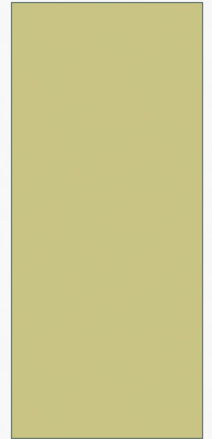


NORTH AVENUE RISING

NORTH AVE TSP

ANAM ARDESHIRI
SABRA & ASSOCIATES



OUTLINE

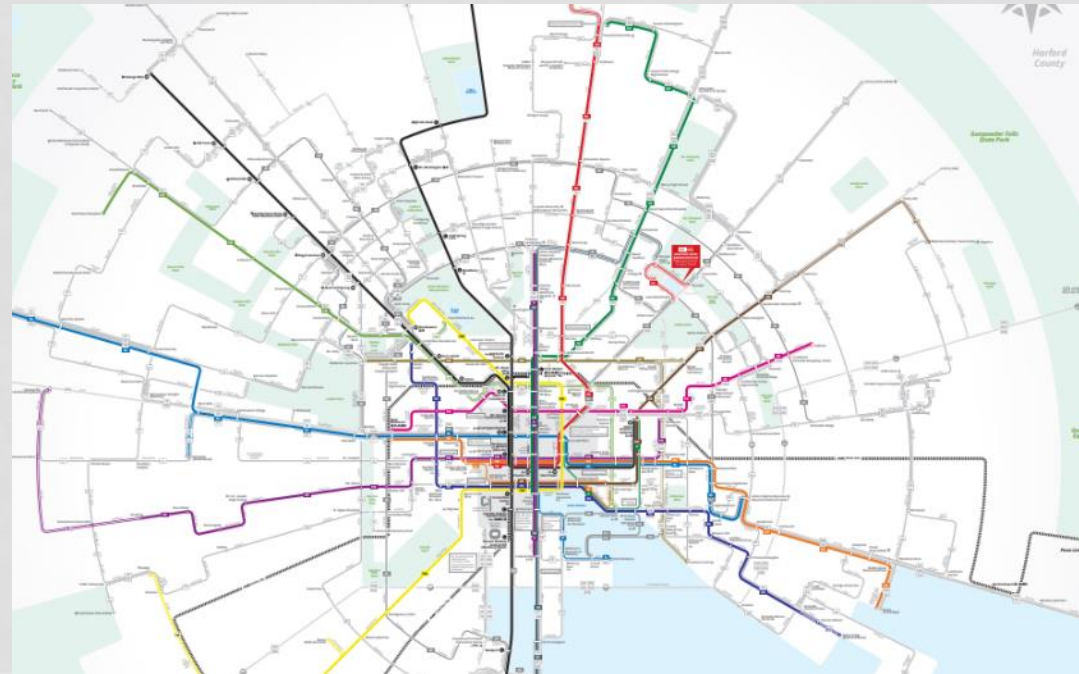
- Introduction
- Goals
- Methodology
- Analysis Tool
- Evaluation
- Challenges

INTRODUCTION



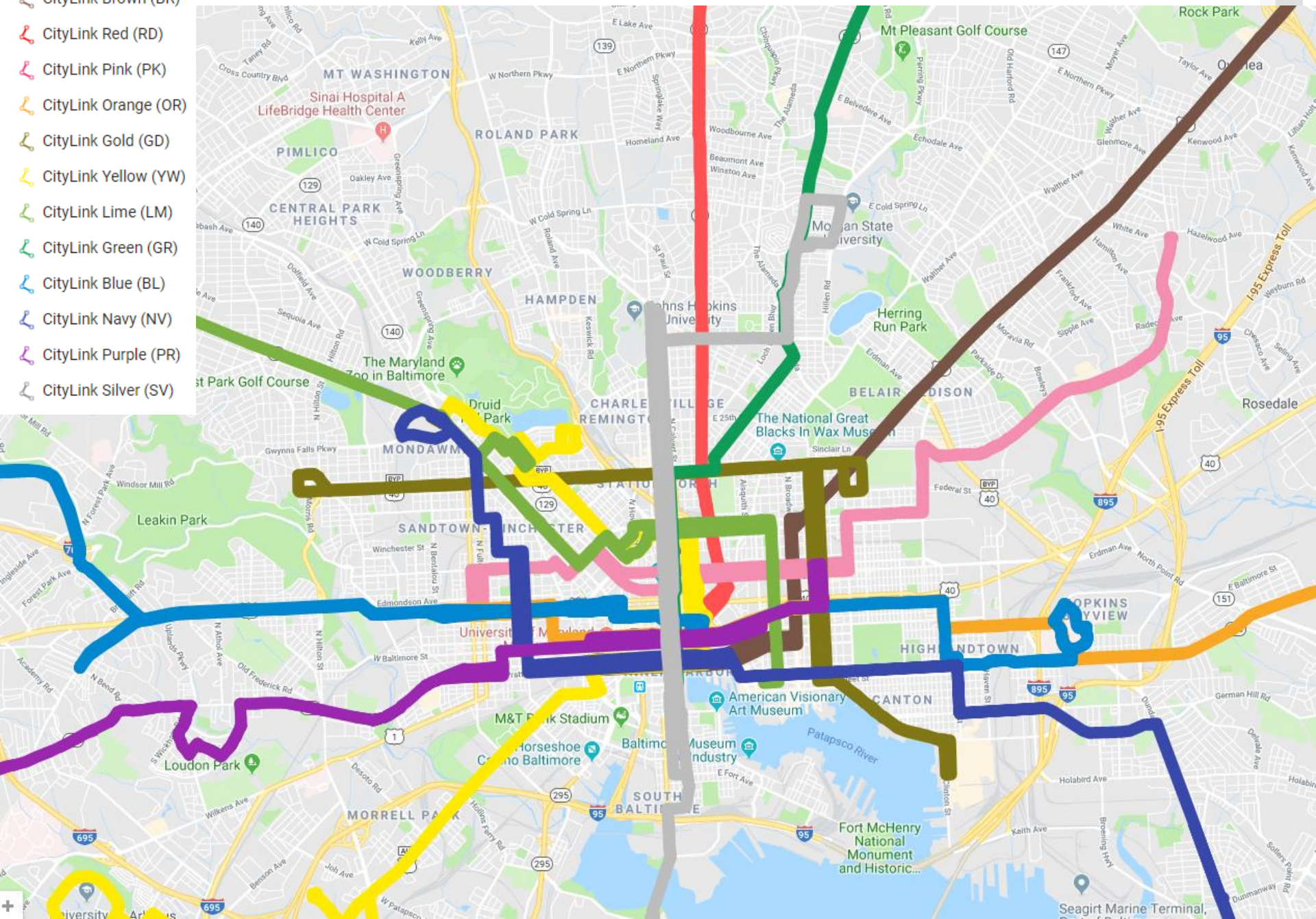
- **BaltimoreLink**

- A complete overhaul and rebranding of the core transit system operating within the city and throughout the greater Baltimore region.
- Launched June 2017



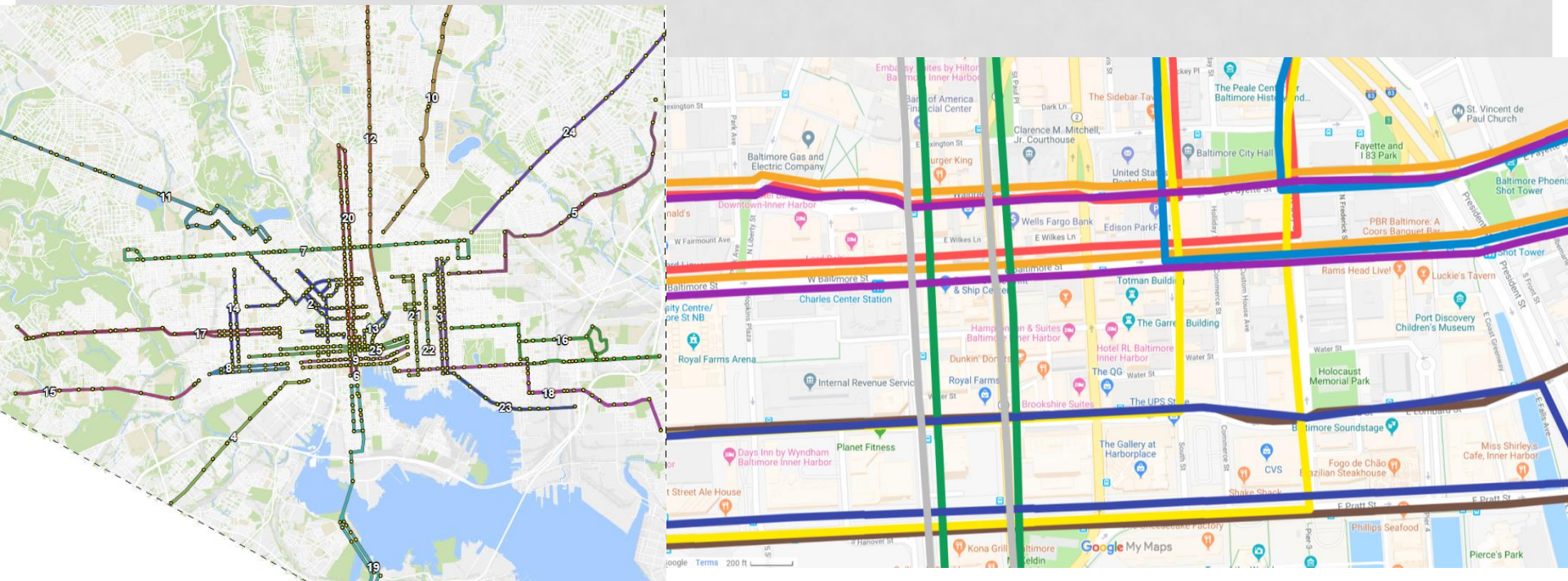
CityLink Routes

- CityLink Brown (BR)
- CityLink Red (RD)
- CityLink Pink (PK)
- CityLink Orange (OR)
- CityLink Gold (GD)
- CityLink Yellow (YW)
- CityLink Lime (LM)
- CityLink Green (GR)
- CityLink Blue (BL)
- CityLink Navy (NV)
- CityLink Purple (PR)
- CityLink Silver (SV)



B-LINK TSP FEASIBILITY STUDY

- Step 1: Prescreening 700 signals in Baltimore City
- Several operational & geometric factors were defined to develop a pre-screening formula to prioritize signalized intersections/corridors for TSP.



PRESCREENING FACTORS

$$\text{Intersection TSP Feasibility Score } (FS_i) = 100 \sum_{j=1}^{13} (f_{ij} * w_j)$$

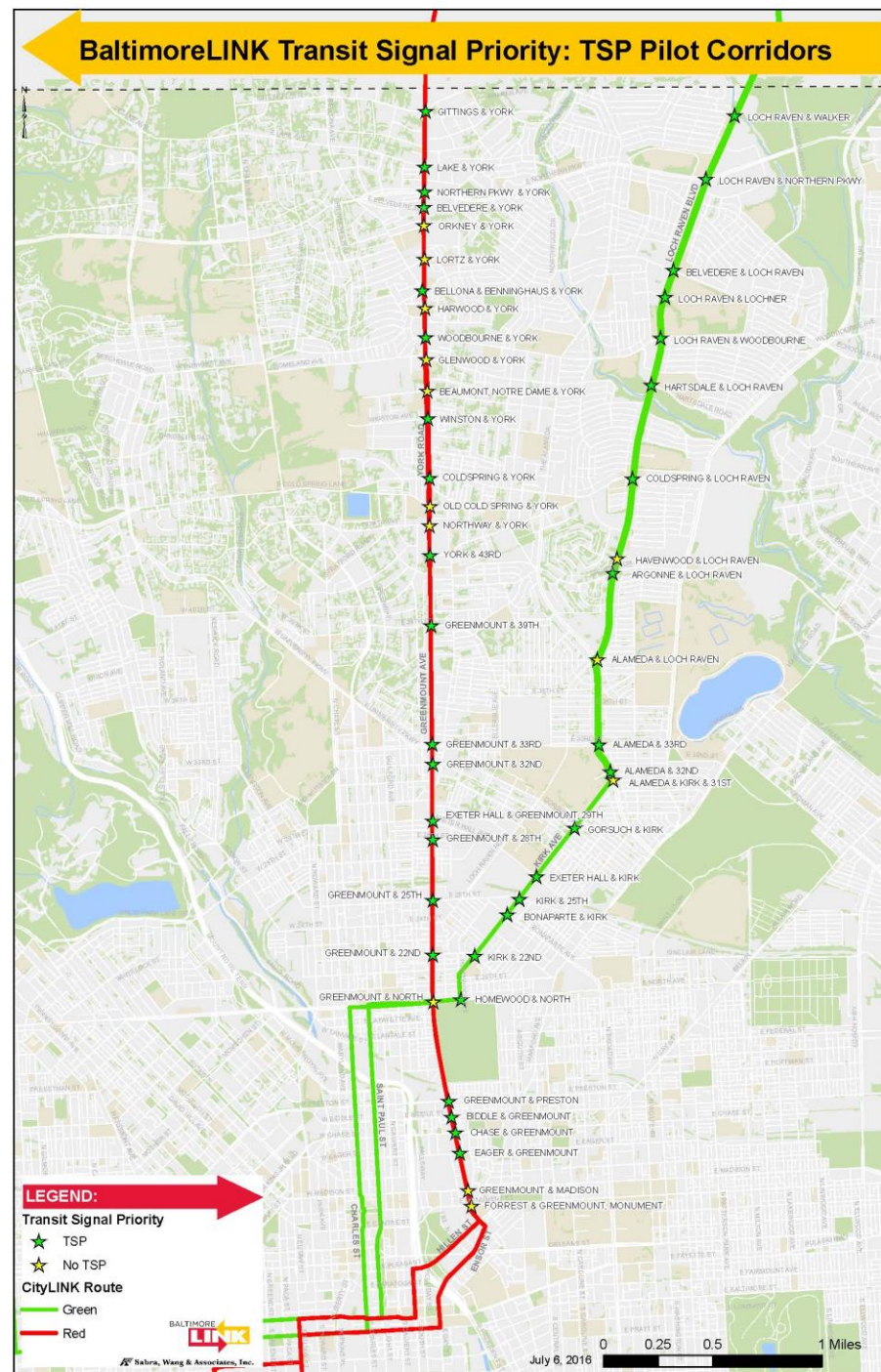
1. Dedicated Bus Lane on CityLINK Route
2. Existing Average Bus Speed on CityLINK Route
3. Bus frequency
 1. No. of CityLINK buses /hr on **approach** direction
 2. No. of CityLINK buses /hr on **conflicting** direction
 3. No. of Non-CityLINK buses /hr on approach direction
 4. No. of Non-CityLINK buses /hr on conflicting direction
4. Approach LOS
5. Conflicting Direction LOS
6. Overall V/C
7. Nearside vs. Farside bus stops
8. Slack time to accommodate TSP
9. Ridership
10. Pretimed vs. Actuated

PILOT AREA / CORRIDOR SELECTION

- **Corridors with the highest average score**
- Implementation considerations
- CBD limitations in cycle length change, too many buses, etc.
- Traffic signal software system & Comm status
- Loch Raven Blvd
 - 18 signals; 12 TSP signals
- Greenmount Ave / York Rd
 - 29 signals; 14 TSP signals

TSP DETAILED ANALYSIS

- Updated scores based on:
 - Updated our Synchro models
 - New traffic counts
 - Nearside stops
 - Detection status



TSP IMPLEMENTATION

- Upgrade traffic controllers
- Transfer controller database
- Establish cellular comm
- Set up central system (ATMS.now)
- Tested and coded TSP parameters



ATMS.NOW

AIMS:now v2.0.0.0 - Build 4.3.48.15 - AIMS:now System / naiztec@10.0.2.10 (licensed to baltimore)

HomeDefinitionsReportsHelp

Real-Time

Time of Day Schedule

Notes

Synchro 7/8/9 Import/Export

Utilities

Admin Event Status

Server Status

Server Activity

Clear Comm Status Buffer

Communication Status

Admin Update

Create Definition

Configuration

Edit

Upload

Download

View

Compare

Copy

Database

Coordination Diagnostics

Archive Selected

Conversion Tool

Local Download

33x Configurator

Controller List

48 Found

Alarm	Status	Lock	ID	Name	IP	X-Reference	Type	Group	Lock User Name	TEAMS ID	Free	Coord State	Coord Src	Pattern	TBC	Local Counter	SP Count Down R1	SP Count Down R2	SP Count Down R3	SP Count Down R4	Cycle	Offset	Seq	Prog Split 1
			336	LOCH RAVEN & HARTSDALE		0	NTCIP 76x ATC Ethernet	Online Ethernet Controllers			COORD	SYNC	B-TBC	6 PM	13	28	2-12	6-12	0-0	0-0	120	105	1	80
			407	YORK & LORTZ		0	NTCIP 76x ATC Ethernet	Online Ethernet Controllers			COORD	SYNC	B-TBC	6 PM	23	10	4-18	0-0	0-0	0-0	110	13	1	0
			473	YORK & WINSTON		0	NTCIP 76x ATC Ethernet	Online Ethernet Controllers			COORD	SYNC	B-TBC	6 PM	23	72	2-38	6-38	0-0	0-0	110	61	1	0
			512	YORK & 43RD		0	NTCIP 76x ATC Ethernet	Online Ethernet Controllers			COORD	SYNC	B-TBC	6 PM	23	8	4-27	0-0	0-0	0-0	110	15	1	0
			517	LOCH RAVEN & HAVENWOOD		0	NTCIP 76x ATC Ethernet	Online Ethernet Controllers			COORD	SYNC	B-TBC	6 PM	13	20	4-20	0-0	0-0	0-0	120	113	1	17
			526	LOCH RAVEN & ARGONNE		0	NTCIP 76x ATC Ethernet	Online Ethernet Controllers			COORD	SYNC	B-TBC	6 PM	13	26	4-25	8-25	0-0	0-0	120	107	1	0
			529	LOCH RAVEN & BELVEDERE		0	NTCIP 76x ATC Ethernet	Online Ethernet Controllers			COORD	SYNC	B-TBC	6 PM	13	27	4-21	8-21	0-0	0-0	120	106	1	23
			558	GREENMOUNT & 29TH		0	NTCIP 76x ATC Ethernet	Online Ethernet Controllers			COORD	SYNC	B-TBC	6 PM	23	70	2-40	6-40	0-0	0-0	110	63	1	0
			702	YORK & GITTINGS & WALKER		0	NTCIP 76x ATC Ethernet	Online Ethernet Controllers			COORD	SYNC	B-TBC	6 PM	14	83	2-37	6-37	0-0	0-0	120	51	1	0
			716	GREENMOUNT & 32ND		0	NTCIP 76x ATC Ethernet	Online Ethernet Controllers			COORD	SYNC	B-TBC	9 MD	44	11	4-19	8-19	0-0	0-0	90	33	1	0
			722	YORK & BELVEDERE		0	NTCIP 76x ATC Ethernet	Online Ethernet Controllers			COORD	SYNC	B-TBC	6 PM	14	21	4-33	8-33	0-0	0-0	120	113	1	0
			745	YORK & OLD COLD SPRING		0	NTCIP 76x ATC Ethernet	Online Ethernet Controllers			COORD	SYNC	B-TBC	6 PM	23	98	2-12	0-0	0-0	0-0	110	35	1	0
			860	YORK & NORTHWAY		0	NTCIP 76x ATC Ethernet	Online Ethernet Controllers			COORD	SYNC	B-TBC	6 PM	24	80	2-30	0-0	0-0	0-0	110	54	1	0
			883	GREENMOUNT & PRESTON		0	NTCIP 76x ATC Ethernet	Online Ethernet Controllers			COORD	SYNC	B-TBC	6 PM	24	102	2-8	6-8	0-0	0-0	110	32	1	0
			884	GREENMOUNT & 25TH		0	NTCIP 76x ATC Ethernet	Online Ethernet Controllers			COORD	SYNC	B-TBC	6 PM	28	13	3-3	7-3	0-0	0-0	110	15	1	0
			889	GREENMOUNT & 22ND		0	NTCIP 76x ATC Ethernet	Online Ethernet Controllers			COORD	SYNC	B-TBC	6 PM	23	4	2-0	6-0	0-0	0-0	110	19	1	0
			954	GREENMOUNT & BIDDLE		0	NTCIP 76x ATC Ethernet	Online Ethernet Controllers			COORD	SYNC	B-TBC	6 PM	25	103	2-7	6-7	0-0	0-0	110	32	1	0
			974	YORK & WOODBOURNE		0	NTCIP 76x ATC Ethernet	Online Ethernet Controllers			BC	6 PM	24	37	4-26	8-26	0-0	0-0	0-0	0-0	110	97	1	15
			1025	GREENMOUNT & CHASE		0	NTCIP 76x ATC Ethernet	Online Ethernet Controllers			BC	6 PM	25	95	2-15	6-15	0-0	0-0	0-0	0-0	110	40	1	0
			1110	KIRK & EXETER HALL		0	NTCIP 76x ATC Ethernet	Online Ethernet Controllers			BC	6 PM	25	35	4-15	8-15	0-0	0-0	0-0	0-0	110	100		

NORTH AVE RISING

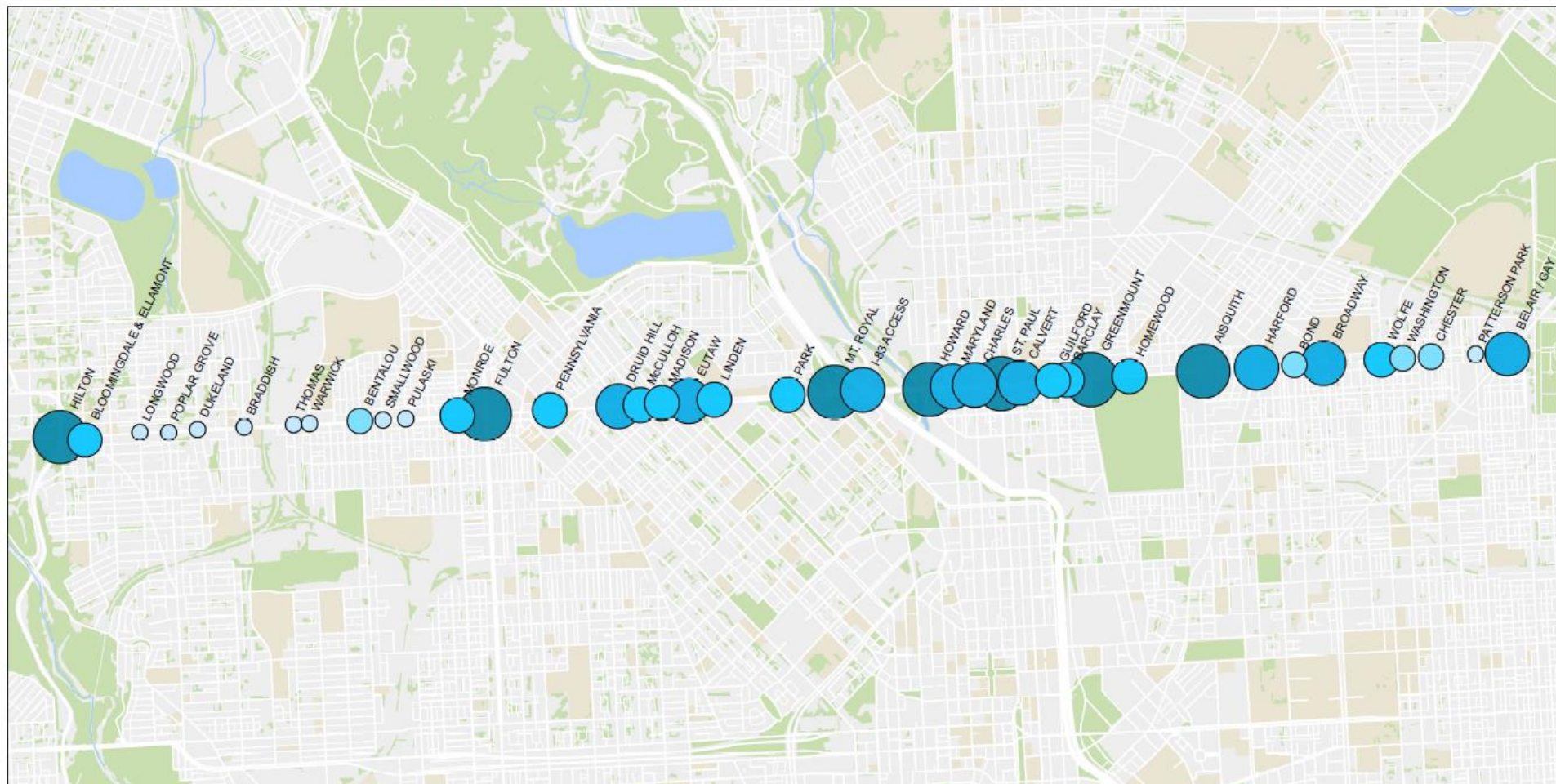
- **Goal:** to support economic revitalization along North Avenue through increased mobility and to broaden access for residents of the corridor to economic opportunity throughout Baltimore.
- Funding:
 - Collaboration between Federal, State, and local funding.
 - The State of Maryland and Baltimore City won funding for the project from the US DOT through the TIGER program (Transportation Investment Generating Economic Recovery).
 - The total project budget is \$27.3 million. The \$10 million from the TIGER grant compliments \$14.7 million in funds committed by MDOT, \$1.6 million from US DOT's FHWA, and \$1 million from Baltimore City.

NORTH AVE RISING

- Sidewalk improvements,
- Dedicated bus lanes,
- Transit signal priority,
- Enhanced bus stops,
- Roadway repaving,
- Bikeshare stations.

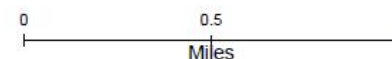
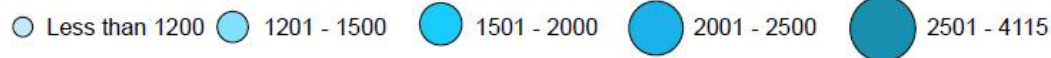


North Avenue Intersections Traffic Volumes, AM

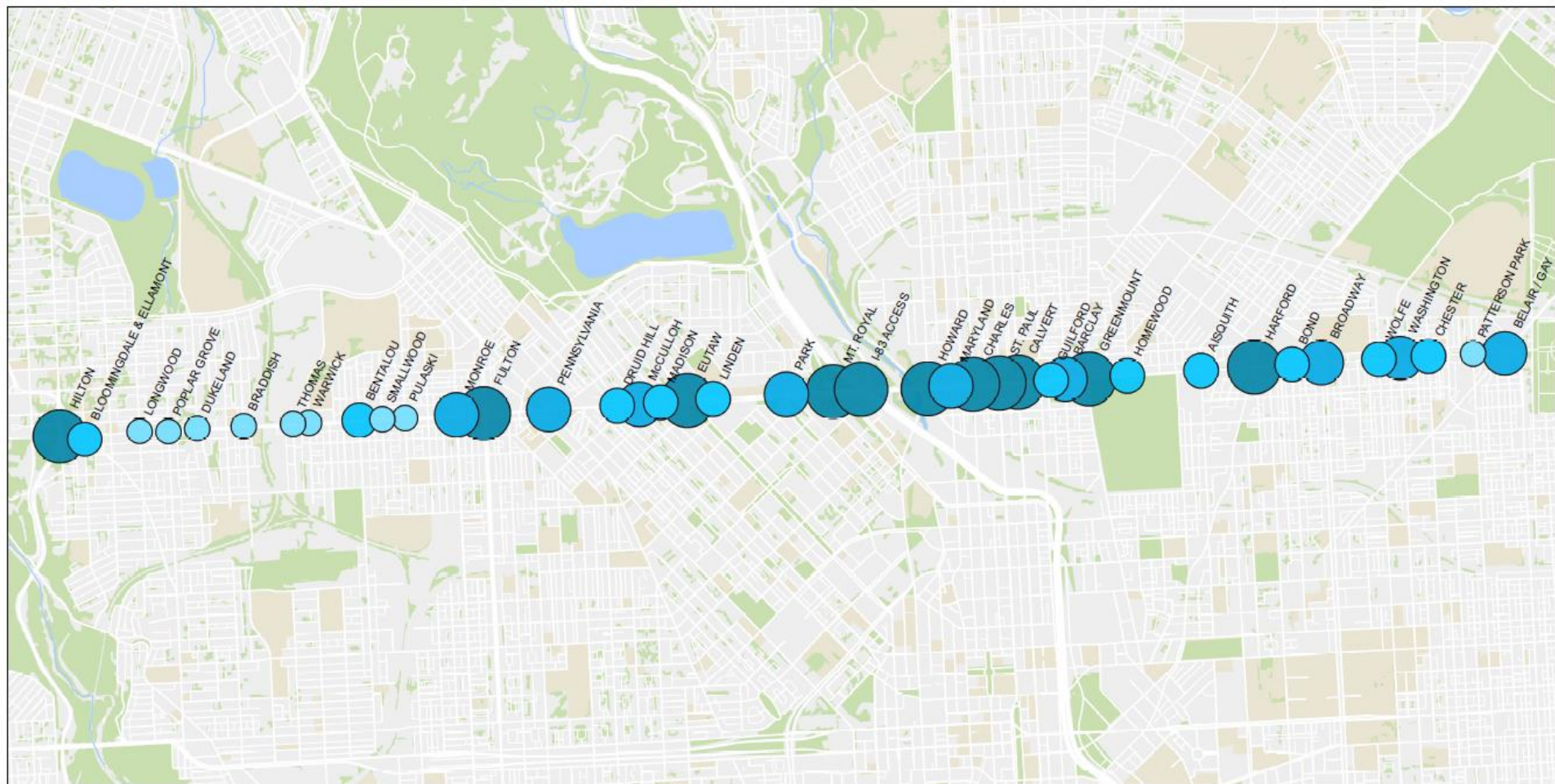


Source: SAI October 2018

Vehicles Through Intersection

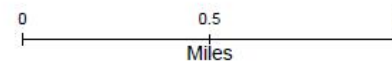
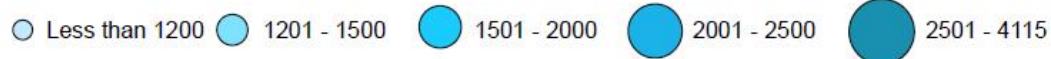


North Avenue Intersections Traffic Volumes, PM



Source: SAI October 2018

Vehicles Through Intersection

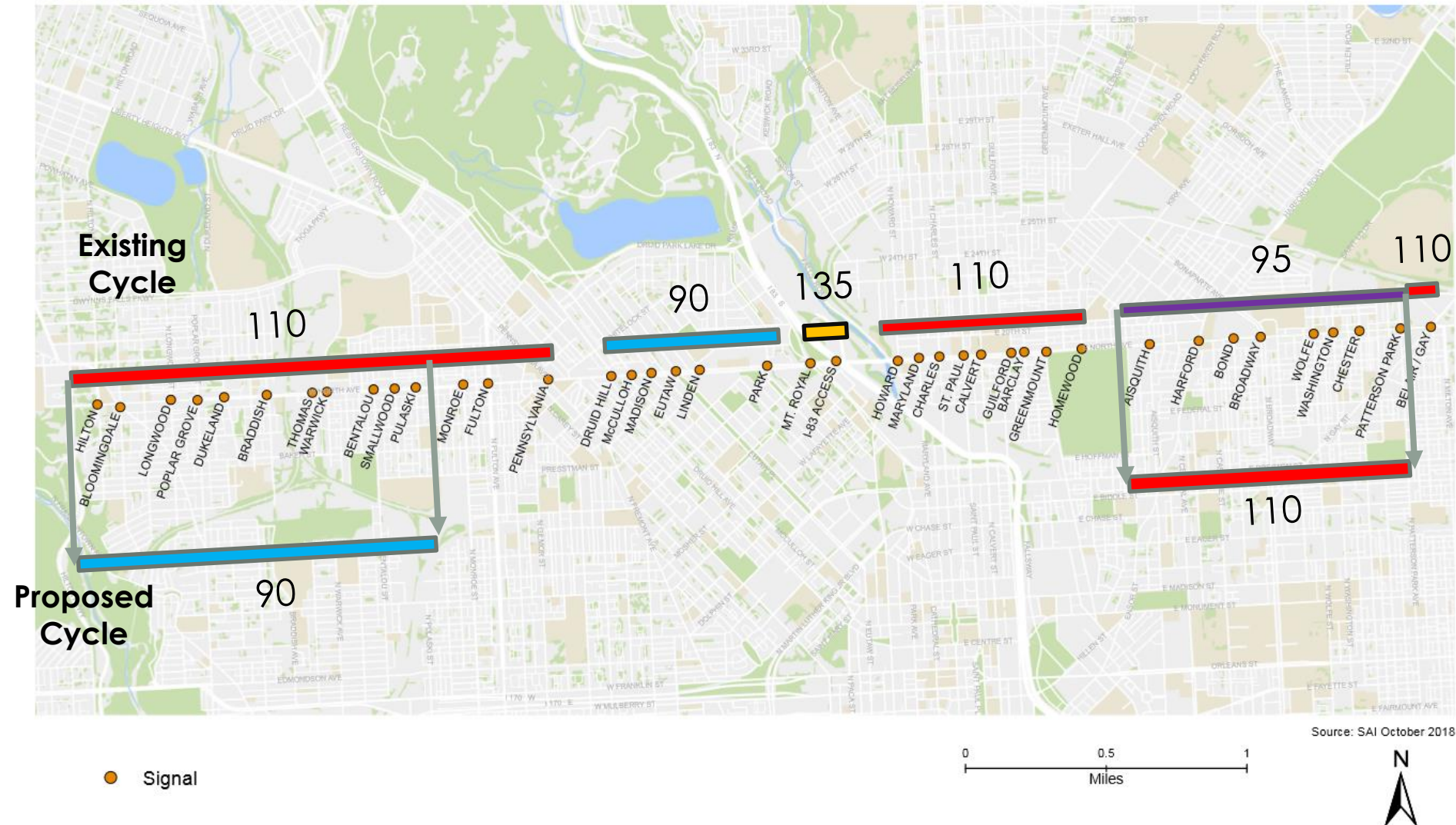


PASSIVE TSP

- Install TSP-enabled ATC controllers and cell modems
- Download (NextEdit Laptop) & Upload (ATMS.Now) controllers' database
- Signal timing optimization
 - Evaluate cycle length
 - Recalculate PCT and FDW
 - Split optimization
 - Optimize offsets for the dominant approach
- Improve transit travel time
 - Lower running speed
 - Variable dwell time
 - Nearside stops

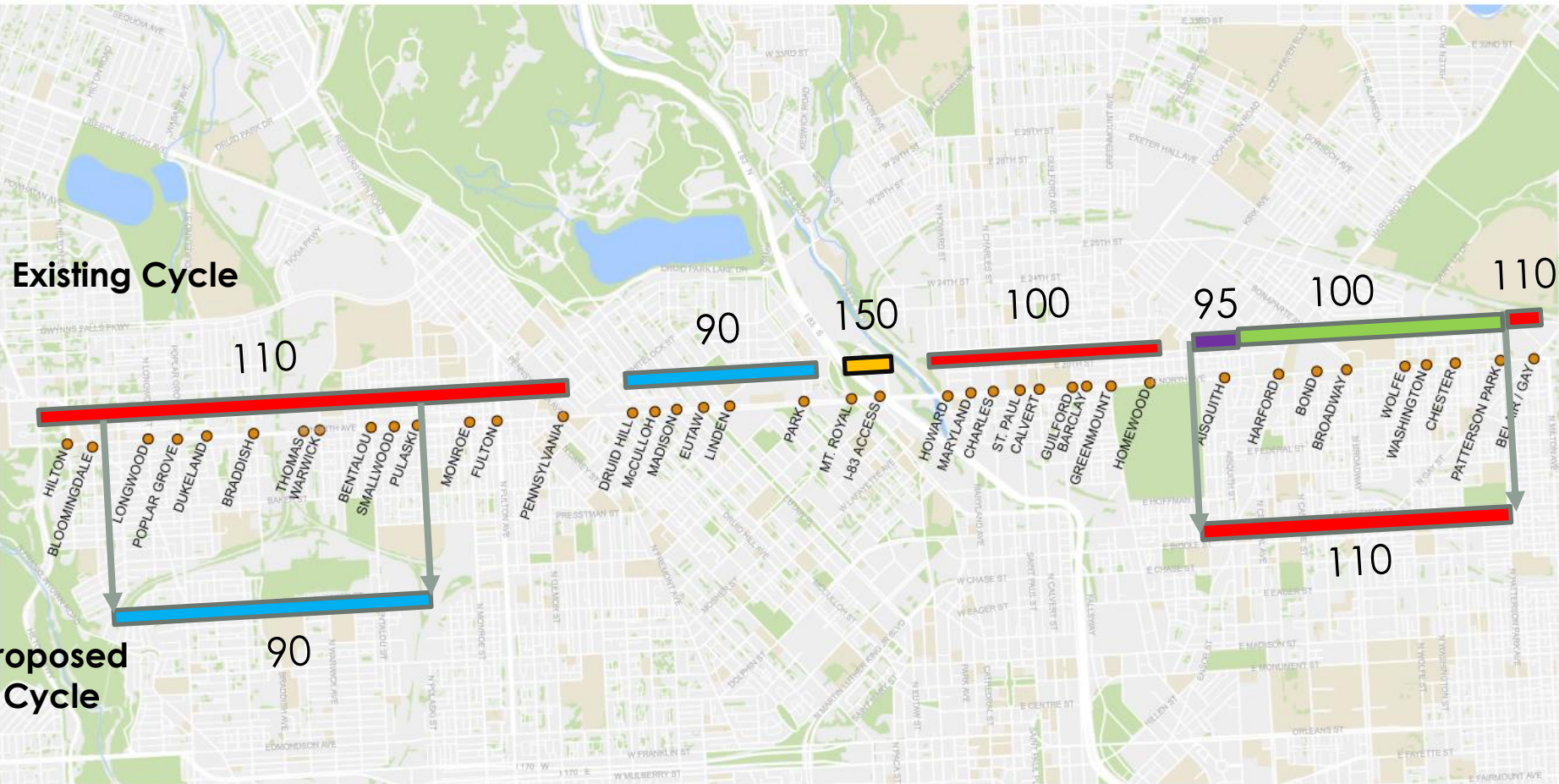
AM PATTERN CYCLE LENGTH

North Avenue Signals



PM PATTERN CYCLE LENGTH

North Avenue Signals



Proposed Cycle

Signal

0 0.5 1
Miles

Source: SAI October 2018

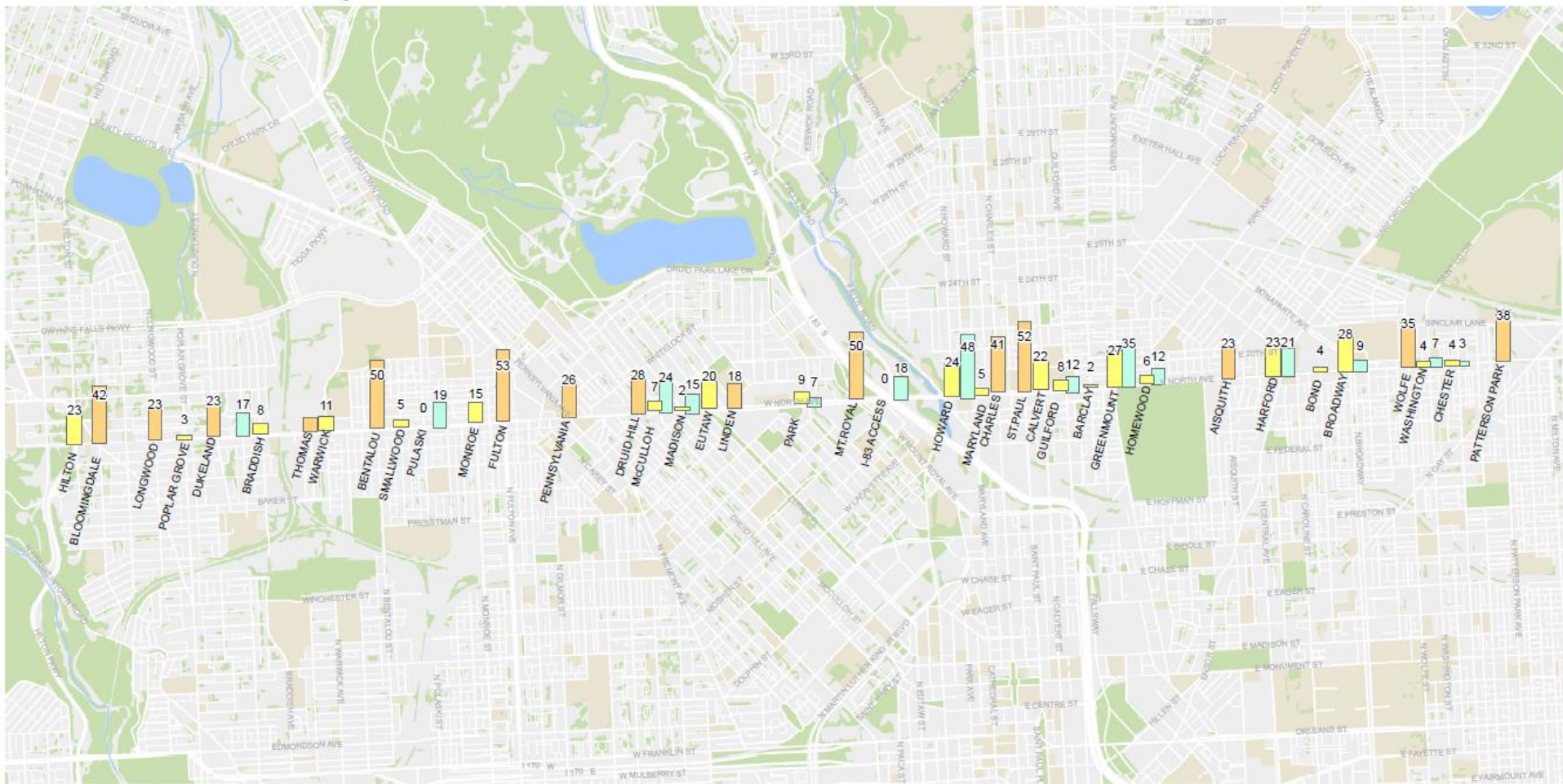


EVALUATION

- Bus Travel Time: Before vs. After Study
- MTA transit data collected by Swiftly

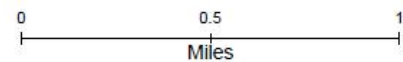
	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V
1	vehicle_id	date	time	lat	lon	heading	speed	assigned	assigned	source	time_proc	route_short_name	sched_adh	sched_adh	headway	scheduled	previous	previous	trip_id	block_id	direction	headsign
2	13016	4/16/2018	12:00:00 AM	39.30884	-76.6754	85	0		UNSET	CalAmp	00:00.9	CityLink GOLD	263000	4.4 minutes (late)	1264961	1440000	17027	-212197	2131156	4854	0	Gold Walbrook Junction
3	17030	4/16/2018	12:00:03 AM	39.29673	-76.5895	358	13.05557		UNSET	CalAmp	00:03.9	CityLink GOLD	245277	4.1 minutes (late)	3750275	3600000	17027	-217599	2131162	4852	0	Gold Walbrook Junction
4	17027	4/16/2018	12:00:03 AM	39.31189	-76.5994	97	8.055562		UNSET	CalAmp	00:03.5	CityLink GOLD	-217599	-3.6 minutes (early)	2079256	2510000	17030	288000	2131227	4853	1	Gold Berea
5	13016	4/16/2018	12:00:10 AM	39.30885	-76.6754	85	0		UNSET	CalAmp	00:10.9	CityLink GOLD	273000	4.6 minutes (late)	1264961	1440000	17027	-217599	2131156	4854	0	Gold Walbrook Junction
6	17027	4/16/2018	12:00:13 AM	39.31191	-76.599	91	0		UNSET	CalAmp	00:13.5	CityLink GOLD	-224000	-3.7 minutes (early)	2056142	2533000	17030	245277	2131227	4853	1	Gold Berea
7	17030	4/16/2018	12:00:13 AM	39.29784	-76.5895	357	11.3889		UNSET	CalAmp	00:13.8	CityLink GOLD	208695	3.5 minutes (late)	3713693	3600000	17027	-224000	2131162	4852	0	Gold Walbrook Junction
8	13016	4/16/2018	12:00:20 AM	39.30885	-76.6754	85	0		UNSET	CalAmp	00:20.9	CityLink GOLD	283000	4.7 minutes (late)	1264961	1440000	17027	-224000	2131156	4854	0	Gold Walbrook Junction
9	17030	4/16/2018	12:00:23 AM	39.29841	-76.5896	356	0		UNSET	CalAmp	00:23.9	CityLink GOLD	184000	3.1 minutes (late)	3700134	3600000	17027	-214000	2131162	4852	0	Gold Walbrook Junction
10	17027	4/16/2018	12:00:23 AM	39.31191	-76.599	91	0		UNSET	CalAmp	00:23.7	CityLink GOLD	-214000	-3.6 minutes (early)	2066134	2533000	17030	208695	2131227	4853	1	Gold Berea
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12	17030	4/16/2018	12:00:33 AM	39.2984	-76.5896	356	0		UNSET	CalAmp	00:34.1	CityLink GOLD	194000	3.2 minutes (late)	3697735	3600000	17027	-204000	2131162	4852	0	Gold Walbrook Junction
13	17027	4/16/2018	12:00:33 AM	39.31193	-76.5988	80	5.833338		UNSET	CalAmp	00:33.6	CityLink GOLD	-204000	-3.4 minutes (early)	2073723	2533000	17030	184000	2131227	4853	1	Gold Berea
14	13016	4/16/2018	12:00:40 AM	39.30883	-76.6754	85	0		UNSET	CalAmp	00:40.9	CityLink GOLD	303000	5.1 minutes (late)	1264961	1440000	17027	-204000	2131156	4854	0	Gold Walbrook Junction
15	17030	4/16/2018	12:00:43 AM	39.29841	-76.5897	356	0		UNSET	CalAmp	00:43.8	CityLink GOLD	204000	3.4 minutes (late)	3707515	3600000	17027	-213894	2131162	4852	0	Gold Walbrook Junction
16	17027	4/16/2018	12:00:43 AM	39.31199	-76.5977	86	10.55556		UNSET	CalAmp	00:43.7	CityLink GOLD	-213894	-3.6 minutes (early)	2066445	2533000	17030	194000	2131227	4853	1	Gold Berea
17	13016	4/16/2018	12:00:50 AM	39.30883	-76.6754	85	0		UNSET	CalAmp	00:50.9	CityLink GOLD	313000	5.2 minutes (late)	1264961	1440000	17027	-213894	2131156	4854	0	Gold Walbrook Junction
18	17030	4/16/2018	12:00:53 AM	39.29842	-76.5898	356	0		UNSET	CalAmp	00:53.9	CityLink GOLD	214000	3.6 minutes (late)	3716900	3600000	17027	-225051	2131162	4852	0	Gold Walbrook Junction
19	17027	4/16/2018	12:00:53 AM	39.31204	-76.5964	87	10.55556		UNSET	CalAmp	00:53.6	CityLink GOLD	-225051	-3.8 minutes (early)	2055288	2533000	17030	204000	2131227	4853	1	Gold Berea
20	13016	4/16/2018	12:01:00 AM	39.30882	-76.6754	85	0		UNSET	CalAmp	01:00.9	CityLink GOLD	323000	5.4 minutes (late)	1264961	1440000	17027	-225051	2131156	4854	0	Gold Walbrook Junction
21	17030	4/16/2018	12:01:03 AM	39.29844	-76.5898	356	0		UNSET	CalAmp	01:03.8	CityLink GOLD	224000	3.7 minutes (late)	3715979	3600000	17027	-229208	2131162	4852	0	Gold Walbrook Junction
22	17027	4/16/2018	12:01:03 AM	39.31207	-76.5956	86	3.611114		UNSET	CalAmp	01:03.7	CityLink GOLD	-229208	-3.8 minutes (early)	2051131	2533000	17030	214000	2131227	4853	1	Gold Berea
23	13016	4/16/2018	12:01:10 AM	39.30881	-76.6754	85	0		UNSET	CalAmp	01:10.9	CityLink GOLD	333000	5.6 minutes (late)	1264961	1440000	17027	-229208	2131156	4854	0	Gold Walbrook Junction
24	17027	4/16/2018	12:01:13 AM	39.31206	-76.5954	85	3.611114		UNSET	CalAmp	01:13.7	CityLink GOLD	-221093	-3.7 minutes (early)	2059246	2533000	17030	224000	2131227	4853	1	Gold Berea
25	17030	4/16/2018	12:01:13 AM	39.29845	-76.5899	356	0		UNSET	CalAmp	01:13.8	CityLink GOLD	234000	3.9 minutes (late)	3725847	3600000	17027	-221093	2131162	4852	0	Gold Walbrook Junction
26	13016	4/16/2018	12:01:20 AM	39.30881	-76.6754	85	0		UNSET	CalAmp	01:21.0	CityLink GOLD	343000	5.7 minutes (late)	1264961	1440000	17027	-221093	2131156	4854	0	Gold Walbrook Junction
27	17027	4/16/2018	12:01:23 AM	39.31209	-76.5946	85	10.00001		UNSET	CalAmp	01:23.6	CityLink GOLD	-234000	-3.9 minutes (early)	2071286	2544000	17030	234000	2131227	4853	1	Gold Berea
28	17030	4/16/2018	12:01:23 AM	39.29849	-76.5898	355	0.555556		UNSET	CalAmp	01:23.8	CityLink GOLD	244000	4.1 minutes (late)	3734325	3600000	17027	-234000	2131162	4852	0	Gold Walbrook Junction
29	13016	4/16/2018	12:01:30 AM	39.3088	-76.6754	85	0		UNSET	CalAmp	01:30.9	CityLink GOLD	353000	5.9 minutes (late)	1264961	1440000	17027	-234000	2131156	4854	0	Gold Walbrook Junction
30	17027	4/16/2018	12:01:33 AM	39.31217	-76.5931	86	11.66668		UNSET	CalAmp	01:33.6	CityLink GOLD	-245901	-4.1 minutes (early)	2060225	2544000	17030	244000	2131227	4853	1	Gold Berea
31	17030	4/16/2018	12:01:33 AM	39.29899	-76.5898	356	8.611118		UNSET	CalAmp	01:33.8	CityLink GOLD	234344	3.9 minutes (late)	3726942	3600000	17027	-245901	2131162	4852	0	Gold Walbrook Junction
32	13016	4/16/2018	12:01:40 AM	39.3088	-76.6754	85	0		UNSET	CalAmp	01:40.9	CityLink GOLD	363000	6.1 minutes (late)	1264961	1440000	17027	-245901	2131156	4854	0	Gold Walbrook Junction
33	17030	4/16/2018	12:01:43 AM	39.2999	-76.5898	357	10.00001		UNSET	CalAmp	01:43.8	CityLink GOLD	216312	3.6 minutes (late)	3711680	3600000	17027	-265000	2131162	4852	0	Gold Walbrook Junction
34	17027	4/16/2018	12:01:43 AM	39.3122	-76.5921	97	5.55556		UNSET	CalAmp	01:43.6	CityLink GOLD	-265000	-4.4 minutes (early)	2054037	2544000	17030	234344	2131227	4853	1	Gold Berea

Eastbound AM Delays

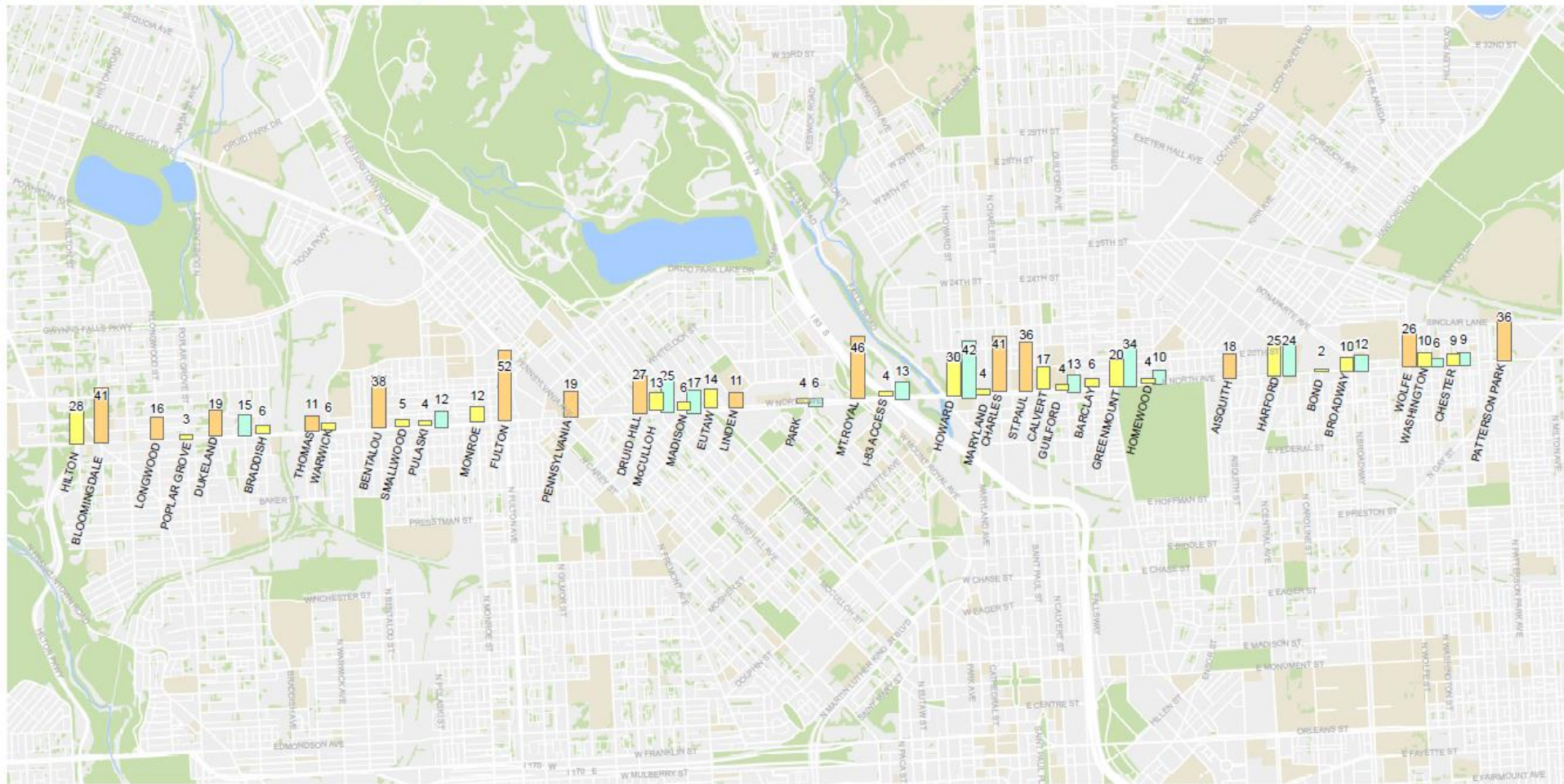


Source: SAI October 2018

Nearside Stop Dwell/ Signal Delay (Sec)
 Farside Stop Dwell Time (Sec)
 Signal Delay (Sec)

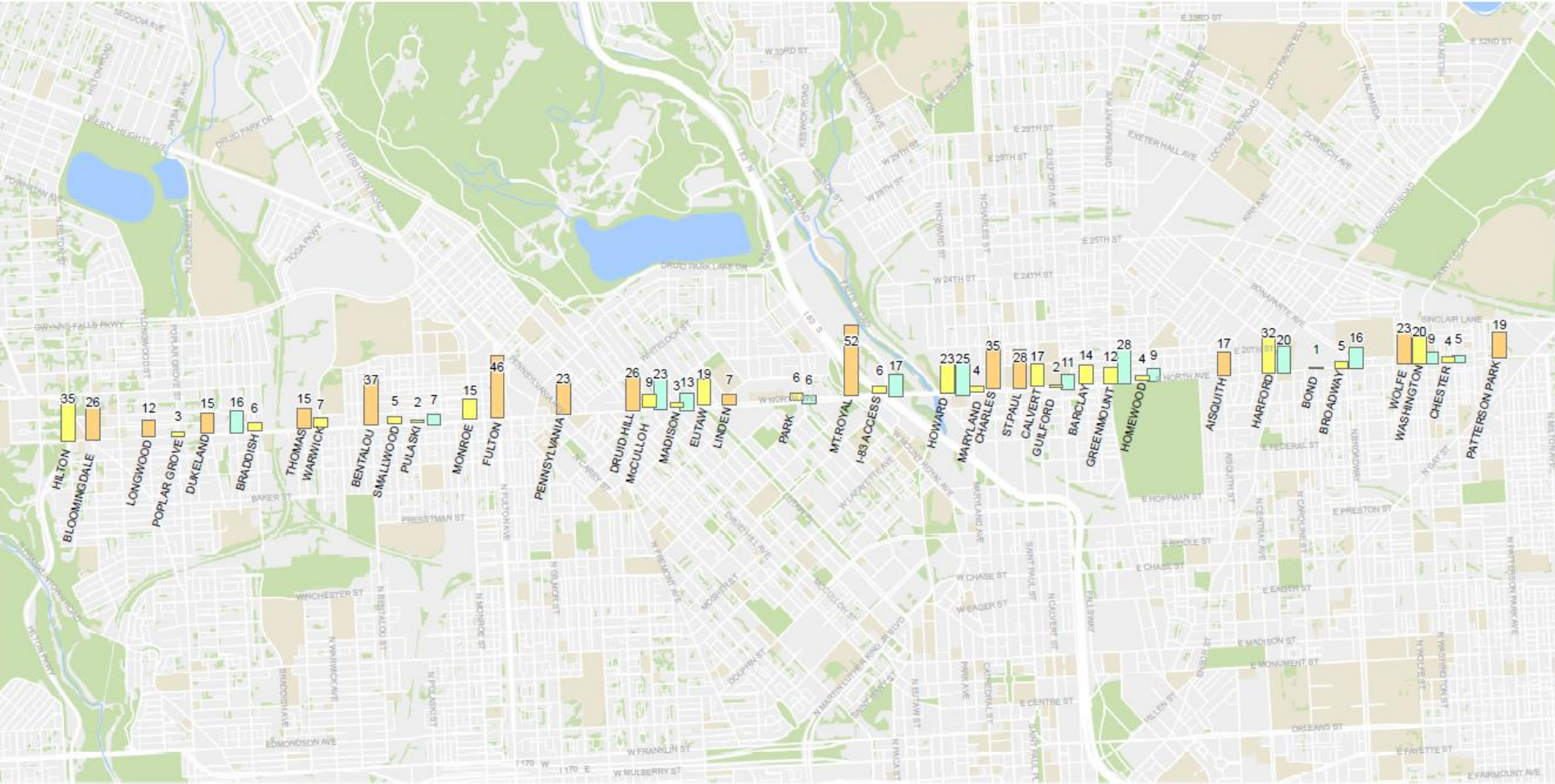


Eastbound Midday Delays



Source: SAI October 2018

Eastbound PM Delays

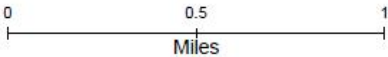


Source: SAI October 2018

Nearside Stop Dwell/ Signal Delay (Sec)

Farside Stop Dwell Time (Sec)

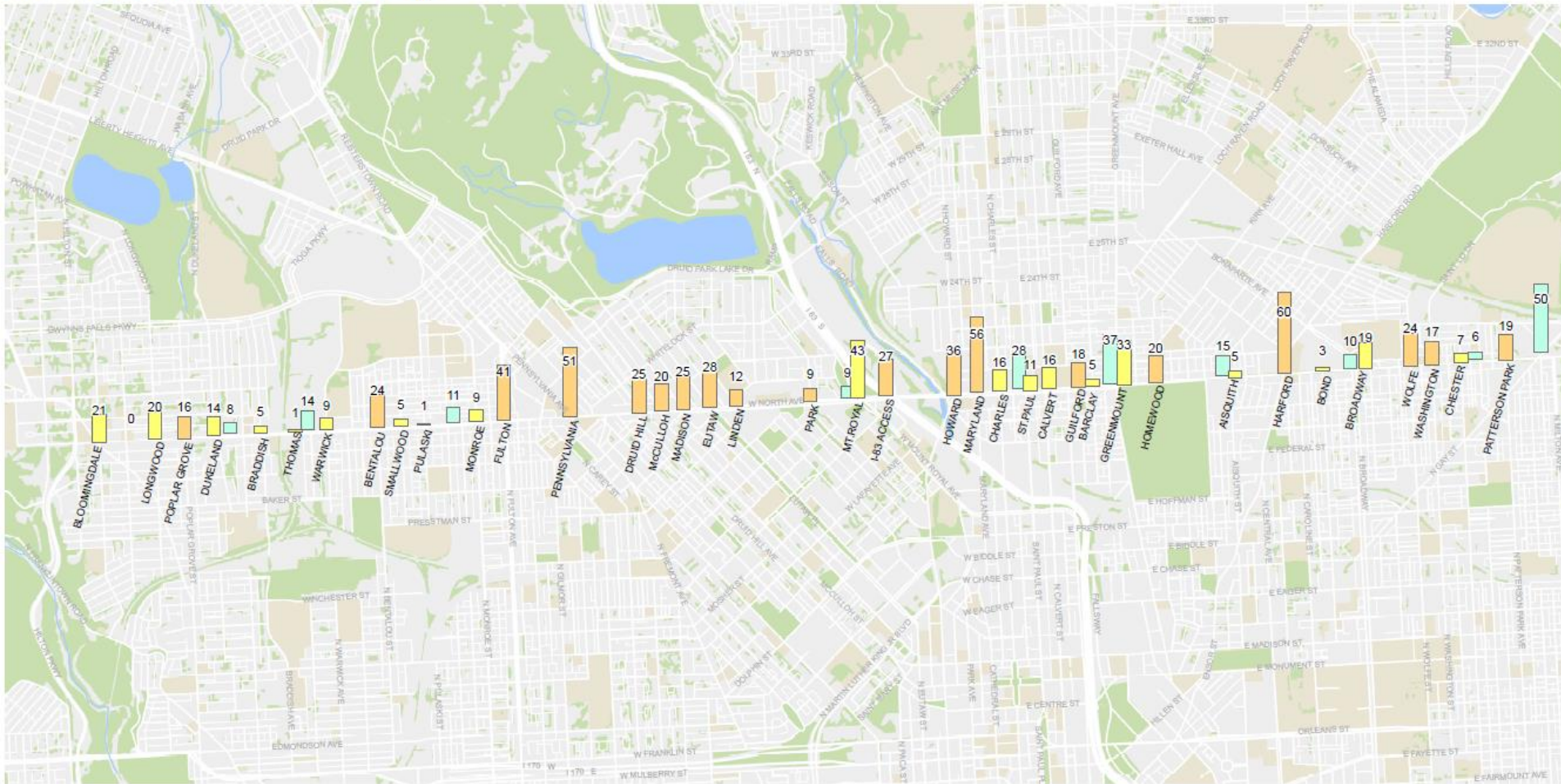
Signal Delay (Sec)



Westbound AM Delays



Westbound Midday Delays



Source: SAI October 2018

Nearside Stop Dwell/ Signal Delay (Sec)

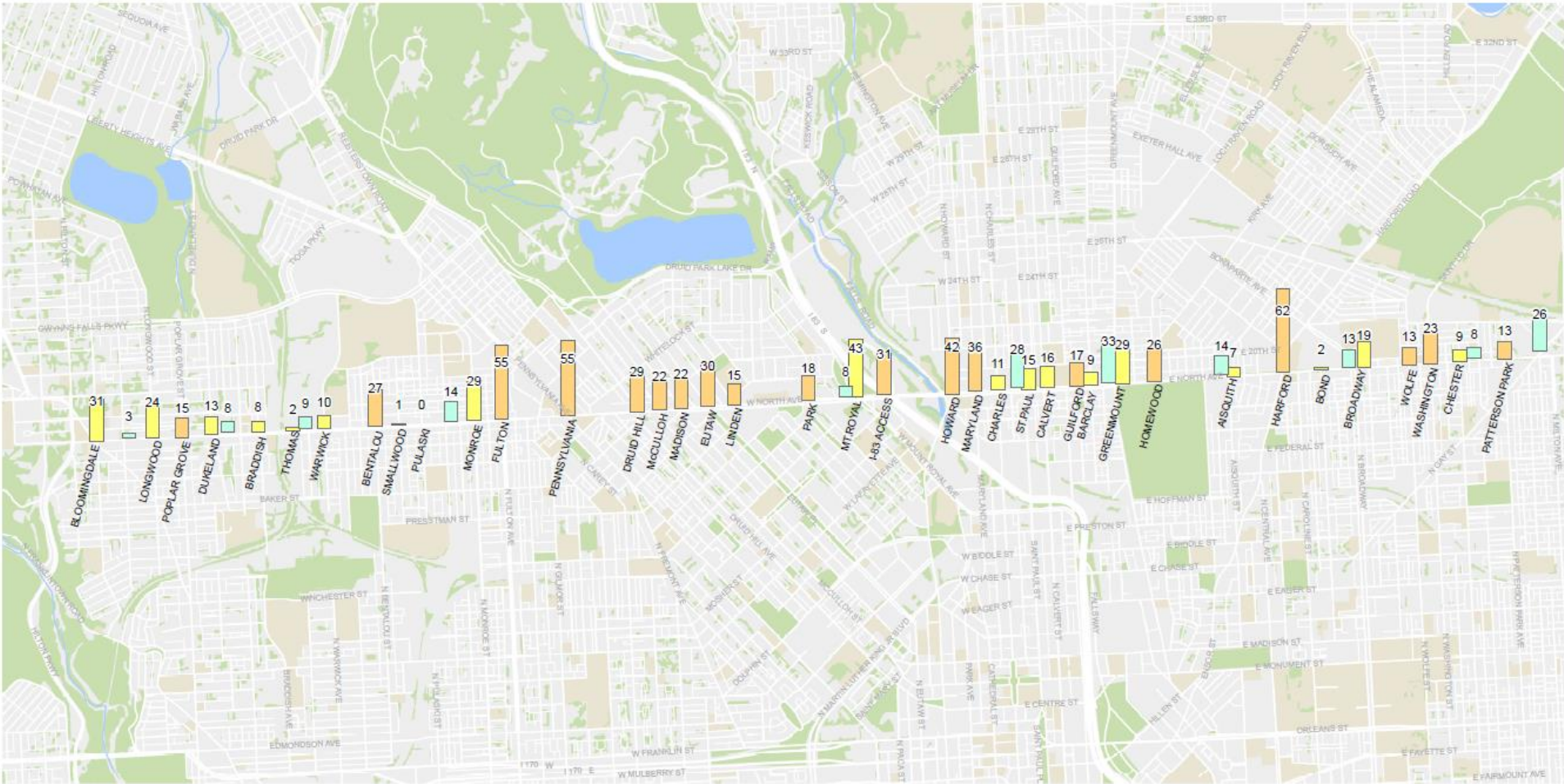
Farside Stop Dwell Time (Sec)

Signal Delay (Sec)

0 0.5 1
Miles



Westbound PM Delays

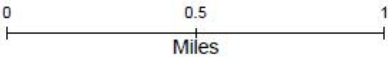


Source: SAI October 2018

Nearside Stop Dwell/ Signal Delay (Sec)

Farside Stop Dwell Time (Sec)

Signal Delay (Sec)



CHALLENGES

- Too many near-side bus stops
- Highly variable boarding/alighting times
- Broken vehicle detections
- Broken ped push buttons
- Occasional comm failure

	Nearside Stops	Farside Stops
EB Direction	15 48%	16 52%
EB Direction	19 63%	11 37%

NEXT...

- Continue fine-tuning,
- Perform “After” travel time/delay evaluation
- Active TSP
 - GTT Opticom phase selector
 - TSP design



QUESTIONS/COMMENTS

