

Empirical Monitoring of Vehicle Miles Traveled Using Available Bus-mounted Camera Video Imagery before and during the Covid-19 Pandemic

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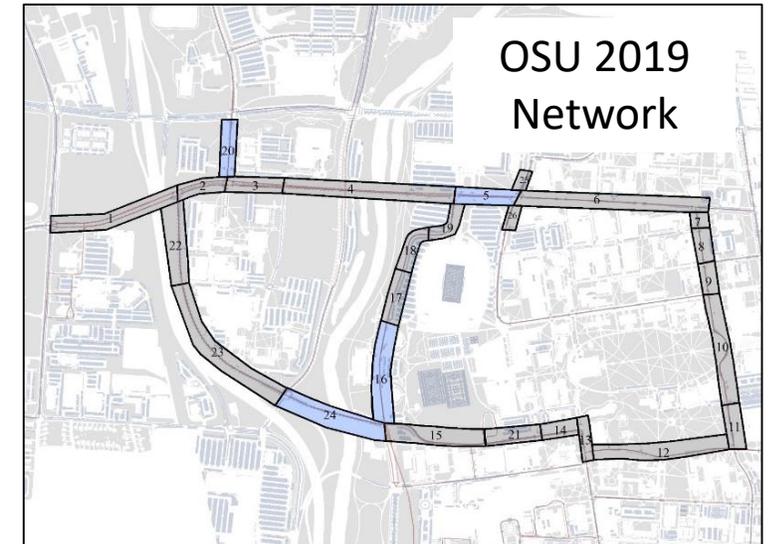
Ohio Transportation Engineering Conference
Columbus, OH

October 26-27, 2021

McCord, Mishalani, Ferzli and Shah
OTEC 2021

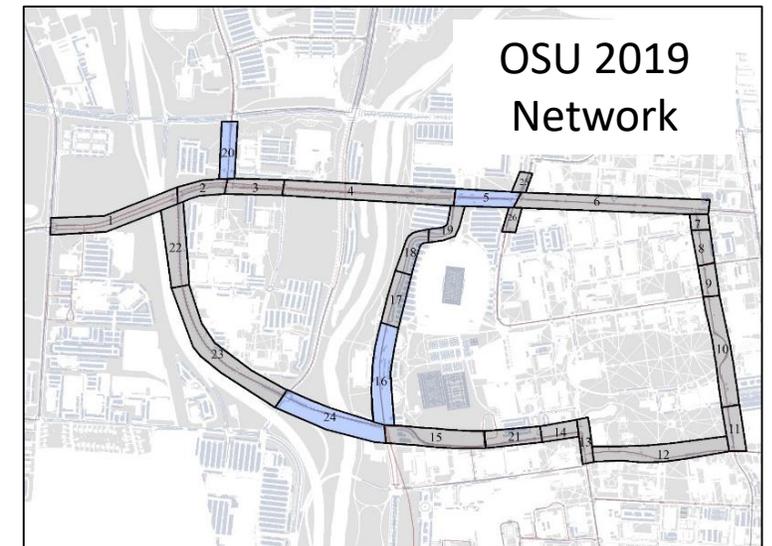
Vehicle Miles Traveled – VMT

- Most common metric of network-wide travel over a time period
- Used for a variety of monitoring and policy purposes



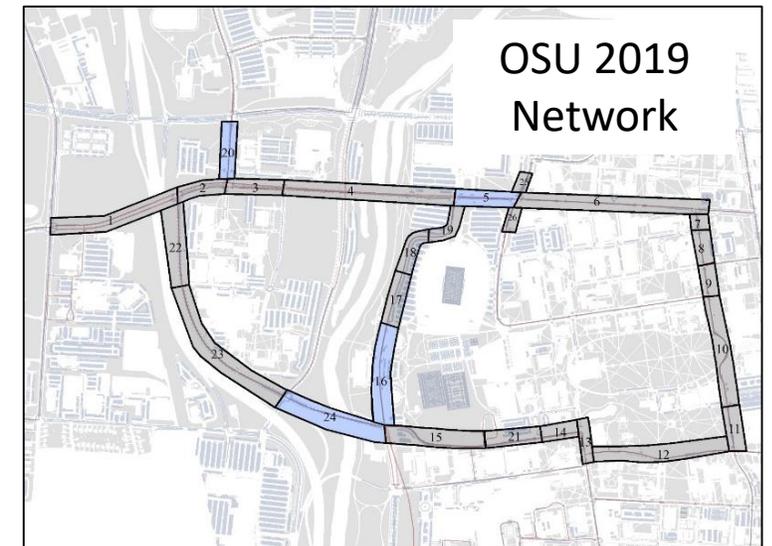
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- Defined as
Sum, over all vehicles, miles traveled by the vehicle on the defined network, during the specified time period



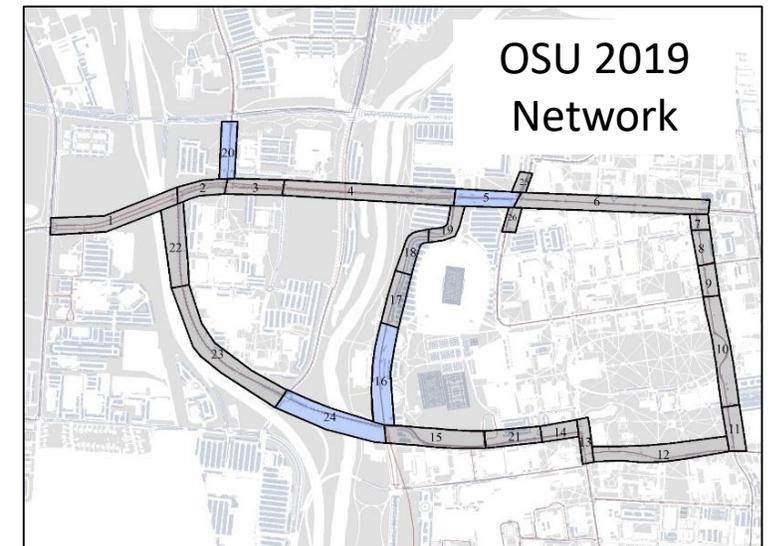
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 - Sum, over all vehicles, miles traveled by the vehicle on the defined network, during the specified time period*
- Usually calculated as mathematical equivalent
 - Sum, over all segments of the defined network, segment length times segment vehicle volume during the specified time period*



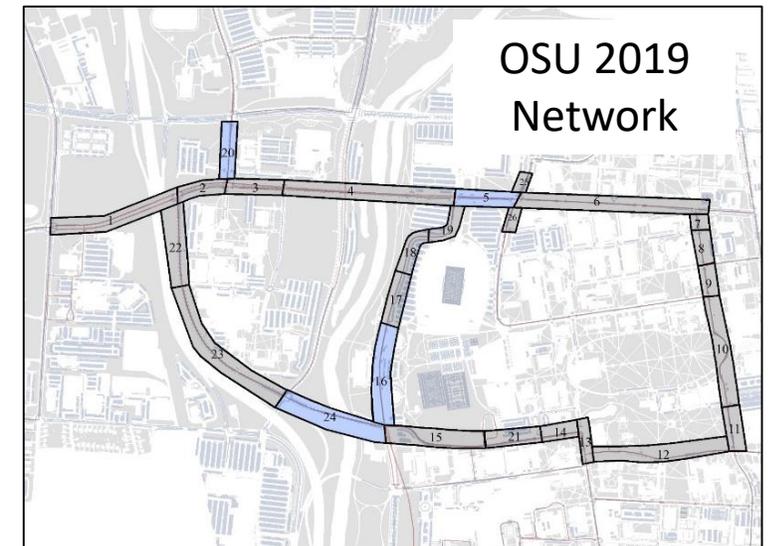
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 - Segment lengths: Straightforward (e.g., GIS)
 - Segment volumes: Traditionally from traffic counts



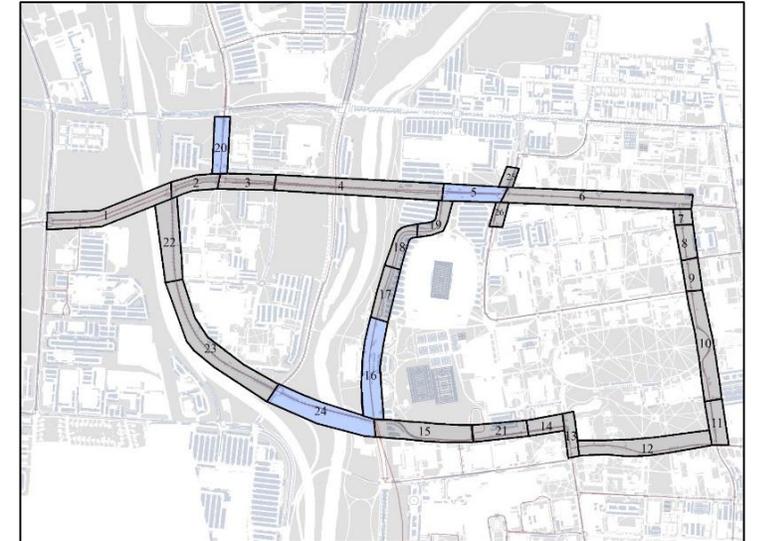
Segment Volumes from Traffic Counts: Traditional

- Volume: Number of vehicles that pass a point on roadway segment over time
- Traditional approach: Go to a point on the roadway, “stay there,” and count

Manual Counting



Road Tubes

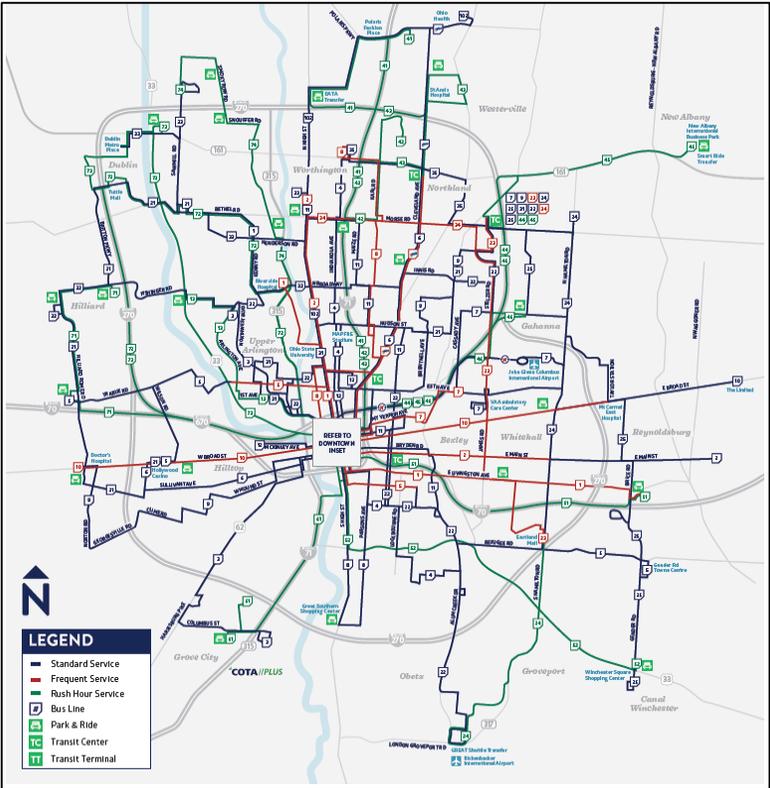


Traditional traffic studies obtain data to estimate traffic volumes over long time durations but only at *limited locations* and on an *infrequent basis*

Segment Volumes from Traffic Counts: Innovative Approach

Transit buses cover major roadways *across the urban network on a regular, repeated, and ongoing basis*

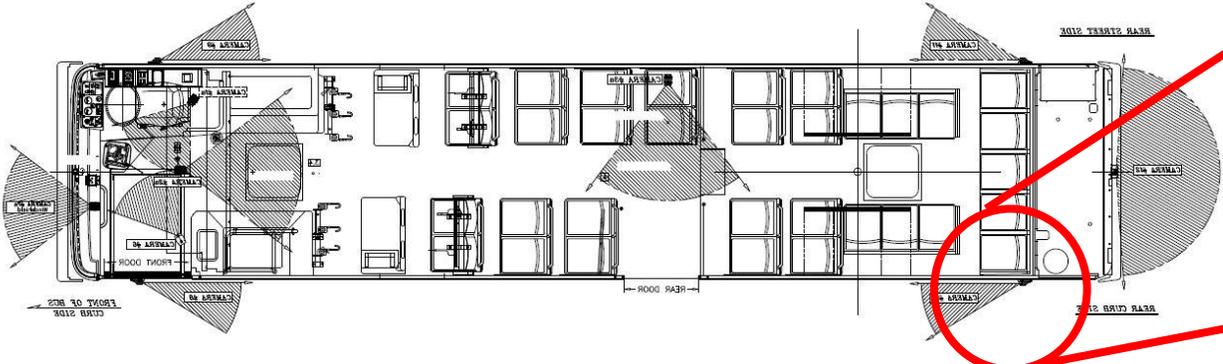
Central Ohio Transit Authority Route Map



Segment Volumes from Traffic Counts: Innovative Approach (cont.)

Transit buses are increasingly being equipped with video cameras for safety, security, and liability (i.e., *other*) purposes

CABS buses



Rear, road-side view camera



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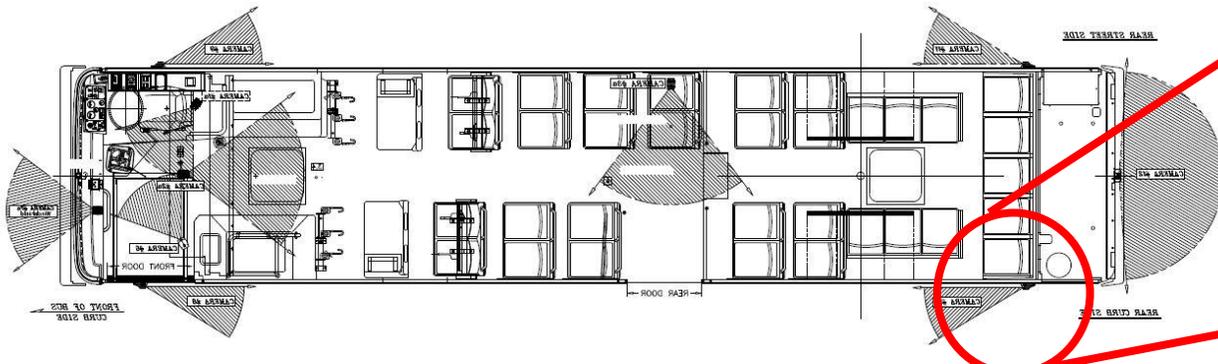
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Segment Volumes from Traffic Counts: Innovative Approach (cont.)

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Rear, road-side view camera



Exploit *available* video imagery and *repeated, ongoing coverage* of transit buses in regular service to estimate traffic volumes on major roadways across *spatially extensive* urban network



Segment Volumes from Traffic Counts: Innovative Approach (cont.)

- Step 0: Convert imagery to digital information

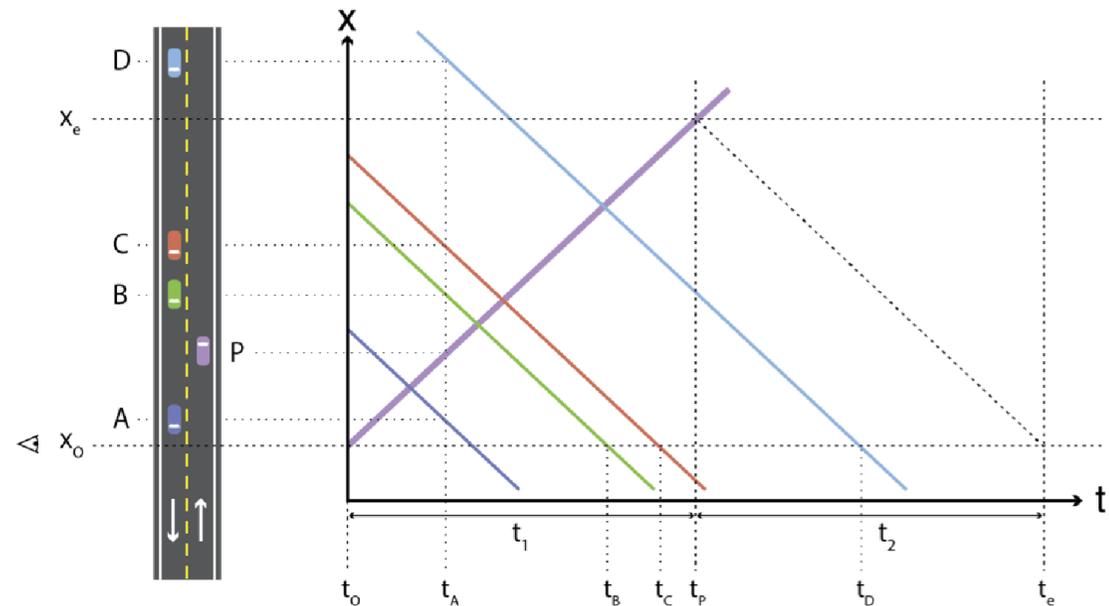
Developed MATLAB-based GUI to digitize vehicle observations, locations, and passage times



Segment Volumes from Traffic Counts: Innovative Approach (cont.)

- Step 0: Convert imagery to digital information
- Step 1: Estimate volume from an individual bus pass over the segment

Developed method to estimate volumes from “moving observers”

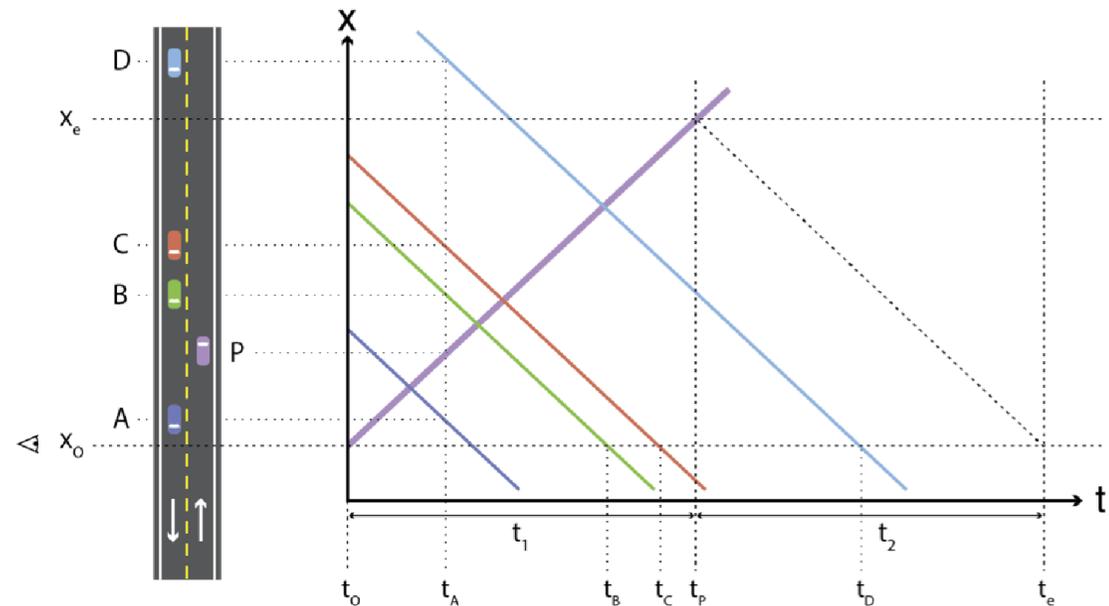


$$\text{Bus pass volume} = n^{veh} / (t_1 + t_2)$$

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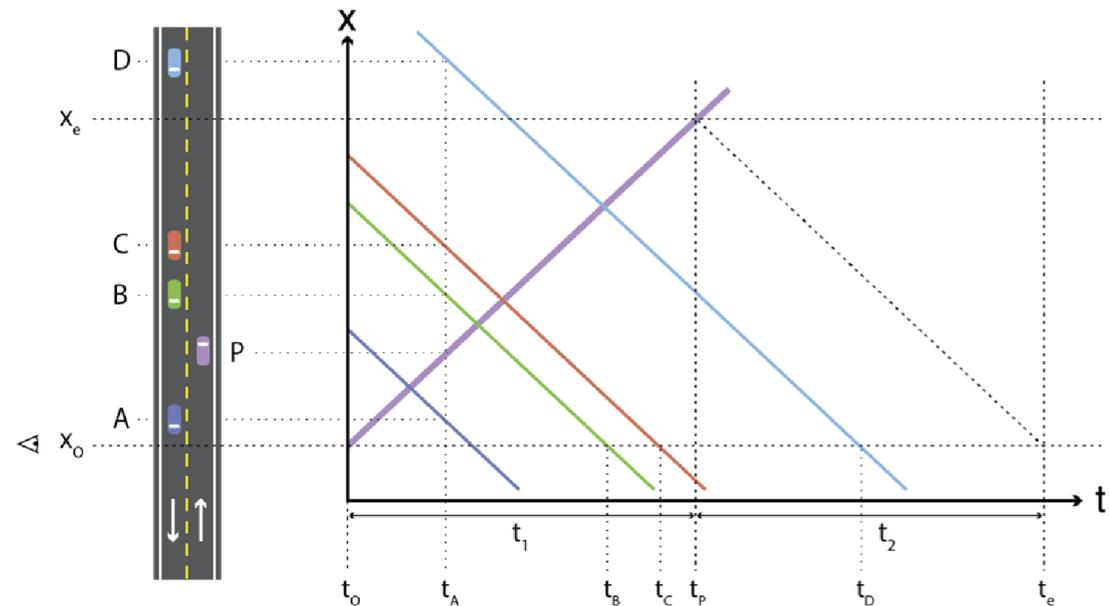
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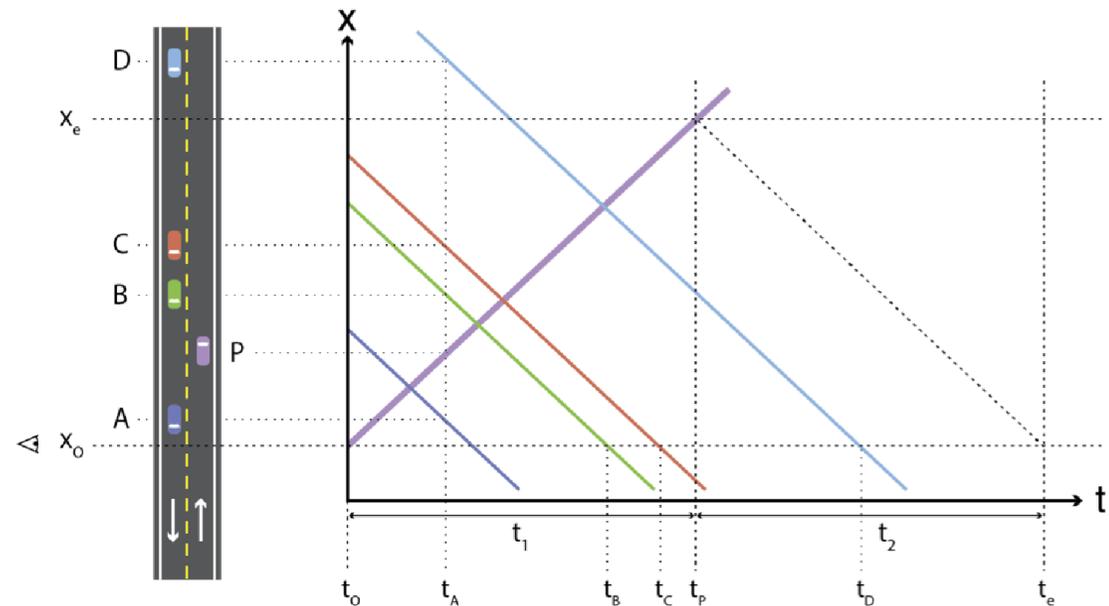
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Validation studies indicate that method can presently be used with relative confidence

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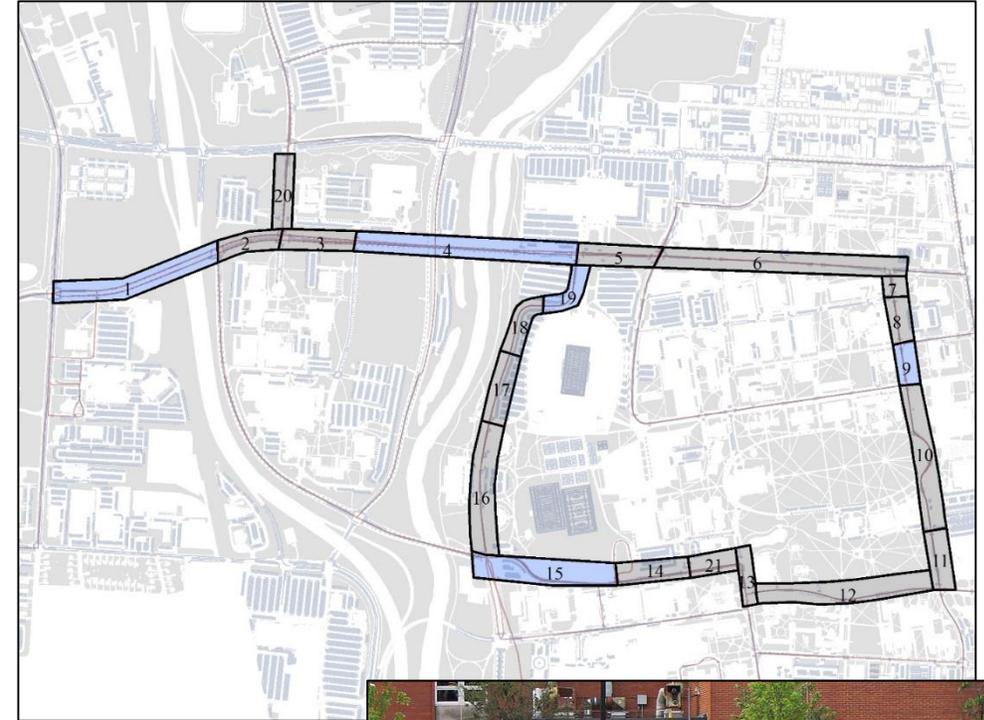


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Empirical Validation Studies

OSU 2018 Network

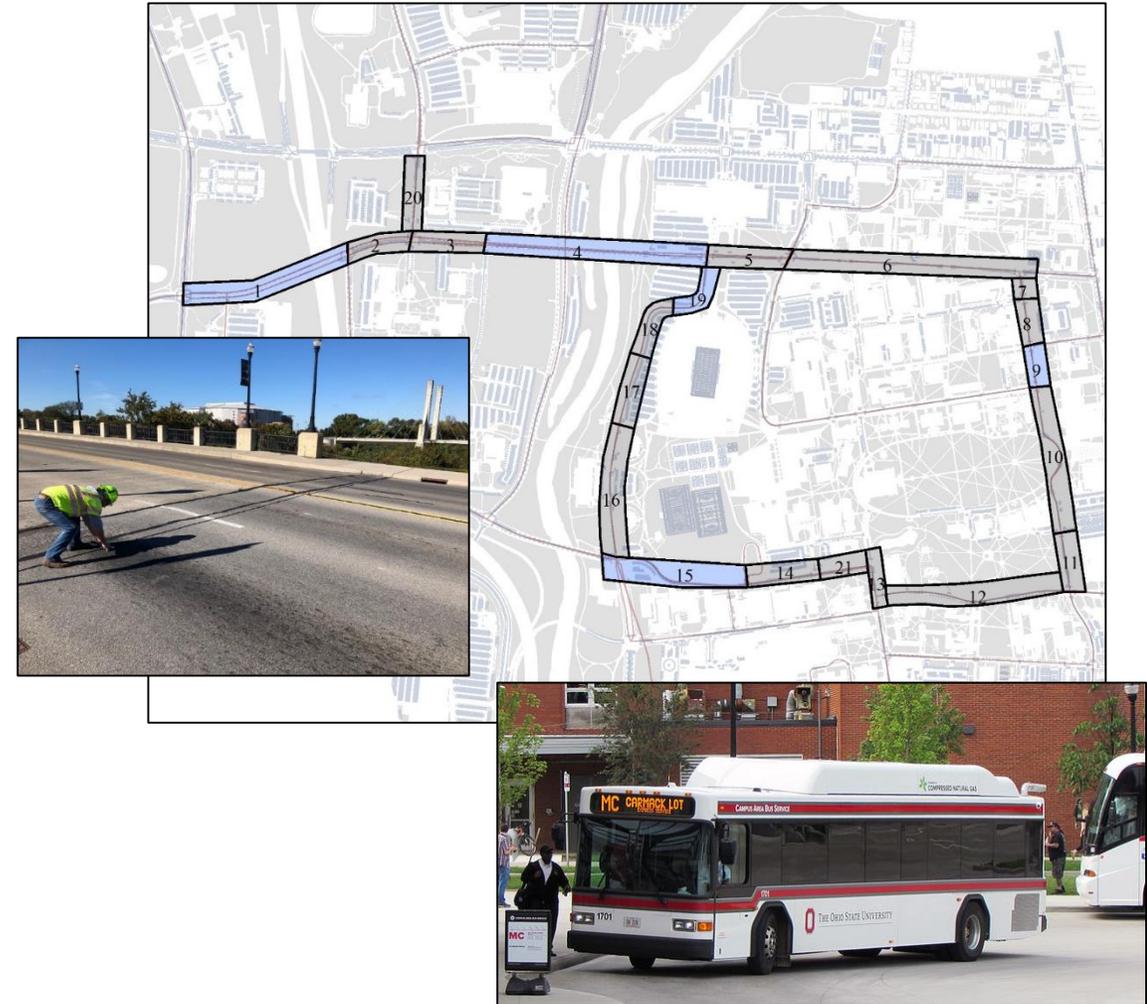
- OSU CABS video imagery across network from OSU CABS buses in regular service: Process into video-based volumes



Empirical Validation Studies (cont.)

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- MORPC road tube counts on subset of segments at same times: Process into traditional volumes during same time periods



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- Manual (student) traffic coverage counts at same times: Process into traditional volumes during same time periods



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- Compare video-based vs. traditional volumes



Validation Study Results

- VMT calculated across road tube segments from
 - Bus-based video volumes
 - Road tube volumes
 - Vendor volumes
- OSU campus
- Thursday end of October, beginning of November (classes in session)
- Volumes
 - From 7:00 am to 7:00 pm
 - Only considered segment-directions with road tubes (segments varied by year)

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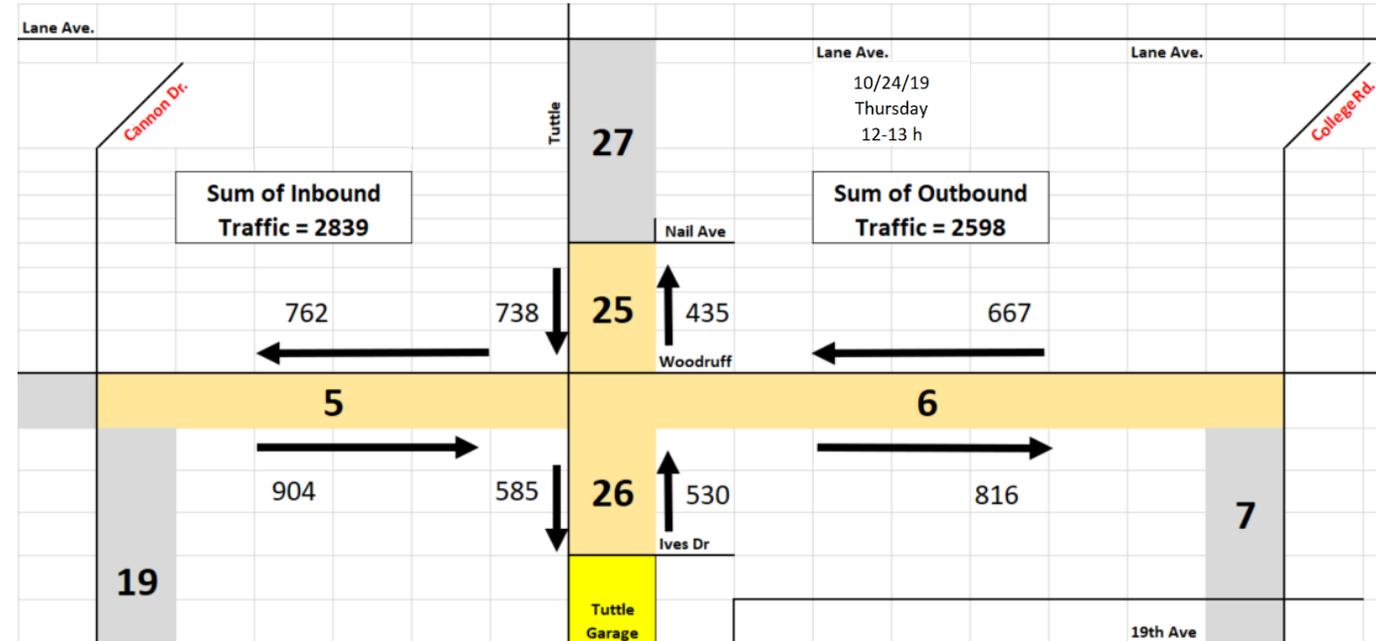
Year	No. Seg-Dir Considered	VMT* [miles]			Relative Error**	
		Tube	Video	Vendor	Video	Vendor
2018	10	9,221	9,498	15,899	3%	72%
2019	8	6,127	6,920	8,429	13%	38%
2020	10	5,909	6,256	12,919	6%	119%

*Different segments are considered in different years; one cannot compare VMT across years

**Compared to tube-based VMT

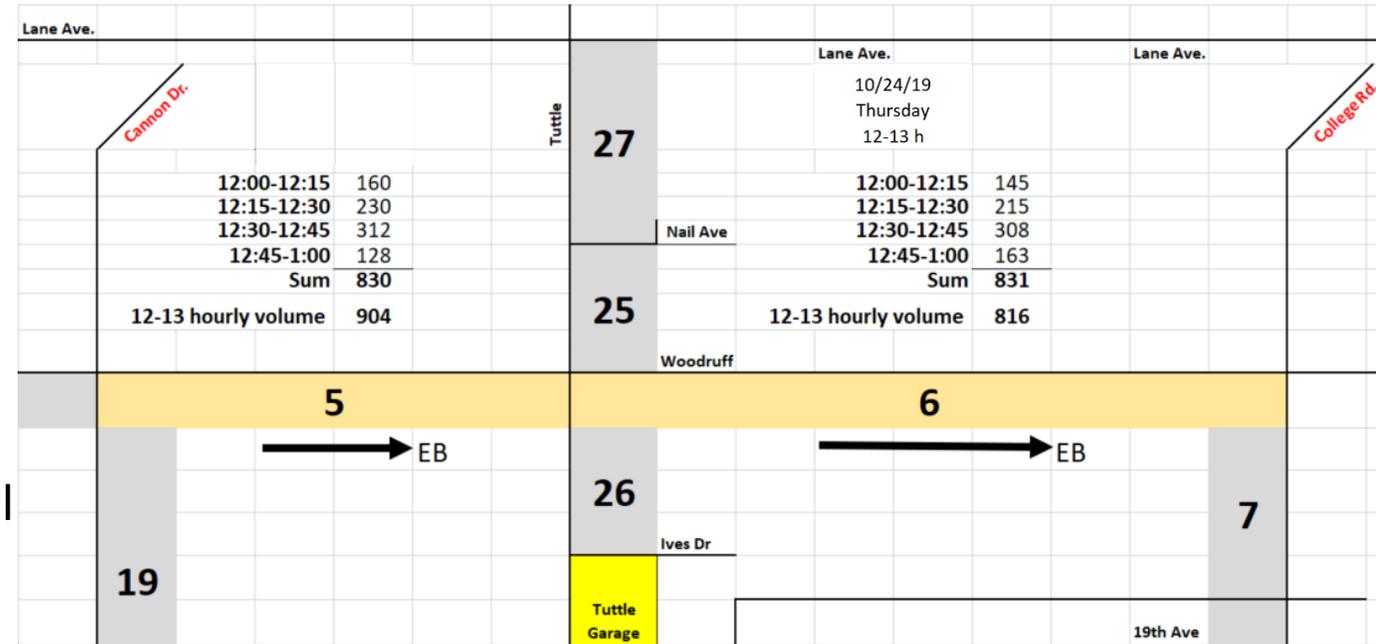
Probing the Vendor Data (as an aside)

- Intersection Volumes
 - Hourly volumes in to and out of intersection are not equal
 - Average Relative Error
 - 2.7% (10/24/19, 8-18 h)
 - Seems reasonable “for data”



Probing the Vendor Data (as an aside) (cont.)

- Intersection Volumes
 - Hourly volumes in to and out of intersection are not equal
 - Average Relative Error
 - 2.7% (10/24/19, 8-18 h)
 - Seems reasonable “for data”
- Volume Summation
 - Sums of 15-minute volumes do not equal hourly volumes
 - Again, differences only a few %
 - Sums of hourly volumes equal 10-hour volumes



Probing the Vendor Data (as an aside) (cont.)

- Intersection Volumes
- Volume Summation

*Differences too small to explain large Relative Errors with tube data
(further exploration ongoing)*

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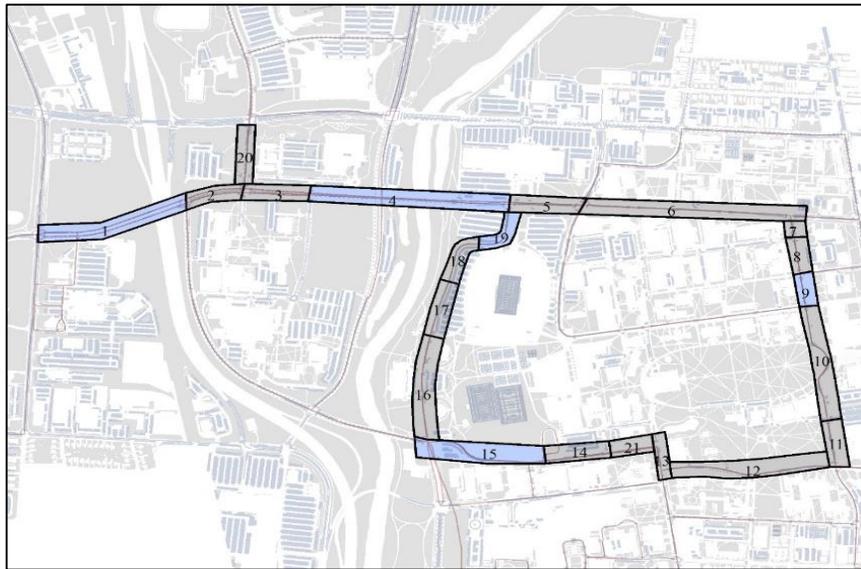
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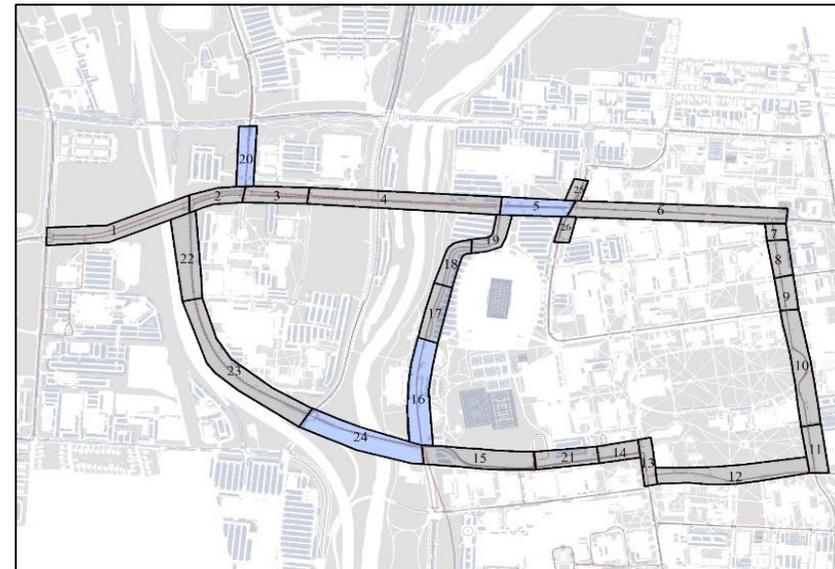
- VMT calculated on extended OSU networks from
 - Bus-based video volumes
 - Traditional control (tube) and coverage (manual) counts
- Thursday end of October 2018, 2019 (classes in session)

2018 Network



7:00-19:00

2019 Network



8:00-18:00

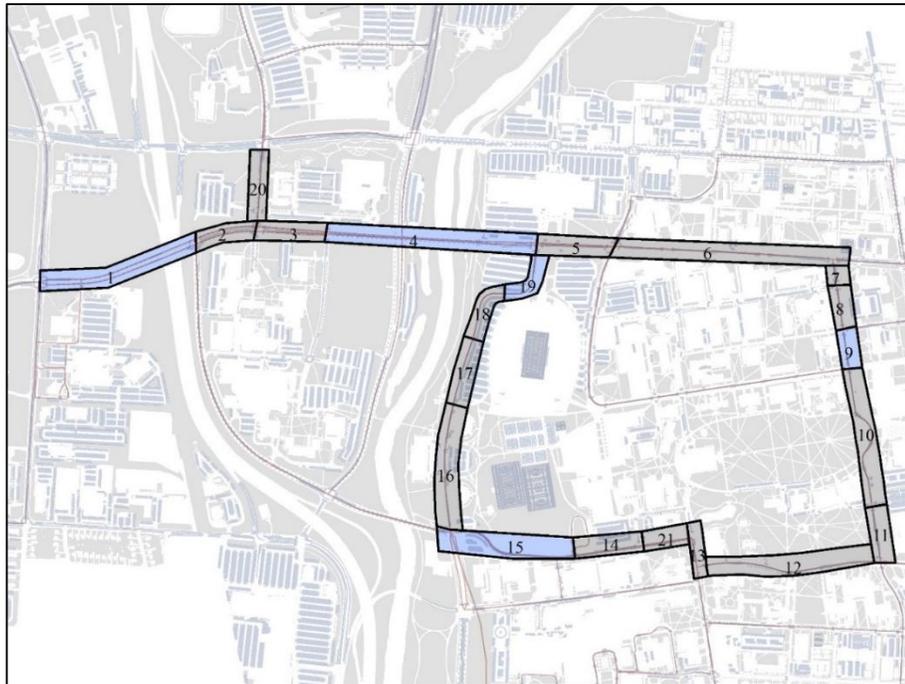
Validation Study Results (cont.)

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Year	Roadway Dir-Miles	Time of Day	Vehicles Miles Traveled		Rel. Error Video to Average Trad'l
			Video	Trad: Avg, [Range]	
2018	6.3	7:00-19:00	23,554	22,589 [20,568, 25,709]	4%
2019	8.0	8:00-18:00	19,130	18,182 [15,792, 19,532]	5%

Annual VMT Monitoring from Bus-based Video Volumes

OSU 2018 Network

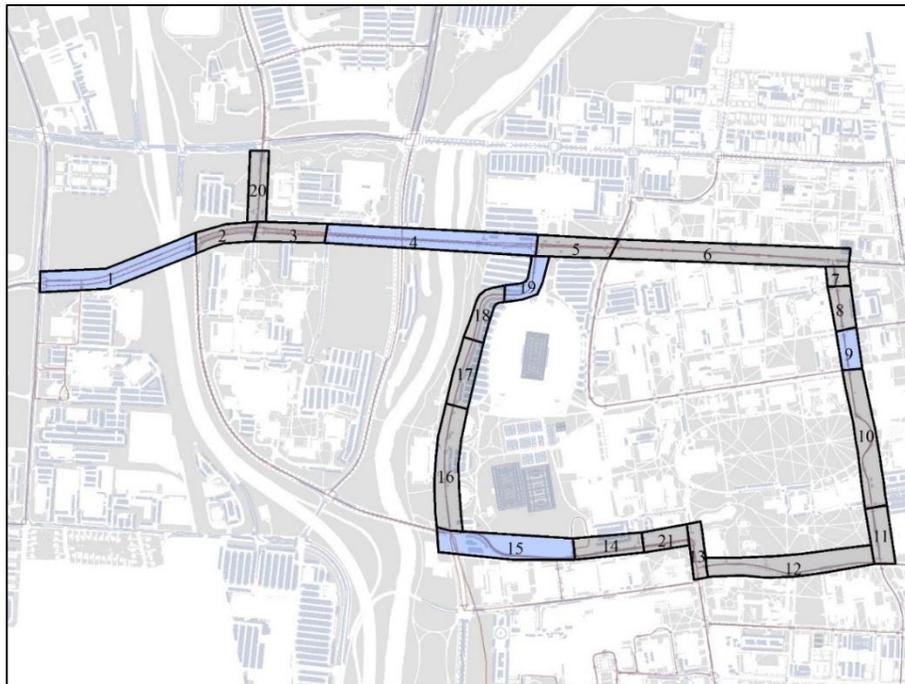


8:00-18:00

- Common network (2018)
- Common time: 8:00-18:00
- Common day: Thursday, end of October (2018, 2019), beginning of November (2020)

Annual VMT Monitoring from Bus-based Video Volumes (cont.)

OSU 2018 Network



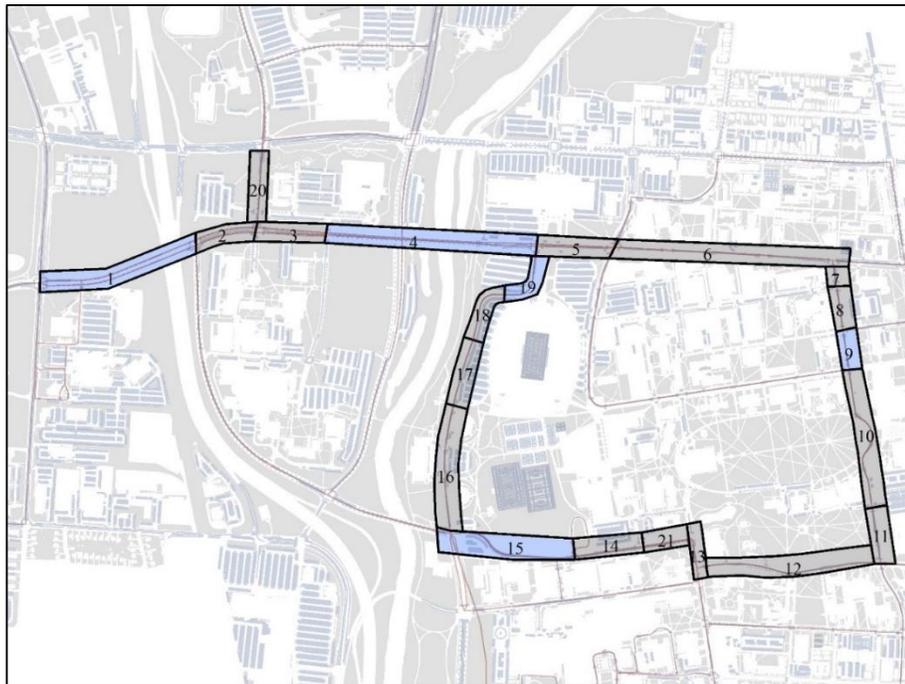
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Vehicle Miles Traveled

2018	2019	2020
19,586	19,130	9,255

Annual VMT Monitoring from Bus-based Video Volumes (cont.)

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G.F.¹		0.98	0.48
ODOT G.F.²		1.015	0.902

¹Growth Factor

²ODOT/Technical Services/Traffic Monitoring/Annual Adjustment; Urban collectors/local

Annual VMT Monitoring from Bus-based Video Volumes (cont.)

2018-2019: Steady traffic

- Reasonable: No change in campus policies or external events
- Consistent with ODOT factor

2019-2020: Noticeable traffic decrease

- Reasonable: Pandemic, Online classes
- Larger decrease than ODOT factor; Consistent with COTA OD drops to OSU (see previous presentation)

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Conclusions

- Using bus video imagery to determine volumes for VMT estimation
 - Appears fairly accurate compared to traditional approach
 - Appears more accurate than “vendor” data at this time

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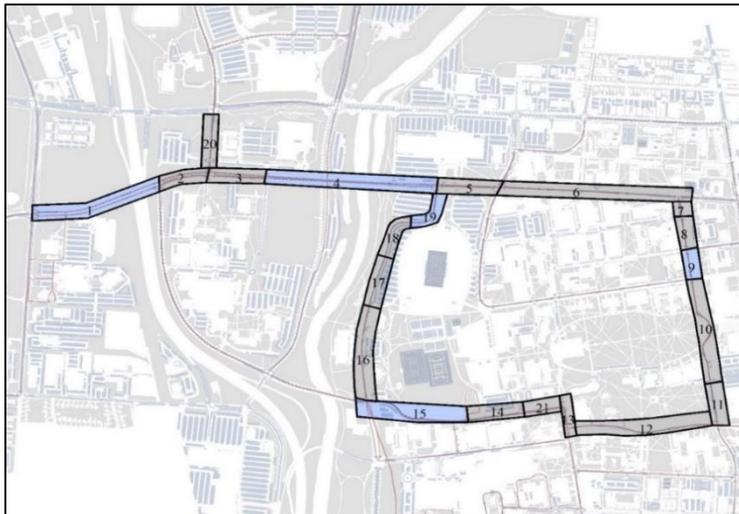
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 - Data are available, coverage is extensive, but processing is presently labor intensive
- OSU VMT changes over time
 - Appears to be “typical” pre-pandemic
 - Affected more by pandemic than roadways seen in ODOT traffic monitoring efforts

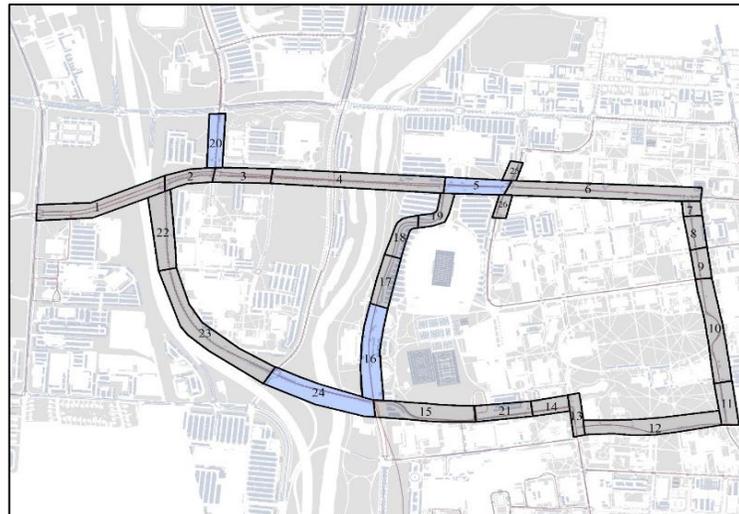
Ongoing and Upcoming

- Research improvements to volume estimation from bus-based video

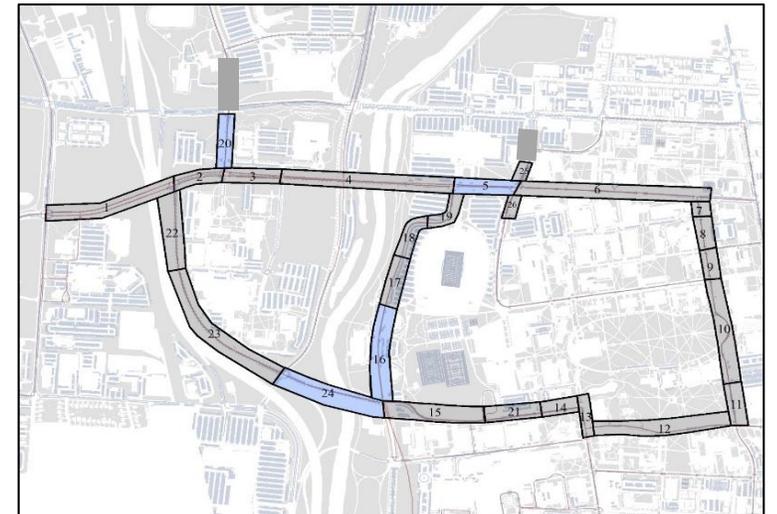
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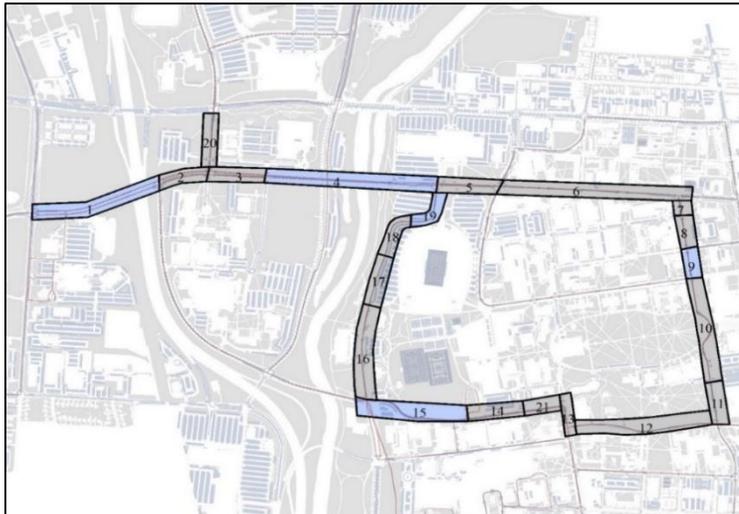
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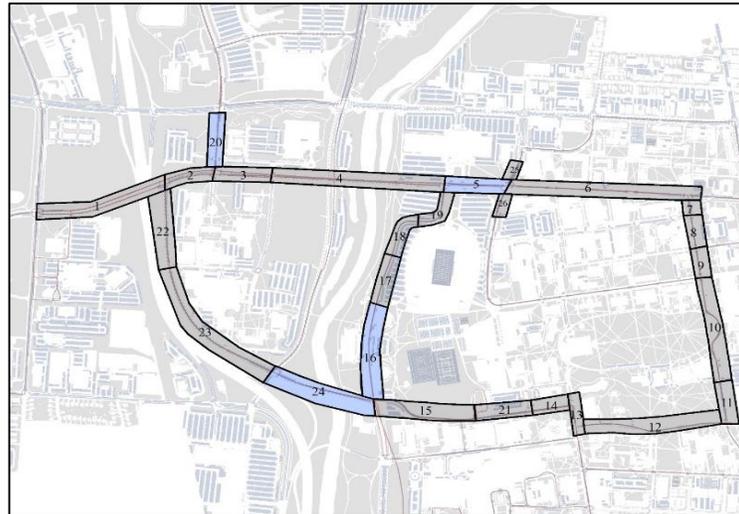
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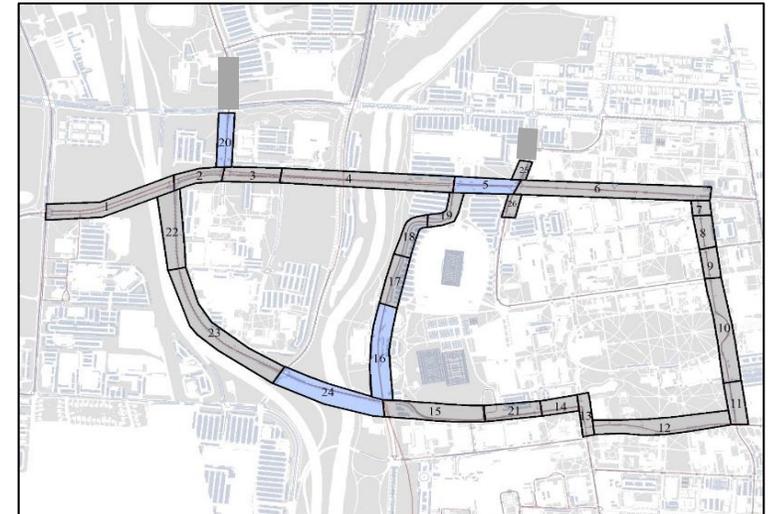
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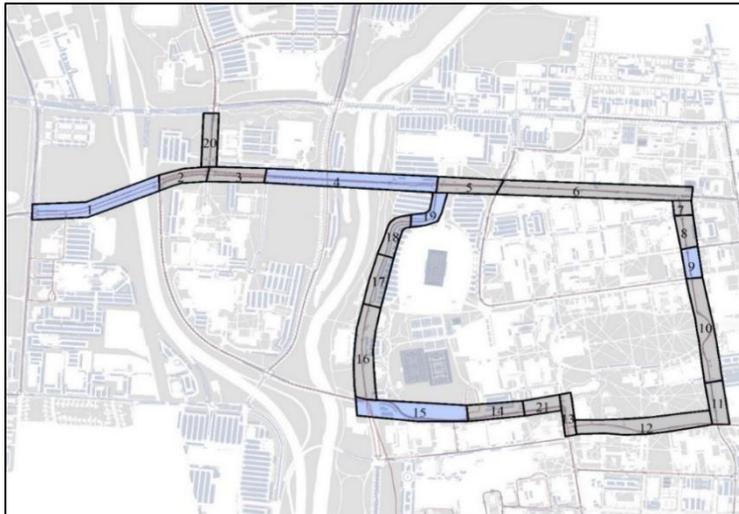
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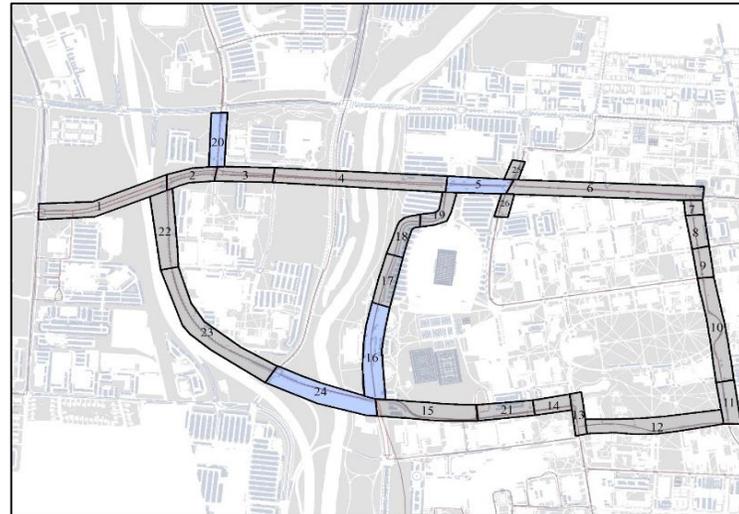
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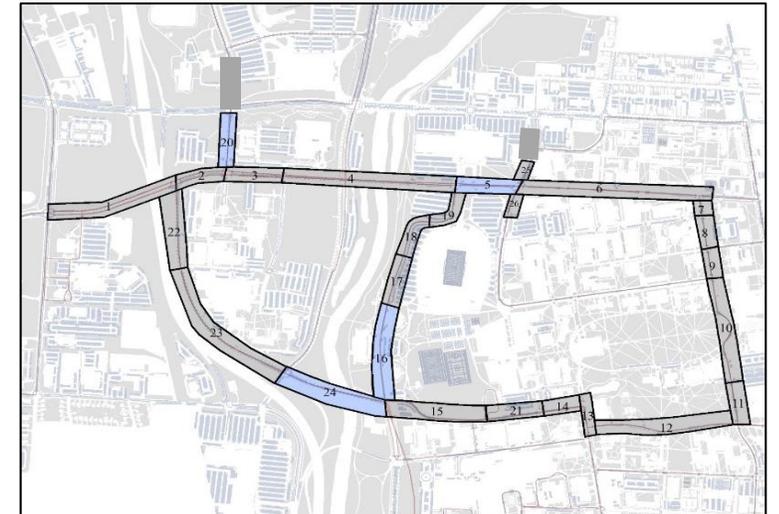
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2019 Network



2020 Network



Acknowledgements

- OSU Students: Diego Ribeiro de Oliveira Galdino, Shahrzad Charmchi Toosi, Marissa McMaster
- OSU Transportation and Traffic Management: Beth Snoke, Tom Holman, Sean Roberts
- Mid-Ohio Regional Planning Commission: Nick Gill, Hwashik Jang, Zhuojun Jiang (presently ODOT)
- ODOT: Vendor data