

# CE 474 – Class 17

October 1, 2015

# The Clearest Explanation Yet for Why Millennials Are Driving Less

Shifting demographics matter, but shifting attitudes may matter more.

ERIC JAFFE | [@e\\_jaffe](#) | Jul 13, 2015 | [74 Comments](#)

*Two new studies find that young Americans are changing the nation's transportation landscape. They drive less, want to stay connected as they travel, embrace car-sharing, bike-sharing, ride-sharing.*



Automotive Rhythms

[Automotive Rhythms / Flickr](#)



Bike commuters travel along a street May 12, 2011, in Portland, Ore. (Photo: File photo by Rick Bowmer, AP)

The [ongoing discussion](#) about Millennial driving trends is not about whether they're declining, but why. It's clear to all that young people are driving less today than they did in the past. But the reasons for these shifts in car use are what remain locked in seemingly endless debate.

**Excel Skills**

- Parse text data file into columns
- Manipulate rows and columns of data
- Sort data by criterion (criteria)
- Use logical (if) statements
- Create frequency data from raw data
- Create frequency plots

**Statistical Skills**

- Create and interpret frequency plots

**VISSIM Skills**

- Increase demand on link
- Set signal timing parameters
- Set data collection point
- Select/configure "data collection" evaluation file

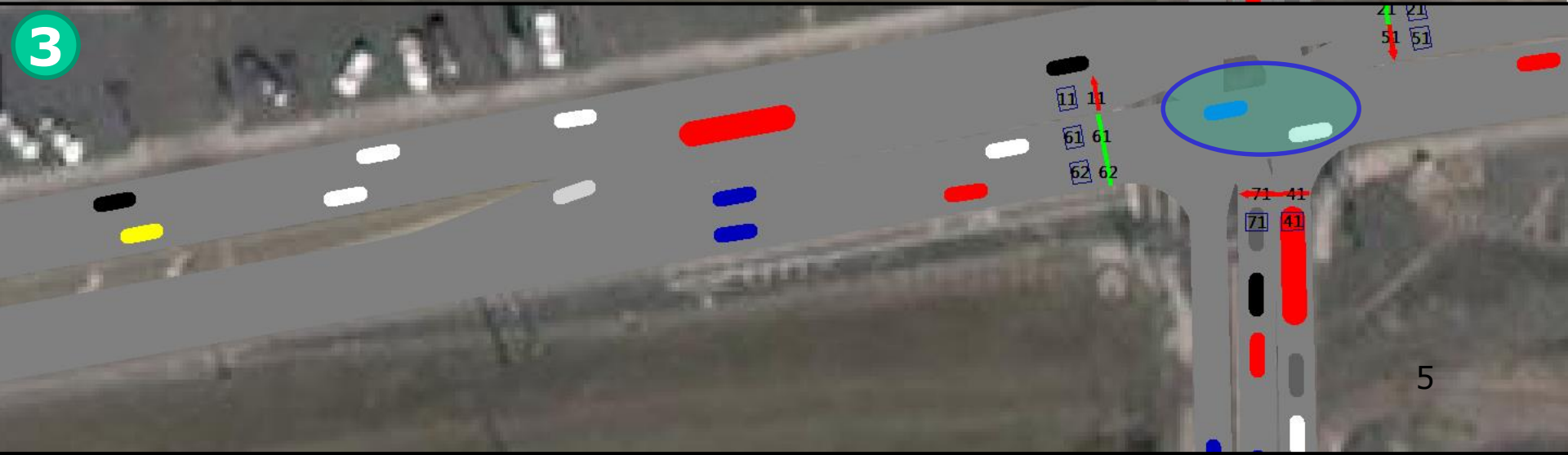
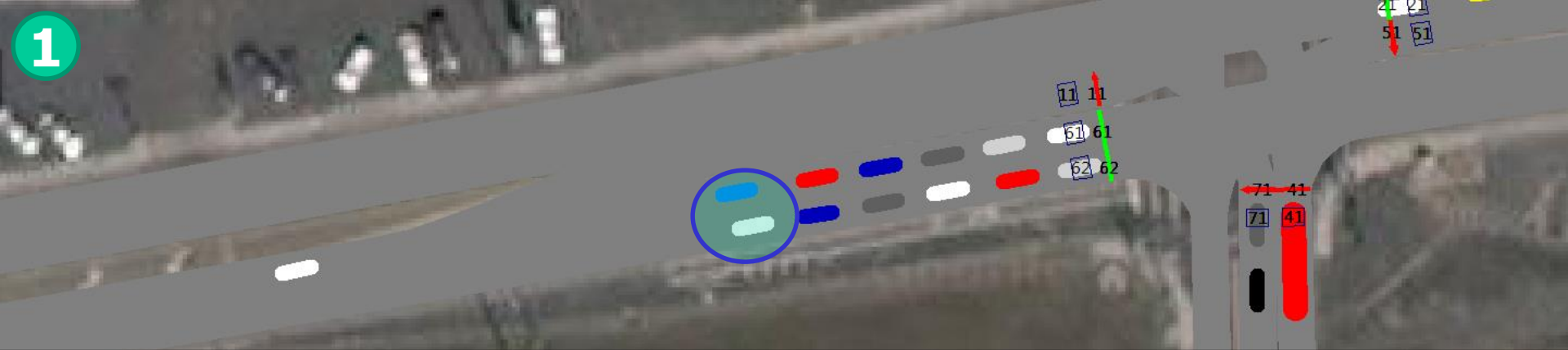
**Transportation Concepts/Knowledge**

- Define Maximum Allowable Headway (MAH)
- Define types of phase termination (and desirability of each)
- Distinguish between queued and non-queued vehicles
- Select MAH, trading competing (type 1, type 2) risks, using phase termination analysis (PTA) results
- Describe concept of PTA and components of process
- Relate PT to MAH



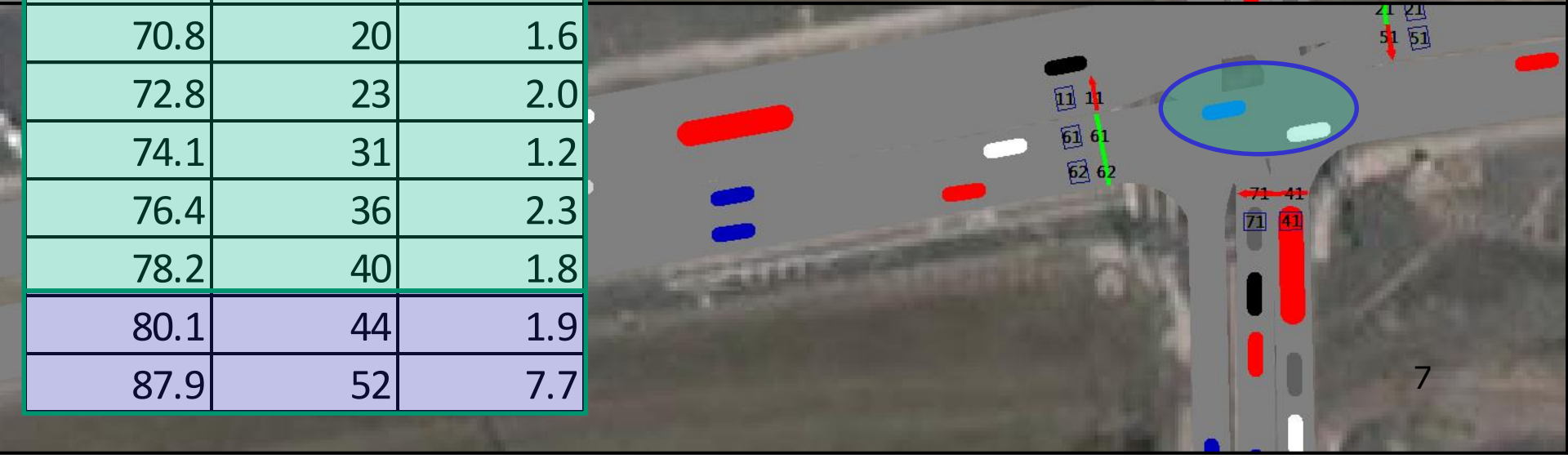
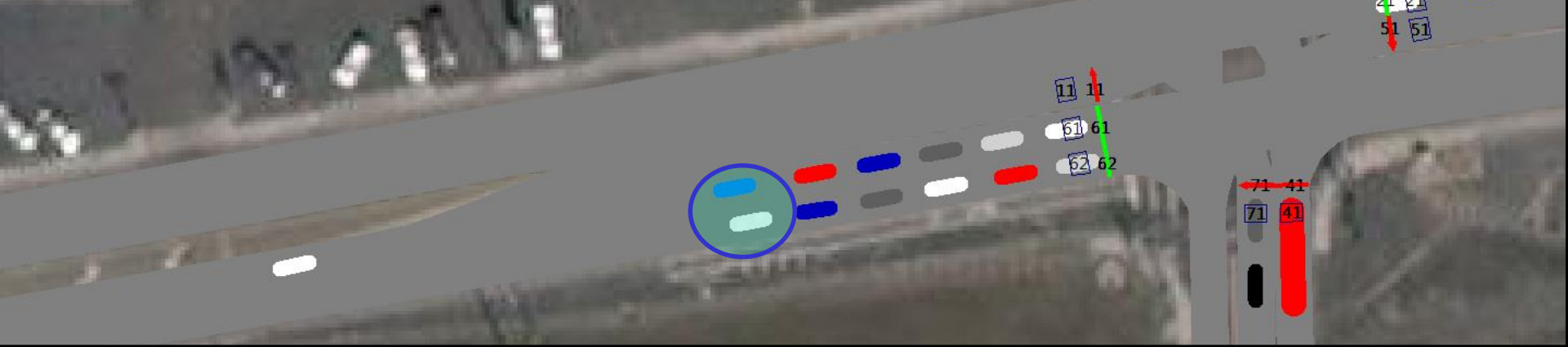
Determine the MAH and Passage Time balancing:

- Phase failure, initial queue not served (Type 1)
- Inefficient extension of green (Type 2)



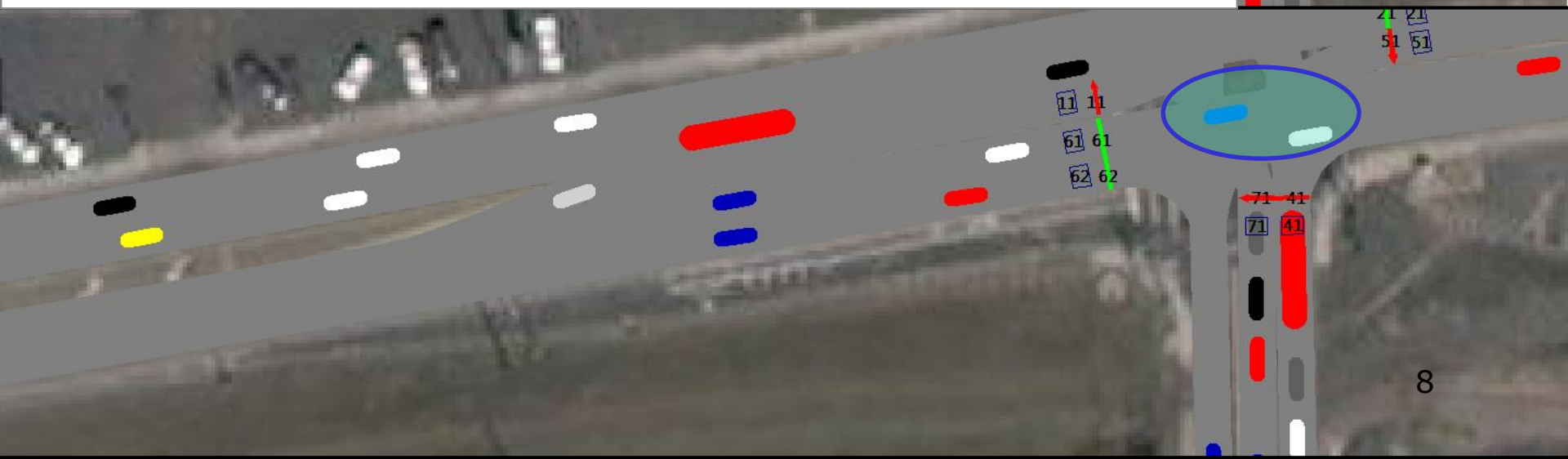
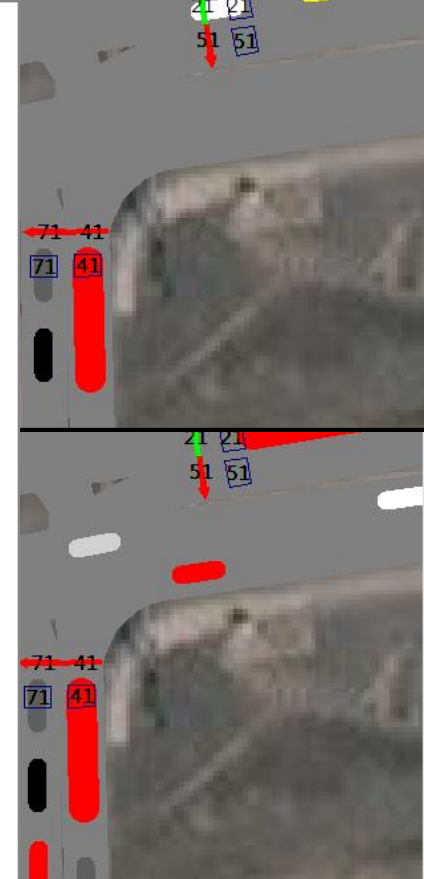
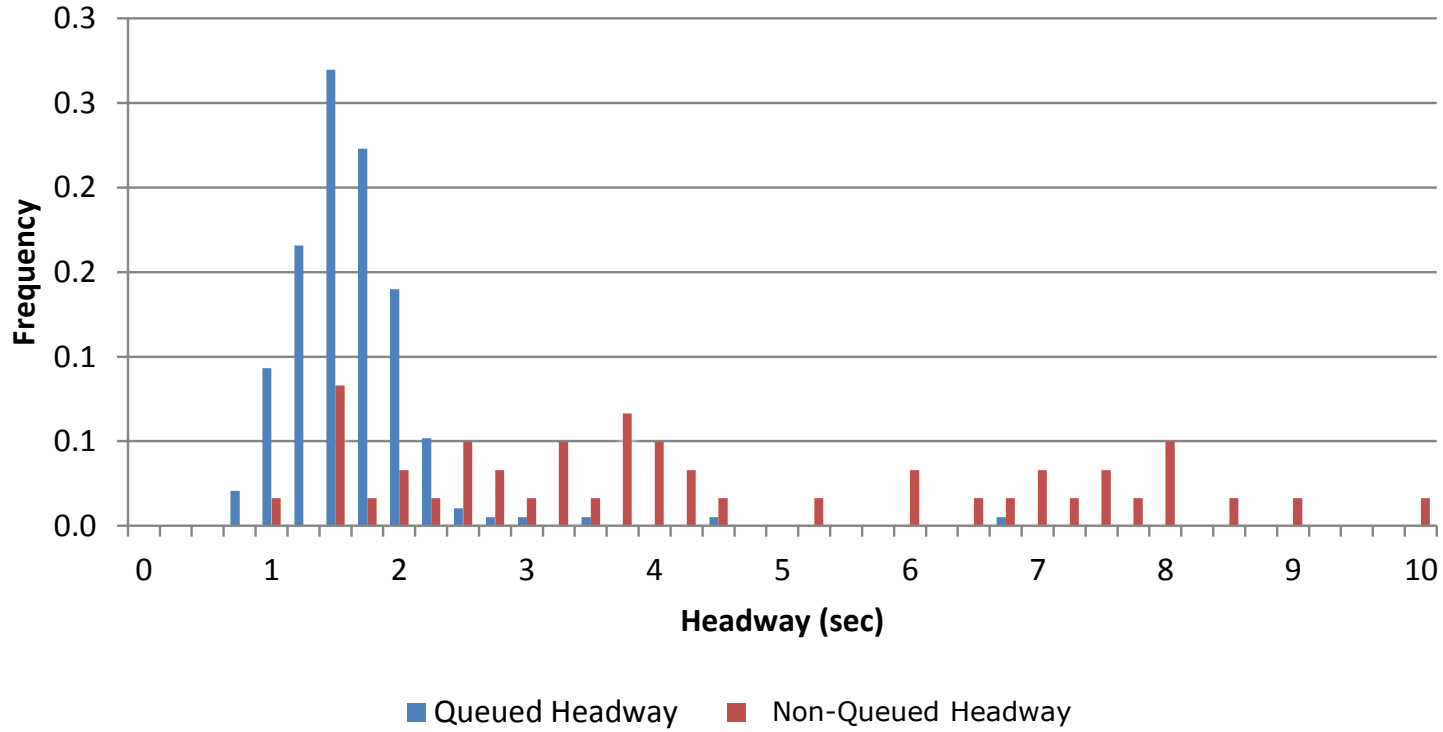


65.0 0.0 36 + 0 5.0

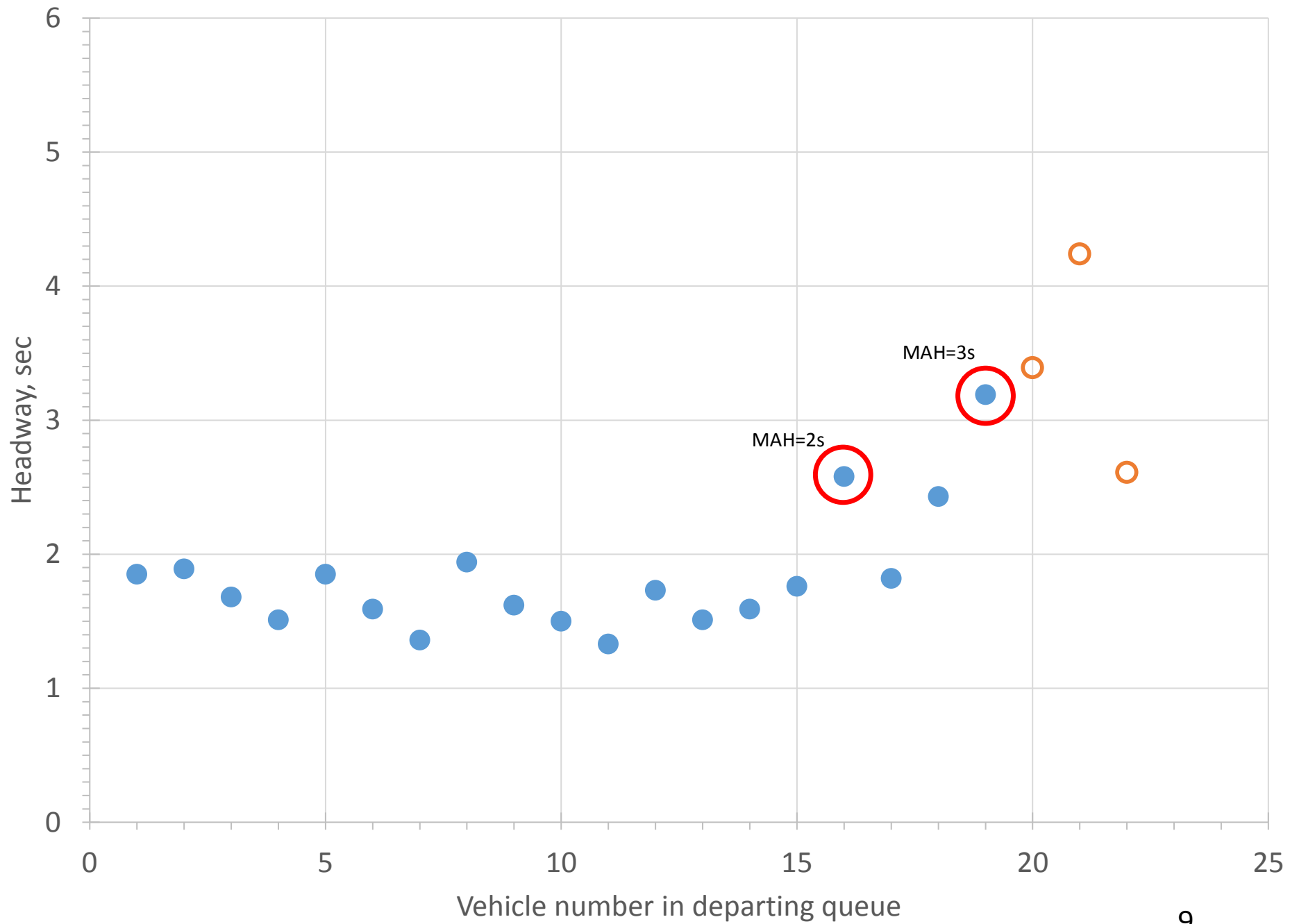


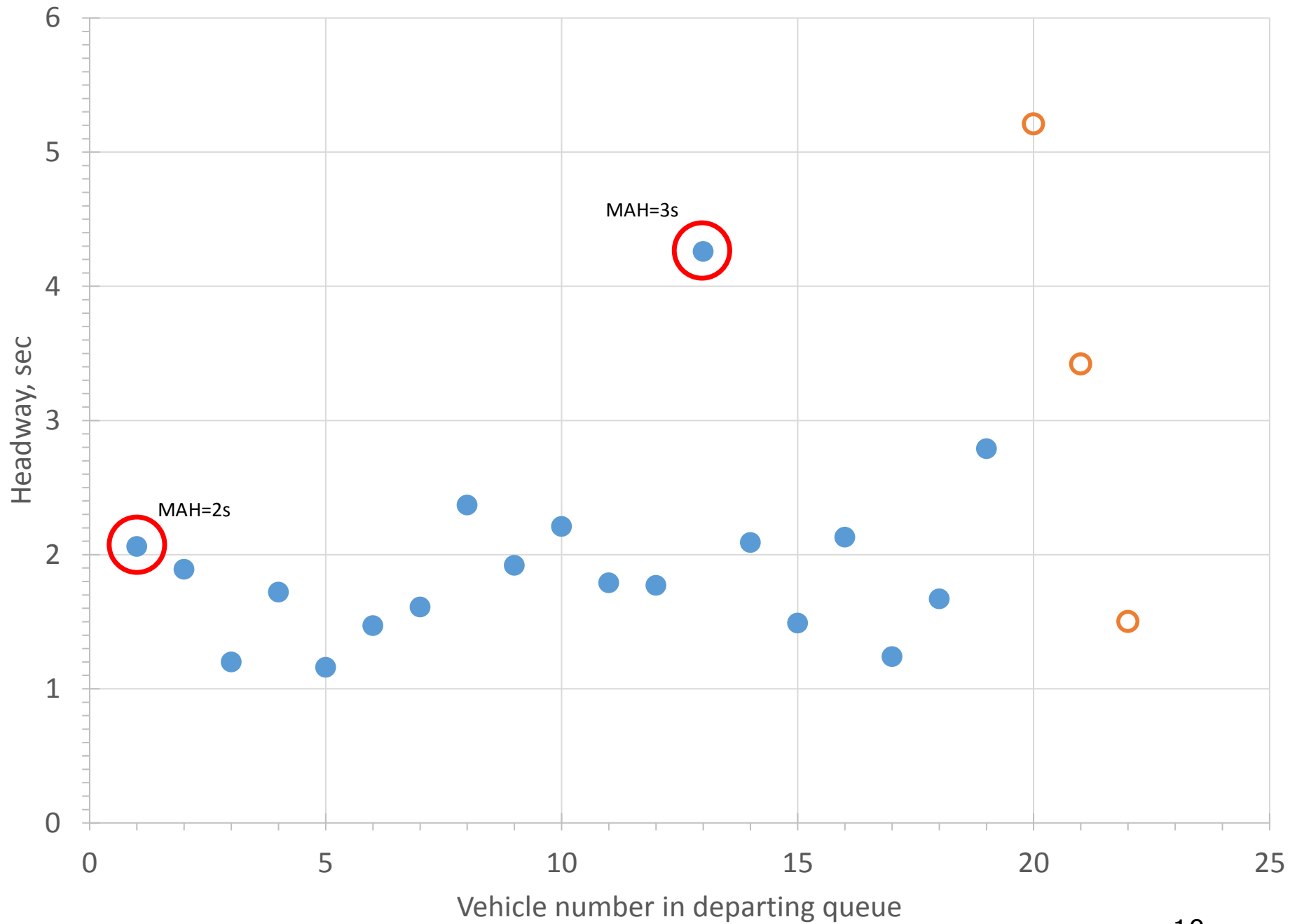
| t(Exit) | VehNo | Headway |
|---------|-------|---------|
| 67.1    | 3     |         |
| 69.2    | 15    | 2.2     |
| 70.8    | 20    | 1.6     |
| 72.8    | 23    | 2.0     |
| 74.1    | 31    | 1.2     |
| 76.4    | 36    | 2.3     |
| 78.2    | 40    | 1.8     |
| 80.1    | 44    | 1.9     |
| 87.9    | 52    | 7.7     |

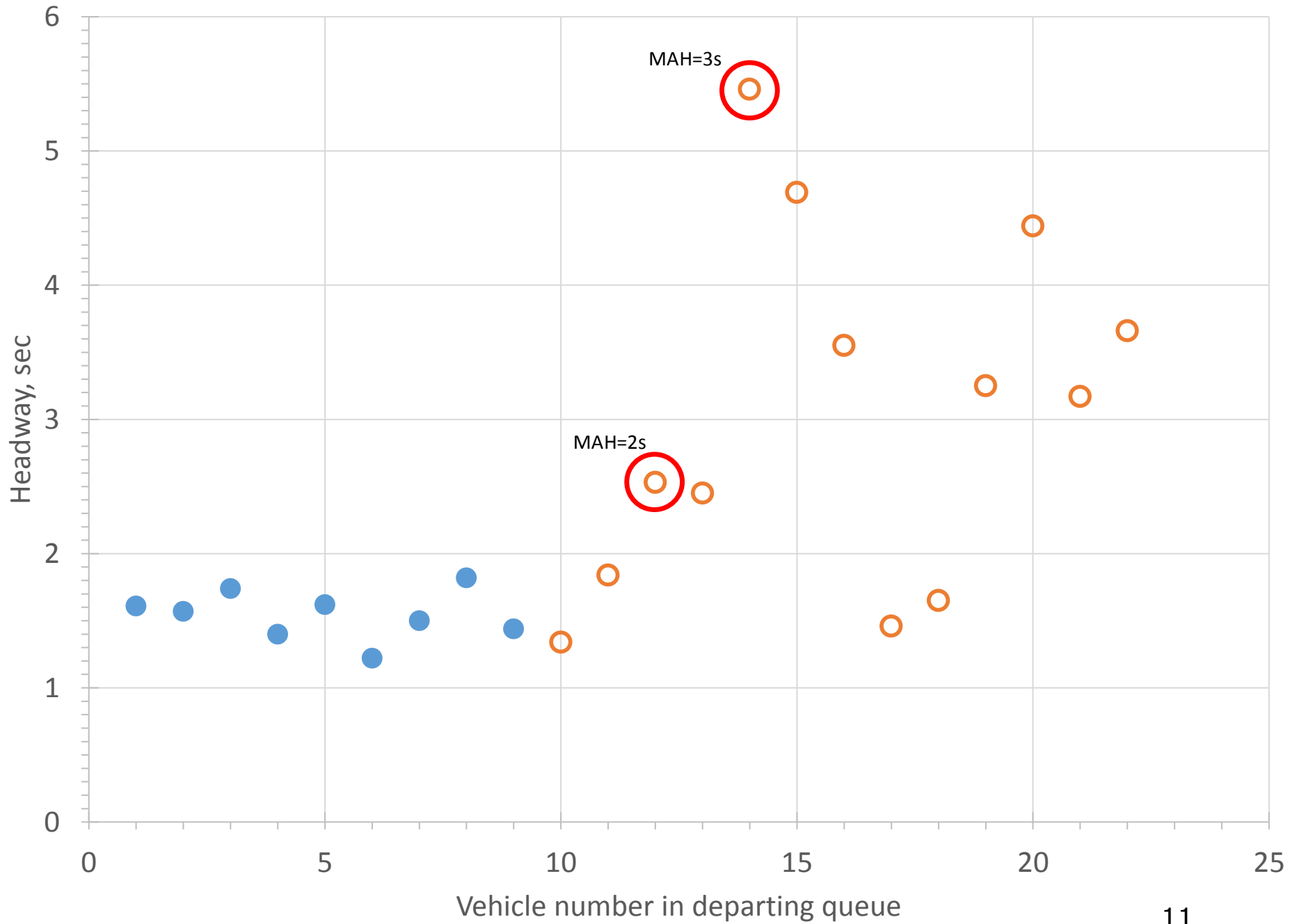
# Headway Frequency

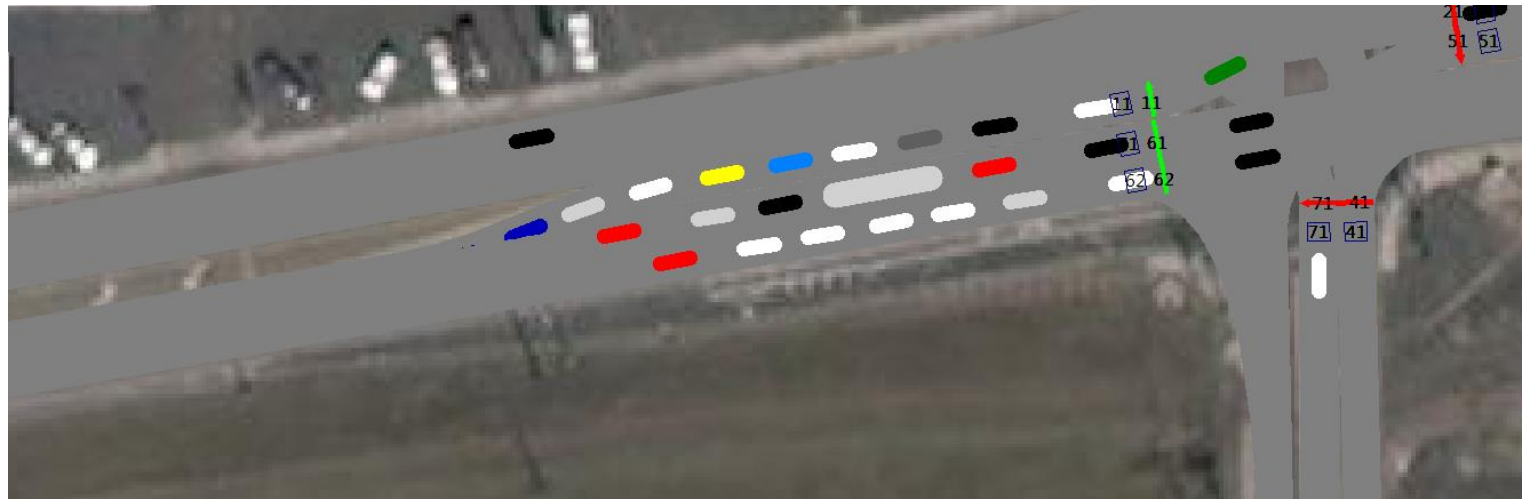












## Task 2

## Evaluation Configuration

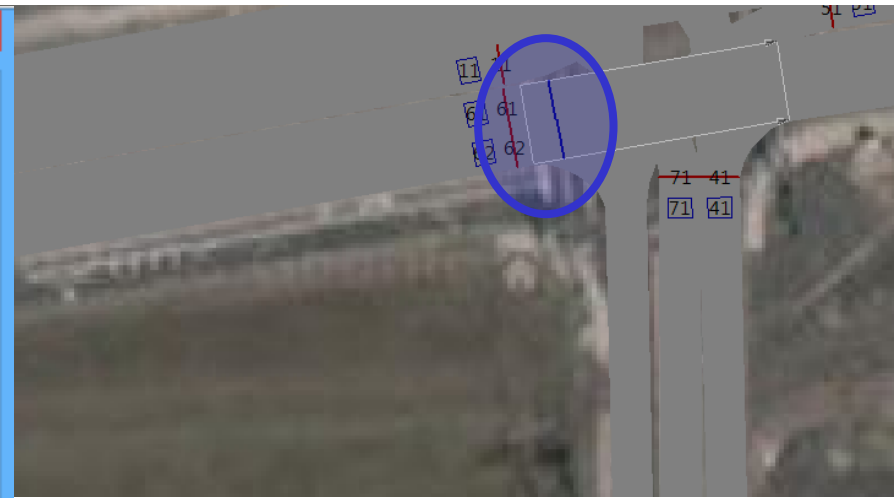
Evaluation output directory: c:\users\mkyte\documents\documents\01. teaching-ui\1-079 ...

Result Attributes Direct Output

|                                   | Write to file                       | Write database           | From time | To time |         |
|-----------------------------------|-------------------------------------|--------------------------|-----------|---------|---------|
| Area measurements (raw data)      | <input type="checkbox"/>            |                          | 0         | 99999   |         |
| Convergence                       | <input type="checkbox"/>            |                          |           |         |         |
| Data collection (raw data)        | <input checked="" type="checkbox"/> |                          | 300       | 3600    |         |
| Discharge record                  | <input type="checkbox"/>            |                          | 0         | 99999   |         |
| Green time distribution           | <input type="checkbox"/>            |                          | 0         | 99999   |         |
| Lane changes                      | <input type="checkbox"/>            |                          | 0         | 99999   | More... |
| Managed lanes                     | <input type="checkbox"/>            |                          |           |         |         |
| Nodes (raw data)                  | <input type="checkbox"/>            | <input type="checkbox"/> | 0         | 900     | More... |
| Pedestrian record                 | <input type="checkbox"/>            |                          | 0         | 99999   | More... |
| Pedestrian travel time (OD data)  | <input type="checkbox"/>            |                          | 0         | 99999   | More... |
| Pedestrian travel time (raw data) | <input type="checkbox"/>            |                          | 0         | 99999   |         |
| Public transport waiting times    | <input type="checkbox"/>            |                          |           |         |         |
| Signal changes                    | <input type="checkbox"/>            | <input type="checkbox"/> |           |         |         |
| Signal control detector record    | <input type="checkbox"/>            |                          |           |         |         |
| SSAM                              | <input type="checkbox"/>            |                          |           |         |         |
| Vehicle input data                | <input type="checkbox"/>            |                          |           |         |         |
| Vehicle record                    | <input type="checkbox"/>            |                          | 0         | 99999   | More... |
| Vehicle travel times (raw data)   | <input type="checkbox"/>            | <input type="checkbox"/> | 0         | 99999   |         |

OK

Cancel



# Deliverables – A36

| Tab | Description  |
|-----|--|
| 1   | Title page with activity number and title, authors, and date completed.  |
| 2   | Raw data from the MER file.  |
| 3   | Parsed data, headway data, and frequency data and plot.  |
| 4   | Phase termination analysis using template including summary table containing number of occurrences of each termination type.                                     |
| 5   | Evaluation of phase termination analysis including discussion of results from Task 5, selection of and justification for MAH, and determination of passage time. |
| 6   | Performance data from VISSIM.  |
| 7   | Analysis and summary of VISSIM performance data including comparison of new data and observations with results from the base case (Activity #28).                |

## Data Collection (Raw Data)

File: C:\Users\mkyte\Documents\mk documents\01. Teaching-UI\1-081 CE 474-Fall 2015\vissim test\network01-a36a37\network01.inpx

Comment:

Date: Monday, September 28, 2015 10:23:28 AM


PTV Vissim 7.00-13 [56176]

Data collection point 1: Link 1 lane 2 at 691.599 ft.

| Measurement | t(Entry) | t(Exit) | VehNo | Vehicle type | Line | v[mph] | b[ft/s <sup>2</sup> ] | Occ  | Pers | tQueue | VehLength[ft] |
|-------------|----------|---------|-------|--------------|------|--------|-----------------------|------|------|--------|---------------|
| 1           | 304.79   | -1      | 298   | 100          | 0    | 29.8   | 0.51                  | 0.01 | 1    | 0      | 14.76         |
| 1           | -1       | 305.12  | 298   | 100          | 0    | 29.9   | 0.51                  | 0.02 | 1    | 0      | 14.76         |
| 1           | 312.56   | -1      | 303   | 100          | 0    | 33.7   | 0.78                  | 0.04 | 1    | 0      | 14.76         |
| 1           | -1       | 312.86  | 303   | 100          | 0    | 33.9   | 0.78                  | 0.06 | 1    | 0      | 14.76         |
| 1           | 388.35   | -1      | 305   | 100          | 0    | 8.4    | 10.37                 | 0.05 | 1    | 69.5   | 14.76         |
| 1           | -1       | 389.23  | 305   | 100          | 0    | 14.3   | 9.36                  | 0.03 | 1    | 69.5   | 14.76         |
| 1           | 390.81   | -1      | 307   | 100          | 0    | 14.7   | 7.25                  | 0.09 | 1    | 69     | 14.76         |
| 1           | -1       | 391.43  | 307   | 100          | 0    | 17.7   | 6.84                  | 0.03 | 1    | 69     | 14.76         |
| 1           | 392.52   | -1      | 313   | 100          | 0    | 21.9   | 9.3                   | 0.08 | 1    | 57.6   | 14.76         |
| 1           | -1       | 392.95  | 313   | 100          | 0    | 24.3   | 6.92                  | 0.05 | 1    | 57.6   | 14.76         |
| 1           | 394.27   | -1      | 318   | 100          | 0    | 24.1   | 7.76                  | 0.03 | 1    | 53.3   | 14.76         |
| 1           | -1       | 394.67  | 318   | 100          | 0    | 26.2   | 7.5                   | 0.07 | 1    | 53.3   | 14.76         |
| 1           | 396.37   | -1      | 319   | 100          | 0    | 24     | 5.79                  | 0.03 | 1    | 51.6   | 14.76         |
| 1           | -1       | 396.78  | 319   | 100          | 0    | 25.6   | 5.63                  | 0.08 | 1    | 51.6   | 14.76         |

| t(Exit) | VehNo | v[mph] | tQueue | VehLength[ft] | Q/NQ |
|---------|-------|--------|--------|---------------|------|
| 305.12  | 298   | 29.9   | 0      | 14.76         | NQ   |
| 312.86  | 303   | 33.9   | 0      | 14.76         | NQ   |
| 389.23  | 305   | 14.3   | 69.5   | 14.76         | Q    |
| 391.43  | 307   | 17.7   | 69     | 14.76         | Q    |
| 392.95  | 313   | 24.3   | 57.6   | 14.76         | Q    |
| 394.67  | 318   | 26.2   | 53.3   | 14.76         | Q    |
| 396.78  | 319   | 25.6   | 51.6   | 14.76         | Q    |
| 399.11  | 323   | 24.6   | 49.1   | 14.76         | Q    |
| 400.45  | 334   | 27.2   | 38.6   | 14.76         | Q    |

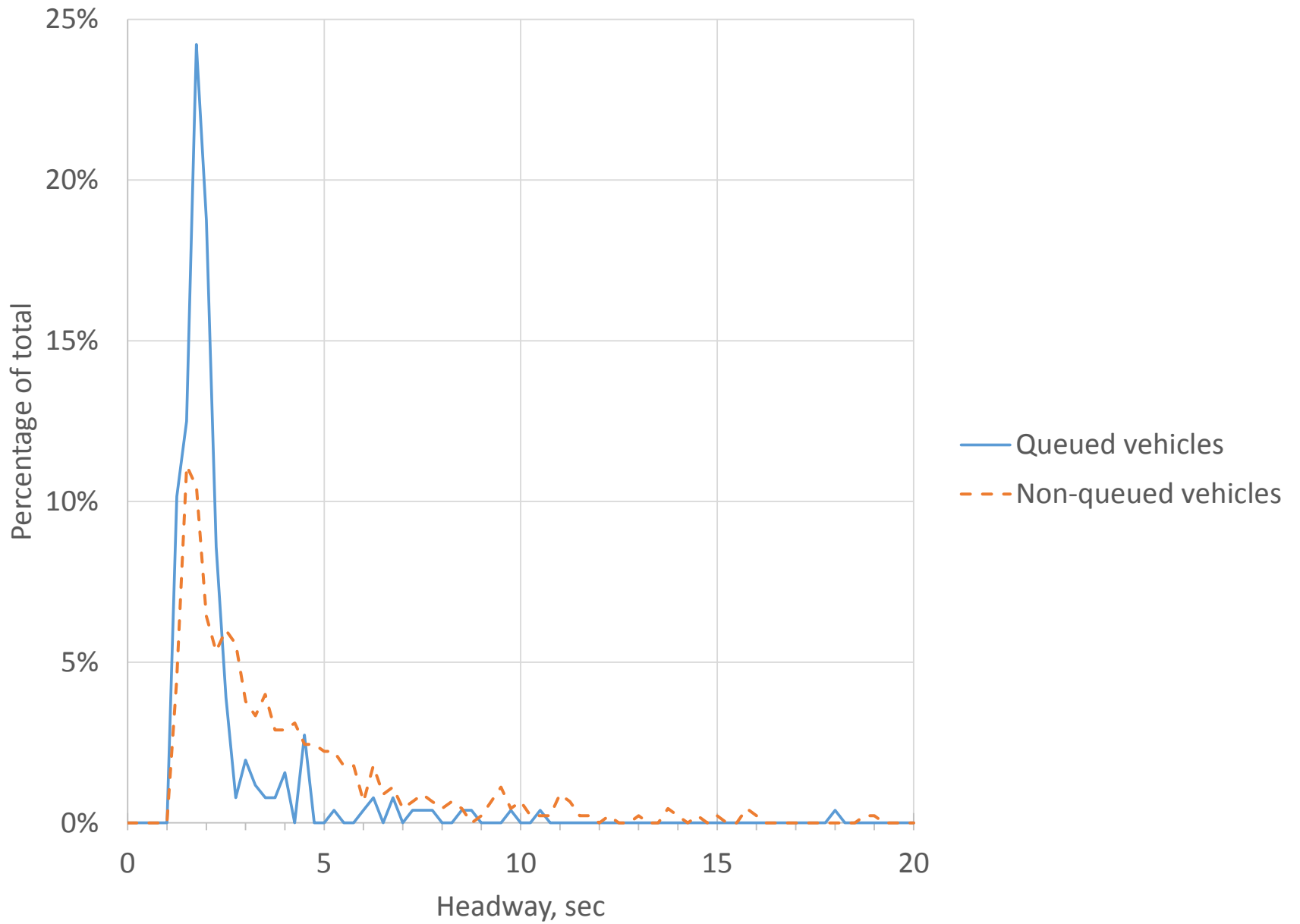
If(tQueue>0,"Q","NQ")





| 11 | t(Exit) | VehNo | v[mph] | tQueue | VehLength[ft] | Q/NQ | Headway |
|----|---------|-------|--------|--------|---------------|------|---------|
| 12 | 305.12  | 298   | 29.9   | 0      | 14.76         | NQ   |         |
| 13 | 312.86  | 303   | 33.9   | 0      | 14.76         | NQ   | 7.74    |
| 14 | 389.23  | 305   | 14.3   | 69.5   | 14.76         | Q    | 76.37   |
| 15 | 391.43  | 307   | 17.7   | 69     | 14.76         | Q    | 2.20    |
| 16 | 392.95  | 313   | 24.3   | 57.6   | 14.76         | Q    | 1.52    |
| 17 | 394.67  | 318   | 26.2   | 53.3   | 14.76         | Q    | 1.72    |
| 18 | 396.78  | 319   | 25.6   | 51.6   | 14.76         | Q    | 2.11    |
| 19 | 399.11  | 323   | 24.6   | 49.1   | 14.76         | Q    | 2.33    |
| 20 | 400.45  | 334   | 27.2   | 38.6   | 14.76         | Q    | 1.34    |

| <i>Q/NQ</i>   | Headway | <i>Bin</i> | <i>Frequency</i> | <i>%Frequency</i> |
|---------------|---------|------------|------------------|-------------------|
| Q             | 76.37   | 0.00       | 0                | 0.0%              |
| Q             | 2.2     | 0.25       | 0                | 0.0%              |
| Q             | 1.52    | 0.50       | 0                | 0.0%              |
| Q             | 1.72    | 0.75       | 0                | 0.0%              |
| Q             | 2.11    | 1.00       | 0                | 0.0%              |
| Q             | 2.33    | 1.25       | 26               | 10.2%             |
| Q             | 1.34    | 1.50       | 32               | 12.5%             |
| Q             | 1.11    | 1.75       | 62               | 24.2%             |
| Q             | 1.56    | 2.00       | 48               | 18.8%             |
| Q             | 1.3     | 2.25       | 22               | 8.6%              |
| Q             | 1.68    | 2.50       | 10               | 3.9%              |
| Q             | 1.31    | 2.75       | 2                | 0.8%              |
| Q             | 2.44    | 3.00       | 5                | 2.0%              |
| Q             | 1.04    | 3.25       | 3                | 1.2%              |
| Q             | 2.07    | 3.50       | 2                | 0.8%              |
| Q             | 1.12    | 3.75       | 2                | 0.8%              |
| <b>Task 4</b> | 2.5     | 4.00       | 4                | 1.6%              |



| t(Exit) | VehNo | v[mph] | tQueue | VehLength[ft] | Q/NQ | Headway | Headway (sec) |        |
|---------|-------|--------|--------|---------------|------|---------|---------------|--------|
|         |       |        |        |               |      |         | QData         | NQData |
| 305.12  | 298   | 29.9   | 0      | 14.76         | NQ   |         |               |        |
| 312.86  | 303   | 33.9   | 0      | 14.76         | NQ   | 7.74    |               | 7.74   |
| 389.23  | 305   | 14.3   | 69.5   | 14.76         | Q    | 76.37   | 76.37         |        |
| 391.43  | 307   | 17.7   | 69     | 14.76         | Q    | 2.20    | 2.2           |        |
| 392.95  | 313   | 24.3   | 57.6   | 14.76         | Q    | 1.52    | 1.52          |        |
| 394.67  | 318   | 26.2   | 53.3   | 14.76         | Q    | 1.72    | 1.72          |        |
| 396.78  | 319   | 25.6   | 51.6   | 14.76         | Q    | 2.11    | 2.11          |        |
| 399.11  | 323   | 24.6   | 49.1   | 14.76         | Q    | 2.33    | 2.33          |        |
| 400.45  | 334   | 27.2   | 38.6   | 14.76         | Q    | 1.34    | 1.34          |        |
| 401.56  | 339   | 28.6   | 34.6   | 14.76         | Q    | 1.11    | 1.11          |        |
| 403.12  | 341   | 29.5   | 32.1   | 14.76         | Q    | 1.56    | 1.56          |        |
| 404.42  | 344   | 31.1   | 30.4   | 14.76         | Q    | 1.30    | 1.3           |        |
| 406.1   | 348   | 30.3   | 29.5   | 14.76         | Q    | 1.68    | 1.68          |        |
| 407.41  | 364   | 31.2   | 22.3   | 14.76         | Q    | 1.31    | 1.31          |        |
| 409.85  | 366   | 30.5   | 22.2   | 14.76         | Q    | 2.44    | 2.44          |        |
| 410.89  | 372   | 30.8   | 20.7   | 14.76         | Q    | 1.04    | 1.04          |        |
| 412.96  | 374   | 30     | 16.1   | 14.76         | Q    | 2.07    | 2.07          |        |

| MAH           | Percentile |                      |               |                      |        |        |
|---------------|------------|----------------------|---------------|----------------------|--------|--------|
| 4.0           | 90.8%      |                      |               |                      |        |        |
| Headway (sec) |            | Signal Information   |               | Termination Outcomes |        |        |
| Queued        | NonQueued  | Ideal Signal Display | Change Occurs | Type 1               | Type 3 | Type 2 |
|               | 7.74       | Red                  |               |                      |        |        |
|               |            | Green                |               |                      |        |        |
| 2.2           |            | Green                |               |                      |        |        |
| 1.52          |            | Green                |               |                      |        |        |
| 1.72          |            | Green                |               |                      |        |        |
| 2.11          |            | Green                |               |                      |        |        |
| 2.33          |            | Green                |               |                      |        |        |
| 1.34          |            | Green                |               |                      |        |        |
| 1.11          |            | Green                |               |                      |        |        |
| 1.56          |            | Green                |               |                      |        |        |
| 1.3           |            | Green                |               |                      |        |        |
| 1.68          |            | Green                |               |                      |        |        |
| 1.31          |            | Green                |               |                      |        |        |
| 2.44          |            | Green                |               |                      |        |        |
| 1.04          |            | Green                |               |                      |        |        |
| 2.07          |            | Green                |               |                      |        |        |
| 1.12          |            | Green                |               |                      |        |        |
| 2.5           |            | Green                |               |                      |        |        |
| 3.31          |            | Green                |               |                      |        |        |
| 1.52          |            | Green                |               |                      |        |        |
| 2.85          |            | Green                |               |                      |        |        |
|               | 4.26       | Red                  | Change        |                      | 1      |        |
|               | 3.14       | Red                  |               |                      |        |        |
|               |            | Red                  |               |                      |        |        |
|               | 1.94       | Red                  |               |                      |        |        |

**Task 5**

|       |      |
|-------|------|
| 57.04 |      |
| 2.32  |      |
| 1.94  |      |
| 1.57  |      |
| 1.65  |      |
| 1.83  |      |
| 2.11  |      |
| 1.42  |      |
| 1.1   |      |
| 1.9   |      |
| 1.4   |      |
| 1.45  |      |
| 1.41  | 1.74 |
|       | 2.81 |
|       | 8.93 |
|       | 2.72 |
|       | 2.14 |
|       | 2.22 |
|       | 6.04 |
|       | 2.61 |
|       | 7.2  |
| 58.54 |      |
| 2.05  |      |
| 1.6   |      |
| 3.77  |      |
| 2.16  |      |
| 1.07  |      |
|       | 4.39 |
|       | 2.13 |
|       | 1.65 |
|       | 4.07 |
|       | 1.12 |
|       | 1.78 |
|       | 1.91 |

↑  
First cycle  
↓

↑  
Second cycle  
↓

Here is an example of two consecutive sets of queued and non-queued data ready for the “phase termination analysis”.

|       |      |
|-------|------|
| 57.04 |      |
| 2.32  |      |
| 1.94  |      |
| 1.57  |      |
| 1.65  |      |
| 1.83  |      |
| 2.11  |      |
| 1.42  |      |
| 1.1   |      |
| 1.9   |      |
| 1.4   |      |
| 1.45  |      |
| 1.41  | 1.74 |
|       | 2.81 |
|       | 8.93 |
|       | 2.72 |
|       | 2.14 |
|       | 2.22 |
|       | 6.04 |
|       | 2.61 |
|       | 7.2  |
| 58.54 |      |
| 2.05  |      |
| 1.6   |      |
| 3.77  |      |
| 2.16  |      |
| 1.07  |      |
|       | 4.39 |
|       | 2.13 |
|       | 1.65 |
|       | 4.07 |
|       | 1.12 |
|       | 1.78 |
|       | 1.91 |

↑  
First cycle  
↓

↑  
Second cycle  
↓

Note that the first two “queued” headways (in red boxes) are large. These are actually not realistically headways as they really represent the time from the last vehicle departing from the previous cycle to the first vehicle departing from the current cycle.

|      |      |
|------|------|
|      |      |
| 2.32 |      |
| 1.94 |      |
| 1.57 |      |
| 1.65 |      |
| 1.83 |      |
| 2.11 |      |
| 1.42 |      |
| 1.1  |      |
| 1.9  |      |
| 1.4  |      |
| 1.45 |      |
| 1.41 | 1.74 |
|      | 2.81 |
|      | 8.93 |
|      | 2.72 |
|      | 2.14 |
|      | 2.22 |
|      | 6.04 |
|      | 2.61 |
|      | 7.2  |
|      |      |
| 2.05 |      |
| 1.6  |      |
| 3.77 |      |
| 2.16 |      |
| 1.07 |      |
|      | 4.39 |
|      | 2.13 |
|      | 1.65 |
|      | 4.07 |
|      | 1.12 |
|      | 1.78 |
|      | 1.91 |

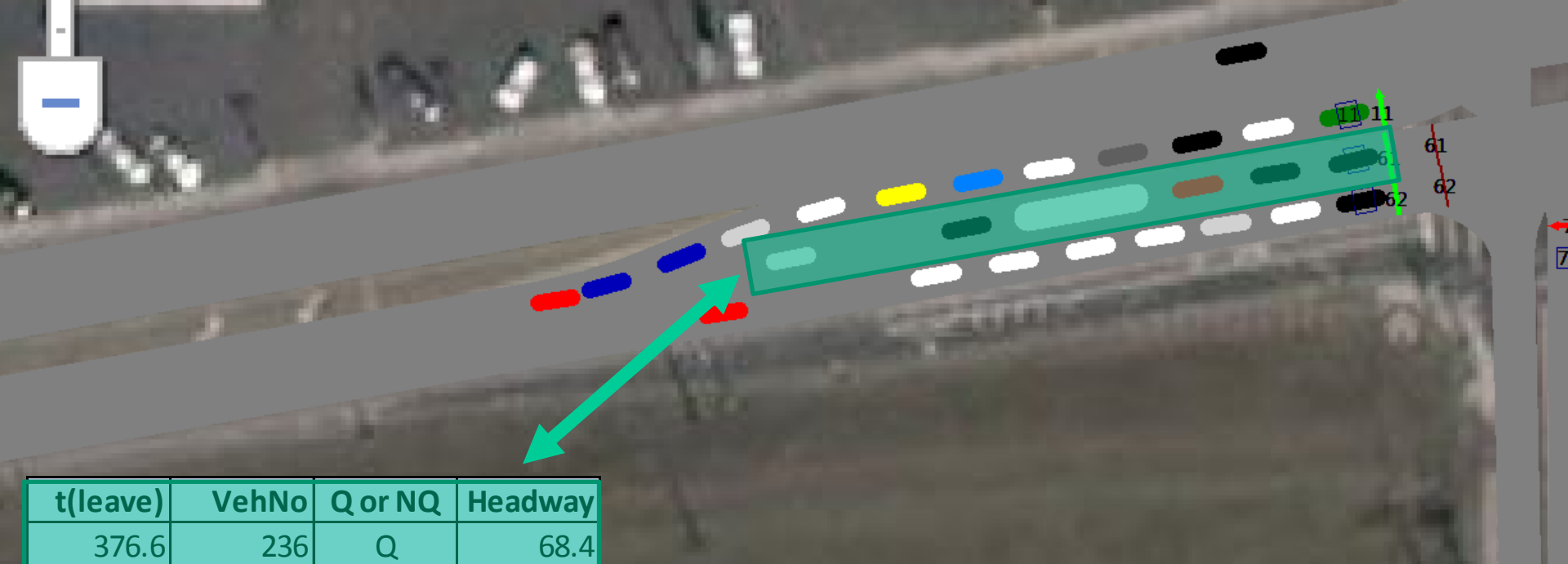
In this figure, we've now eliminated these two very large headways.



| Headway (sec) |           | Signal Information   |               | Termination Outcomes |        |        |
|---------------|-----------|----------------------|---------------|----------------------|--------|--------|
| Queued        | NonQueued | Ideal Signal Display | Change Occurs | Type 1               | Type 3 | Type 2 |
|               | 7.74      | Green                |               |                      |        |        |
| 76.37         |           | Red                  | Change        |                      | 1      |        |
| 2.2           |           | Red                  |               |                      |        |        |
| 1.52          |           | Red                  |               |                      |        |        |
| 1.72          |           | Red                  |               |                      |        |        |
| 2.11          |           | Red                  |               |                      |        |        |
| 2.33          |           | Red                  |               |                      |        |        |
| 1.34          |           | Red                  |               |                      |        |        |
| 1.11          |           | Red                  |               |                      |        |        |
| 1.56          |           | Red                  |               |                      |        |        |

|                                       |       | Outcome Distribution |       |       |       |       |
|---------------------------------------|-------|----------------------|-------|-------|-------|-------|
|                                       |       | Type 1 Termination   | 5     |       |       |       |
|                                       |       | Type 3 Termination   | 3     |       |       |       |
|                                       |       | Type 2 Termination   | 7     |       |       |       |
| Results of Phase Termination Analysis |       |                      |       |       |       |       |
| Headway                               | 1.5   | 2.0                  | 2.5   | 3.0   | 3.5   | 4.0   |
| Percentile                            | 22.9% | 70.2%                | 83.3% | 86.4% | 88.5% | 90.8% |
| Type 1 Termination                    | 15    | 12                   | 7     | 6     | 5     | 5     |
| Type 3 Termination                    | 0     | 1                    | 3     | 2     | 3     | 3     |
| Type 2 Termination                    | 0     | 2                    | 5     | 7     | 7     | 7     |

- Other slides





















| t(leave) | VehNo | Q or NQ | Headway |
|----------|-------|---------|---------|
| 376.6    | 236   | Q       | 68.4    |
| 378.51   | 238   | Q       | 1.9     |
| 380.37   | 244   | Q       | 1.9     |
| 383.67   | 251   | Q       | 3.3     |
| 384.95   | 255   | Q       | 1.3     |
| 386.3    | 259   | Q       | 1.4     |
| 387.72   | 262   | NQ      | 1.4     |
| 391.81   | 266   | NQ      | 4.1     |
| 399.46   | 273   | NQ      | 7.6     |
| 405.67   | 279   | NQ      | 6.2     |
| 409.21   | 282   | NQ      | 3.5     |
| 413.42   | 286   | NQ      | 4.2     |
| 421.68   | 293   | NQ      | 8.3     |
| 442.39   | 310   | NQ      | 20.7    |

## Documents library

Line High Volume

Arrange by: Folder ▾

| Name  | Date modified      | Type                  | Size     |
|---|--------------------|-----------------------|----------|
|  _RBCLog              | 9/18/2011 3:24 PM  | Text Document         | 1 KB     |
|  Line and SH8.rbc     | 9/15/2011 5:04 PM  | RBC File              | 42 KB    |
|  Line and SH8.rbc.bak | 9/15/2011 5:04 PM  | BAK File              | 42 KB    |
|  Isa data file        | 9/17/2011 9:32 AM  | Microsoft Excel W...  | 34 KB    |
|  mer file             | 9/17/2011 9:32 AM  | Microsoft Excel W...  | 137 KB   |
|  mer#2 file           | 9/18/2011 7:33 AM  | Microsoft Excel W...  | 21 KB    |
|  rbc.frq              | 9/15/2011 5:04 PM  | FRQ File              | 1 KB     |
|  rbc                  | 2/24/2011 12:57 PM | Configuration sett... | 23 KB    |
|  RBCLog               | 9/15/2011 5:04 PM  | Text Document         | 6 KB     |
|  Team2_Lab3.fzi       | 9/18/2011 7:29 AM  | FZI File              | 1 KB     |
|  Team2_Lab3          | 9/18/2011 8:52 AM  | INO File              | 74 KB    |
|  team2_lab3         | 9/5/2010 12:22 PM  | Configuration sett... | 8 KB     |
|  Team2_Lab3         | 9/18/2011 8:52 AM  | VISSIM input file     | 74 KB    |
|  Team2_Lab3         | 9/18/2011 3:24 PM  | LSA File              | 0 KB     |
|  Team2_Lab3         | 9/18/2011 3:24 PM  | MER File              | 0 KB     |
|  Team2_Map.bgr      | 9/3/2010 11:24 AM  | BGR File              | 1 KB     |
|  Team2_Map          | 9/3/2010 11:24 AM  | Bitmap image          | 1,355 KB |
|  vissim             | 9/18/2011 7:36 AM  | Configuration sett... | 11 KB    |

| Headway (sec) |           |
|---------------|-----------|
| Queue         | Free-Flow |
|               |           |
| 1.95          |           |
| 1.58          |           |
| 1.82          |           |
| 1.56          |           |
| 2.27          |           |
| 1.19          |           |
| 1.5           |           |
| 1.6           |           |
| 1.67          |           |
| 1.73          |           |
| 0.9           |           |
| 1.92          |           |
| 1.87          |           |
|               | 3.58      |
|               | 4.29      |
|               | 7.55      |
|               | 2.15      |
|               | 8.5       |
|               |           |
| 1.91          |           |
| 1.57          |           |
| 1.88          |           |
| 1.67          |           |
| 1.69          |           |
| 1.5           |           |
| 1.85          |           |



Why blank?

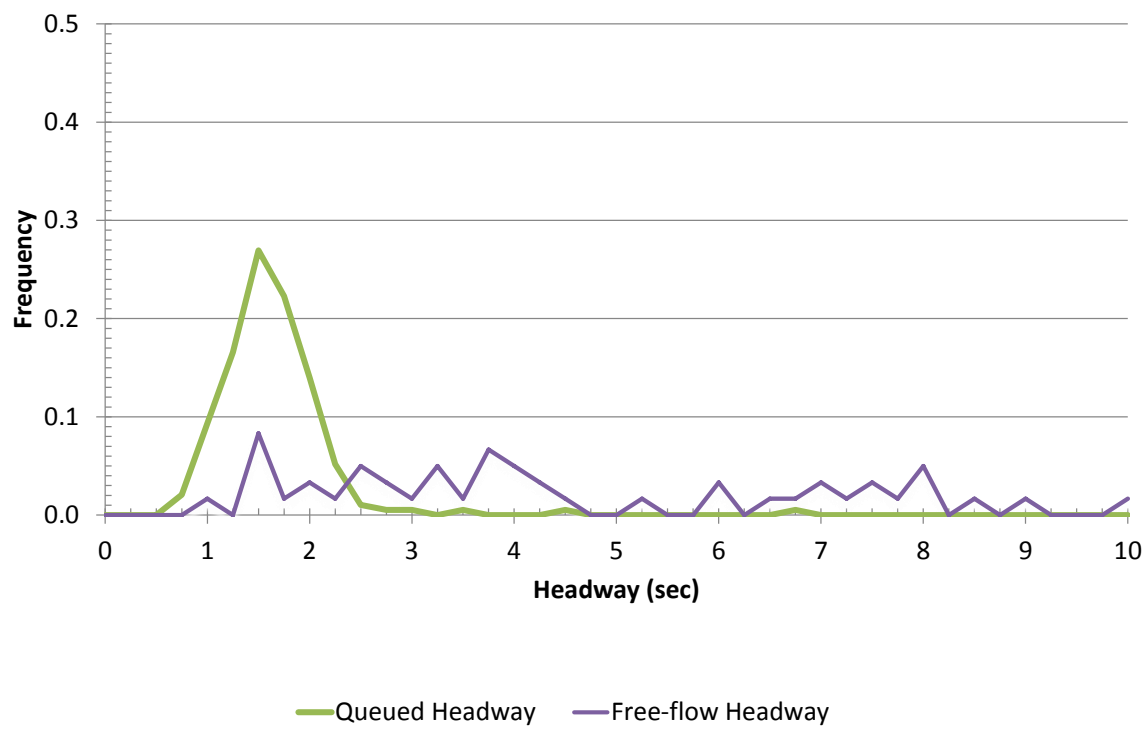
## Headway (sec)

| Queue | Free-Flow |
|-------|-----------|
| 1.95  |           |
| 1.58  |           |

|      | Queued Data |                  |                   |                        | Non-Queued Data |                  |                   |                        |
|------|-------------|------------------|-------------------|------------------------|-----------------|------------------|-------------------|------------------------|
|      | <i>Bin</i>  | <i>Frequency</i> | <i>%Frequency</i> | <i>%CumulativeFreq</i> | <i>Bin</i>      | <i>Frequency</i> | <i>%Frequency</i> | <i>%CumulativeFreq</i> |
| 1.82 | 0.00        | 0                | 0.000             | 0.000                  | 0.00            | 0                | 0.000             | 0.000                  |
| 1.56 | 0.25        | 0                | 0.000             | 0.000                  | 0.25            | 0                | 0.000             | 0.000                  |
| 2.27 | 0.50        | 0                | 0.000             | 0.000                  | 0.50            | 0                | 0.000             | 0.000                  |
| 1.19 | 0.75        | 0                | 0.000             | 0.000                  | 0.75            | 0                | 0.000             | 0.000                  |
| 1.5  | 1.00        | 6                | 0.031             | 0.031                  | 1.00            | 0                | 0.000             | 0.000                  |
| 1.6  | 1.25        | 16               | 0.083             | 0.114                  | 1.25            | 1                | 0.020             | 0.020                  |
| 1.67 | 1.50        | 36               | 0.187             | 0.301                  | 1.50            | 0                | 0.000             | 0.020                  |
| 1.73 | 1.75        | 52               | 0.269             | 0.570                  | 1.75            | 5                | 0.100             | 0.120                  |
| 0.9  | 2.00        | 39               | 0.202             | 0.772                  | 2.00            | 1                | 0.020             | 0.140                  |
| 1.92 | 2.25        | 27               | 0.140             | 0.912                  | 2.25            | 2                | 0.040             | 0.180                  |
| 1.87 | 2.50        | 10               | 0.052             | 0.964                  | 2.50            | 1                | 0.020             | 0.200                  |
|      | 2.75        | 2                | 0.010             | 0.974                  | 2.75            | 3                | 0.060             | 0.260                  |
|      | 3.00        | 1                | 0.005             | 0.979                  | 3.00            | 3                | 0.060             | 0.320                  |
| 1.91 | 3.25        | 1                | 0.005             | 0.984                  | 3.25            | 0                | 0.000             | 0.320                  |
| 1.57 | 3.50        | 0                | 0.000             | 0.984                  | 3.50            | 3                | 0.060             | 0.380                  |
| 1.88 | 3.75        | 1                | 0.005             | 0.990                  | 3.75            | 1                | 0.020             | 0.400                  |
| 1.67 | 4.00        | 0                | 0.000             | 0.990                  | 4.00            | 4                | 0.080             | 0.480                  |
| 1.69 | 4.25        | 0                | 0.000             | 0.990                  | 4.25            | 3                | 0.060             | 0.540                  |
| 1.5  | 4.50        | 0                | 0.000             | 0.990                  | 4.50            | 2                | 0.040             | 0.580                  |
| 1.85 | 4.75        | 1                | 0.005             | 0.995                  | 4.75            | 1                | 0.020             | 0.600                  |
|      | 5.00        | 0                | 0.000             | 0.995                  | 5.00            | 0                | 0.000             | 0.600                  |

| Headway (sec) |           |
|---------------|-----------|
| Queue         | Free-Flow |

Headway Frequency

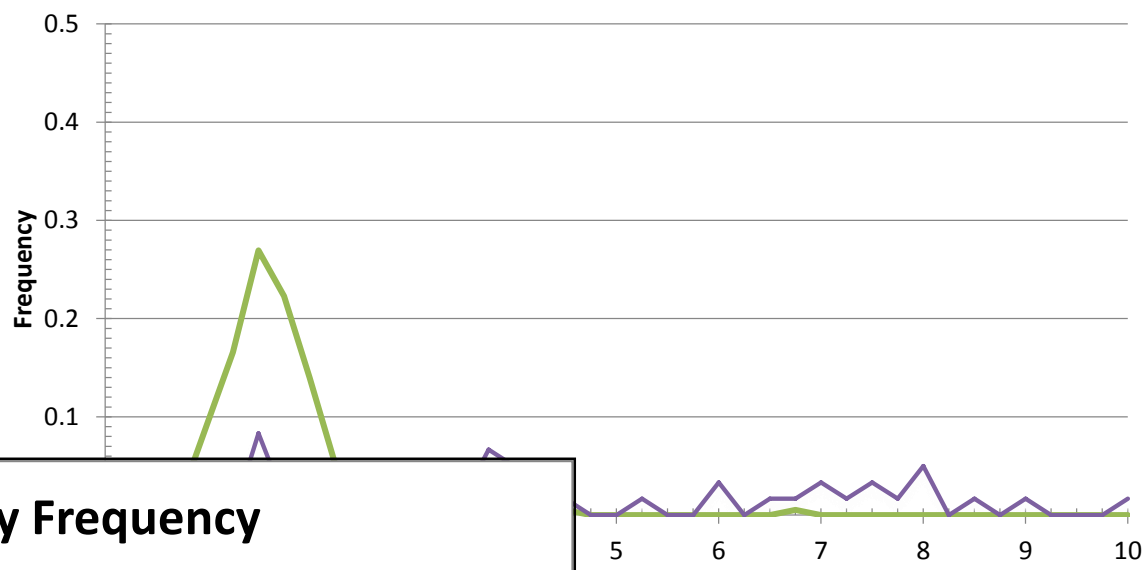


| Queued Data |           |            |     |       |
|-------------|-----------|------------|-----|-------|
| Bin         | Frequency | %Frequency | %Cu |       |
| 0.00        | 0         | 0.000      |     |       |
| 0.25        | 0         | 0.000      |     |       |
| 0.50        | 0         | 0.000      |     |       |
| 0.75        | 0         | 0.000      |     |       |
| 1.00        | 6         | 0.031      |     |       |
| 1.25        | 16        | 0.083      |     |       |
| 1.50        | 36        | 0.187      |     |       |
| 1.75        | 52        | 0.269      |     |       |
| 2.00        | 39        | 0.202      |     |       |
| 2.25        | 27        | 0.140      |     |       |
| 2.50        | 10        | 0.052      |     |       |
| 2.75        | 2         | 0.010      |     |       |
| 3.00        | 1         | 0.005      |     | 0.979 |
| 3.25        | 1         | 0.005      |     | 0.984 |
| 3.50        | 0         | 0.000      |     | 0.984 |
| 3.75        | 1         | 0.005      |     | 0.990 |
| 4.00        | 0         | 0.000      |     | 0.990 |
| 4.25        | 0         | 0.000      |     | 0.990 |
| 4.50        | 0         | 0.000      |     | 0.990 |
| 4.75        | 1         | 0.005      |     | 0.995 |
| 5.00        | 0         | 0.000      |     | 0.995 |
| 5.25        | 0         | 0.000      |     | 0.979 |
| 5.50        | 0         | 0.000      |     | 0.984 |
| 5.75        | 0         | 0.000      |     | 0.984 |
| 6.00        | 3         | 0.015      |     | 0.990 |
| 6.25        | 1         | 0.005      |     | 0.990 |
| 6.50        | 0         | 0.000      |     | 0.990 |
| 6.75        | 0         | 0.000      |     | 0.990 |
| 7.00        | 0         | 0.000      |     | 0.990 |
| 7.25        | 0         | 0.000      |     | 0.990 |
| 7.50        | 0         | 0.000      |     | 0.990 |
| 7.75        | 0         | 0.000      |     | 0.990 |
| 8.00        | 0         | 0.000      |     | 0.990 |
| 8.25        | 0         | 0.000      |     | 0.990 |
| 8.50        | 0         | 0.000      |     | 0.990 |
| 8.75        | 0         | 0.000      |     | 0.990 |
| 9.00        | 0         | 0.000      |     | 0.990 |
| 9.25        | 0         | 0.000      |     | 0.990 |
| 9.50        | 0         | 0.000      |     | 0.990 |
| 9.75        | 0         | 0.000      |     | 0.990 |
| 10.00       | 0         | 0.000      |     | 0.990 |

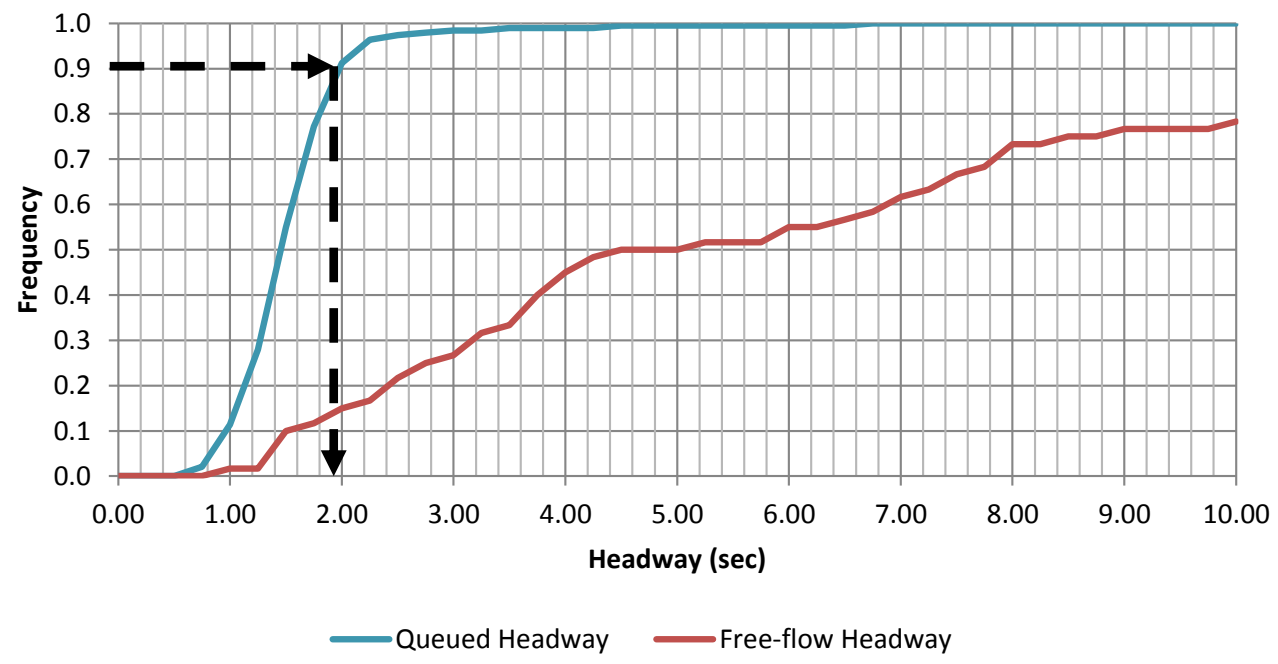
| Headway (sec) |           |
|---------------|-----------|
| Queue         | Free-Flow |
| 1.95          |           |
| 1.58          |           |
| 1.82          |           |
| 1.56          |           |
| 2.27          |           |
| 1.19          |           |
| 1.5           |           |
| 1.6           |           |
| 1.67          |           |
| 1.73          |           |

| Queued Data |           |            |     |  |
|-------------|-----------|------------|-----|--|
| Bin         | Frequency | %Frequency | %Cu |  |
| 0.00        | 0         | 0.000      |     |  |
| 0.25        | 0         | 0.000      |     |  |
| 0.50        | 0         | 0.000      |     |  |
| 0.75        | 0         | 0.000      |     |  |
| 1.00        | 6         | 0.031      |     |  |
| 1.25        | 16        | 0.083      |     |  |

Headway Frequency



Cumulative Headway Frequency



Headway (sec)

Free-flow Headway

|       |       |
|-------|-------|
| 0.060 | 0.320 |
| 0.000 | 0.320 |
| 0.060 | 0.380 |
| 0.020 | 0.400 |
| 0.080 | 0.480 |
| 0.060 | 0.540 |
| 0.040 | 0.580 |
| 0.020 | 0.600 |
| 0.000 | 0.600 |



| Headway (sec) |           | Signal Information   |               | Outcomes |      |        |
|---------------|-----------|----------------------|---------------|----------|------|--------|
| Queue         | Free-Flow | Ideal Signal Display | Change Occurs | Type 1   | Good | Type 2 |
|               |           |                      |               |          |      |        |
| 1.95          |           | G                    |               |          |      |        |
| 1.58          |           | G                    |               |          |      |        |
| 1.82          |           | G                    |               |          |      |        |
| 1.56          |           | G                    |               |          |      |        |
| 2.27          |           | R                    | Change        | 1        |      |        |
| 1.19          |           | R                    |               |          |      |        |
| 1.5           |           | R                    |               |          |      |        |
| 1.6           |           | R                    |               |          |      |        |
| 1.67          |           | R                    |               |          |      |        |
| 1.73          |           | R                    |               |          |      |        |
| 0.9           |           | R                    |               |          |      |        |
| 1.92          |           | R                    |               |          |      |        |
| 1.87          |           | R                    |               |          |      |        |

| Headway (sec) |           | Signal Information   |               | Outcomes |      |        |
|---------------|-----------|----------------------|---------------|----------|------|--------|
| Queue         | Free-Flow | Ideal Signal Display | Change Occurs | Type 1   | Good | Type 2 |
|               |           |                      |               |          |      |        |
| 1.95          |           | G                    |               |          |      |        |
| 1.58          |           | G                    |               |          |      |        |
| 1.82          |           | G                    |               |          |      |        |
| 1.56          |           | G                    |               |          |      |        |
| 2.27          |           | R                    | Change        | 1        |      |        |
| 1.19          |           | R                    |               |          |      |        |
| 1.5           |           | R                    |               |          |      |        |
| 1.6           |           | R                    |               |          |      |        |
| 1.67          |           | R                    |               |          |      |        |
| 1.73          |           | R                    |               |          |      |        |
| 0.9           |           | R                    |               |          |      |        |
| 1.92          |           | R                    |               |          |      |        |
| 1.87          |           | R                    |               |          |      |        |

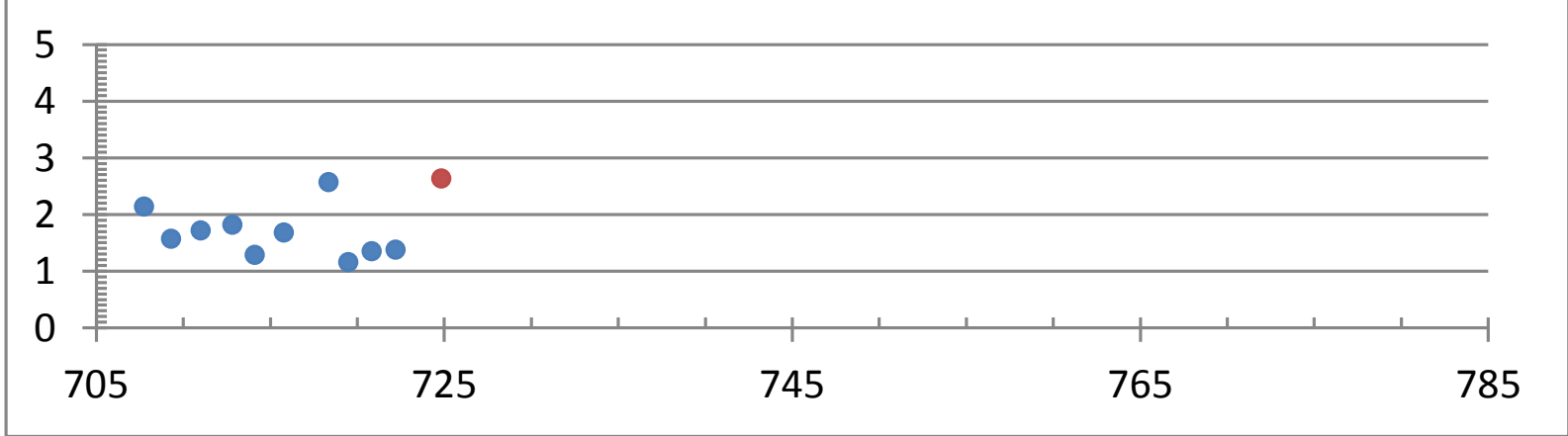
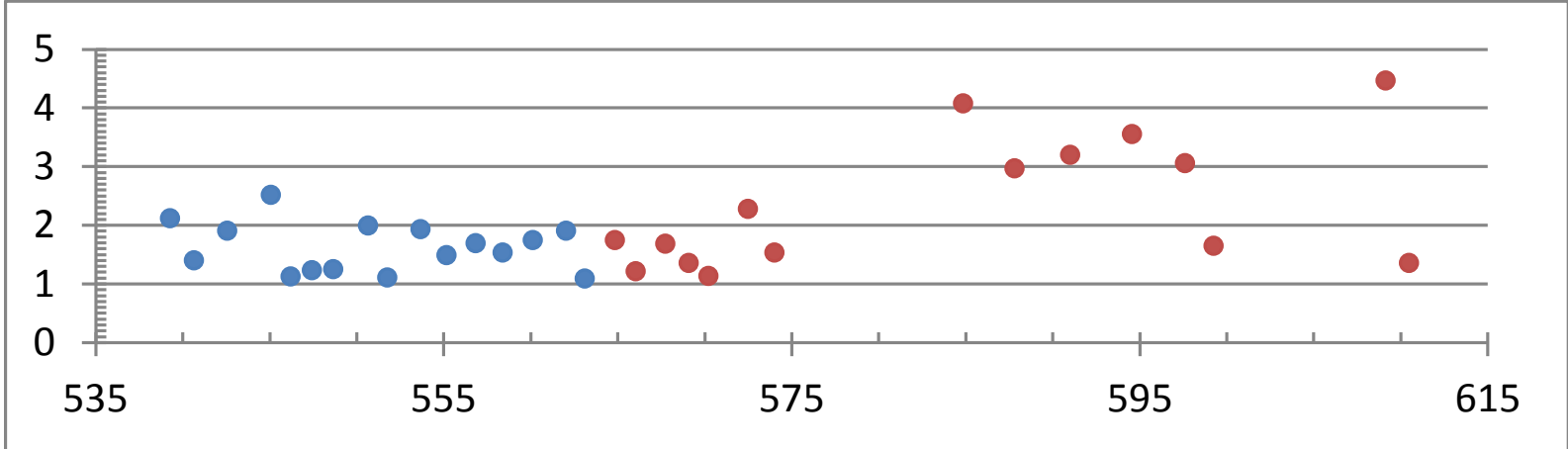
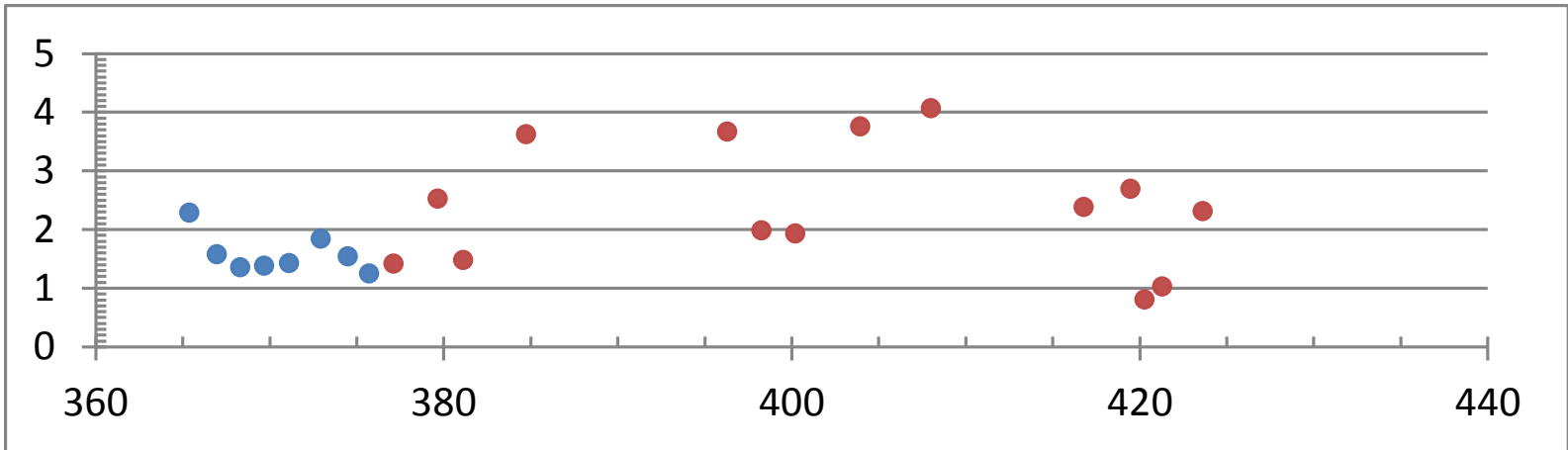


| Outcome Distrubution |    |
|----------------------|----|
| Error Type 1         | 17 |
| Good                 | 1  |
| Error Type 2         | 1  |



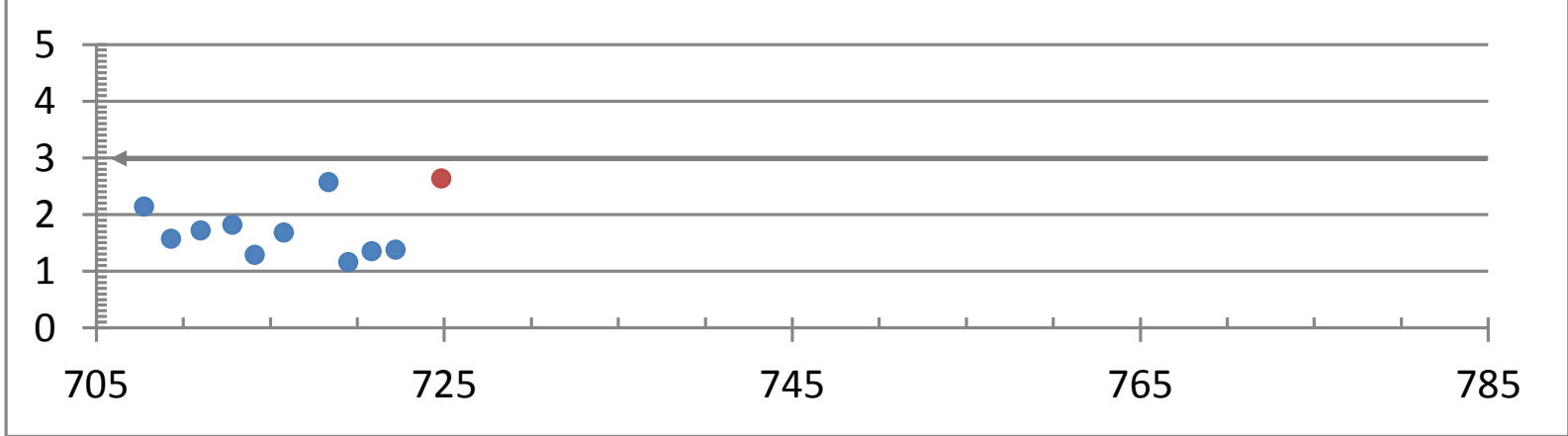
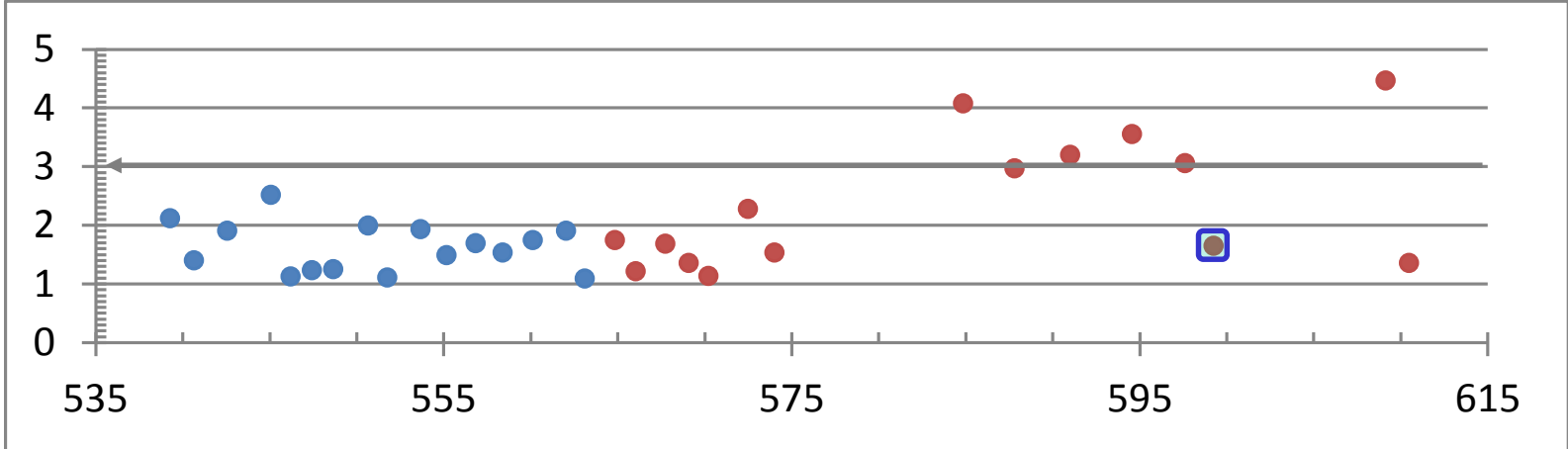
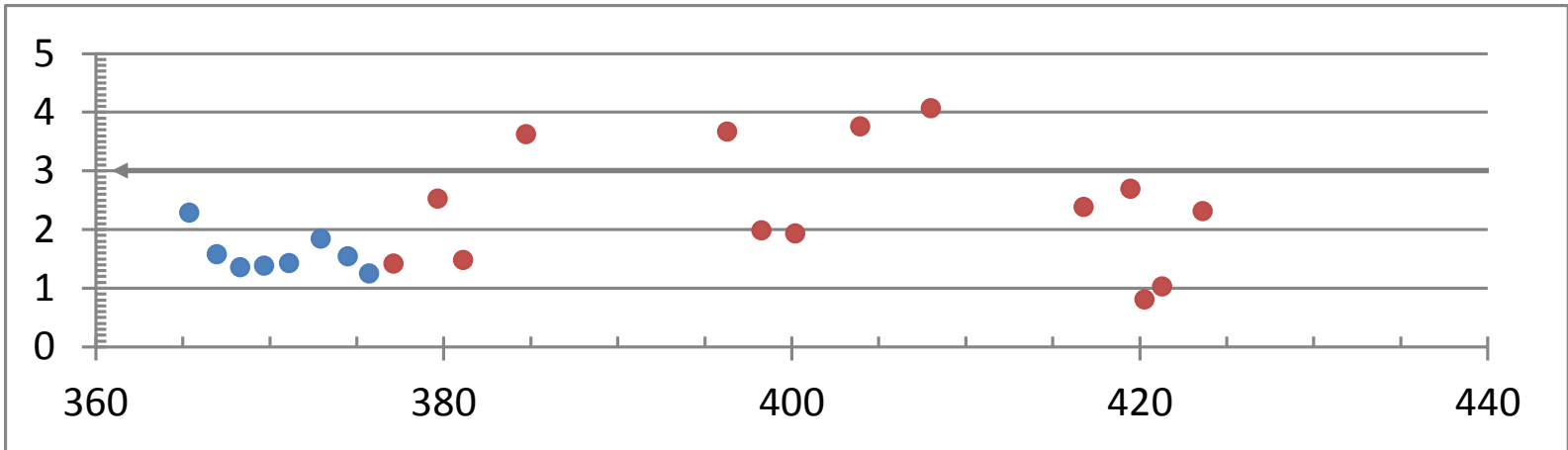
| Outcome Summary |                |      |      |      |
|-----------------|----------------|------|------|------|
| Conclusion      | Percentiles    |      |      |      |
|                 | 97th (Optimal) | 95th | 85th | 75th |
| Headway (sec)   | 2.69           | 2.36 | 2.11 | 1.94 |
| Error Type 1    | 3              | 7    | 14   | 17   |
| Good            | 14             | 10   | 4    | 1    |
| Error Type 2    | 2              | 2    | 1    | 1    |

↑ Headway, sec

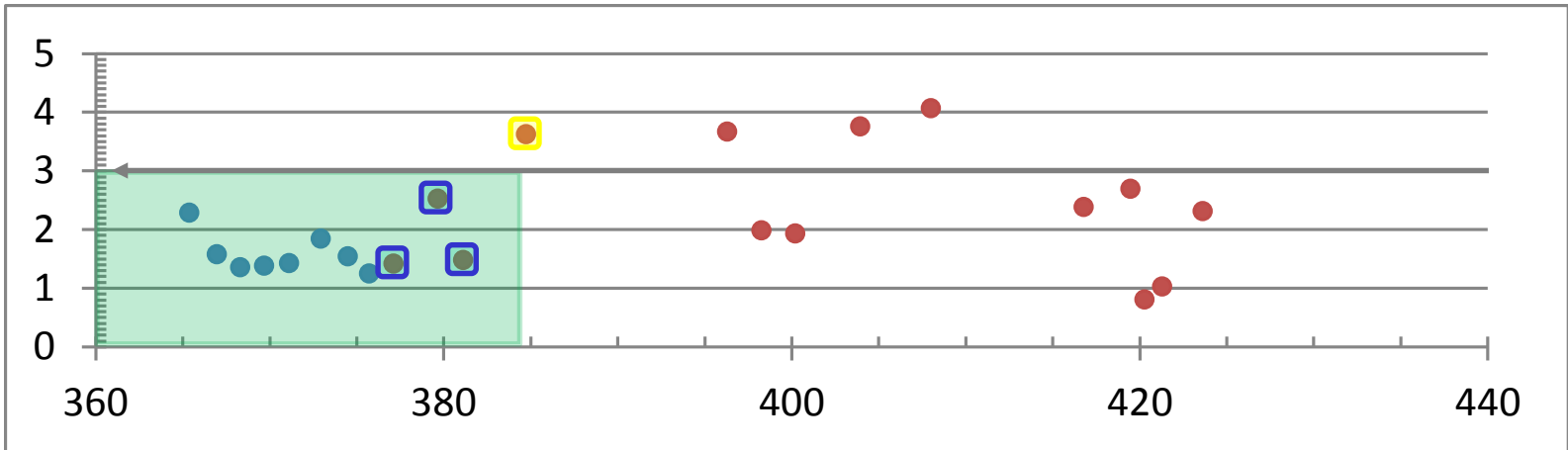


→ Time

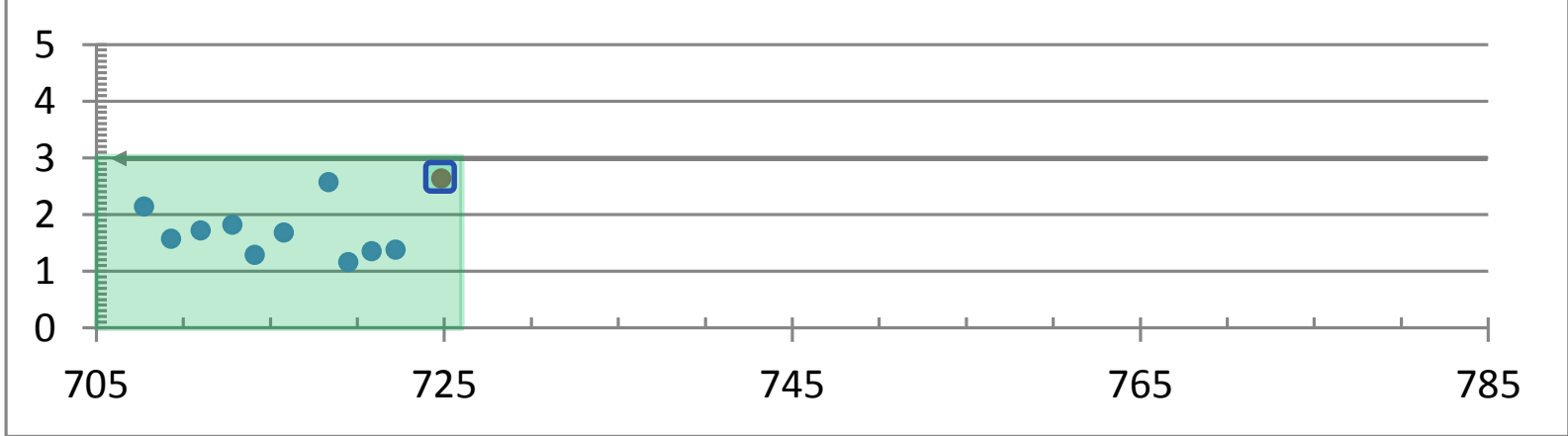
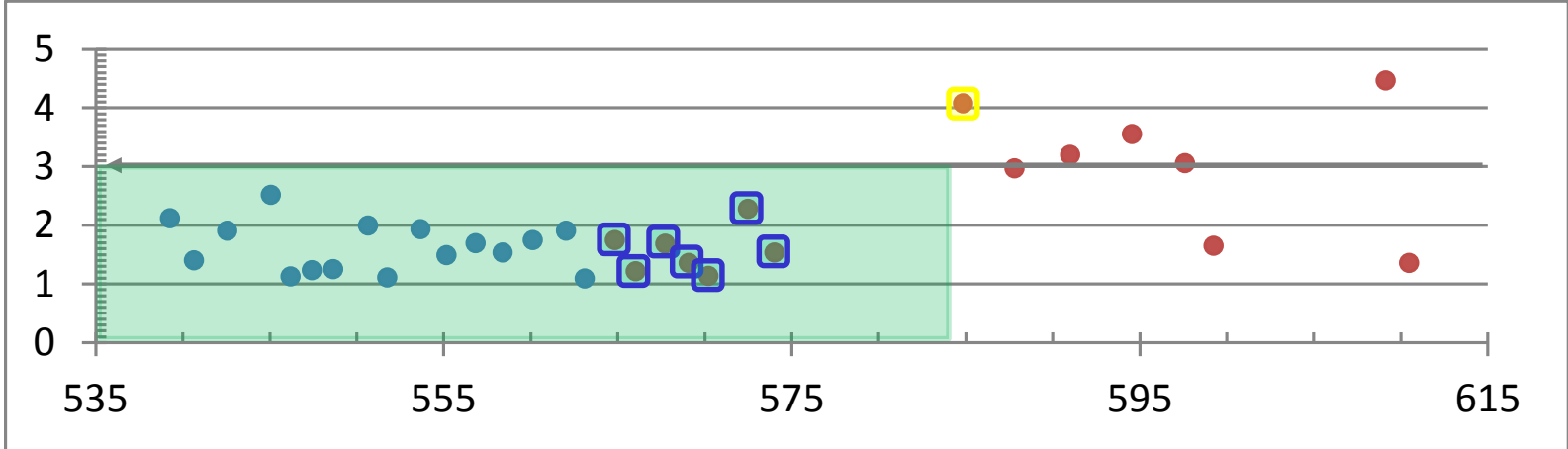
↑ Headway, sec



↑ Headway, sec

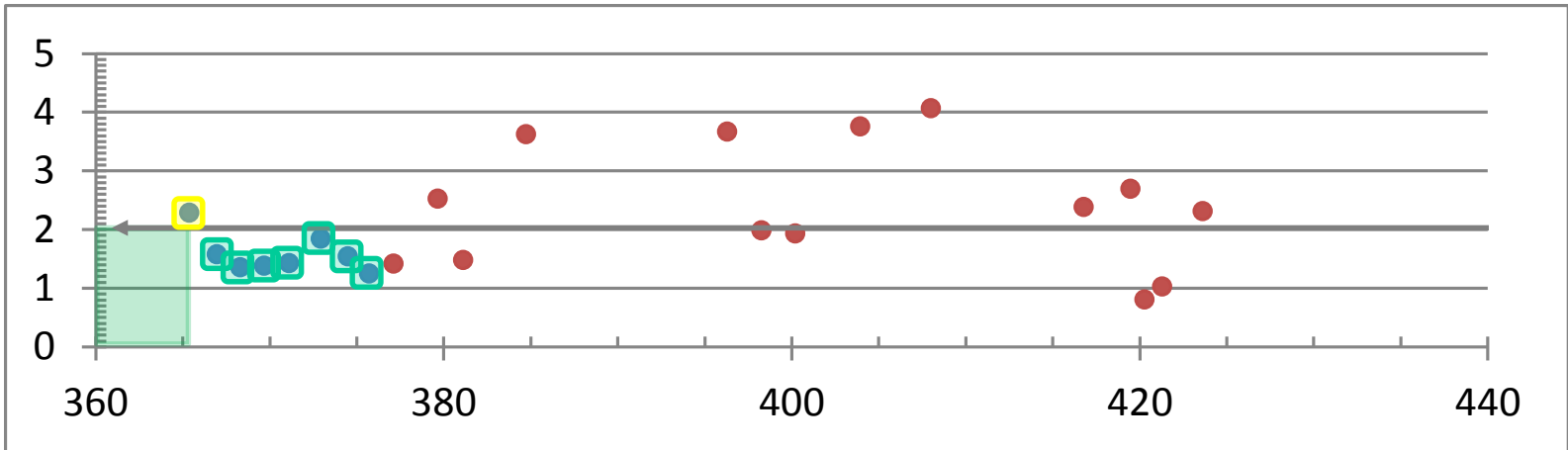


□ Type 2:  
Green extends too long

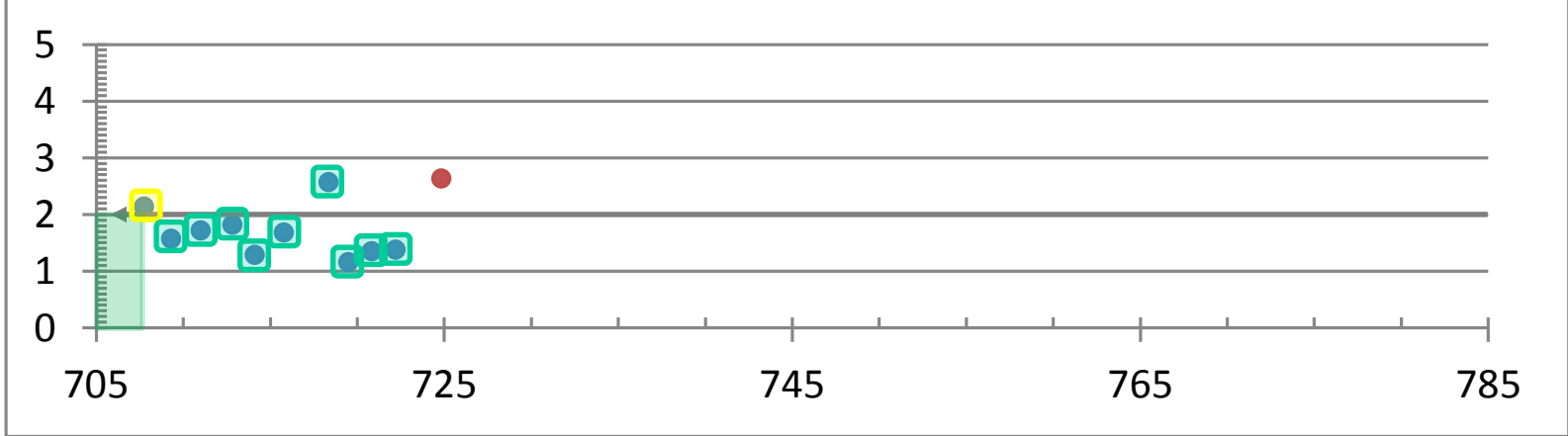
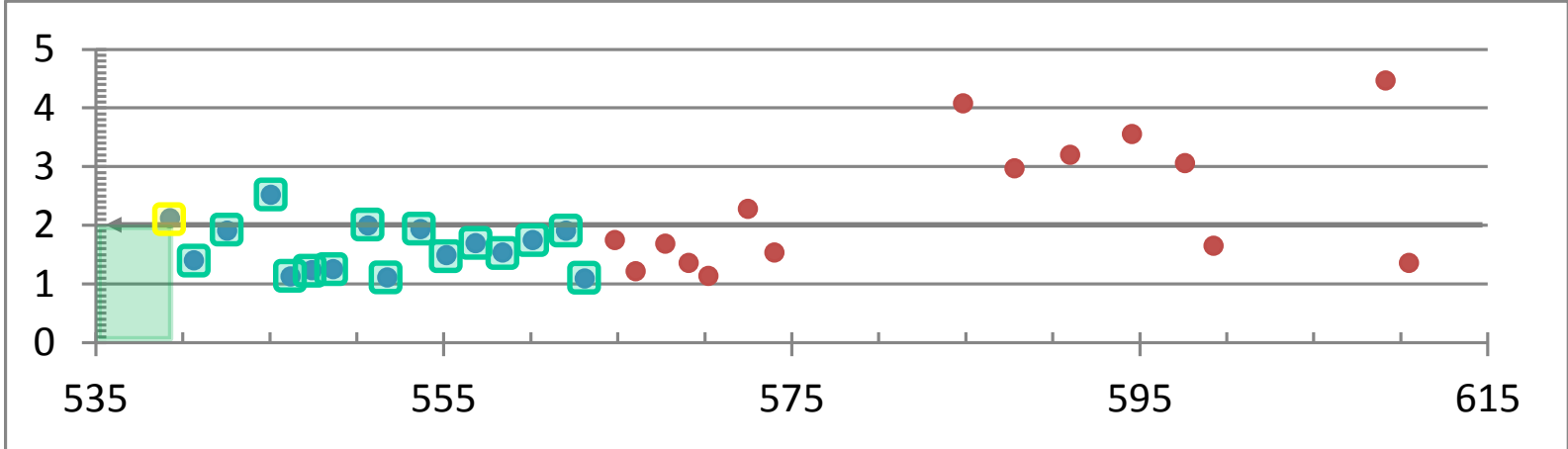


→ Time

↑ Headway, sec

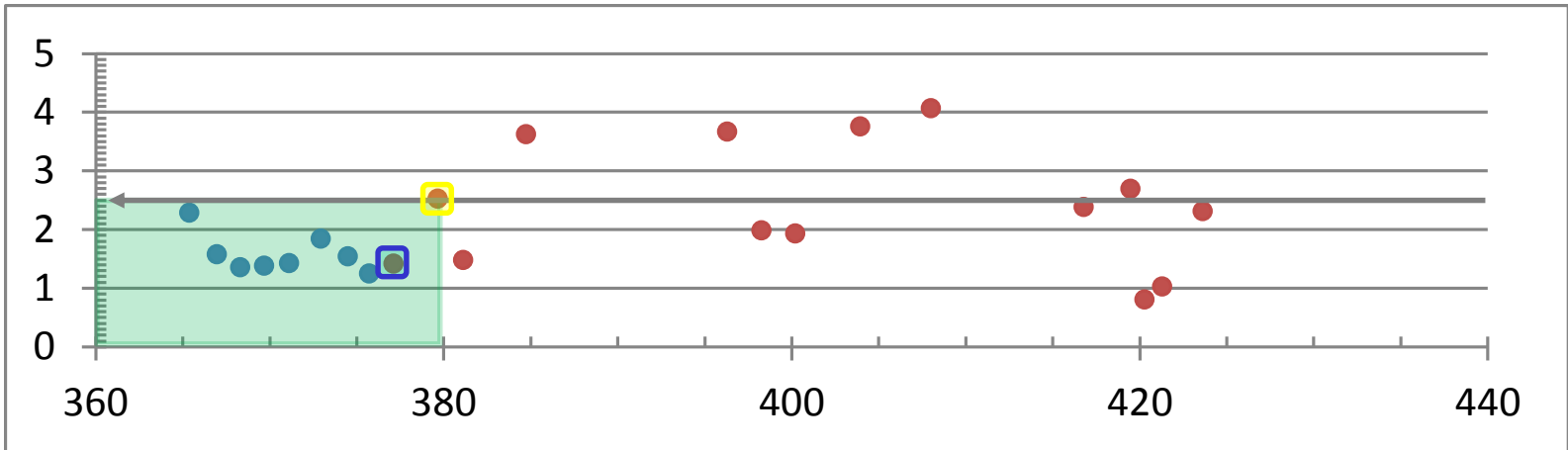


□ Type 1: Green ends too early



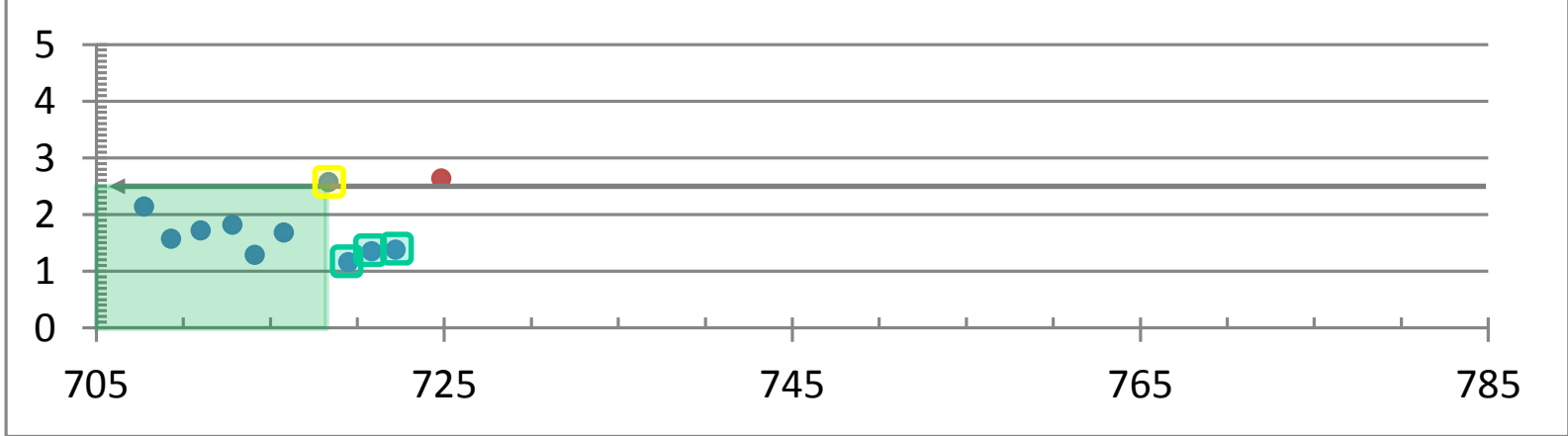
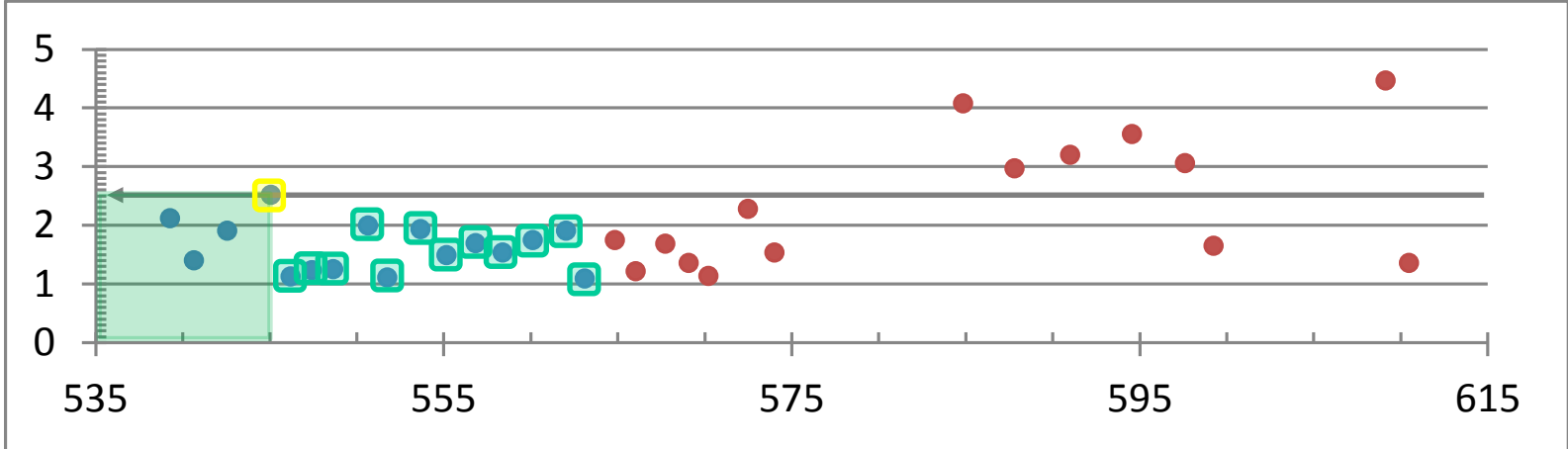
→ Time

↑ Headway, sec



■ Type 1:  
Green ends too early

■ Type 2:  
Green extends too long



→ Time