US 33 Microsimulation Modeling

Rob Bostrom,
CDM Smith

November 8, 2019

Presentation Summary

- Insights from ODOT Lit Review
- Modeling Process
- US 33 Simulation
  - Introduction
  - Data collection
  - Corridor impacts – SE, technology
  - Base Year Model
  - US 33 Scenarios

Lit Review Insights

Big Picture Insights from Literature Review

- 2019 Status
- Long implementation time
- VMT will likely increase
- Technology gaps
- Priority research needs IDed
- Scenario analysis using models
- CAV rollout will be transformational (duh) and disruptive.
- Costs will impact rollout time.
- Private ownership is up in the air.

Modeling Insights from Literature Review

- TDM/Simulation process is needed.
- Review of capacity and other key parameters
- Specific adjustments to VISSIM and TransModeler identified
- Simulation will allow key parameters to be tested and tweaked.
- Scenarios identified based on
  - Model year
  - Penetration rates
  - SAE levels of automation
  - MAAS variability
- Need for risk analysis

ODOT CAV Simulation Literature Review

- CDM Smith team included:
  - Steve Shladover, University of California expert in AV
  - Delft University, Netherlands, European traffic modelers
  - HDR, Vissim experts
  - Caliper Corporation, TransModeler developers and experts
  - Ken Troup – main writer
  - Boyang Zhang – lit review and tech expert
  - Rob Bostrom – PM
- Rebekah Anderson – ODOT PM
- Spreadsheet of relevant documents
- Report available from ODOT (Rebekah Anderson) or CDM Smith

Next Steps

- Publish results in TFResource Wiki
  - On line resource created by TRB committee ADB45.
  - Provides information and insights into needed adaptations of existing transportation planning models
    http://tfresource.org/Content_Charrette:_Autonomous_Vehicles
  - Will be updated by CDM Smith
- Make available to others

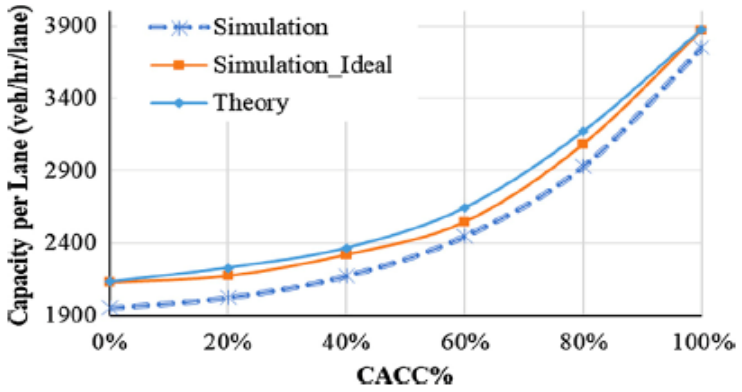
Modeling Process

Modeling Flow

- Model preparation
  - MORPC model – expansion, SE modifications, review of CCs and network
  - US 33 simulation model
    - Create BY model – extensive data collection
    - Validate using MORPC ODs and other sources
- Test scenarios

Travel Demand Modeling

- Travel Demand Models can be enhanced to handle most CAV uncertainties.
  - Models help understand range of futures and potential policies.
  - CAV treated as a mode.
- Numerous efforts and practical tests of TDM.
  - The Ohio TDM will be based on the 3C models developed by ODOT and WSP.
  - Oslo, Norway modeling of shared use AVs using Vissim



Potential Impacts of CAV on Traffic Operations

- Transportation cost
- Transportation safety
- Vehicle operations (including capacity changes, congestion, and other traffic impacts)
- Energy use and related emissions
- Personal mobility and convenience (including shared, owned, or rented vehicles)

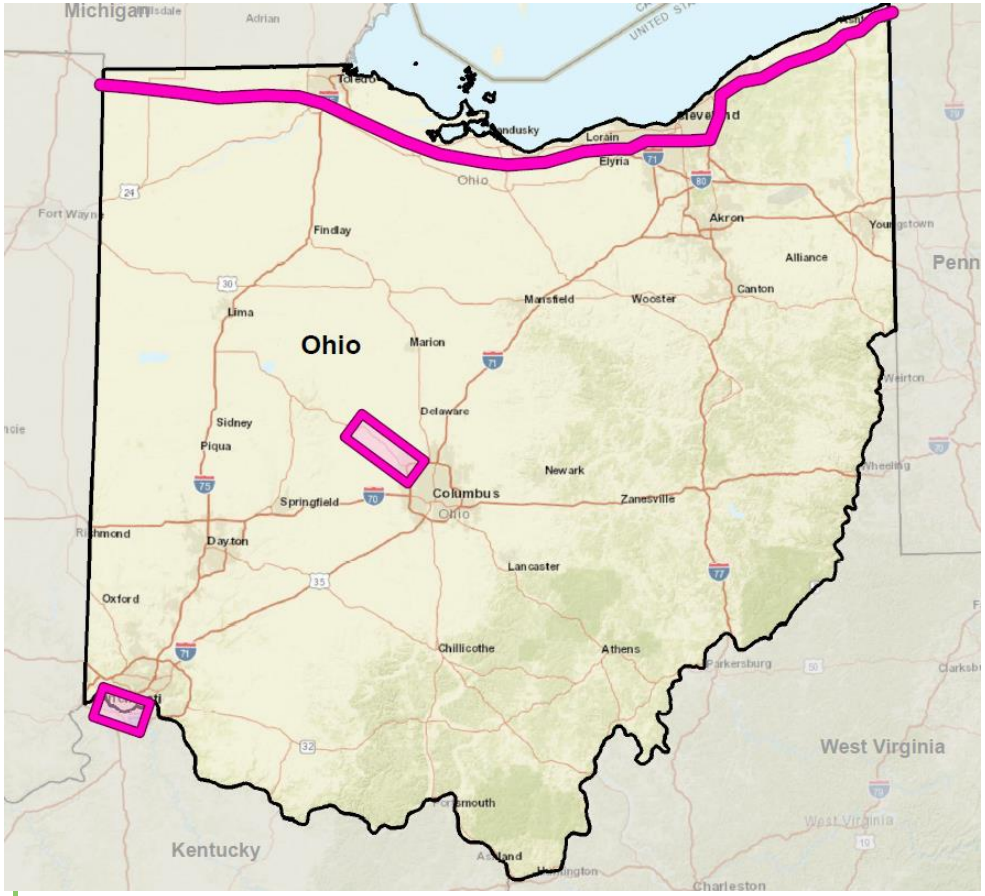
CAV Impacts on Modeling

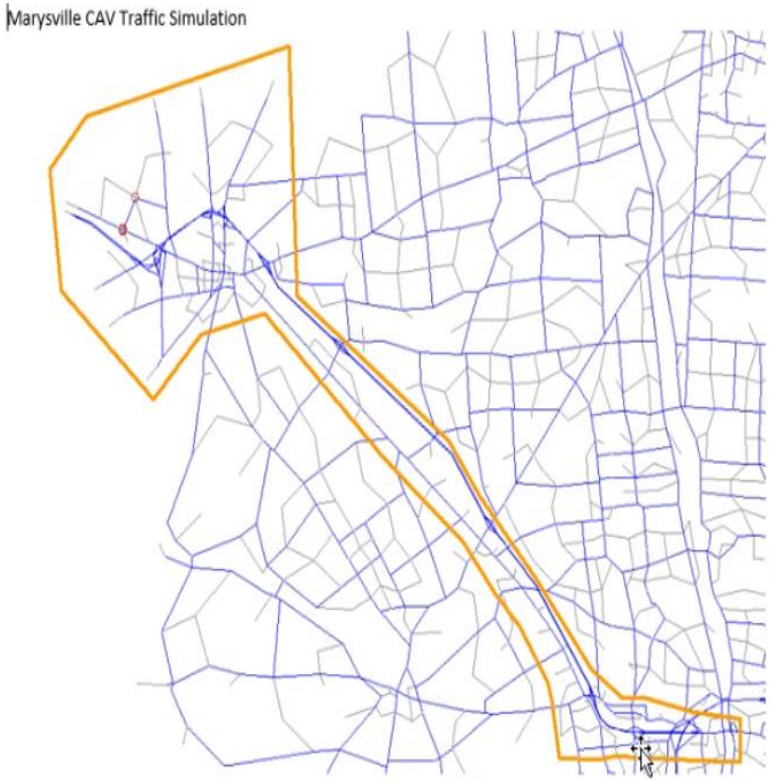
- Modeling in the Past:
  - Travel behavior and mode choice trends for next 20-30 years relatively stable
  - Model calibration calibrated w survey data and validated with existing mode usage
- With CAVs:
  - New modes
  - different behavior
  - different impacts

- Going forward: models need to be adjusted

US 33 Introduction

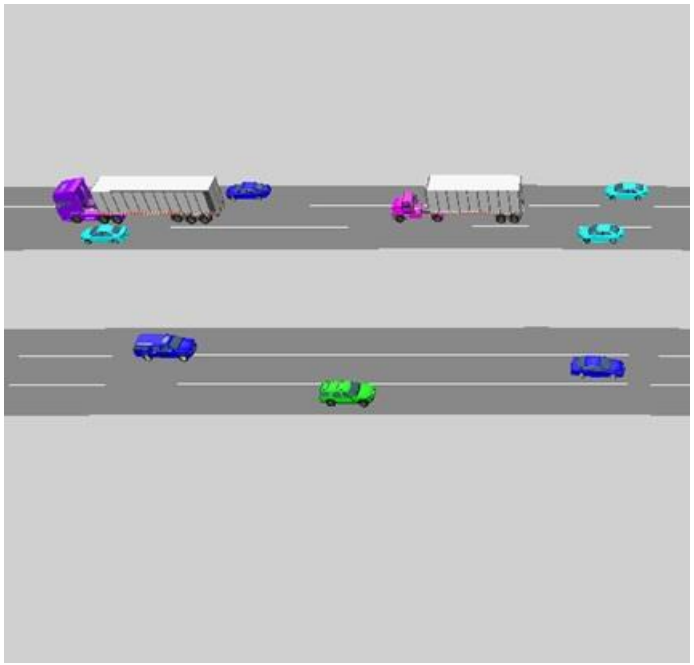
Ohio Corridor Studies – Statewide and Marysville





Traffic Simulation Modeling of CAVs

- TDM set up so that the market penetration level is an adjustable parameter.
- The simulation allows better testing of such key measures as capacity, car following and the interaction of CAVs and the existing traffic.
- Ohio DOT using Vissim and TransModeler as basis for simulating traffic.
  - Developing use cases and recommended model adjustments
  - Parameter Ranges



Simulation of AVs in Ohio

- *Vissim*
- Adjustments to internal parameters and Car Following made. Used in numerous CAV-related research studies.
- Marysville corridor

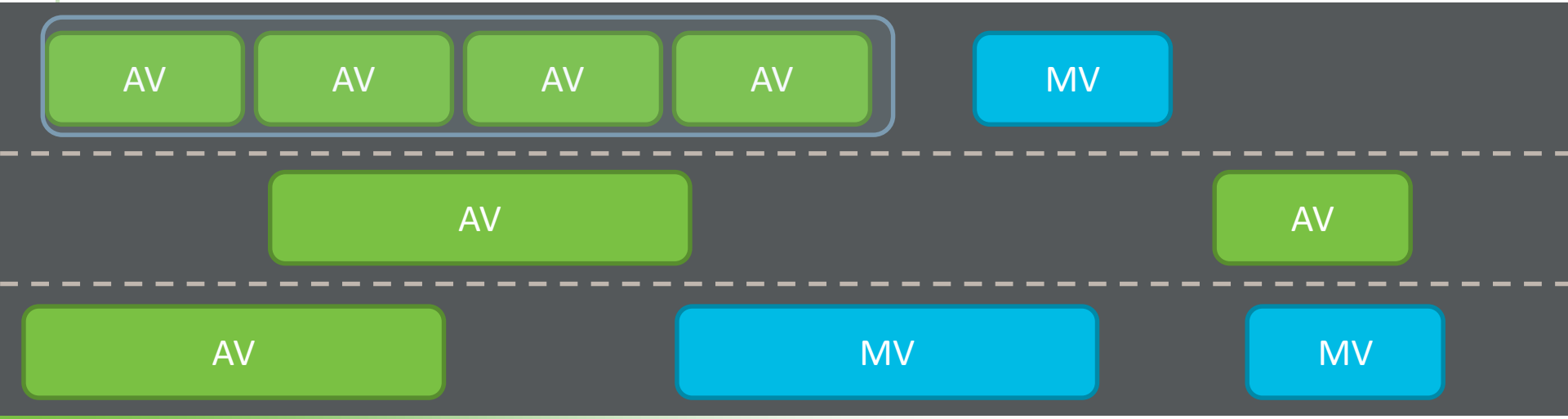
- *TransModeler*
- allows new vehicle classes equivalent to SAE levels. Used with adjustments documented in FHWA study
- Brent Spence Bridge

Incorporating CAVs into Supply Side

Changes in Driving Patterns:

- Different rules for merging
- Different rules for passing
- Adherence to speed limits
- Acceleration/deceleration
- Ability to form platoons
- Shorter headways
- Speed harmonization
- Remove human element from vehicle control

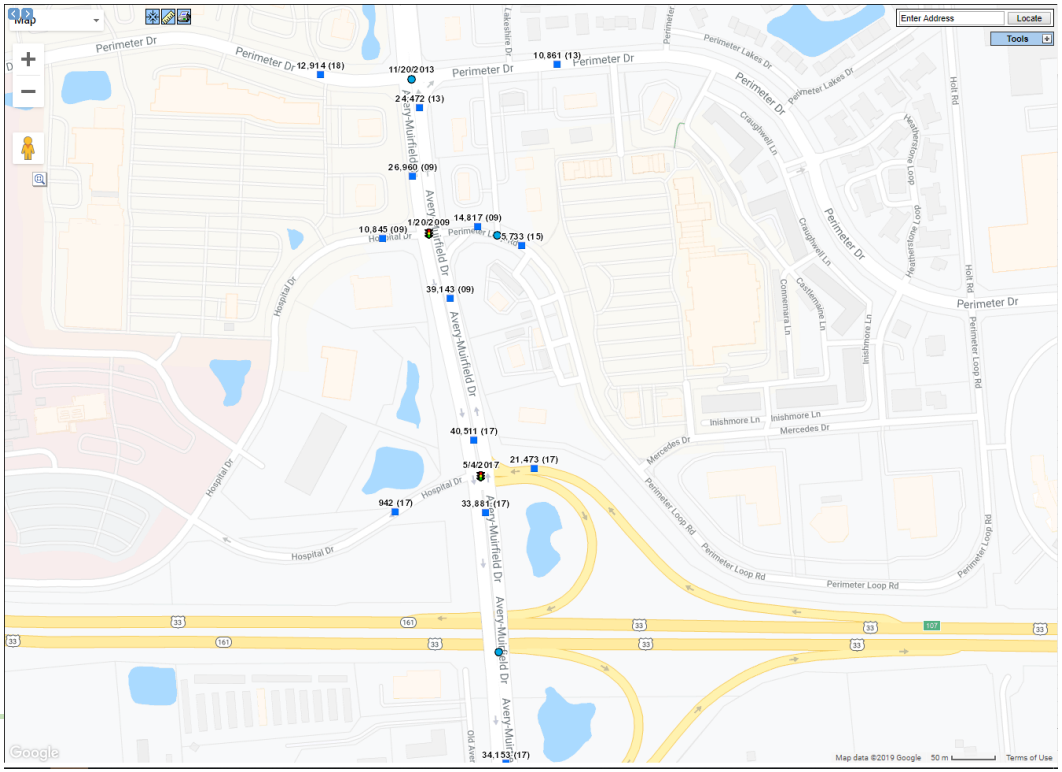
AV = automated MV = manual



Data Collection

Sources of Traffic Counts

- ODOT 2019 TMCs. Classified counts.
- ODOT and MORPC MS2 TMCs (one in Year 2009. Others 2013 or newer). Some are classified counts.
- ODOT MS2 AADT Counts (Most of them are in Year 2018). Classified counts.

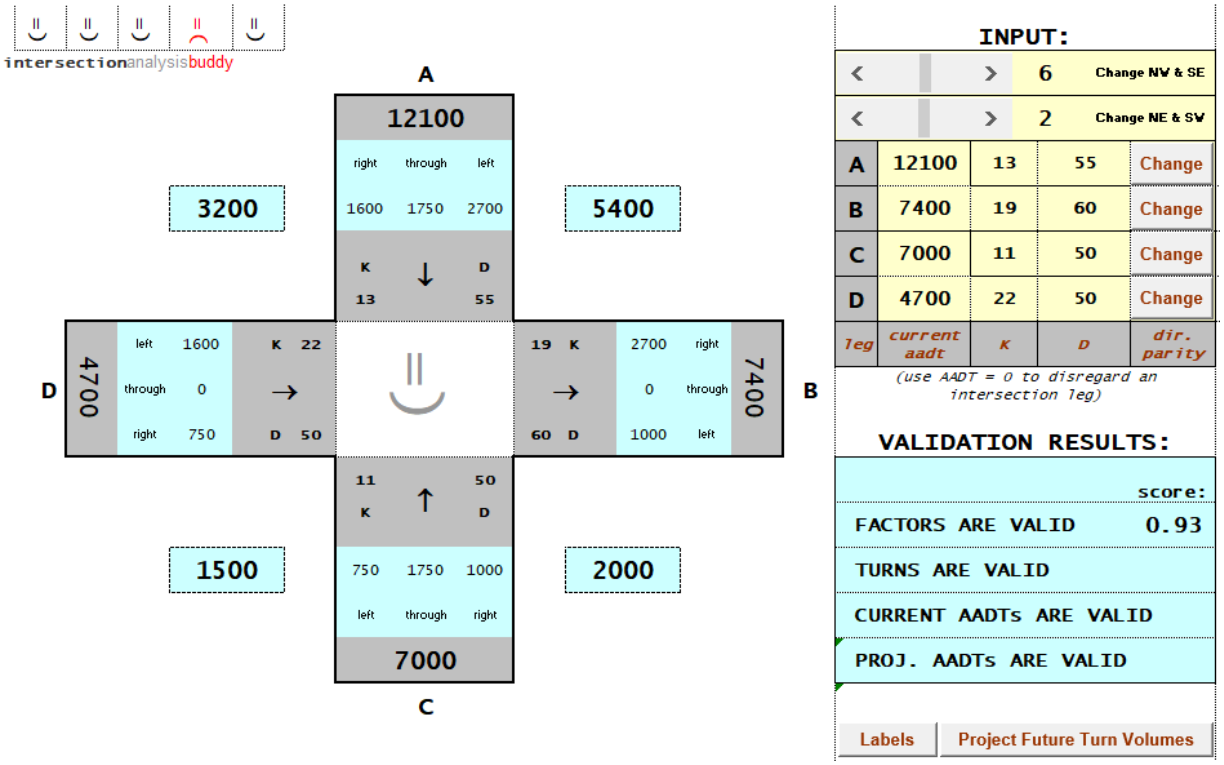


Processing Traffic Counts

- ODOT 2019 TMCs: Use the AM and PM peak hour volumes as they are
- MS2 TMCs: Identify the AM and PM peak hour volumes
- MS2 AADT Counts
  - Mainline and DCs: AADT * AM/PM % to derive AM and PM peak hour volumes
  - Ramps and intersections:
  1) Utilize the “Intersection Analysis Buddy” tool to develop turning movement AADT volumes
  2) AADT * AM/PM % to derive AM and PM turning movement volumes

Example of Intersection Analysis Buddy Tool

- Inputs: Two-way AADT, D-factor, K-factor, and peak direction
- Outputs: Balanced turning movement AADT volumes



Growing Past into Existing Year

- Annual growth rates (CAGRs) were calculated from historical traffic counts from ODOT MS2
- CAGRs were averaged for four geographical areas
  - Dublin,
  - Between Dublin and Marysville,
  - Marysville,
  - West of Marysville by US 33
- Existing Year Volume =

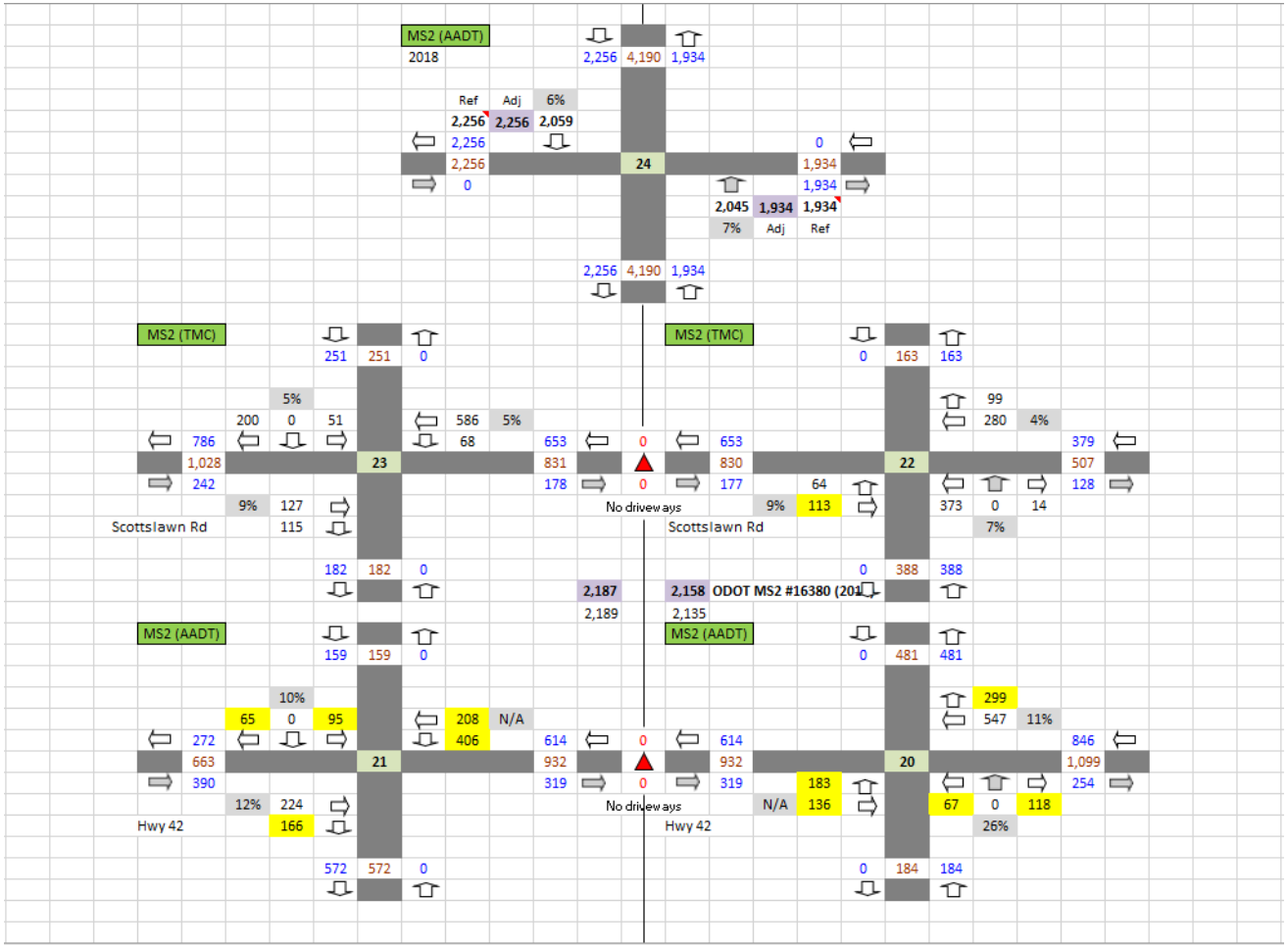
  Historical Volume * (1+CAGR)^(# of Years)

Volume Balancing

- Volume balancing was carried out along US 33 Mainline and intersections involving US 33
- Establish reference points along US 33
- AM/PM turning movement volumes from MS2 AADT counts were the targets for adjustment
- HDR to adjust balancing for other local streets if needed

Volume Balancing Example

- Cells highlighted in yellow indicated adjusted volumes



Existing Daily Volumes

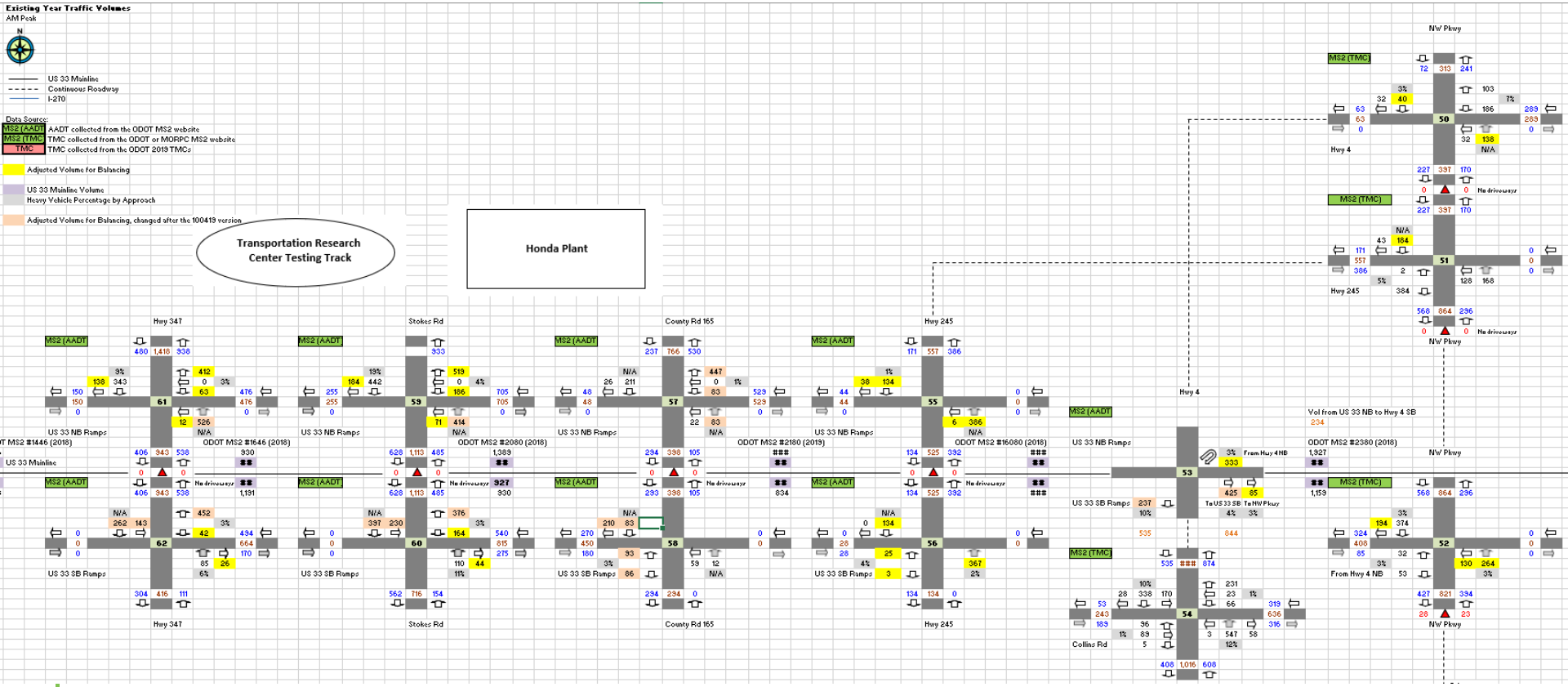
- Identified for US 33 Mainline and intersection approaches
- AADT from MS2 where available
- Same as AM and PM volumes,

  Existing Year AADT =

  Historical AADT * (1+CAGR)^(# of Years)

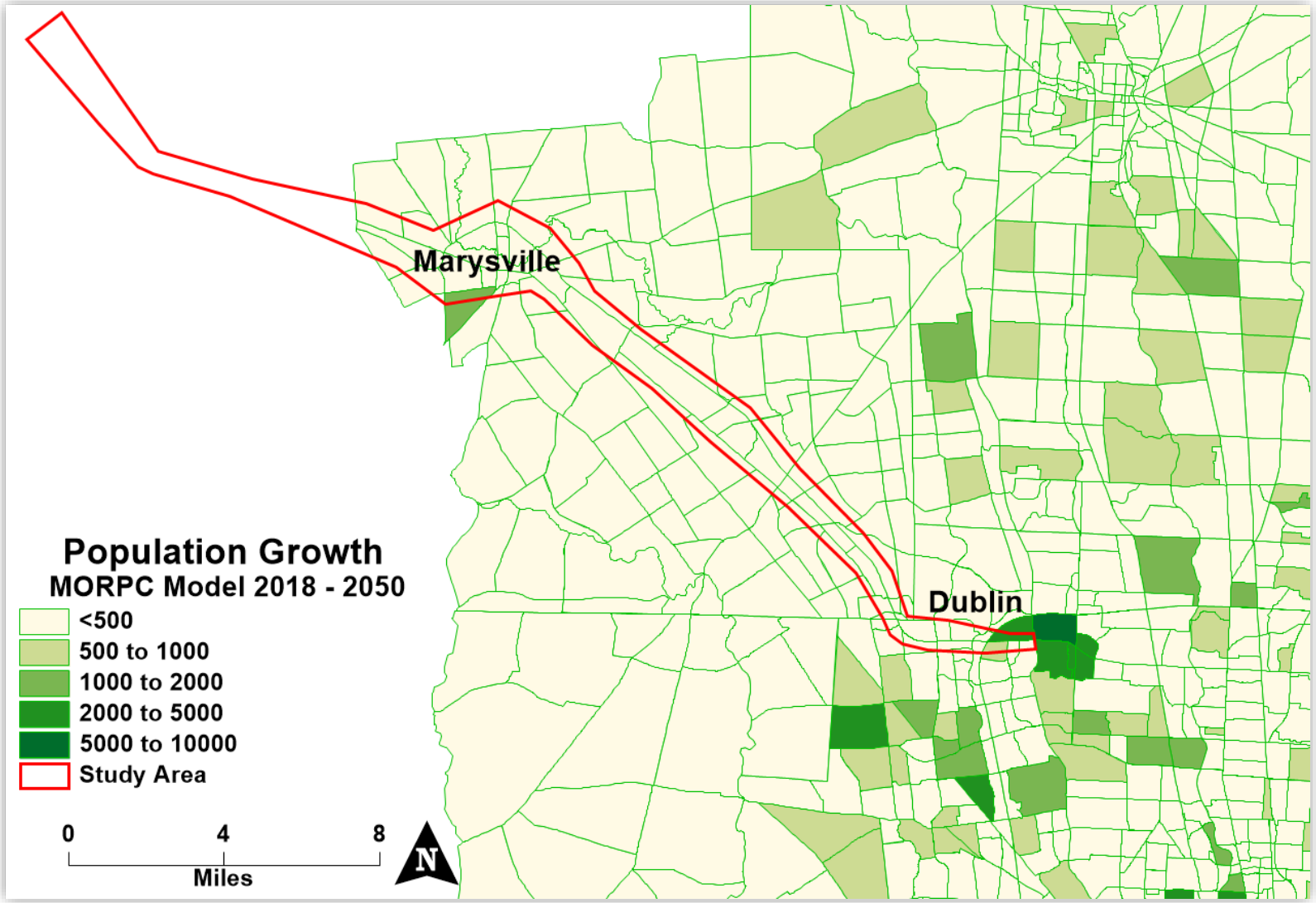
Delivered Volume Spreadsheet

- Existing AM and PM peak hour mainline and turning movement volumes
- Existing daily mainline and intersection approach volumes



Corridor Impacts

MORPC Model Socioeconomic Data



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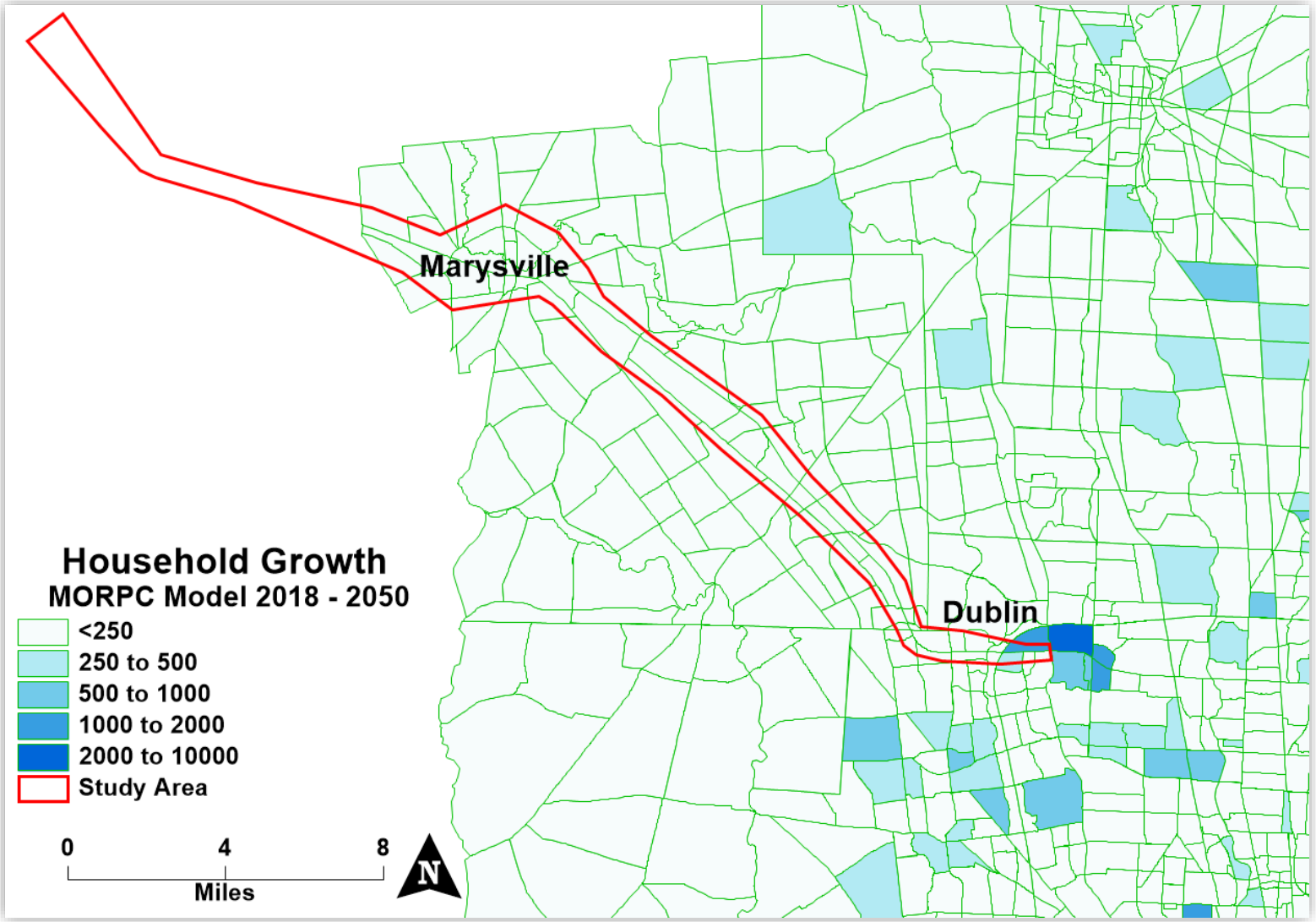

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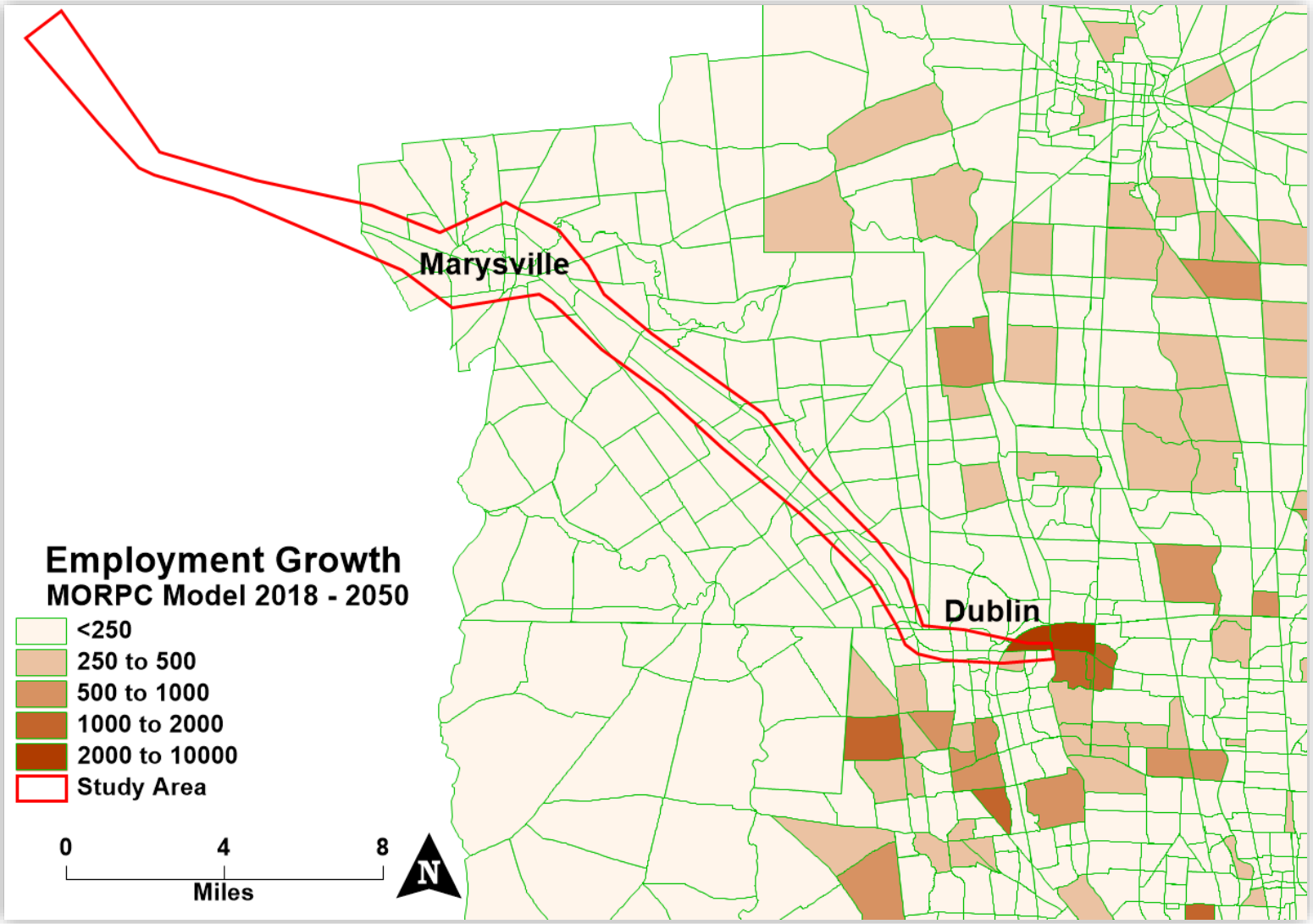


MORPC Model Socioeconomic Data

- As the three maps show, within the Study Area, population, household and employment are all showing light growth from 2018 to 2050.

- In the scenario where this study corridor is upgraded to an enhanced CAV corridor, more growth in population, household and employment should be expected.

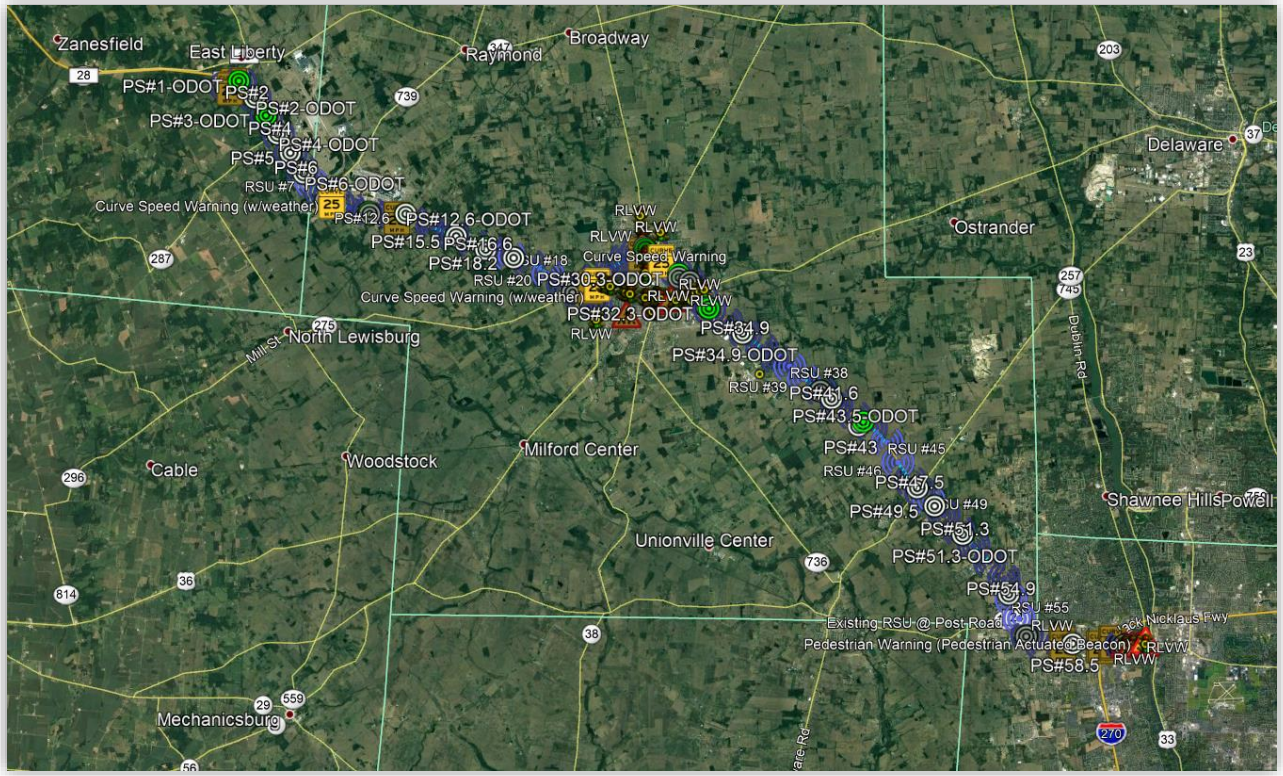
Parallel Studies

- USR 33 Corridor Study
  - Develop a 20-year long range project-based plan looking at access to/from U. S. Route 33 from State Route 274 (west of the City of Bellefontaine) to State Route 161 (the City of Dublin).
  - The plan will look at current and future land use and traffic volumes within a five mile buffer of US-33 in rural areas, and within a one mile buffer in incorporated areas.

Parallel Studies

- Ohio's 33 Smart Mobility Corridor

  https://www.33smartcorridor.com/



Existing and Proposed Smart Infrastructures

Base Year Simulation

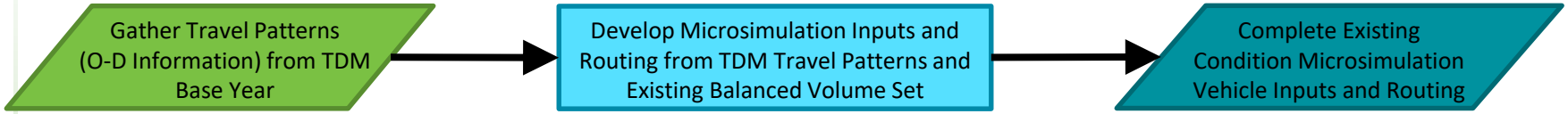
Base Year Model Development

- Base model complete – includes geometry, signal info, traffic data and other info.
- Validation under way
  - Need MORPC study area expansion volumes andselect links for OD review
- CAV customization
  - Adding platoon logic
  - Future may include dynamic elements
    - Speed zones
    - Conflict areas that activate on vehicle to infrastructure messaging

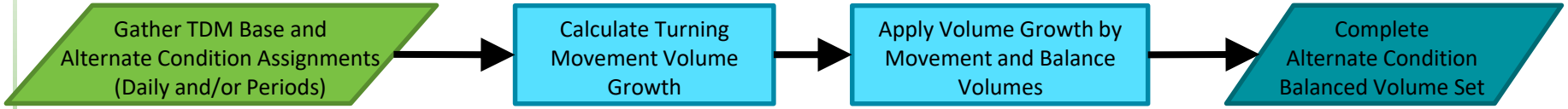
Steps to Develop Microsimulation Model Vehicle Inputs and Routing

1. Develop Existing Condition Balanced Turning Movement Volumes

2. Develop Existing Condition Microsimulation Vehicle Inputs and Routing

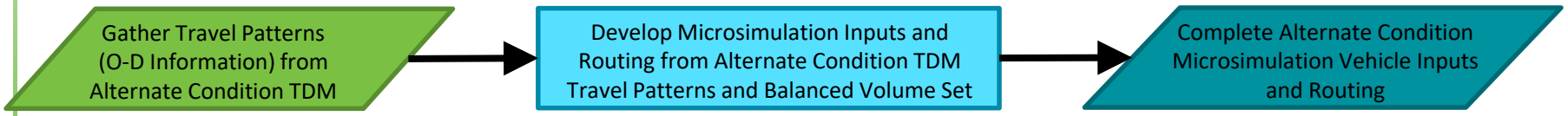


3. Develop Alternate Condition (Future Year, Geometric Variant, CAV Adoption, etc.) Turning Movement Volumes



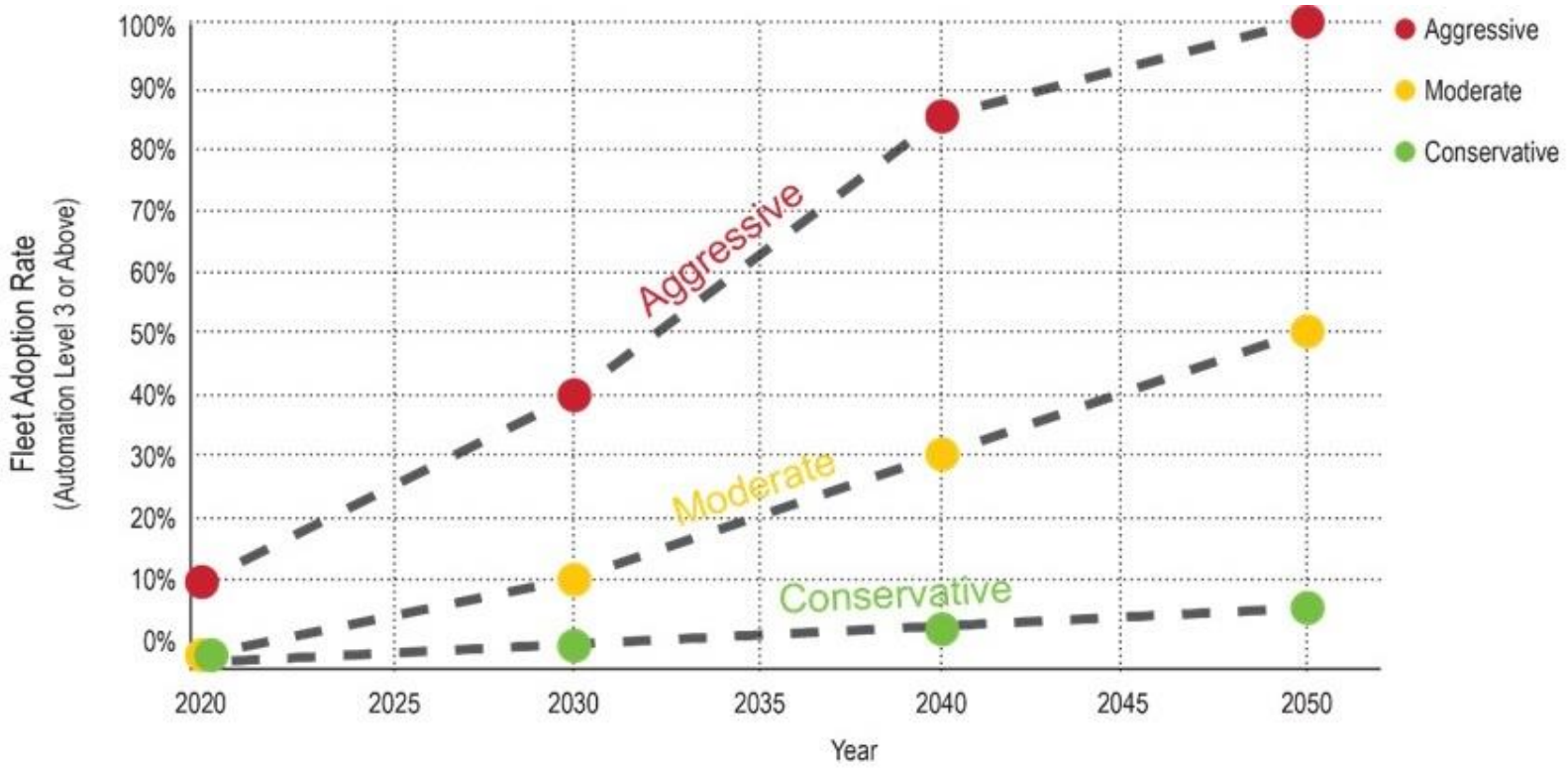
See Ohio Traffic Forecasting Manual for Process

4. Develop Alternate Condition Microsimulation Vehicle Inputs and Routing



Marysville CAV Scenarios

AV Adoption Rate Scenarios



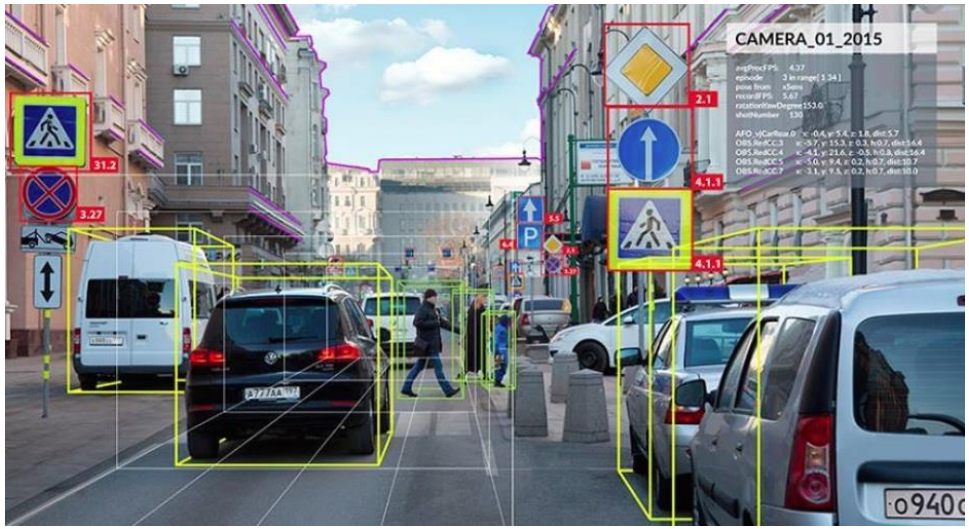
Source: HDR

Refining and Using CAV Scenarios

- *Involve* stakeholders in review and detailed definitions of scenarios
- *Include* demographic parameters to help define plausible futures, e.g.
  - Population changes
  - Residential and land use changes
  - Regional economics and job locations
- *Define* measures to use in analyzing scenarios, e.g.
  - Vehicle Miles Traveled (VMT)
  - Vehicle Hours Traveled (VHT)
  - Cost of transportation
  - Equity impacts
- *Use* TDMs and simulation models to produce output.

Connected and Automated Vehicle Capabilities

Autonomous Vehicle Capabilities	Connected Vehicle Capabilities	Combined Capabilities
Advanced Lane Detection	Dynamic Route Guidance	Modular Lanes
Adaptive Cruise Control with Steering Assist	V2V Basic Safety Messages	Cooperative Adaptive Cruise Control
Automated Emergency Braking	Queue Warning	Speed Harmonization



Societal Trends Driving Uncertainty

Changing Demographics	Improved Technology	Shifting User Preferences	Improved Travel Options
• Millennial travel behavior • Aging population • Generation Z	• Automated vehicles • EVs • Workplace automation • Improved user information & navigation • Smart City	• Urbanization • Shift from individual ownership to fleet ownership • Telecommuting • E-commerce & delivery options	• Better walking and biking options • Improved public transit • Shared mobility

Recommended Scenarios

Scenario	Target Year	Penetration Rate	SAE Level 3 Rate	SAE Level 4-5 Rate
Pilots proliferate	2025	5%	4%	1%
Private AVs	2030	10%	6%	4%
Shared and private AVs	2035	20%	10%	10%
More AVs, some Level 5	2040	50%	25%	25%
More MAAS and more Level 5	2045	80%	16%	64%
More Level 5	2045	100%	10%	90%
No more Manual Vehicles	2050	100%	5%	95%
Widespread MAAS	2050	100%	0%	100%

Source: CDM Smith

Example of CAV Scenario at 20%

- HDR_Past_CAV_Microsimulation_Experience.pptx

Team Members/Next Steps

ODOT CAV US 33 Simulation Team

- CDM Smith team included:
  - Rob Bostrom, CDMS - PM
  - Boyang Zhang, CDMS – Simulation, SE Data
  - Szu-Han Chen, CDMS – Data Collection
  - Marwan Madi, CDMS – Scenarios
  - Negaar Minaei, CDMS – TDM Runs
  - Jon Markt, HDR - Simulation
  - Matt Selhorst HDR - Simulation
  - Zhoujun Jiang, MORPC – TDM Runs
  - WSP – TDM Runs
  - Drive Ohio – Scenarios
- ODOT PM – Rebekah Anderson

Next Steps

- Current task order
  - Finish BY model
  - Fine tune scenarios
  - Possible SE changes due to CAV in study area
  - Run one scenario for testing purposes
  - Document results
- Next task order
  - Run scenarios
  - Document results

Contact Information

- Rob Bostrom, CDM Smith, Bostromnr@cdmsmith.com, mobile: 859.312.2232

QUESTIONS?