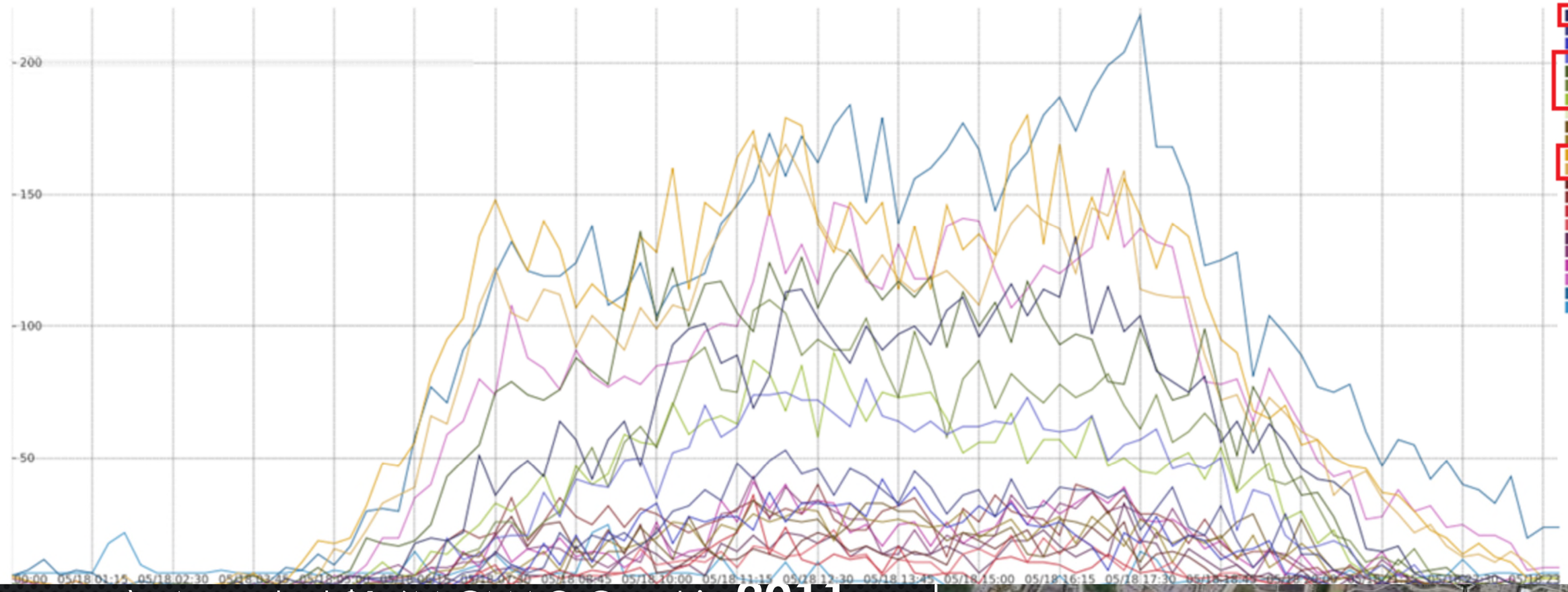
CITY OF FRANKLIN ADAPTIVE SIGNAL CONTROL TECHNOLOGY (ASCT) PROJECT AND STUDY

ADAM MOSER, COF TRAFFIC ENGINEER

DR. MEREDITH CEBELAK, GRESHAM SMITH

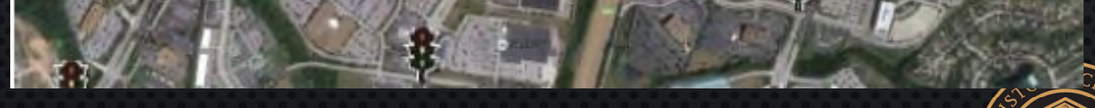
Problem



a) Awarded $1.6M CMAQ Grant in **2011**

b) Started Design **2014**

c) Finished Construction/Implementation **2021**



...DON'T ASK

Existing System

- 19 Traffic Signals in Project Area
  - NEMA TS-1
  - Siemens M50 and M60 Controllers
  - Mix of inductive loops and radar detection (stop bar & exit)
- IP/Ethernet via Fiber Optic Communications (City Owned)
- Existing CCTV Camera Infrastructure
- Traffic Operations Center (TOC) – Central Software (TACTICS)

Necessary Upgrades

- Upgrade to Latest Controller (NTCIP comm; common Firmware)
- Upgrade Vehicle Detection
  - Type and Location Depends on ASCT Software Selection!!

RFP For Technical Selection of ASCT Software!!

ASCT Software

- Systems Engineering Analysis Report (SEAR) Had City Specified Constraints
  - Could not change controller type (Siemens M50 and M60)
  - Could not change central system software (Could not interfere with TACTICS operation)
- InSync and SCOOT shortlisted
- 2017: Split Cycle Offset Optimisation Technique (SCOOT) selected
  - Met **MOST** Requirements in SEAR

Finish Design!!!

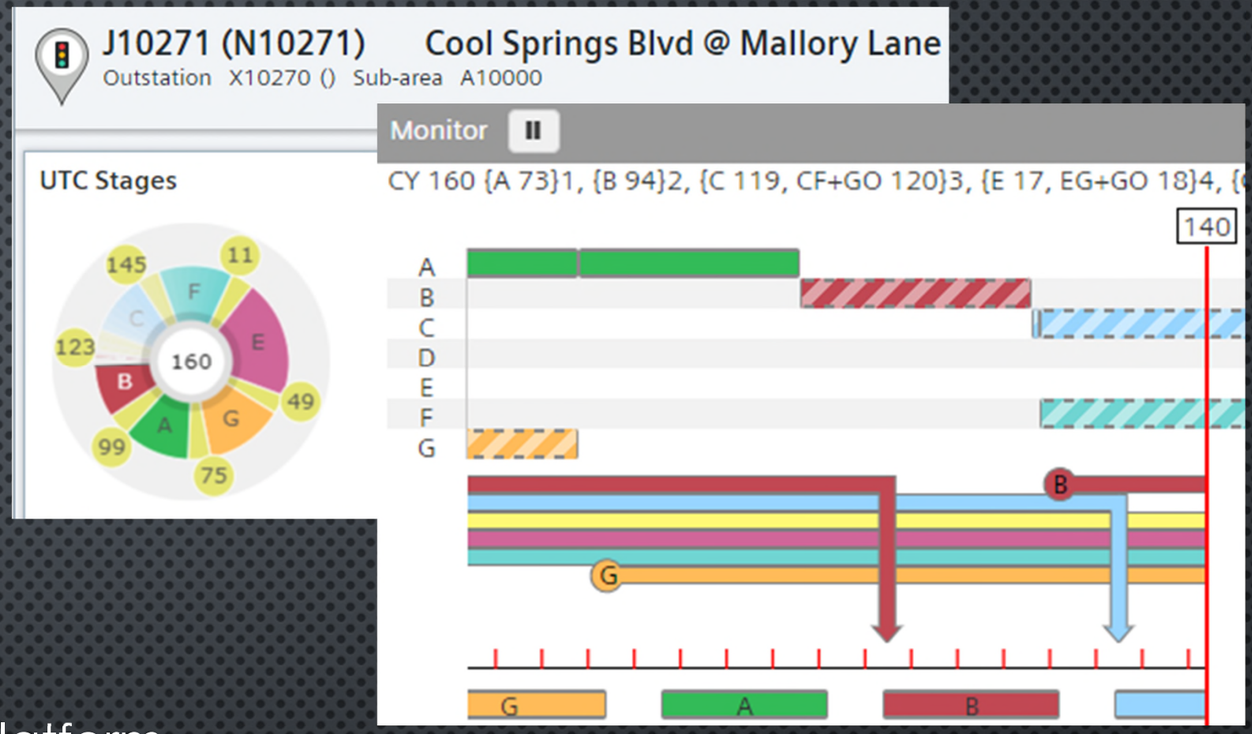
- Both Stop Bar and Advance Detection Required for SCOOT – By Lane
  - Magnetometers Best Option For City
  - Upgrade Stop Bar Detection To Microwave Radar (no inductive loops)
- 2020: Stansell Electric Selected for Low-Bid Portion of Vehicle Detection Installation

SCOOT Implementation

- Implementation by Temple Inc Personnel
  - Onsite Work – 3 – 4 months
  - Fine Tuning – 2 – 3 months
  - Fully Operational June/July 2021
- Intensive Training June 2021

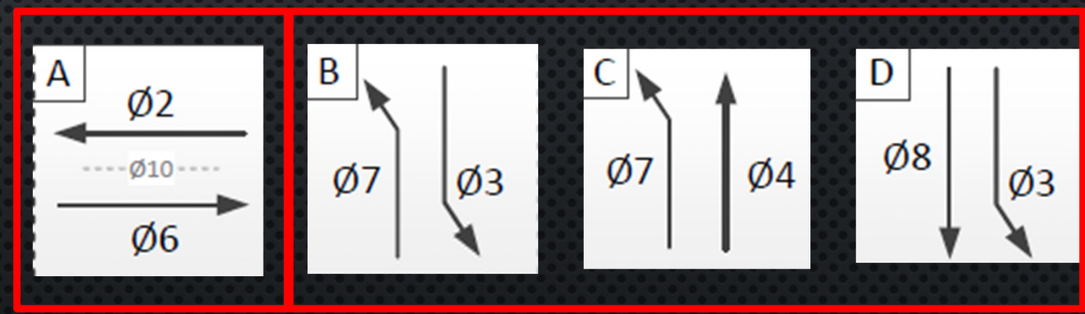
SCOOT Operation

- Operates on the Urban Traffic Control (UTC) platform
  - Centralized Control System Developed in the UK in the 1970s
  - SCOOT works in harmony with UTC and was first implemented in 1980s
  - Operates on ‘Stages’, not ‘Phases’
  - A UTC ‘Stage’ is a combination of allowable NEMA ‘Phases’
  - Does Not Operate a Typical NEMA Ring Structure
- SCOOT Stages may be a single UTC Stage or a combination of UTC Stages



SCOOT Stage Examples

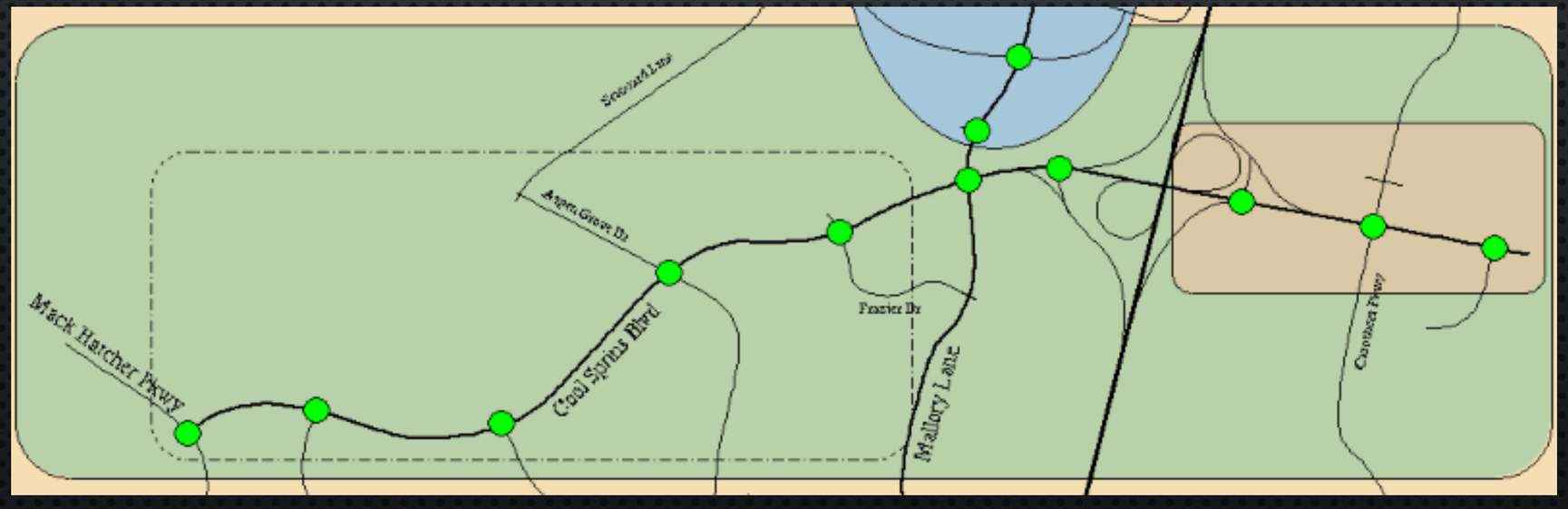
1 2



UTC Stage Examples

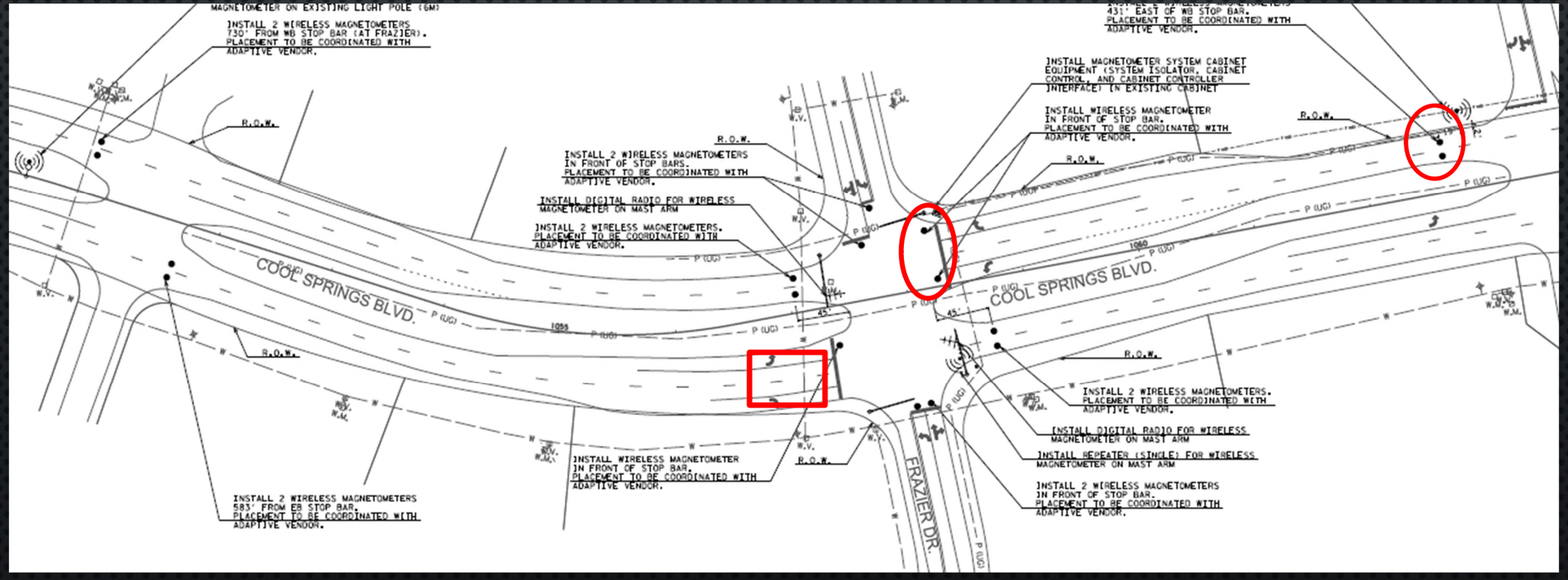
SCOOT Operation

- Intersection controller operates in '**Free**' mode
  - Min Greens and Clearances are 'hard coded' into SCOOT – cannot be violated
  - SCOOT applies Calls, Holds, and Force-Offs to controller (Node)
- SCOOT arranges intersections into 'Nodes', that are then grouped into Regions
  - Regions control the common cycle length
  - Nodes in a Region can optimize offsets
  - Nodes can double-cycle 1) IF allowed and 2) IF reduction of delay outweighs progression



SCOOT Operation

- Stop Bar Detection – Calls the Stage ONLY
- Advance Detection – ***Proactive*** - Used for Normal Links and Entry Links
  - Determines when a Stage is to occur (Arrivals)
  - Determines how long the Stage will be via SCOOT calculation
- Filter Detection – ***Reactive*** – Stage optimized on the next cycle
  - Typically 6 – 10' after the stop bar to measure vehicles exiting Stage
  - Most common on permissive turns (left, right)
  - Also used where advance detection cannot be installed (private property)



Cool Springs Blvd @ Aspen Grove Drive

10.100.80.30 MODEM #4 (E01001)
10.100.87.30 Detection

X10140	J10141	N10141	F10142
OK	OK	OK	ON

SCOOT Control Active

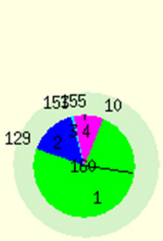
Control

SCOO | XSCO

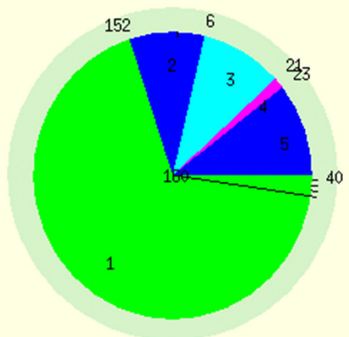
OUTT: Junction | Node | Links | Detectors | Stages

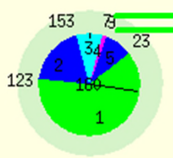
Clear Faults: Outstation | Junction | Detectors

Commands: Fine Tune | Det Stat | History



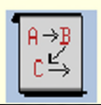
N10131





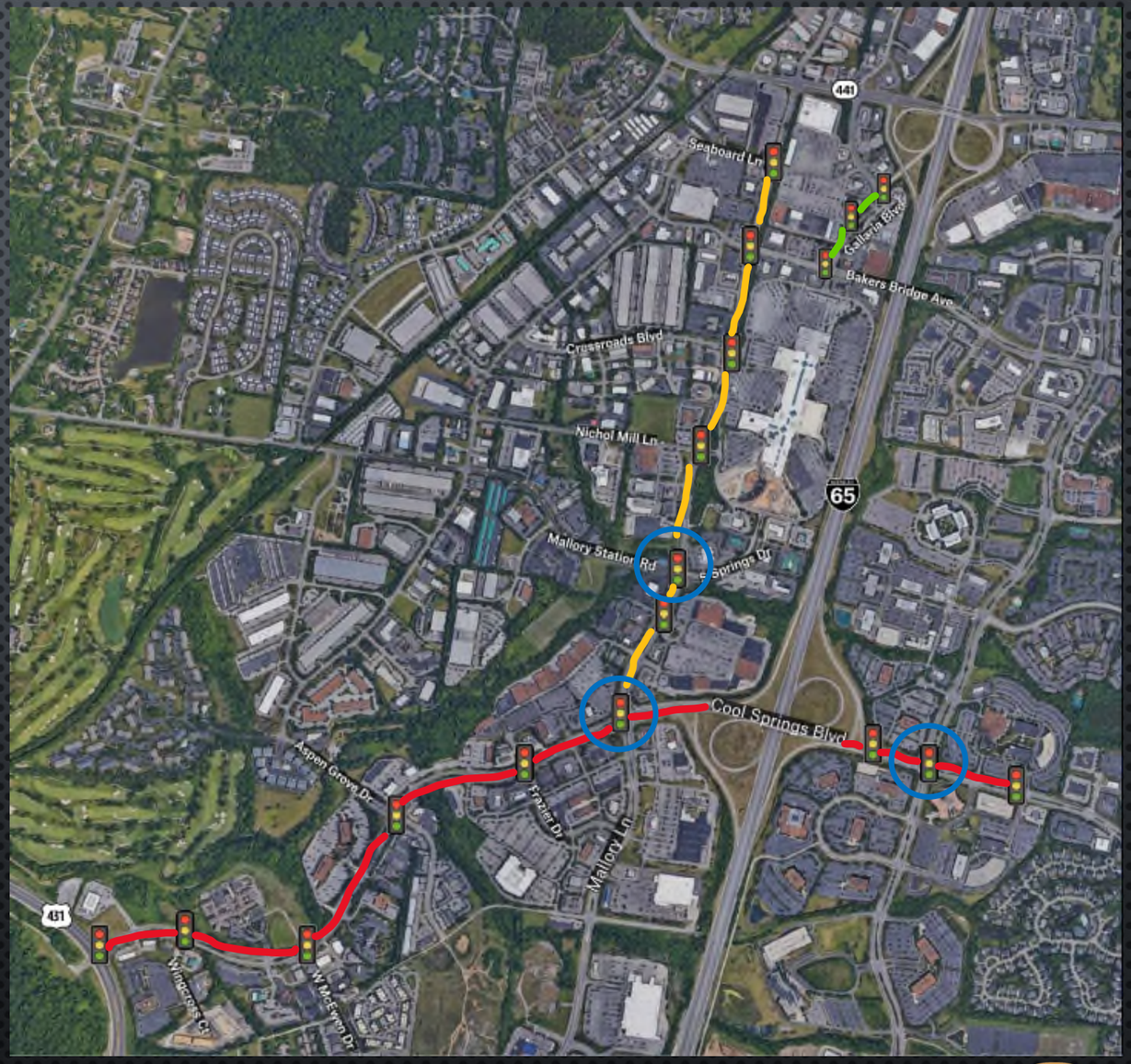
N10151

10141
OS.F...
ycle Time: 160 [96+]
tage: N10141/1



Before/After Study

- Data Collection
  - 3 Corridors:
    - Cool Springs Blvd
    - Mallory Ln
    - Galleria Blvd
  - 3 Intersections:
    - Mallory Ln @ Cool Springs Blvd
    - Carothers Pkwy @ Cool Springs Blvd
    - Mallory Ln @ Mallory Station Rd



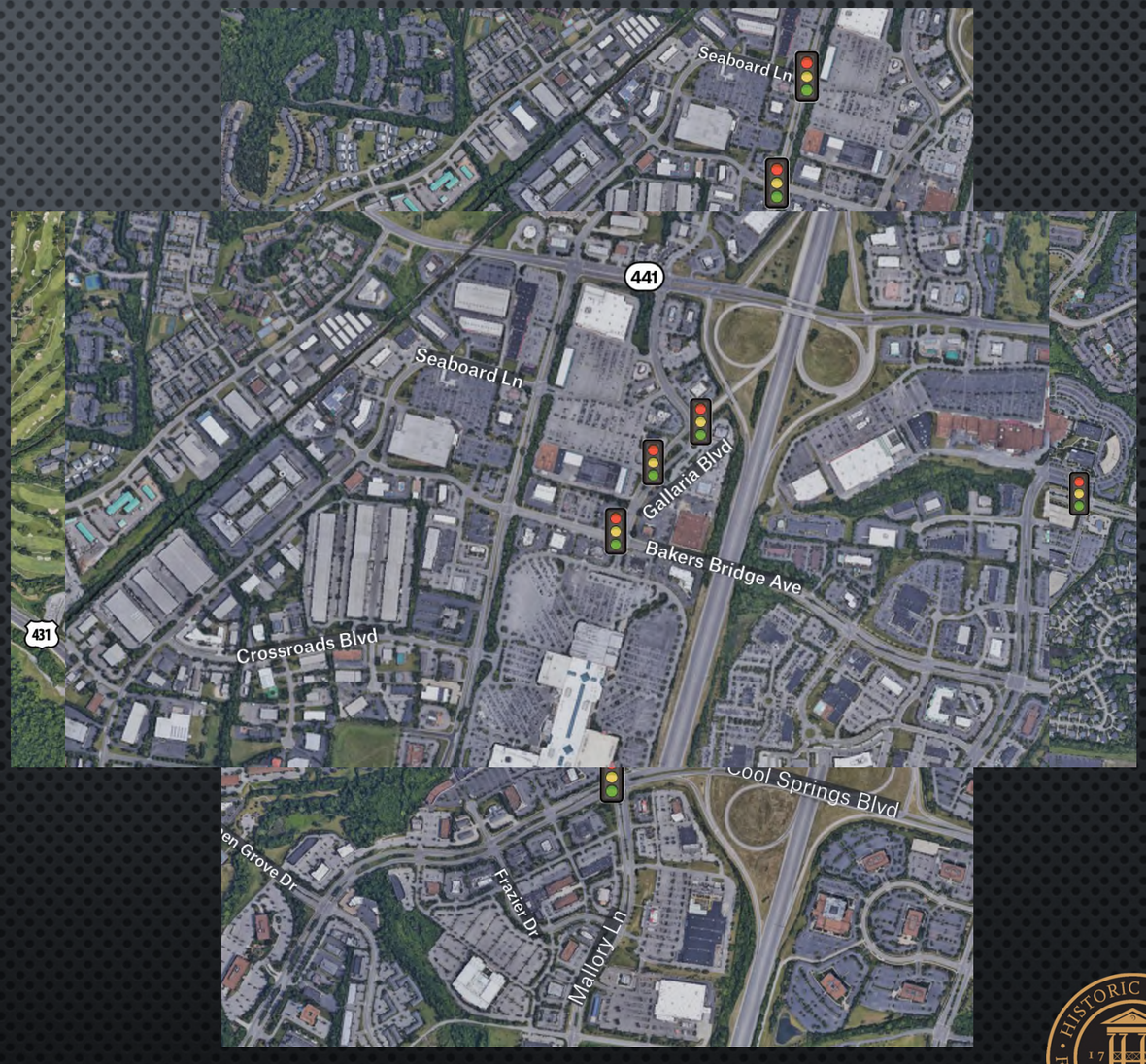
Before/After Study - Data Collection

- MOEs from SEAR
  - Volumes
  - Stop, Speed, Travel Time
  - Total Corridor Delay
  - Queue Length
  - Lane Group Control Delay
  - Vehicle Emissions
- Before
  - October 2019, September 2021
- After
  - October 2021

Objective	Performance Measure	Type of data collection and analysis
Smooth the flow of traffic along coordinated routes	Number of stops on route Arrivals on red	Floating car surveys Purdue Coordination Diagram and associated statistics from advance detection
Maximize the throughput of traffic along coordinated routes	Volume at critical locations on route	Continuous flow volume measurement by ASCT system or TACTICS Volume measurement from temporary detection devices (COF temp detection) as needed
Equitably serve adjacent land uses	Av delay per vehicle per phase No. of phases with residual queues	Field observations Reason for phase termination – continuous measurement by ASCT system Derive estimate of phase failures from signal system data in TACTICS
Manage queues, to prevent excessive queuing from reducing efficiency	Queue spillover frequency and severity	Surveys at critical locations. Ongoing queue detection and continuous reporting by ASCT or TACTICS CCTV camera validation and observation

Before/After Study – Overall Results

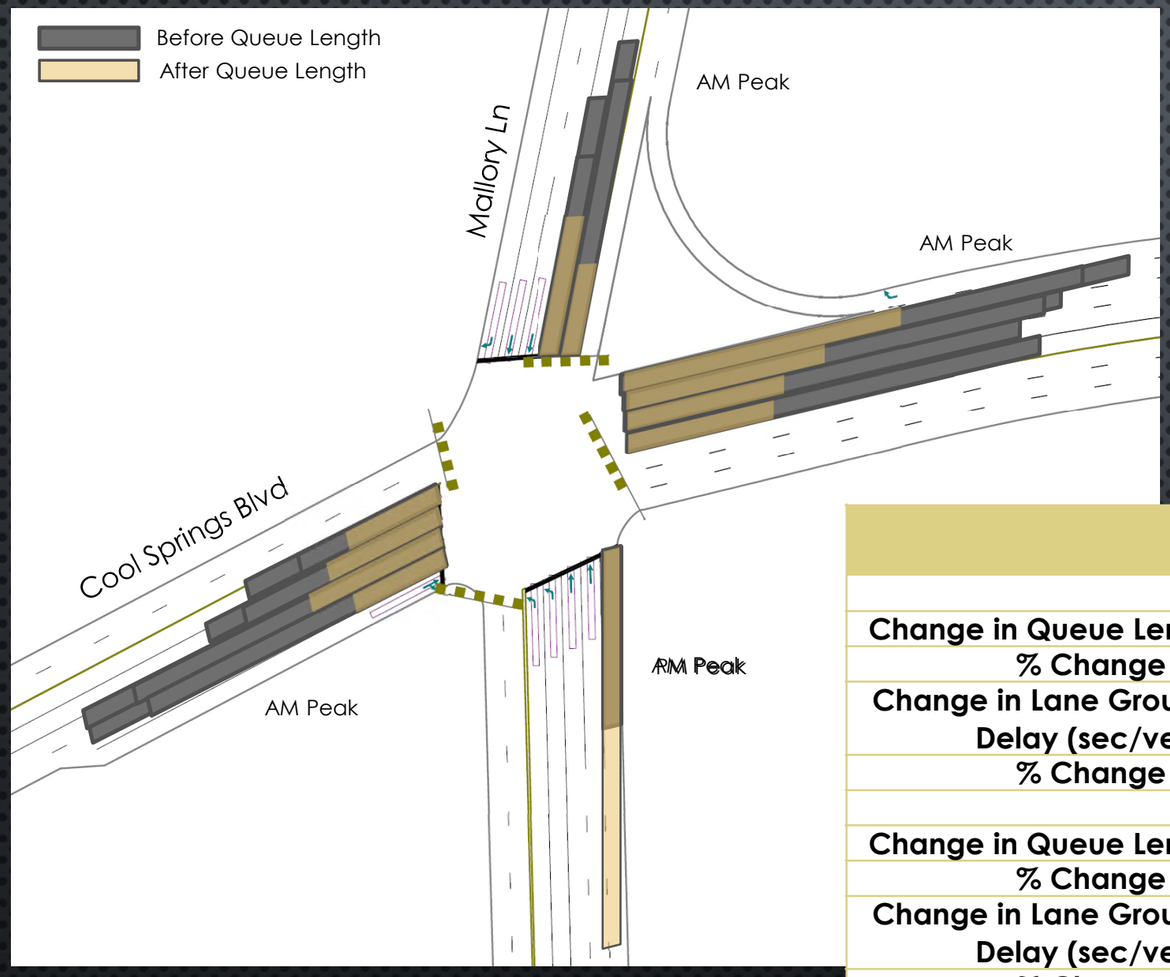
MOEs	Northbound Total Change	Southbound Total Change	Total
	Weekday		
Avg. Travel Time (sec)	-67.00	-64.00	-131.00
Avg. Number of Stops	-0.15	-0.20	-0.35
Avg. Total Delay (sec)	-44.85	-24.40	-69.25
Avg. Trip Speed (mph)	-25.03	-26.42	-51.45
	Weekend		
Avg. Travel Time (sec)	-5.00	65.00	60.00
Avg. Number of Stops	-0.20	1.00	0.80
Avg. Total Delay (sec)	-2.60	33.80	31.20
Avg. Trip Speed (mph)	-10.90	2.32	-8.59



Before/After Study – Cool Springs Blvd

	Eastbound Avg Run			Westbound Avg Run		
	Before	After	% Imp	Before	After	% Imp
Weekday A.M. Peak						
Avg. Travel Time (sec)	293	259	-12%	431	385	-11%
Avg. Running Time (sec)	256	230	-10%	269	251	-7%
Avg. Number of Stops	1.8	2.0	11%	4.4	4.0	-9%
Avg. Total Corridor Delay (sec)	37	29	-23%	162	134	-17%
Avg. Trip Speed (mph)	26.93	30.90	15%	18.71	20.96	12%
Weekday Midday Peak						
Avg. Travel Time (sec)	387	321	-17%	456	436	-4%
Avg. Running Time (sec)	265	240	-10%	264	305	16%
Avg. Number of Stops	3.0	1.6	-47%	4.8	4.0	-17%
Avg. Total Corridor Delay (sec)	122	81	-33%	192	131	-32%
Avg. Trip Speed (mph)	12.71	24.72	94%	10.87	18.66	72%
Weekday P.M. Peak						
Avg. Travel Time (sec)	369	470	27%	529	458	-13%
Avg. Running Time (sec)	257	289	12%	277	265	-4%
Avg. Number of Stops	2.8	2.6	-7%	4.6	3.6	-22%
Avg. Total Corridor Delay (sec)	112	181	62%	252	193	-23%
Avg. Trip Speed (mph)	22.02	17.82	-19%	15.09	17.86	18%
Weekend Midday Peak						
Avg. Travel Time (sec)	344	369	7%	438	341	-22%
Avg. Running Time (sec)	254	272	7%	275	248	-10%
Avg. Number of Stops	2.4	3.0	25%	4.6	2.4	-48%
Avg. Total Corridor Delay (sec)	90	97	8%	163	93	-43%
Avg. Trip Speed (mph)	14.68	21.60	47%	11.51	23.68	106%

Before/After Study - Mallory Ln @ Cool Springs Blvd



	Mallory Ln		Cool Springs Blvd	
	Northbound	Southbound	Eastbound	Westbound
Weekday				
Change in Queue Length (feet)	1.25	-81.81	-70.00	-46.53
% Change	-1%	32%	32%	21%
Change in Lane Group Control Delay (sec/veh)	-1.81	10.80	2.73	-17.42
% Change	1.30%	-22.44%	-56.45%	17.64%
Weekend				
Change in Queue Length (feet)	64.72	-25.97	-32.50	-20.14
% Change	-41%	14%	17%	10%
Change in Lane Group Control Delay (sec/veh)	5.93	6.50	2.03	-1.13
% Change	-13.09%	-11.17%	-4.36%	-0.24%

Before/After Study – Benefit Cost Analysis

ASCT System Costs

	Cool Springs Blvd.	Mallory Ln.	Galleria Blvd.	System Total
Signalized Intersections	10	7	2	19
Initial Deployment	$846,809.47	$592,766.63	$169,361.89	$1,608,938.00
ASCT Maintenance Costs	$35,000	$35,000	$35,000	$105,000.00
Sensys Replacement	$169,552.50	$93,471.25	$27,171.88	$290,195.63
TOTAL COST	**$881,809.47**	**$627,766.63**	**$204,361.89**	**$1,713,938.00**
Annual Cost	**$88,180.95**	**$62,776.66**	**$20,436.19**	**$171,393.80**

ASCT System Total Benefits

Peak Time Period	Travel Time		Fuel Consumption		Total
	Time Saved per Vehicle (secs)	Value	Gallons	Value	
Weekday AM	108	$178,565	2,967	$9,196	$187,762
Weekday Midday	-61	-$180,231	-2,994	-$9,282	-$189,513
Weekday PM	235	$753,399	12,517	$38,801	$792,200
Weekend Midday	-52	$14,971	249	$771	$15,742
TOTAL	**230**	**$ 766,704.18**	**12,738**	**$39,486.69**	**$ 806,190.87**

Before/After Study – Benefit Cost Analysis

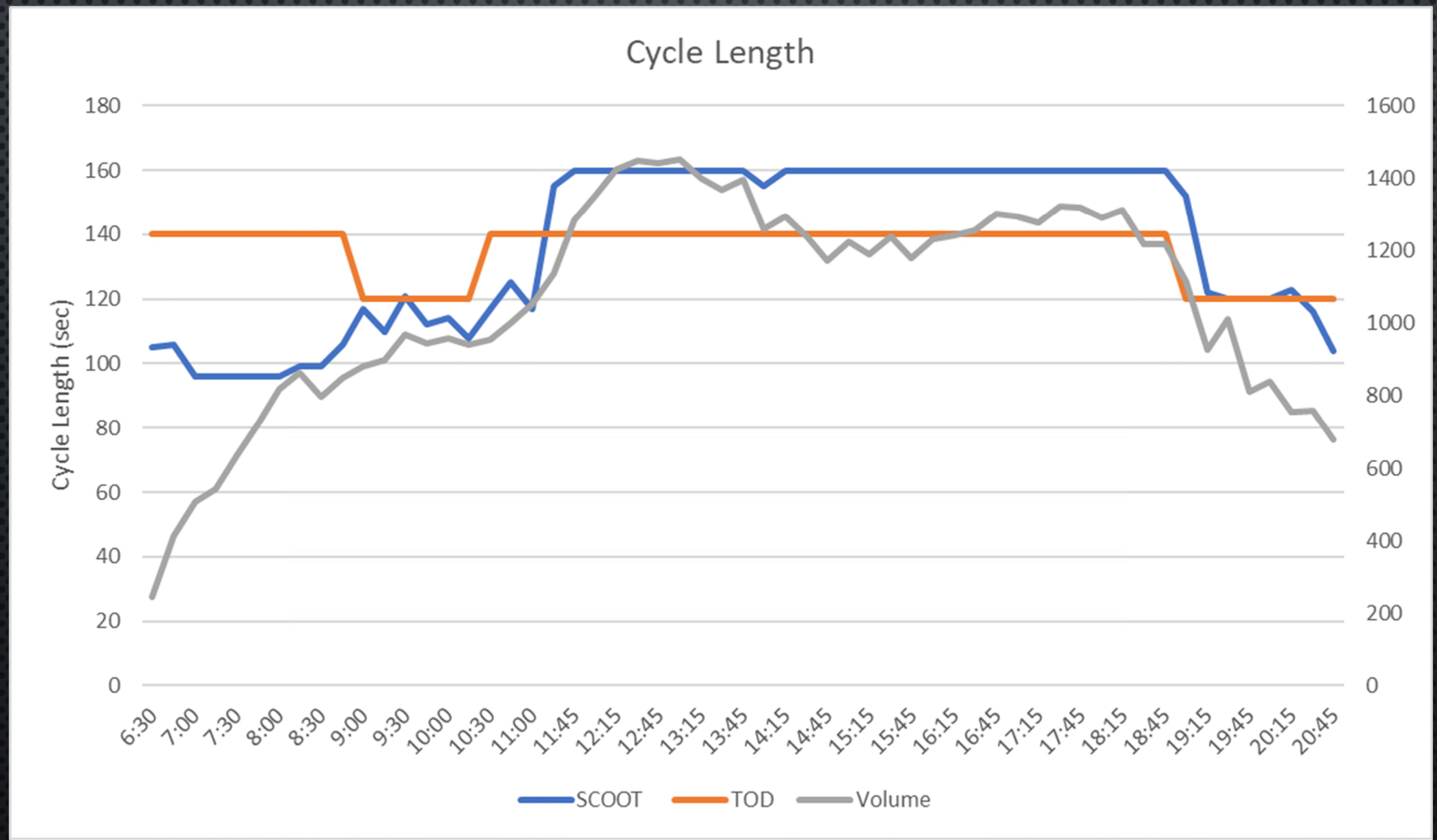
Benefit/Cost Analysis

Route	Total Annual Benefit	Annual Cost	Benefit/Cost Ratio
Cool Spring Blvd	$599,198	$88,181	7.04
Mallory Ln	$112,033	$62,776.66	2.02
Galleria Blvd	$94,960	$20,436.19	4.86
Total	**$846,946**	**$171,394**	**4.94**

$1 Spent = $5 Benefit

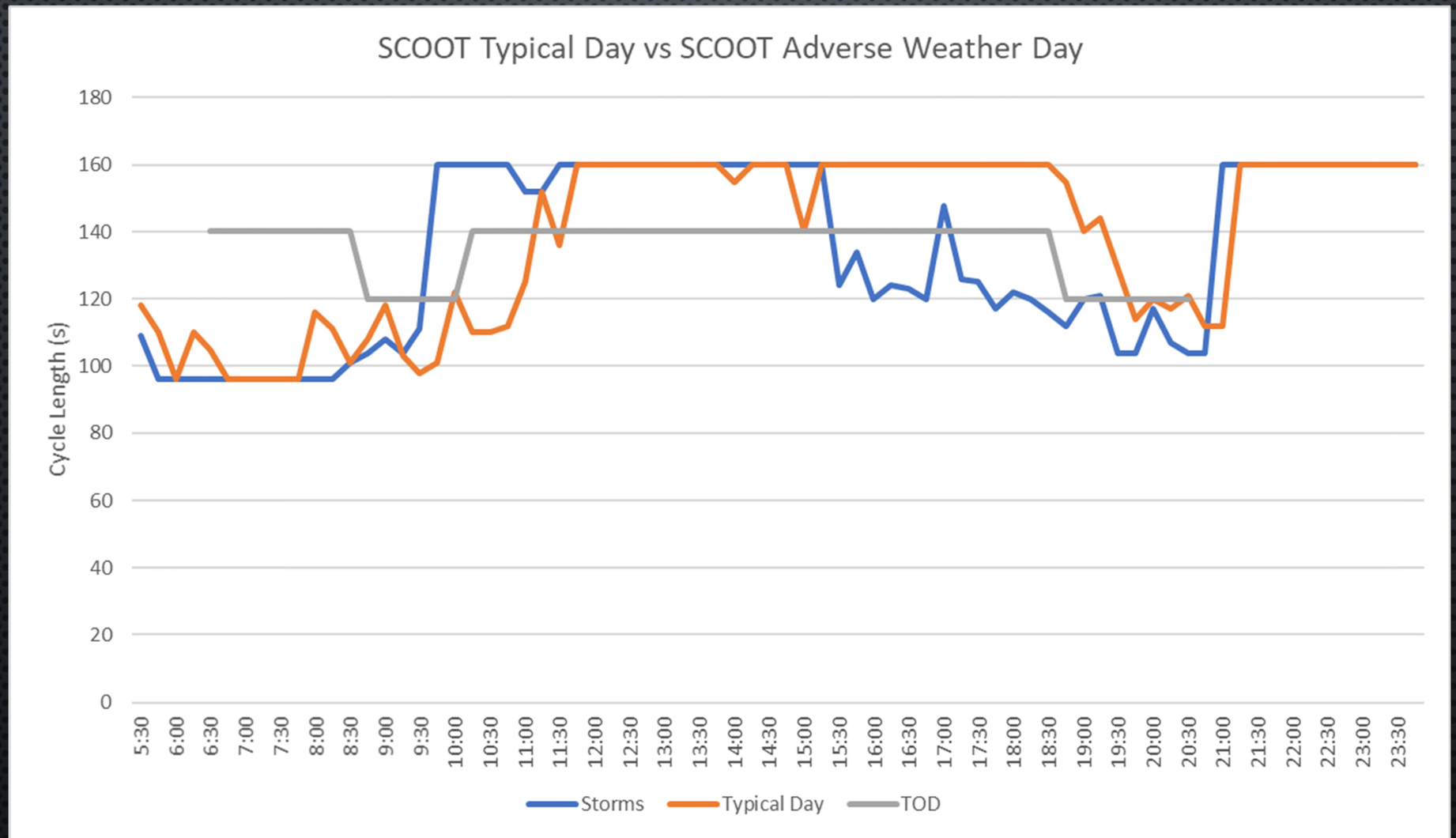
SCOOT Good

- <u>SCOOT Improvements:</u>
  - Overall, it reacts to changes in volume (Carothers Pkwy @ Cool Springs Blvd)



SCOOT Good

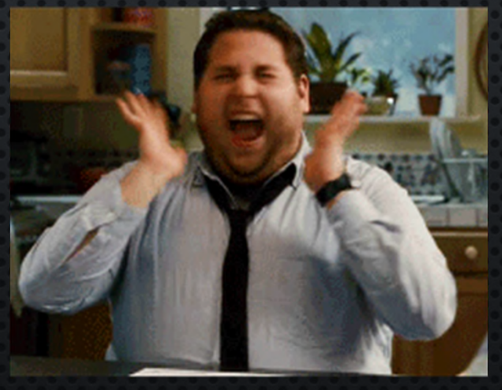
- SCOOT Improvements:
  - Reacts to volume decrease from weather – School Early Release (Cool Springs @ Mack Hatcher)



SCOOT Bad

- <u>SCOOT Limitations:</u>
  - Upon SCOOT initiation (daily startup or comm loss), has to honor ALL pedestrian timing for 10 cycles (applies max cycle length for 10 cycles)
  - Why 10 cycles? – to 'Ghost' an infrequent side street pedestrian phase
    - Ghosted Stage means we 'hide' it and only service Stage when called
    - Ghosted Stage will not be included in minimum cycle length calculation
  - SCOOT has to service Main Street (coordinated) ped phases (walk + clear)
  - No easy way to add or subtract stage time
  - Cycle lengths in increments of 4, 8, 16 seconds
    - Increment depends on how high the cycle length is – example 128 sec cycle can only move up to 144 sec (16 seconds increment)
    - Min cycle length = min greens + clearances + main st. ped (walk+clear)

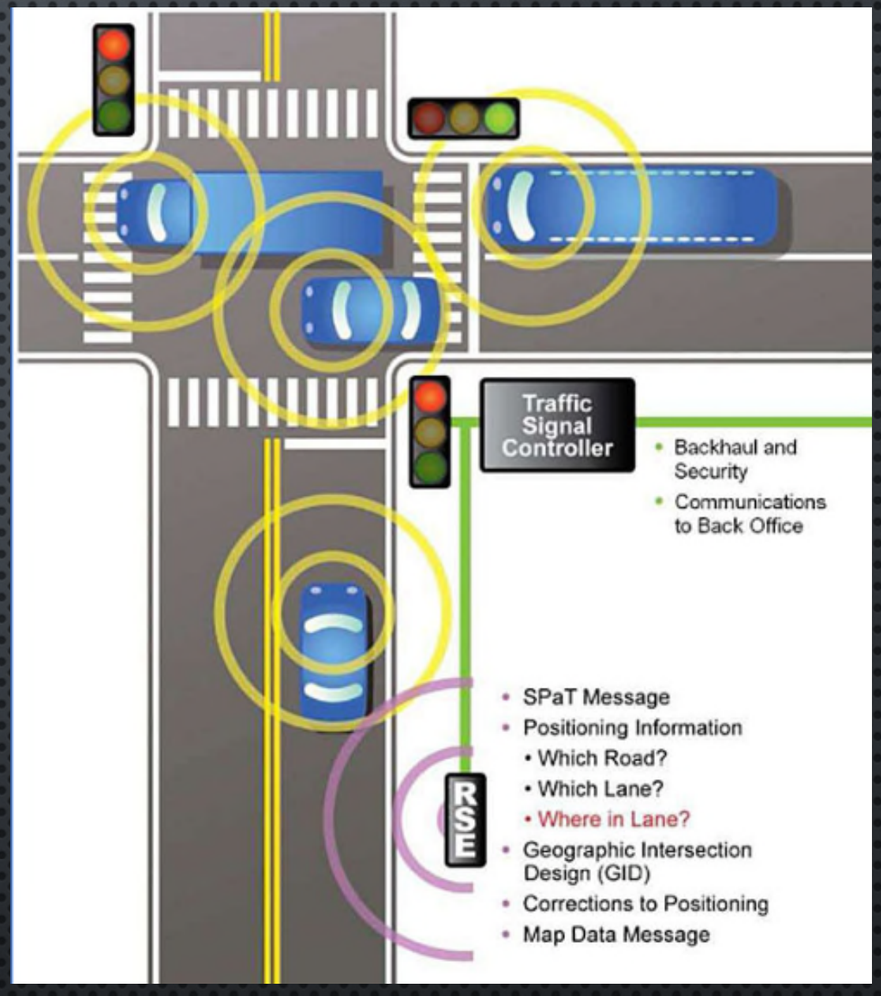
- **<u>Overall comment by staff – "Its just difficult to use"</u>**



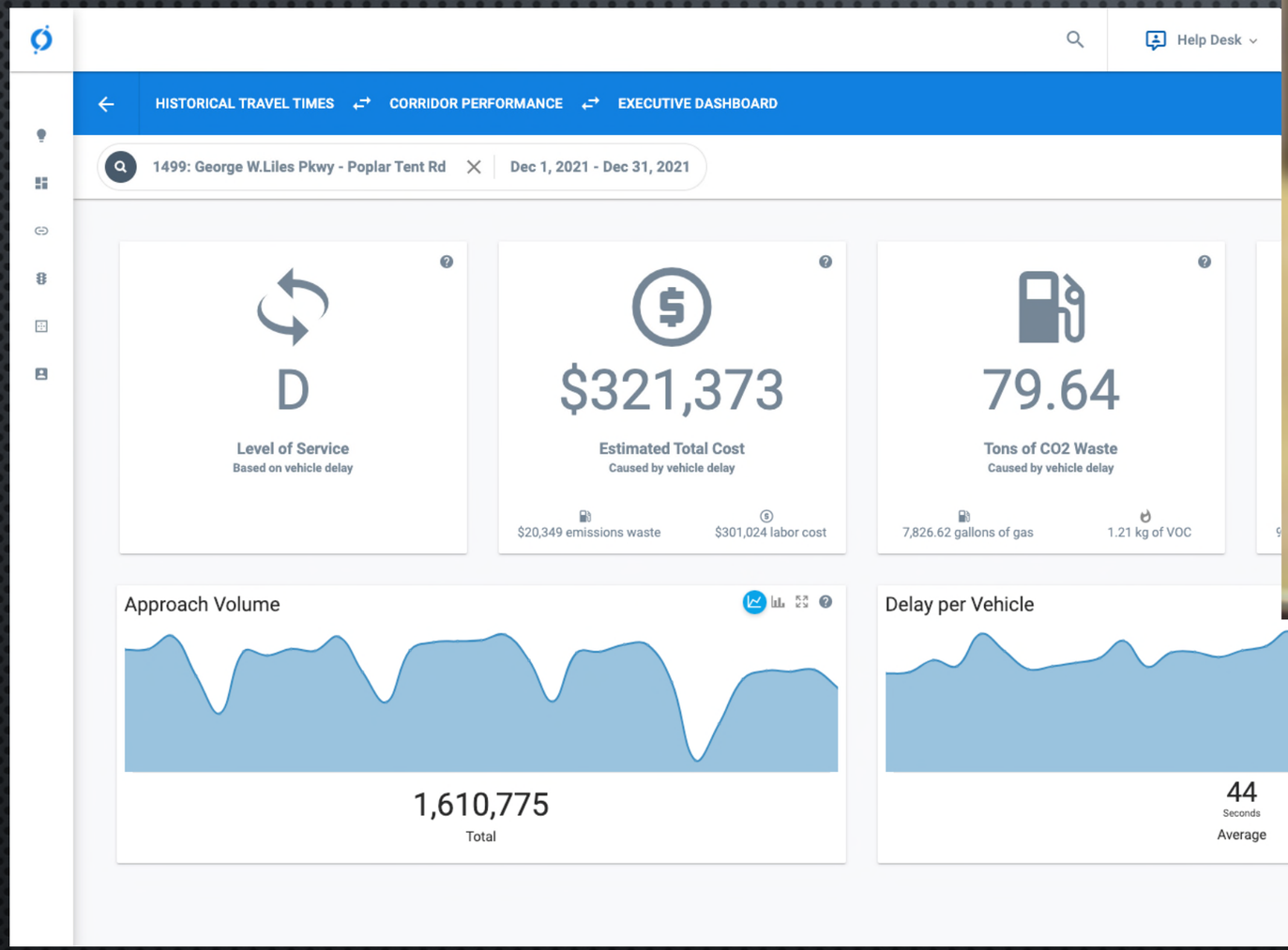
Technology Initiatives

SR 96 (Murfreesboro Rd) Traffic Signal Improvement Project

- $1,500,000 CMAQ Grant (federal grant)
- New ATC controllers & Central Software
- Automated Traffic Signal Performance Measures (ATSPM)
- Connected Vehicle (CV) components - SPaT
- Status:
  - Final Design
  - 2023 Construction



Technology Initiatives



ATSPM - Miovision Traffop

CV – Applied Information C-V2X + DSRC radios incl. TravelSafely App

Questions?

Thank You for your Time, Attention, and Participation!

Please Don't Hesitate to Contact Us with Questions or Concerns.

Project Contacts	Phone	Email
Adam Moser, P.E. Traffic Engineer	(615) 550-6663	Adam.Moser@FranklinTN.gov
Meredith Cebelak, PhD, P.E. TN TSM&O Dept Leader	(615) 770-8622	Meredith.Cebelak@greshamsmith.com