Pavement Stabilisation as a Sustainable Pavement Recycling Treatment Option for Brisbane City Council

Ashish Shah, Lead Engineer, Management, Asset Management

BE (Civil), ME (IT), RPEQ, MIEAust, MAICD

Greg Stephenson, Senior Engineer – Civil Infrastructure, Asset Management

BE (Civil), MSTT, PhD, RPEQ, MIEAust

BRISBANE CITY COUNCIL

Australian Pavement Recycling and Stabilisation Conference

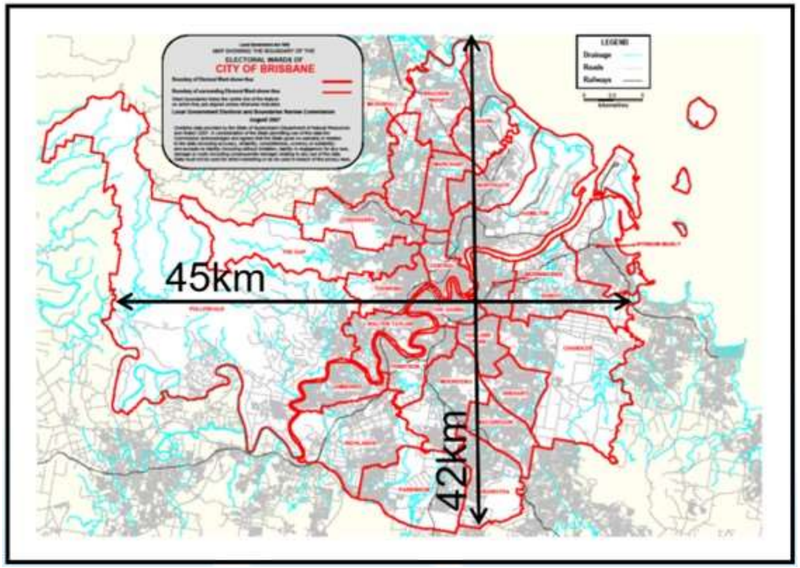
Designing for Reuse and Resilience

Pullman King George Square, Brisbane • 7th August 2024

AustStab

Pavement Recycling and Stabilisation Association

Brisbane City Council



- Formed in 1925 – 20 Local Authorities / Joint Boards
- 26 Electoral Wards
- Area = 1,367km^2
- 1.28 million residents in 2022

Sub - Network	Sealed Length (km)	Area (km^2)				
		Asphalt	Bitumen Seal	Concrete & Pavers	Total	% of Network
Local Access	3,863	31.05	0.77	0.59	32.41	58.7
Neighbourhood Access	705	6.78	0.06	0.02	6.86	12.4
District Access	391	4.89	0.01	0.01	4.91	8.9
Industrial Access	375	4.57	0.01	0.03	4.61	8.3
Arterial & Major Arterial	438	6.43	0.01	0.02	6.46	11.7
Total Length/Area	5,772	53.72	0.86	0.67	55.25	
%-age of Network (By Area)		97.2	1.6	1.2	100	100

- Road Network consists of 5,772km of sealed roads
- 20% - heavily trafficked industrial, sub-arterial or arterial roads
- 71% - low speed residential access

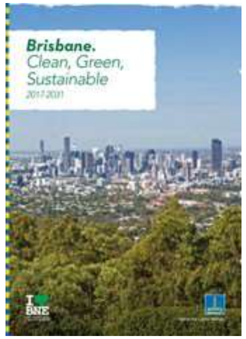
Carbon Neutral Council

Climate Active Carbon Neutral ORGANISATION

Council maintains its carbon neutral status in line with the Australian Government's Climate Active Carbon Neutral Standard for Organisations and is certified carbon neutral under the Climate Active program.

Brisbane Vision 2031

In some cases, Council will be a provider or leader, in other cases it may fund, advocate, regulate, form partnerships or monitor achievements.



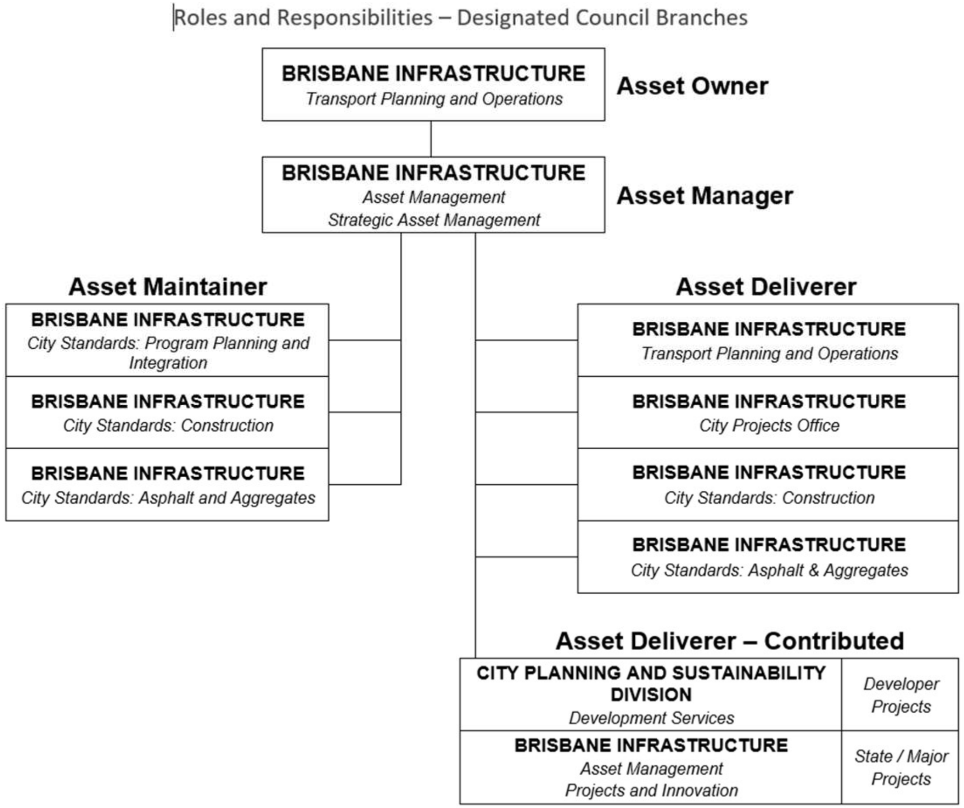
Brisbane. Clean, Green, Sustainable 2017-2031

Waste and resource recovery - Brisbane will reduce, reuse and recycle waste

Asset Management Model

- Asset Owner (AO)
- Asset Manager (AM)
- Asset Deliverer (AD)
- Asset Maintainer (AMNT)

Diverse organisation with engineering expertise spread across many policy and delivery functions



Asphalt Innovations Group

Asset Management
- Convenor / Secretariat

Asphalt & Aggregates
- 2 Quarries
- 2 Asphalt Plants
- 1 Recycling Facility

City Projects Office
- Pavement Design

Program, Planning & Integration
- Community Interface
- Project Identification

Purpose :- “To advance the investigation and implementation of asphalt and pavement technologies”

Objective :– New, Cost-Effective Pavement Solutions, Local Road Applications

Topics :- Pavement Design, New Products, Construction Compliance, Testing, Trials, Feedback From Technical Presentations & Conferences – Industry Trends

Stabilisation – Existing Materials

- Many of Brisbane’s roads were not designed or built to modern standards – thin pavements.
- Old pavements are extremely variable.
- Variability - street to street and within streets.
- Pavement Materials and Failures
  - Fine grained decomposed granite, ridge gravels and clayey crushed quartzite (Pine Mountain)
    - *Loss of strength in high moisture conditions*
    - *Chemical Stabilisation*
  - Coarse weathered Tuff and very coarse Hornfels (Mt Coot-tha)
    - *Excess movement under traffic through poor grading*
    - *Mechanical & Chemical Stabilisation*

Cement Stabilisation

- Stabilisation trials from 1967 - cement up to 6% by weight
- Streets were stabilised in the 1970's as individual projects
- Pavement Management Systems introduced in 1977

- In 1981, a preliminary programme ran to stabilise 60,000m^2 of local roads, using a cement content of 4% by weight to a depth of 150mm
- By 1982, substantial programmes of cement stabilisation using standardised methods were introduced

- 1998/1999 and 1999/2000 - over 100 stabilisation projects in 2 years
- At least 3,000,000m^2 of local roads have been stabilised

Cement Stabilisation – BCC Empirical Design

- Standard design thicknesses
- CBR ≥ 3%
- T_{20} below 1.5×10^6 ESA
- 70/30 GP Cement / Fly Ash blend

Strength Classification	Traffic Loading (maximum) (ESA)	Cement Stabilised Layer Depth (mm)	Asphalt Thickness (mm)
Band 1 to 2	4.0×10^4	150	30 Type 2 C170 AC
Band 3	1.5×10^5	200	30 Type 2 C170 AC
Band 4	9.0×10^5	225	50 Type 3 MG AC
Band 5	1.5×10^6	230	50 Type 3 MG AC

- 4.5% to account for the variability in the pavement materials & process
- Quality control => 4 weeks after stabilisation, check with 40kN FWD
  - 150mm thick = Maximum Allowable Deflection (D_0) < 1.3mm
  - 200mm thick = Maximum Allowable Deflection (D_0) < 0.3mm
- Pre-stabilisation FWD > 1.8mm = likely to be construction issues

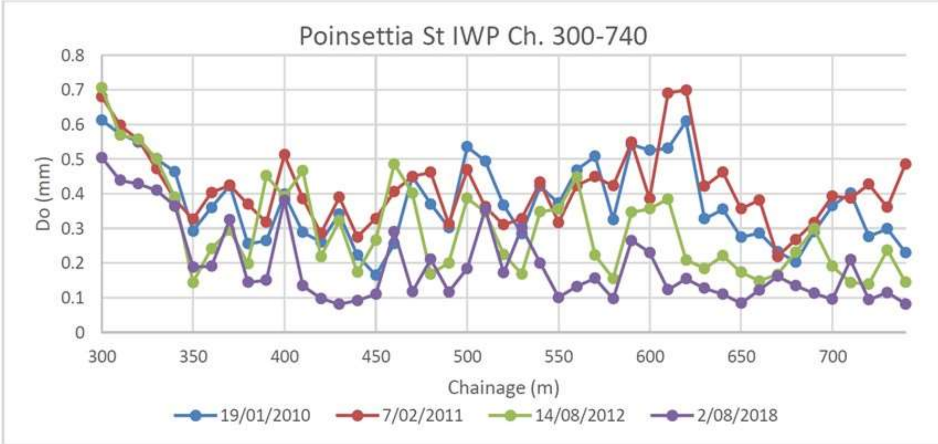
Stabilisation – Performance Issues

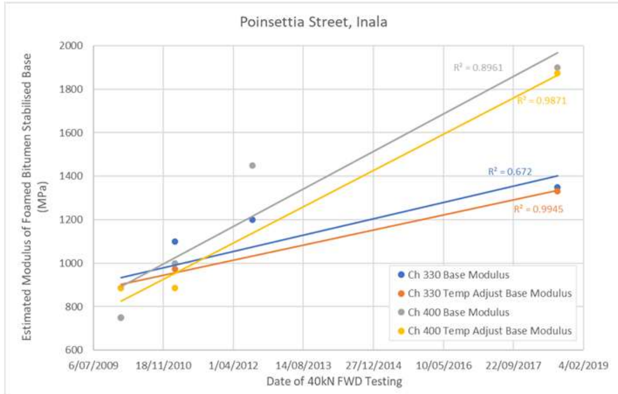
- Regular Pattern of Shrinkage Cracking
  - Reflects Through AC Surface
  - Not Perceived as a Structural Issue for Local Streets
  - Not Normally Cracked Sealed
- Occasional Project is Unsuccessful & Reconstructed
- Older stabilised streets starting to require resurfacing due to AC condition

Previous Resurfacing Treatment	Current Resurfacing Treatment
• Cold plane entire surface to a 30mm depth • Repair pavement failures with 100mm Type 4 AC • Penetrating Emulsion Prime to cold planed surface • Crumb rubber modified bitumen seal • 30mm Type 2 (C170) asphalt surface	• Cold plane entire surface to a 30mm depth • Repair pavement failures with 100mm Type 4 AC • C170 bitumen primer seal to cold planed surface • 30mm Type 2 (C170 with 10% CR) asphalt surface

"FoamMix" – ex-situ Recycling Trial

- Foamed bitumen added to reclaimed 2nd Class RAP and pavement gravel at Pine Mountain
- Mixed 3% foamed bitumen at Ambient Temp
- No secondary stabilising agent
- 97% Recycled Materials
- Place like Gravel @ OMC
- FWD Testing indicates Stiff Granular Material
- Gains strength/stiffness over time
- Trial Sites continue to be monitored
  - Archerfield Road, Richlands
  - Poinsettia Street, Inala



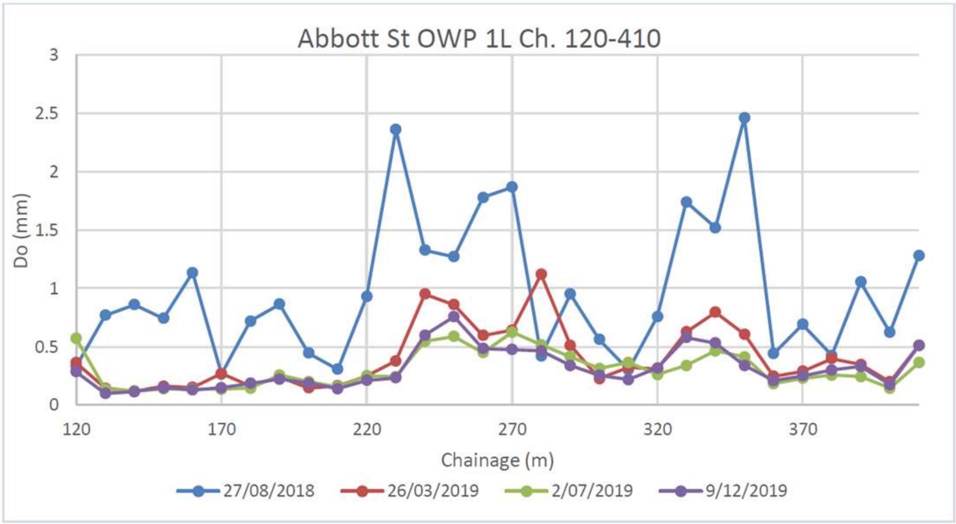


Bitumen Emulsion Stabilised Gravel

- July 2018 - 300tonnes of Emulsion Treated Base (ETB)
- Plant produced at Bracalba Quarry
  - DTMR Type 2.3 roadbase material (BCC Class 2)
  - 1% Hydrated Lime
  - 3% Anionic Slow Set emulsion
- Abbott Street, Camp Hill
  - 300mm of the existing pavement was profiled out
  - 250mm of ETB was placed straight on top of untreated subgrade material
  - 50mm Type 3 (M1000) Asphalt Surfacing
- Subgrade was very soft and moved under the wheels of the trucks as they discharged the ETB into the paver

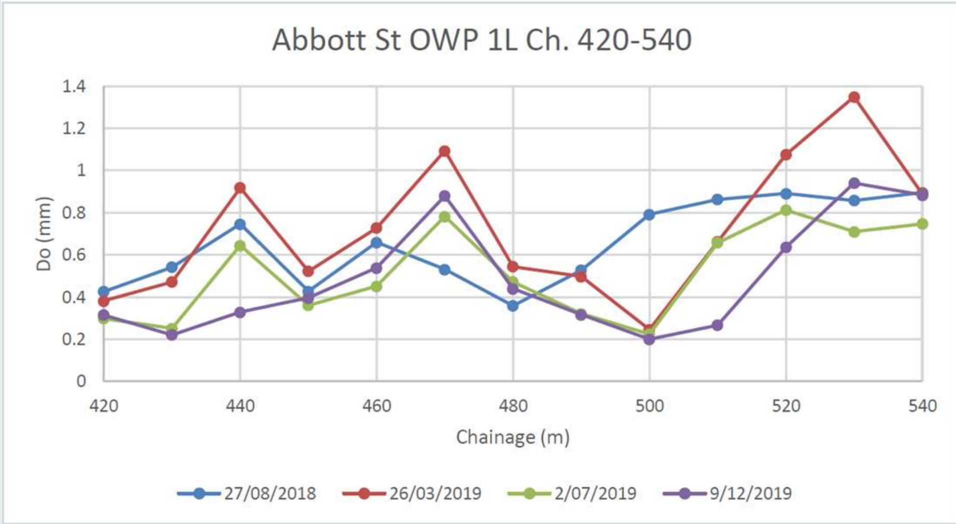
Bitumen Emulsion Stabilised Gravel

Emulsion Treated Base



- Rapid strength gain in the first 6 months
- Reached “cured” state at around 12 months
- Limited effect of seasonal changes
- Reduced moisture sensitivity - More resilient

No Emulsion Treated Base

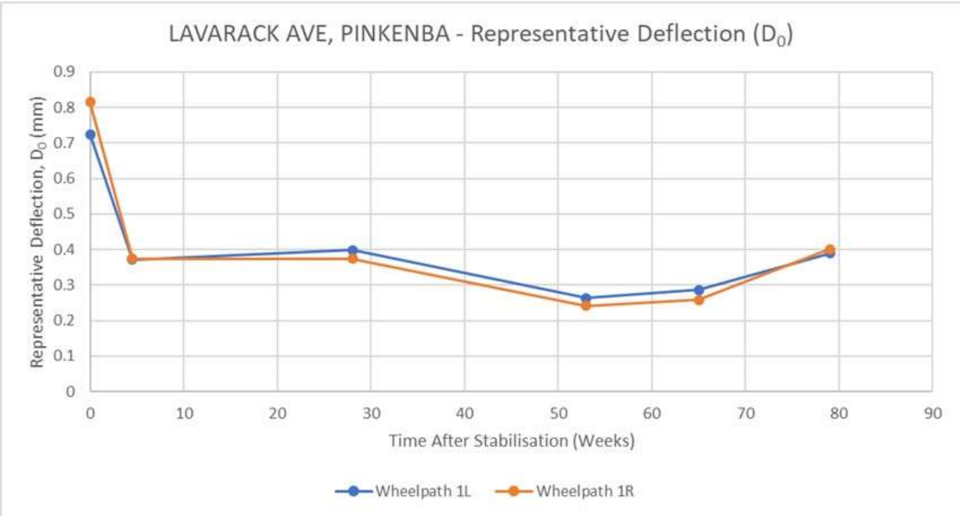


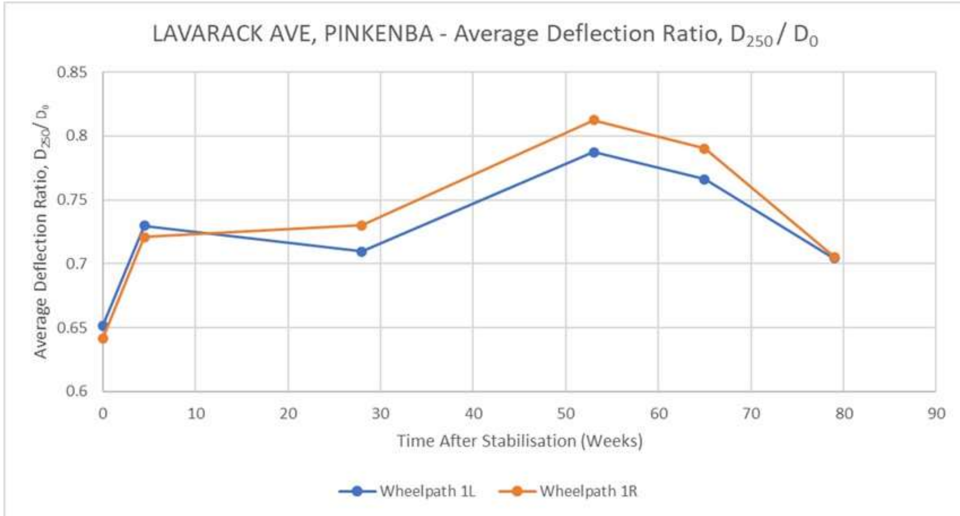
- Some post-construction deflections are higher than pre-construction deflections
- Significant changes in total deflection appear to be linked to seasonal changes

Insitu Foamed Bitumen Stabilisation

- Lavarack Avenue, Pinkenba - Curtin Ave East to Holt St (Southern Lane) - July 2022
- Cold plane the entire surface 50mm deep
- Insitu foam bitumen stabilise the existing pavement to 230mm depth
  - Wirtgen W380CR cold recycler
  - Paver laid
  - 3.0% C170 bitumen
  - 1.5% GB cement (70/30 GP Cement/Fly Ash Blend to AS 3972)
- 1-coat bitumen seal
- Resurface with a minimum 50mm Type 3 (M1000) AC

Insitu Foamed Bitumen Stabilisation

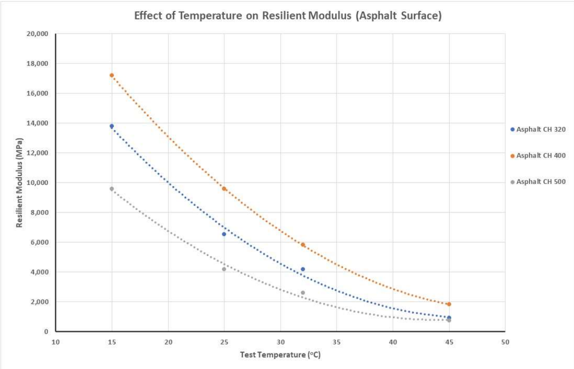


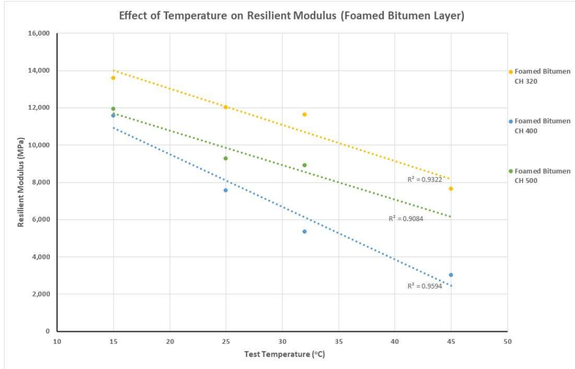


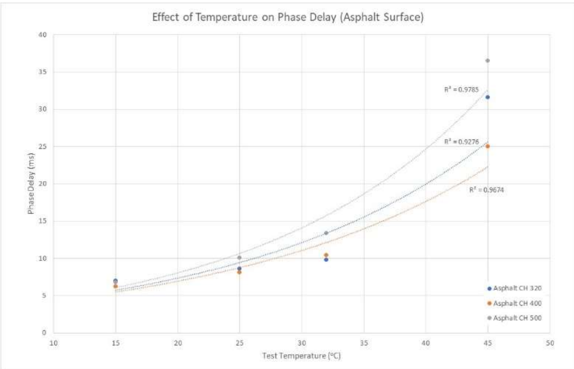
- 4.5 weeks after stabilisation, the pavement was significantly stiffer and generally continued to gain stiffness over time
- Higher deflection and reduced deflection ratio on 6th February 2024 was attributed the pavement temperature being over 50°C

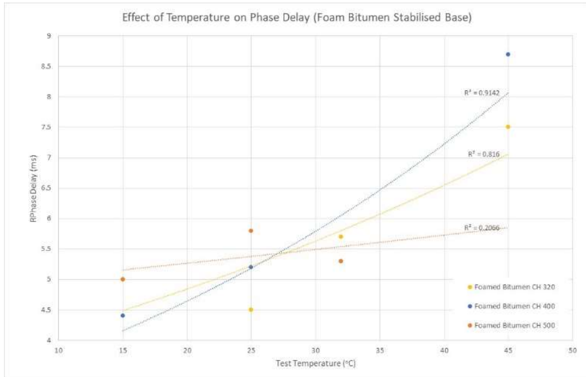
FWD Test Date	30/08 2022	13/02 2023	9/08 2023	27/10 2023	6/02 2024
Weeks Post-stabilisation	4.5	28	53	65	79
Pavement Temperature	16.1°C	45.5°C	21.9°C	29.2°C	51.3°C

Insitu Foamed Bitumen Stabilisation









Resilient modulus testing – Feb 2024

- 15°C, 25°C, 32°C and 45°C

At Higher Temperature

- Reduction in asphalt stiffness is more significant.
- Foamed bitumen stabilised material performs more like an elastic material
- Asphalt surface plays the major role in the increased deflections

Construction Challenges – Urban Areas

- Thin and inconsistent pavements difficult to identify in pavement investigation (Empirical design is limited to low volume roads)
- Shallow and aged PUP infrastructure damaged during construction
- Heavy single pass stabilisation equipment used to minimise environmental concerns in residential areas – weak subgrade issues
- Due to length, variable width, road-side vegetation and service penetrations, access for large size paving trains is limited
- Maintaining the balance between internal and external workforces and resources

Summary

- Cement stabilisation using the Empirical Design remains a low-cost alternative for local roads - albeit with some risk of premature failure.
- As the standard of the local road network continues to improve, the local streets that are candidates for cement stabilisation have significantly reduced.
- Second generation rehabilitation and resurfacing techniques for previously cement stabilised pavements?
- Ex-situ Recycling with Foamed Bitumen or Bitumen Emulsion may allow greater re-use of existing pavement materials for moderately trafficked roads.
- Insitu Foamed Bitumen Stabilisation may be an option for strengthening moderate to heavily trafficked roads where sufficient "acceptable" quality gravel exists.

Summary

- Council, through the Asphalt Innovation Group, will further develop these sustainable practices
  - Prevent the existing pavement materials from entering the waste stream
  - Deliver better the outcomes for the environment and our communities
- Stabilisation will contribute to
  - Reducing Council carbon footprint
  - Commensurate savings in the purchase of offsets for the greenhouse gas emissions generated by Council's operations
- Stabilisation in its varied forms is key part of the arsenal of pavement recycling technologies
  - Long been embedded in Council's practices to sustainably manage the road network
  - Will play a vital role in Council fulfilling its carbon neutral commitment into the future