

EXPRESS LANE OPERATIONAL ANALYSIS EXPERIENCES IN FLORIDA

15TH INTERNATIONAL CONFERENCE ON
MANAGED LANES



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Senior Transportation Engineer

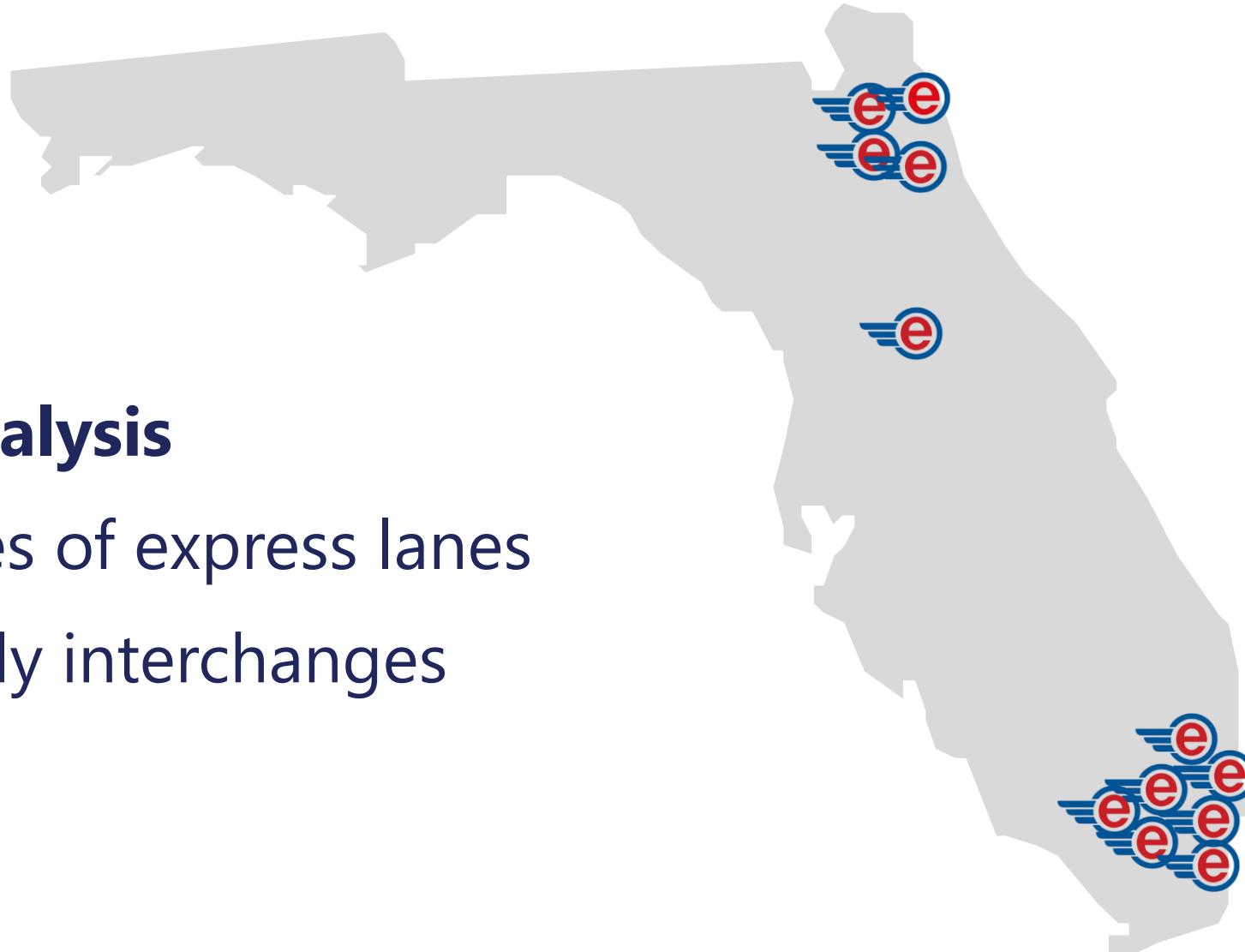


Presentation Agenda

- » Florida express lane projects
- » Data collection requirements
- » Traffic volume development
- » Express lane implementation
- » Output presentation
- » Lessons learned



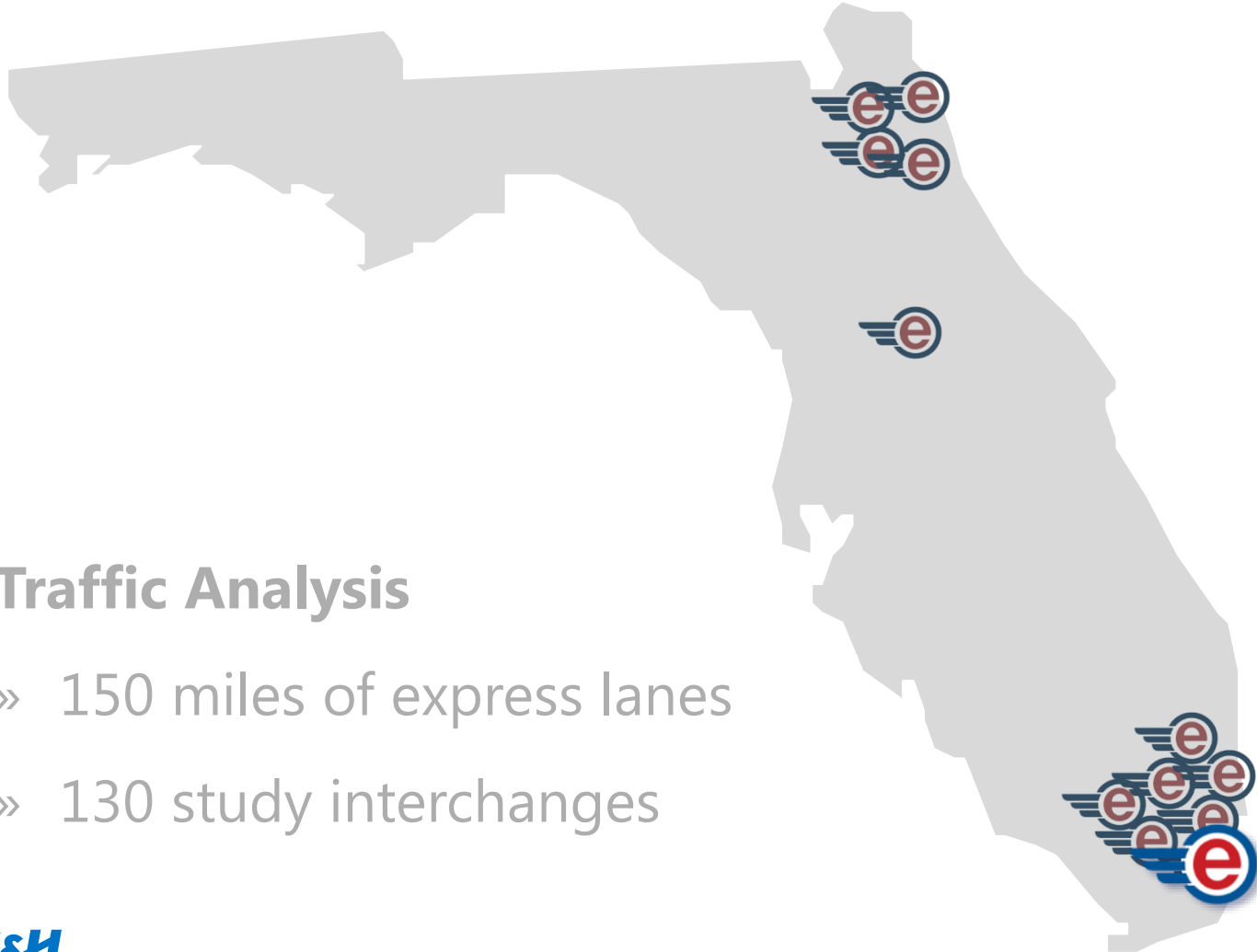
Florida Express Lane Experience



Traffic Analysis

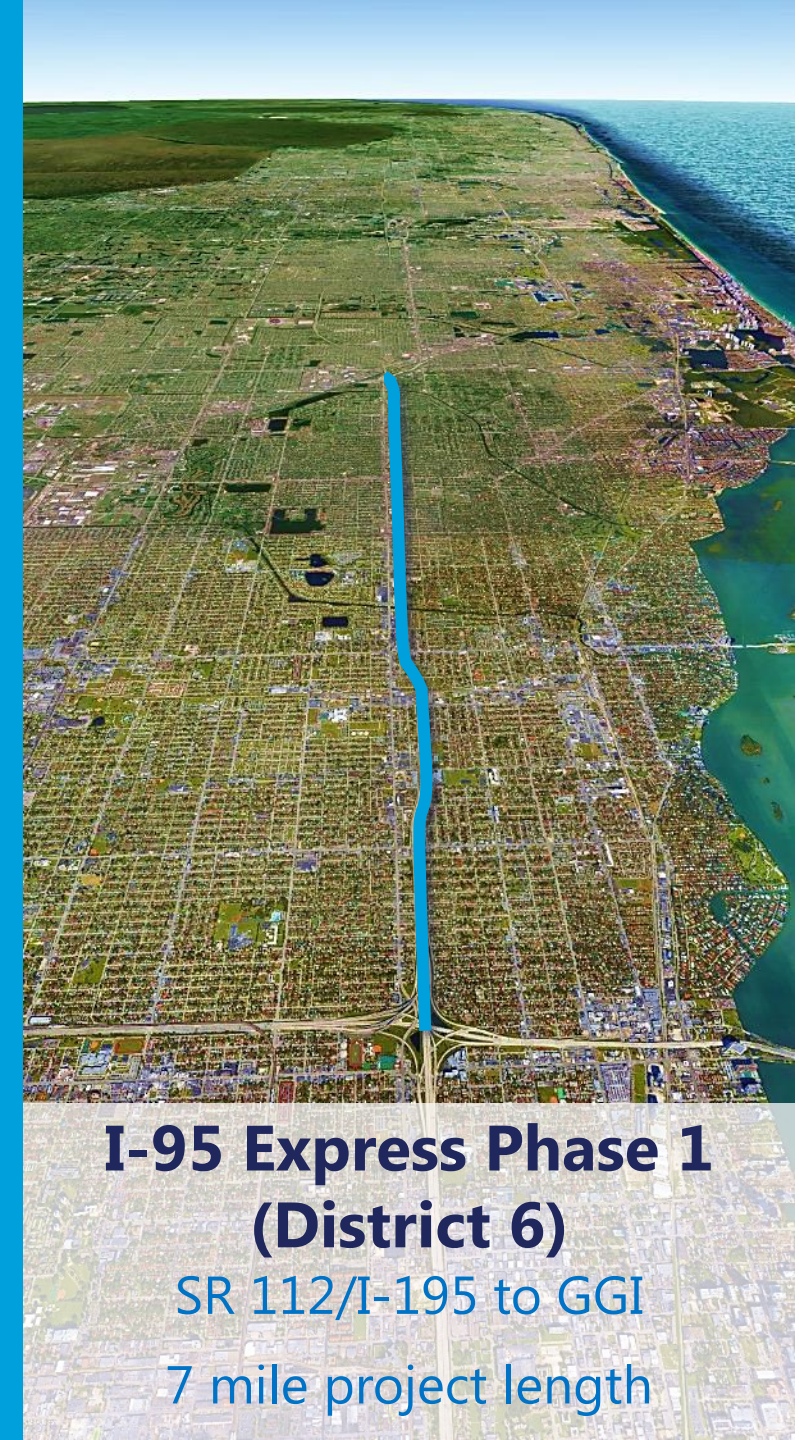
- » 150 miles of express lanes
- » 130 study interchanges

Express Lane Experience



Traffic Analysis

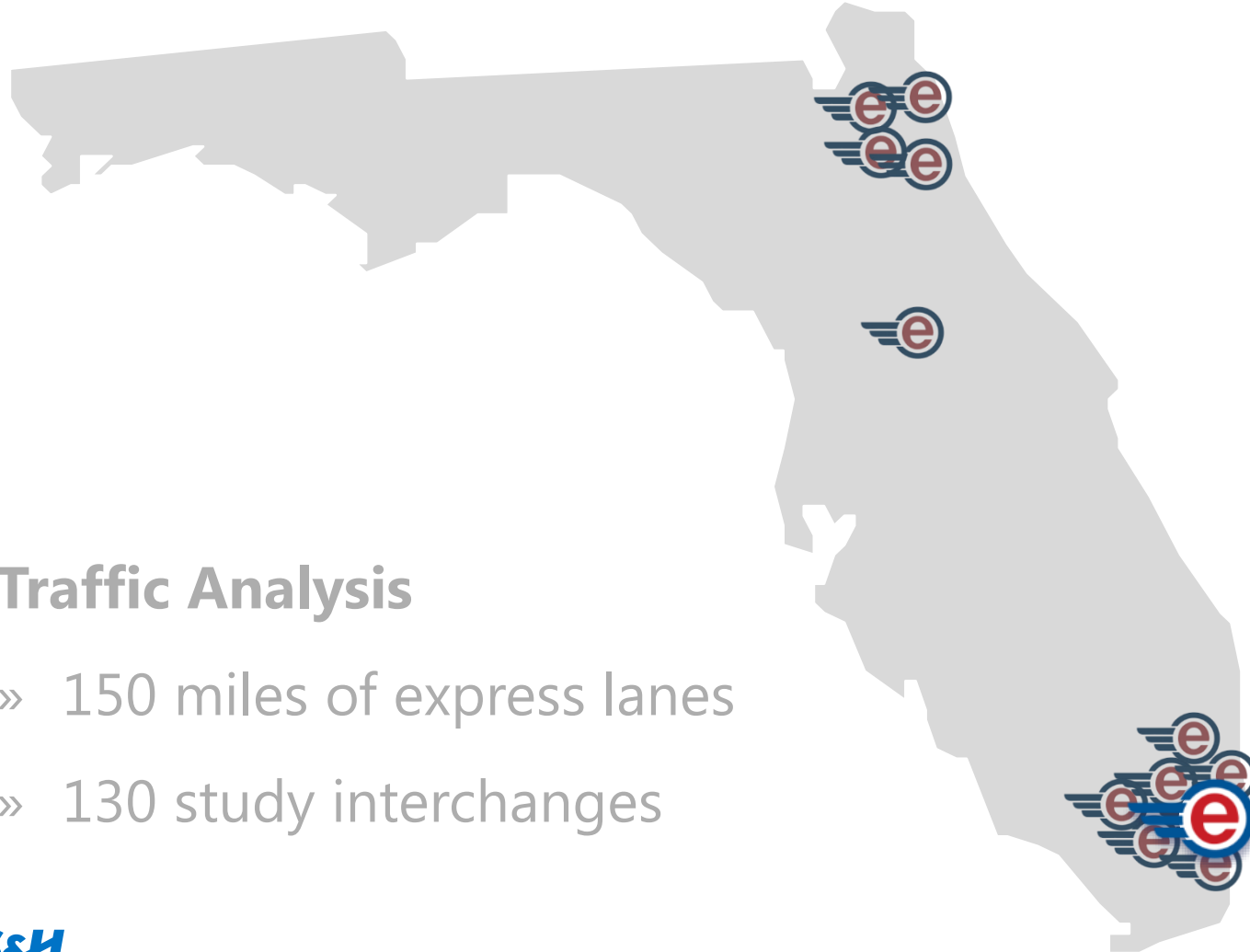
- » 150 miles of express lanes
- » 130 study interchanges



I-95 Express Phase 1 (District 6)

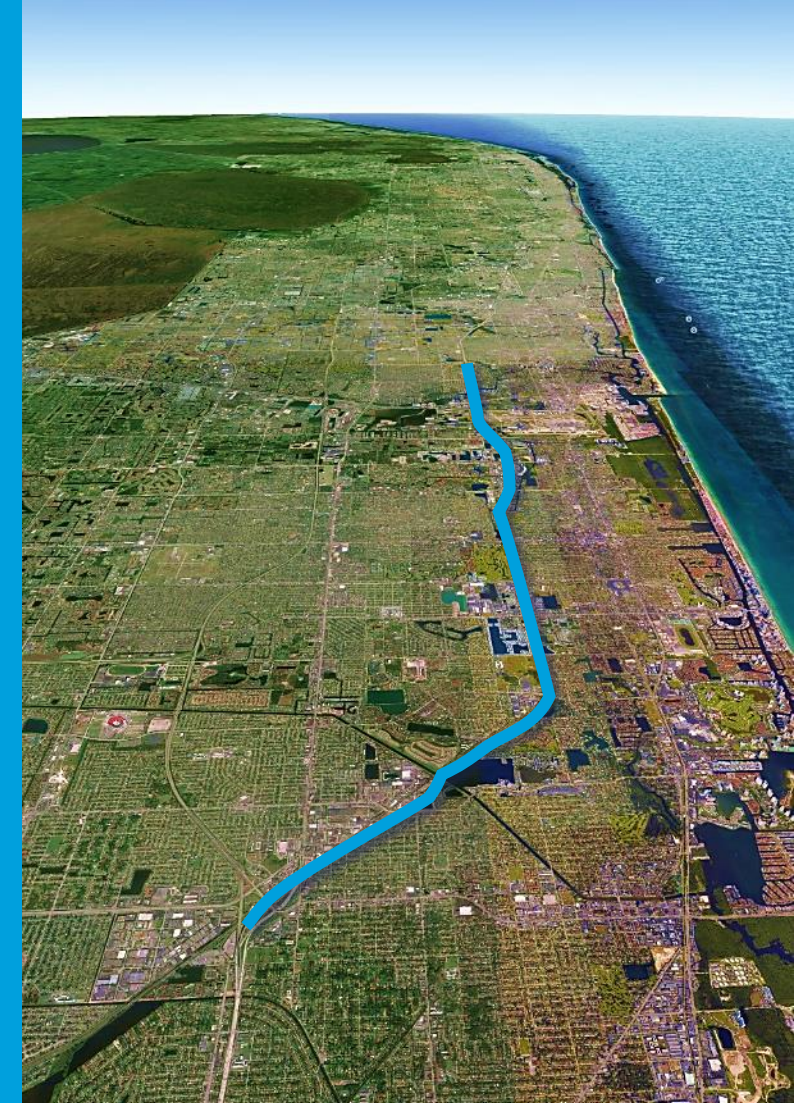
SR 112/I-195 to GGI
7 mile project length

Express Lane Experience



Traffic Analysis

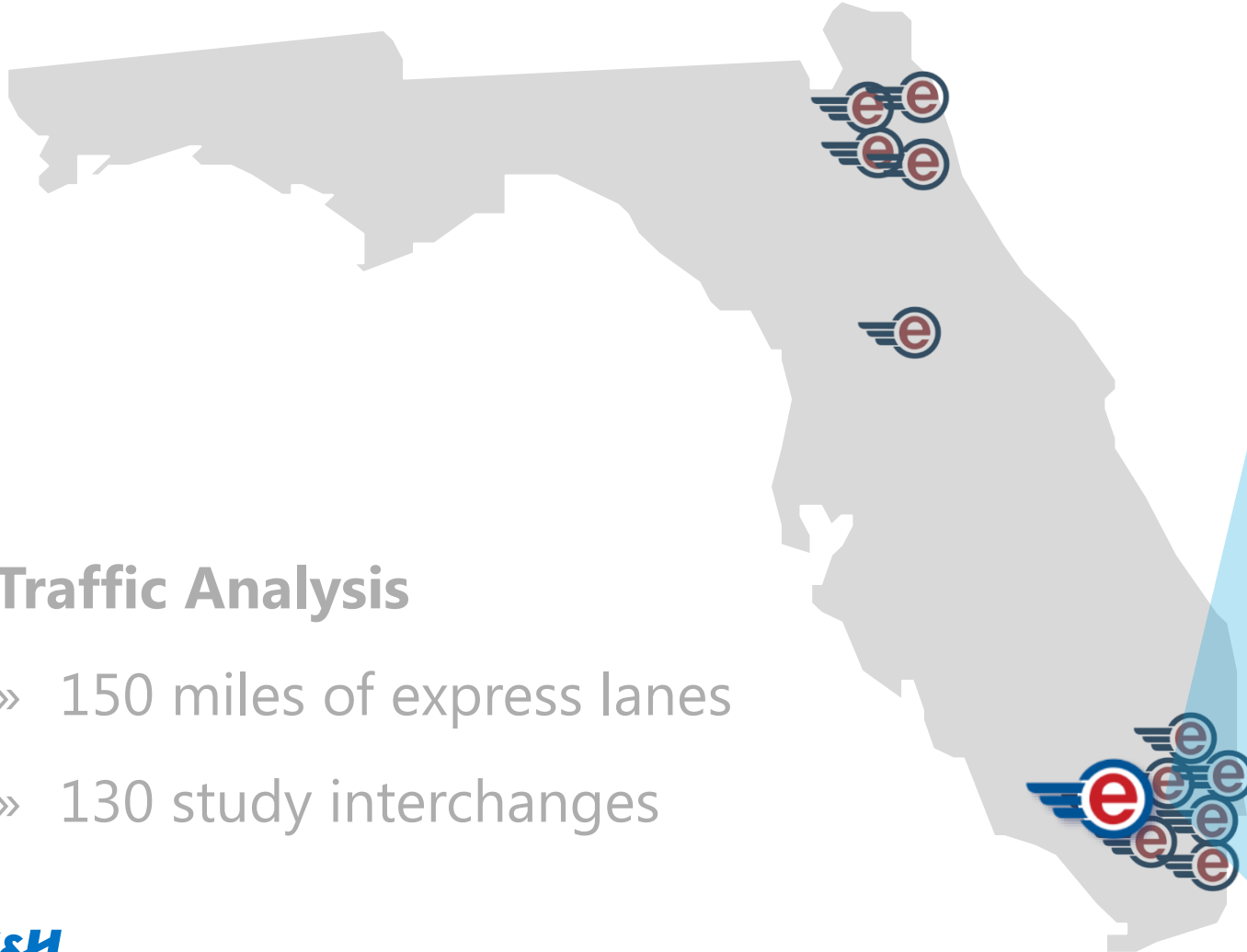
- » 150 miles of express lanes
- » 130 study interchanges



I-95 Express Phase 2 (District 4 and 6)

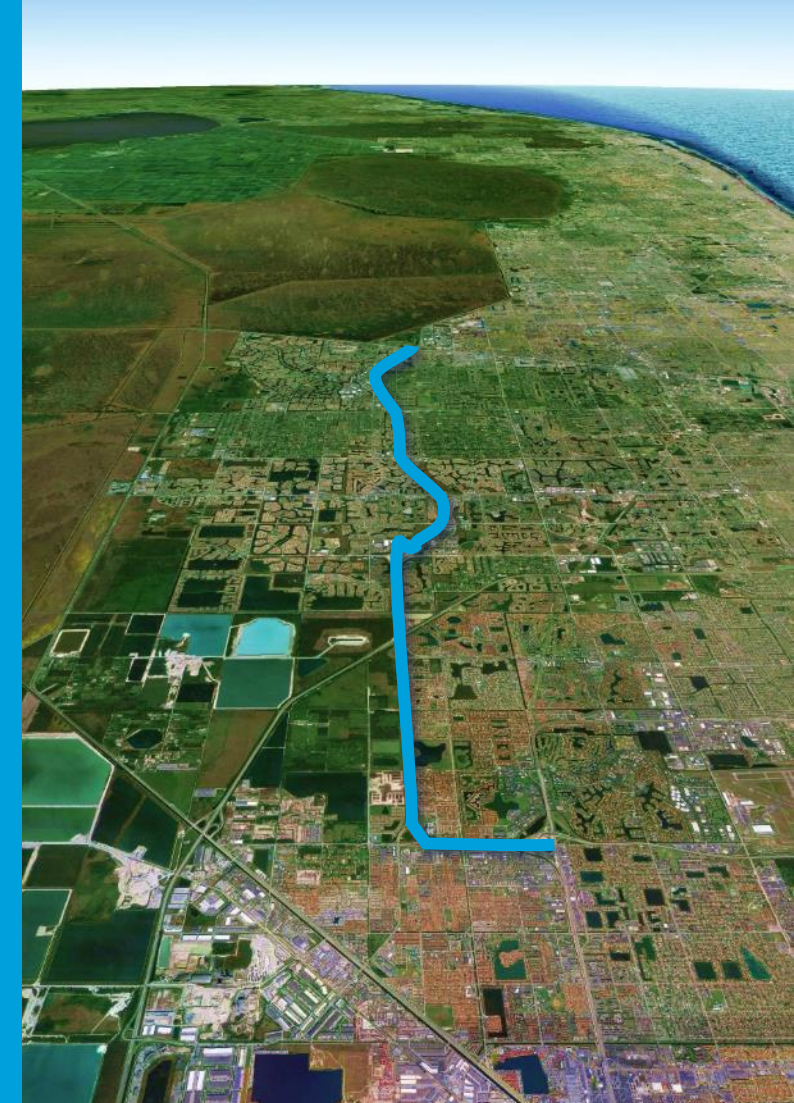
GGI to Broward Blvd
15 mile project length

Express Lane Experience



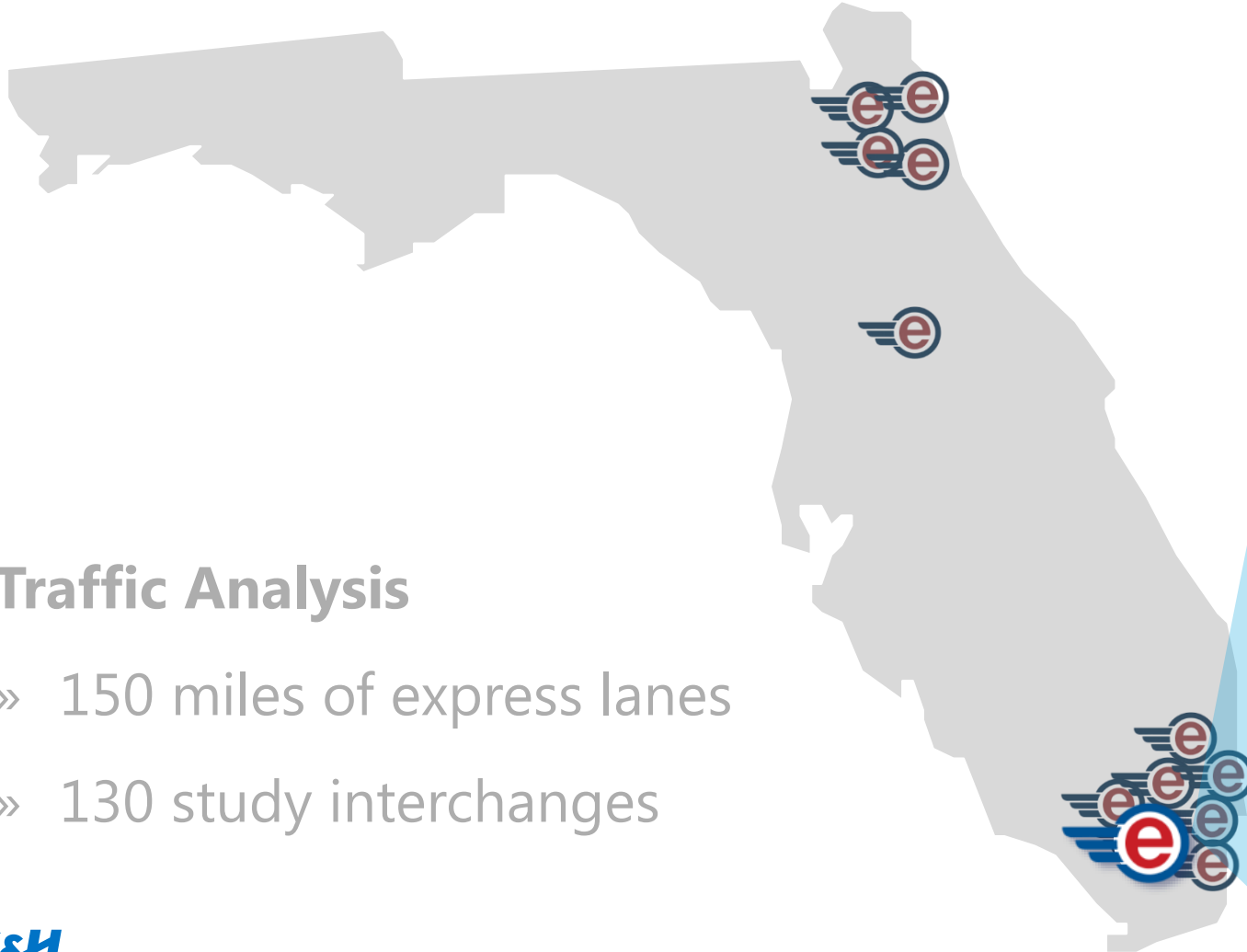
Traffic Analysis

- » 150 miles of express lanes
- » 130 study interchanges



**I-75 PD&E
(District 4 and 6)**
Palmetto Expressway to I-595
19 mile project length

Express Lane Experience



Traffic Analysis

- » 150 miles of express lanes
- » 130 study interchanges

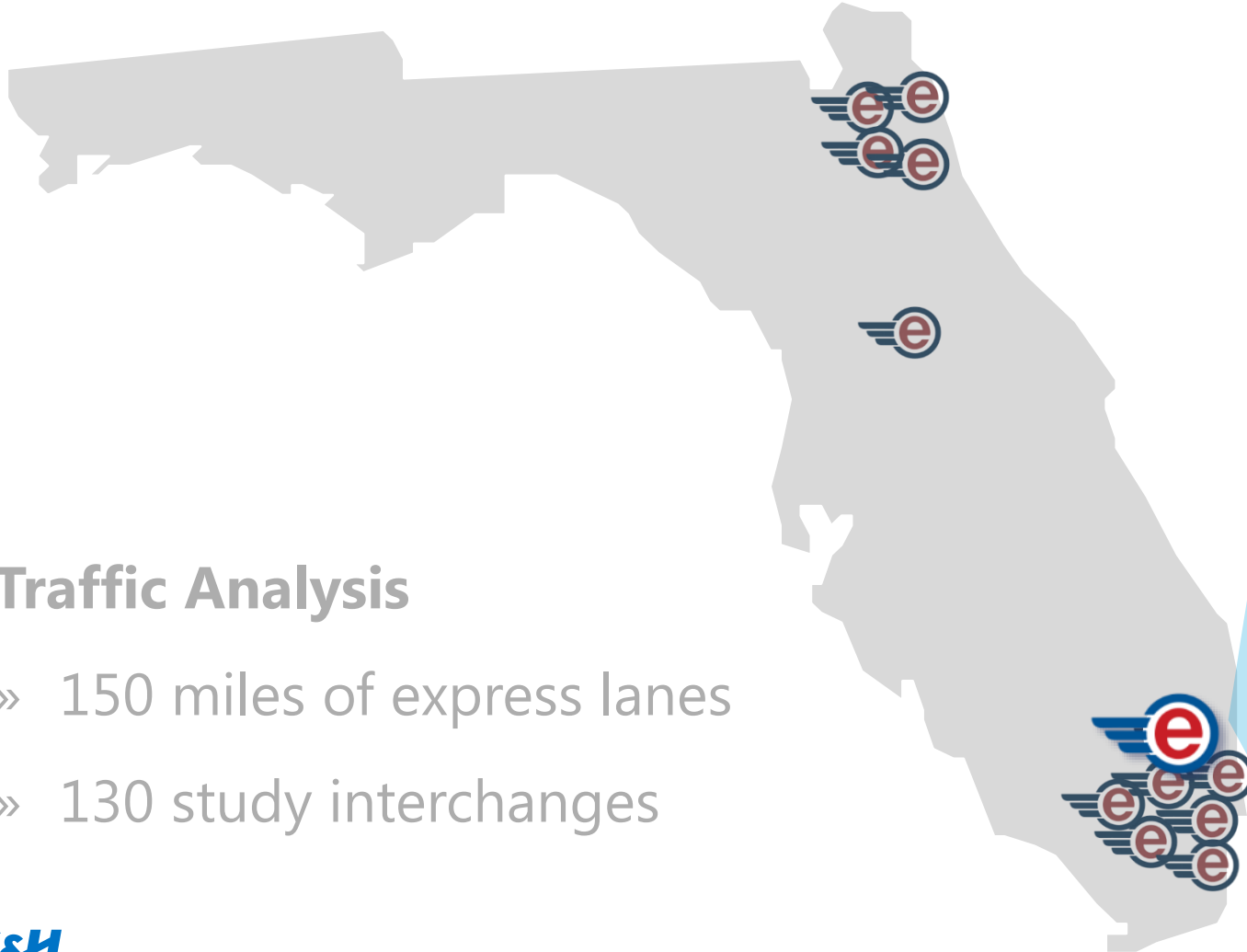


Palmetto Express (N/S) (District 6)

SR 836 to NW 154th Street

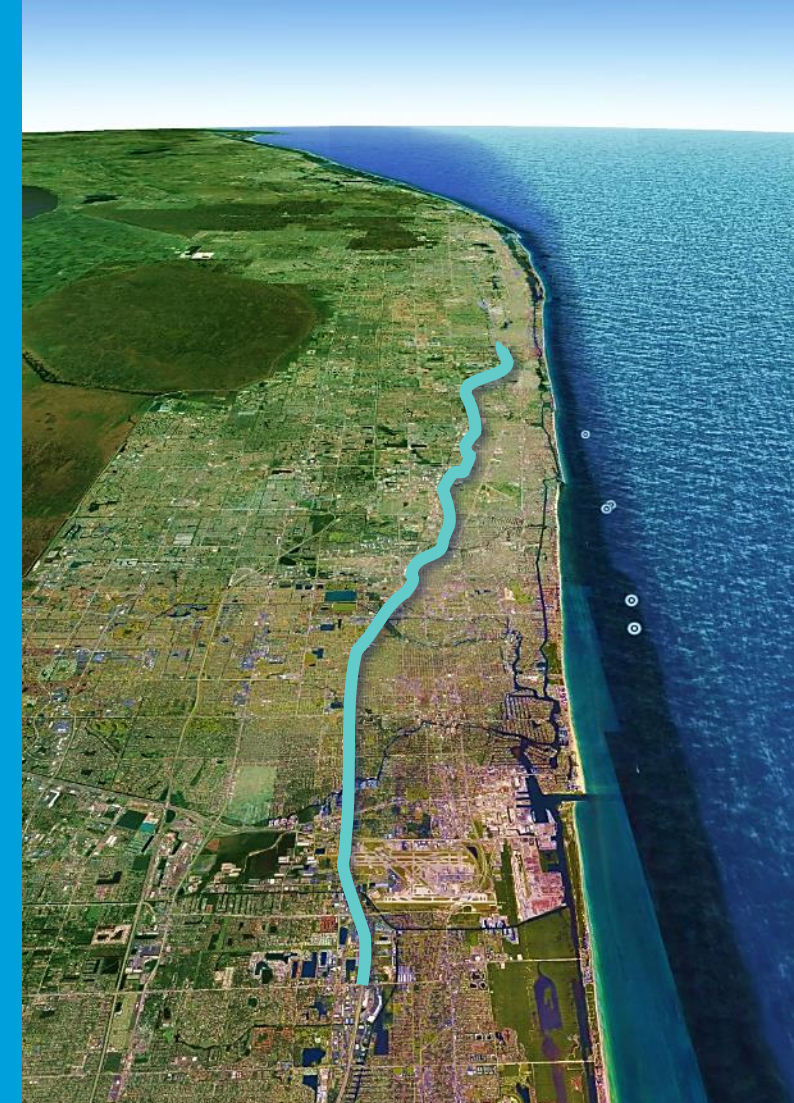
9 mile project length

Express Lane Experience



Traffic Analysis

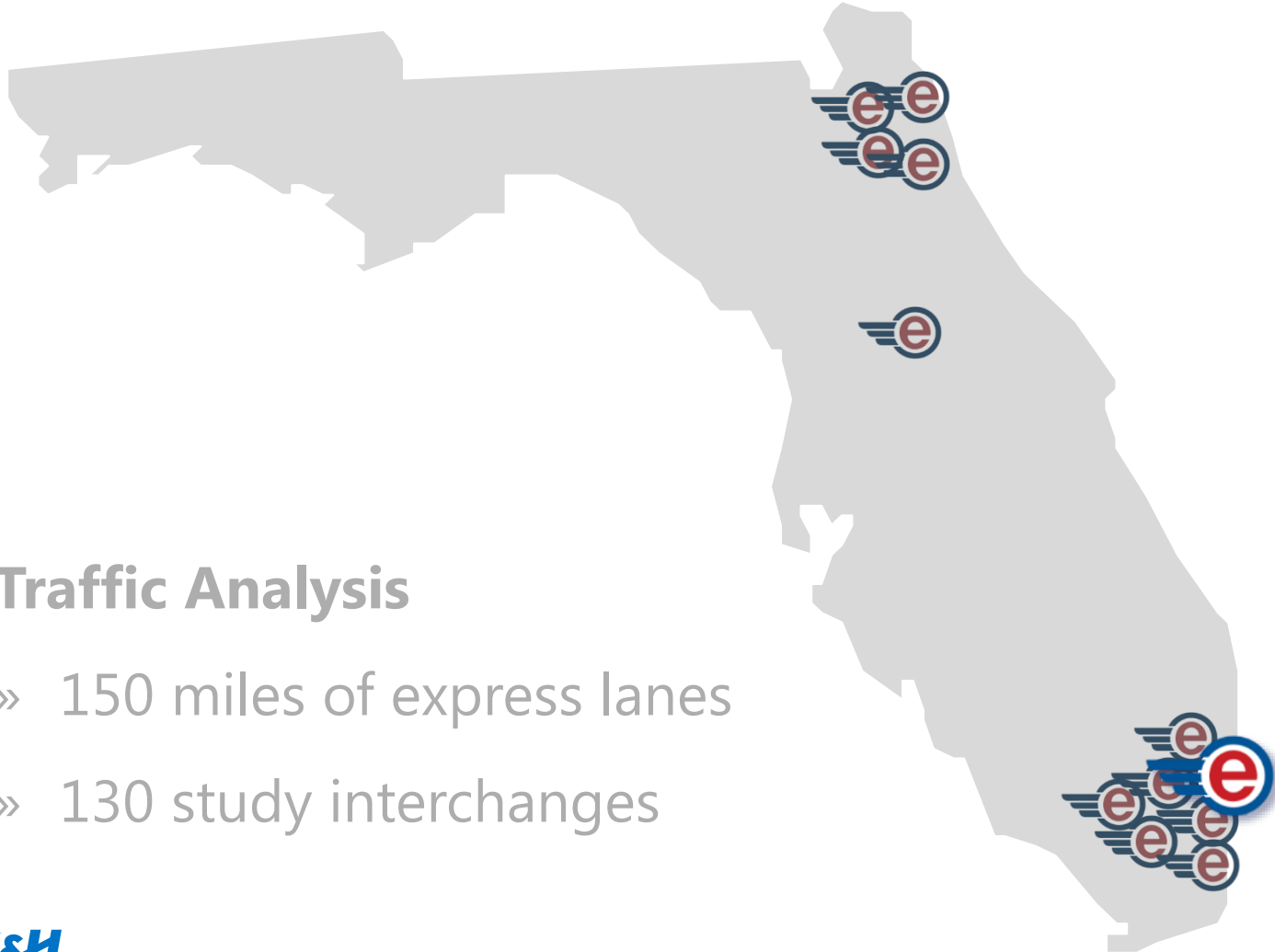
- » 150 miles of express lanes
- » 130 study interchanges



I-95 Express Phase 3 (District 4)

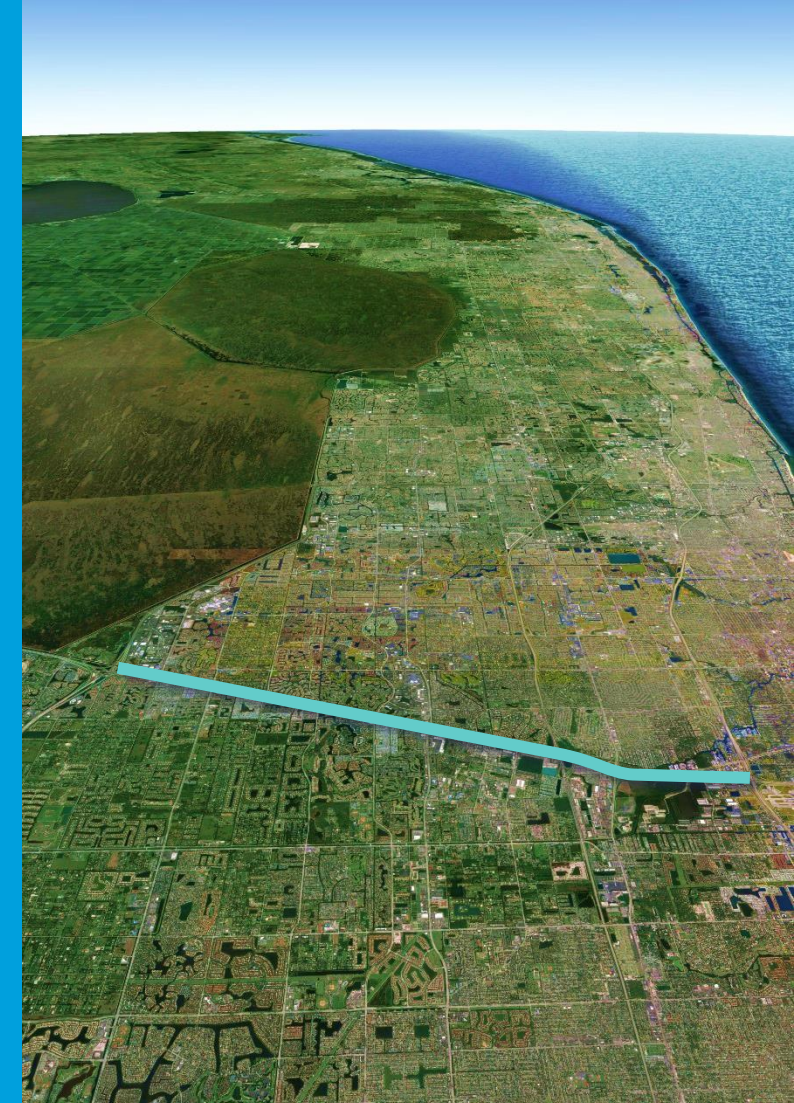
Stirling Rd to Linton Blvd
29 mile project length

Express Lane Experience



Traffic Analysis

- » 150 miles of express lanes
- » 130 study interchanges

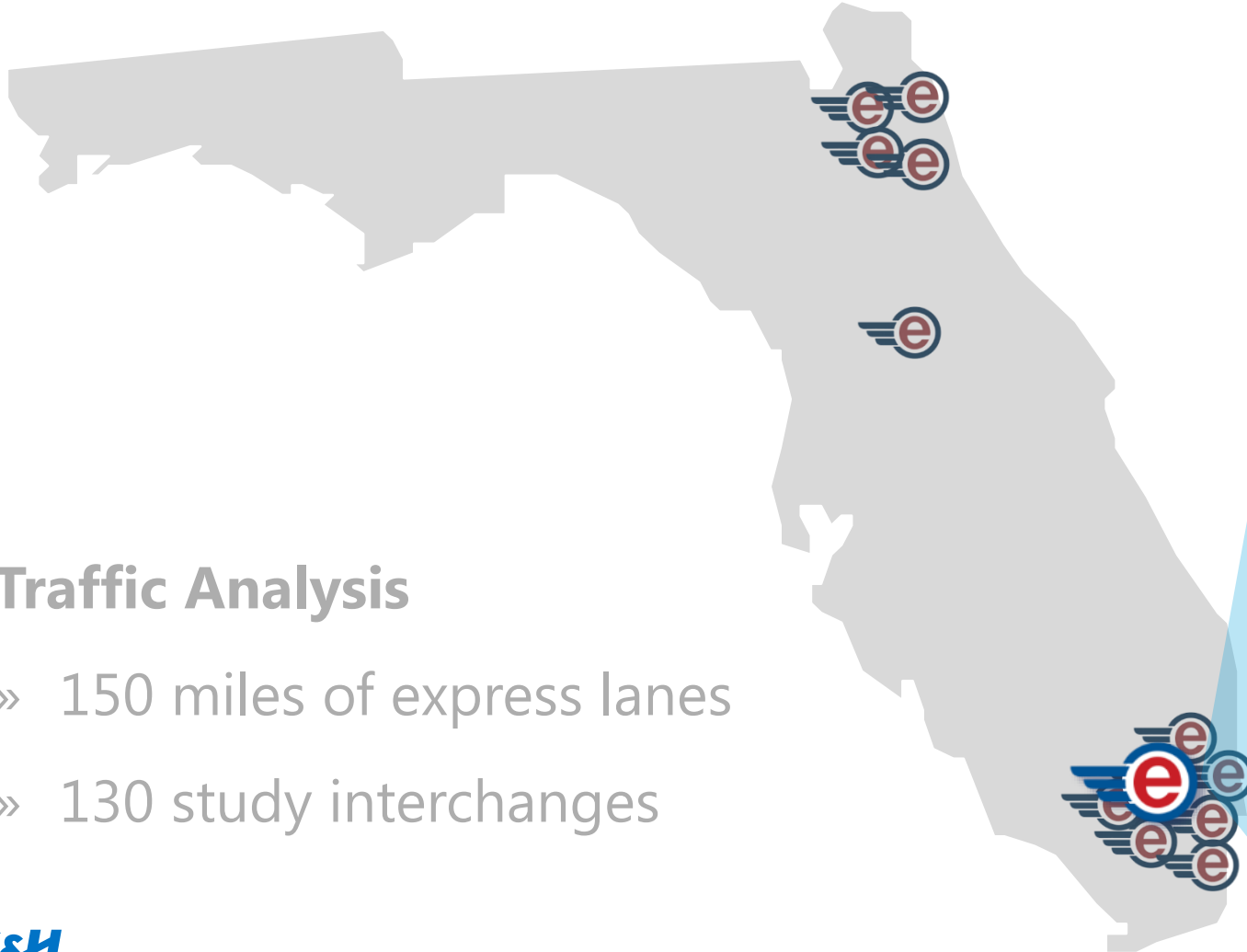


**I-595 PD&E Reeval.
(District 4)**

I-75 to I-95

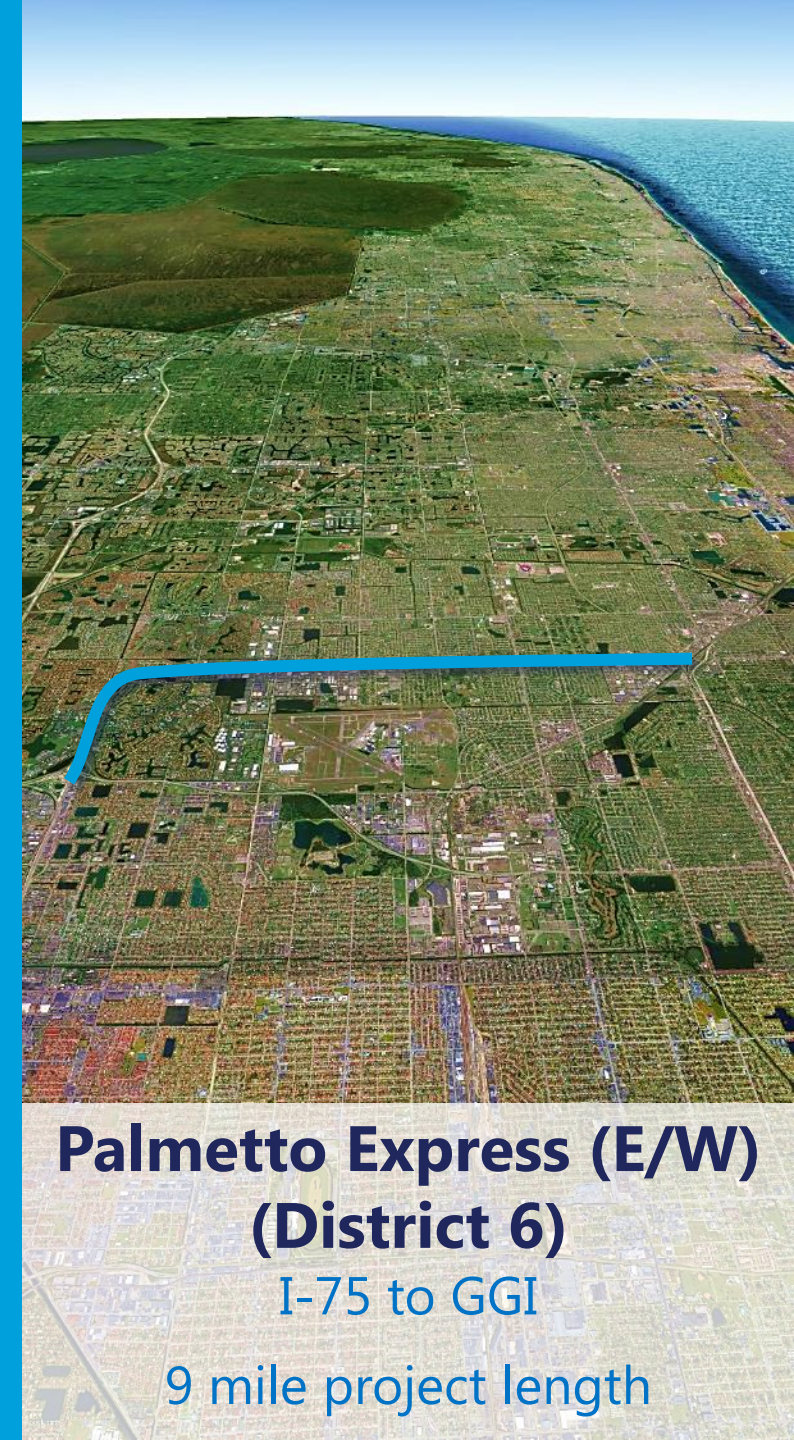
11 mile project length

Express Lane Experience



Traffic Analysis

- » 150 miles of express lanes
- » 130 study interchanges

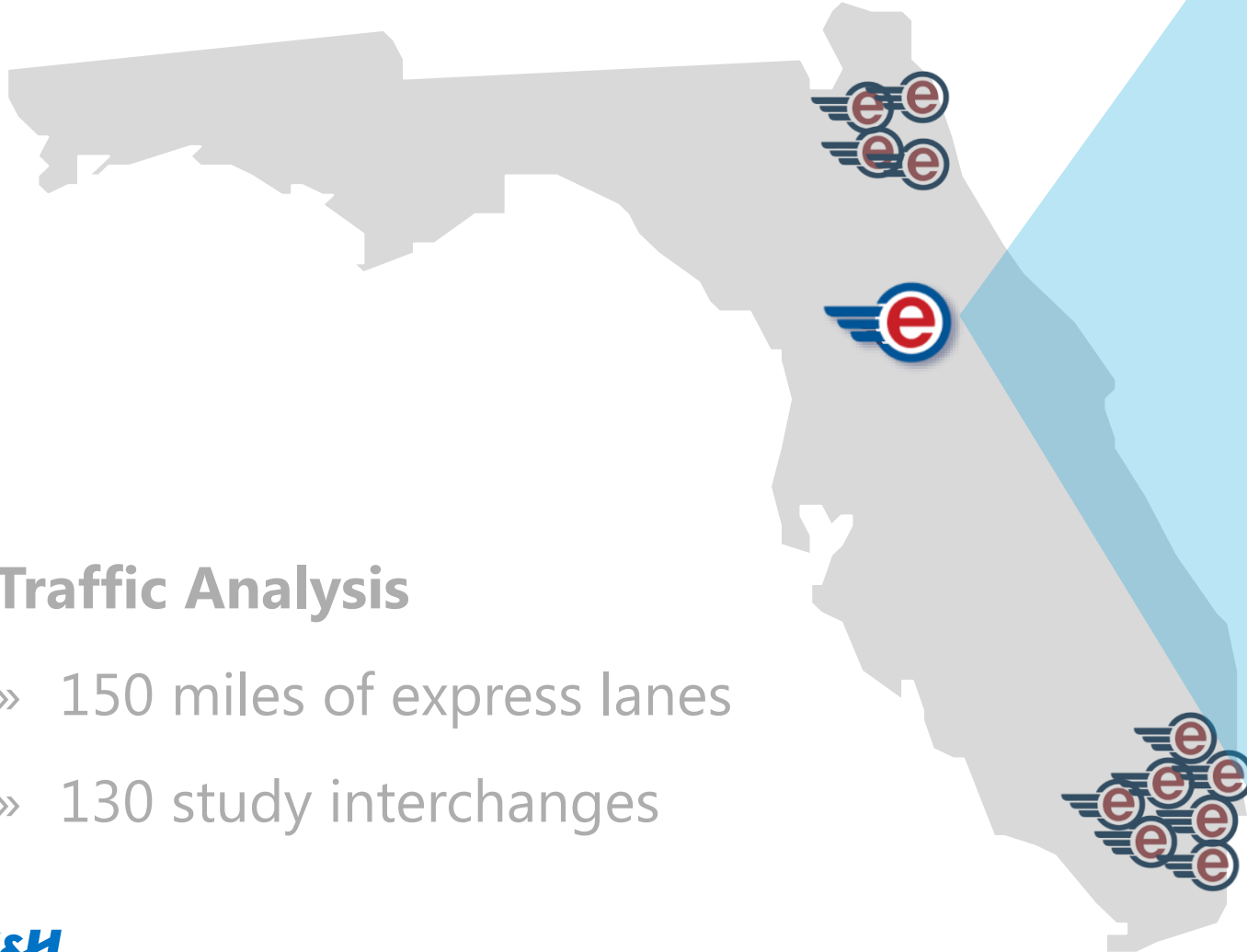


Palmetto Express (E/W) (District 6)

I-75 to GGI

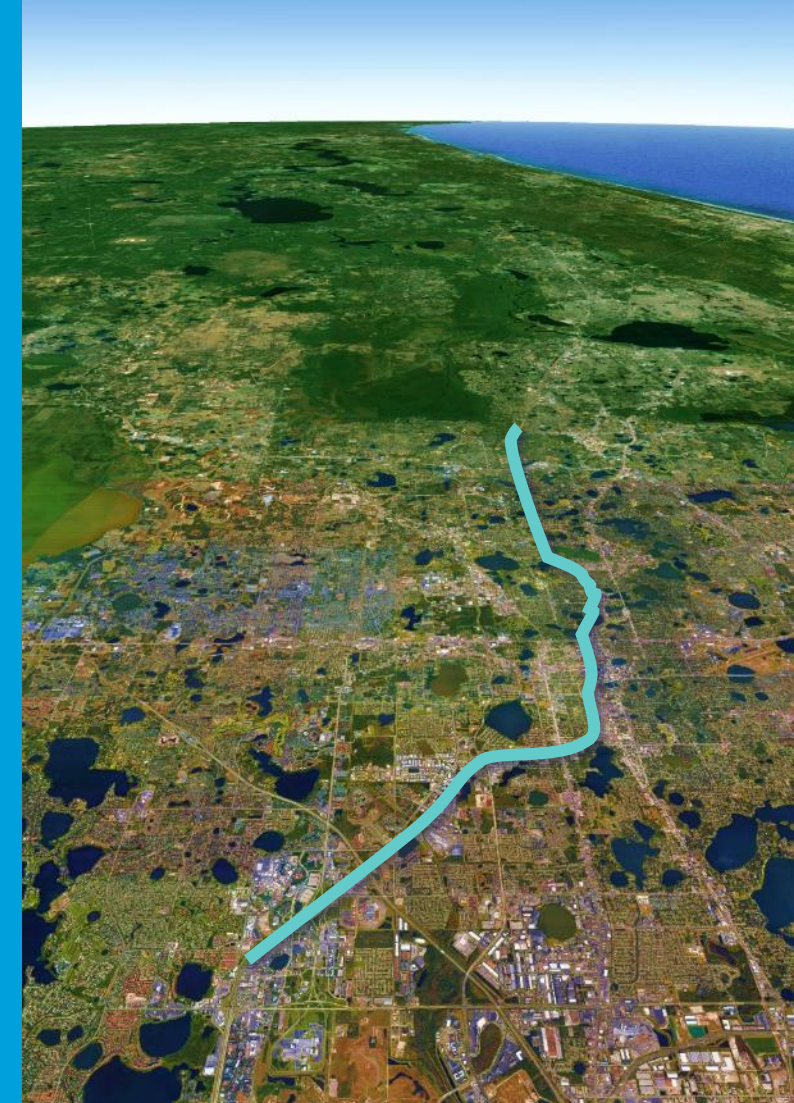
9 mile project length

Express Lane Experience



Traffic Analysis

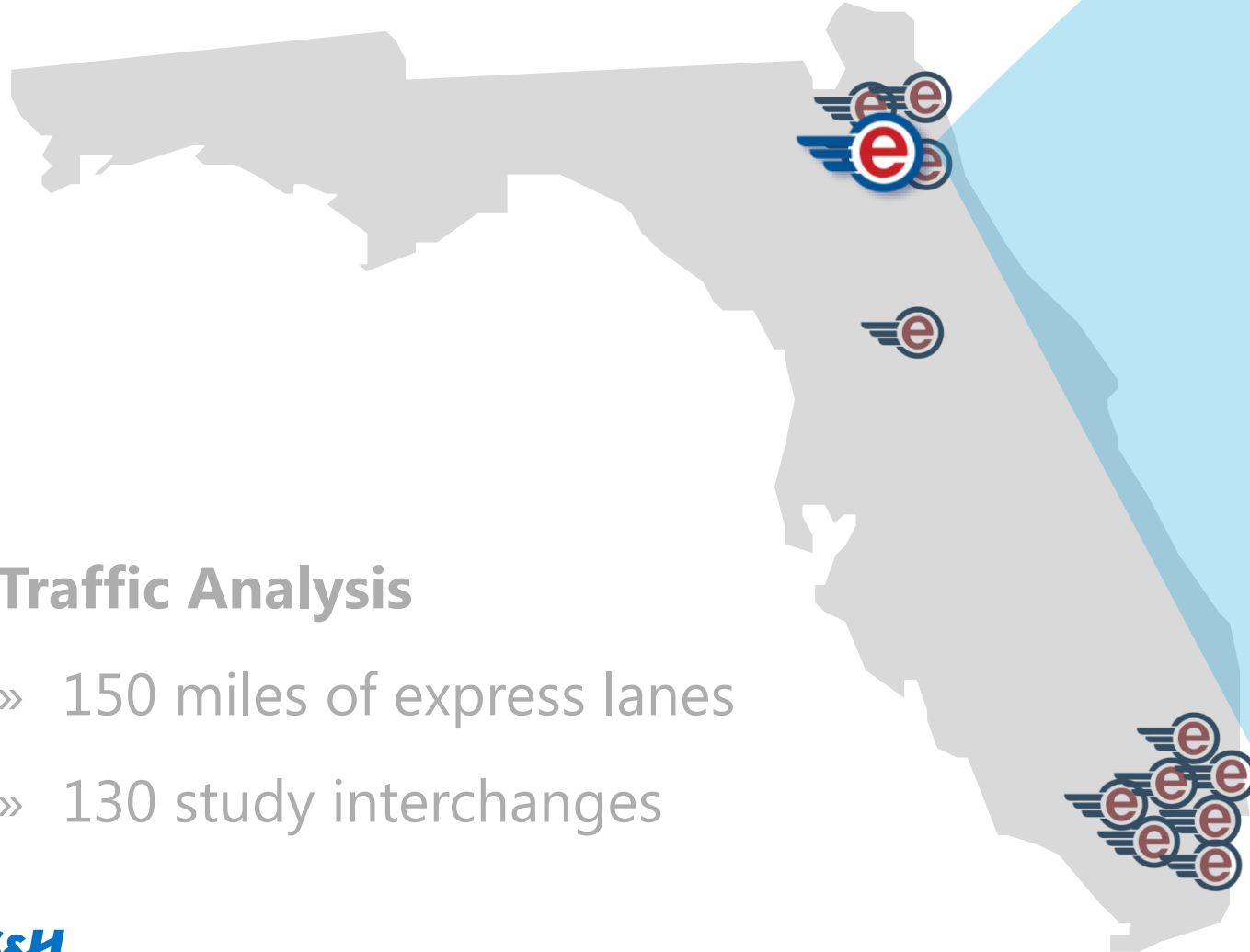
- » 150 miles of express lanes
- » 130 study interchanges



I-4 Ultimate P3 (District 5)

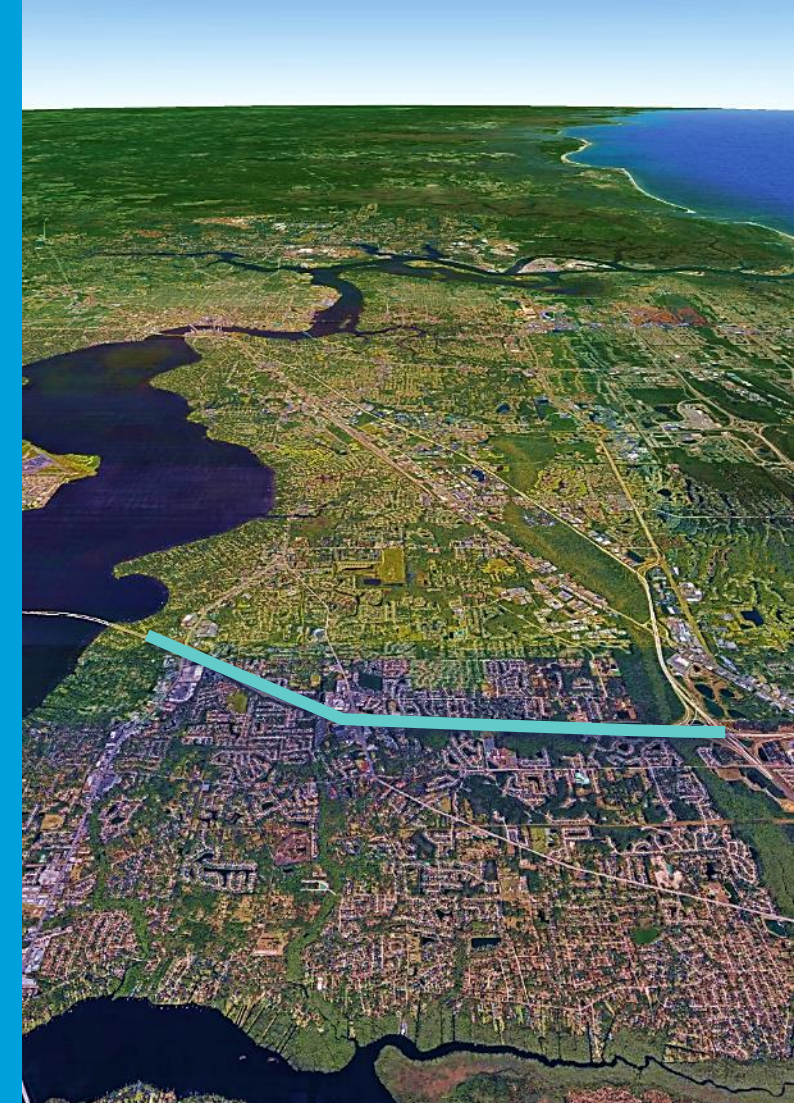
SR 435 (Kirkman Rd) to SR 434
21 mile project length

Express Lane Experience



Traffic Analysis

- » 150 miles of express lanes
- » 130 study interchanges

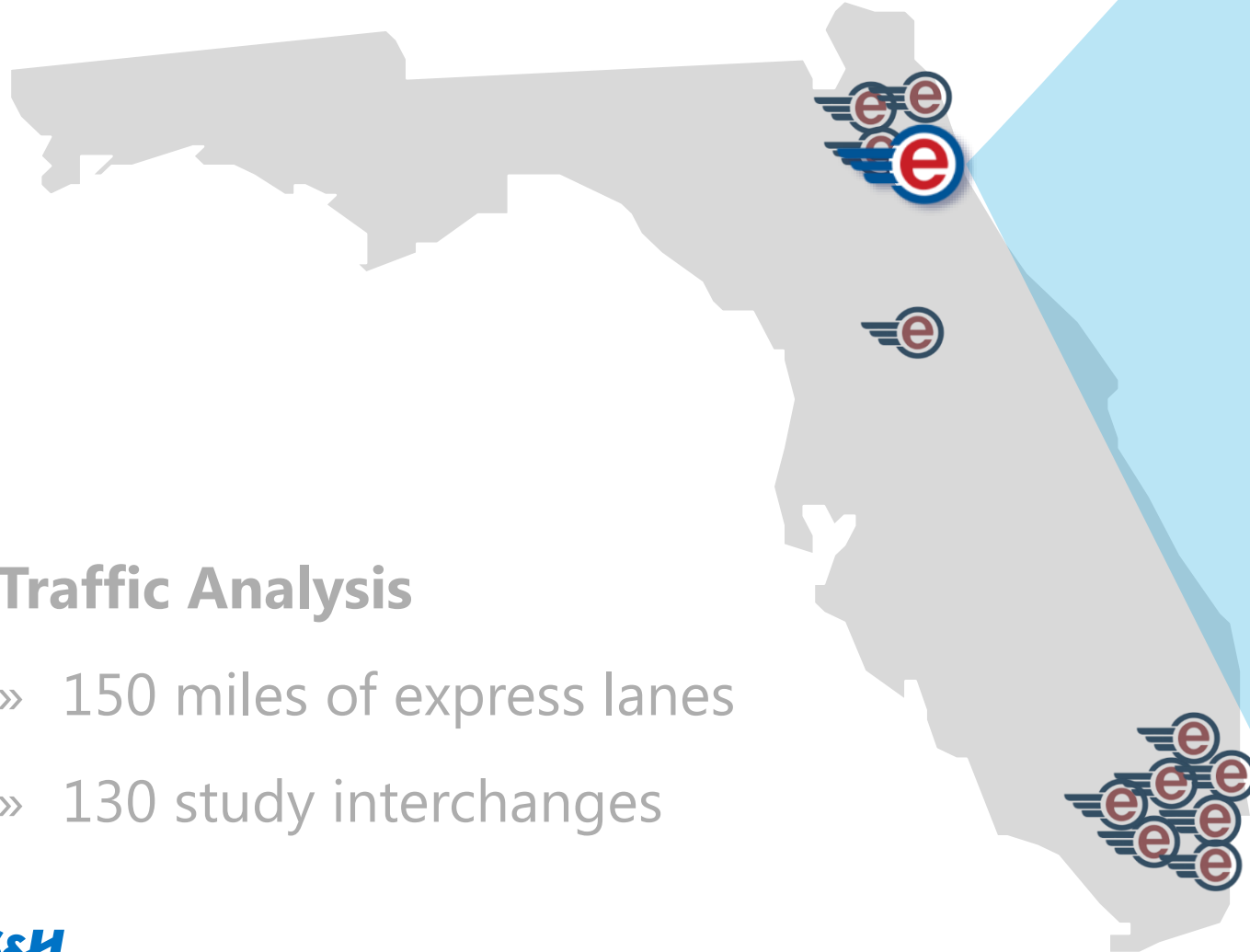


I-295 W Express Phase 1 (District 2)

SR 13/San Jose Blvd to I-95

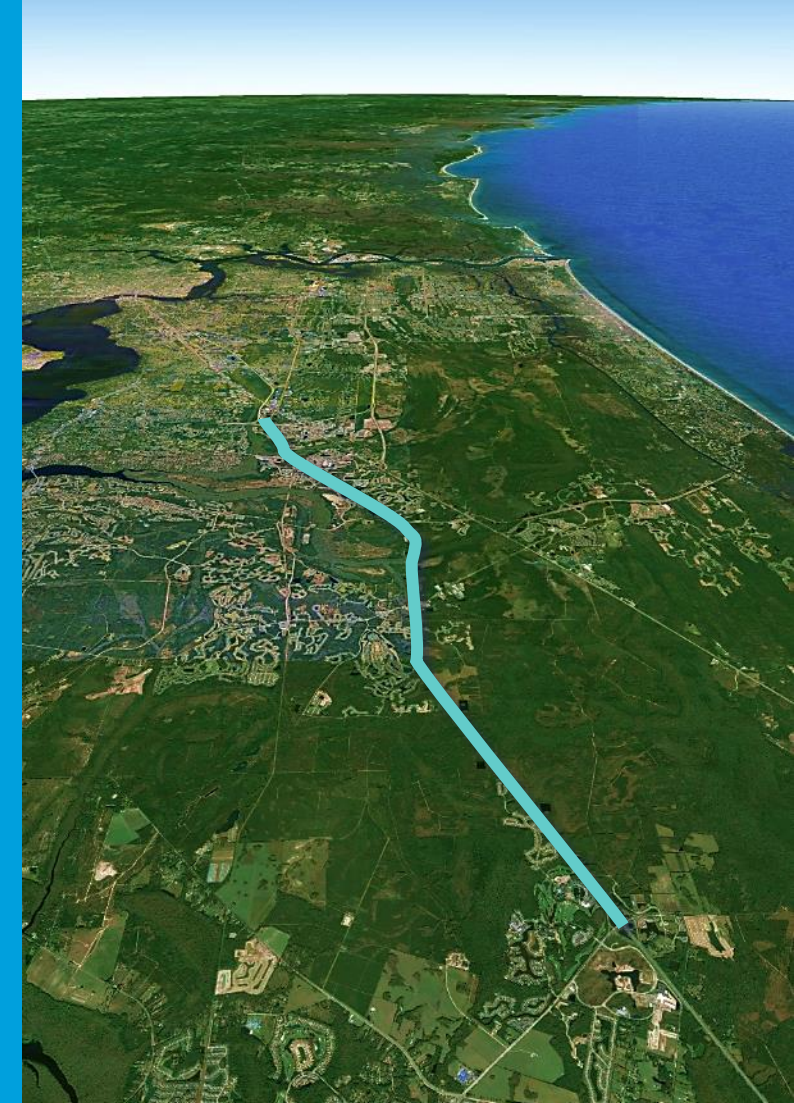
4 mile project length

Express Lane Experience



Traffic Analysis

- » 150 miles of express lanes
- » 130 study interchanges

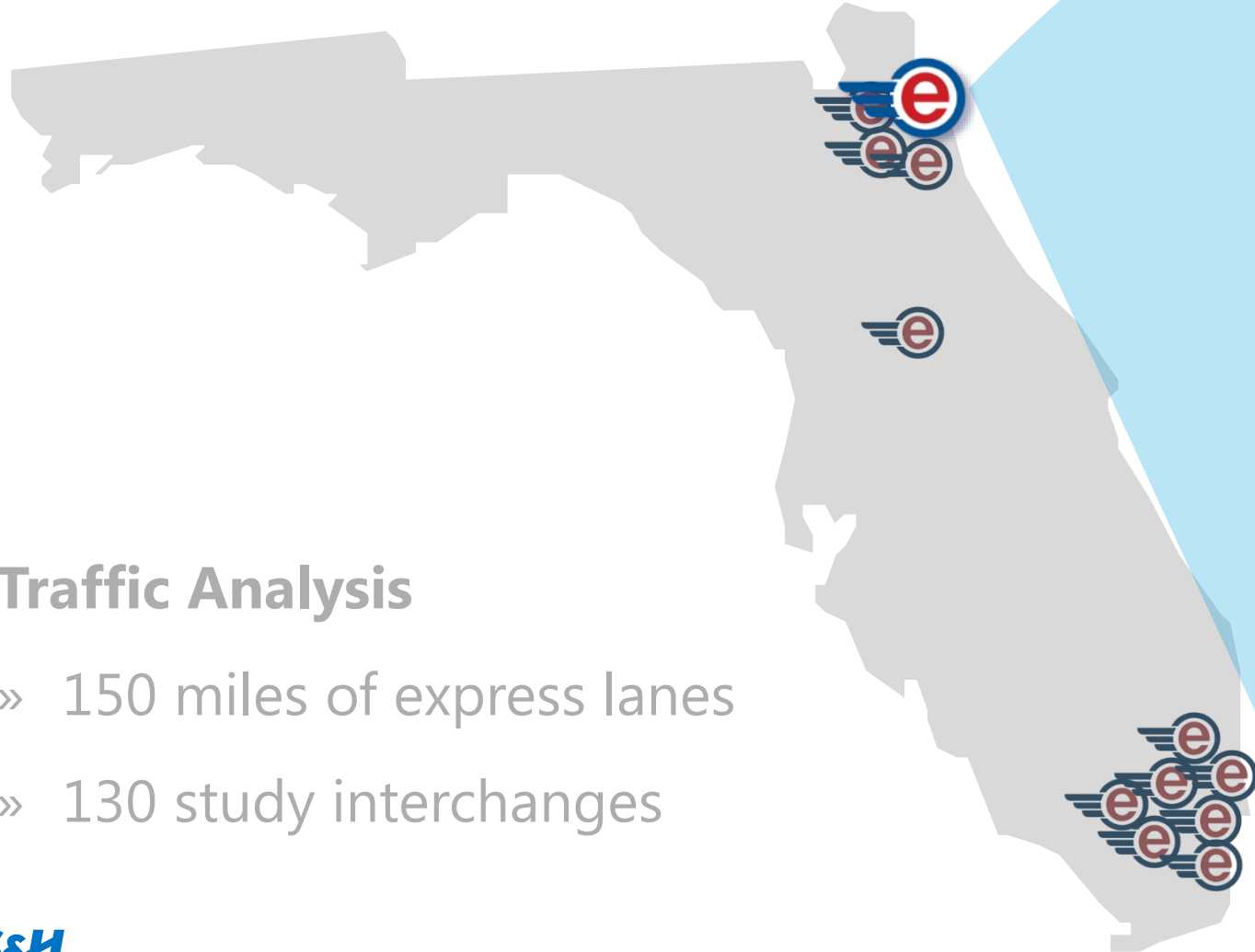


I-95 Express Phase 1 (District 2)

IGP to I-295

14 mile project length

Express Lane Experience



Traffic Analysis

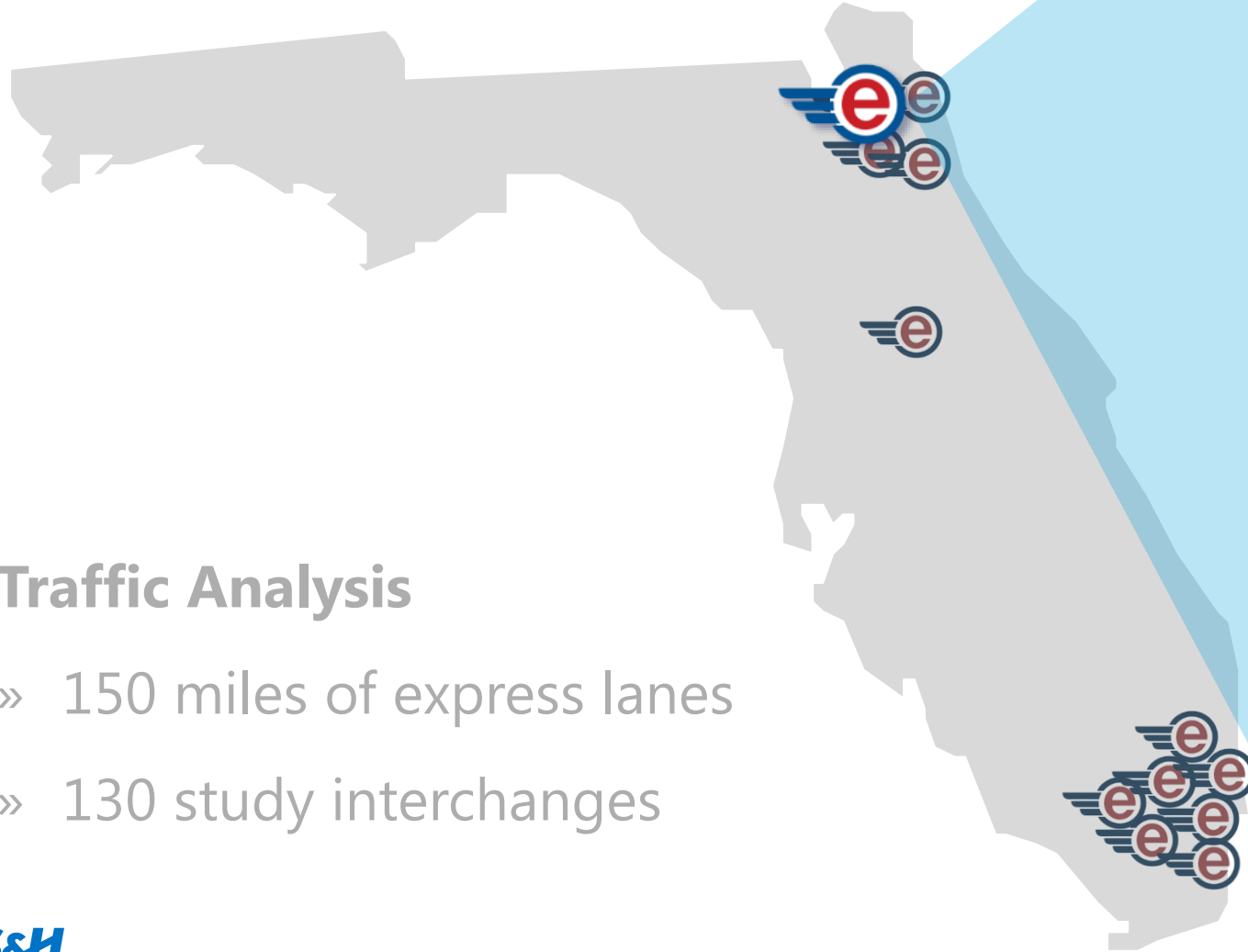
- » 150 miles of express lanes
- » 130 study interchanges



I-295 E Express Phase 1 (District 2)

SR 9B to Town Center Pkwy
7 mile project length

Express Lane Experience



Traffic Analysis

- » 150 miles of express lanes
- » 130 study interchanges

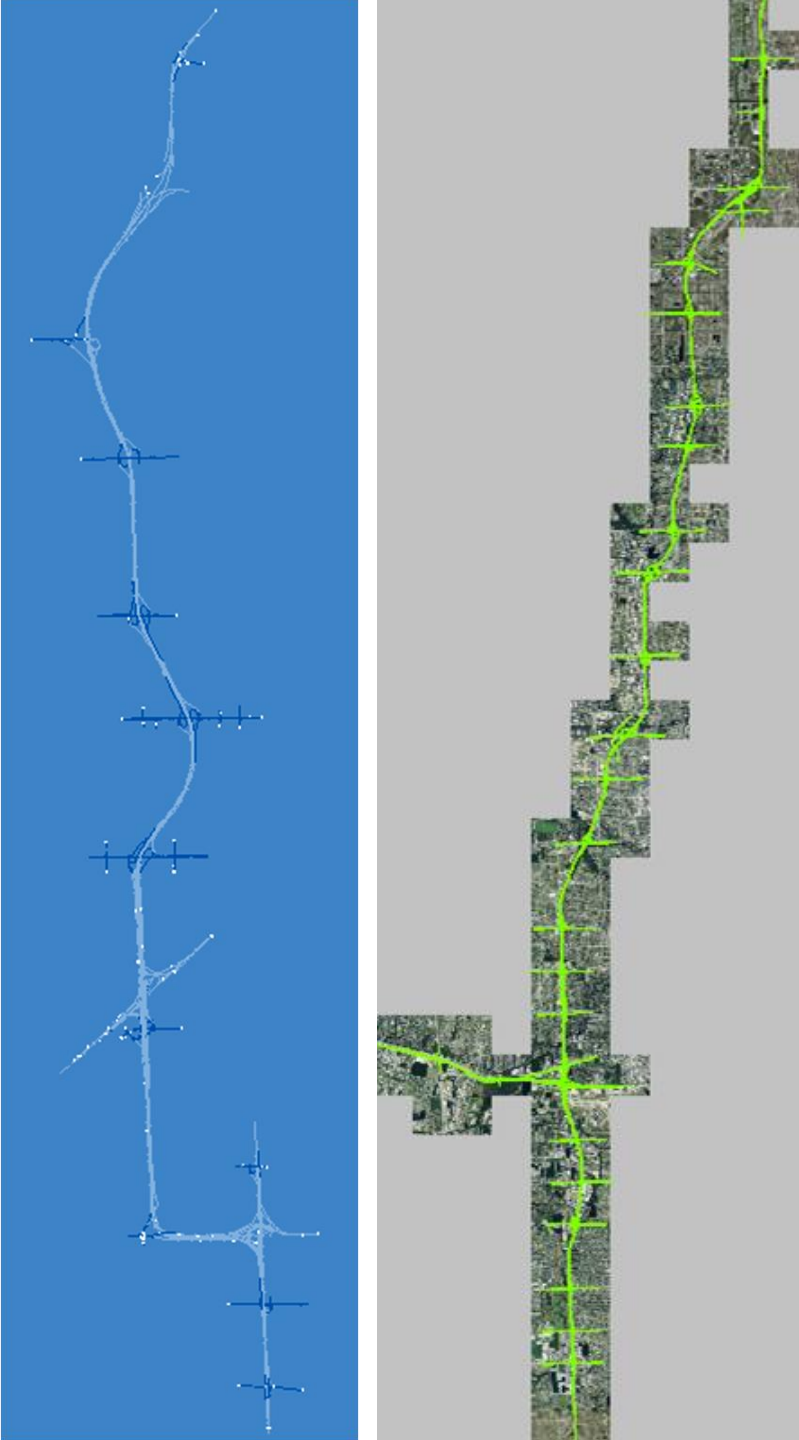


I-95 PD&E (District 2)

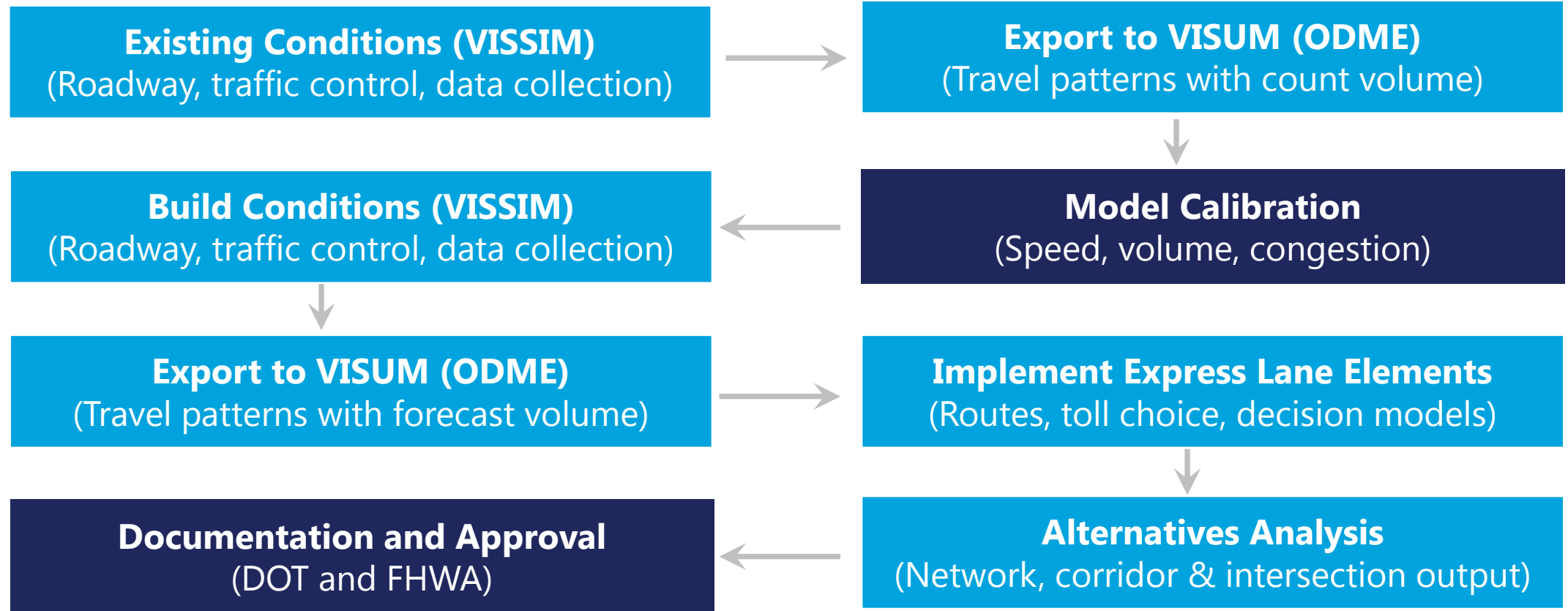
JTB to Atlantic Blvd
5 mile project length

Simulation Programs

- » TSIS / CORSIM
 - Initial Florida express lane projects
 - Manual/static express lane assignment
 - TSIS 6.3 provides managed lane functionality
- » PTV VISSIM
 - Currently used on most Florida express lane projects
 - Managed lane facilities (dynamic tolling)
 - *VISSIM 5.4*
 - *VISSIM 6 (issues with COM scripts)*
 - *VISSIM 7*
 - *VISSIM 8*



Work Flow for VISSIM Express Lane Analysis



Data Collection Requirements

- » Interchange
 - Turning movement counts
 - Queue length
 - Traffic signal data
- » Freeway mainline
 - Volume
 - Travel speed (sensors, RITIS data)
 - Travel time (travel time runs)
- » **Travel patterns**
 - **O-D study (Bluetooth)**



Traffic Volume Development

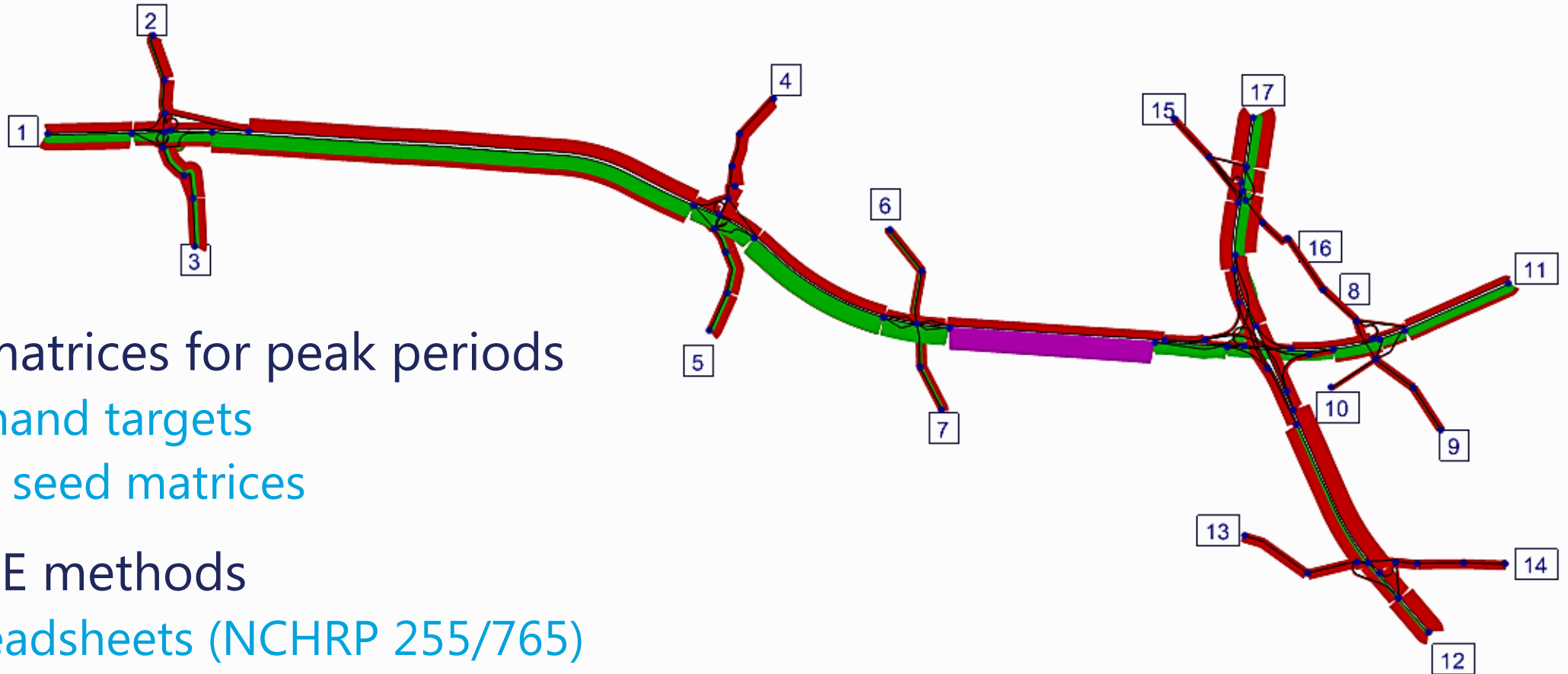
» Existing Conditions

- Balance point upstream of congestion
- Throughput at bottlenecks should equal volume count

» Future Conditions

- Regional model to develop mainline demand volume
 - *Express lanes in the model or additional general purpose lanes capacity in model*
 - *Peak period volume from model*
 - *AADT, K, and D for mainline*
 - *Growth rate from model applied to peak period*

Origin-Destination Matrix Estimation



- » O-D matrices for peak periods
 - Demand targets
 - O-D seed matrices
- » ODME methods
 - Spreadsheets (NCHRP 255/765)
 - Models (VISUM, Cube Analyst, etc.)

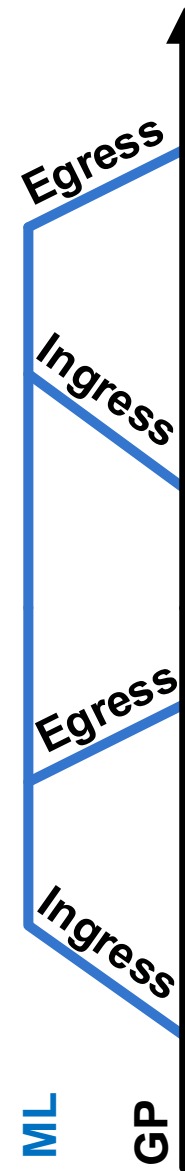
Express Lane Implementation: Managed Lane Facility

- » Managed Lane Route
 - Temporary detour of a static route
 - General purpose decision: no toll, no restrictions
 - Managed decision: toll and/or occupancy restrictions
- » Toll Pricing model
 - Traffic Responsive or COM Script
 - *COM Script based on Florida's Turnpike tolling algorithm (developed with AECOM)*
- » Decision model
 - Utility of the toll computed from travel time savings and current price
 - *Developed by Stated/Revealed Preference Surveys*
 - *Parameters based on Florida's Turnpike I-95 Phase 1 data (developed with AECOM)*

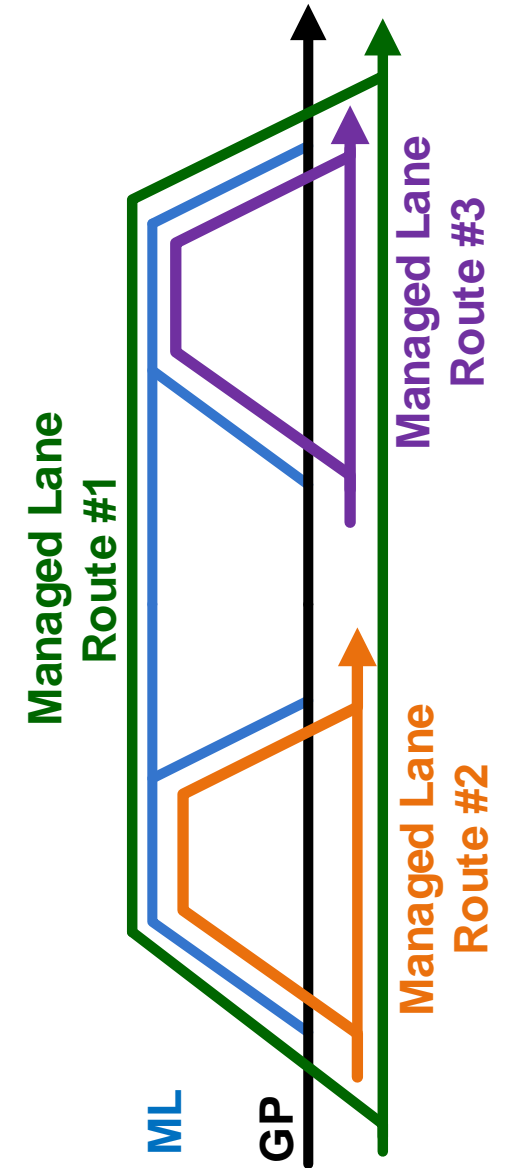
Managed Lane Routes

- » Route for each ingress and egress pair
- » Consists of a general purpose and managed lane decision
- » Referenced to a Express Lane Facility
 - Toll Pricing Model
 - Decision Model
- » Choice is made at point of entry

Express Lane Network

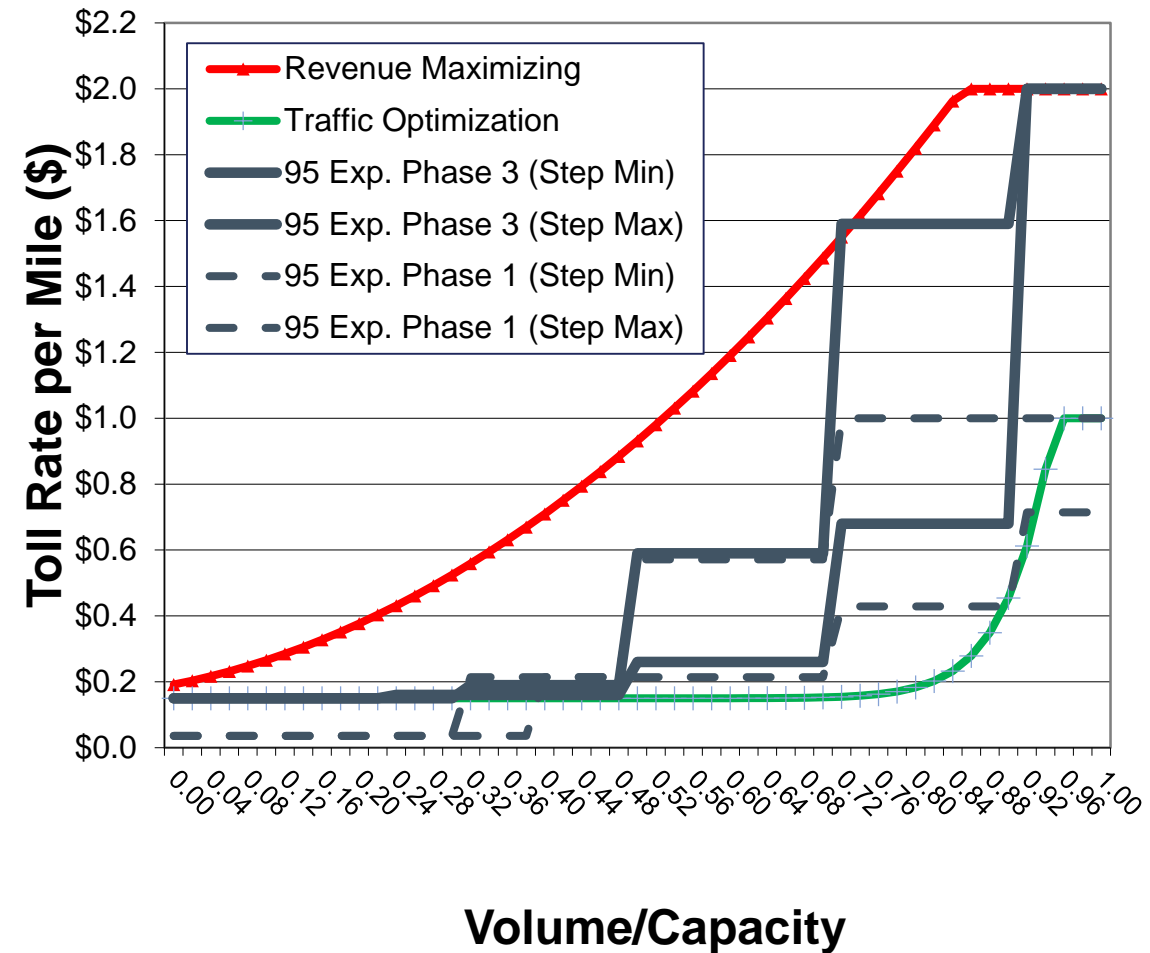


VISSIM ML Routes



Toll Pricing Model

- » COM Script (primarily used)
 - VB (or equivalent) script
 - Florida's Turnpike algorithm (density)
 - *Min toll = \$.15/mile or \$.50 segment*
 - Unique toll for each segment
 - Combination script establishes total toll
 - Update interval of 15 minutes



Decision Model

- » Probability of vehicle using managed lane based on its utility
- » Example Probability (short trips)
 - Logit alpha = 1.0
 - Time coefficient = 0.49
 - Cost coefficient = -0.61
 - Base utility = -0.8

		Toll Price										
		\$0.5	\$1.0	\$2.0	\$3.0	\$4.0	\$5.0	\$6.0	\$7.0	\$8.0	\$9.0	\$10.0
Travel Time Savings (min.)	0	25%	20%	12%	7%	4%	2%	1%	1%	0%	0%	0%
	1	35%	28%	18%	11%	6%	3%	2%	1%	1%	0%	0%
	2	47%	39%	26%	16%	9%	5%	3%	2%	1%	0%	0%
	3	59%	51%	37%	24%	15%	8%	5%	3%	1%	1%	0%
	4	70%	63%	49%	34%	22%	13%	8%	4%	2%	1%	1%
	5	79%	74%	61%	46%	31%	20%	12%	7%	4%	2%	1%
	6	86%	82%	72%	58%	43%	29%	18%	11%	6%	3%	2%
	7	91%	88%	80%	69%	55%	40%	26%	16%	10%	5%	3%
	8	94%	92%	87%	78%	66%	52%	37%	24%	15%	9%	5%
	9	96%	95%	92%	86%	76%	64%	49%	34%	22%	13%	8%
	10	98%	97%	95%	91%	84%	74%	61%	46%	31%	20%	12%

$$U_{(Toll)} = \text{Cost Coefficient} \times \text{Toll rate} + \text{Time Coefficient} \times \text{Time Gain} + \text{Base Utility}$$

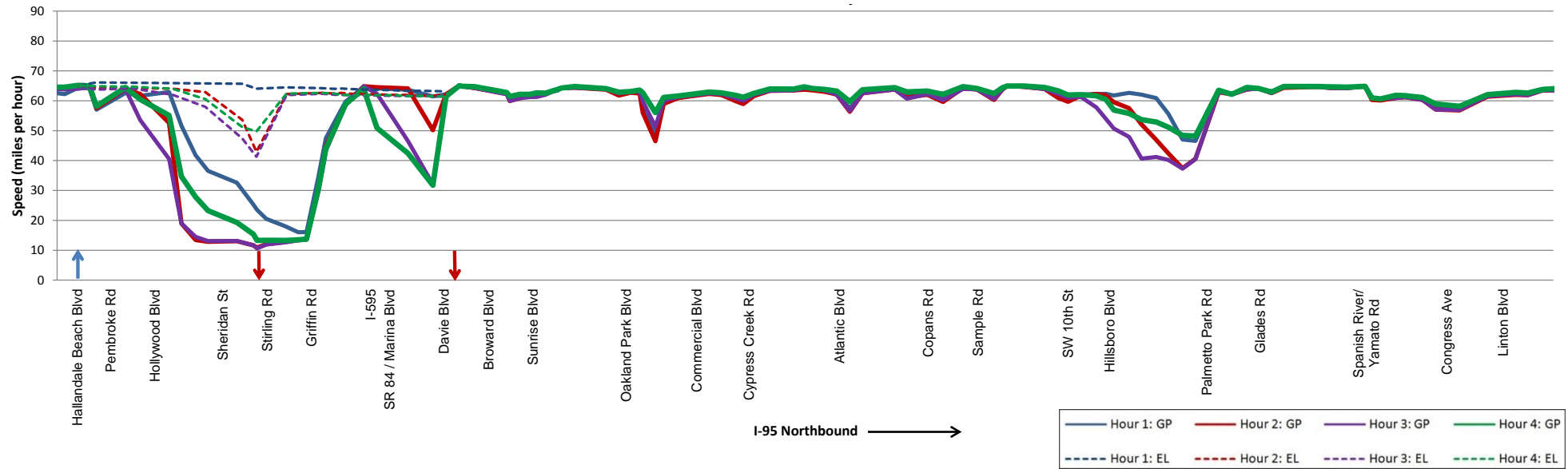
$$P_{(Toll)} = 1 - \frac{e^{a \cdot U_{Toll-free}}}{e^{a \cdot U_{Toll-free}} + e^{a \cdot U_{Toll}}} = 1 - \frac{1}{1 + e^{a \cdot U_{Toll}}}$$

Presentation of Results

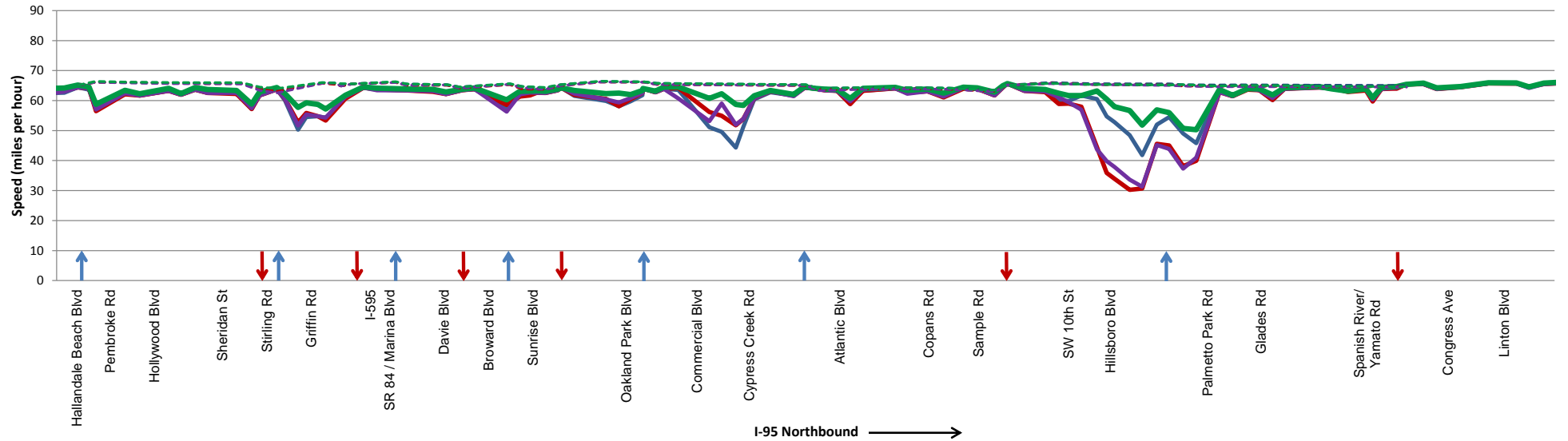
- » Speed profiles
- » Lane schematics
- » Heat maps
- » Weave diagrams
- » Travel time comparisons
- » Network-wide



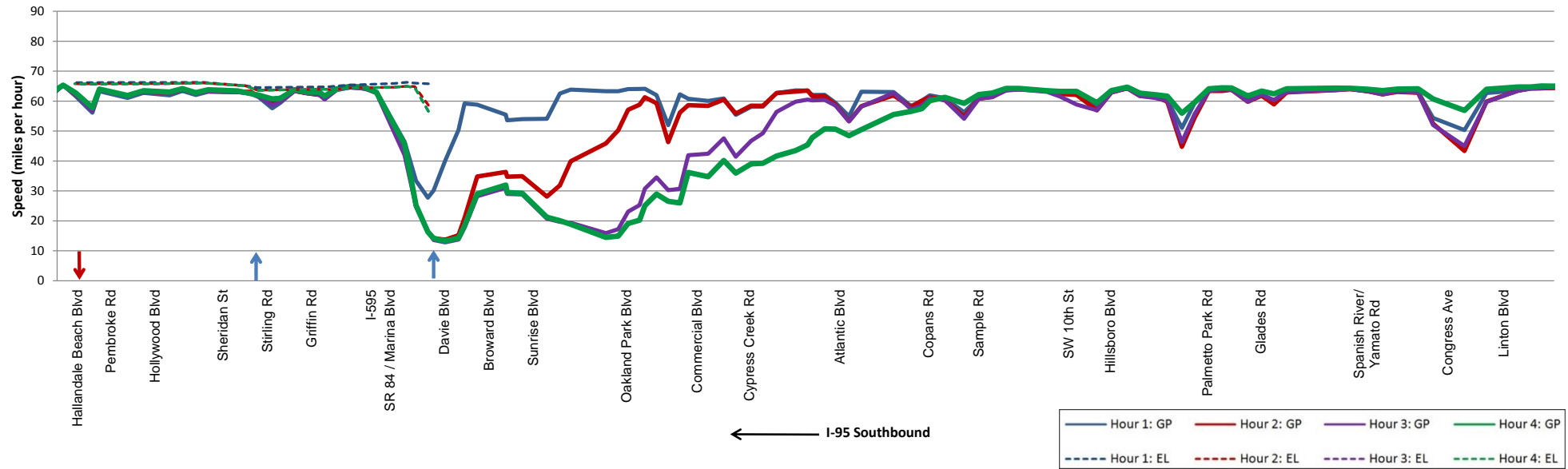
No-Build: I-95 Northbound Travel Speed Profile



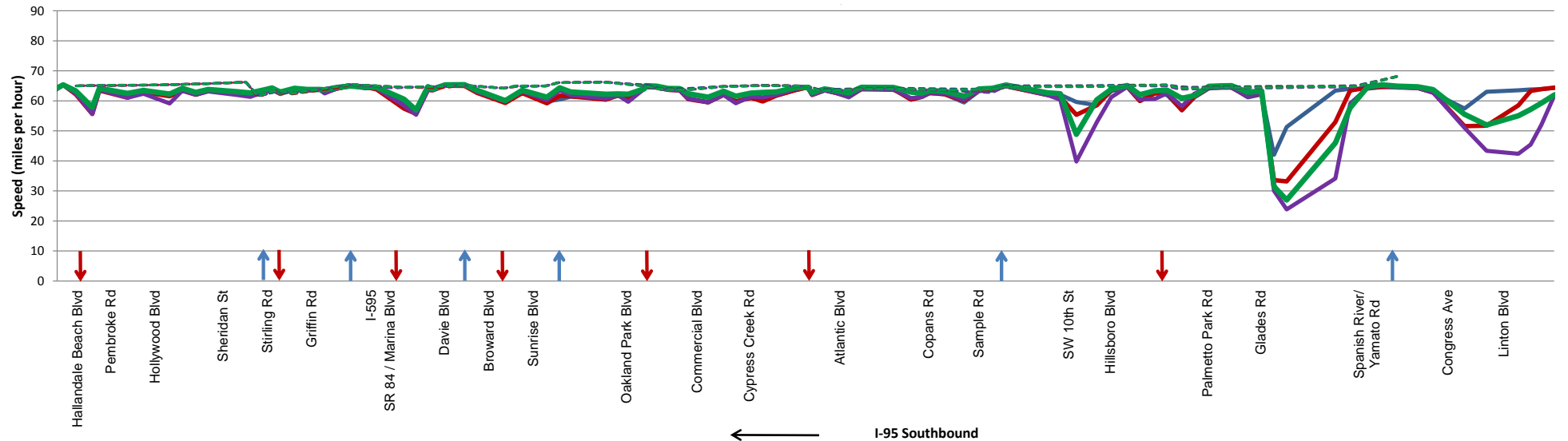
Build: I-95 Northbound Travel Speed Profile



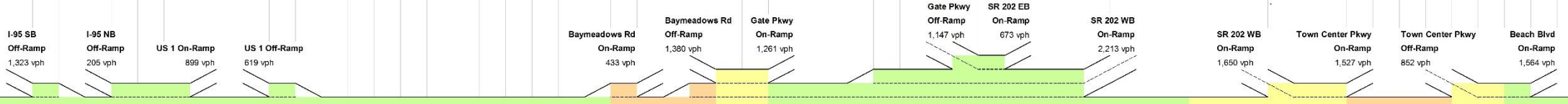
No-Build: I-95 Southbound Travel Speed Profile



Build: I-95 Southbound Travel Speed Profile



Distance (ft)	2,006	517	970	561	1,500	543	1,500	1,550	708	793	1,066	1,494	2,003	1,998	1,906	1,513	1,144	1,999	2,002	783	874	626	1,346	1,403	1,502	1,497	1,488	1,973	597	304	278	1,189	923	950	993	1,652	584	1,094	1,985	374	1,427	715	1,070	1,497	297	1,496	1,515	1,147	1,501	1,297	1,996	
Speed (mph)	65	64	63	64	63	63	62	65	64	64	64	64	64	64	64	63	63	61	60	57	46	21	28	30	28	31	37	53	58	59	60	64	64	64	63	61	56	40	34	29	25	27	29	36	40	48	63	65	65	65	65	
Density (veh/mi/ln)	13	15	20	20	16	16	16	16	15	19	19	19	17	17	17	24	24	37	38	40	50	72	73	68	49	44	37	27	24	18	17	19	19	19	22	26	29	46	53	66	58	54	50	38	34	28	21	20	20	20	20	
Total Demand vph	2,800	4,260	4,260	4,260	4,490	4,490	4,490	3,520	4,200	4,200	4,200	4,200	4,200	4,200	4,200	8,470	8,470	8,470	8,470	8,470	8,470	8,470	8,470	7,810	7,810	7,810	9,280	9,280	7,990	7,990	7,990	7,990	9,260	9,260	8,400	6,060	6,060	6,060	6,060	7,790	6,170	6,170	6,170	6,170	7,010	7,010	7,010	5,360	5,360	5,360	5,360	
Total Simulated vph	2,512	3,835	3,834	3,828	4,033	4,030	4,032	3,133	3,752	3,752	3,756	3,752	3,750	3,751	3,749	7,614	7,615	7,614	7,612	7,612	7,618	7,617	7,190	7,192	7,197	8,581	8,607	7,356	7,354	7,355	7,351	7,351	8,500	8,500	7,828	5,615	5,615	5,615	5,616	7,266	5,739	5,752	5,826	5,862	6,714	6,798	6,813	5,249	5,253	5,251	5,254	5,254



Simulated vph	2,512	3,835	3,834	3,828	4,033	4,030	4,032	3,133	3,752	3,752	3,756	3,752	2,245	2,246	2,244	4,557	4,558	4,557	4,555	4,555	4,555	4,555	4,555	4,122	4,120	4,124	5,504	5,525	4,264	4,262	4,263	4,972	4,972	6,119	6,119	5,446	3,233	3,233	5,616	7,266	5,739	5,752	5,826	5,862	6,714	6,798	6,813	5,249	5,253	5,251	5,254	5,254
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Distance (ft)	1,996	1,999	1,996	185	1,487	897	1,997	1,999	1,998	1,998	1,995	1,998	1,992	739	1,498	1,690	1,996	1,704	1,497							
Speed (mph)	62	62	62	62	62	63	62	63	63	63	63	64	64	64	64	62	62	62	62	62	62	62	39	38	38	44
Density (veh/mi/ln)	24	24	24	24	25	24	25	24	24	24	24	24	24	24	24	24	38	38	44							

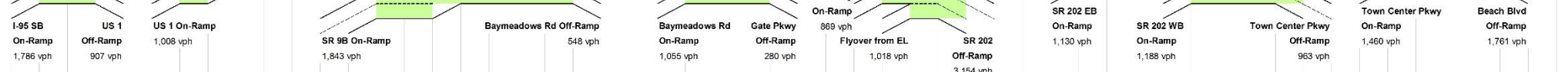
Legend

Speed > 45 mph		Density 45-55 vpmpl	
Speed 30-45 mph		Density 55-75 vpmpl	
Speed 20-30 mph		Density ≥ 75 vpmpl	
Speed ≤ 20 mph			

Simulated vph within 10% of Demand
Simulated vph outside 10% of Demand

Distance (ft)	1,610	1,985	1,312	846	1,495	1,999	1,992	1,997	1,997	2,002	419	358	1,496	670	1,500	1,712	1,859	364	1,500	811	1,505	1,469
Speed (mph)	62	63	62	62	63	63	63	63	63	62	57	59	63	62	62	62	62	62	62	62	62	62
Density (veh/mi/ln)	25	24	24	24	22	22	23	22	23	23	25	16	15	15	15	28	27	27	28	28	28	28

Simulated vph	1,678	1,679	1,679	3,465	3,463	2,556	3,564	3,563	3,562	3,571	2,058	2,063	2,066	3,909	3,908	3,903	3,900	3,902	3,906	3,912	3,364	3,362	4,417	4,137	1,704	1,706	1,706	1,708	1,709	1,709	1,710	4,248	4,248	4,249	5,118	6,131	6,127	2,973	2,972	2,971	4,680	5,810	5,807	6,995	6,997	6,034	6,035	6,034	7,494	7,496	5,735	5,735	5,734	5,734	5,738
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Distance (ft)	1,986	1,998	1,879	996	1,074	1,256	1,057	449	777	1,498	1,611	1,996	1,142	1,510	1,494	1,143	1,993	1,805	1,645	1,500	1,757	1,972	1,805	649	1,497	1,990	477	645	1,095	1,095	648	864	601	1,105	456	687	949	1,095	1,076	1,110	1,189	1,493	1,484	2,062	1,144	1,503	1,294	1,999					
Speed (mph)	66	66	66	63	65	66	64	65	64	63	64	65	65	65	65	64	64	64	64	62	62	56	46	48	59	63	63	63	64	64	63	63	63	63	63	64	63	65	64	18	18	18	19	24	24	24	24	24	22	22	22	22	22
Density (veh/mi/ln)	8	8	9	14	13	13	14	18	19	19	16	16	16	15	15	20	20	20	21	27	30	32	43	24	23	23	20	19	19	16	16	23	25	23	18	18	18	18	18	18	18	18	19	24	24	24	24	24	22	22	22	22	22
Total Demand vph	1,690	1,690	1,690	3,520	3,520	2,600	3,720	3,720	3,720	3,720	3,720	3,720	6,940	6,940	6,940	6,940	6,940	6,940	6,940	6,940	6,380	6,380	7,960	7,650	7,650	7,650	7,650	8,500	8,500	8,500	5,100	5,100	5,100	5,100	6,540	6,540	7,790	7,790	6,730	6,730	6,730	8,280	8,280	6,310	6,310	6,310	6,310	6,310					
Total Simulated vph	1,678	1,679	1,679	3,465	3,463	2,556	3,564	3,563	3,562	3,571	3,579	3,584	3,588	6,746	6,745	6,740	6,737	6,732	6,740	6,752	6,196	6,194	7,282	6,972	6,972	6,974	6,976	7,845	7,841	7,837	4,683	4,682	4,681	4,680	5,810	5,807	6,995	6,997	6,034	6,035	6,034	7,494	7,496	5,735	5,735	5,734	5,734	5,738					

Lane Schematics

Travel Time and Speed Comparisons

General Use Lanes

AM Peak Hour		No-Build	Build 1		Build 2	
Direction	General Use Lanes	Travel Time (Travel Speed)	Travel Time (Travel Speed)	% Change	Travel Time (Travel Speed)	% Change
I-295 Southbound	W. of US 17 to N. of US 1 (15 miles)	64.2 min (14 mph)	17.6 min (51 mph)	-73%	16.3 min (55 mph)	-75%
I-295 Northbound	N. of US 1 to W. of US 17 (15 miles)	14.0 min (64 mph)	13.9 min (64 mph)	-1%	13.8 min (65 mph)	-2%
PM Peak Hour		No-Build	Build 1		Build 2	
Direction	General Use Lanes	Travel Time (Travel Speed)	Travel Time (Travel Speed)	% Change	Travel Time (Travel Speed)	% Change
I-295 Southbound	W. of US 17 to N. of US 1 (15 miles)	72.1 min (12 mph)	14.3 min (63 mph)	-80%	14.5 min (62 mph)	-80%
I-295 Northbound	N. of US 1 to W. of US 17 (15 miles)	33.3 min (27 mph)	26.2 min (34 mph)	-21%	19.4 min (46 mph)	-42%

Express Lanes

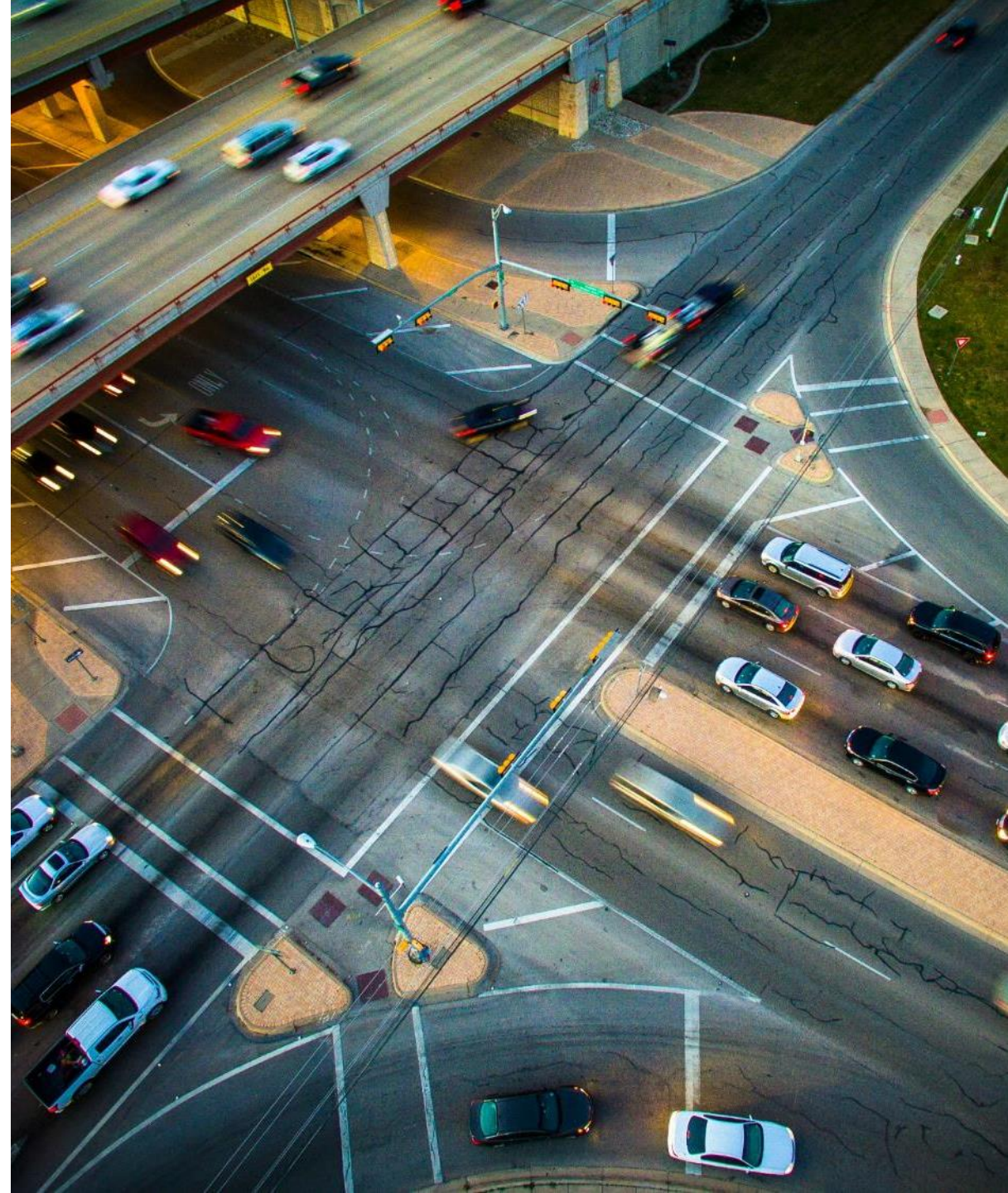
AM Peak Hour		Build 1	Build 2
Direction	Express Lanes	Travel Time (Travel Speed)	Travel Time (Travel Speed)
I-295 Southbound	W. of SR 13 to OSA (2.7 miles)	2.6 min (63 mph)	2.5min (65 mph)
I-295 Northbound	W. of I-95 to W. of SR 13 (4.3 miles)	4.0 min (65 mph)	3.9 min (66 mph)
PM Peak Hour		Build 1	Build 2
Direction	Express Lanes	Travel Time (Travel Speed)	Travel Time (Travel Speed)
I-295 Southbound	W. of SR 13 to OSA (2.7 miles)	2.6 (64 mph)	2.5 (65 mph)
I-295 Northbound	W. of I-95 to W. of SR 13 (4.3 miles)	5.5 (47 mph)	4.0 (65 mph)

Network-wide MOEs

	AM Peak			PM Peak		
	No-Build	Build 1	Build 2	No-Build	Build 1	Build 2
Average Speed (mph)	23	40 (74%)	41 (78%)	16	30 (88%)	37 (131%)
Total Delay (hr)	44,694	14,899 (-67%)	14,040 (-69%)	71,836	28,971 (-60%)	18,308 (-75%)
Latent Delay (hr)	115,195	55,340 (-52%)	54,023 (-53%)	166,841	56,864 (-66%)	43,478 (-74%)
Latent Demand (veh)	27,335	9,886 (-64%)	9,178 (-66%)	38,263	3,136 (-92%)	3,135 (-92%)
Total Travel Time (hr)	72,554	45,175 (-38%)	44,372 (-39%)	97,708	59,245 (-39%)	48,628 (-50%)
Total Stops	4,592,430	868,259 (-81%)	792,346 (-83%)	6,260,176	2,154,681 (-66%)	1,072,150 (-83%)
Vehicles Arrived	272,028	294,737 (8%)	295,460 (9%)	273,070	322,182 (18%)	322,241 (18%)

Lessons Learned

1. Setup and follow procedures/check lists
 - Provide consistency and improve accuracy
2. Collect all necessary data
 - O-D patterns are critical
3. Simulation program
 - Maintain same version and patch throughout the project
4. Network construction
 - Use high resolution images (.sid) and design files



Lessons Learned

5. VISSIM/VISUM
 - Combination is valuable for ODME and static route creation
6. Toll pricing and decision model
 - Use agency toll algorithm (if available)
 - Develop reasonable decision model parameters
 - *Adjustments may be required based on simulation performance*
7. Capacity constrained demand methods could be beneficial
 - Excessive demand may cause express lanes to fail



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