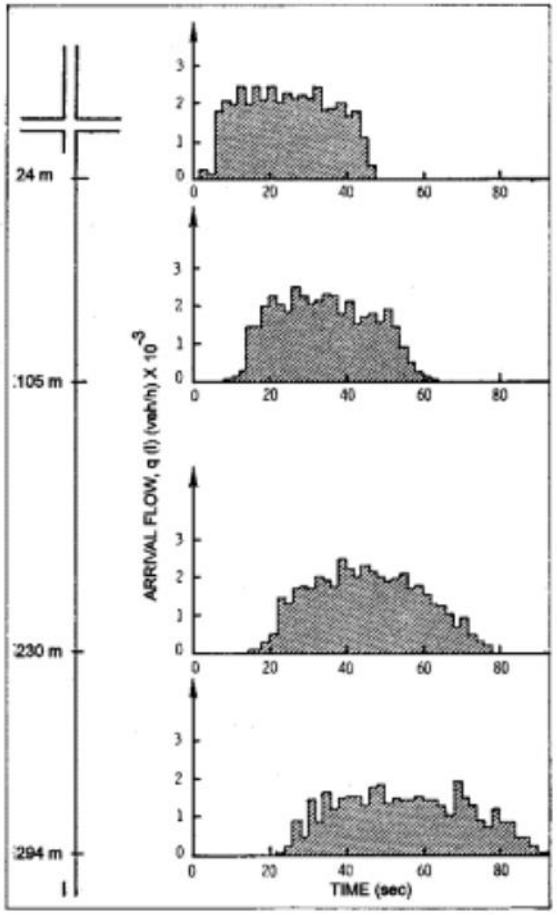
DISPERSION OF TRAFFIC QUEUES

CJ Bester & E Els

Stellenbosch University



Hillier and Rothery, 1967

Contents

- Overview
- Literature Study
  - Background
  - Shifted negative exponential distribution
- Methodology
- Data Analysis
- Conclusions and Recommendations

Overview

- Traffic queues disperse as they progress from the intersection
- Natural forming headways:
  - Time
  - Distance
- Dispersion distance is crucial for signal timing and cycle lengths
- Time headway distribution models provide accurate representation of queue behaviour and road capacity

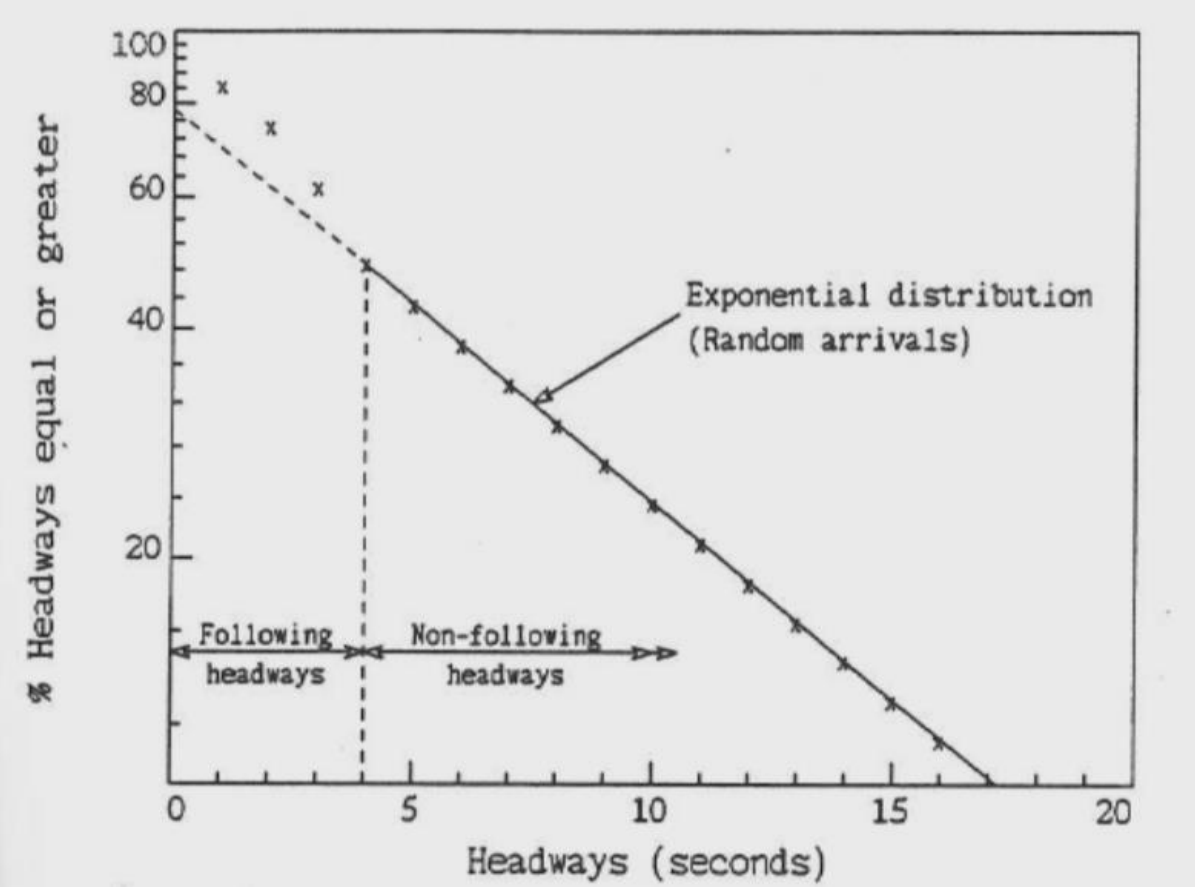
Literature study – background

- **Time headway is measured from the leading vehicle's nose to the following vehicle's, passing a specific point**

- **Time headway distribution models:**
  - **Single headway**
  - **Mixed headway**

Literature study – background

- Single headway distribution models:
  - Exponential
  - Normal
  - Gamma
  - Lognormal
- Mixed headway distribution models:
  - Semi-Poisson
  - Combined single statistical distributions
  - Followers and non-followers
  - Travelling queue distribution
- Shifted single headway models improves accuracy



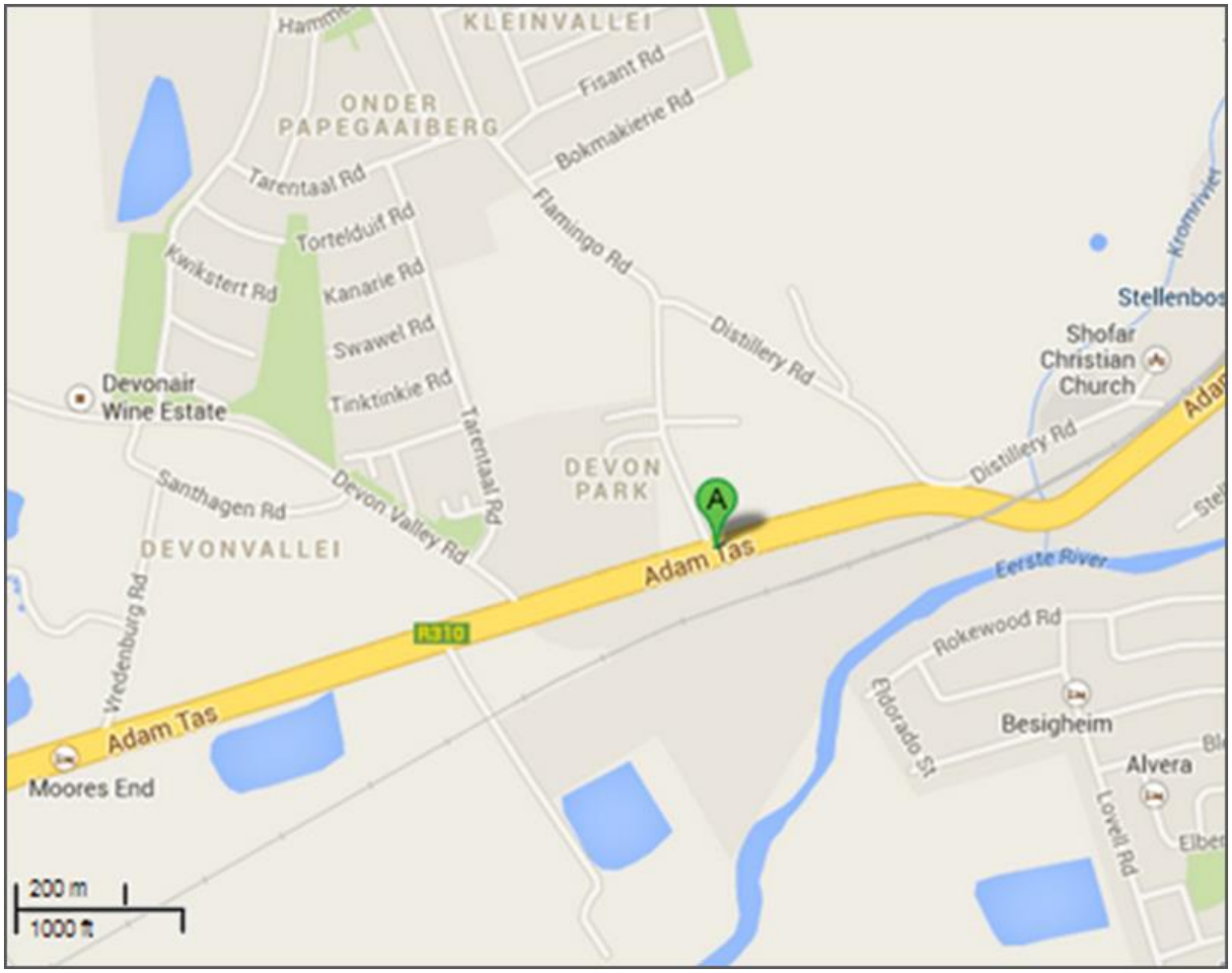
Van As & Joubert, 1990

Literature study – Queue dispersion

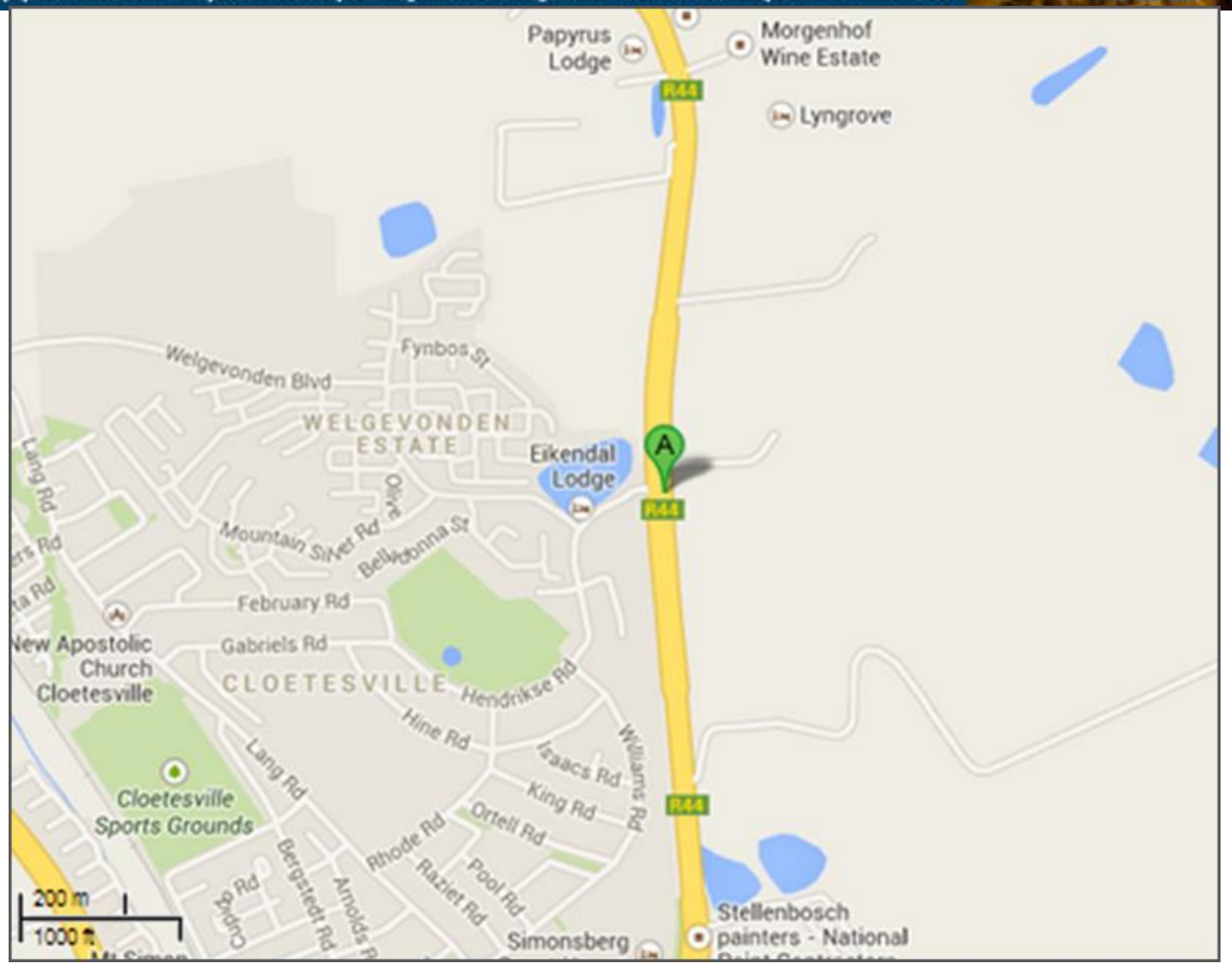
- Queue Dispersion Behaviour – Queues become less dense further from intersection
- Formulate separation point at 3.5 seconds
- Negative exponential model interpolated from vehicle follower behaviour graph
- Shifted negative exponential model acquired by shifting with the minimum time headway

Methodology

- GoPro Hero2 HD video cameras positioned at distances 500, 1000 and 1500m from intersection
- Recording times 07:30-08:30, 11:00-12:00 and 16:30-17:30
- Stopwatch application
- Time headways categorised into second intervals
- Plot vehicle follower behaviour graph
- Negative exponential distribution interpolated
- Shifted negative exponential distribution


KLEINVALLEI
ONDER PAPEGAAIBERG
Fisant Rd
Bokmakierie Rd
Tarentaal Rd
Torteldui Rd
Kwikstert Rd
Kanarie Rd
Swawel Rd
Tinktinkie Rd
Flamingo Rd
Distillery Rd
Devonair Wine Estate
Santhagen Rd
Devon Valley Rd
Tarentaal Rd
DEVON PARK
DEVONVALLEI
Vredenburg Rd
A
Adam Tas
R310
Adam Tas
Moores End
Eerste River
Rokewood Rd
Eldorado St
Besigheim
Alvera
Lovell Rd
Shofar Christian Church
Distillery Rd
Kromrivier
200 m
1000 ft

R310


Papyrus Lodge
Morgenhof Wine Estate
R44
Lyngrove
Welgevonden Blvd
Fynbos St
WELGEVONDEN ESTATE
Eikendal Lodge
A
Mountain Silver Rd
Belladonna St
February Rd
Gabriels Rd
New Apostolic Church Cloetesville
CLOETESVILLE
Hendrikse Rd
Hine Rd
Isaacs Rd
King Rd
Ortell Rd
Williams Rd
Lang Rd
Cloetesville Sports Grounds
Rhode Rd
Raziet Rd
Pool Rd
Bergzicht Rd
Simonsberg
Stellenbosch painters - National
200 m
1000 ft

R44

Data Analysis

- R310
  - Multi-lane
  - Many passing opportunities
  - Chaotic right lane (Daganzo,

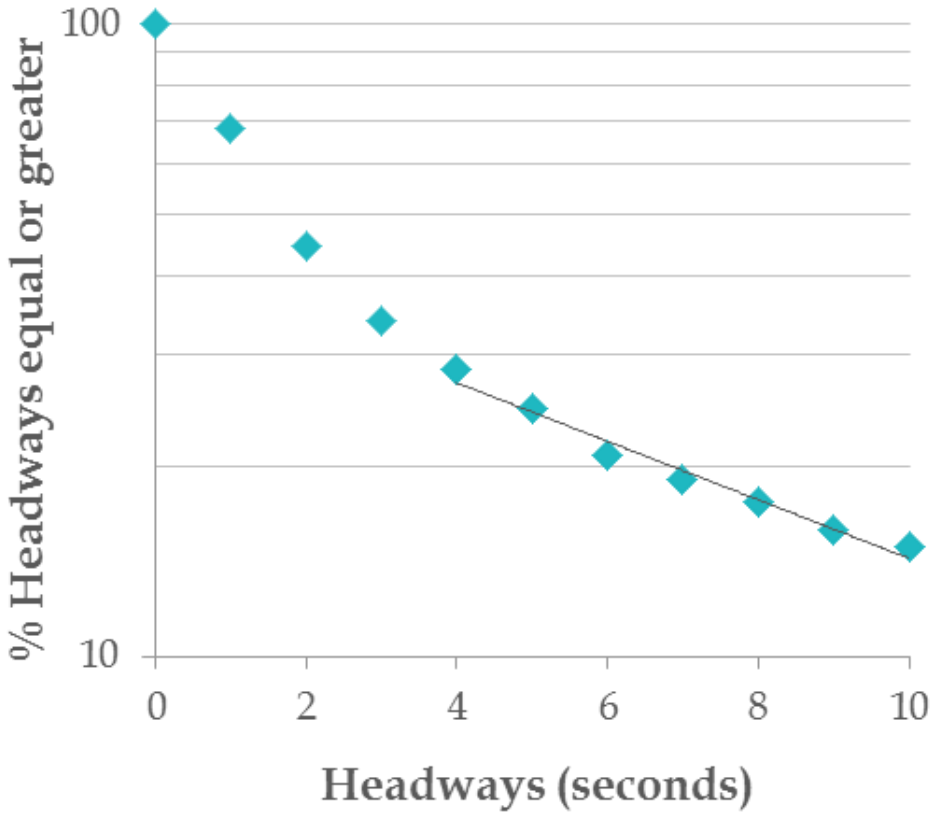
- R44
  - Two-lane
  - Few passing opportunities
- R44 has more accurate queue dispersion behaviour

Data Analysis

SEC. INTERVAL	QUANTITY	HEADWAYS EQUAL OR GREATER	% HEADWAYS EQUAL OR GREATER
0	1	342	100
1	107	234	68.42
2	82	152	44.44
3	36	116	33.92
4	19	97	28.36
5	13	84	24.56
6	13	71	20.76
7	6	65	19.01
8	5	60	17.54
9	6	54	15.79
10	3	51	14.91
NAN	51	0	0
TOTAL	342		

Data Analysis

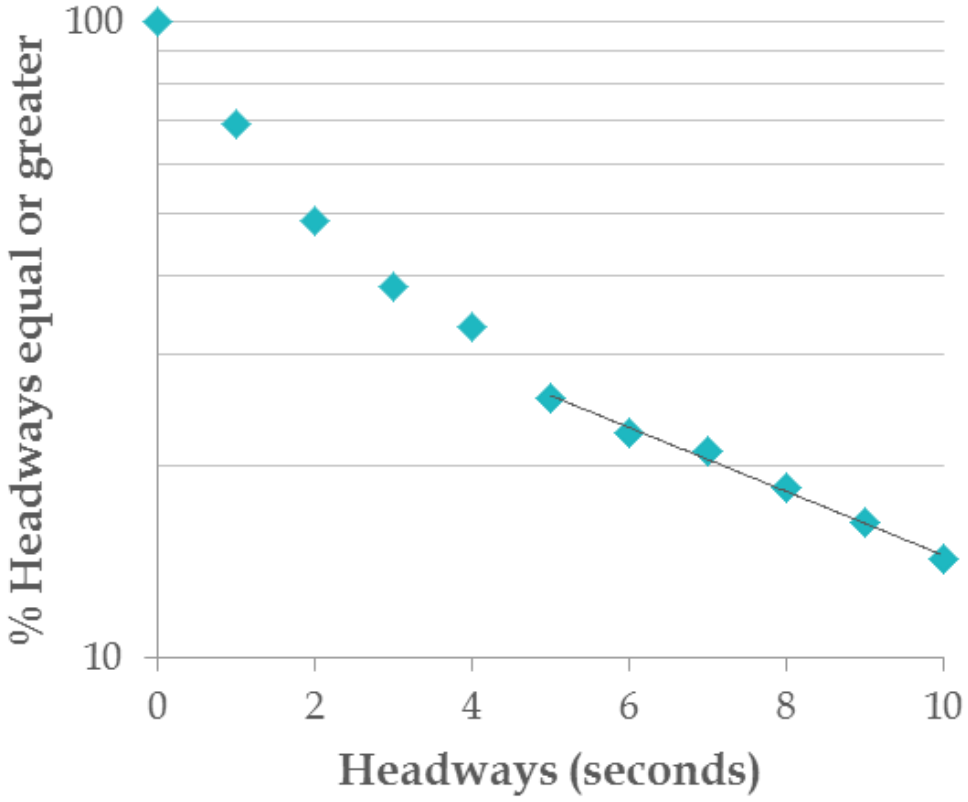
07:30 – 08:30



500m

Data Analysis

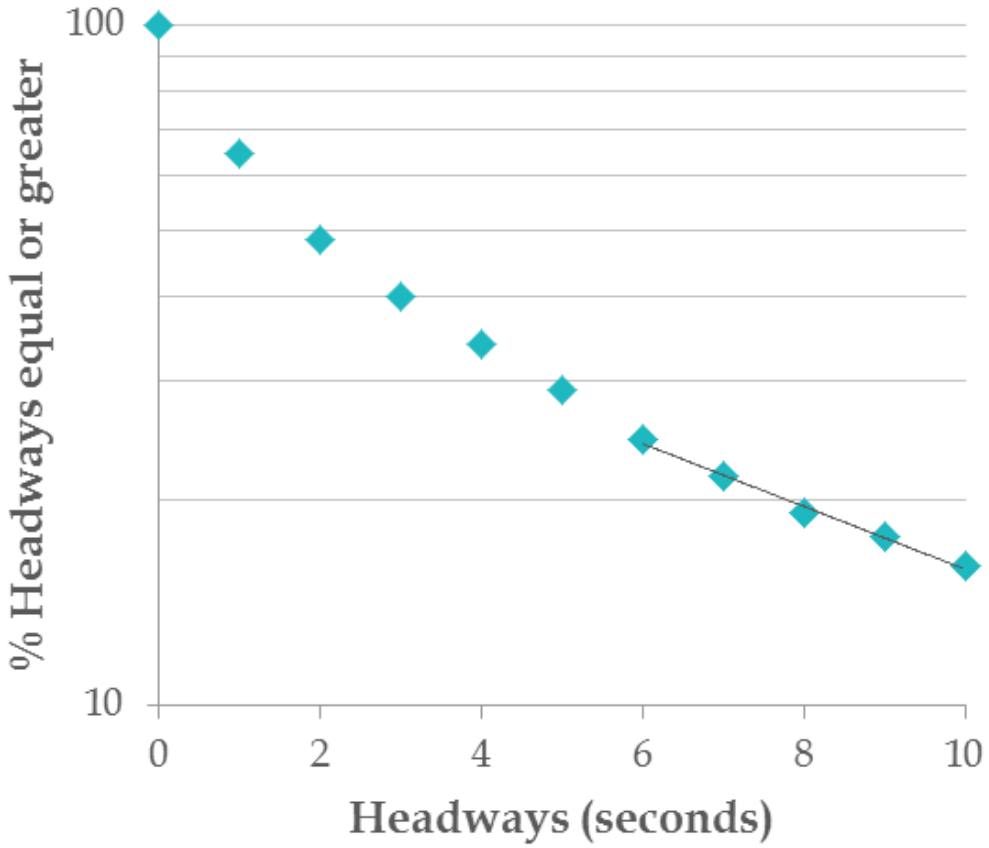
07:30 – 08:30



1 000m

Data Analysis

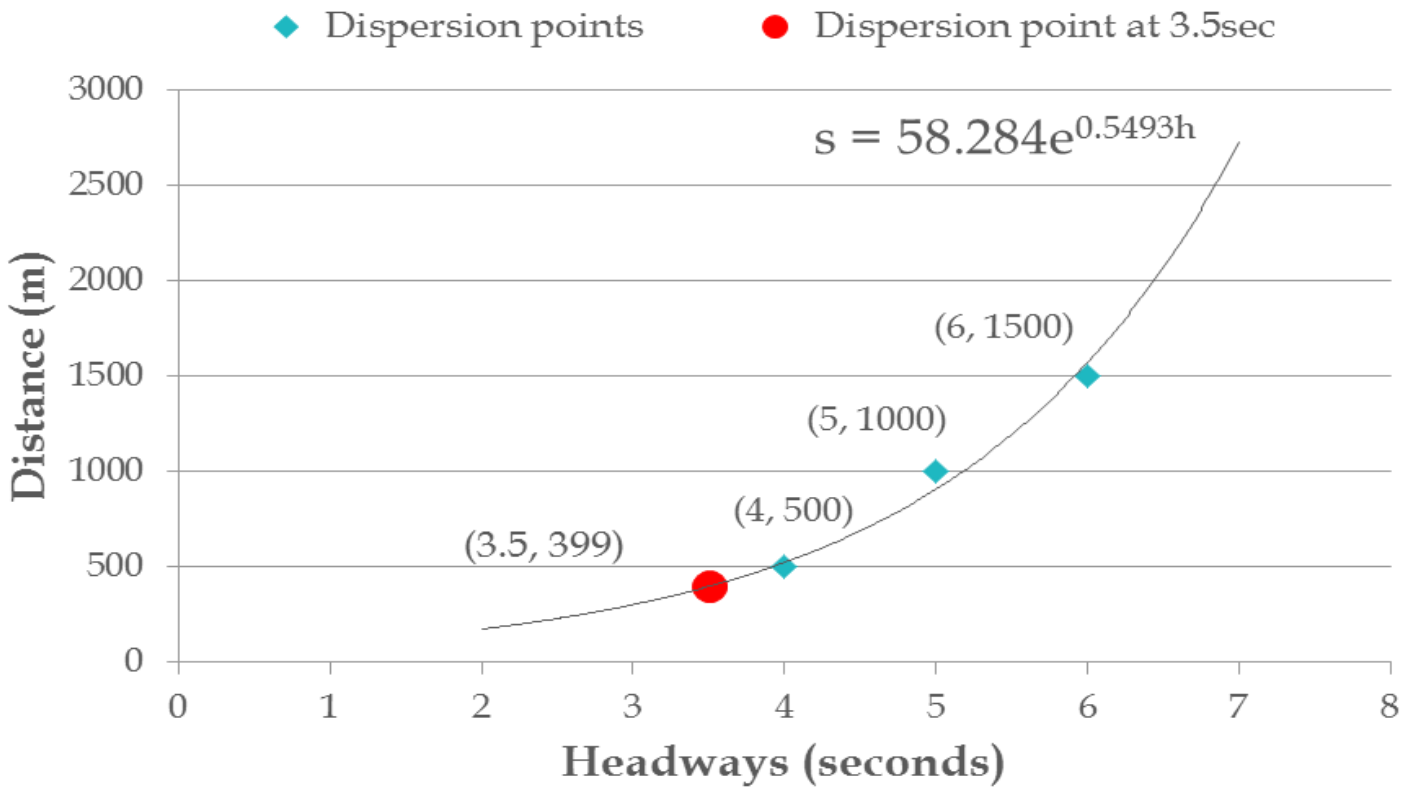
07:30 – 08:30



1 500m

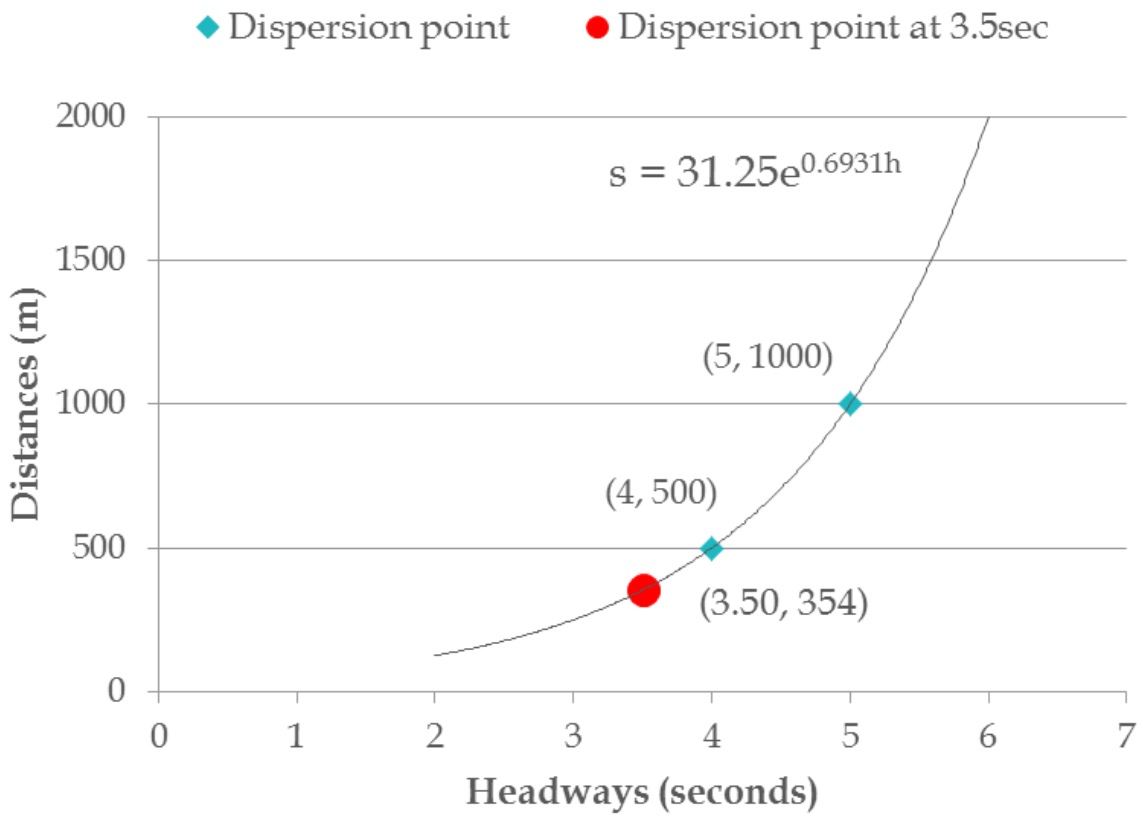
Results

07:30 – 08:30



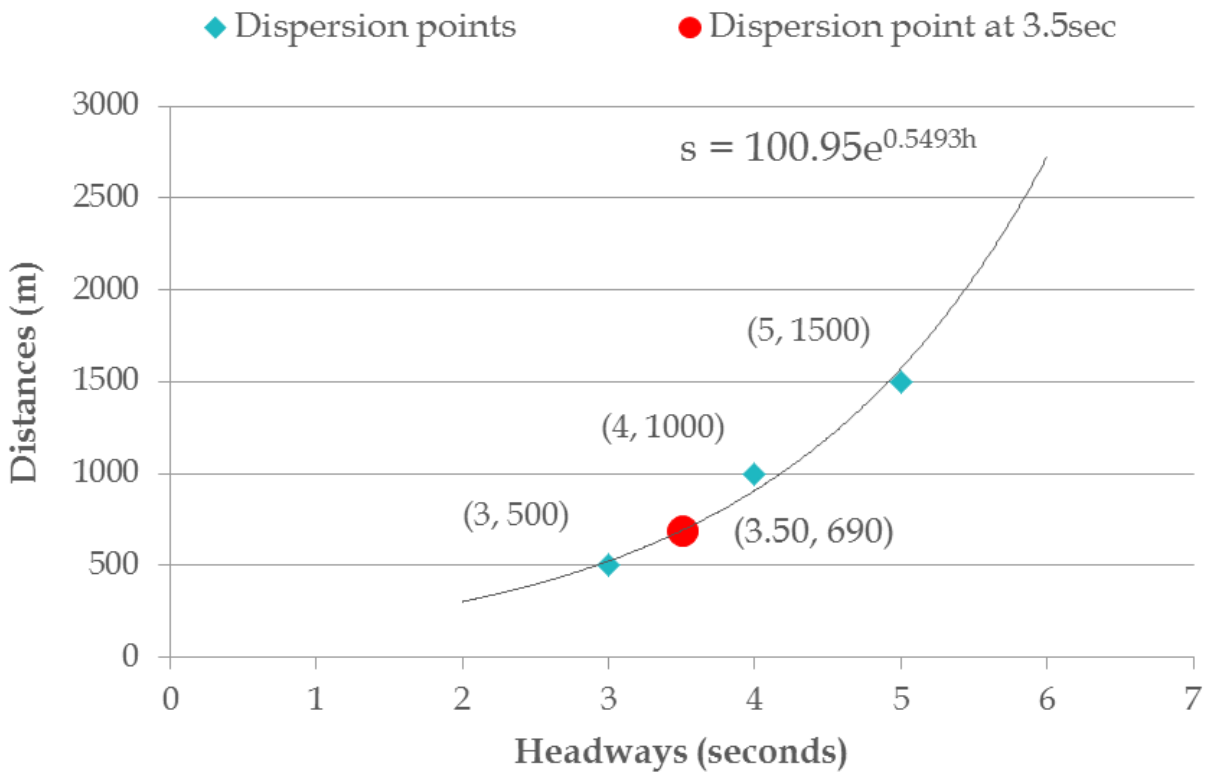
Results

11:00 – 12:00



Results

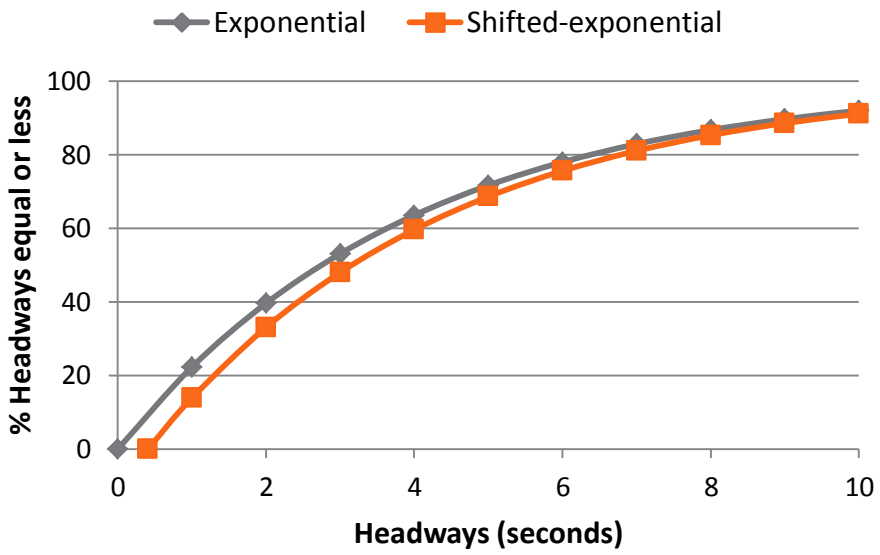
16:30 – 17:30



Shifted Negative Exponential Distribution

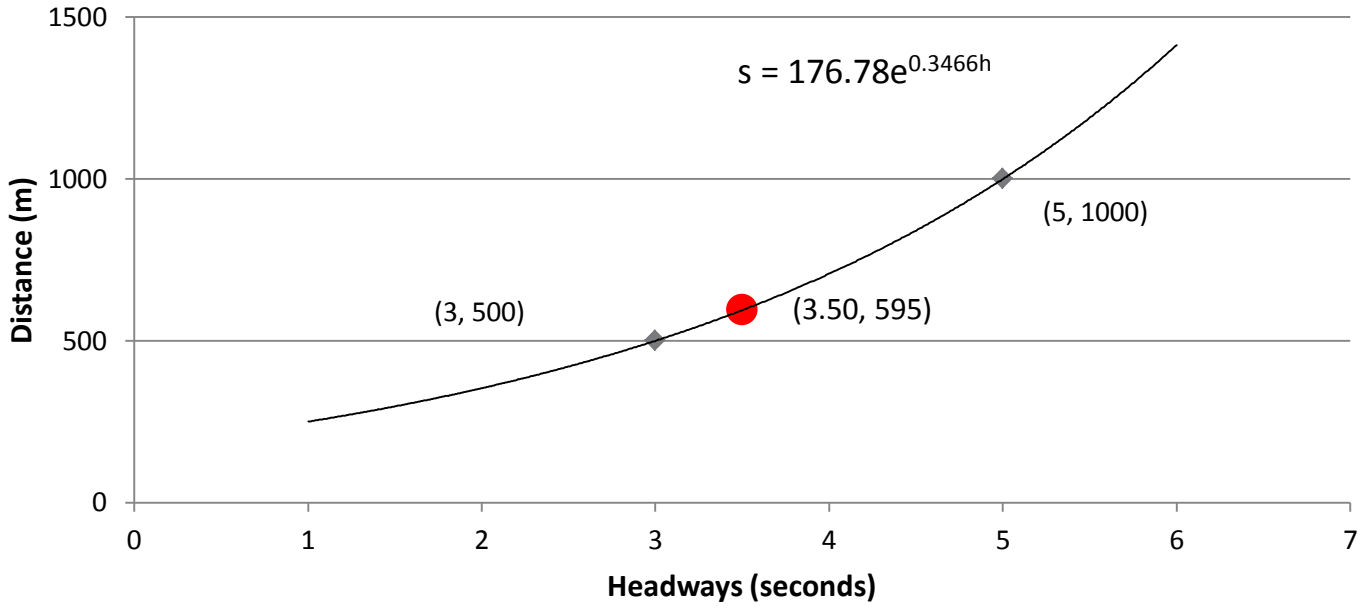
$$z = 100(1 - e^{-0.252t})$$

$$z = 100\left(1 - e^{-0.252(t-0.407)}\right)$$



R310 Results:

- Dispersion distance = 595m

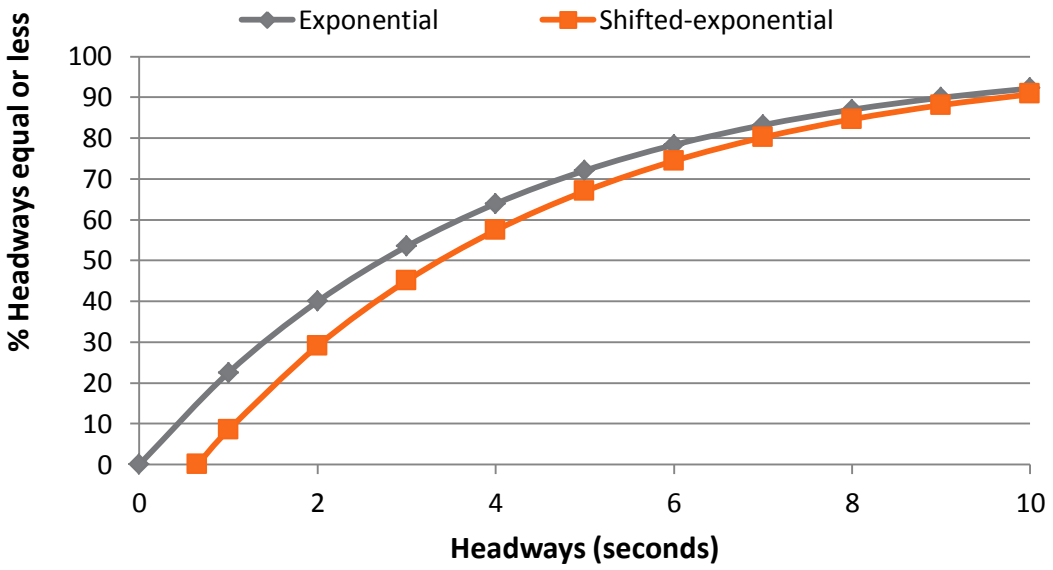


R310 Results:

- Time headway distribution models:

$$z = 100(1 - e^{-0.255t})$$

$$z = 100\left(1 - e^{-0.255(t-0.653)}\right)$$



Conclusions

- Dispersion distance is affected by:
  - Traffic flow & composition
  - Higher speed limits
  - Multilane roads
- The Shifted Negative Exponential Distribution gives a good fit of the data

Recommendations

- Larger data set
- Recording distance not more than 900m
- Shorter distance intervals between recordings

THANK YOU