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UNDERSTANDING REGIONAL TRAVEL PATTERNS WITH BIG DATA

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Introduction

Introduction

- The Northeastern Indiana Regional Coordinating Council (NIRCC) invested in passively collected big data to better understand
  - The movements of both people and truck freight into, out of, through, and within Northeastern Indiana
- No cost-constrained survey can provide a picture of the OD trip matrix at the level of zones or even moderately disaggregate districts
- Traditional surveys typically contain observations for 3% or less of the cells in the OD matrix
- Passive OD data typically provides observations for a quarter to a third of the cells in a regional OD matrix

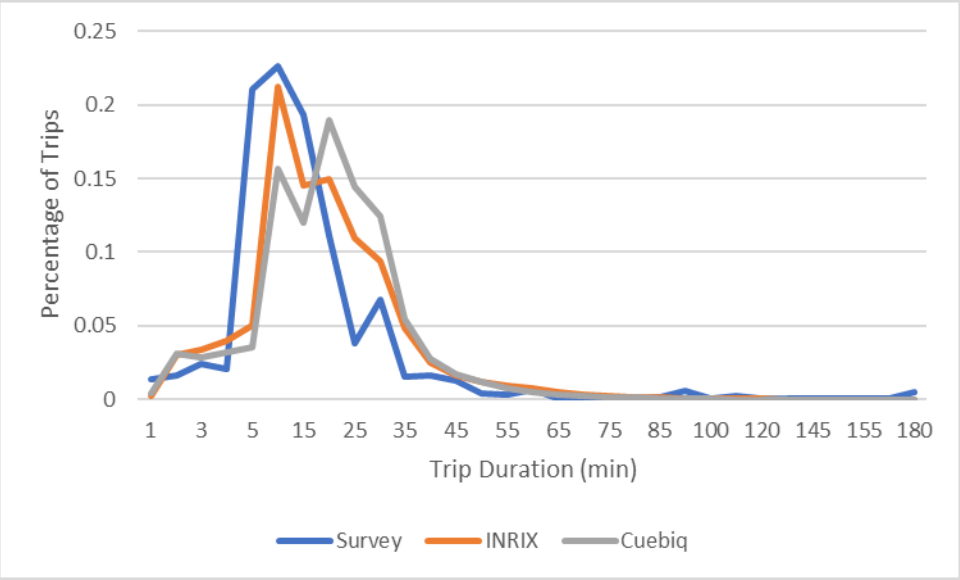
Raw Big Data

- Purchased StreetLight Data:
  - CUEBIQ
    - Location-based services (LBS) data
    - Drawn from smartphone applications
    - Reflects trips for all travelers/vehicle classes together
  - INRIX
    - Based on navigational global positioning systems (GPS) devices
    - Trips by vehicle class (auto, single-unit trucks, and multi-unit trucks)

HYBRID Data

- 2 Vehicle Classes
  - Auto and Trucks (SUT + MUT)
- IE\EI\EE Trips are from INRIX
- I-I Trips:
  - Auto: CUEBIQ minus INRIX Trucks
  - Truck: INRIX

Raw Big Data



- Higher percentage of short trips (shorter than 15 minutes) in the survey
- Higher share in trips between 20 and 55 minutes in passive OD data
- Passive OD data is biased by trip length/duration

Big Data Expansion

- Passive OD data should be expanded to accurately represent all travel of interest

- If the passive OD data is properly expanded, the resulting trip table is a very reliable tool for analyzing the movements of travelers and trucks in the region

Big Data Expansion

Expansion Methods

- Traffic Count Methods
  - ➢ Simple Scaling
  - ➢ Variable Scaling
    - ❖ Matrix Partitioning
      - ✓ Iterative Screenline Fitting (ISF)
    - ❖ Network Assignment-Based
      - ✓ Parametric Scaling
      - ✓ Nonparametric (ODME)
        - o Direct ODME
        - o Indirect ODME

- Other Sample Penetration Methods
  - ➢ Market Penetration
  - ➢ Trip Generation-Based

ISF

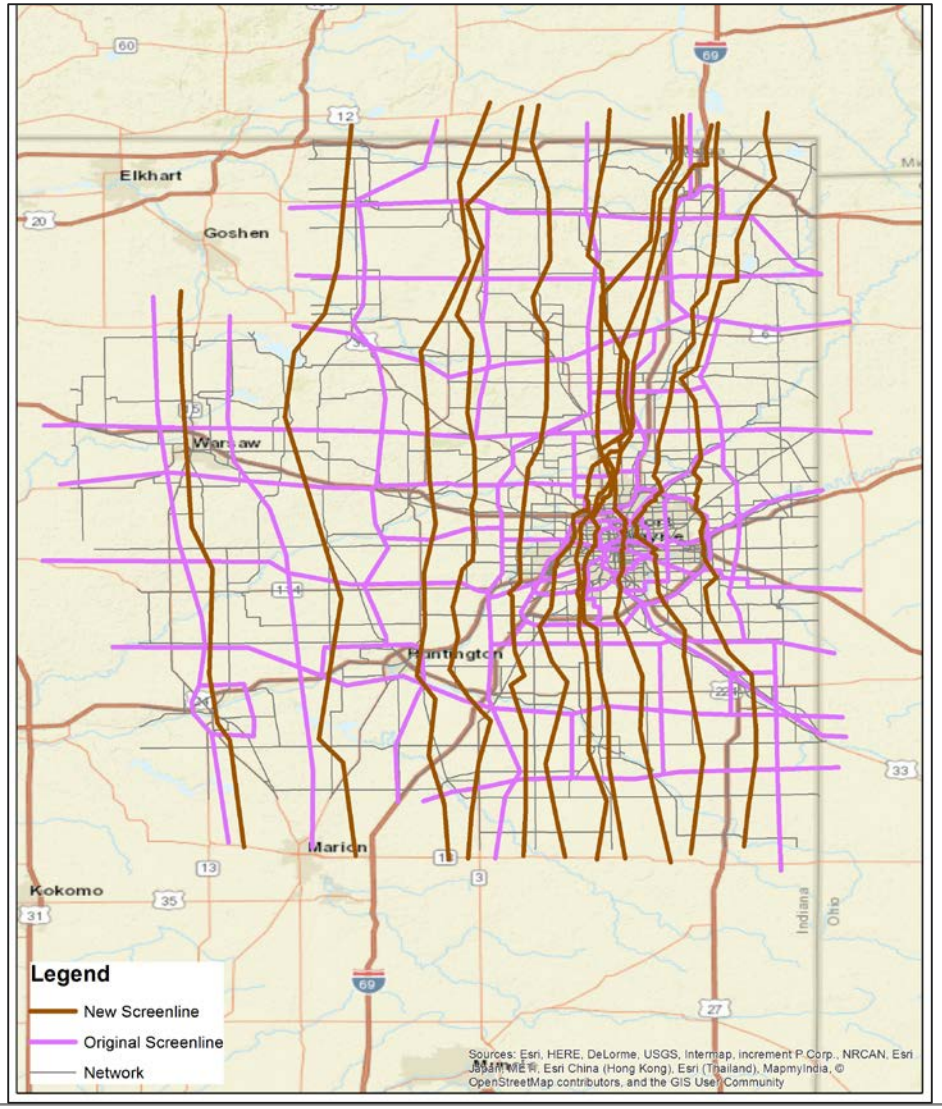
- 93 screenlines were built for the region:
  - 66 polygons
  - 27 screenlines crossing the region and partitioning the entire region to 2 subareas

- Criteria to prepare screenlines:
  - Count station locations,
  - zone borders,
  - centroid connector locations, and
  - natural\physical barriers such as rivers, freeways, and waterways

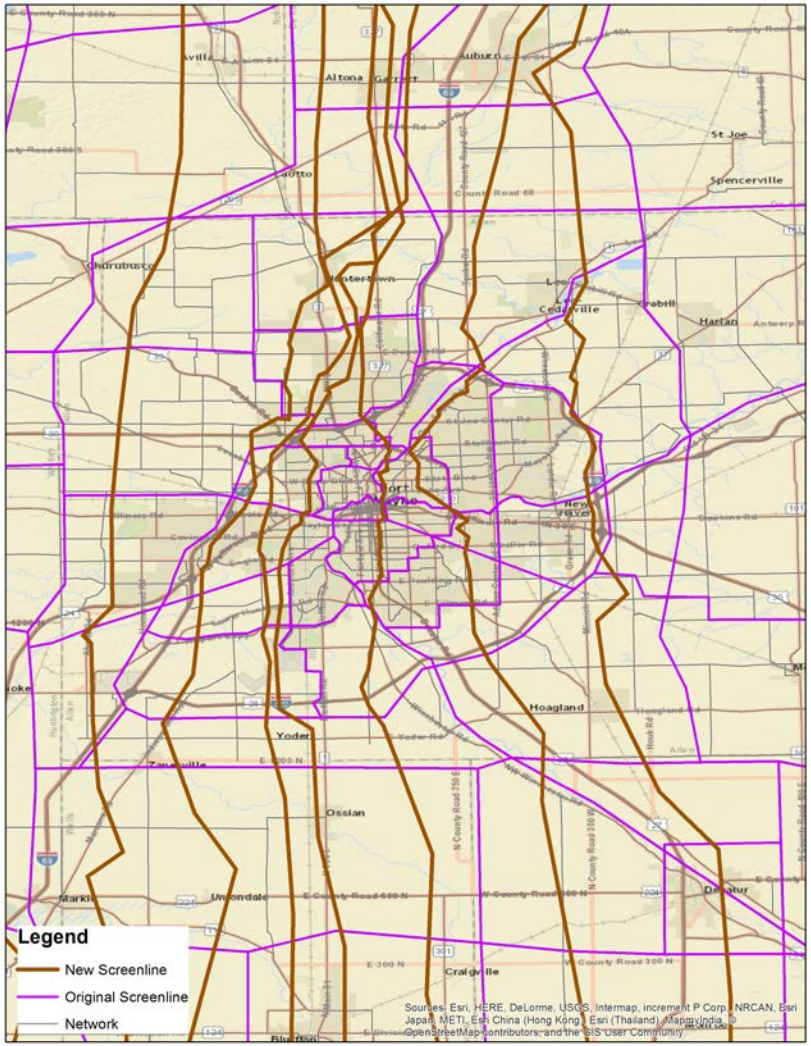
- 902 links out of 3,738 links with AADT cross the screenlines

- The majority portion of counts can be used for validation
  - Only 24 percent of counts will be used in the trip table adjustment

93 Screenlines

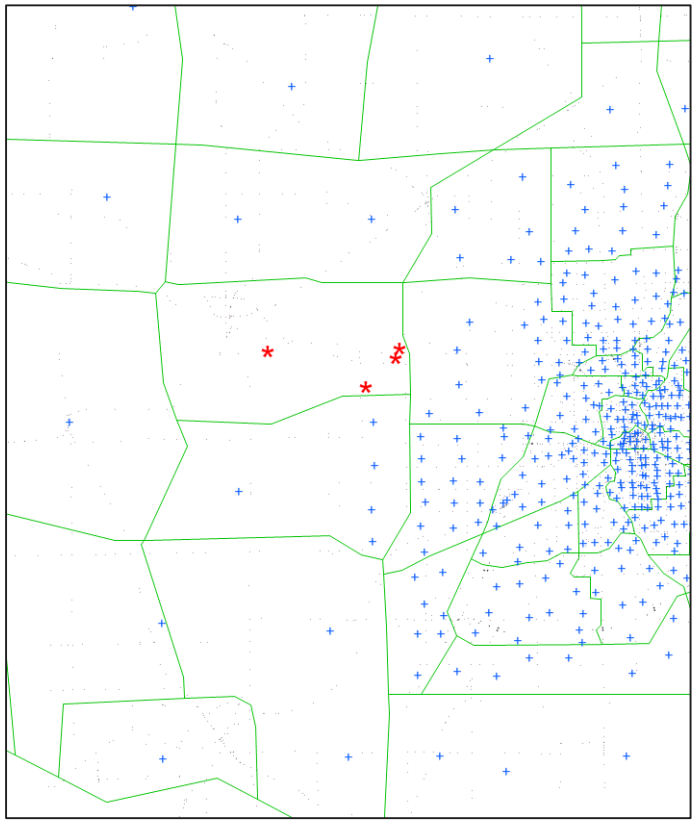


11 New Screenlines (Details in Allen County)



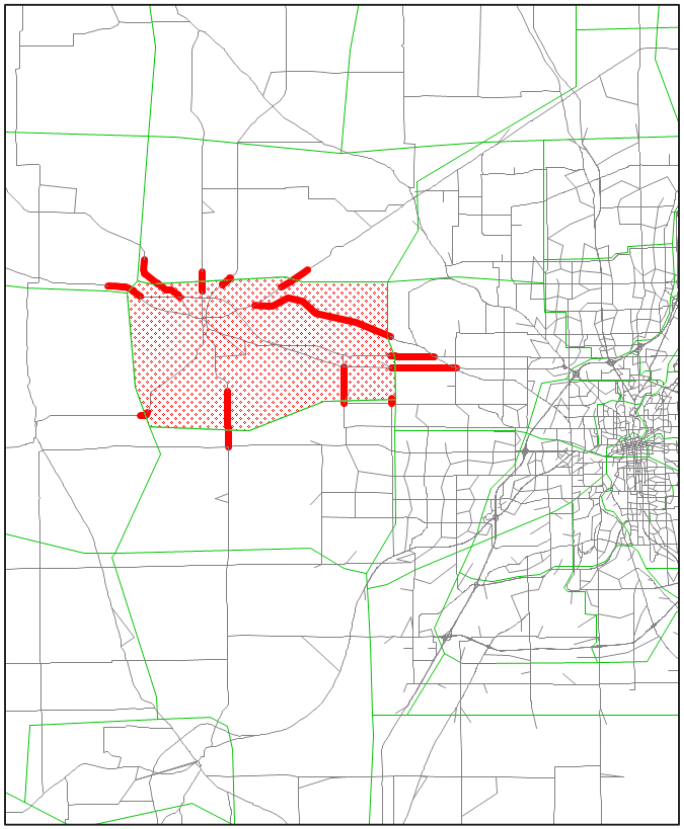
Methodology

- Iterative trip table expansion process
- Dividing trip table to 4 quadrant for each screenline
  - ➢ Diagonal quadrants are not changed
  - ➢ Non-diagonal quadrants are factored
- Tagging links crossing each screenline
- Counting number of crossing for each link



Methodology

- The factor for diagonal quadrants is 1
- The non-diagonal quadrants' factor for each screenline:
  - Ratio of weighted total count to wighted total volume of all link crossing the screenline
  - Weights:
    - Number of screenline crossing
    - Functional Class (2 for highways)
    - Area Type (2 for Allen County)
- Saving the corresponding factor for each cell (i to j) in a separate matrix (one matrix for each screenline, totally 93 matrices)
- Taking the average of 93 factors for each cell (factors equal to 1 are excluded)



Improving ISF with ODME

- Independent ODME
  - To check and evaluate ISF performance

- Sequential ODME
  - To obtain the best trip table from BIG Data

- To limit over-fitting to counts by ODME
  - Upper and lower bounds (3 and 0.5) were imposed on ODME expansion factors
  - The number of ODME iterations was also limited to 15 to avoid extreme change in trips

Summary

All Vehicle Classes and All Links with AADT > 0

Data	Fratar RMSE (%)	ISF RMSE (%)	Sequential ODME (%)
CUEBIQ	64.79	52.85	42.51
INRIX	65.92	55.70	49.82
HYBRID	56.61	55.04	51.87

Summary

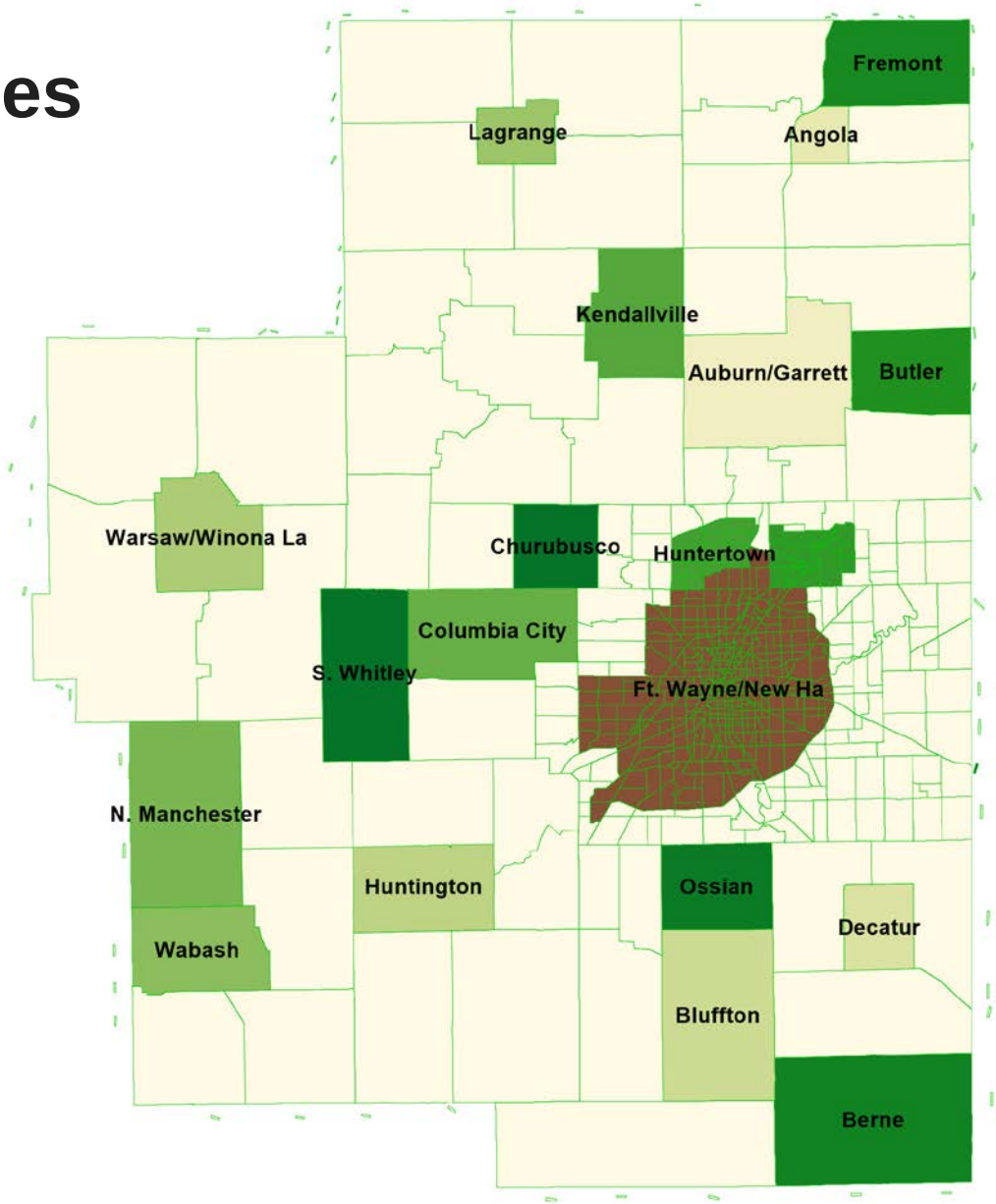
- ISF improved CUEBIQ, INRIX, and HYBRID compared to fratar
- Sequential ODME significantly improved CUEBIQ, INRIX, and HYBRID compared to ISF
- Sequential ODME also yielded slightly better results compared to independent ODME
- Number of links with AADT affects the expansion method performance

Regional Interactions of Communities of Interest

Community Analysis

- 20 Communities
  - 12 Primary Communities
  - 8 Secondary Communities
- Based on CUEBIQ Data after ISF and Sequential ODME

Selected Communities

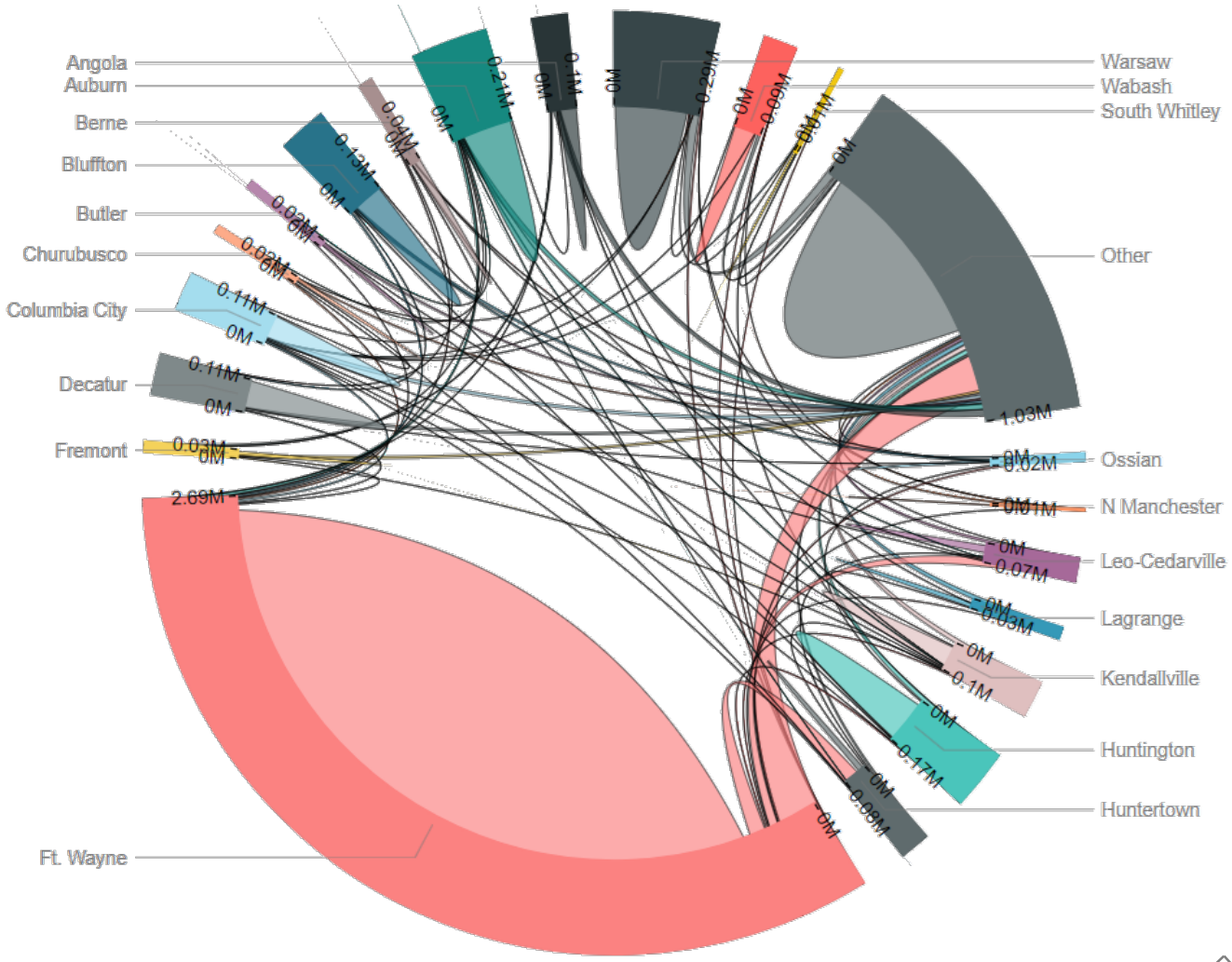


Daily Flow between Communities

Community	Ft. Wayne	Auburn	Angola	Decature	Bluffton	Huntington	Warsaw	Lagrange	Wabash	N Manchester	Columbia City	Kendallville	Secondary	Other	Total
Ft. Wayne	1,202,846	4,544	470	1,334	2,863	1,980	2,143	360	791	281	3,082	1,055	50,118	70,339	1,342,205
Auburn	4,626	86,830	236	22	19	30	52	32	16	3	149	962	2,651	9,682	105,311
Angola	438	209	32,504	2	6	0	9	225	0	0	4	607	2,970	12,111	49,085
Decature	1,295	21	6	48,603	1,007	28	10	0	13	0	10	4	582	4,800	56,380
Bluffton	2,705	13	2	890	53,018	322	7	0	17	0	50	3	4,044	4,985	66,057
Huntington	1,811	22	1	46	383	73,057	45	6	359	36	212	6	376	7,321	83,680
Warsaw	1,951	49	11	4	4	52	127,113	2	92	128	572	12	350	14,495	144,835
Lagrange	316	47	278	2	0	0	6	8,279	0	0	33	558	81	7,318	16,917
Wabash	860	13	0	30	8	383	110	0	39,402	444	83	0	49	4,702	46,085
N Manchester	342	0	0	0	0	34	137	0	448	928	25	0	25	2,066	4,007
Columbia City	3,087	173	2	10	29	198	520	22	67	18	40,891	165	1,249	6,731	53,161
Kendallville	1,031	992	557	3	5	6	19	583	1	0	50	38,917	478	7,709	50,350
Secondary	50,192	2,583	3,035	590	3,986	409	497	68	49	25	1,156	548	66,070	21,049	150,257
Other	72,412	9,656	11,847	4,848	4,730	7,432	14,516	7,337	4,825	1,882	6,736	7,589	21,087	340,860	515,759
Total	1,343,914	105,153	48,948	56,384	66,056	83,932	145,184	16,914	46,081	3,745	53,054	50,427	150,129	514,169	2,684,090

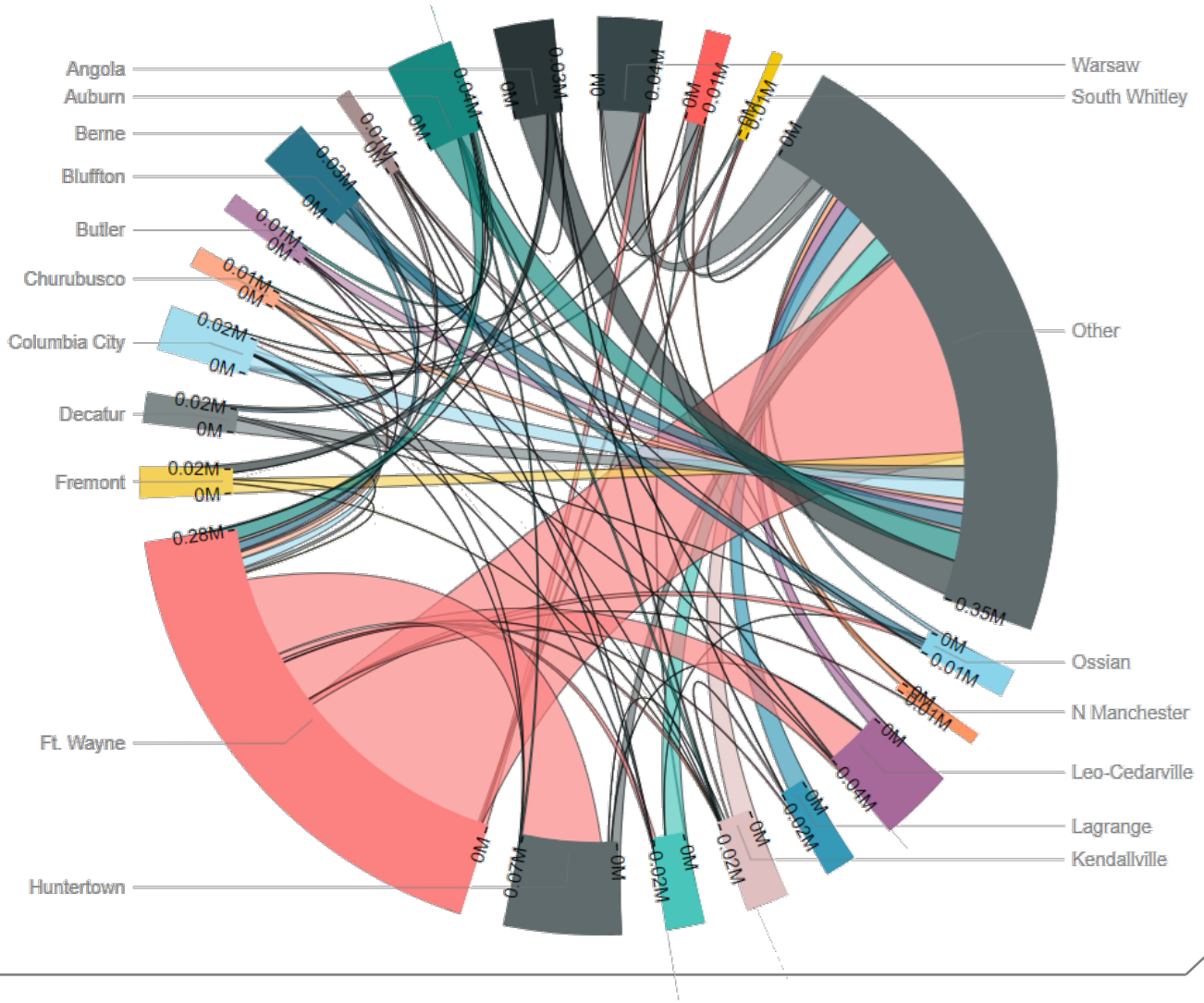
Daily Flow between Communities

- Travel within communities far outweighs travel between them within the region



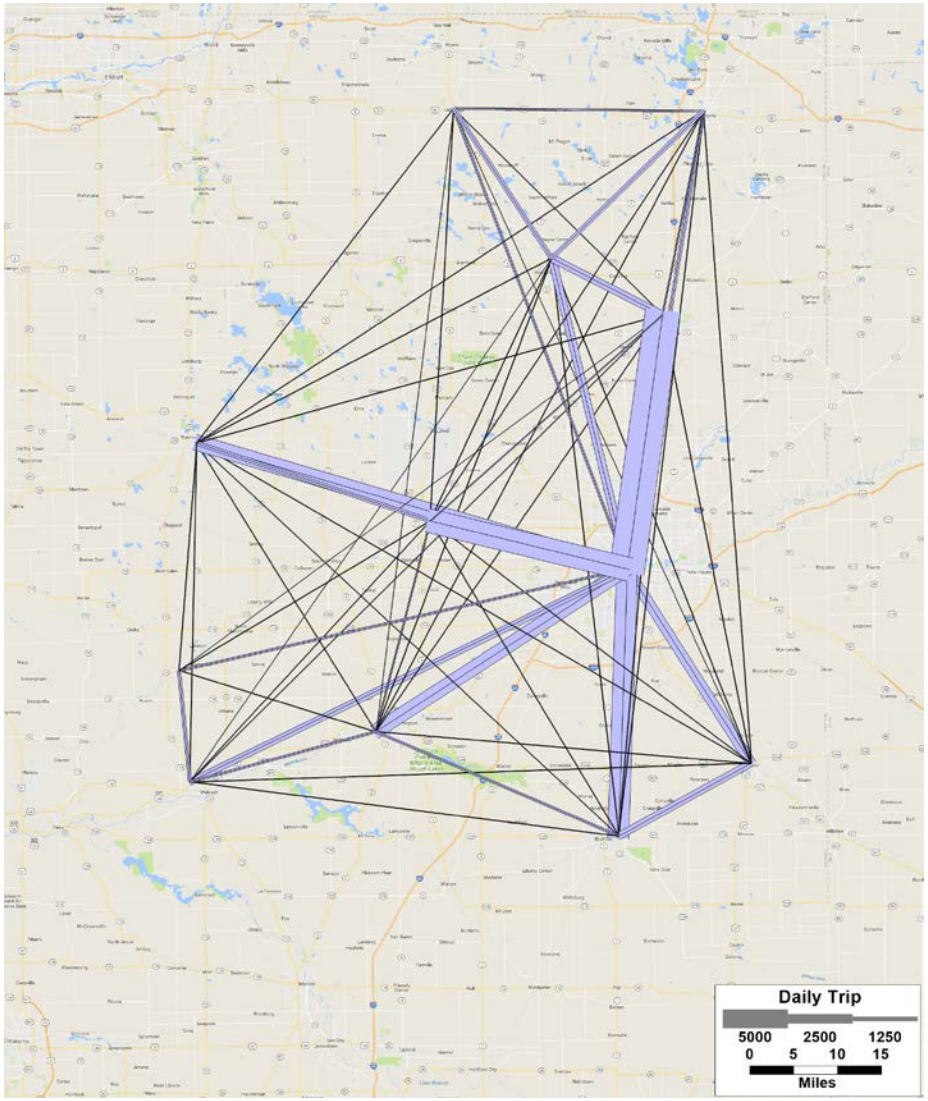
Daily Flow between Communities (No Intradistrict)

- Travel to/from communities is dominated by travel into / out of the region (Other)

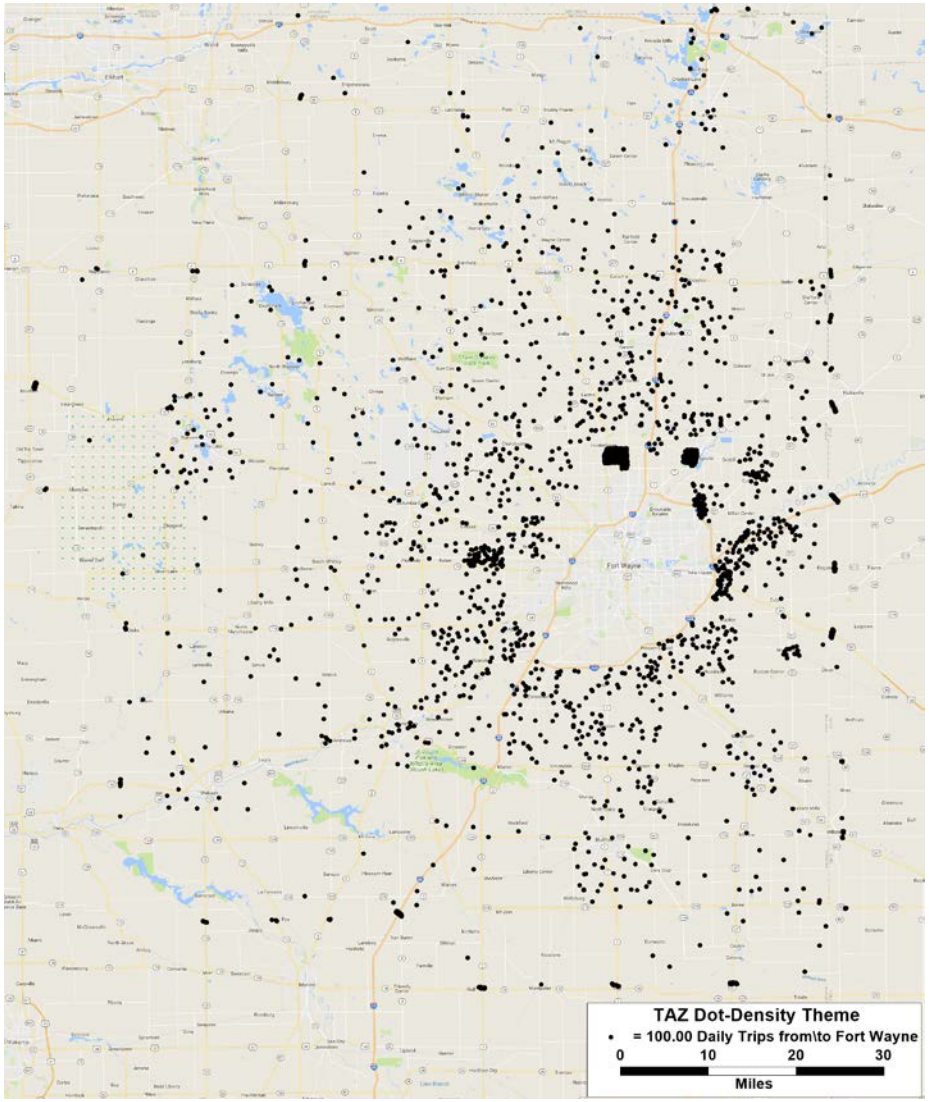


Desire Lines between Primary Communities

- Interactions with Ft. Wayne are dominant as expected
- Main partners are
  - Auburn/Garrett
  - Columbia City
  - Warsaw
  - Bluffton
  - Huntington
- Bluffton – Ossian is strongest interaction not involving Ft. Wayne



OD Bound to/from Ft. Wayne/New Haven



Top 20 Daily Flows between Communities

Rank	Daily Flow	Community 1	Community 2
1	56,479	Huntertown	Ft. Wayne/New Haven
2	30,473	Leo-Cedarville	Ft. Wayne/New Haven
3	9,170	Auburn/Garrett	Ft. Wayne/New Haven
4	7,139	Ossian	Bluffton
5	6,169	Columbia City	Ft. Wayne/New Haven
6	5,798	Fremont	Angola
7	5,568	Bluffton	Ft. Wayne/New Haven
8	4,500	Ossian	Ft. Wayne/New Haven
9	4,104	Churubusco	Ft. Wayne/New Haven
10	4,094	Warsaw/Winona Lake	Ft. Wayne/New Haven
11	3,791	Huntington	Ft. Wayne/New Haven
12	2,629	Decatur	Ft. Wayne/New Haven
13	2,354	Butler	Auburn/Garrett
14	2,086	Kendallville	Ft. Wayne/New Haven
15	1,955	Kendallville	Auburn/Garrett
16	1,953	Berne	Ft. Wayne/New Haven
17	1,896	Bluffton	Decatur
18	1,651	Wabash	Ft. Wayne/New Haven
19	1,508	S. Whitley	Ft. Wayne/New Haven
20	1,340	S. Whitley	Columbia City

Top 5 Communities for each Community

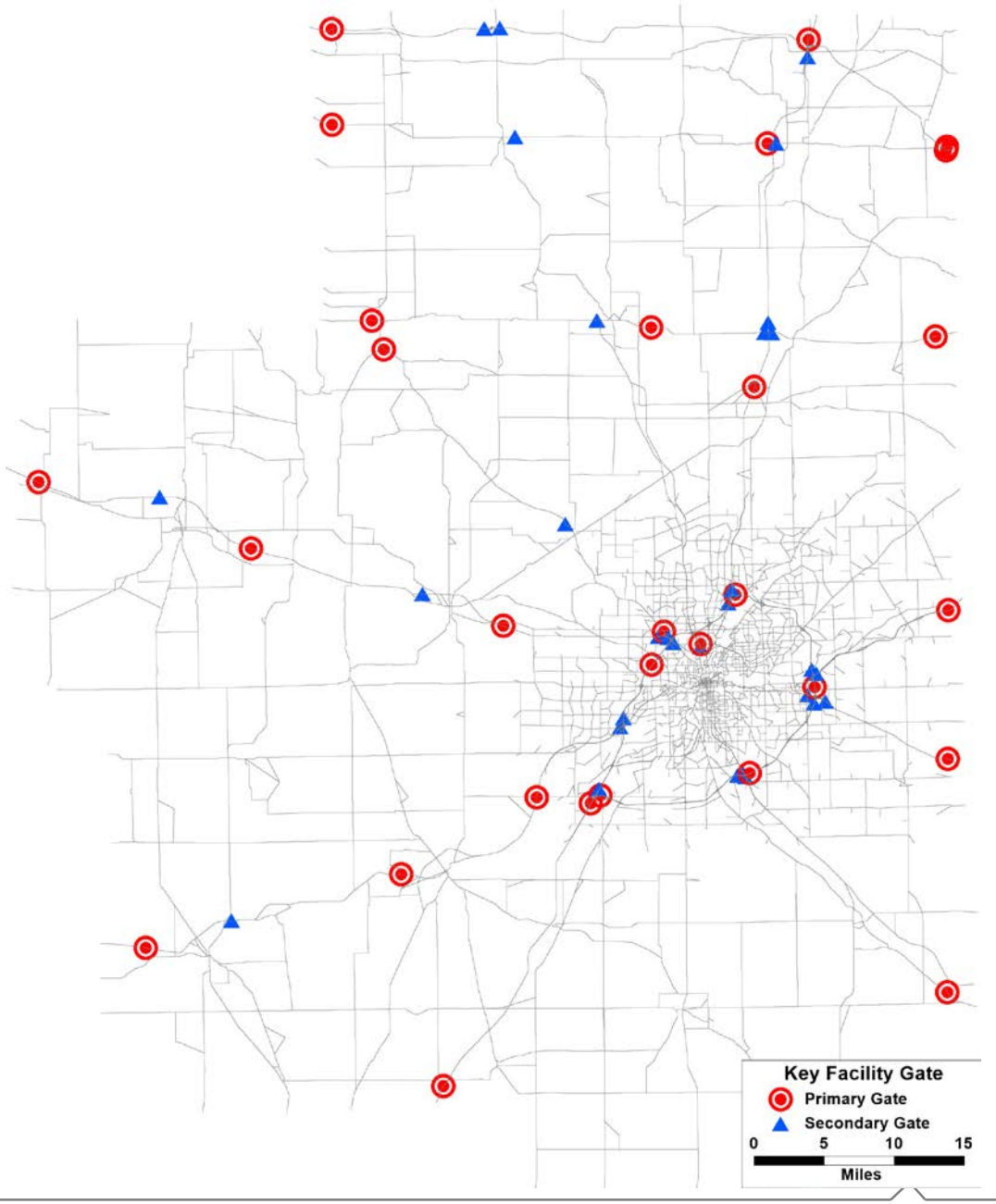
Community	First	Second	Third	Forth	Fifth
Ft. Wayne/New Haven	Huntertown	Leo-Cedarville	Auburn/Garrett	Columbia City	Bluffton
Auburn/Garrett	Ft. Wayne/New Haven	Butler	Kendallville	Huntertown	Leo-Cedarville
Angola	Fremont	Kendallville	Ft. Wayne/New Haven	Lagrange	Auburn/Garrett
Decatur	Ft. Wayne/New Haven	Bluffton	Berne	Ossian	Huntington
Bluffton	Ossian	Ft. Wayne/New Haven	Decatur	Berne	Huntington
Huntington	Ft. Wayne/New Haven	Wabash	Bluffton	Columbia City	Berne
Warsaw/Winona Lake	Ft. Wayne/New Haven	Columbia City	Churubusco	N. Manchester	Wabash
Lagrange	Kendallville	Ft. Wayne/New Haven	Angola	Fremont	Auburn/Garrett
Wabash	Ft. Wayne/New Haven	N. Manchester	Huntington	Warsaw/Winona Lake	Columbia City
N. Manchester	Wabash	Ft. Wayne/New Haven	Warsaw/Winona Lake	Huntington	Columbia City
Columbia City	Ft. Wayne/New Haven	S. Whitley	Warsaw/Winona Lake	Churubusco	Huntington
Kendallville	Ft. Wayne/New Haven	Auburn/Garrett	Angola	Lagrange	Fremont
Huntertown	Ft. Wayne/New Haven	Auburn/Garrett	Leo-Cedarville	Columbia City	Churubusco
Leo-Cedarville	Ft. Wayne/New Haven	Auburn/Garrett	Huntertown	Butler	Warsaw/Winona Lake
Butler	Auburn/Garrett	Ft. Wayne/New Haven	Kendallville	Leo-Cedarville	Angola
Fremont	Angola	Kendallville	Ft. Wayne/New Haven	Auburn/Garrett	Lagrange
Berne	Ft. Wayne/New Haven	Decatur	Bluffton	Ossian	Huntington
Ossian	Bluffton	Ft. Wayne/New Haven	Berne	Huntington	Decatur
Churubusco	Ft. Wayne/New Haven	Auburn/Garrett	Columbia City	Warsaw/Winona Lake	Huntertown
S. Whitley	Ft. Wayne/New Haven	Columbia City	Warsaw/Winona Lake	Huntington	N. Manchester

Origin and Destination for Key Facilities

Key Facility Analysis

- 30 Primary Gates
- 30 Secondary Gates
- INRIX Trips after ISF and Sequential ODME

Gates


Key Facility Gate
Primary Gate
Secondary Gate
0
5
10
15
Miles

Primary Gates' Results

Facility Name	Through Trips	To/From the Region	Inside Ft. Wayne/New Haven	To/From Ft. Wayne/New Haven	Inside the Region without Ft. Wayne/New Haven
I-69 N. of I-80/I-90	7,051	15,676	4	342	3,147
I-69 S. of US 6	3,706	11,520	65	7,552	8,919
I-69 S. of US 30	4,470	11,365	36,770	17,596	3,752
I-69 S. of I-469S	9,147	14,418	184	4,403	1,586
I-69 N. of SR 18	9,229	17,891	18	45	68
I-469 E. of I-69 N	1,691	8,180	22,156	12,232	3,854
I-469 between US 30 & US 24	7,313	11,099	5,357	8,931	4,821
I-469 E. of US 27	5,662	7,404	2,287	5,203	2,572
I-469 E. of I-69S	5,471	5,841	1,800	8,301	3,045
I-80/I-90 E. SR 13	5,242	3,728	0	2	71
I-80/I-90 W. of IN/OH State Line	3,325	16,848	0	2	115
US 20 E. of SR 13	355	5,160	4	5	293
US 20 W. of I-69	619	2,212	5	395	4,464
US 20 W. of IN/OH State Line	341	2,869	2	1	38
US 6 W. of SR 5	1,555	8,612	10	253	3,094
US 6 E. of Kendallville	714	1,952	4	736	6,002
US 6 W. of IN/OH State Line	229	2,930	0	5	96
US 33 E. of SR 5	1,333	4,327	11	1,157	1,488
US 33 W. of US 30	1,171	2,949	7,241	7,893	1,195
US 33 W. of IN/OH State Line	324	3,153	0	49	150
US 30 W. of SR 19	1,446	8,572	6	10	52
US 30 E. of Warsaw	1,424	4,307	36	4,459	11,297
US 30 E. of Columbia City	1,299	4,175	138	13,270	16,966
US 30 E. of US 27 (Lima Rd)	3	868	36,126	7,265	403
US 30 W. of IN/OH State Line	1,754	11,566	24	87	129
US 24 W. of Wabash	1,057	6,285	6	17	272
US 24 W. of Huntington	758	3,175	13	2,300	5,517
US 24 S. of CR E900N	624	2,616	117	9,829	4,437
US 24 W. of IN/OH State Line	5,765	6,598	21	39	64
US 27 S. of Geneva	172	4,487	4	20	49

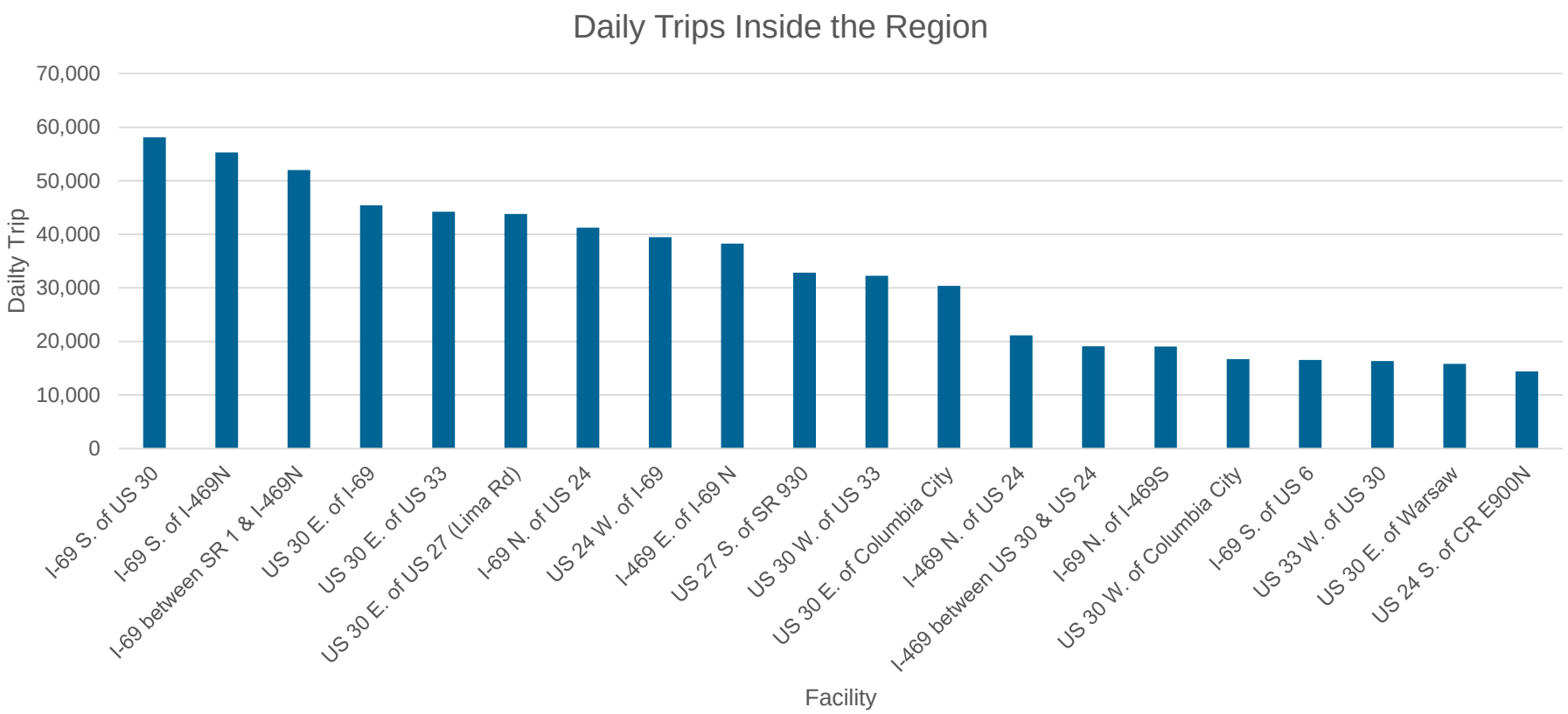
Secondary Gates' Results

Facility Name	Through Trips	To/From the Region	Inside Ft. Wayne/New Haven	To/From Ft. Wayne/New Haven	Inside the Region without Ft. Wayne/New Haven
I-69 S. of I-80/I-90	3,961	13,633	4	457	3,200
I-69 N. of US 6	4,247	12,213	37	4,162	8,873
I-69 between SR 1 & I-469N	3,666	10,567	25,215	21,885	4,914
I-69 S. of I-469N	4,559	11,345	29,482	22,205	3,595
I-69 N. of US 24	4,389	11,349	22,862	14,658	3,716
I-69 N. of I-469S	4,362	12,094	5,902	10,598	2,533
I-469 N. of US 24	2,025	8,608	6,627	9,771	4,761
I-469 S. of US 30	5,520	5,744	2,726	4,955	3,038
I-469 W. of US 27	5,659	6,269	1,840	5,517	2,541
I-80/I-90 E. SR 9	4,713	5,272	0	30	995
I-80/I-90 W. SR 9	5,411	4,259	0	12	794
US 20 E. of Lagrange	557	1,891	5	237	6,690
US 20 E. of I-69	195	1,972	7	769	5,541
US 6 W. of Kendallville	844	3,666	9	2,209	8,889
US 6 W. of I-69	733	2,237	4	1,263	6,387
US 6 E. of I-69	437	2,310	23	1,887	5,790
US 33 W. of Churubusco	1,218	3,191	37	3,394	3,420
US 30 W. of Warsaw	1,268	8,010	7	392	3,763
US 30 W. of Columbia City	1,203	3,850	48	6,259	10,390
US 30 W. of US 33	1,413	4,549	10,409	18,313	3,526
US 30 E. of US 33	2,393	7,346	17,140	22,810	4,246
US 30 E. of I-69	92	4,206	25,353	19,373	683
US 30 W. of I-469	35	2,495	4,982	8,957	267
US 30 E. of I-469	1,580	10,308	80	4,204	1,802
US 24 E. of Wabash	758	3,306	9	1,794	4,315
US 24 W. of I-69	286	2,187	26,655	11,484	1,338
US 24 E. of I-469	5,755	5,819	200	6,128	1,890
US 27 S. of SR 930	61	702	26,637	5,964	239
US 27 N. of I-469	150	1,399	1,375	5,553	210
US 27 S. of I-469	432	4,442	232	6,285	1,776

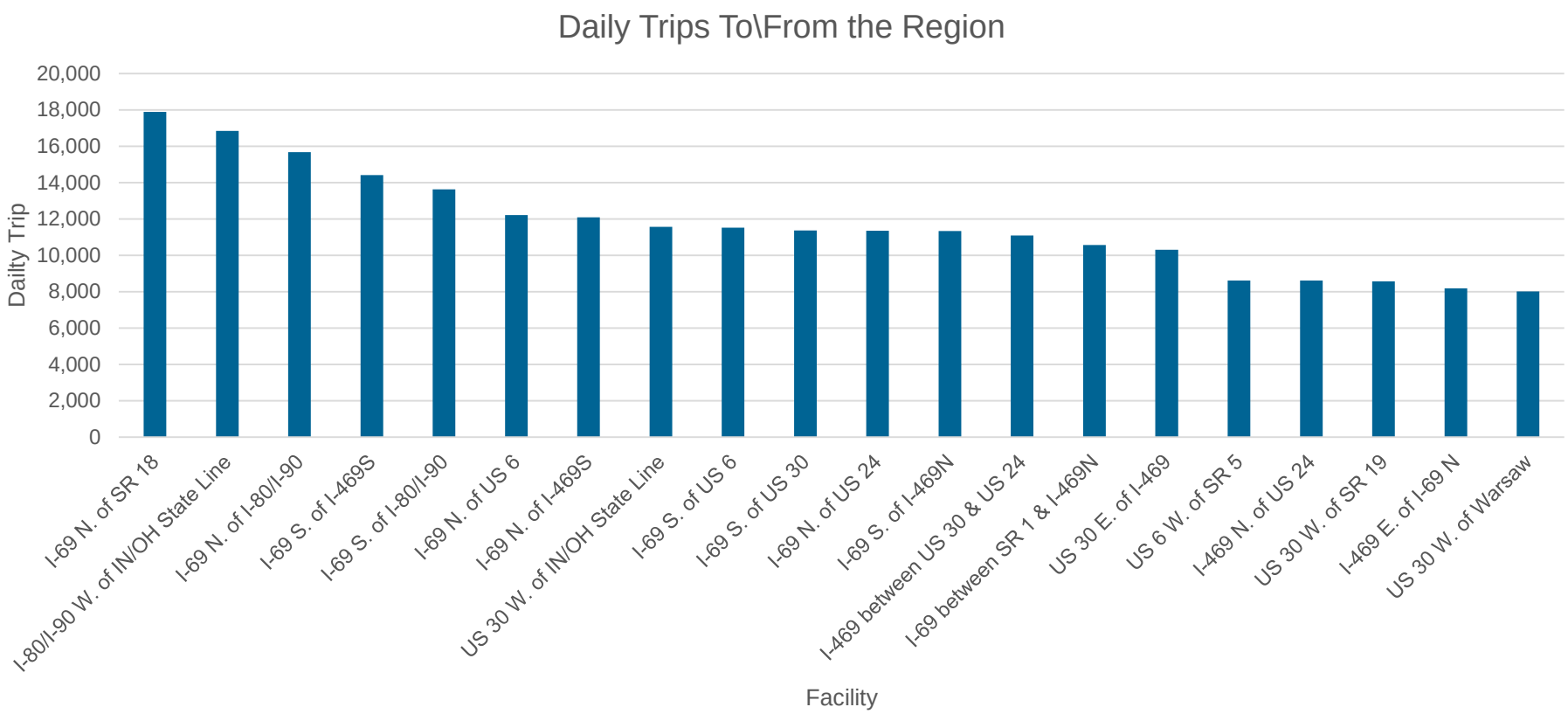
Results by Corridor

Corridor	Through Trips	To/From the Region	Inside Ft. Wayne/New Haven	To/From Ft. Wayne/New Haven	Inside the Region without Ft. Wayne/New Haven
I-69	58,789	142,070	120,544	103,903	44,304
I-469	33,340	53,145	42,793	54,911	24,631
I-80/I-90	18,691	30,106	0	46	1,976
US 20	2,065	14,104	23	1,407	17,026
US 6	4,513	21,707	50	6,353	30,259
US 33	4,045	13,620	7,289	12,494	6,254
US 30	13,910	70,252	94,350	105,398	53,523
US 24	15,004	29,986	27,021	31,592	17,834
US 27	814	11,030	28,247	17,822	2,274

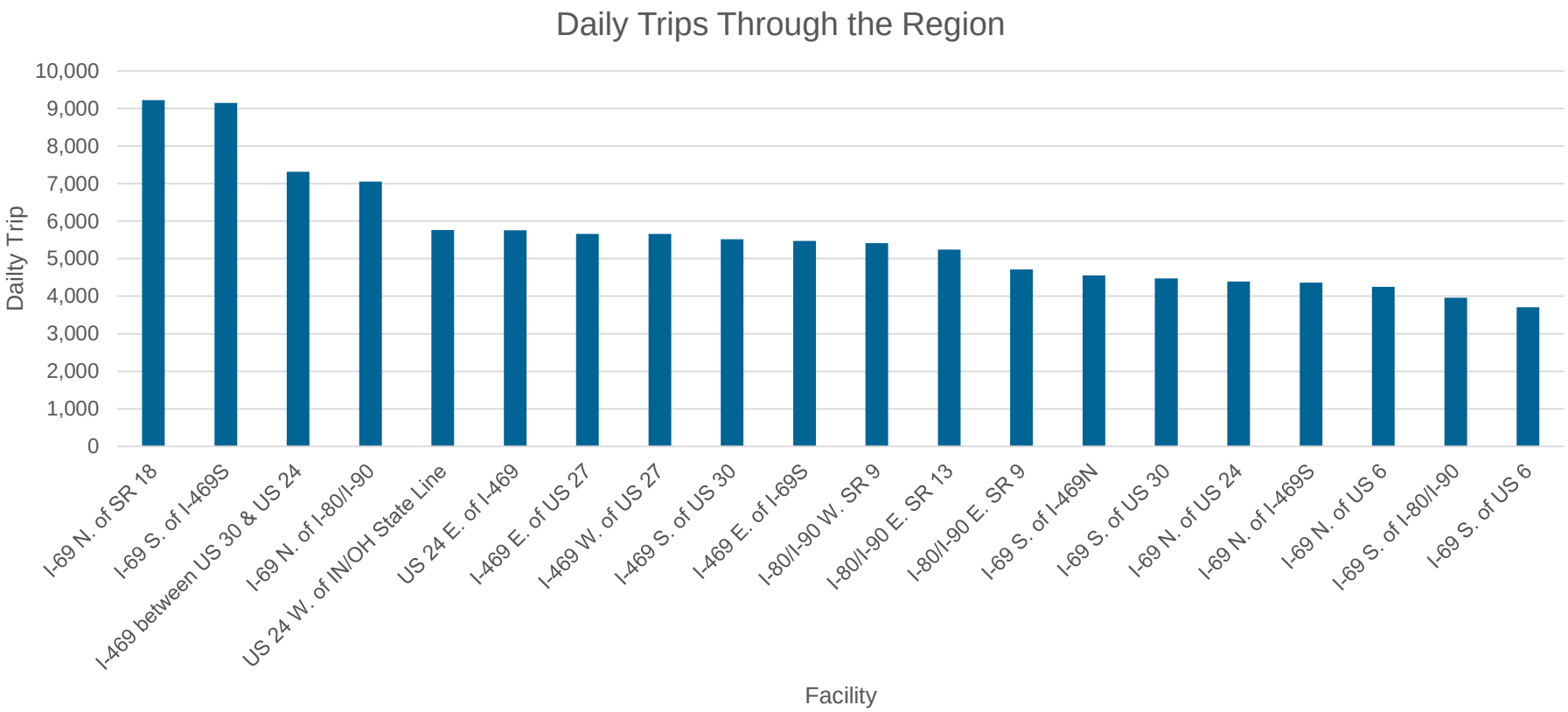
Top 20 Gates Serving Trips within the Region

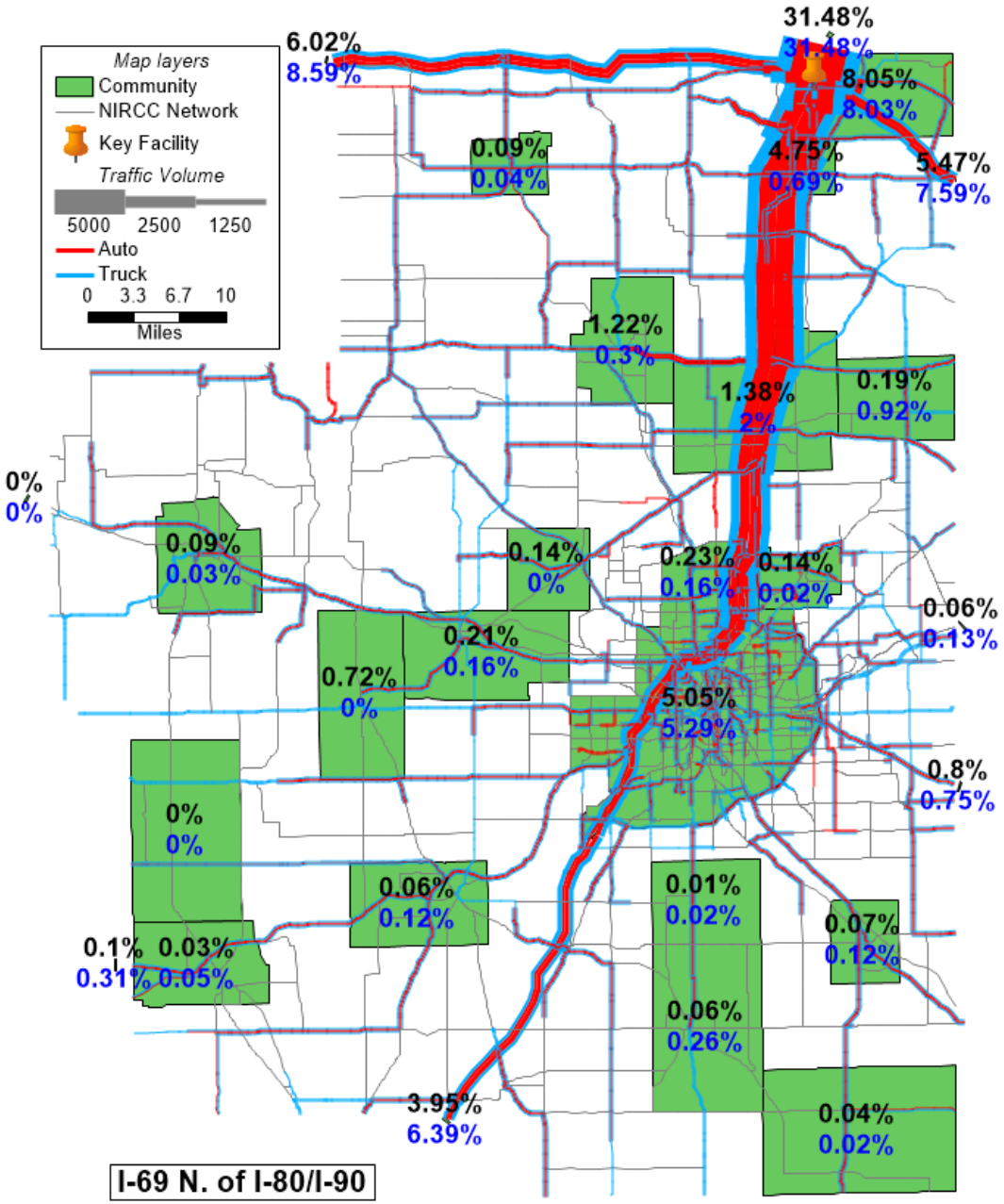


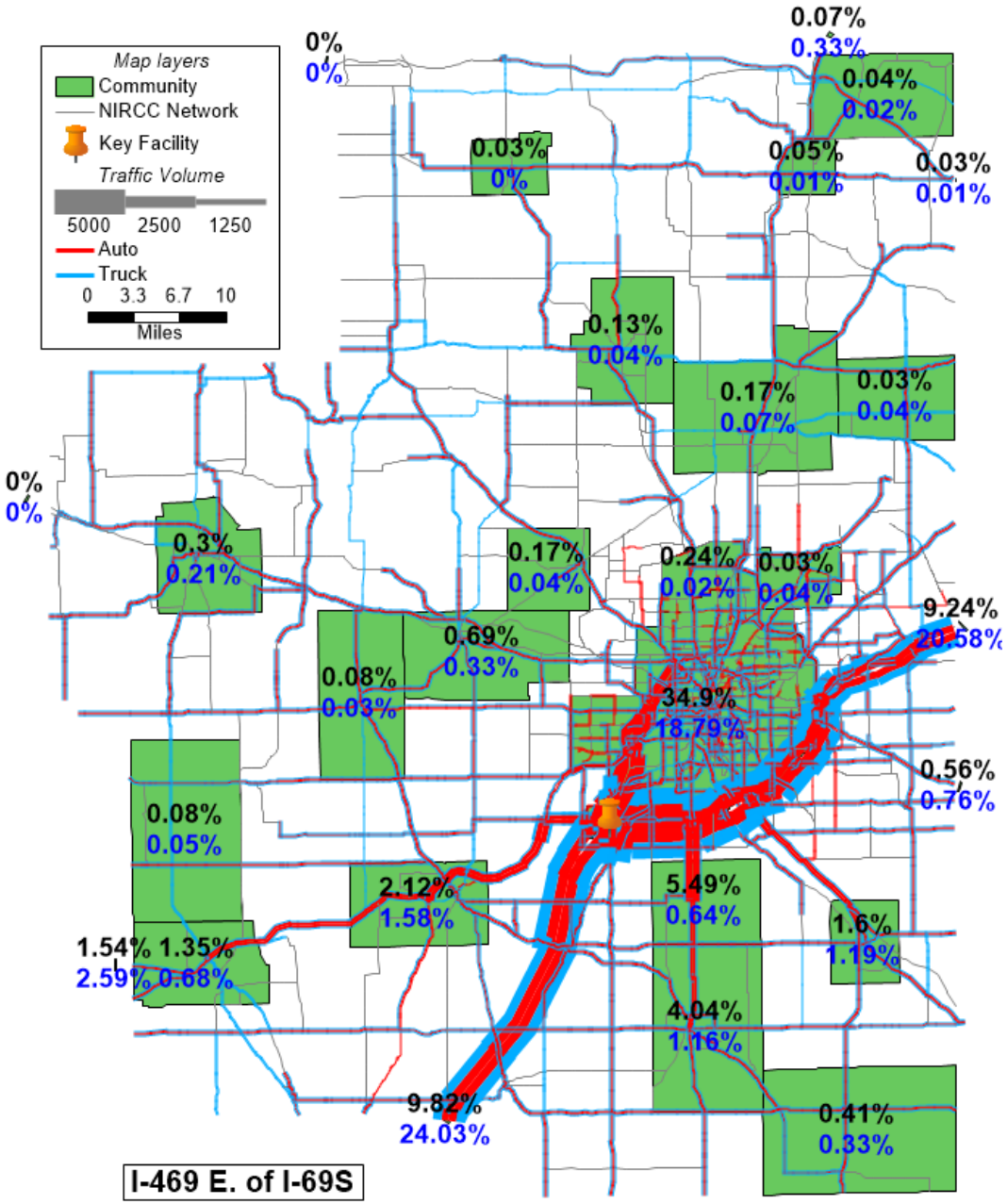
Top 20 Gates Serving Trips to and from the Region

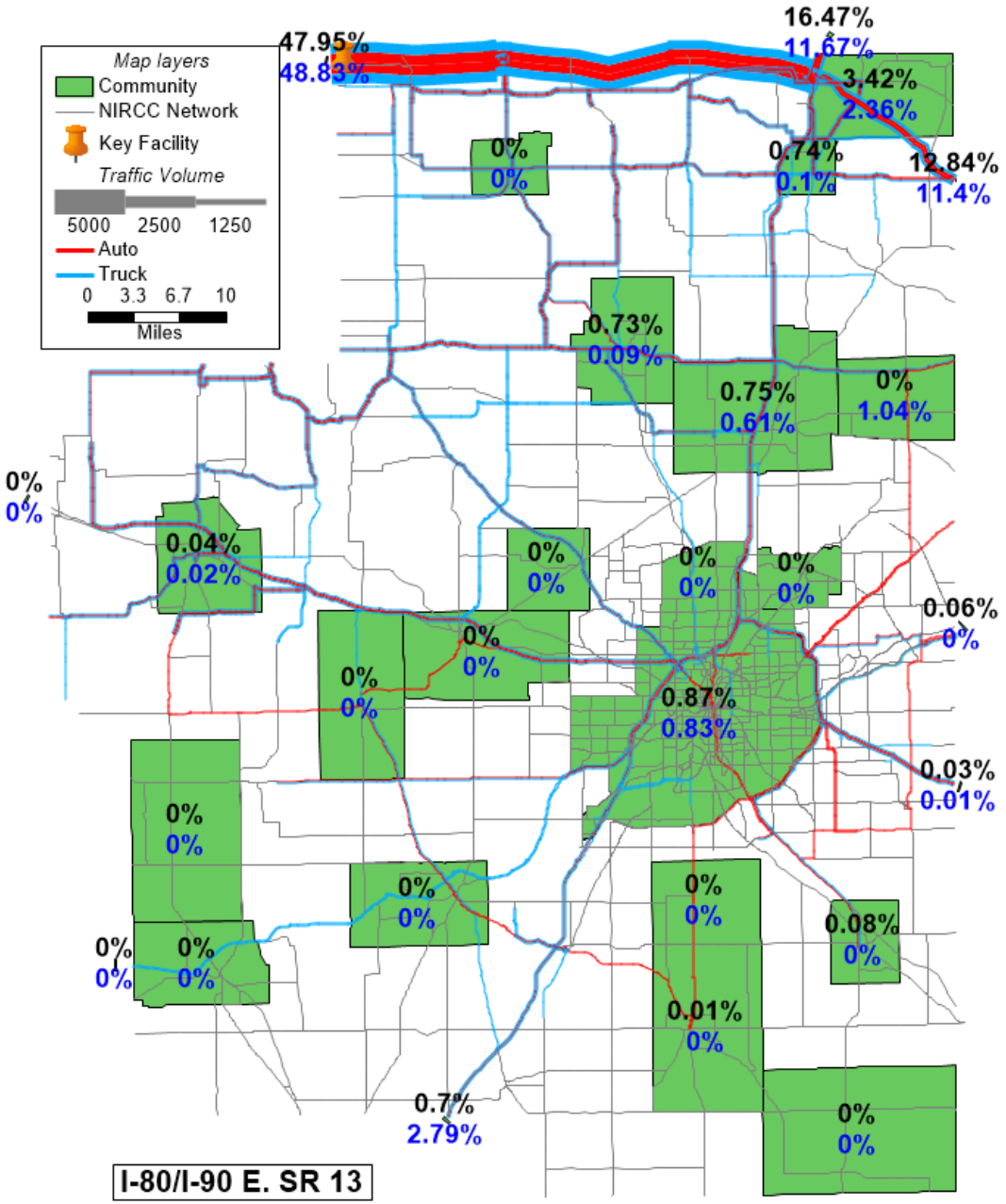


Top 20 Gates Serving Trips through the Region




Map layers
Community
NIRCC Network
Key Facility
Traffic Volume
5000 2500 1250
Auto
Truck
0 3.3 6.7 10
Miles
6.02%
8.59%
31.48%
31.48%
8.05%
8.03%
0.09%
0.04%
4.75%
0.69%
5.47%
7.59%
1.22%
0.3%
1.38%
2%
0.19%
0.92%
0%
0%
0.09%
0.03%
0.14%
0%
0.23%
0.16%
0.14%
0.02%
0.06%
0.13%
0.21%
0.16%
0.72%
0%
5.05%
5.29%
0.8%
0.75%
0%
0%
0.06%
0.12%
0.01%
0.02%
0.07%
0.12%
0.1%
0.31%
0.03%
0.05%
0.06%
0.26%
3.95%
6.39%
0.04%
0.02%
I-69 N. of I-80/I-90


Map layers
Community
NIRCC Network
Key Facility
Traffic Volume
5000 2500 1250
Auto
Truck
0 3.3 6.7 10
Miles
0%
0%
0.07%
0.33%
0.04%
0.02%
0.03%
0%
0.05%
0.01%
0.03%
0.01%
0.13%
0.04%
0.17%
0.07%
0.03%
0.04%
0%
0%
0.3%
0.21%
0.17%
0.04%
0.24%
0.02%
0.03%
0.04%
9.24%
20.58%
0.69%
0.33%
0.08%
0.03%
34.9%
18.79%
0.56%
0.76%
0.08%
0.05%
2.12%
1.58%
5.49%
0.64%
1.6%
1.19%
1.54% 1.35%
2.59% 0.68%
4.04%
1.16%
9.82%
24.03%
0.41%
0.33%
I-469 E. of I-69S


Map layers
Community
NIRCC Network
Key Facility
Traffic Volume
5000 2500 1250
Auto
Truck
0 3.3 6.7 10
Miles
47.95%
48.83%
16.47%
11.67%
3.42%
2.36%
0.74%
0.1%
12.84%
11.4%
0%
0%
0.73%
0.09%
0.75%
0.61%
0%
1.04%
0%
0%
0.04%
0.02%
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0.87%
0.83%
0.03%
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0%
0%
0%
0.08%
0%
0.01%
0%
0.7%
2.79%
0%
0%
I-80/I-90 E. SR 13

Contacts

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