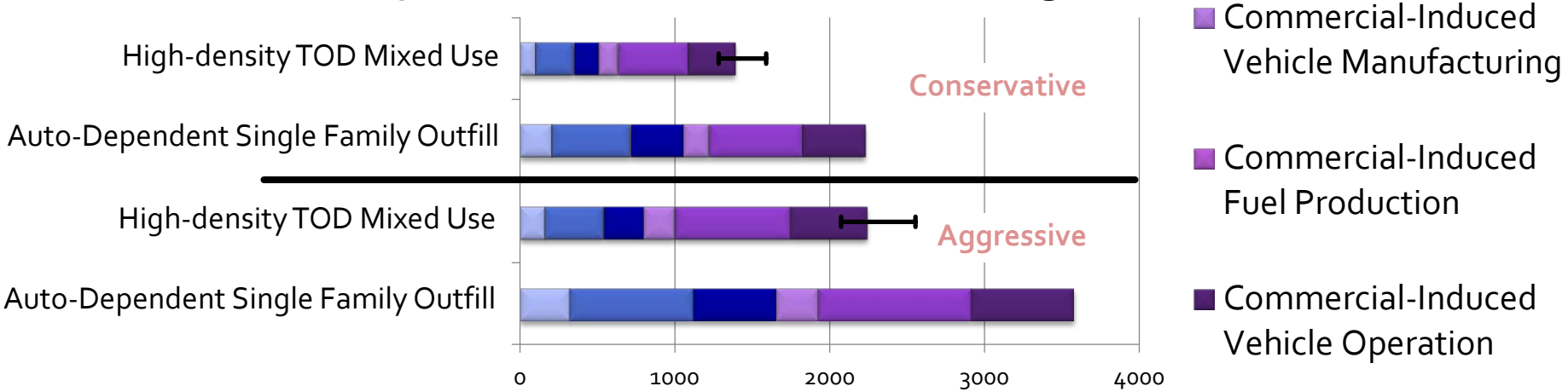
Transportation Selected Results

PRELIMINARY RESULTS. PLEASE VISIT urbansustainability.lab.asu.edu FOR INFORMATION ABOUT FINAL RESULTS.

Life-Cycle Energy Use Over 60 Years (TJ)



Life-Cycle NOx Emissions Over 60 Years (Mg)

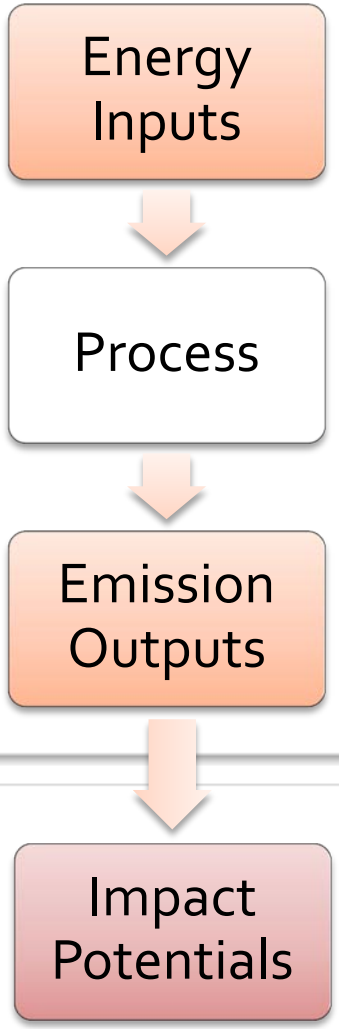


Findings

What are the comprehensive energy and air emissions changes that occur from urban infill around light rail?

Environmental Indicators

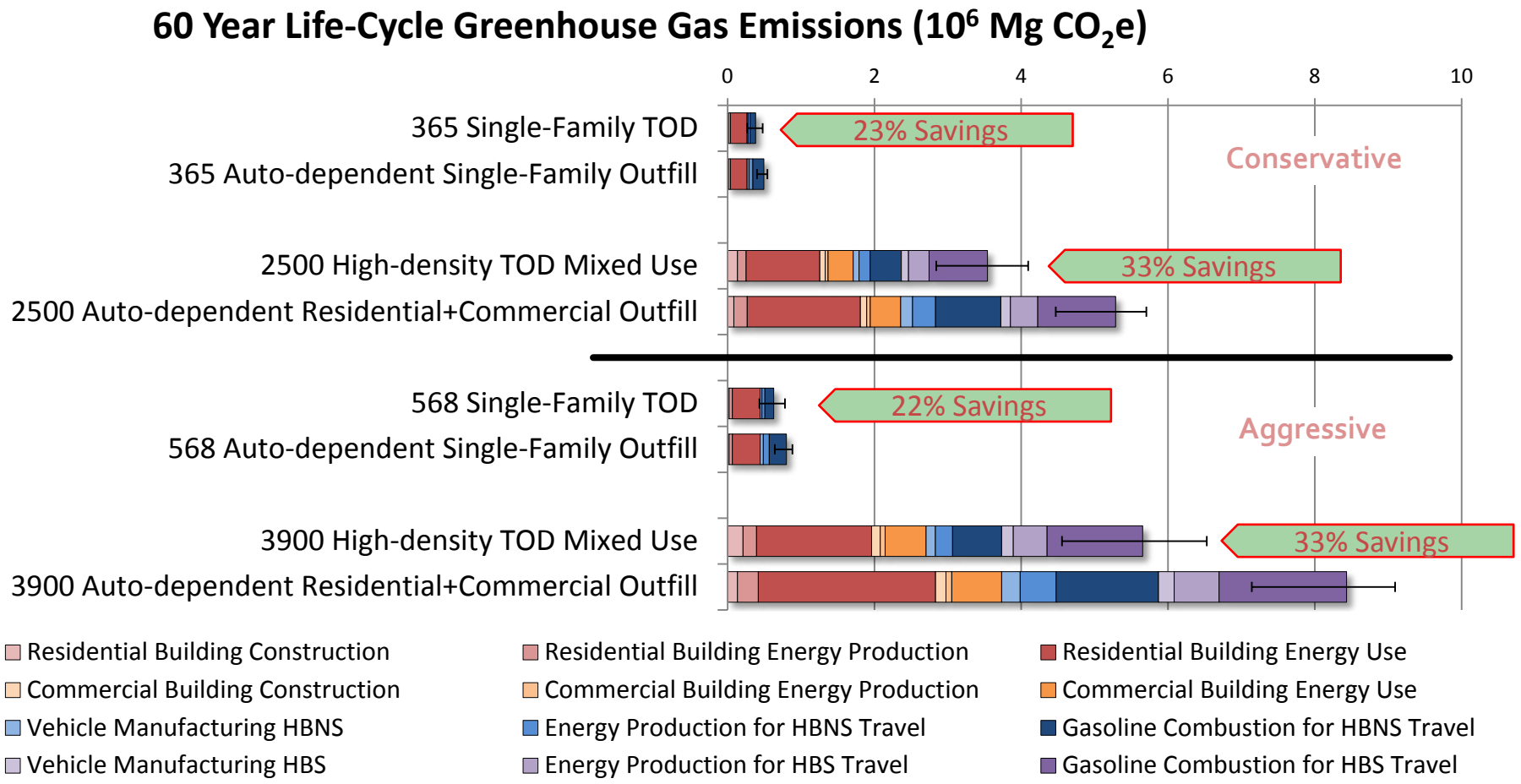
- Energy
- Air Emissions
  - SO_X Respiratory irritant, acid deposition
  - CO Asphyxiant
  - NO_X Respiratory irritant, smog
  - VOC Photochemical smog, cancerous
  - PM Respiratory and cardiovascular damage
- Greenhouse Gases
  - CO_2, CH_4, N_2O



- Human Health and Environmental Impact Potentials
  - Respiratory: SOx, NOx, PM_{10} and $PM_{2.5}$
  - Photochemical Smog Formation: CH_4, CO, VOC, and NOx

Consolidated Results

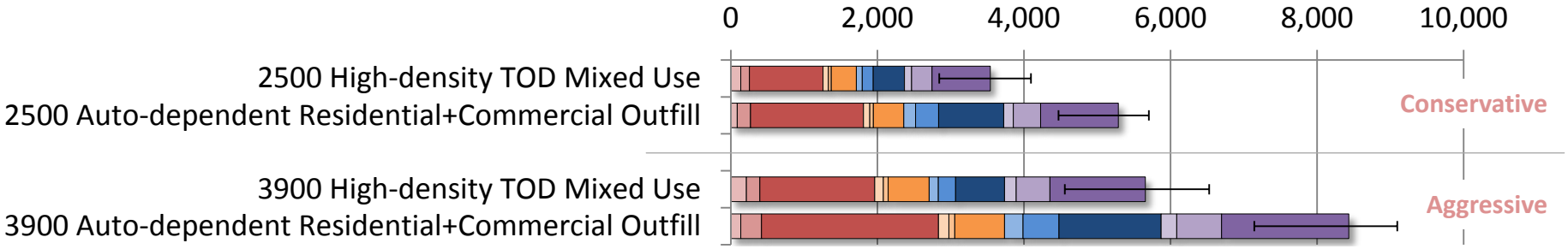
PRELIMINARY RESULTS. PLEASE VISIT urbansustainability.lab.asu.edu FOR INFORMATION ABOUT FINAL RESULTS.



PRELIMINARY RESULTS. PLEASE VISIT urbansustainability.lab.asu.edu FOR INFORMATION ABOUT FINAL RESULTS.

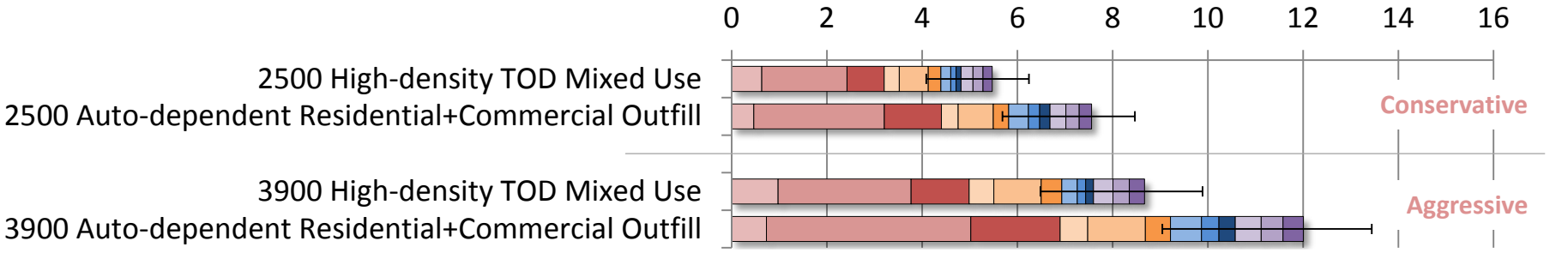
60 Year Life-Cycle Human Greenhouse Gas Emissions (10^6 Mg CO2e)

33% Savings Possible



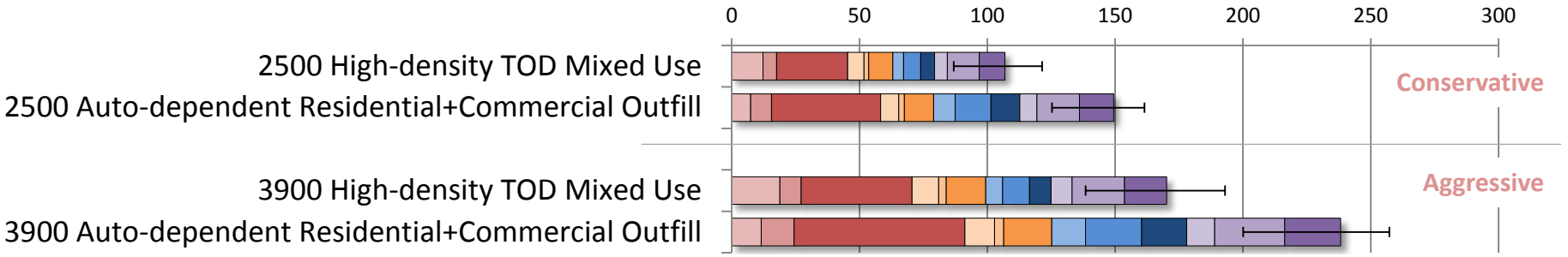
60 Year Life-Cycle Human Health Respiratory Potential (Gg PM_{10}e)

28% Savings Possible



60 Year Life-Cycle Smog Formation Potential (Gg O_3e)

28% Savings Possible

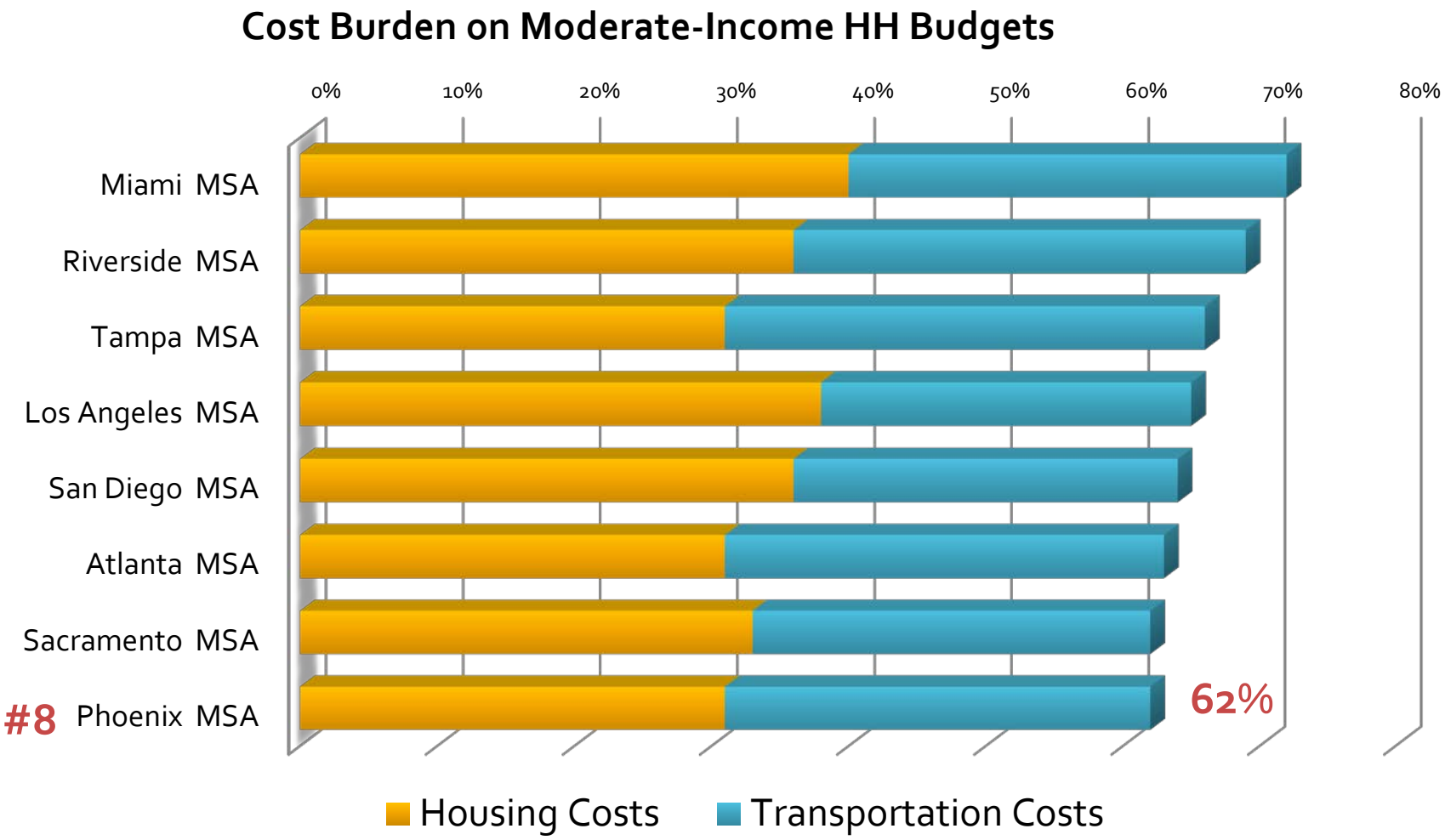


- Residential Building Construction
- Residential Building Energy Production
- Residential Building Energy Use
- Commercial Building Construction
- Commercial Building Energy Production
- Commercial Building Energy Use
- Vehicle Manufacturing HBNS
- Energy Production for HBNS Travel
- Gasoline Combustion for HBNS Travel
- Vehicle Manufacturing HBS
- Energy Production for HBS Travel
- Gasoline Combustion for HBS Travel

Transitions

What are the non-technical TOD implementation barriers and how can they be overcome?

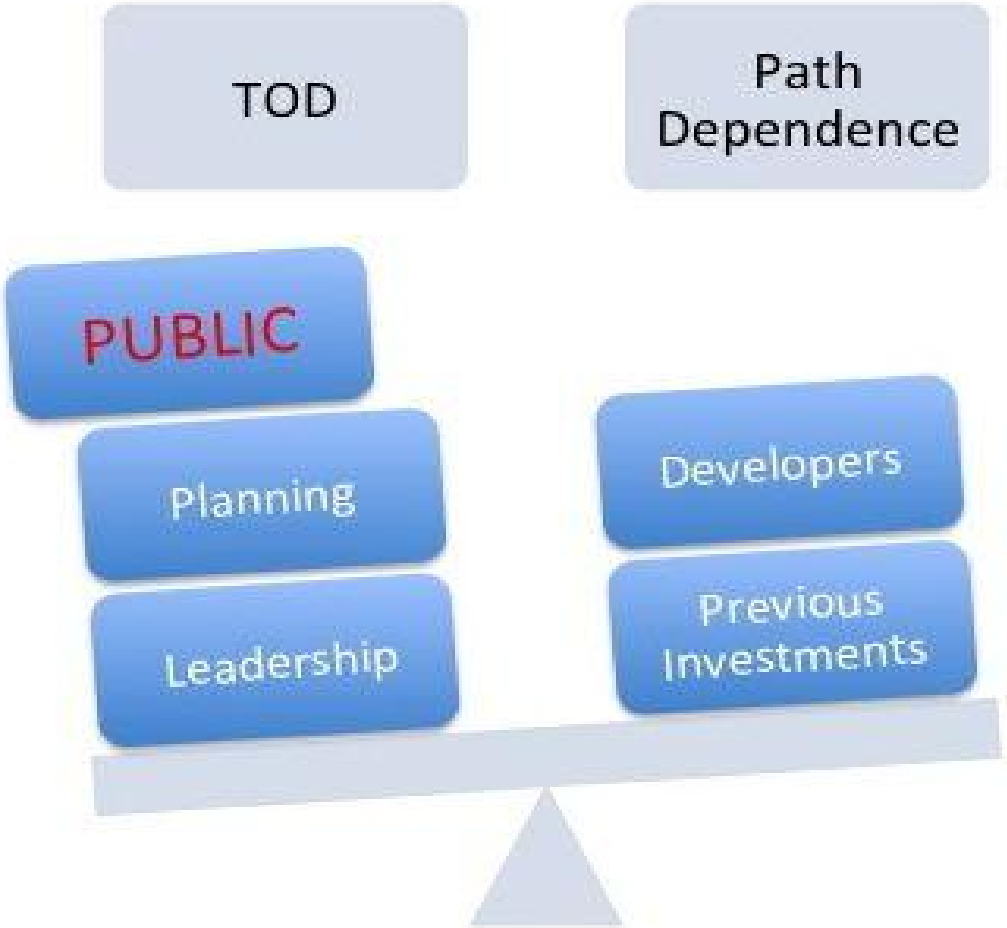
Housing and Transportation Cost Burden



Recommendations

1. Standardize best practices: walkscores, worker / resident ratios, station typologies
2. Master plan ½ mile from each station
3. Evaluate the entire light rail system
4. Involve residents in business recruitment, project approval
5. Promote the TOD car-less lifestyle

Changing the Balance



Questions and Discussion

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Presentation and report will be available:

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