



**Asia-Pacific
Economic Cooperation**

2017/TPTWG/WKSP1/007

Overview of Technology Responses to Overloading

Submitted by: Australia



**Workshop on Regulating High Mass Heavy Road
Vehicles for Safety, Productivity and Infrastructure
Outcomes
Brisbane, Australia
3-6 April 2017**

Overview of Technology Responses to Overloading

APEC Transportation Working Group Workshop – 3 April 2017

Geoff Smith Manager (TSDM)

Our values, our diversity



Customers
first



Unleash
potential



Be
courageous



Ideas into
action



Empower
people





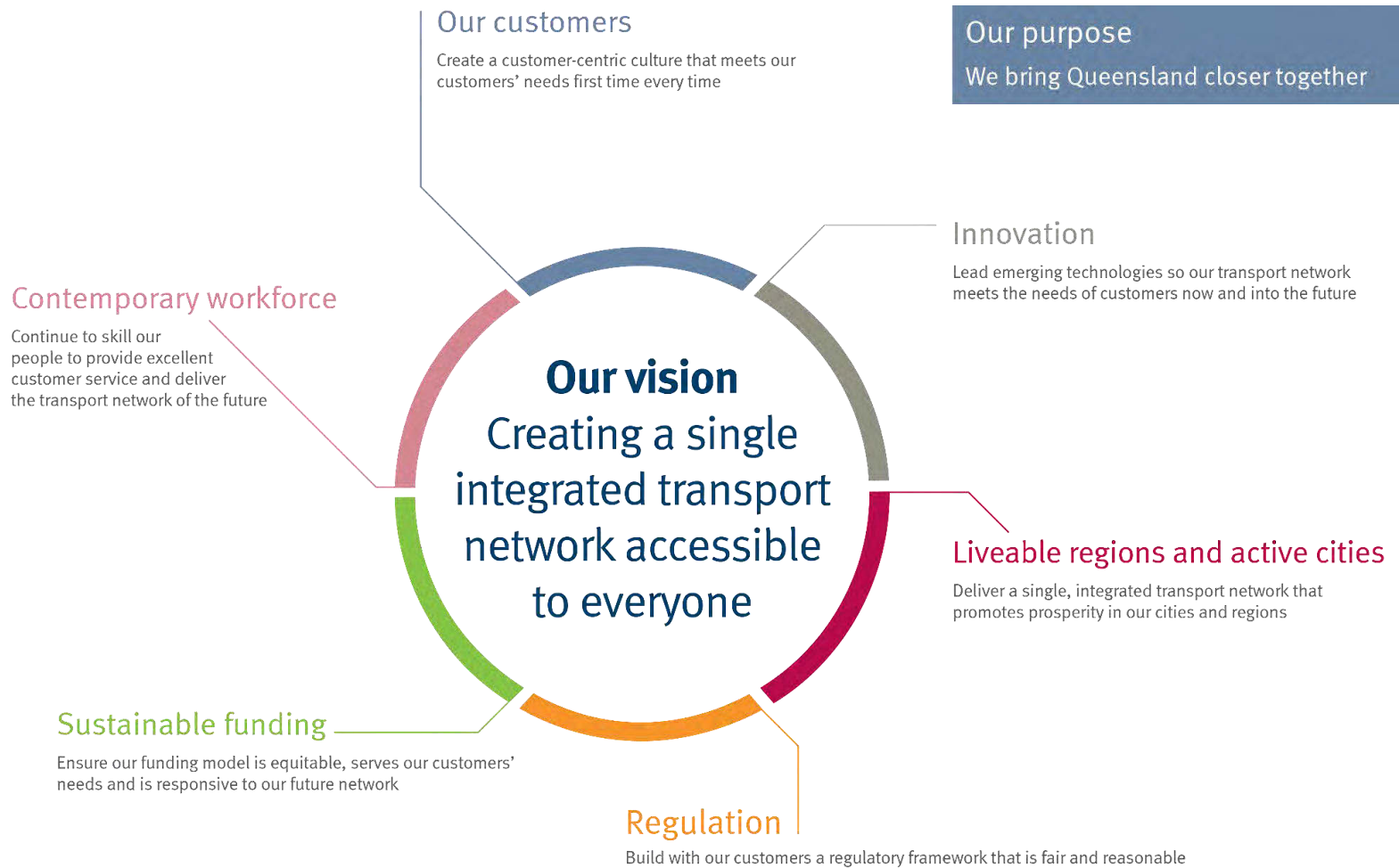
Queensland Government's objectives for the community

Advance Queensland

**ADVANCE
QUEENSLAND**



Our strategic plan



About us...

Creating a single integrated transport network accessible to everyone

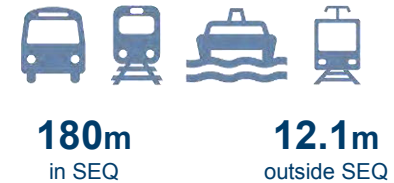
As at 30 June 2016 we manage:



As at 30 June 2016:



As at 30 June 2016 there were:



trips taken annually on bus,
rail, ferry and light rail



Heavy Vehicle Compliance



Cost of Overloading

- An assessment of the impact of overloading on the road asset was estimated as an extra \$30m-\$45m per annum (in 1999\$). It was also noted that the estimated efficiency gains for new works for that year was \$80m.
- In effect half of the network efficiency gains were being lost to accelerated asset damage

Cost of Overloading

- As a general rule, a 1 year reduction in pavement life (from a 20 year design life) can be expected for every 1% increase in overloading
- Current industry design and load/damage calculations indicate that:
 - For unbound pavements – a 20% overload is 2 times more damaging than the legal load
 - For asphalt pavements – a 20% overload is between 3 – 4 times more damaging than the legal load
 - For cement pavements – a 20% overload is between 9 – 10 times more damaging than the legal load

Key Technologies

Weigh in Motion (WiM)



Weighbridge

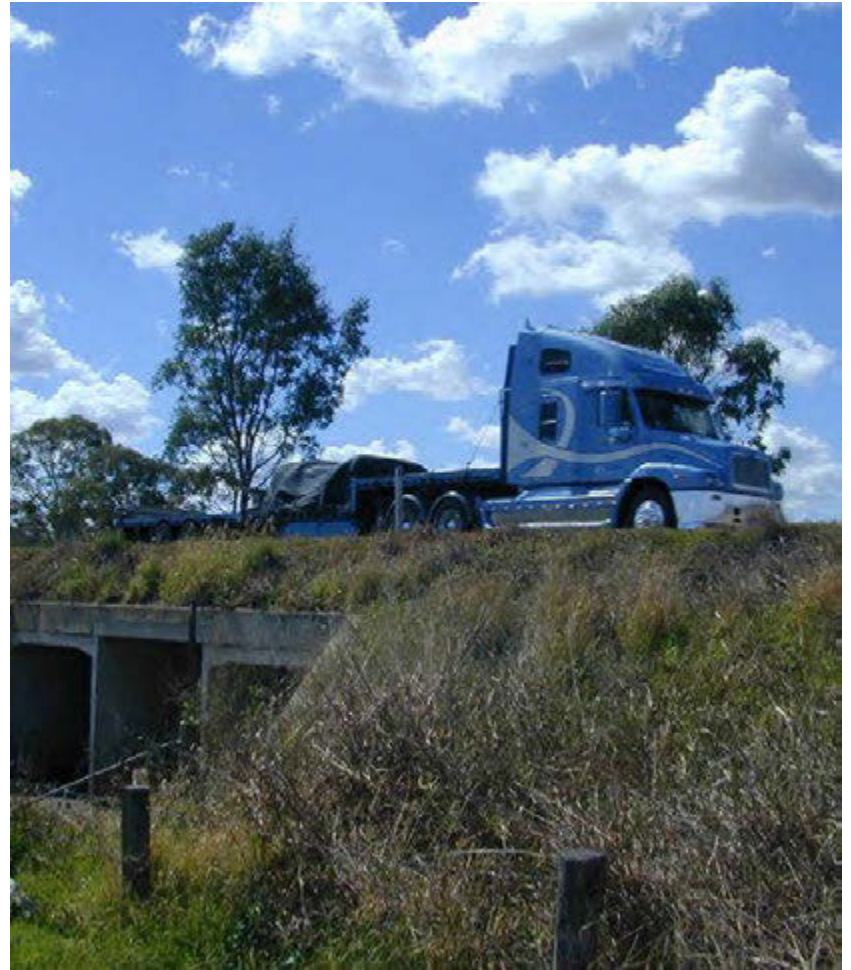


ANPR Camera



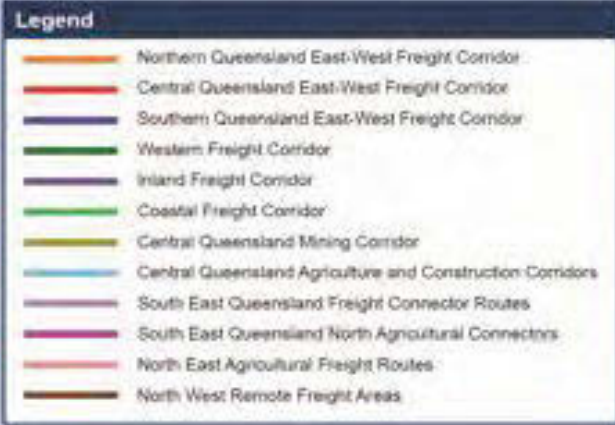
Weigh in Motion (WiM)

- Austroads (2000) defined Weigh in Motion (WiM) as a device that measures the dynamic axle mass of a moving vehicle to estimate the corresponding static axle mass



Weigh in Motion (WiM) Site Strategy

- Key freight routes
- Cordon lines around freight generators or hubs such as ports, freight depots and mines
- Entry/exits to adjacent state borders
- Supporting interception sites as a pre-selection tool
- Protection of susceptible pavements and bridges
- Sites delivered under major projects to inform a pavement maintenance contract



Key Freight Routes

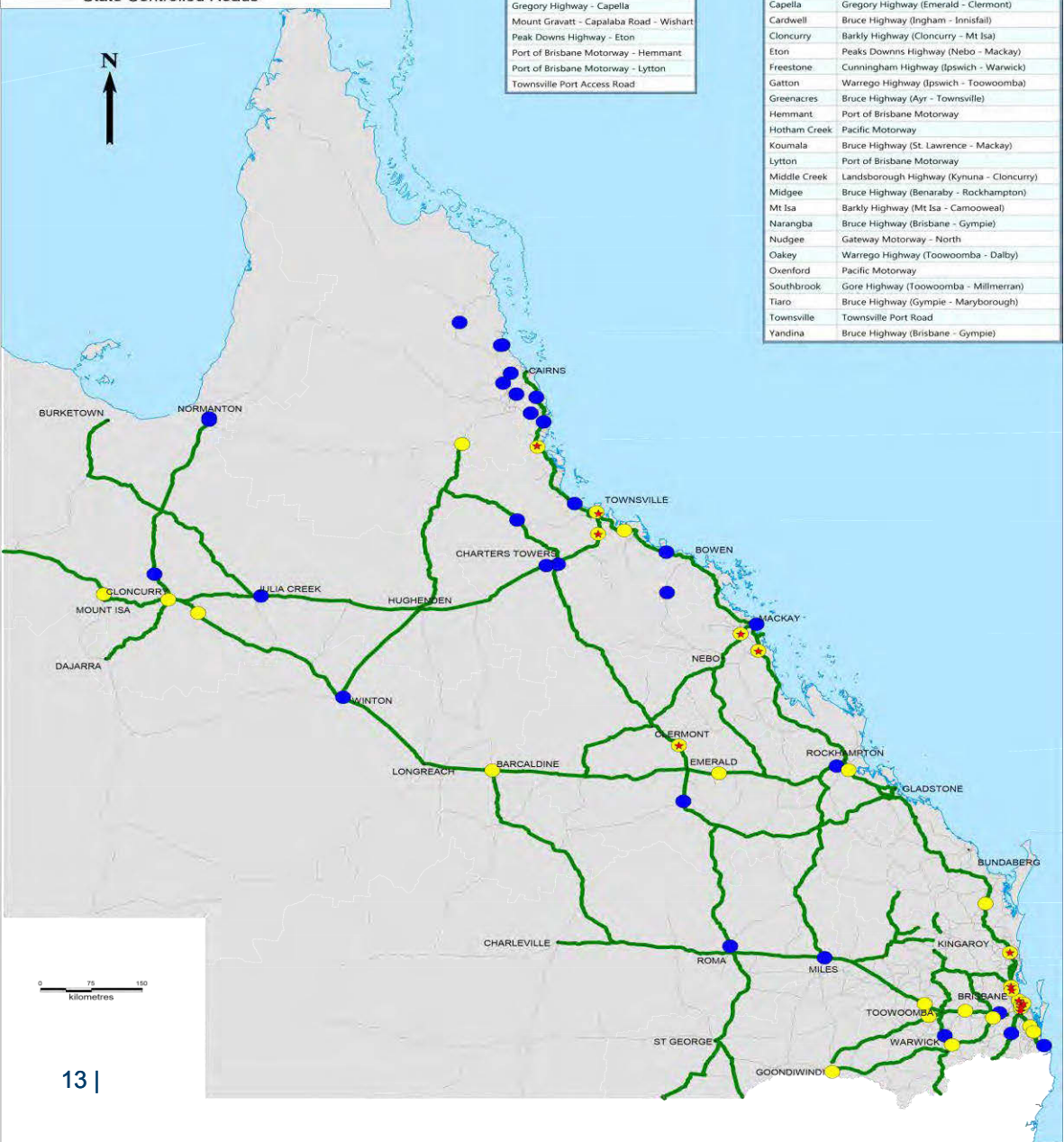


- Legend**
- ★ ANPR Sites
 - Priority 1 WiM Sites
 - Priority 2 WiM Sites
 - Priority Freight Corridors
 - State Controlled Roads

ANPR Sites	
Bruce Highway - Burpengary	
Bruce Highway - Cardwell	
Bruce Highway - Koumala	
Bruce Highway - Narangba	
Bruce Highway - Yandina	
Flinders Highway - Calcium	
Gateway Motorway - Belmont	
Gateway Motorway - Nudgee	
Gregory Highway - Capella	
Mount Gravatt - Capalaba Road - Wishart	
Peak Downs Highway - Eton	
Port of Brisbane Motorway - Hemmant	
Port of Brisbane Motorway - Lytton	
Townsville Port Access Road	

PRIORITY WiM SITES	
40 Mile Scrub	Kennedy Highway (Mt Garnet - The Lynd)
Amberley	Cunningham Highway (Ipswich - Warwick)
Barcardine	Landsborough Highway (Barcardine - Longreach)
Belmont	Gateway Motorway - South
Boggabilla	Newell Highway
Bore Creek	Capricorn Highway (Duaringa - Emerald)
Burpengary	Bruce Highway (Brisbane - Gympie)
Calcium	Flinder Highway (Townsville - Charters Towers)
Capella	Gregory Highway (Emerald - Clermont)
Cardwell	Bruce Highway (Ingham - Innisfail)
Cloncurry	Barkly Highway (Cloncurry - Mt Isa)
Eton	Peaks Downs Highway (Nebo - Mackay)
Freestone	Cunningham Highway (Ipswich - Warwick)
Gatton	Warrego Highway (Ipswich - Toowoomba)
Greenacres	Bruce Highway (Ayr - Townsville)
Hemmant	Port of Brisbane Motorway
Hotham Creek	Pacific Motorway
Koumala	Bruce Highway (St. Lawrence - Mackay)
Lytton	Port of Brisbane Motorway
Middle Creek	Landsborough Highway (Kynuna - Cloncurry)
Midjee	Bruce Highway (Benaraby - Rockhampton)
Mt Isa	Barkly Highway (Mt Isa - Camooweal)
Narangba	Bruce Highway (Brisbane - Gympie)
Nudgee	Gateway Motorway - North
Oakey	Warrego Highway (Toowoomba - Dalby)
Oxenford	Pacific Motorway
Southbrook	Gore Highway (Toowoomba - Millmerran)
Tiaro	Bruce Highway (Gympie - Maryborough)
Townsville	Townsville Port Road
Yandina	Bruce Highway (Brisbane - Gympie)

Location of WiM Sites



Heavy Vehicle Interception Site





Entrance to Weigh Station

WiM Site

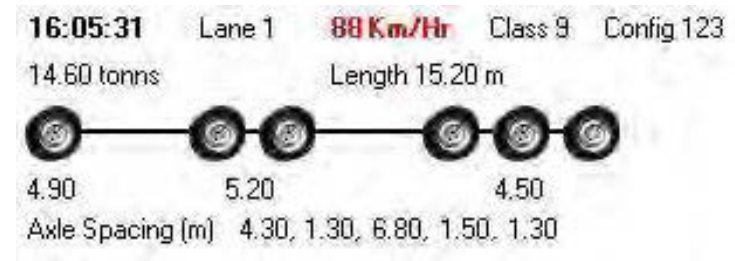


TMR Weigh Station

20. 2. 2004

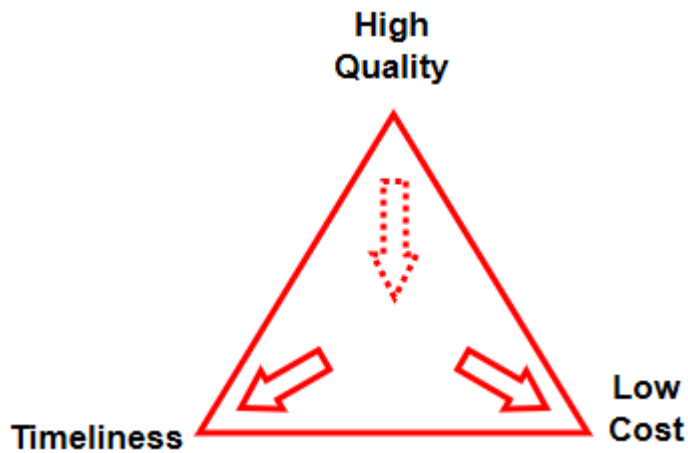
WiM Data Types

- Vehicle Configuration
- Austroads Vehicle Class
- Speed
- Axle Spacings
- Axle Group Mass
- Gross Vehicle Mass



Data Strategy

- Choose from:
 - High quality
 - Low cost
 - Timely to implement



WiM - Data Utilisation

1. Asset Preservation

- Compliance programming
- Vehicle selection

2. Asset Management

- Heavy vehicle access
- Freight management

WiM - Data Utilisation

3. Asset Maintenance

- Capital and maintenance funding
- Pavement and bridge design

4. Asset Operations

- Traffic management & network operations (traffic data)

5. Road Safety e.g. fatigue management

ANPR Camera – Data Utilisation

- Overload Management
- Heavy vehicle route enforcement
- Driver fatigue management
- Time over distance speed
- Traffic Planning
 - Origin Destination (OD) Surveys
 - Travel Time Surveys

Co-location of WiM/ANPR

- Provides intelligence for compliance activities
 - Targeted education campaign to peak industry groups
 - Supports Chain of Responsibility investigations
 - Targeted enforcement (repeat offenders)
 - Select overloaded heavy vehicles from the traffic stream without inconveniencing responsible operators








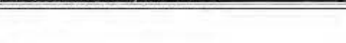
Co-location of WiM/ANPR

- Road Safety Benefits
 - Reduced on-road activities by TMR compliance officers
 - Reduced incidence and severity of overloaded heavy vehicles
 - Reduce potential for traffic incidents by limiting the extraction of heavy vehicles from the traffic stream

Vehicle Display

ys Monitor ● WiM-ANPR Data Viewer ✕ ● WiM-ANPR Data Viewer +

.16.110.7000 Google

 <p>5.05 12.28 16.19 Axle Spacing [m] 3.30 1.34 7.47 1.21 1.24</p> <p>19/06/2014 13:44:07 Lytton 403MXL 97</p> <p>403MXL</p>	 <p>12:41:06 Lane 1 73 km/h Class 9 Config 123 42.88 tonnes Length 17.78 m</p> <p>5.04 18.97 18.87 Axle Spacing [m] 4.44 1.28 6.32 1.32 1.26</p> <p>19/06/2014 12:41:07 Lytton 424IPI 97</p> <p>424IPI</p>
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 <p>13:44:54 Lane 1 72 km/h Class 3 Config 11 6.59 tonnes Length 9.53 m</p> <p>2.11 4.48 Axle Spacing [m] 4.85</p>	 <p>13:28:11 Lane 1 93 km/h Class 8 Config 122</p>

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Thank you and stay connected



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Blog blog.tmr.qld.gov.au

Technology Solutions



APEC Transportation Working Group Workshop – 4 April 2017

Geoff Smith Manager (TSDM)

WiM System Components

- Mass sensor
- Vehicle/axle detectors
- Field processor
- Communications

WiM Sensor Technology

- Strain gauge - Culway
- Piezoelectric Sensor
- Kistler Lineas Sensor – Quartz piezo
- Capacitive Pad
- Bending Plate

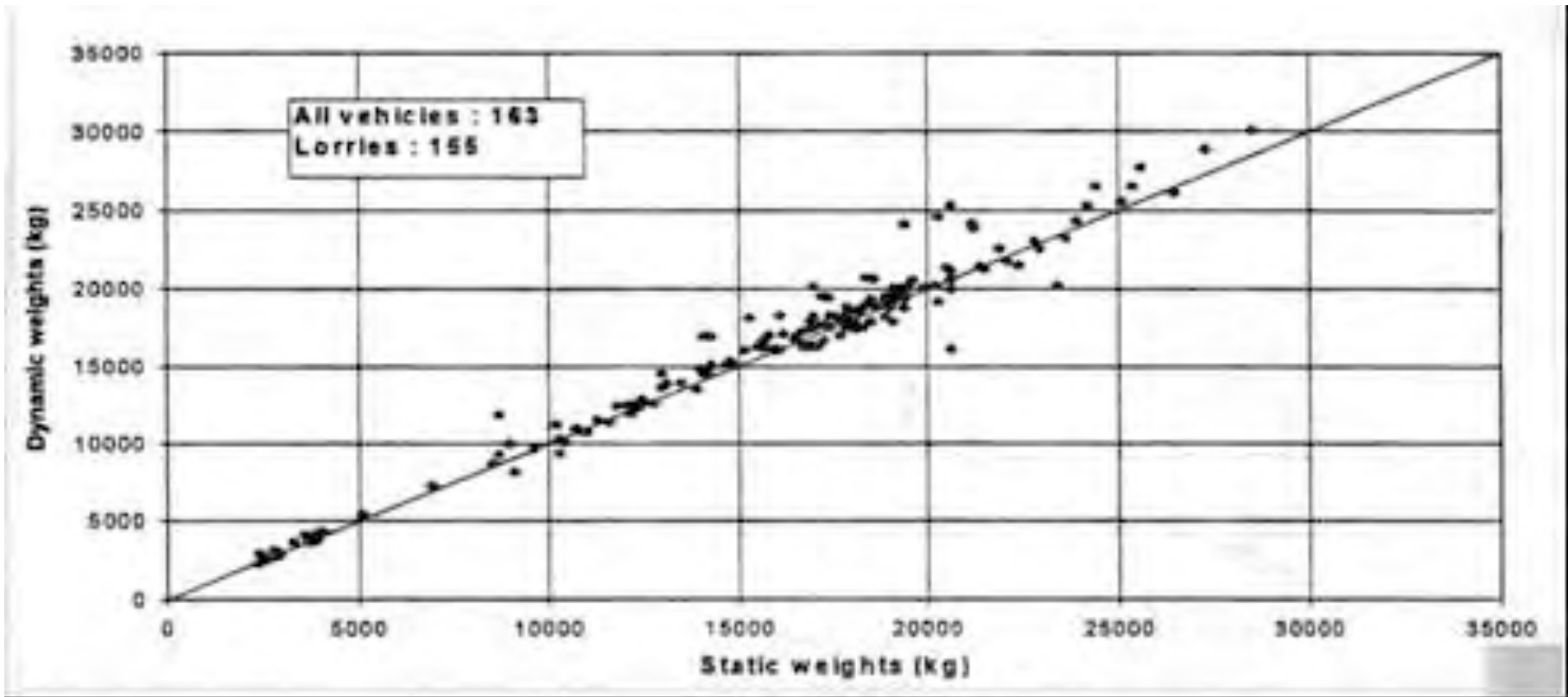
Culway Installation



Why Piezo Based WiM?

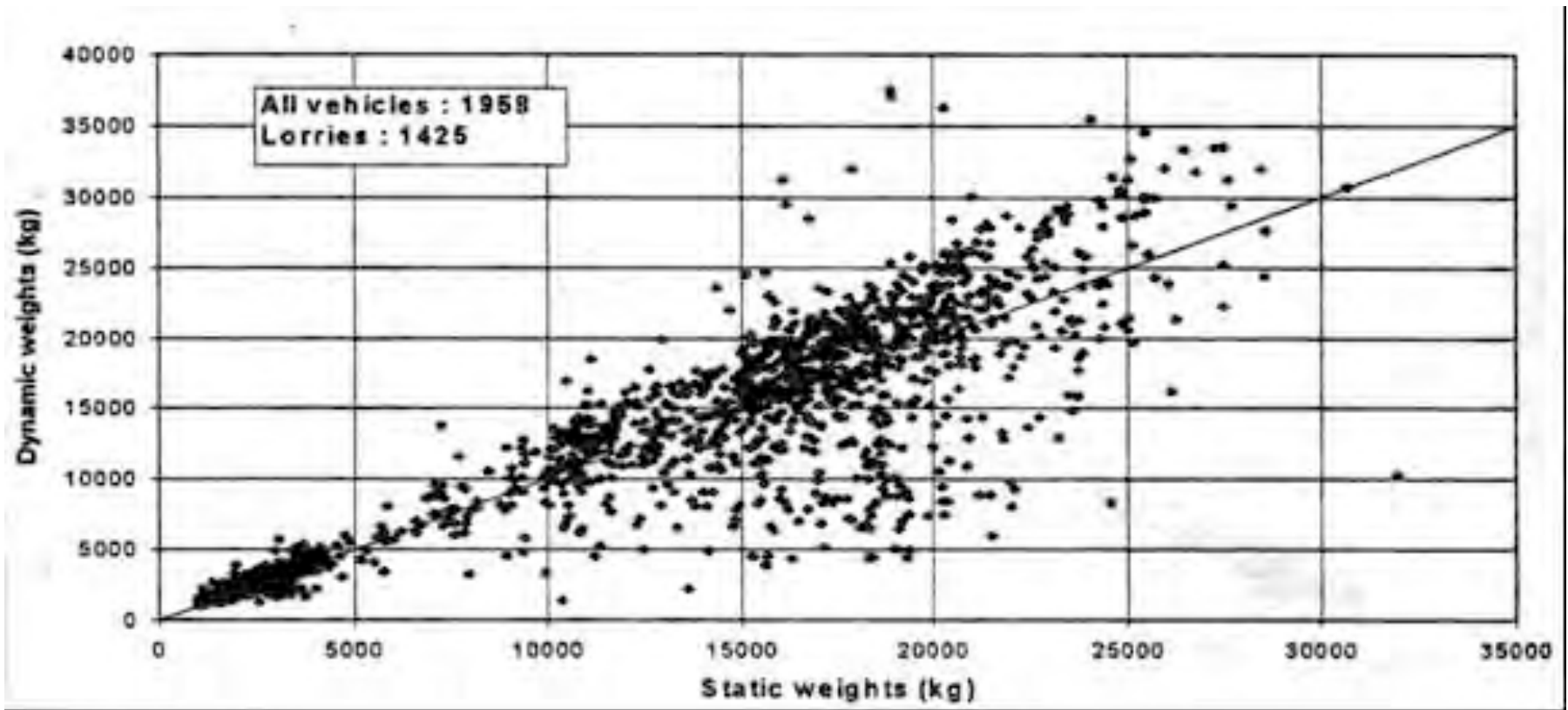
- Absence of suitable culverts
- Lower sensor cost and the ease of installation
- The expense of concrete or deep lift asphalt pavement for plate solutions
- Superior multi-lane solution

Scatter of Typical Dual Pad System



Source Mikros Systems

Scatter of Typical Piezo Sensor System



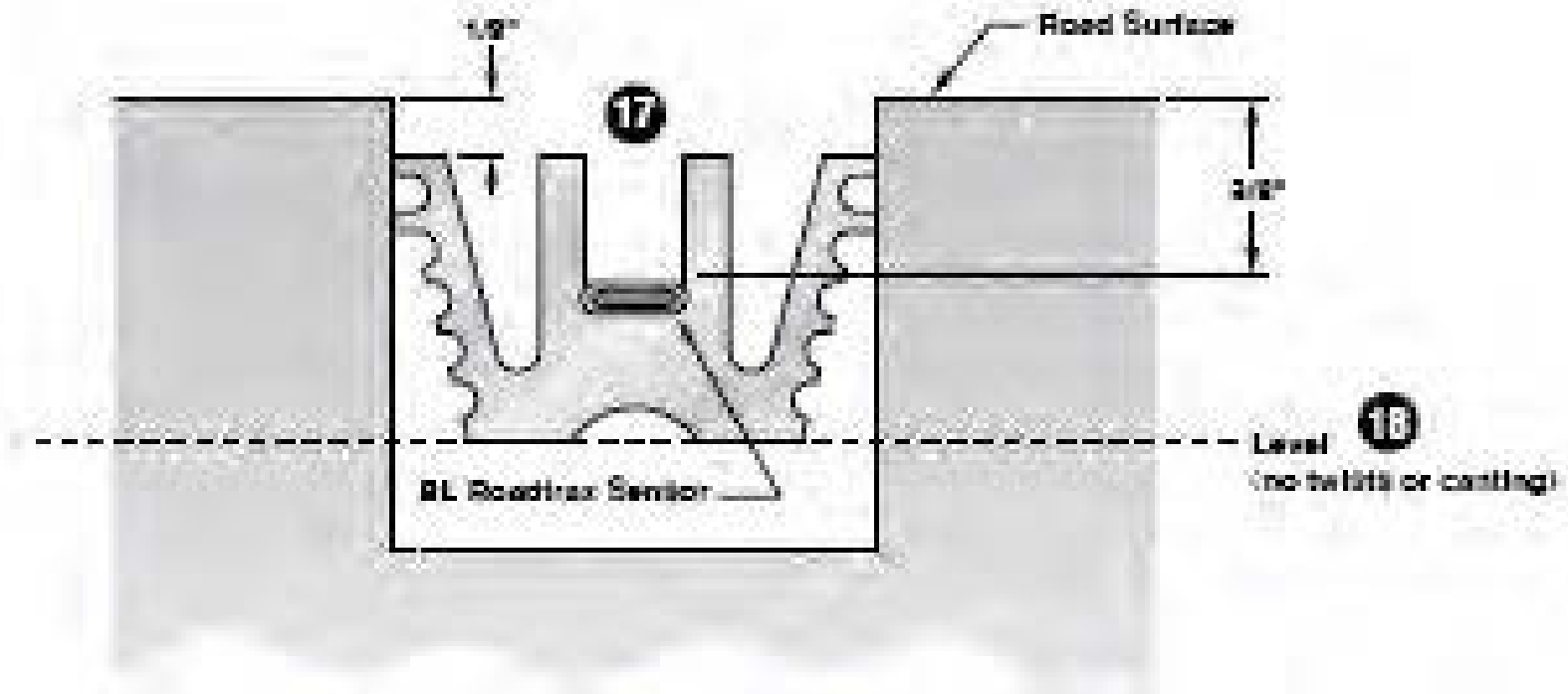
Source Mikros Systems

BL Piezo Installation



Wet cutting self-propelled pavement saw with multiple diamond blades to form a 19mm cut.

BL Piezo Installation



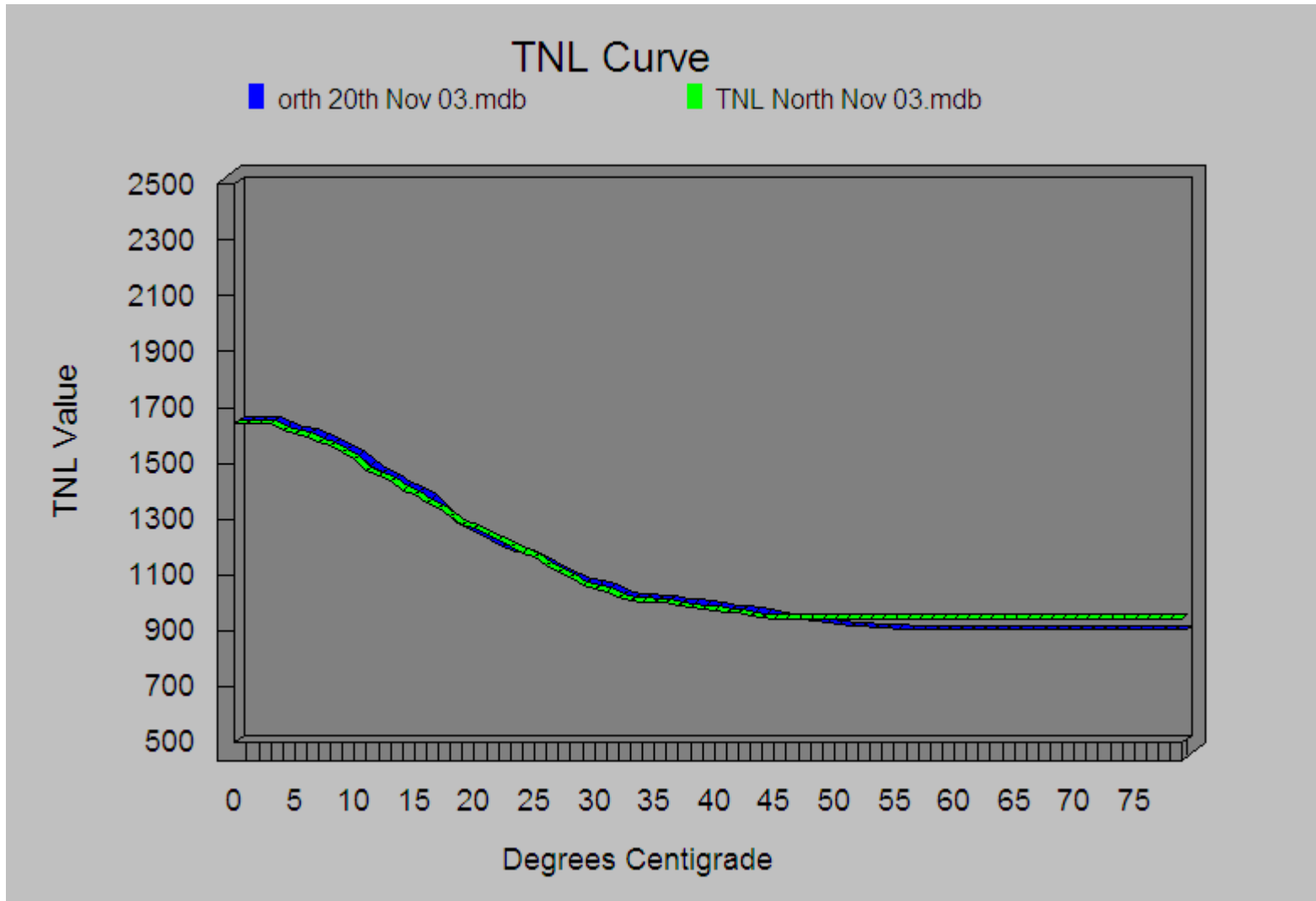
BL Piezo Installation



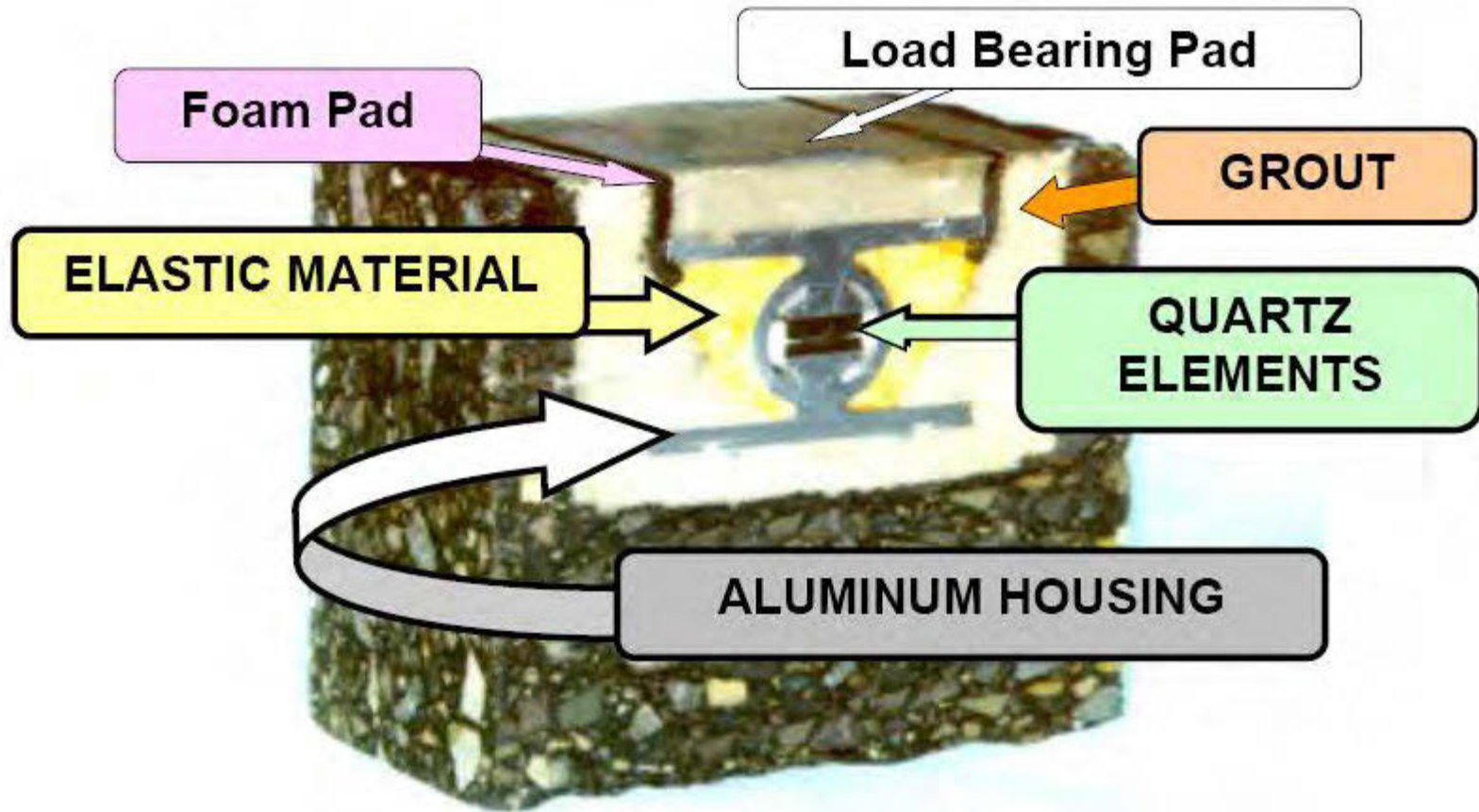
Qld Experience Piezo WiM

- First site installed in 1999
- Temperature compensation is essential
 - Without temperature correction, mass recorded in afternoon could more than double that recorded in the morning (same vehicle and load)
- Piezo sensors are not only very sensitive to temperature changes but also sensitive to the rate at which the temperature changes

Typical Temperature Compensation



Cross Section of Kistler Piezo



Kistler Piezo



Kistler Piezo



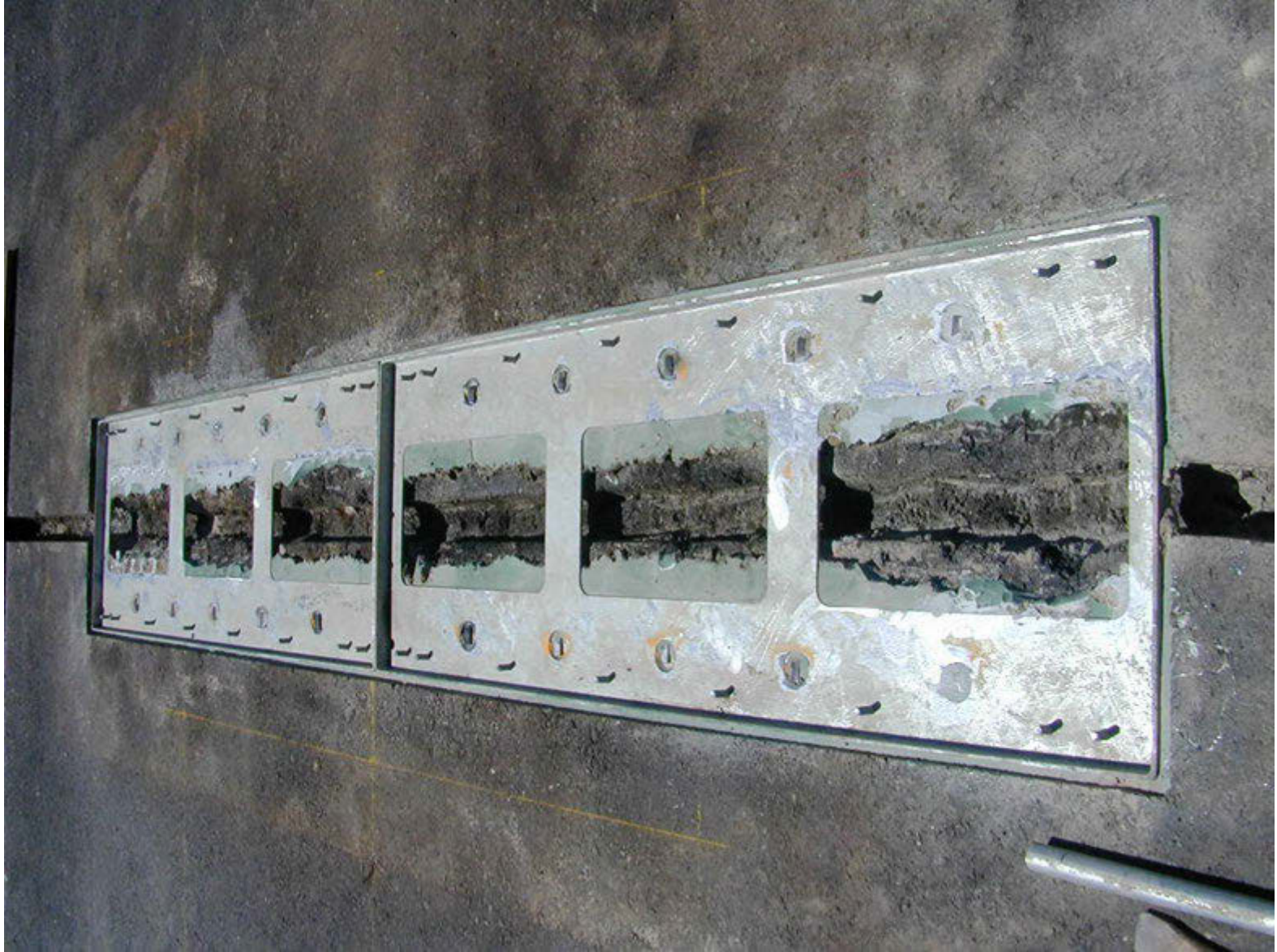
Kistler Piezo



Bending Plate



Bending Plate



Bending Plate



WiM Accuracy Classes – TMR

- Class A
 - For legal purposes such as enforcement of legal weight limits for example, IAP audit. None of the existing WiM sites in Queensland currently achieve this level of accuracy
- Class B
 - For infrastructure design, pre-selection of overloaded vehicles
- Class C
 - Detailed statistical analysis, infrastructure planning, freight planning and regulation and targeted enforcement
- Class D
 - Binary level of accuracy that is, loaded or unloaded only - essentially an intelligent vehicle classifier. Suitable for traffic studies plus limited freight planning and regulation

WiM Accuracy Classes

	A ₁	B ₂	C ₃	D ₄
	Tolerance for 95% Probability of Conformity			
Gross	±6%	±10%	±15%	±25%
Axle Group	±10%	±15%	±20%	
Single Axle	±15%	±20%	±30%	

- 1 - equivalent of ASTM Type III (6%)
- 2 - equivalent of ASTM Type I (10%)
- 3 - equivalent of ASTM Type II (15%)
- 4 - equivalent of Euro Type D (25%)

WiM Accuracy – Contributing Factors

- Sensor configuration and type
- Pavement quality and smoothness – key component
- Calibration procedure and frequency
- Condition of sensors
- Vehicle behaviour

Pavement Condition

- Site considered unacceptable for WiM if any of the levels of pavement smoothness exceeded
- Site assigned an accuracy class of "D" – binary WiM site.

Site Class	Excellent	Good	Acceptable
Rutting (3m straightedge)	≤ 4mm	≤ 7mm	≤ 10mm
Roughness (NRM)	0 – 33	33 – 68	68 – 105

WiM Site Availability

- Goal is for WiM sites to fully operation 24/7
- Equipment malfunctions, telemetry outages and pavement failures will impact on availability and reliability of data
- Realistic goal is 80% availability

Good	Fair	Poor
$\geq 90\%$	$\geq 80\%$ $< 90\%$	$< 80\%$





MIDDLE CREEK

WiM Site Maintenance

In most instances the source of an outage to a WiM site is related to the condition of the pavement



Automatic Number Plate Recognition (ANPR) Technology

- Utilises infra-red cameras to automatically capture images of vehicle number plates and record registration number, date and time

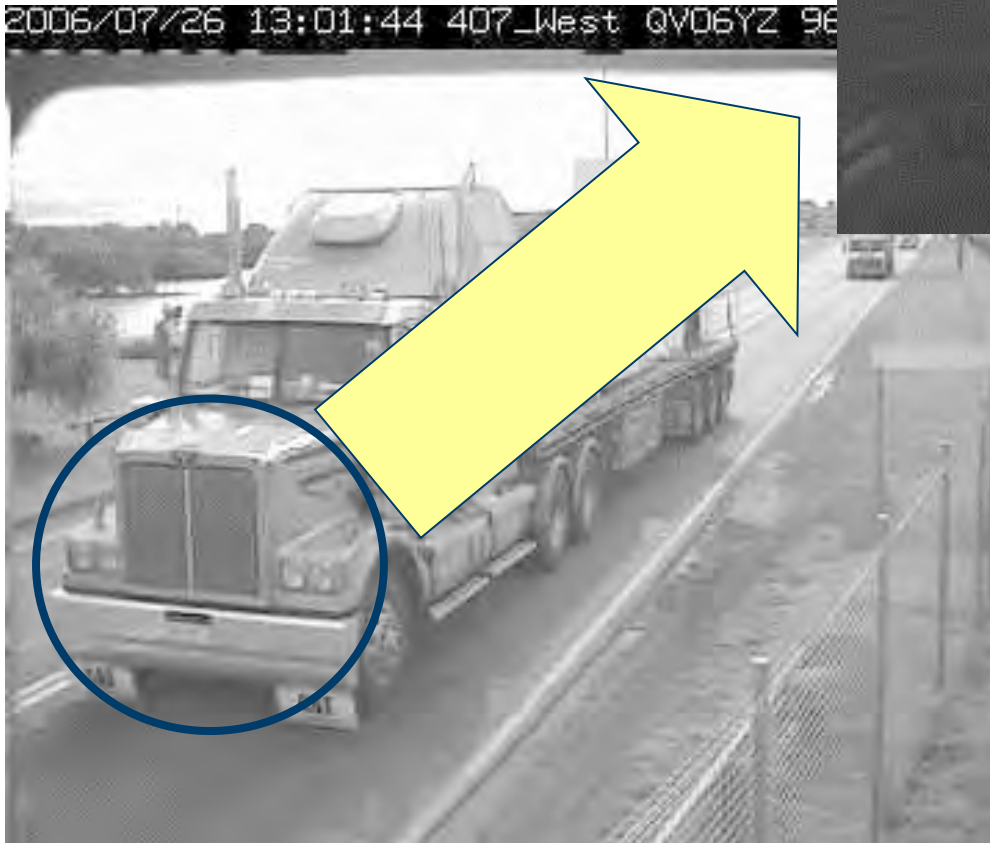


2004/12/21 14:35:54
Bulimba_West_L1 QGS728 93
QGS-728



Day Capture

Scene Image



Infrared Image



Plate Capture

Night Capture

Scene Image

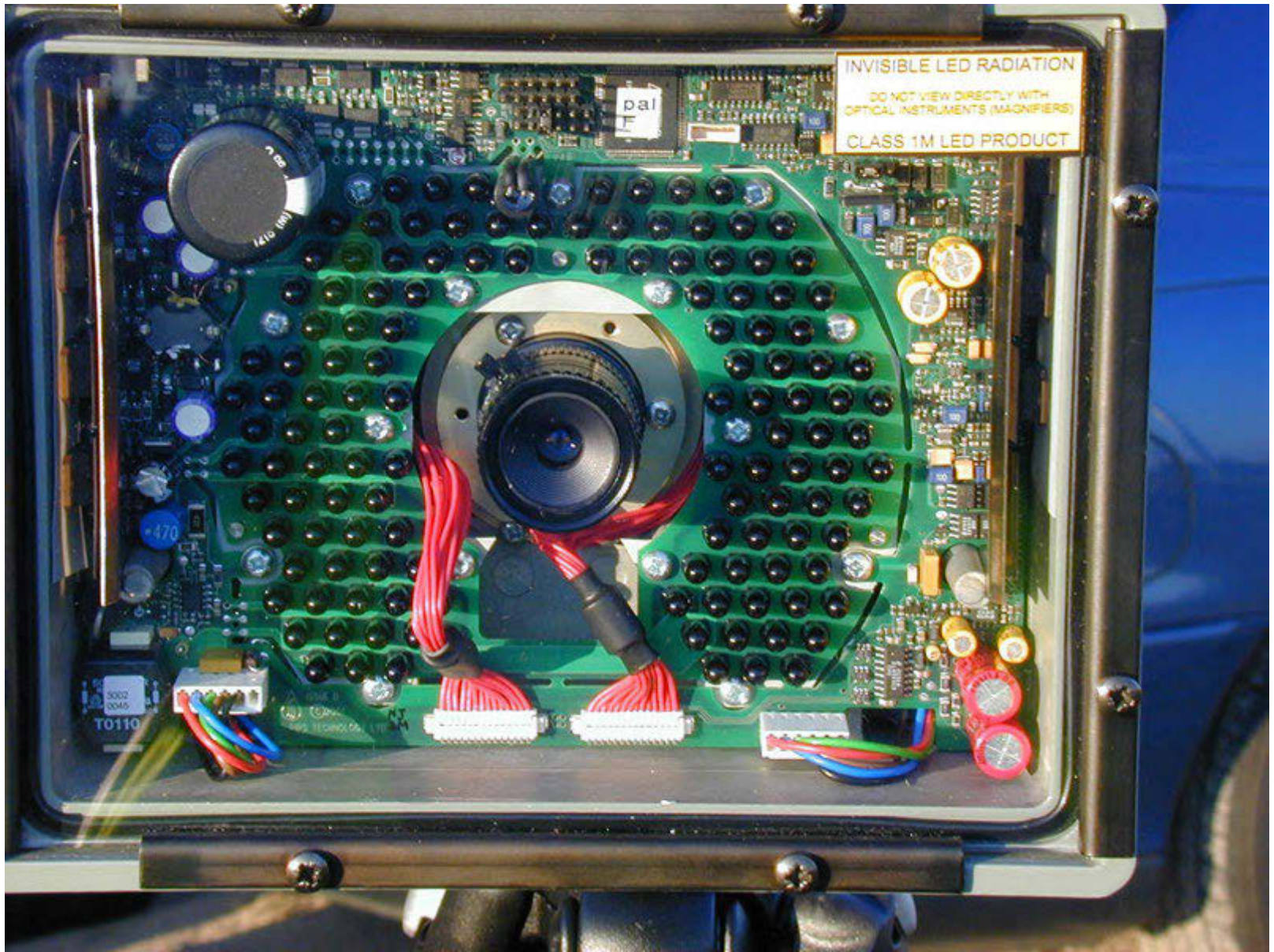


Infrared Image



Plate Capture

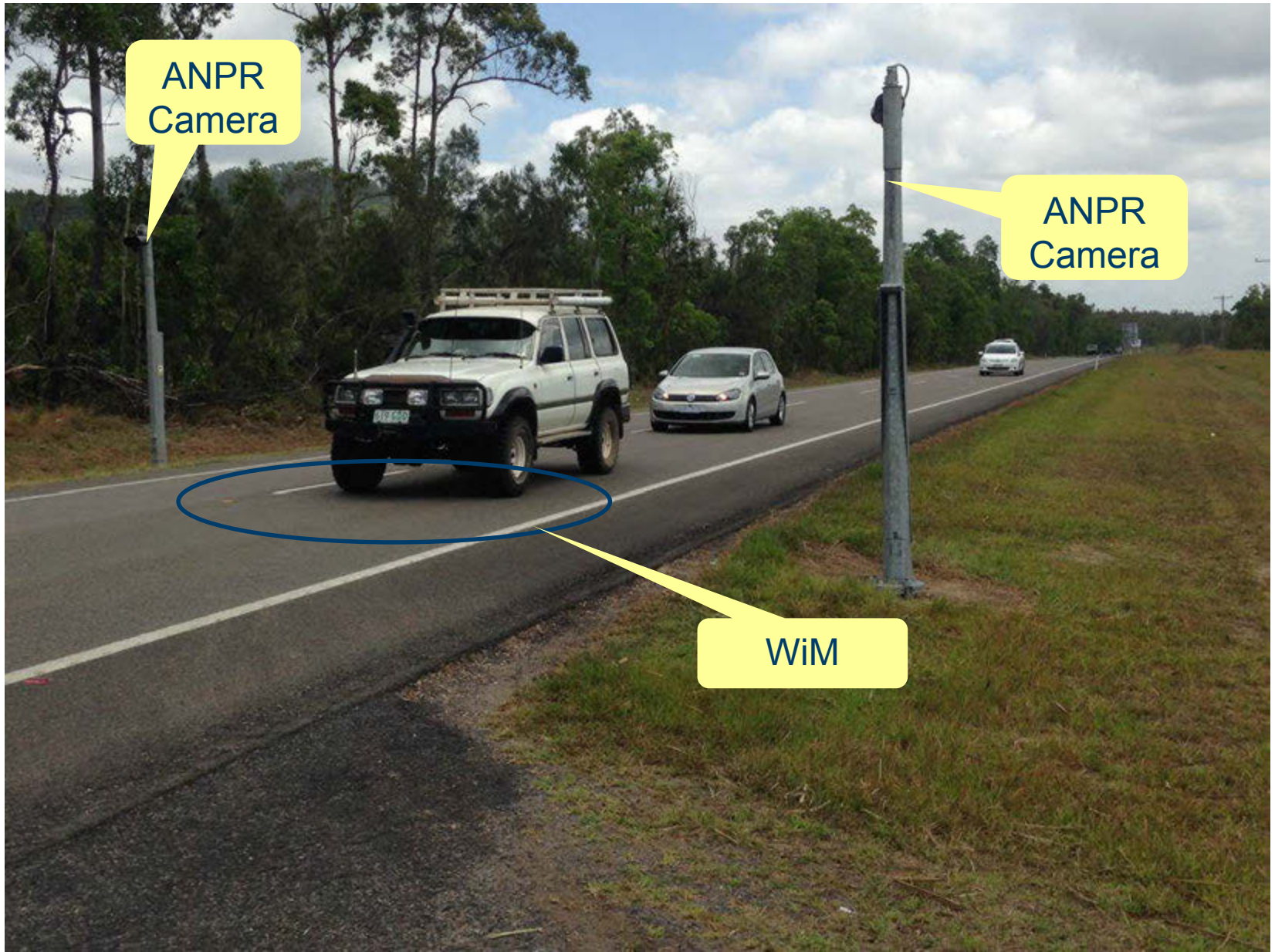
Typical ANPR Camera



ANPR & WiM - Motorway



ANPR & WiM - Rural Environment

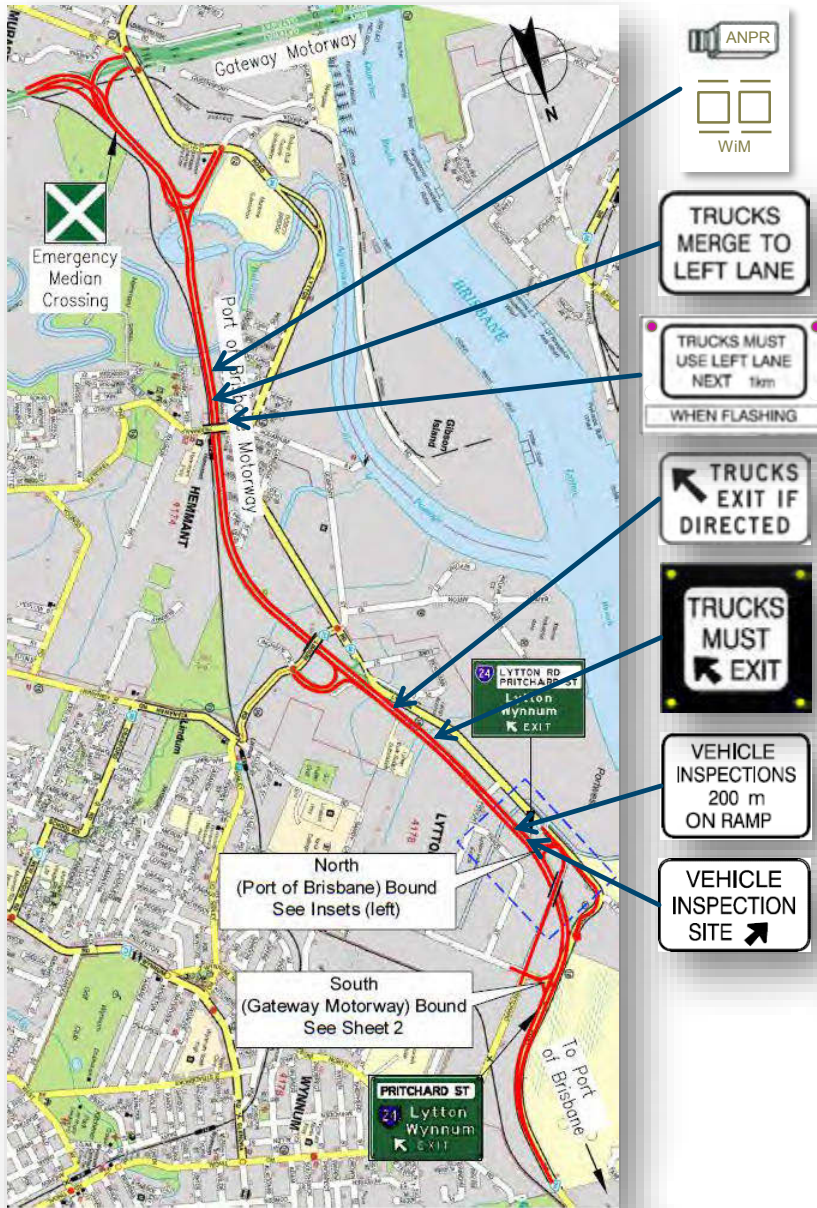




Heavy Vehicle Interception Sites

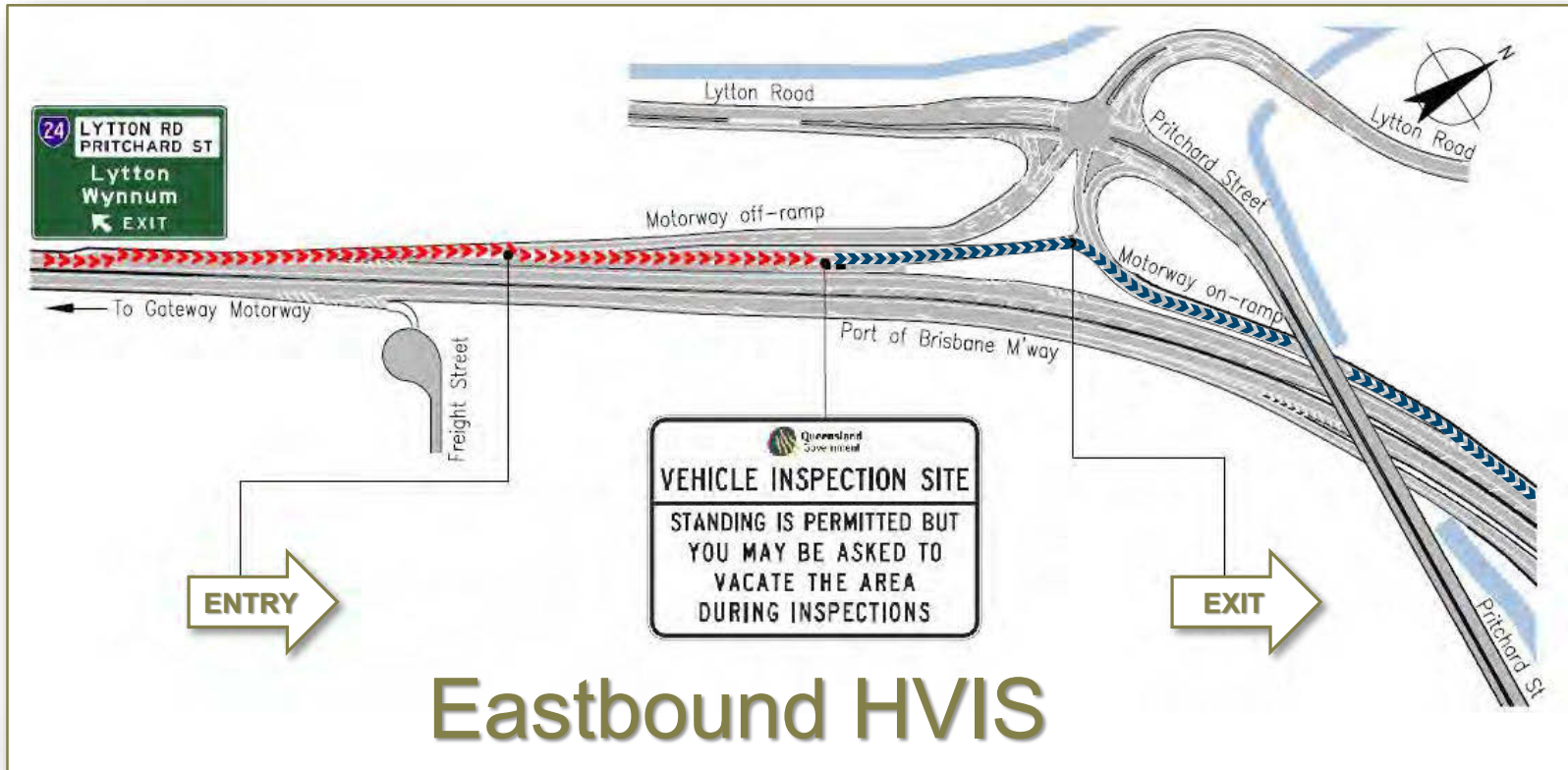
- Pull Over – where enforcement personnel pull over a suspect vehicle or driver encountered during their journey
- Short duration – where enforcement personnel spend less than two hours at a time
- Long duration – where enforcement personnel spend more than two hours at a time
- Long duration including weighing facilities – these are located on motorways or other high speed divided roads

Typical Motorway Site Layout



- Automatic Number Plate Recognition (ANPR) and Weigh-in-Motion (WiM)

- Changeable Message Sign (CMS)



- **Entry** from Motorway off-ramp
- **Exit** onto Motorway on-ramp
 - allows sufficient acceleration length before re-entering Motorway
 - causes inspected local traffic to 'go around'

Heavy Vehicle Interception Site (HVIS)



HVIS Operations










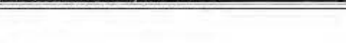
Monitoring Heavy Vehicles



Vehicle Display

ys Monitor ● WiM-ANPR Data Viewer ✕ ● WiM-ANPR Data Viewer +

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Database Reporting

CONFIDENTIAL

Date and Time: Sun 13-Jun-2010 13:05:52	Vehicle: 4 of 7	Vehicle Overloading:
Region: 205 - Mackay/Whitsunday	Traffic Class: 2	Axle Overloading: 3.22%
Road Section: 10G - Bruce Highway (St. Lawrence - Mackay)	Config: 123	Speed: 102.00 km/h
WIM Site: 80042 - WIM Site Koumala	GVM: 44.57 t	Speeding: 2.00%
Speed Limit: 100 km/h	Freight: 25.93 t	Validity: Failed
Site Stream: T2	Vehicle ESA: 5.17	

788KCA

OVERLOADING AND SPEEDING

CONFIDENTIAL

CONFIDENTIAL

Date and Time: Tue 15-Jun-2010 09:52:12	Vehicle: 5 of 7	Vehicle Overloading:
Region: 205 - Mackay/Whitsunday	Traffic Class: 2	Axle Overloading: 5.04%
Road Section: 10G - Bruce Highway (St. Lawrence - Mackay)	Config: 123	Speed: 102.00 km/h
WIM Site: 80042 - WIM Site Koumala	GVM: 45.52 t	Speeding: 2.00%
Speed Limit: 100 km/h	Freight: 26.48 t	Validity: Failed
Site Stream: T2	Vehicle ESA: 7.57	

488HPJ

OVERLOADING AND SPEEDING

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