ATSPM in the City of Dublin, CA

What Agencies Can Accomplish

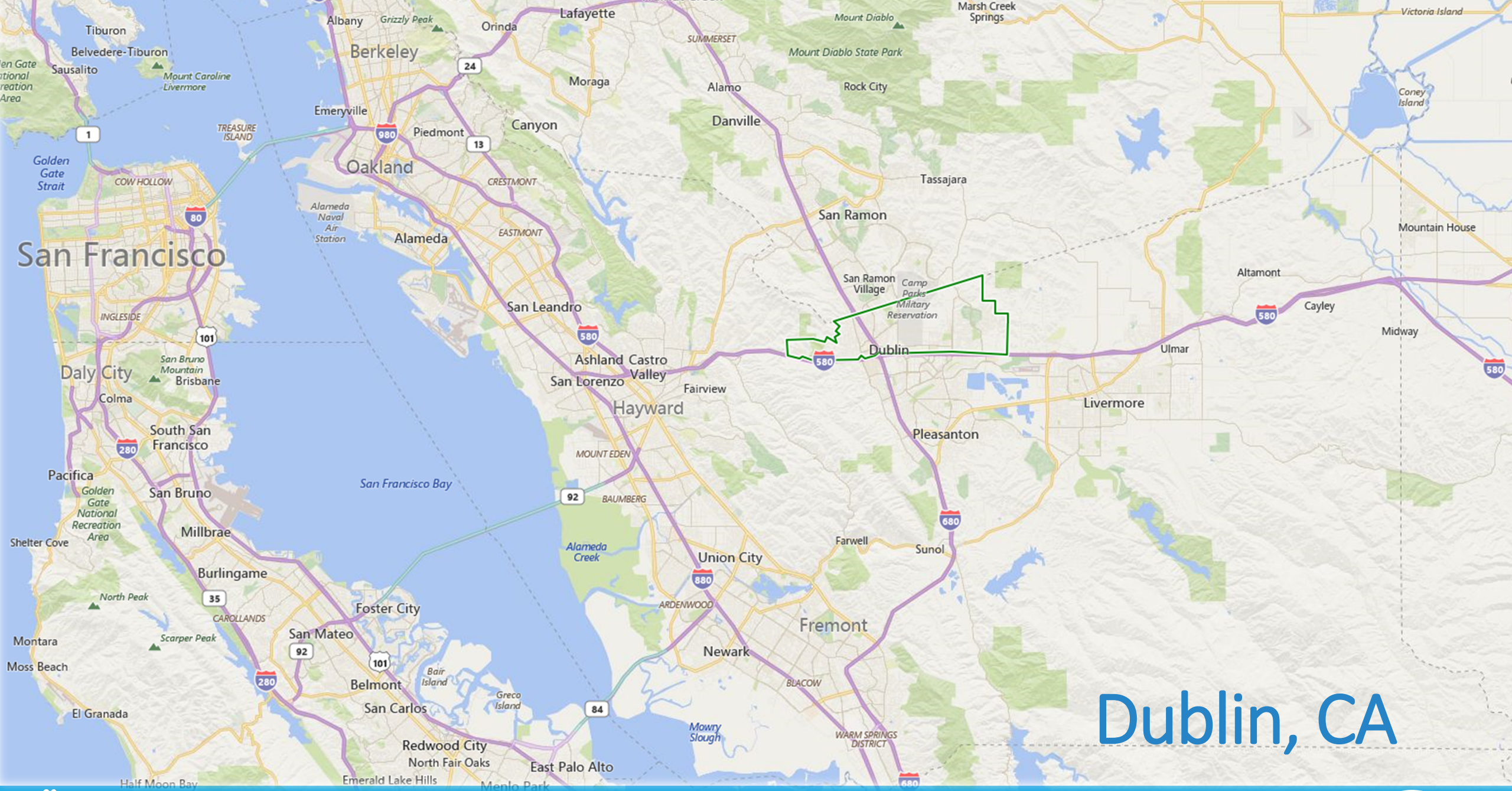
DUBLIN
CALIFORNIA

JOANNA LIU | JUNE 26, 2018

AMG ADVANCED MOBILITY GROUP

Automated Traffic Signal Performance Measures (ATSPM)

- Over 330,000 traffic signals are currently operating in the U.S.
- Largely reliant on citizen complaints and manual signal timing design methods – timing consuming and expensive
- FHWA's fourth round of Every Day Counts (EDC-4) innovation "automated traffic signal performance measures" (ATSPM)
  - An evolution in signal management
  - Provide continuous monitoring of more than a dozen performance measures based on high-resolution event-based data
  - Linear reactive method -> Method of operation that continuously use data to provide feedback

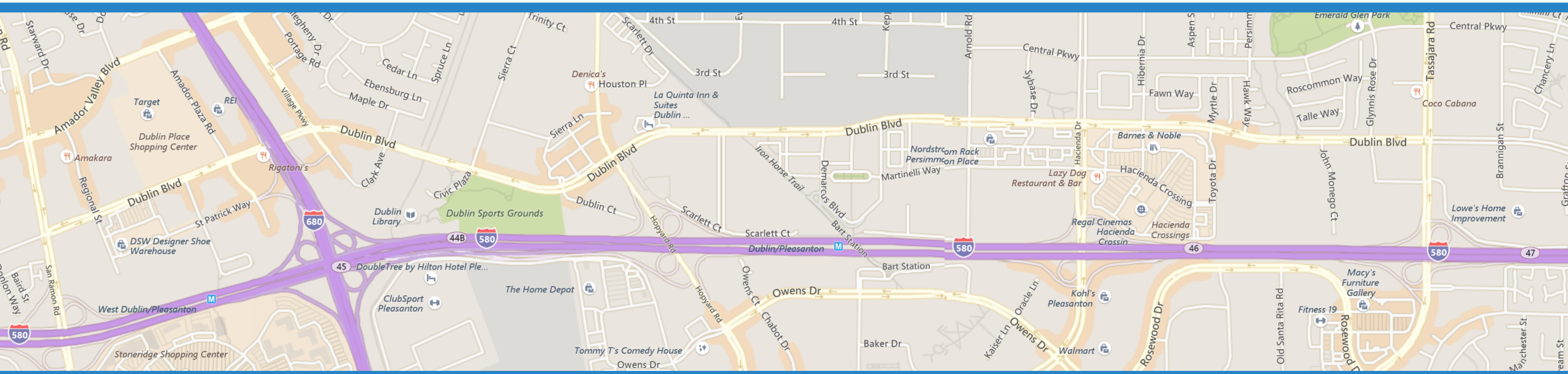


Dublin, CA

DUBLIN CALIFORNIA

AMG ADVANCED MOBILITY GROUP

City of Dublin



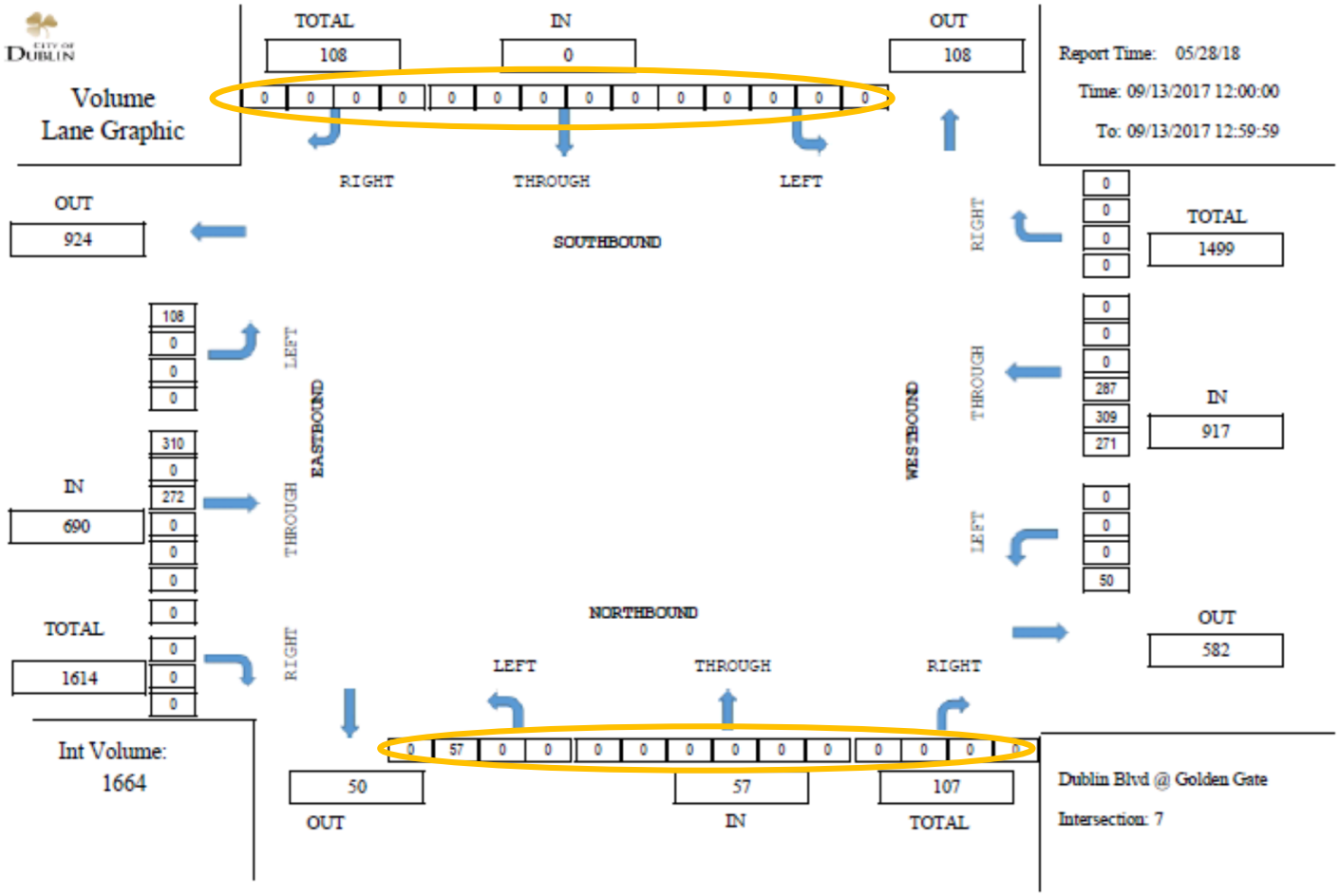
- ITS-based strategies on a 3.6-mile stretch of Dublin Boulevard
  - Adaptive Traffic Control System
  - Bus Queue Jump
  - Transit Signal Priority
  - Bicycle Detection System
- History
  - City purchased ATMS with ATSPM features
  - City installed Cloud-based ATSPM Module

Outline

- Reasonable Check of Each Performance Measure
- Case Studies
  - Performance Measures Used for ATSPM-Based Before-After Study for Dublin Blvd ATCS
  - Queuing on WB Dublin Blvd
  - WBL improvement on Dublin/Village Intersection
- Top Performance Measures to Use

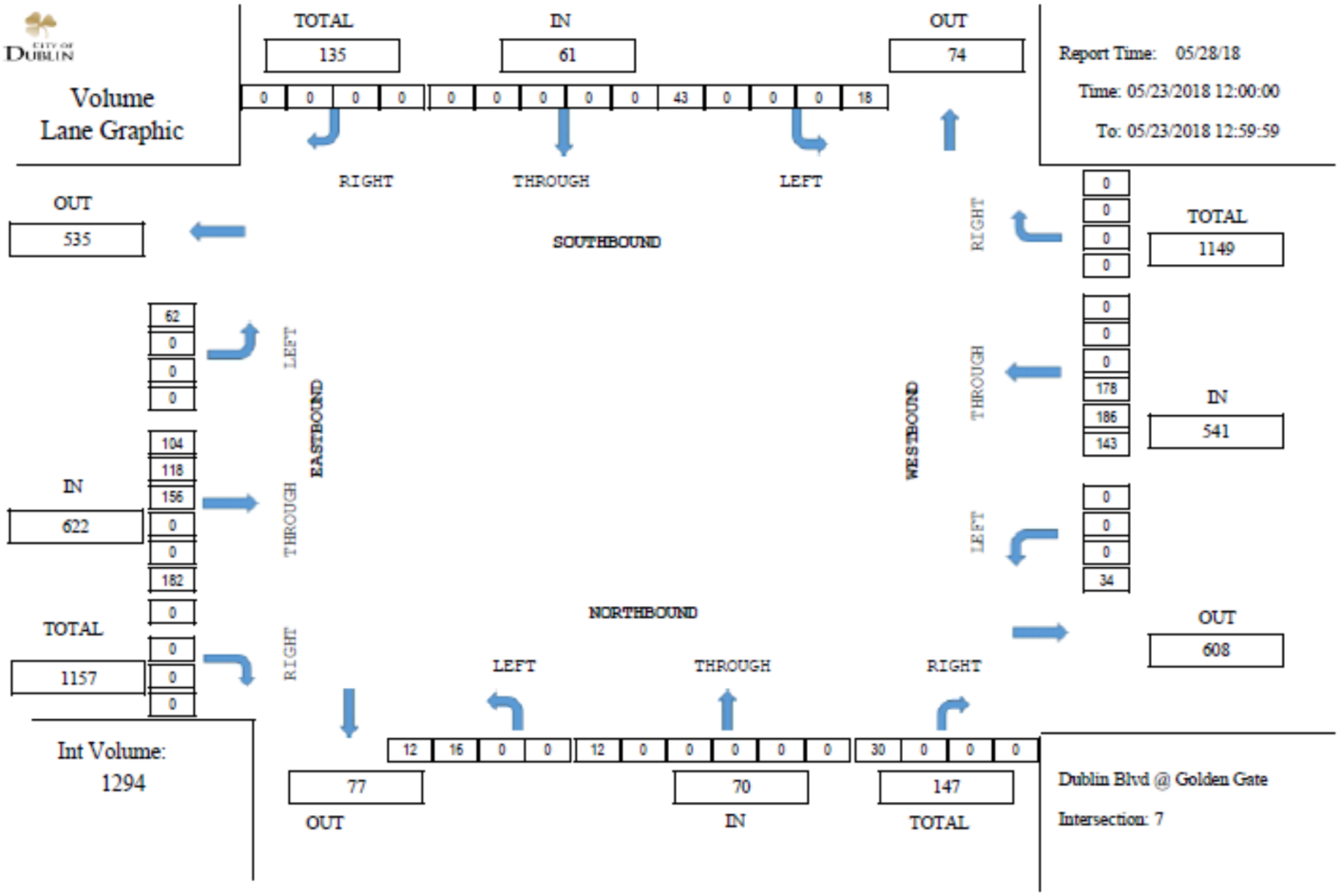
Reasonable Check of Each Performance Measure

Coding Issue – Before



Detector 12 (WBT1)	YES	YES
Detector 13 (WBT2)	YES	YES
Detector 14 (WBT3)	YES	YES
Detector 15 (NBL1)		
Detector 16 (NBL2)	YES	YES
Detector 17 (SBL1)		
Detector 18 (SBT1)		
Detector 19 (NBT1)		
Detector 20		
Detector 21 (NBR1)		

Coding Issue – After



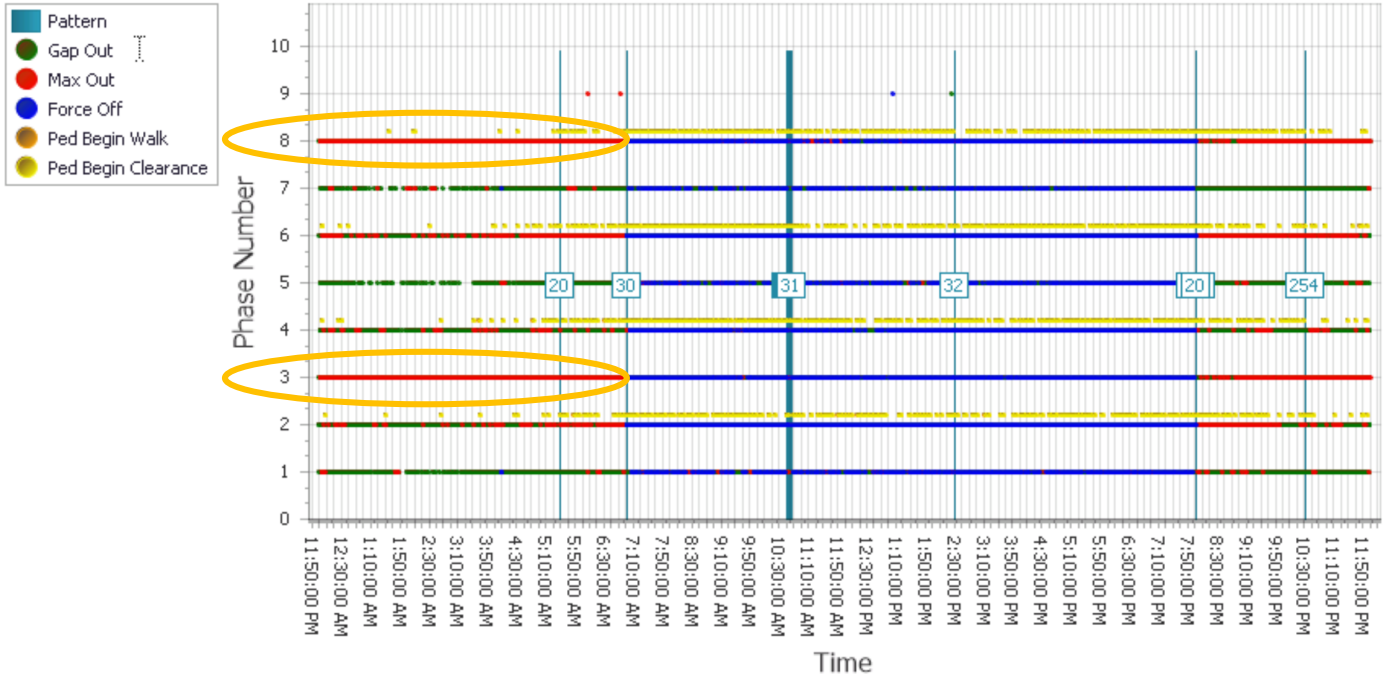
Det	Volume	Occupancy
Detector 10	YES	YES
Detector 11	YES	YES
Detector 12 (WBT1)	YES	YES
Detector 13 (WBT2)	YES	YES
Detector 14 (WBT3)	YES	YES
Detector 15 (NBL1)	YES	YES
Detector 16 (NBL2)	YES	YES
Detector 17 (SBL1)	YES	YES
Detector 18 (SBT1)	YES	YES
Detector 19 (NBT1)	YES	YES
Detector 20	YES	YES
Detector 21 (NBR1)	YES	YES

ATMS Software Issue - Before

Purdue Phase Termination Diagram

Controller: 8 Dublin Blvd @ Amador Plaza

Time: 09/13/2017 12:00:00
09/13/2017 11:59:59



Split History with Max(M),Gap(G), and Force-off(F)

Report Date: 5/28/2018

Controller: 8 Dublin Blvd @ Amador Plaza

Time: 09/13/2017 00:00:00 To 09/13/2017 04:59:59

Date/Time	Pattern	Cycle	SP1	SP2	SP3	SP4	SP5	SP6	SP7	SP8	SP9	SP10	SP11	SP12	SP13	SP14	SP15	SP16
09/13/2017 00:00:58 AM	254	58	15/G	34/G	9/G	0	10/G	40/G	0	0	0	0	0	0	0	0	0	0
09/13/2017 00:01:56 AM	254	131	0	131	0	0	0	131/G	0	0	0	0	0	0	0	0	0	0
09/13/2017 00:04:07 AM	254	89	0	77/G	12/G	0	11/G	66/G	0	12/G	0	0	0	0	0	0	0	0
09/13/2017 00:05:36 AM	254	46	0	35/G	11/G	0	0	35/G	0	11/G	0	0	0	0	0	0	0	0
09/13/2017 00:06:22 AM	254	165	0	15[illegible]/G	0	0	14/G	140/G	0	11/G	0	0	0	0	0	0	0	0
09/13/2017 00:09:07 AM	254	36	0	17/G	19/G	0	0	17/G	8/G	11/G	0	0	0	0	0	0	0	0
09/13/2017 00:09:43 AM	254	114	24/G	90/G	0	0	10/G	104	0	0	0	0	0	0	0	0	0	0
09/13/2017 00:11:37 AM	254	109	26/G	83/G	0	0	0	109	0	0	0	0	0	0	0	0	0	0
09/13/2017 00:13:26 AM	254	60	0	40/G	0	0	0	40/G	0	21/G	0	0	0	0	0	0	0	0
09/13/2017 00:14:27 AM	254	17	0	17/G	0	0	0	17	0	0	0	0	0	0	0	0	0	0
09/13/2017 00:14:44 AM	254	40	12/G	17/G	0	0	0	29/G	0	11/G	0	0	0	0	0	0	0	0
09/13/2017 00:15:24 AM	254	119	13/G	92/G	0	0	0	105/G	0	14/G	0	0	0	0	0	0	0	0
09/13/2017 00:17:23 AM	254	104	0	93/G	0	0	0	93	11/G	0	0	0	0	0	0	0	0	0
09/13/2017 00:19:07 AM	254	153	14/G	120/G	0	0	0	134/G	0	20/G	0	0	0	0	0	0	0	0
09/13/2017 00:21:41 AM	254	74	0	63/G	11/G	0	24/G	39/G	0	11/G	0	0	0	0	0	0	0	0
09/13/2017 00:22:55 AM	254	54	0	44/G	10/G	0	0	44/G	0	10/G	0	0	0	0	0	0	0	0

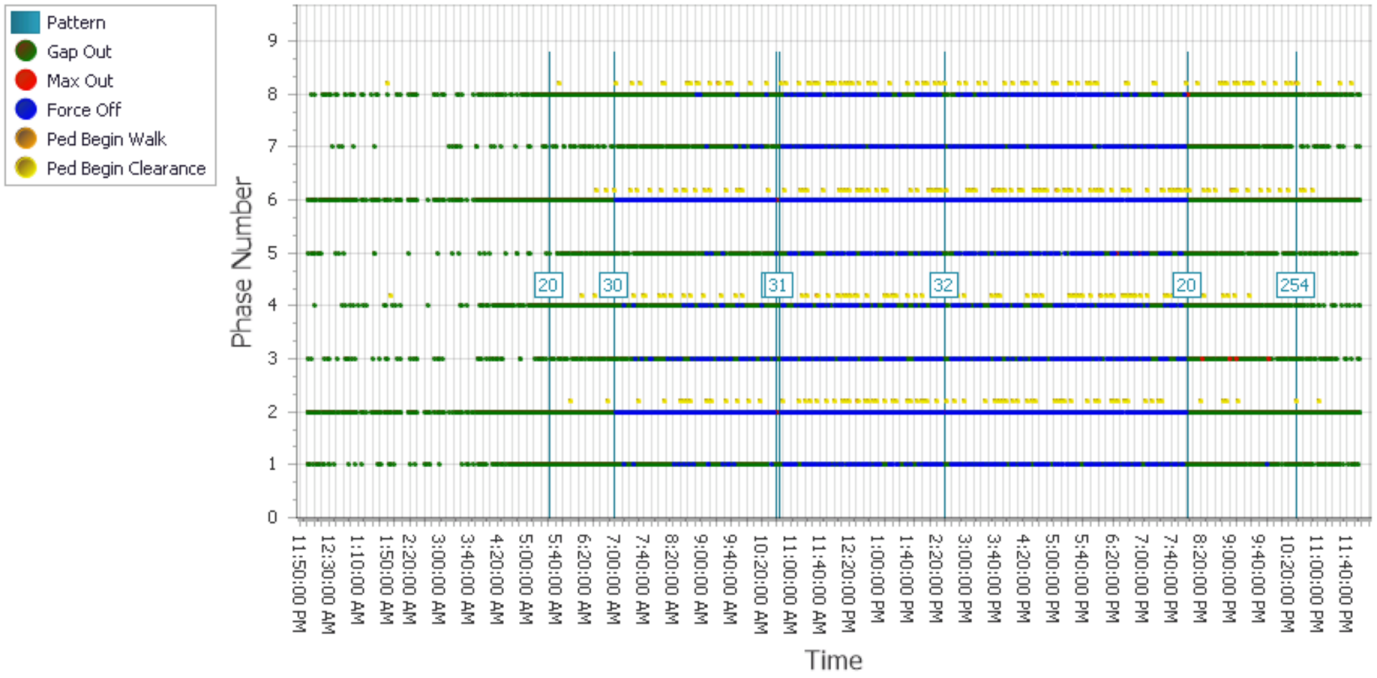
ATMS Software Issue - After

Purdue Phase Termination Diagram

Controller: 8 Dublin Blvd @ Amador Plaza

Time: 05/23/2018 12:00:00

05/23/2018 11:59:59



Split History with Max(M),Gap(G), and Force-off(F)

Report Date: 5/28/2018

Controller: 8 Dublin Blvd @ Amador Plaza

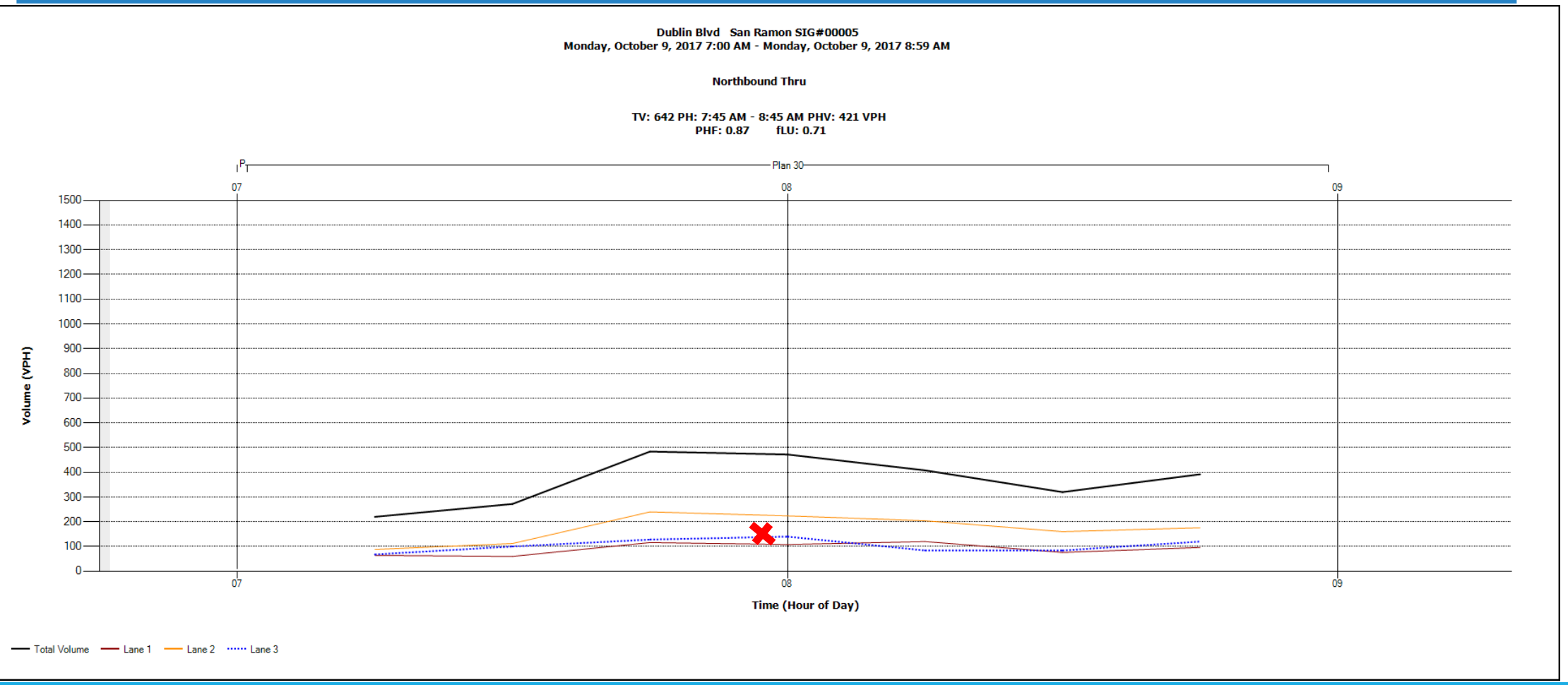
Time: 05/23/2018 00:00:00 To 05/23/2018 23:59:59

Date/Time	Pattern	Cycle	SP1	SP2	SP3	SP4	SP5	SP6	SP7	SP8	SP9	SP10	SP11	SP12	SP13	SP14	SP15	SP16
05/23/2018 00:01:19 AM	254	17	0	17/G	0	0	0	17/G	0	0	0	0	0	0	0	0	0	0
05/23/2018 00:01:36 AM	254	251	24/G	216/G	11/G	0	23/G	217/G	0	11/G	0	0	0	0	0	0	0	0
05/23/2018 00:05:47 AM	254	255	13/G	242/G	0	0	10/G	245/G	0	0	0	0	0	0	0	0	0	0
05/23/2018 00:10:02 AM	254	45	0	36/G	0	0	11/G	24/G	0	10/G	0	0	0	0	0	0	0	0
05/23/2018 00:10:47 AM	254	28	0	17/G	0	11/G	0	17/G	0	0	0	0	0	0	0	0	0	0
05/23/2018 00:11:15 AM	254	255	14/G	241/G	0	0	10/G	245/G	0	0	0	0	0	0	0	0	0	0
05/23/2018 00:15:30 AM	254	229	19/G	211/G	0	0	21/G	208/G	0	0	0	0	0	0	0	0	0	0
05/23/2018 00:19:19 AM	254	158	0	147/G	0	0	0	147/G	0	11/G	0	0	0	0	0	0	0	0
05/23/2018 00:21:57 AM	254	128	11/G	98/G	9/G	0	0	109/G	0	10/G	0	0	0	0	0	0	0	0
05/23/2018 00:24:05 AM	254	255	12/G	231/G	1	0	0	243/G	0	11/G	0	0	0	0	0	0	0	0
05/23/2018 00:28:20 AM	254	8	0	0	8/G	0	0	0	0	0	0	0	0	0	0	0	0	0
05/23/2018 00:28:28 AM	254	58	0	47/G	0	0	0	47/G	0	11/G	0	0	0	0	0	0	0	0
05/23/2018 00:29:26 AM	254	64	12/G	42/G	0	0	0	54/G	0	10/G	0	0	0	0	0	0	0	0
05/23/2018 00:30:30 AM	254	127	14/G	93/G	9/G	0	0	107/G	0	11/G	0	0	0	0	0	0	0	0
05/23/2018 00:32:37 AM	254	231	0	220/G	0	0	0	220/G	11/G	0	0	0	0	0	0	0	0	0
05/23/2018 00:36:28 AM	254	186	11/G	165/G	0	0	11/G	164/G	0	11/G	0	0	0	0	0	0	0	0

Cross Street	Turning Movement Volume Report	Arrival on Red Report
San Ramon	NBT 2 lanes (should be 3) EBT 3 lanes (should be 2) WBL 2 lanes (should be 3) WBL graphic problem	2 phase 4 graphics - 1 for EB 1 for NB
Regional		2 phase 8 graphics – 1 for NB and 1 for EB
Golden Gate	EBR graphic shown (No exclusive EBR)	
Amador Plaza	EBR graphic shown (No exclusive EBR) No WBR graphic	
Village	NBT 1 lanes (should be 2) SBT 2 lanes (should be 1)	2 phase 8 graphics – 1 for NB and 1 for SB
Clark	No NBL graphic EBL graphic problem	
Sierra-Civic	SBT graphic problem	No graphic for phase 3/4/7/8
Dublin Court	WBT 2 lanes (should be 3)	No graphic for phase 4/7
Dougherty		2 phase 8 graphics – 1 for EB 1 for NB
Scarlett		
De Marcus	No NBL graphic EBL and EBT graphic problems WBT lane 2 missing in the graphic	Phase 3 graphic is for EB
Iron Horse	EBT graphic problem WBT lane 2 missing in the graphic	
Arnold	NBL lane 1 missing in the graphic EBL and EBT graphic problems WBT lane 1 missing in the graphic	2 phase 3 graphics – 1 for NB 1 for EB Phase 7/8/4 graphic are all for SB
Persimmon	NBL 2 lane (should be 1 lane) No NBT graphic EBT graphic problem WBT lane 2 missing in the graphic	
Hacienda		2 phase 2 graphics – 1 for EB 1 for NB Phase 8 graphic is for EB
Hacienda/Martinelli	NBT 2 lanes (should be 3) EBT 2 lanes (should be 1)	

Cloud-Based ATSPM Report Graphics Issue

Cloud-Based ATSPM Report Graphics Issue

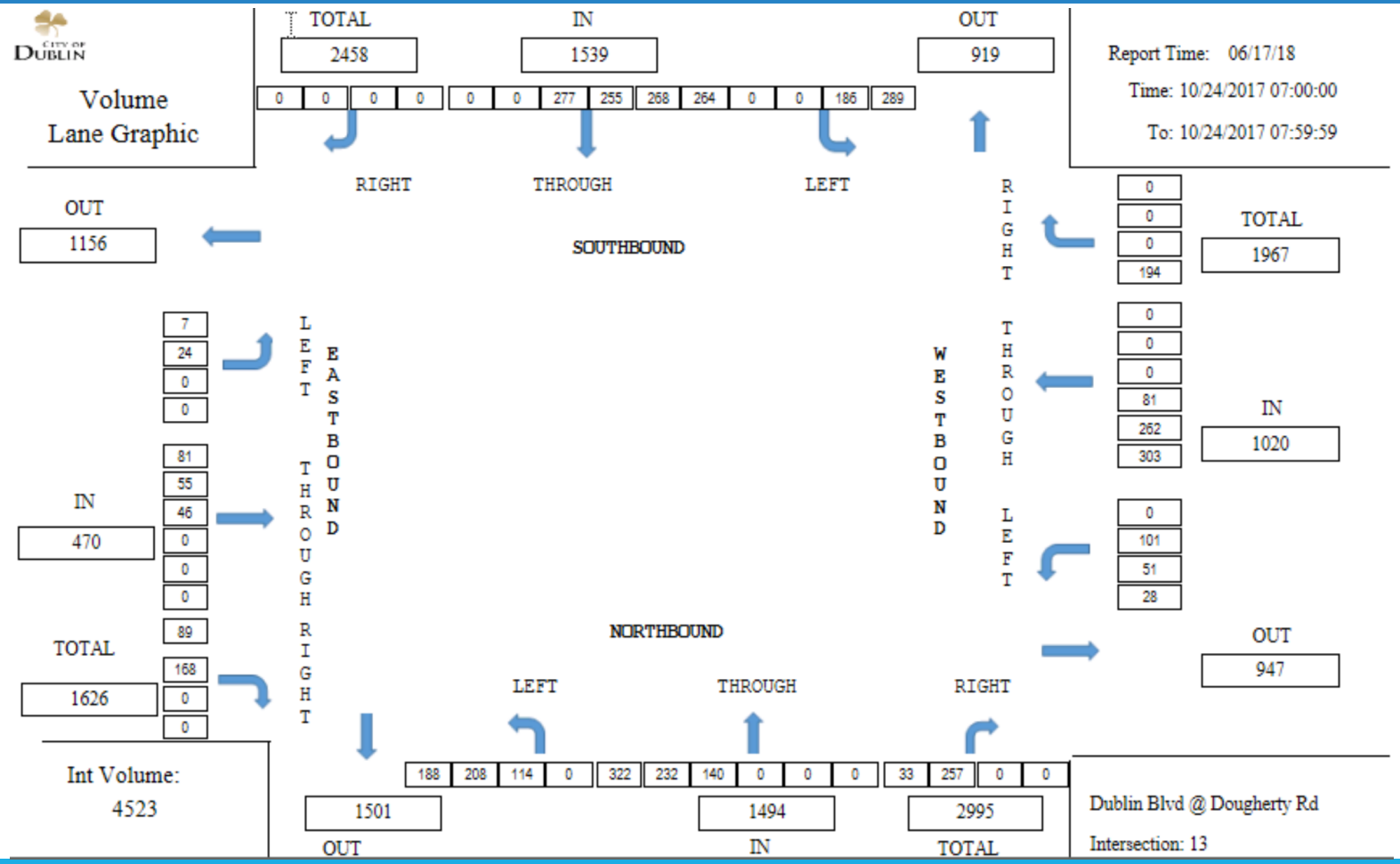


Case Studies

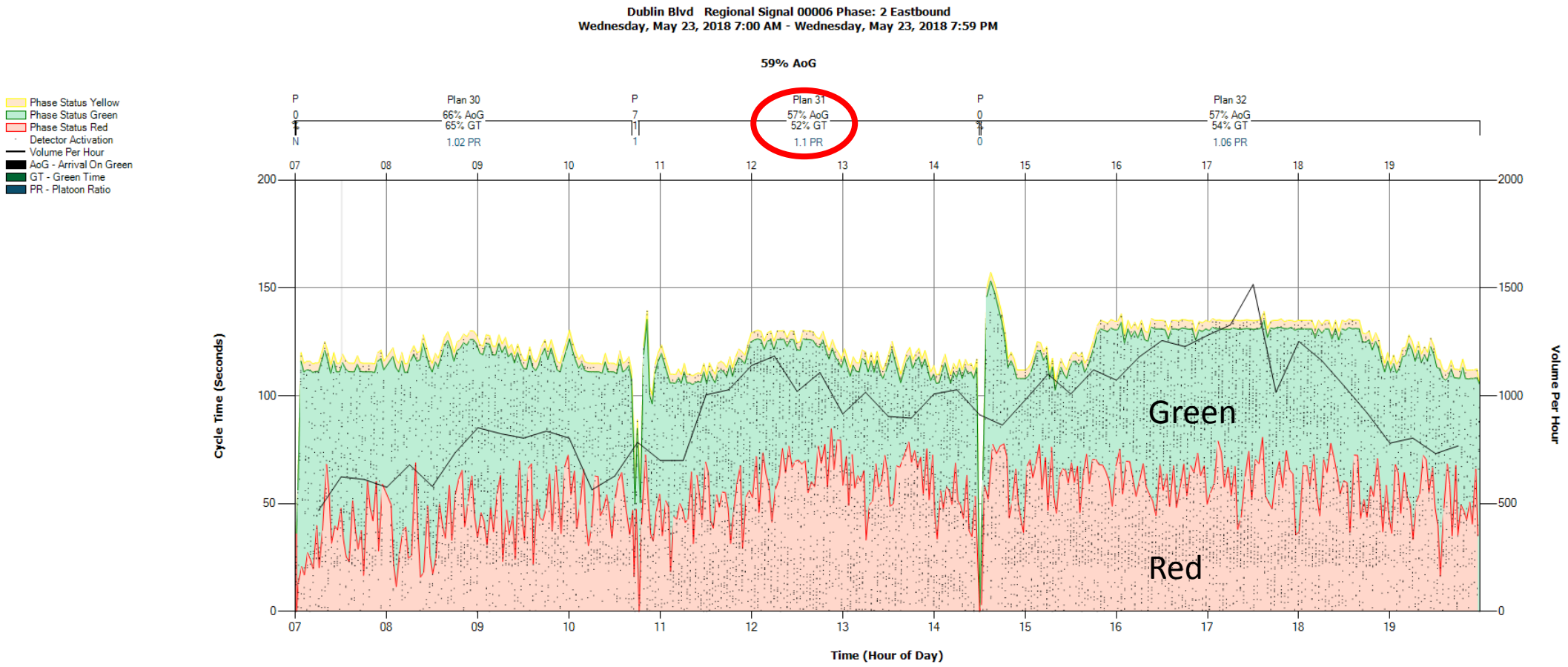
ATSPM-Based Before-After Study

- Vehicle Throughput
  - Intersection Turning Movement Volumes (Volume/Occupancy Per Lane Graph)
- Progression Quality on Coordinated Phases
  - Percent of Arrival on Green (Purdue Coordination Diagram, Arrivals on Red Report)
- Minor Street Efficiency
  - Percent of Cycle Length given to Side Street Green Phases (Purdue Coordination Diagram, Arrivals on Red Report)
  - Phase Termination Causes (Purdue Phase Termination Diagram, Split Monitor Report, Split History with Max/Gap/Force-Off Report)
  - Level of Service (Approach Delay)
- Pedestrian Delay (Pedestrian Delay Report)
- Activation of Bicycle Detection (Volume/Occupancy Report)
- Activation of Bus Queue Jump (Volume/Occupancy Report)
- Activation of Transit Priority (Transit Priority Report)

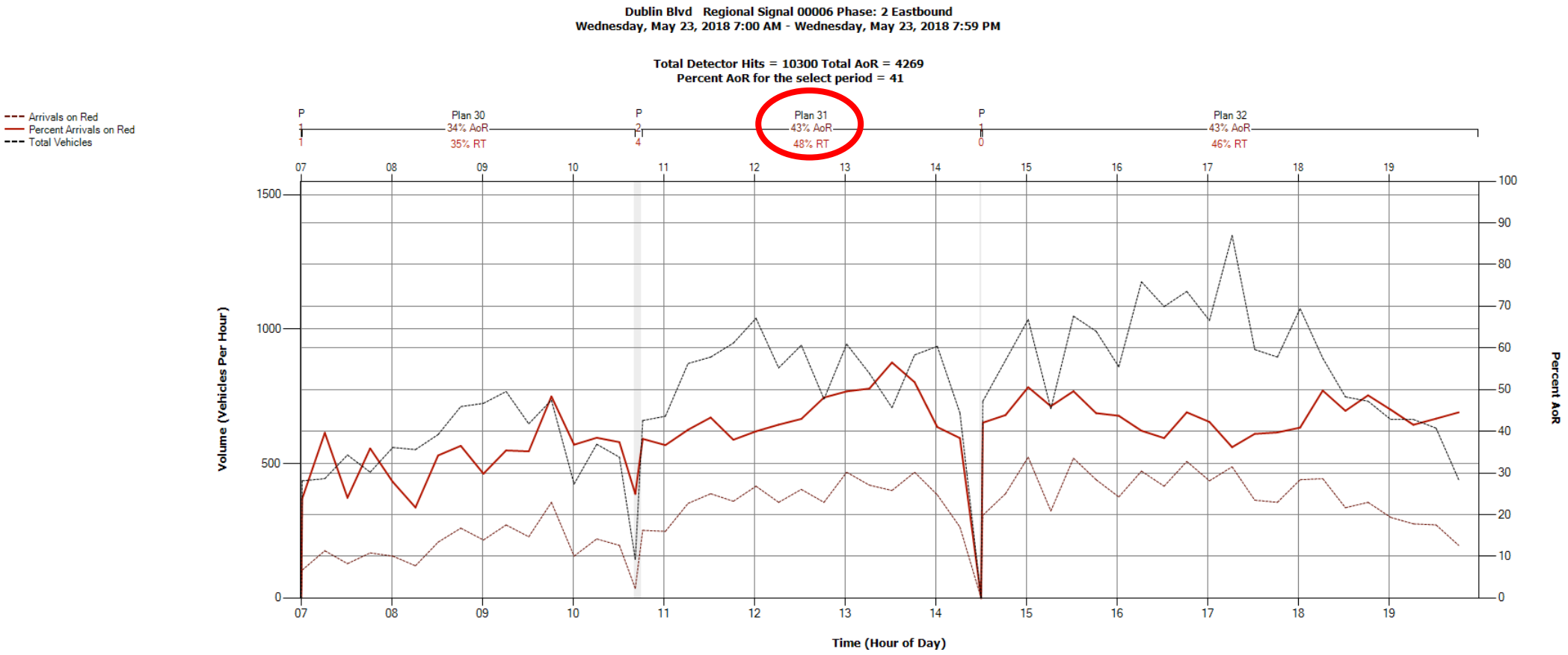
Volume/Occupancy Per Lane Graph - Vehicle Throughput



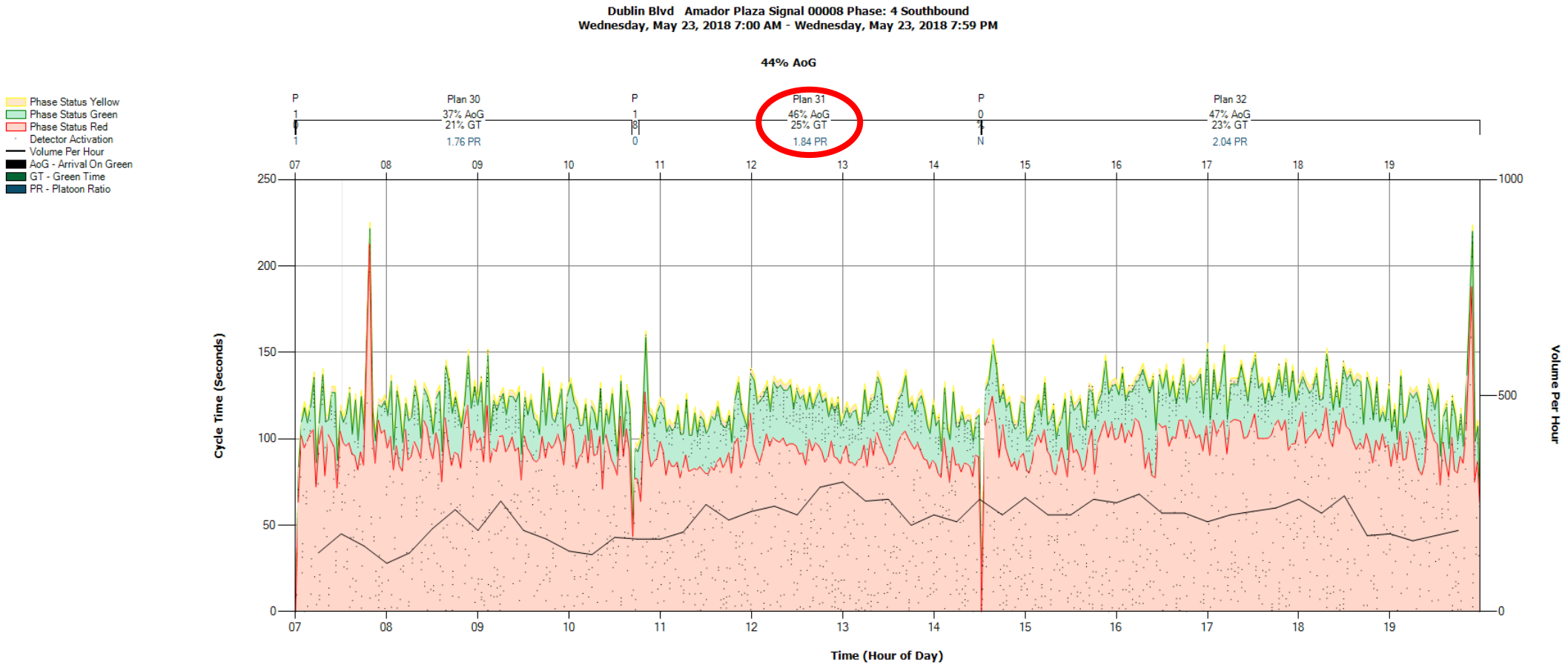
Purdue Coordination Diagram – Progression Quality on Coordination Phases



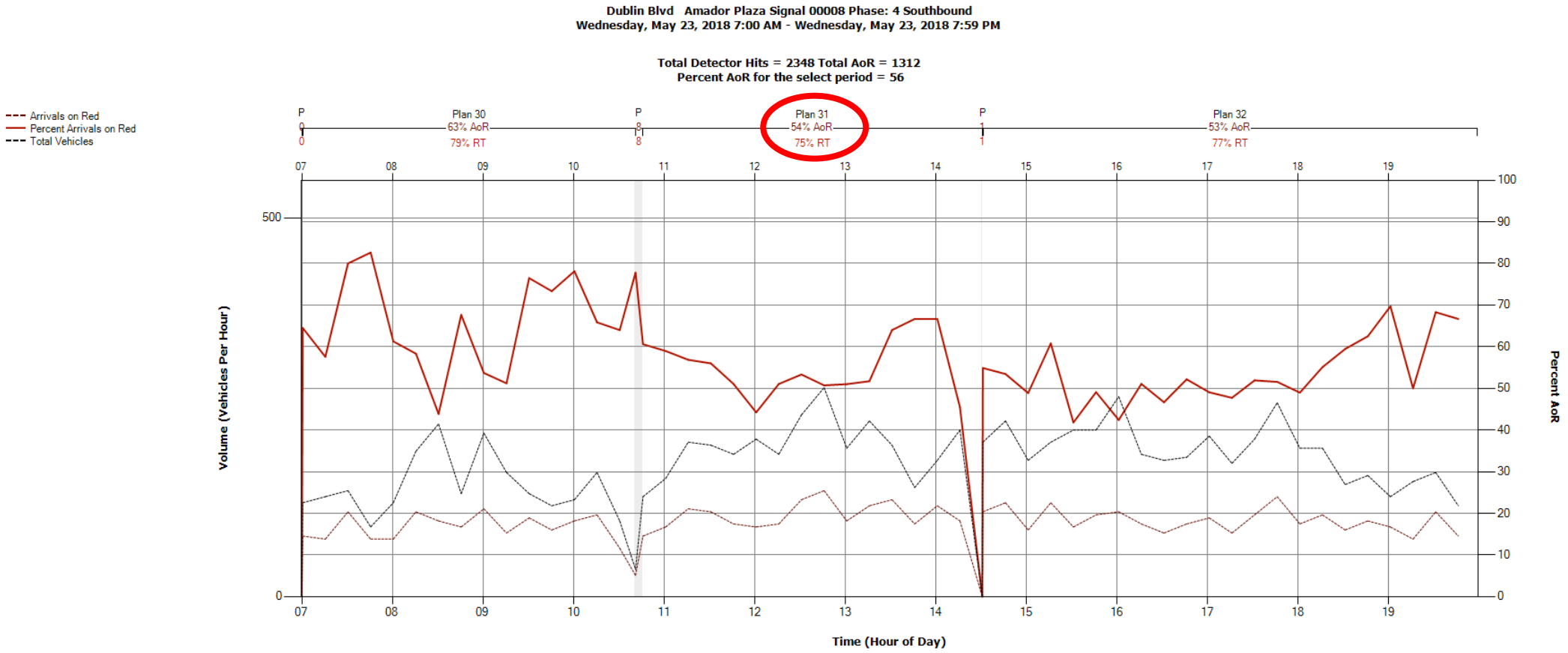
Arrival on Red – Progression Quality on Coordination Phases



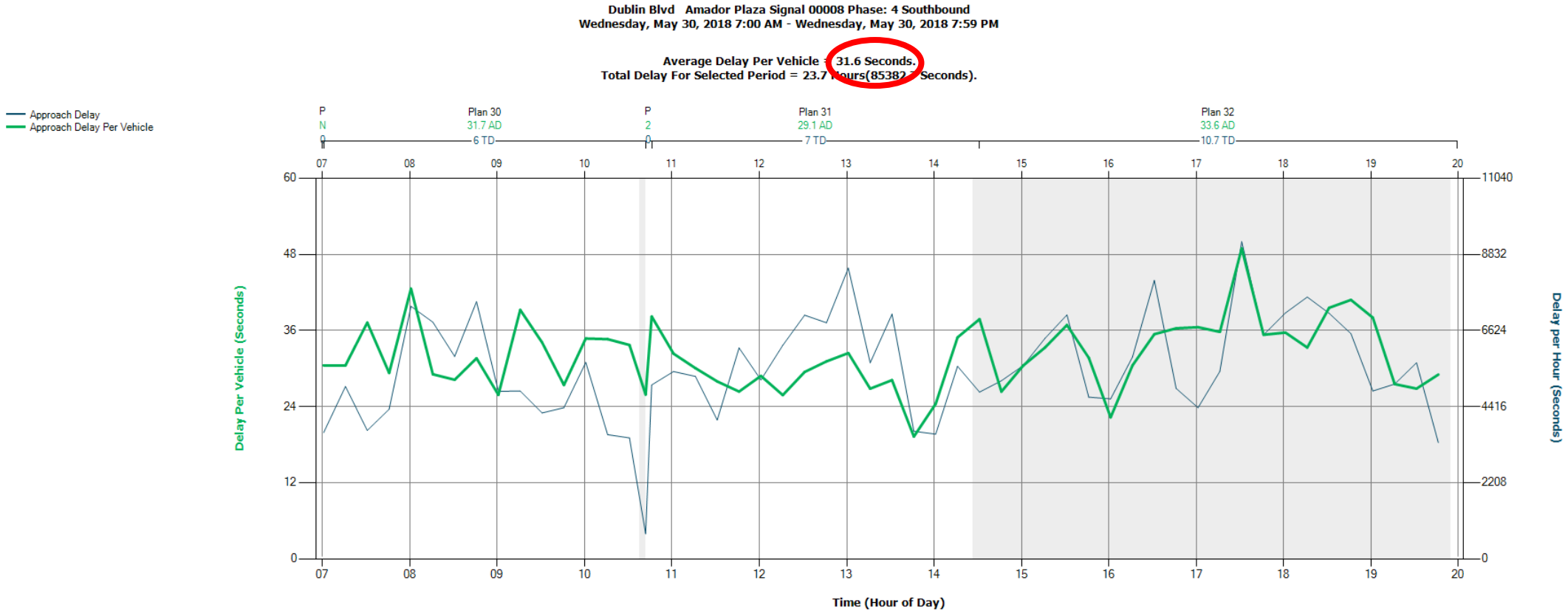
Purdue Coordination Diagram – Side Street Efficiency



Arrival on Red – Side Street Efficiency



Approach Delay – Side Street Level of Service



Simplified Approach Delay. Displays time between detector activation during the red phase and when the phase turns green.
Does NOT account for start up delay, deceleration, or queue length that exceeds the detection zone.

Split History – Phase Termination Causes

Split History with Max(M),Gap(G), and Force-off(F)

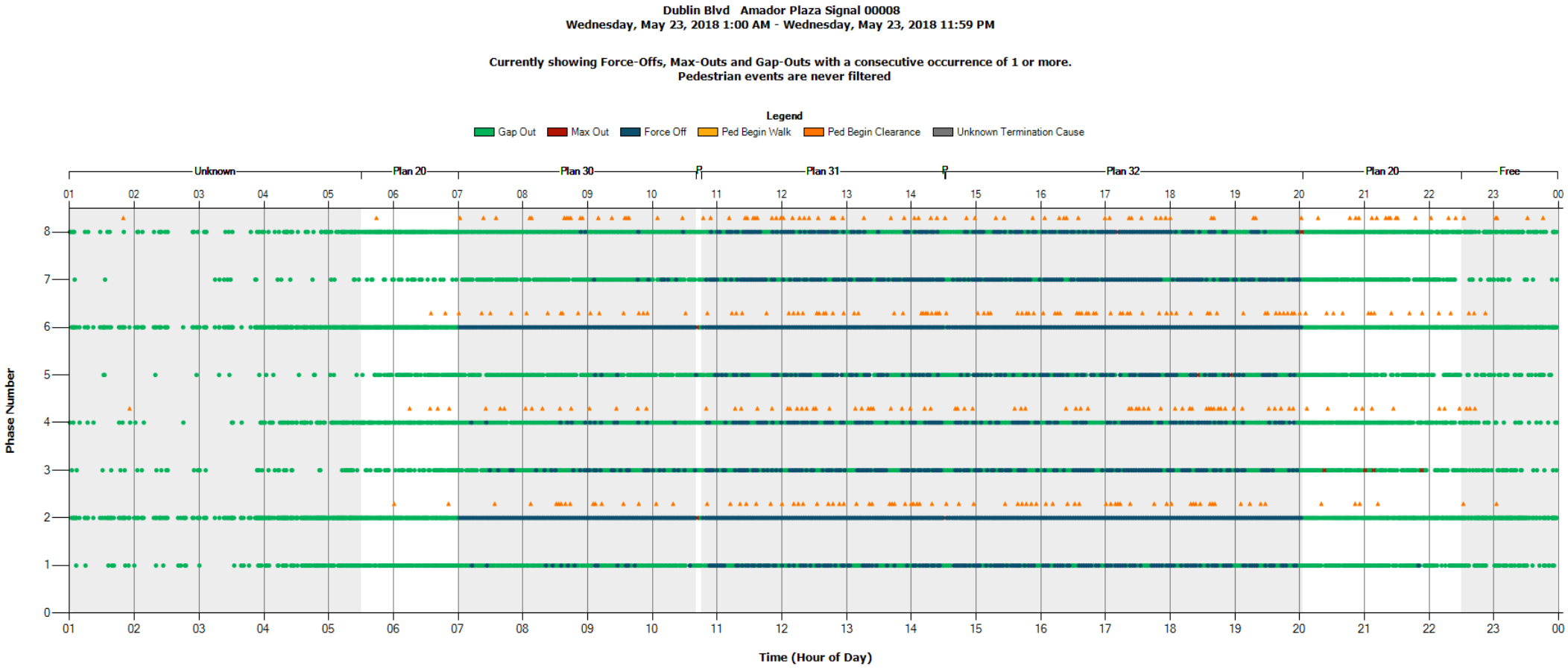
Report Date: 5/28/2018

Controller: 8 Dublin Blvd @ Amador Plaza

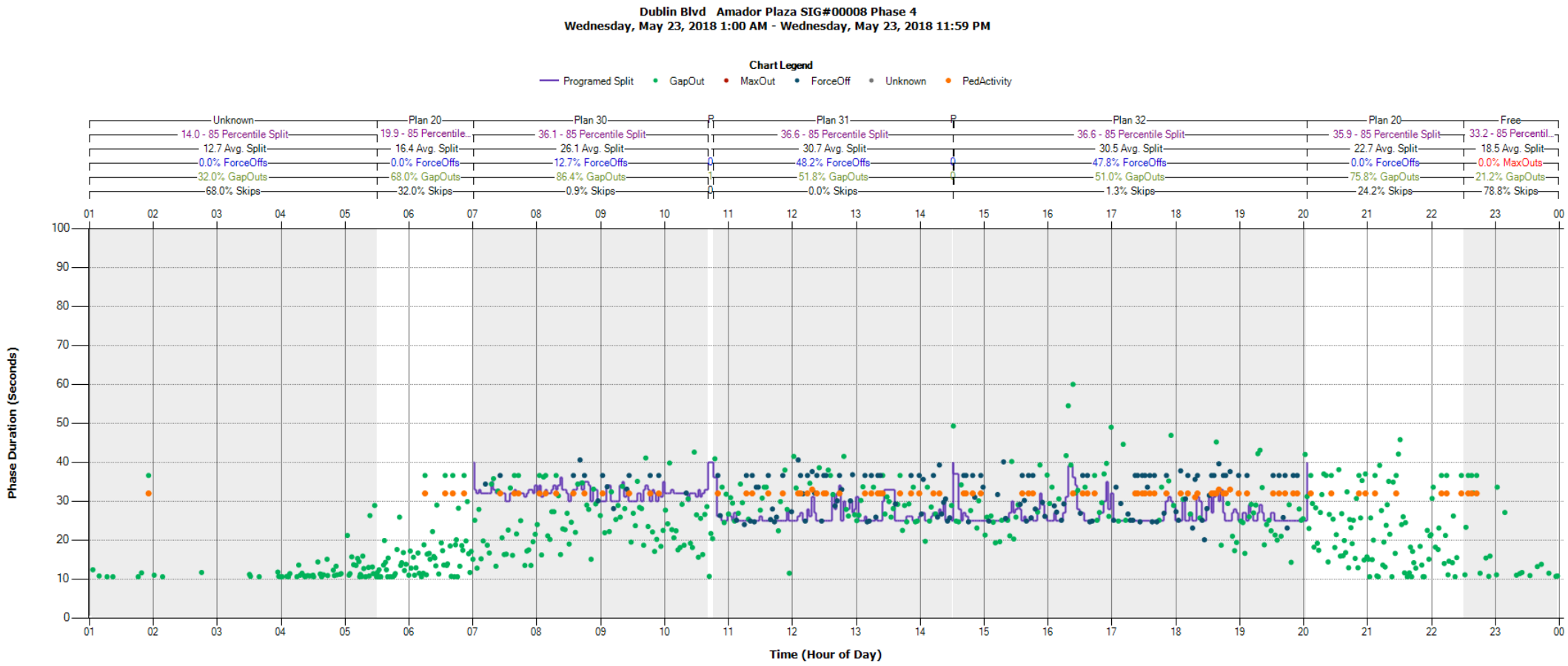
Time: 05/23/2018 07:00:00 To 05/23/2018 08:59:59

Date/Time	Pattern	Cycle	SP1	SP2	SP3	SP4	SP5	SP6	SP7	SP8	SP9	SP10	SP11	SP12	SP13	SP14	SP15	SP16
05/23/2018 07:00:12 AM	254	201	39/G	129/F	8/G	25/G	36/G	132/F	0	33/G	0	0	0	0	0	0	0	0
05/23/2018 07:03:33 AM	30	115	18/G	75/F	9/G	13/G	11/G	82/F	11/G	11/G	0	0	0	0	0	0	0	0
05/23/2018 07:05:28 AM	30	117	33/G	56/F	0	28/G	18/G	71/F	18/G	10/G	0	0	0	0	0	0	0	0
05/23/2018 07:07:25 AM	30	115	20/G	71/F	9/G	15/G	0	91/F	12/G	12/G	0	0	0	0	0	0	0	0
05/23/2018 07:09:20 AM	30	116	22/G	63/F	11/G	20/G	20/G	65/F	11/G	20/G	0	0	0	0	0	0	0	0
05/23/2018 07:11:15 AM	30	114	31/F	29/F	19/G	35/F	13/G	47/F	11/G	43/G	0	0	0	0	0	0	0	0
05/23/2018 07:13:10 AM	30	116	32/G	56/F	10/G	18/G	15/G	73/F	8/G	20/G	0	0	0	0	0	0	0	0
05/23/2018 07:15:06 AM	30	119	19/G	74/F	9/G	17/G	14/G	79/F	0	26/G	0	0	0	0	0	0	0	0
05/23/2018 07:17:05 AM	30	125	23/G	54/F	13/G	35/G	23/G	54/F	21/G	27/G	0	0	0	0	0	0	0	0
05/23/2018 07:19:10 AM	30	120	21/G	63/F	0	36/G	16/G	68/F	15/G	21/G	0	0	0	0	0	0	0	0
05/23/2018 07:21:10 AM	30	115	24/G	60/F	18/G	13/G	0	84/F	11/G	20/G	0	0	0	0	0	0	0	0
05/23/2018 07:23:05 AM	30	120	11/G	63/F	14/G	32/G	0	74/F	13/G	33/G	0	0	0	0	0	0	0	0
05/23/2018 07:25:05 AM	30	115	29/F	29/F	20/G	37/F	11/G	47/F	12/G	45/G	0	0	0	0	0	0	0	0
05/23/2018 07:27:00 AM	30	115	33/G	50/F	11/G	21/G	11/G	72/F	14/G	18/G	0	0	0	0	0	0	0	0

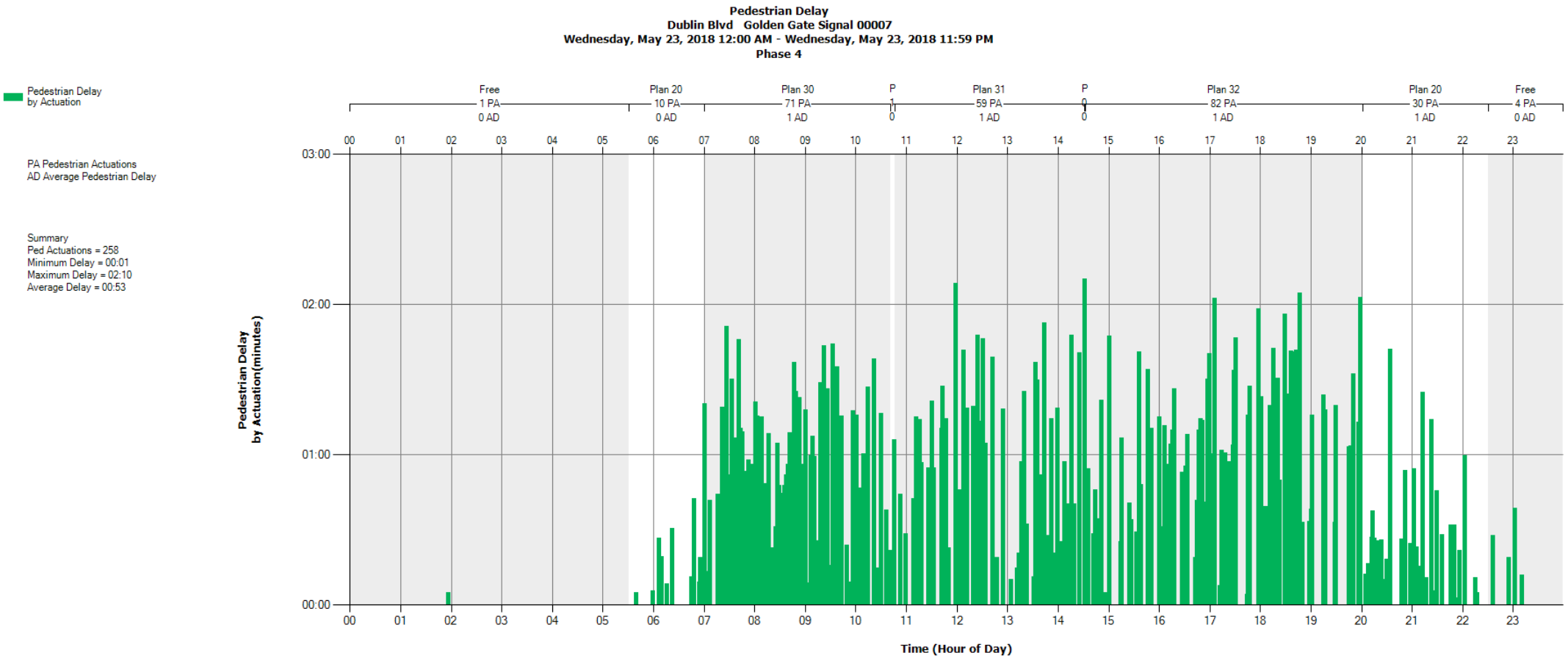
Phase Termination Diagram



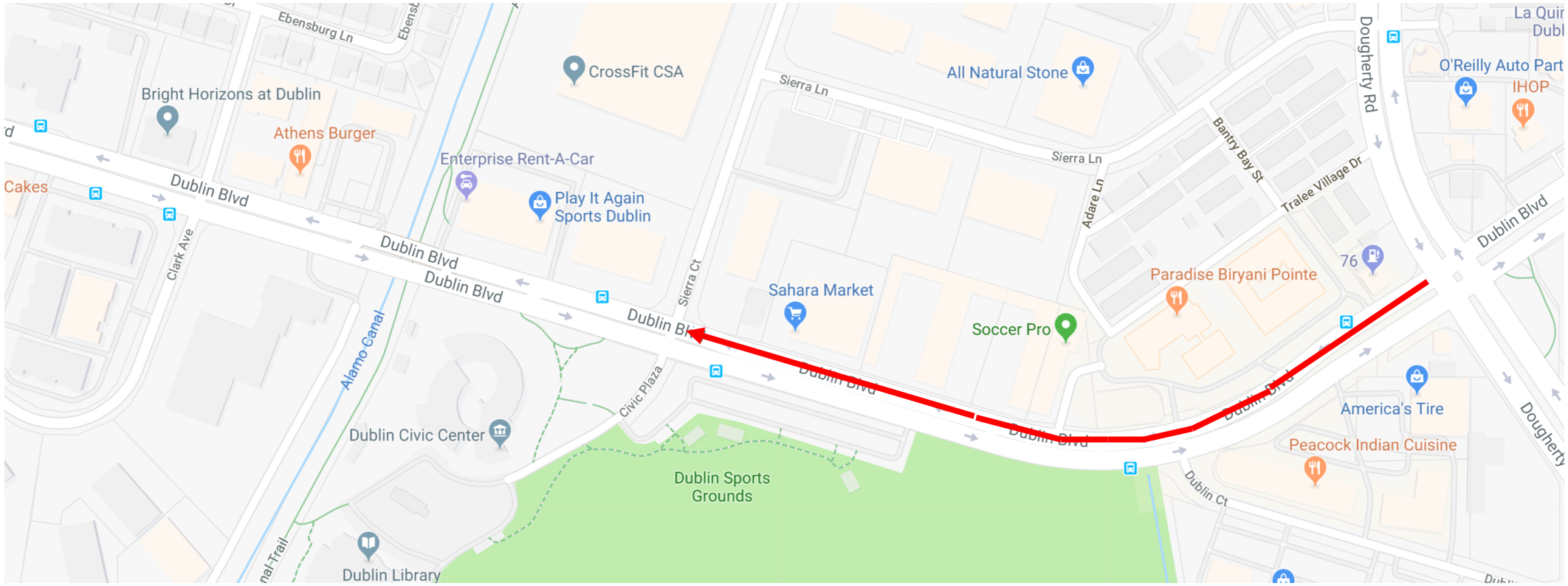
Split Monitor Report



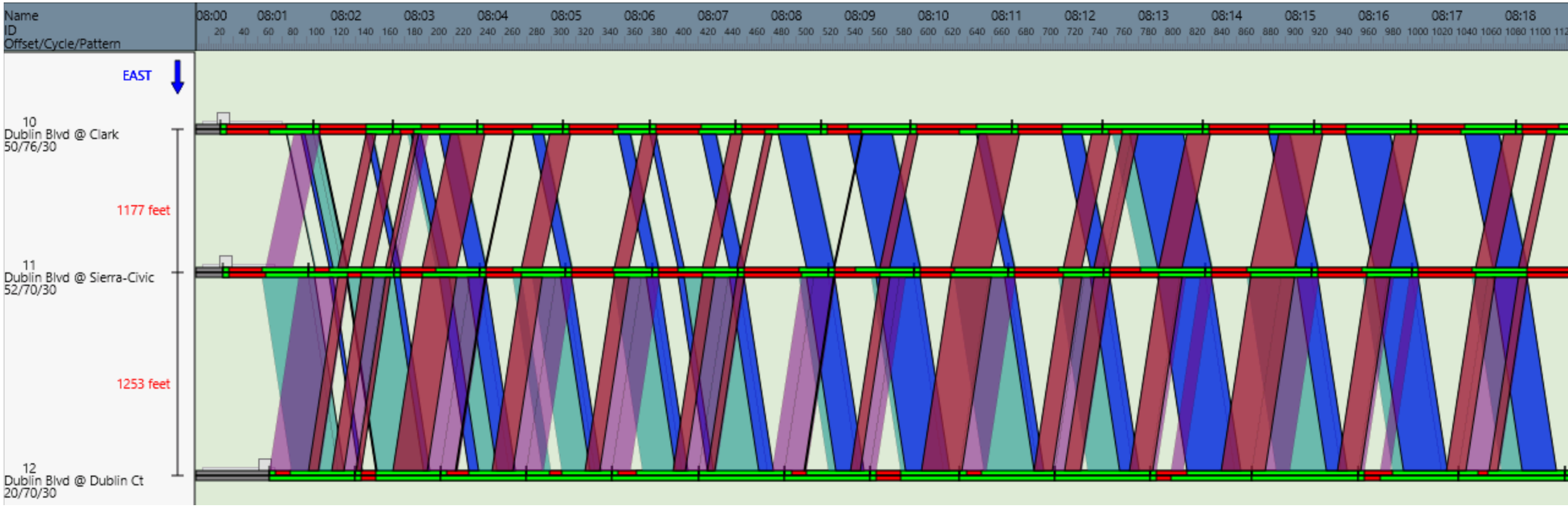
Pedestrian Delay



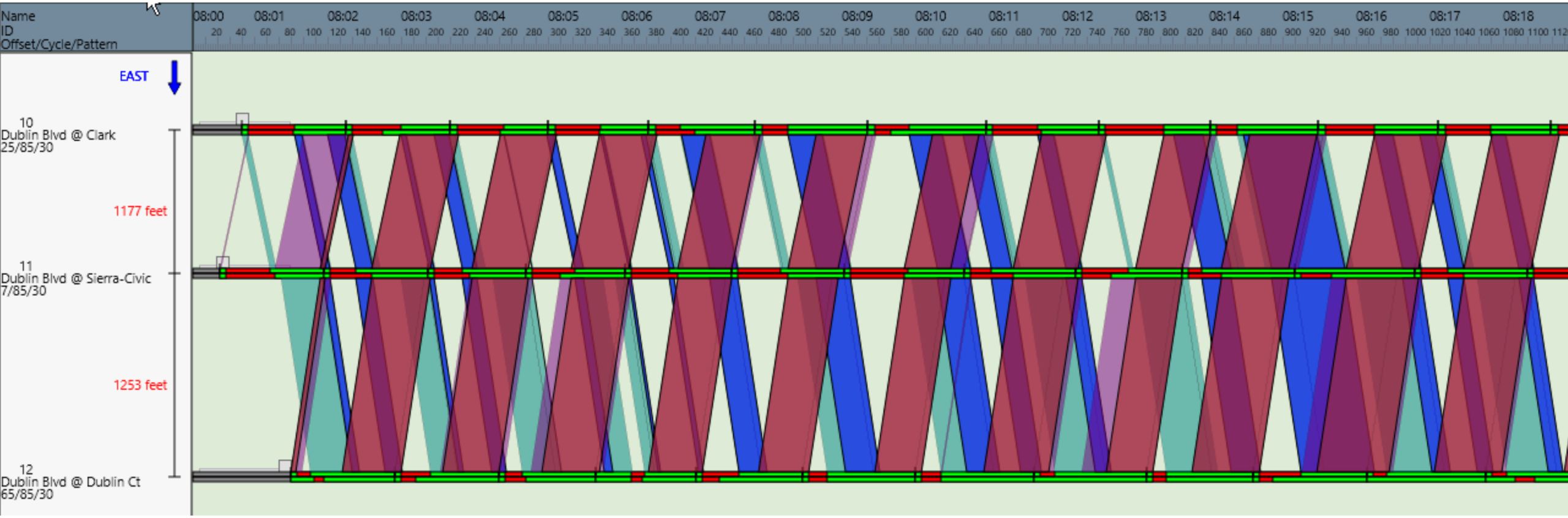
Case Study 2 – WB Traffic Stopped at Civic Plaza During the Morning Peak Period



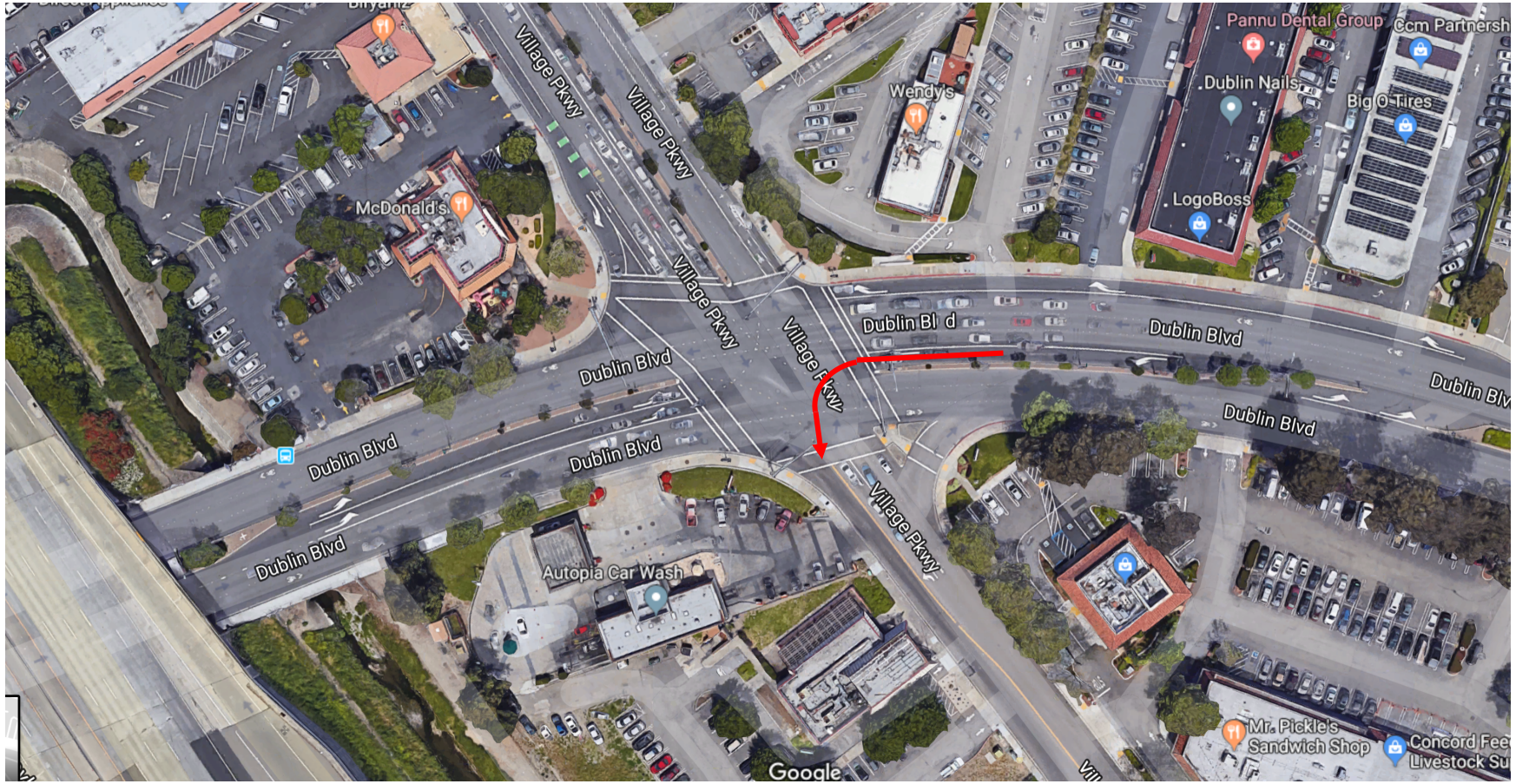
Time-Space Diagram - Before



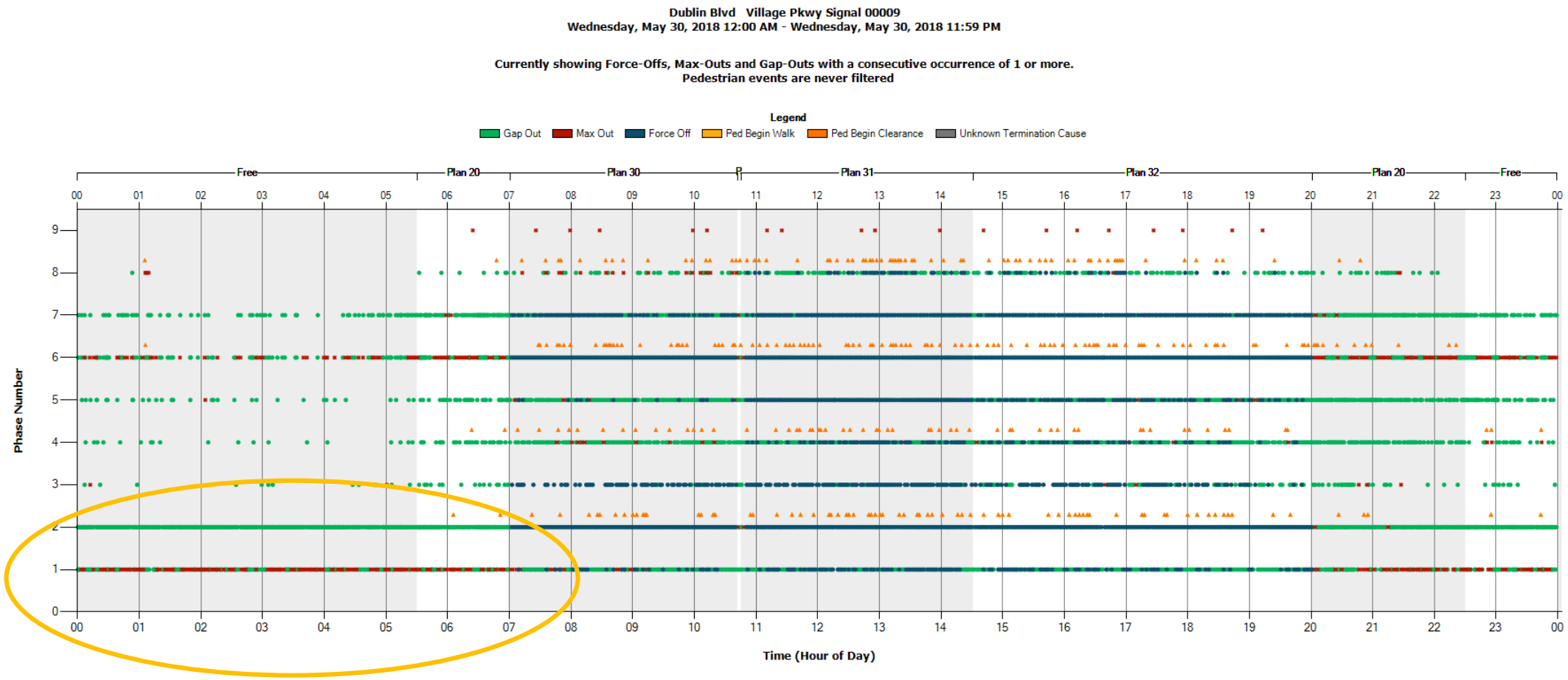
Time-Space Diagram – After
(Shift Offset @ Sierra-Civic by -20 seconds)



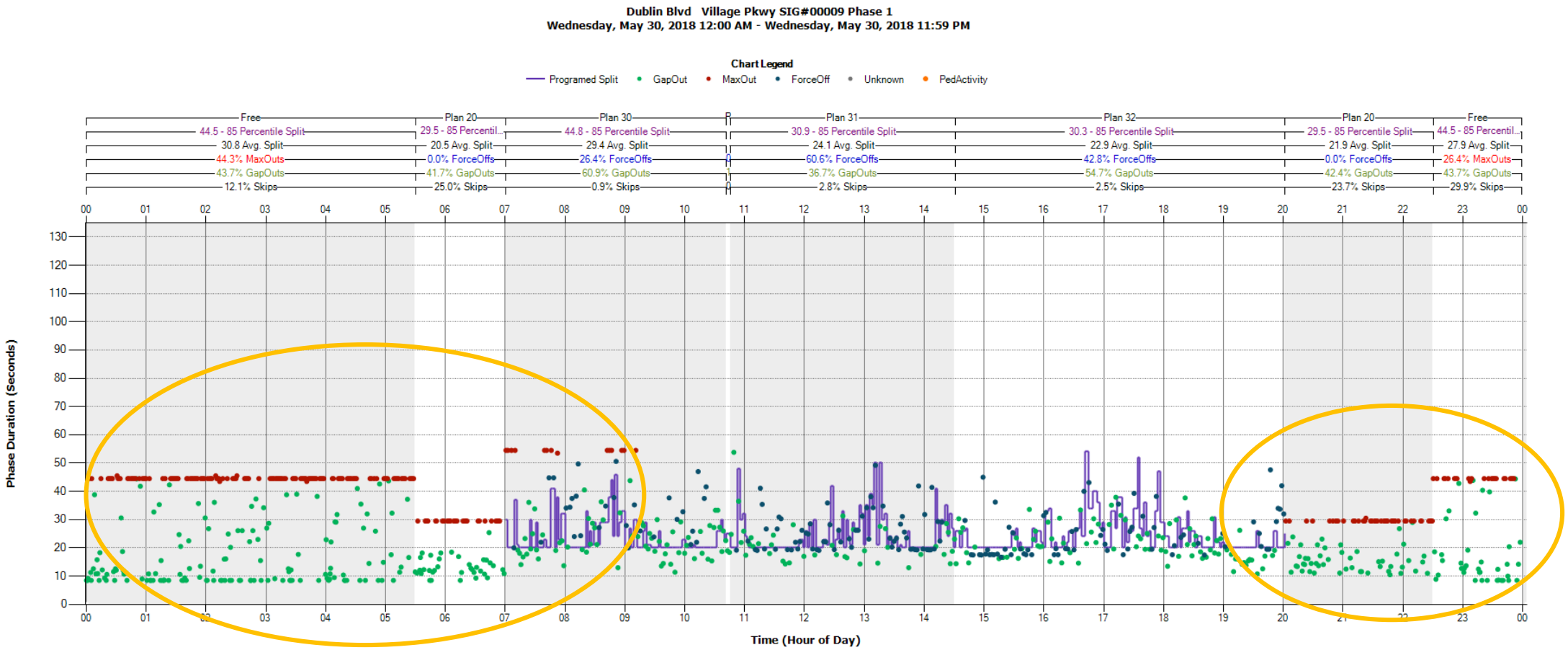
Case Study 3 – Long LT Green without Gapping Out



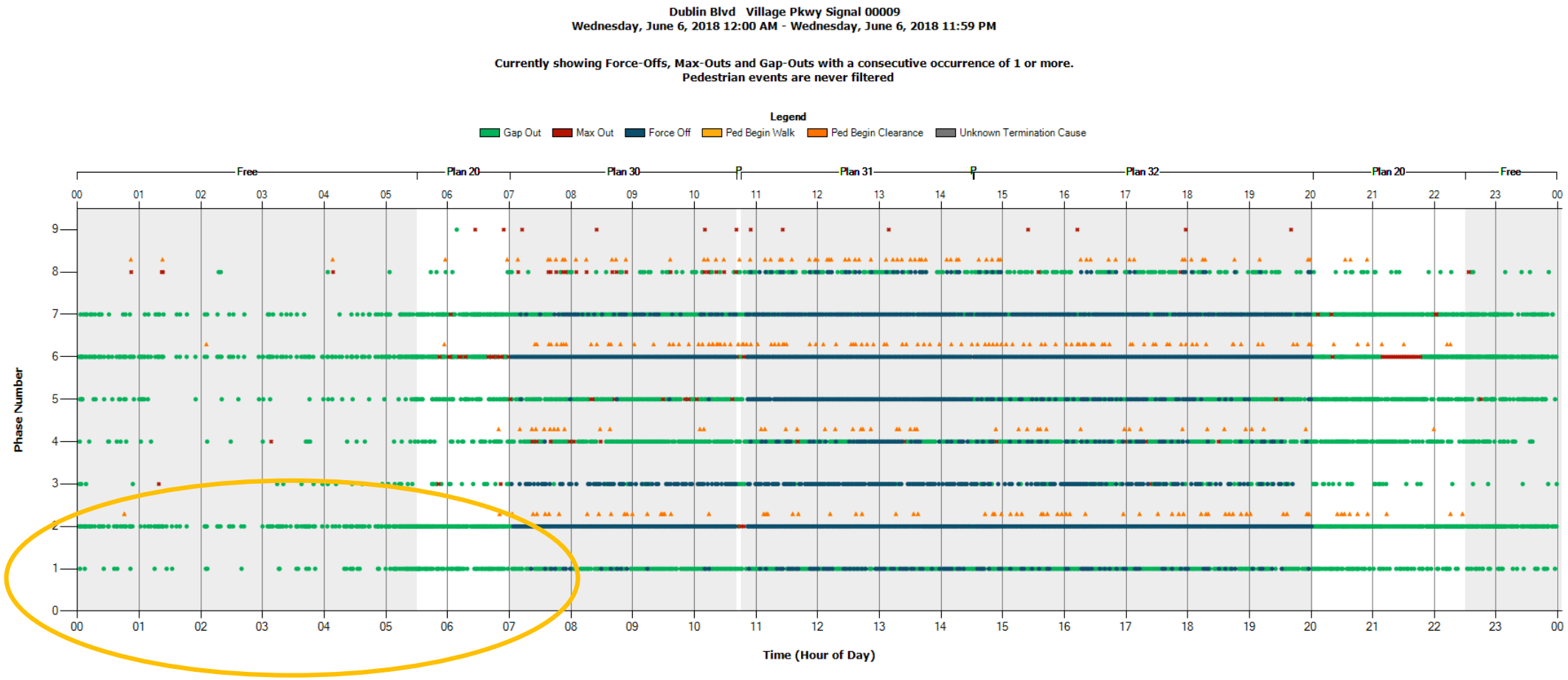
Phase Termination Diagram - Before



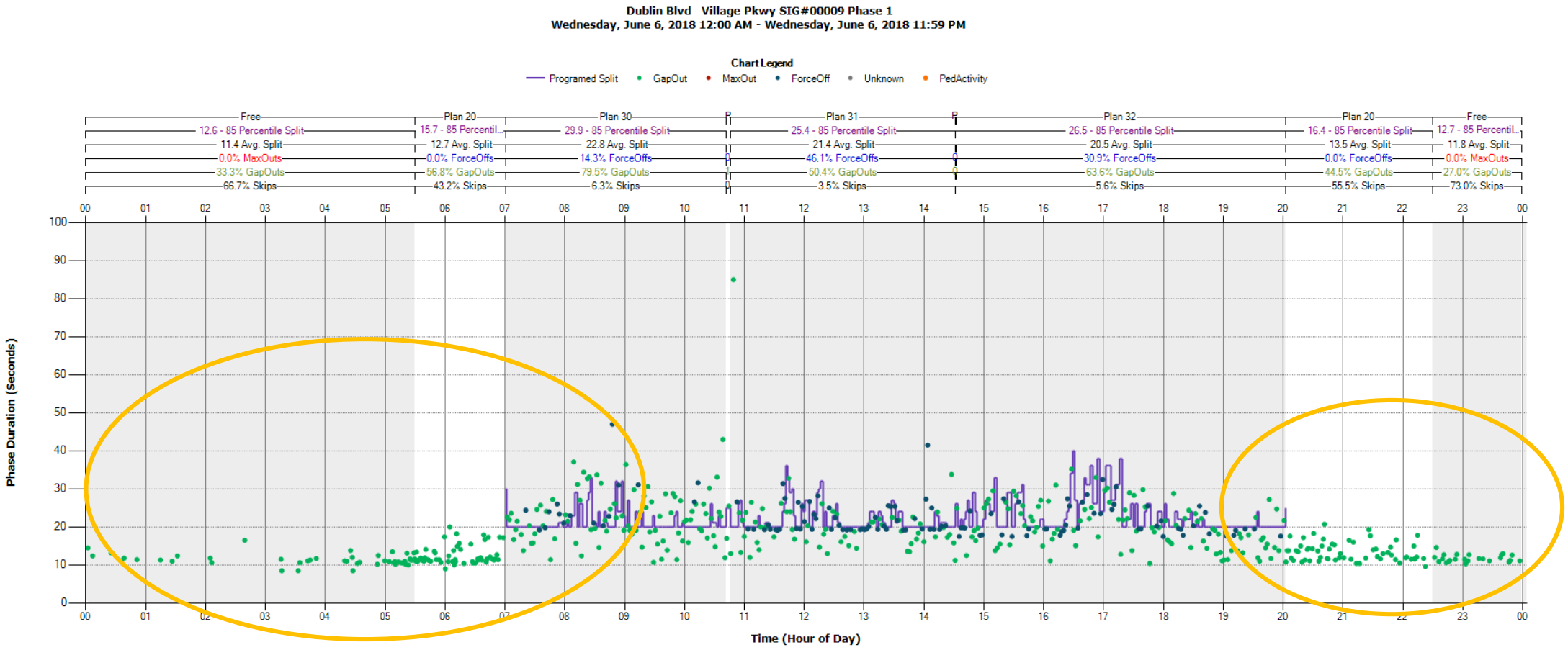
Split Monitor Report - Before



Phase Termination Diagram – After (Fixed the Detector Card Issue)



Split Monitor Report – After (Fixed the Detector Card Issue)



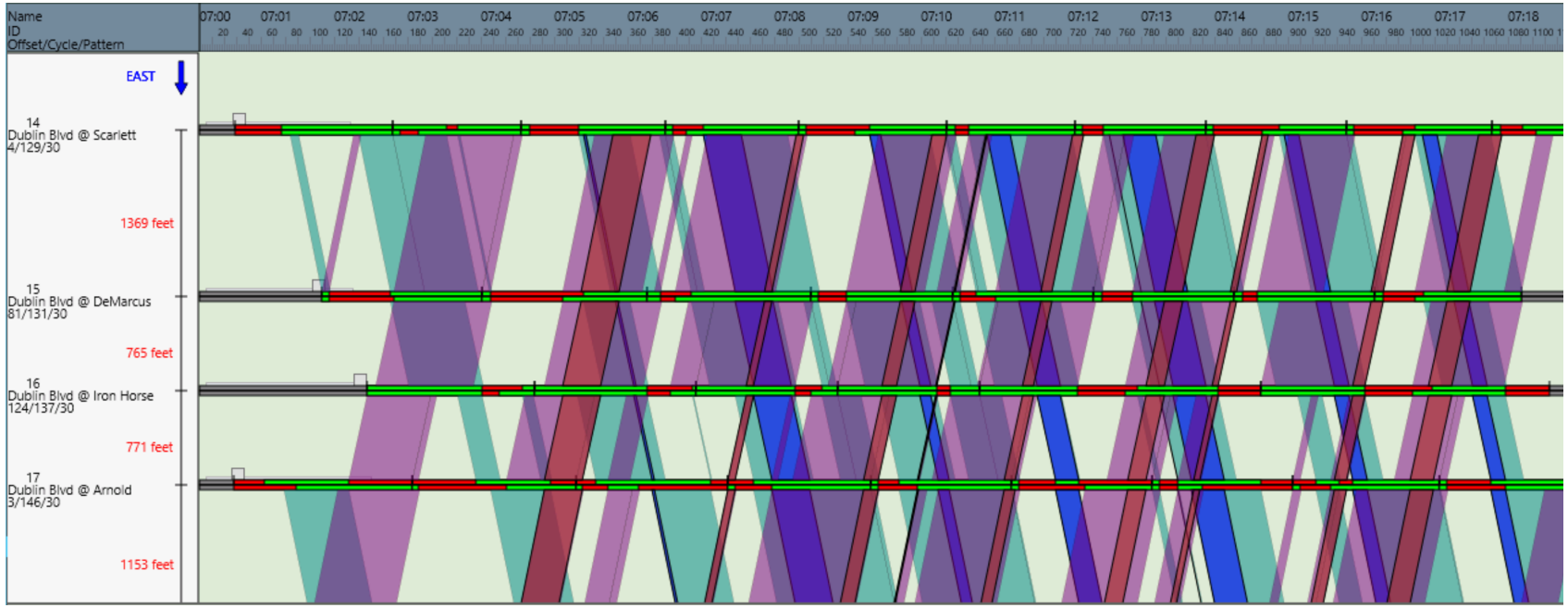
Top Performance Measures for System Health Check-up and Operational Monitoring

1. System Health

1. **No SPM data:** identifies signals with less than 500 records in the database between midnight and midnight the previous day
   - Any Purdue Report
2. **Too many max outs:** identifies phases with more than 90% max outs in at least 50 activations between 1 a.m. and 5 a.m.
   - Phase Termination Diagram/Split Monitor Report
3. **Too many force offs:** identifies phases with more than 90% force offs in at least 50 activations between 1 a.m. and 5 a.m.
   - Phase Termination Diagram/Split Monitor Report
4. **Too many ped calls:** identifies phases with more than 200 pedestrian activations between 1 a.m. and 5 a.m.
   - Pedestrian Delay Report
5. **Low PCD detector count:** identifies phases with PCD detectors that have less than 100 vehicles counted between 5 p.m. and 6 p.m. the previous day.
   - Volume/Occupancy per Lane Graph

2. Signal Coordination Operations

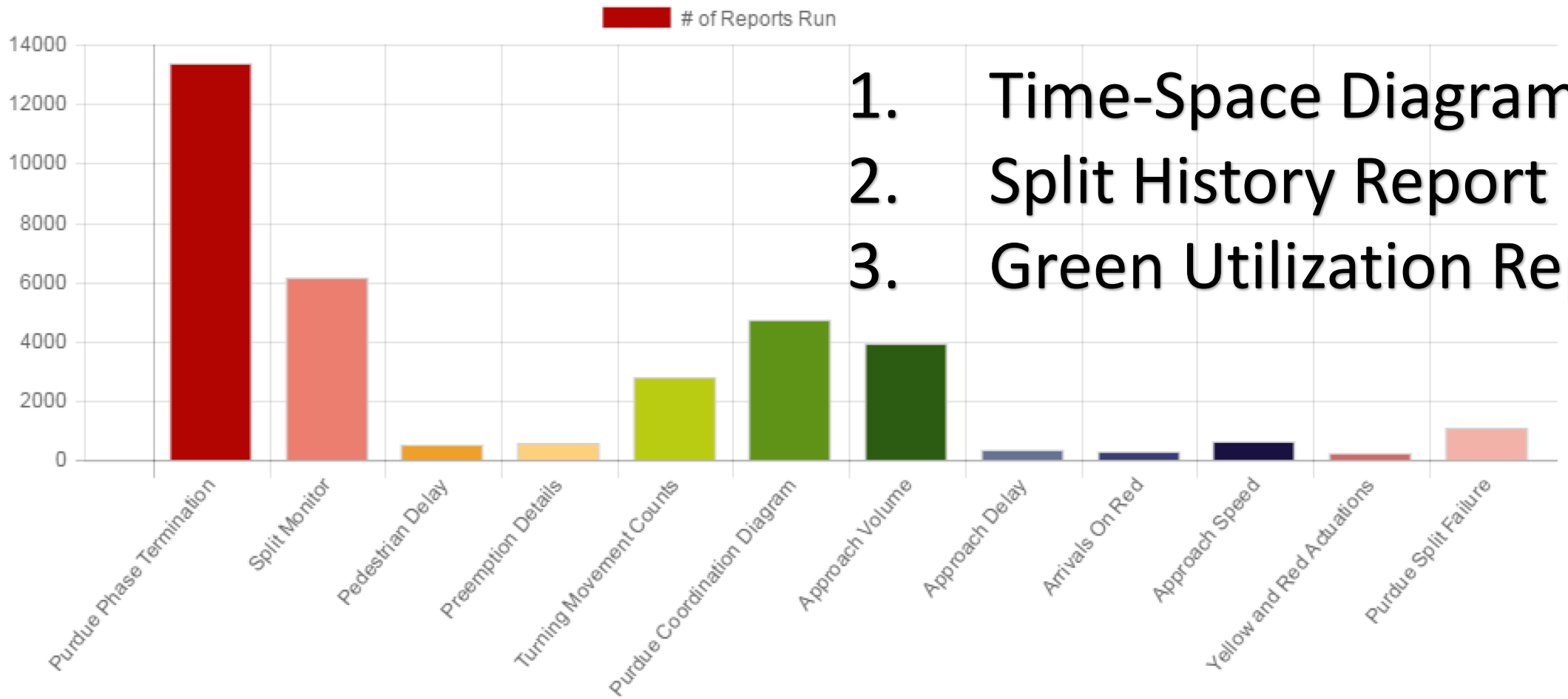
- Purdue Coordination Diagram
- Arrival on Red
- Time-Space Diagram



3. Left-Turn/Side-Street Green Too Short

- Split Monitor Report
- Split History Report with Max/Gap/Force Off
- Phase Termination Diagram
- Approach Delay Report
- Green Utilization Report (For Adaptive Intersections Only)

UDOT Metric Utilization Frequency



1. Time-Space Diagram
2. Split History Report
3. Green Utilization Report

References

- UDOT Automated Transportation Signal Performance Measures, UDOT http://www.westernstatesforum.org/Documents/2017/Presentations/UDOT_Mackey_FINALb_AutomatedSignalPerformanceMeasures_WEB.pdf.
- Automated Transportation Signal Performance Measures, FHWA, https://www.fhwa.dot.gov/innovation/everydaycounts/edc_4/atspm.cfm.
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Questions?

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