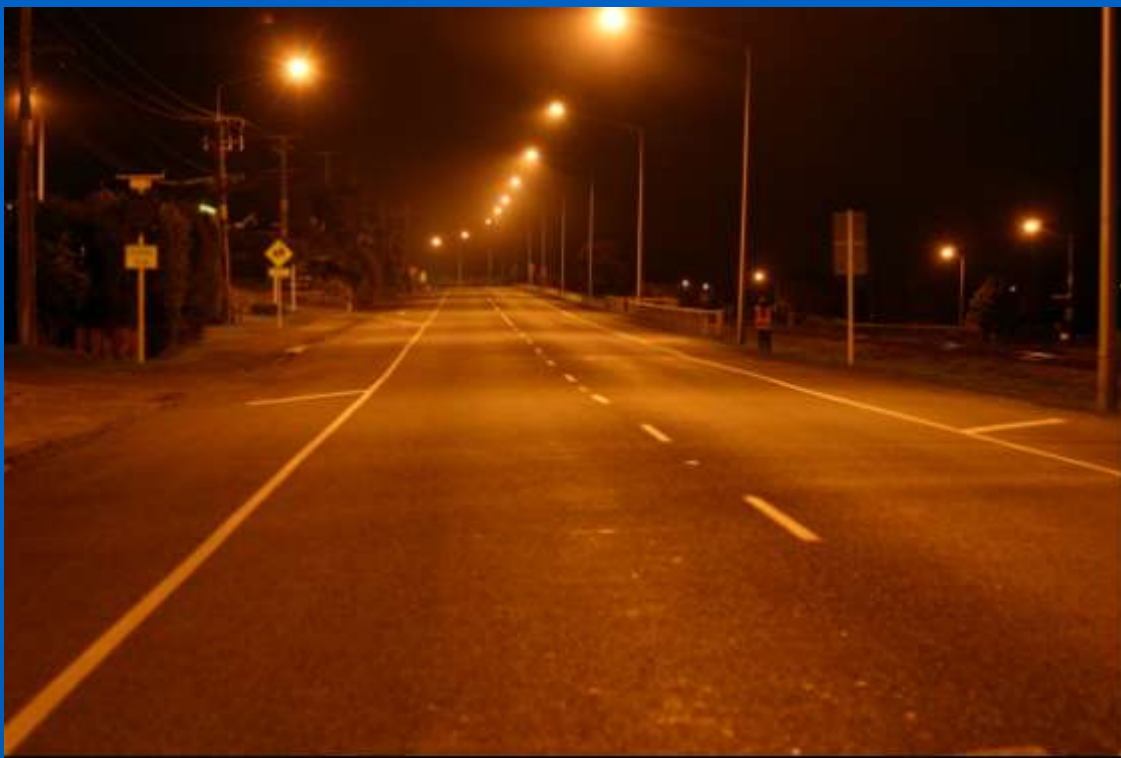


Reflection Properties of New Zealand Road Surfaces for Road Lighting Design

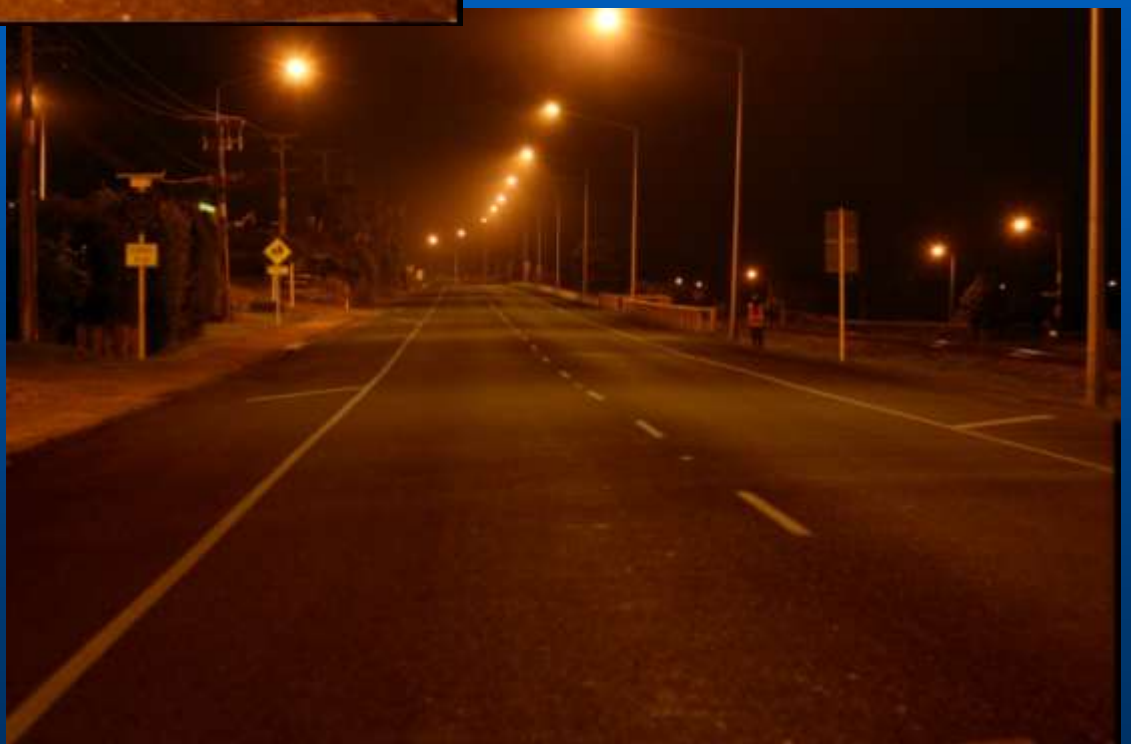
Mike Jackett Jackett Consulting and

Bill Frith Opus International Consultants, Central Laboratories

The objective of road safety lighting is to provide a bright road surface that allows drivers to see by silhouette.



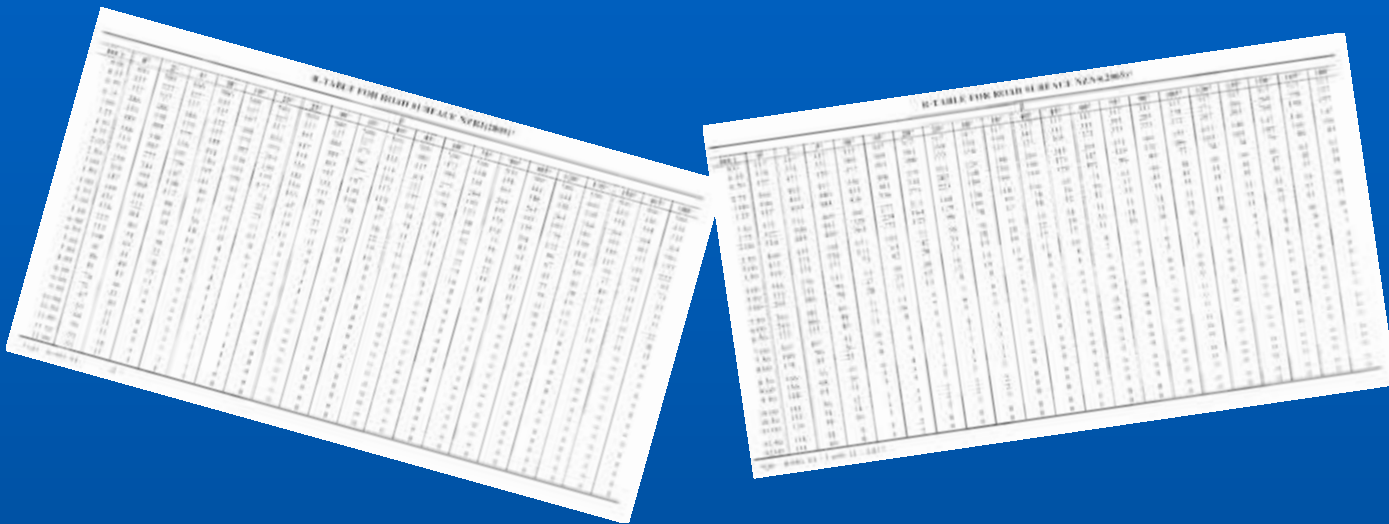
Light surface ($Q_0 = 0.09$)



Dark surface ($Q_0 = 0.05$)

R-tables

Lighting designers rely on “known” reflection properties of road surfaces (r-tables) to create a design.

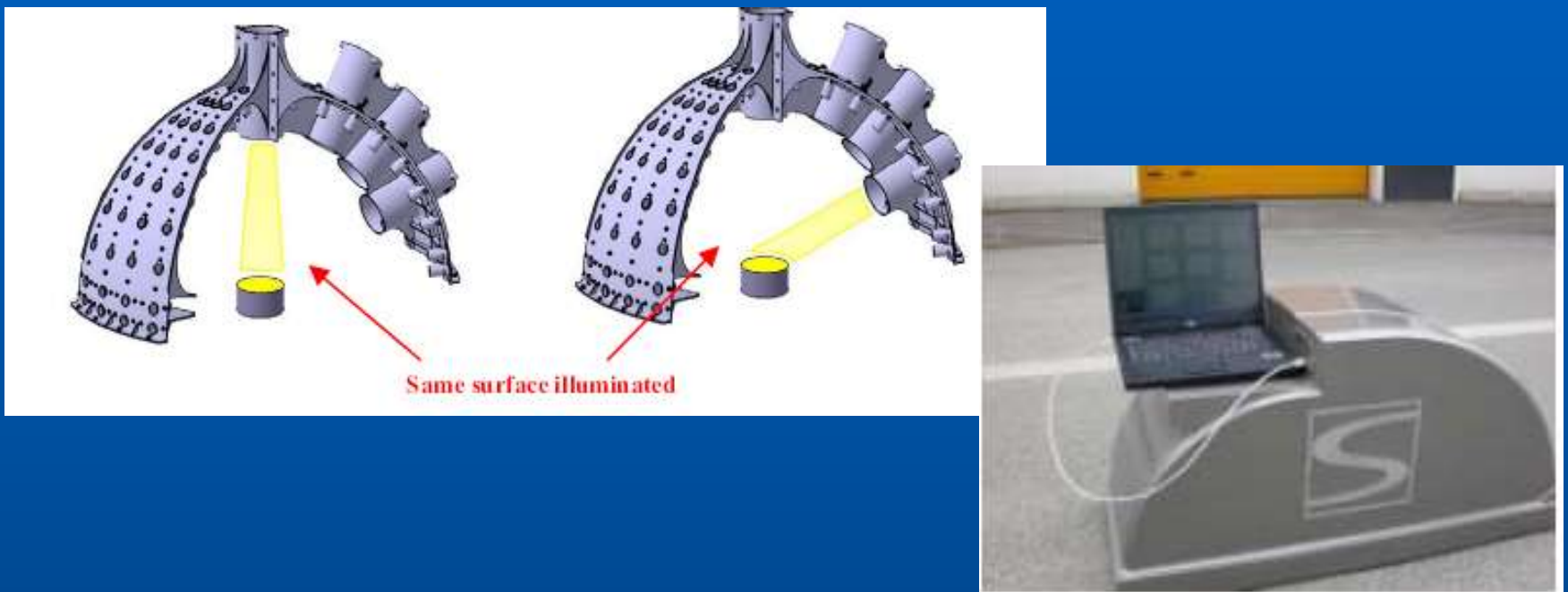
Two technical tables titled "R-TABLE FOR ROAD SURFACE MEASUREMENT" and "R-TABLE FOR ROAD SURFACE MEASUREMENT". They contain numerical data organized in columns and rows, likely representing reflection coefficients for different road surface conditions and measurement angles.

This study checked the accuracy of the current NZ r-tables (last measured 30 years ago) using a modern portable reflectometer from Europe, called Memphis.



Memphis

The Memphis reflectometer measured 180 different combinations of incident and reflection angles in just 15 seconds storing the results in a laptop.

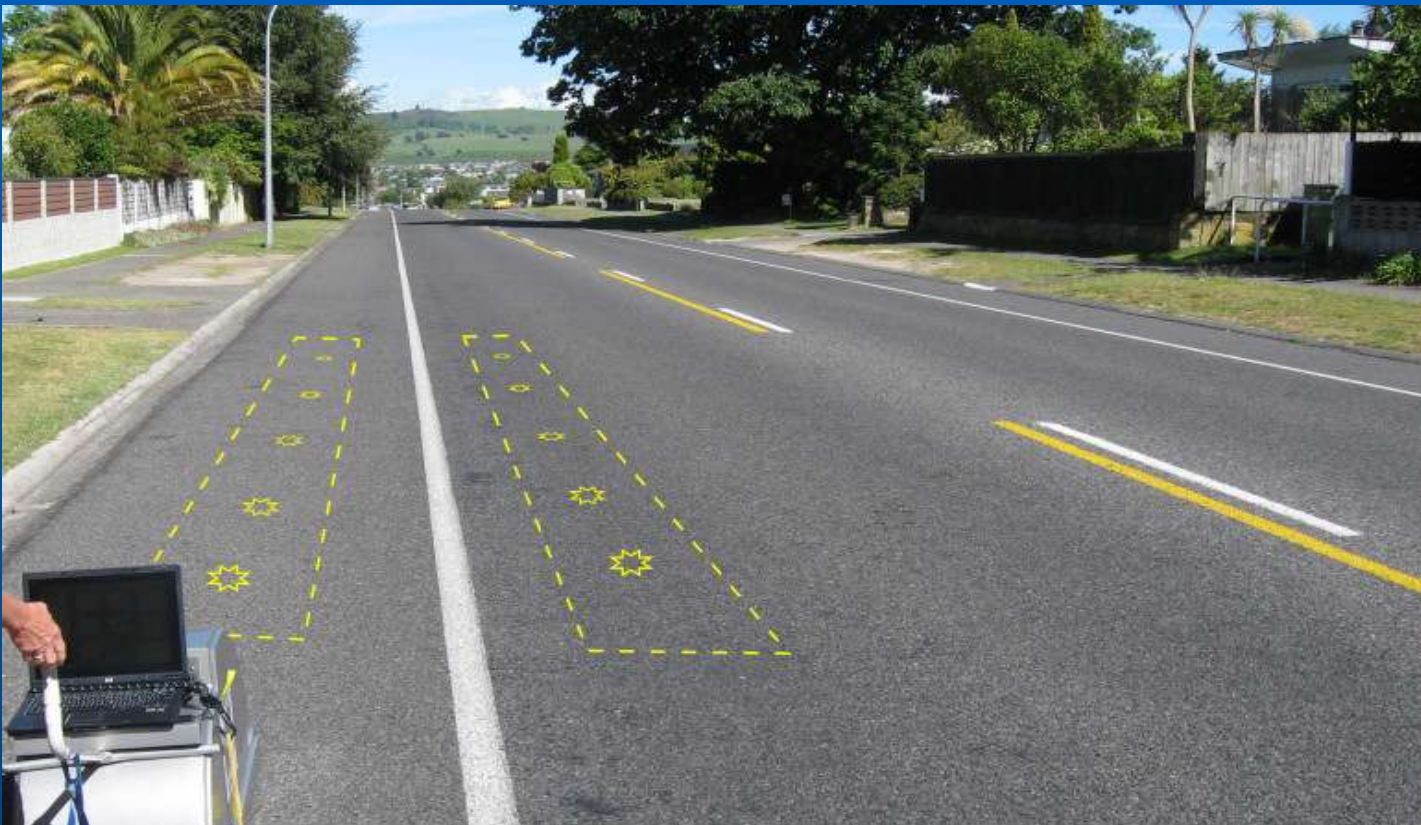


Calibration plates ensured Memphis remained in calibration from Europe and when travelling in NZ.



Measurements

A sample of 140 sites were selected in 10 RCAs.
In total 10 spot measurements were made at each site – 5 on the shoulder, 5 in the wheel track.



The data collected at each site included:

- GPS and street location
- Photos, site and road surface
- Surface type / chip size
- A set of ten spot measurements as above

Results

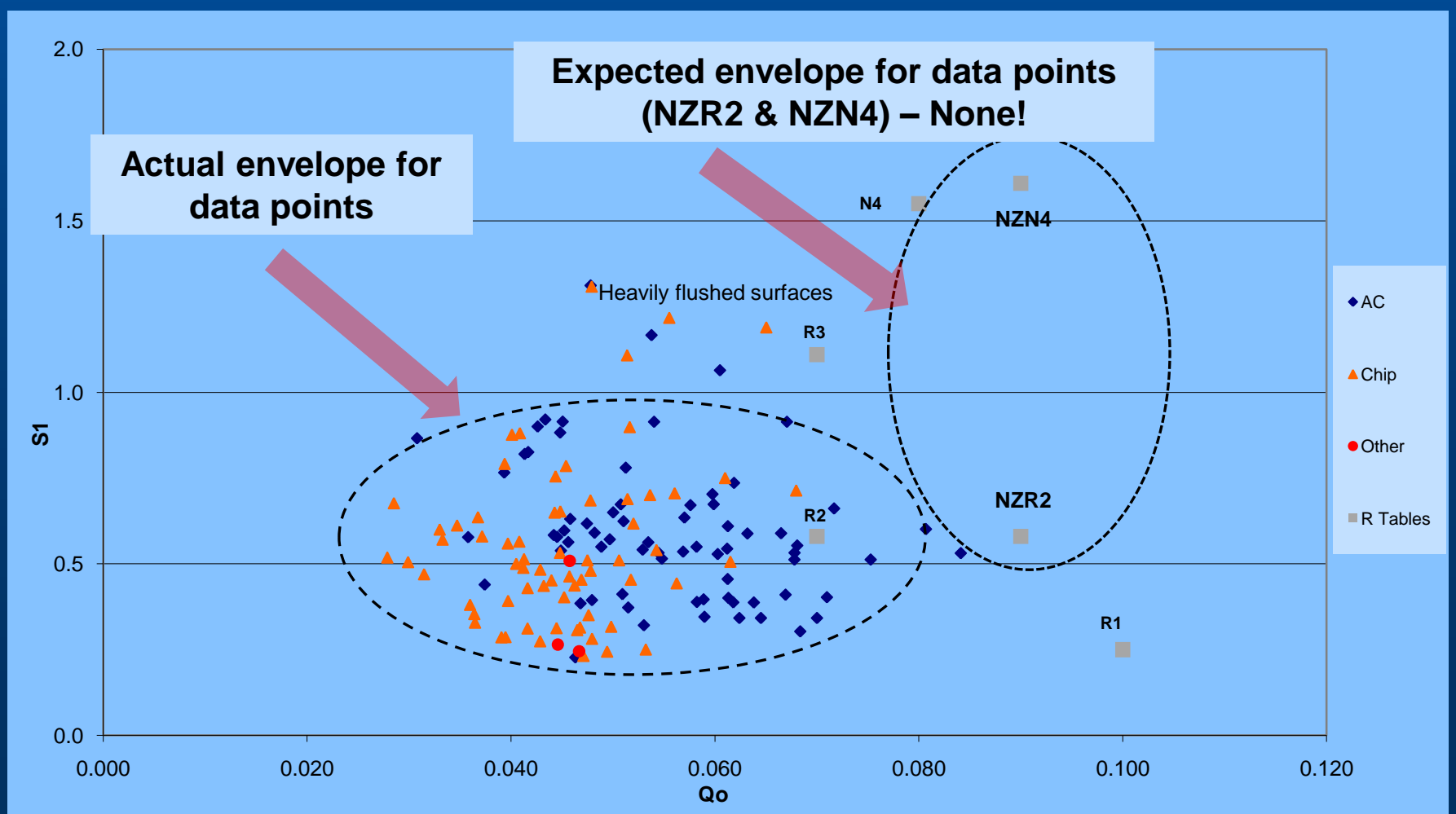
Reflection properties can be summarised using two parameters:

Q0 – Measures how well the surface reflects light

S1 - Measures specularity of the surface

The study results for Q0 and S1 are shown below.

	Q0	S1
Study Average	0.050	0.57
NZR2 (NZ r-table)	0.090	0.58
NZN4 (NZ r-table)	0.090	1.61



Results

Variation in Q0 and S1 by district

RCA	Average Q0	Average S1
Wellington CC	0.060	0.45
Porirua CC	0.054	0.48
Taupo DC	0.052	0.65
Lower Hutt CC	0.052	0.53
Christchurch CC	0.052	0.54
SH (Wgtn)	0.052	0.77
Kapiti Coast DC	0.050	0.47
Upper Hutt CC	0.049	0.45
Auckland CC	0.046	0.67
Hamilton CC	0.041	0.72
All sites	0.050	0.57

Across all surfaces Q0 varied by a ratio of 3:1 suggesting efficiencies if lighting can be designed to the actual surface Q0.



Observations

- The current New Zealand r-tables need updating
- The study results suggest our roads are darker (lower Q0) and less specular (lower S1) than indicated by the current r-tables
- Current road lighting designs are likely to be
 - underachieving on luminance (-45%)
 - producing higher disability glare (+60%)
 - overachieving on uniformity (+15%)
- Chip seal surfaces usually require more light than AC surfaces to achieve the same luminance level
- Surface wear (from traffic polishing and surface flushing) tends to increase both Q0 and S1

Conclusions

- Current r-tables overstate road brightness and understate glare
- The best fit r-table for NZ would be the CIE R2 table with a Q0 of 0.05
- Designing to the r-table above could increase lighting costs by around 50% but may also bring greater crash savings.
- Greater knowledge of the variation in reflection properties both nationally and locally could promote design efficiencies.