ROAD INFRASTRUCTURE MANAGEMENT FORUM

Our Carbon Equation

New Zealand IPWEA
INSTITUTE OF PUBLIC WORKS ENGINEERING AUSTRALASIA

Renewal of Structured Road Markings – And Its Carbon Impact

Obinna Akaa & Damien Douglas | WSP

wsp

RIMS
Roading Infrastructure Management Support

in association with
IDS Infrastructure Decision Support

Wellington State Highways

- 368 km of State Highway running through Wellington & Wairarapa Regions
- Boundaries – South of Levin and north of Mount Bruce
- 748 lane km of surfacing and pavement layers
- 260 km of road safety barriers
- 1424 km of paint vs. 653 km of structured markings
- 10,700 edge marker posts

Our Carbon Equation

Capital Journeys®

Joint venture between WSP and Fulton Hogan that has held the NOC contract from 2014-2022

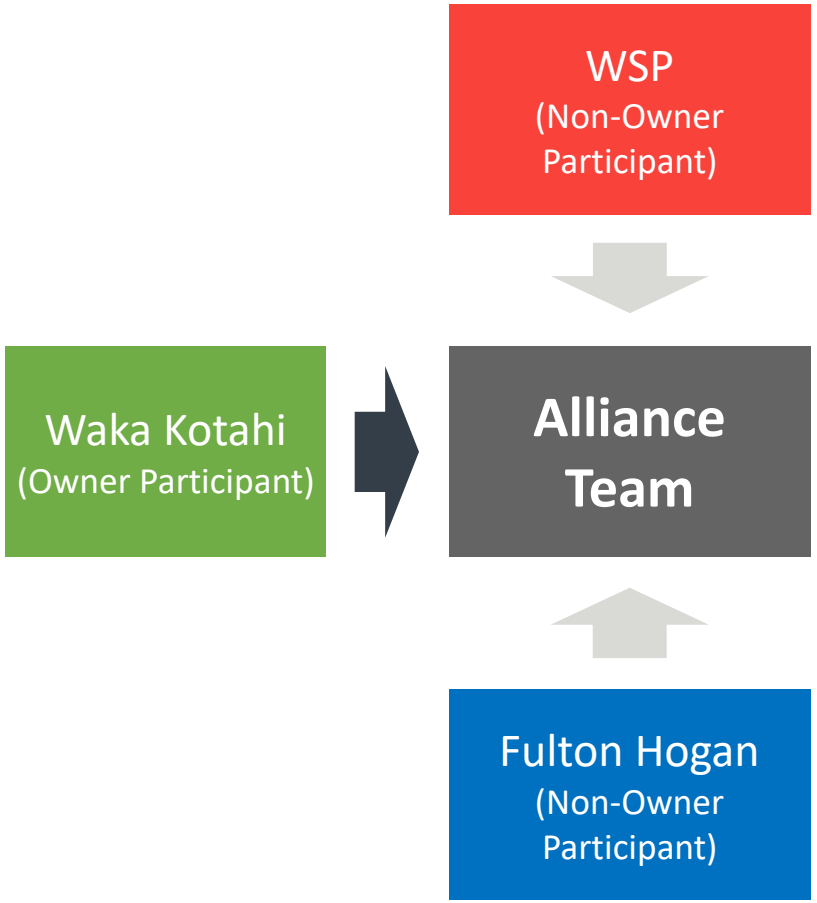
CAPITAL JOURNEYS®

WSP Fulton Hogan

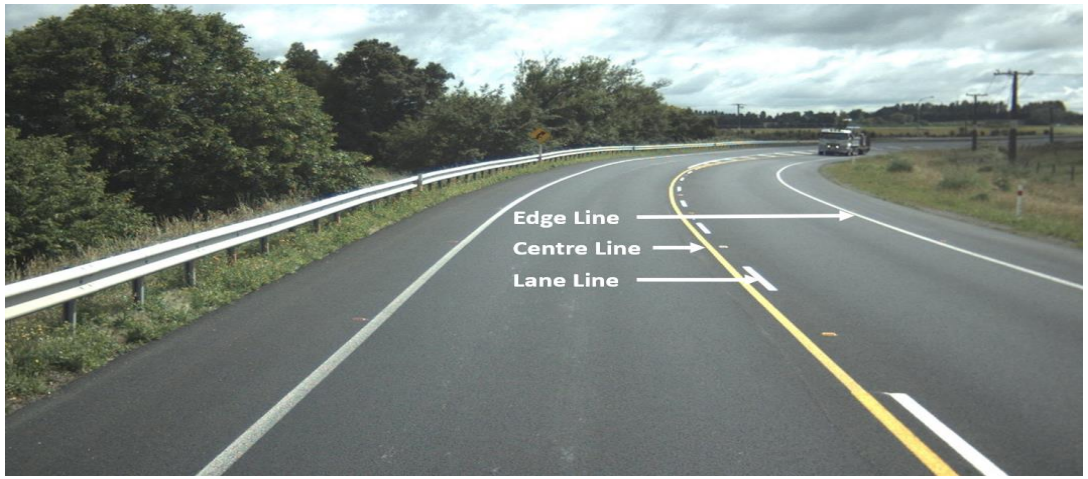
Our Carbon Equation

Wellington Transport Alliance

New network manager from 1 July



Road Delineation



- **Road markings**
  - **Paints**
  - **Audio tactile profiled (ATP) markings**
  - **High-performance structured markings e.g. cold applied plastic (CAP), thermoplastic markings**

- Raised pavement markers

- Edge-marker post & delineator panel

Our Carbon Equation

Road Markings & GHG

NZ GHG 2019 Report:

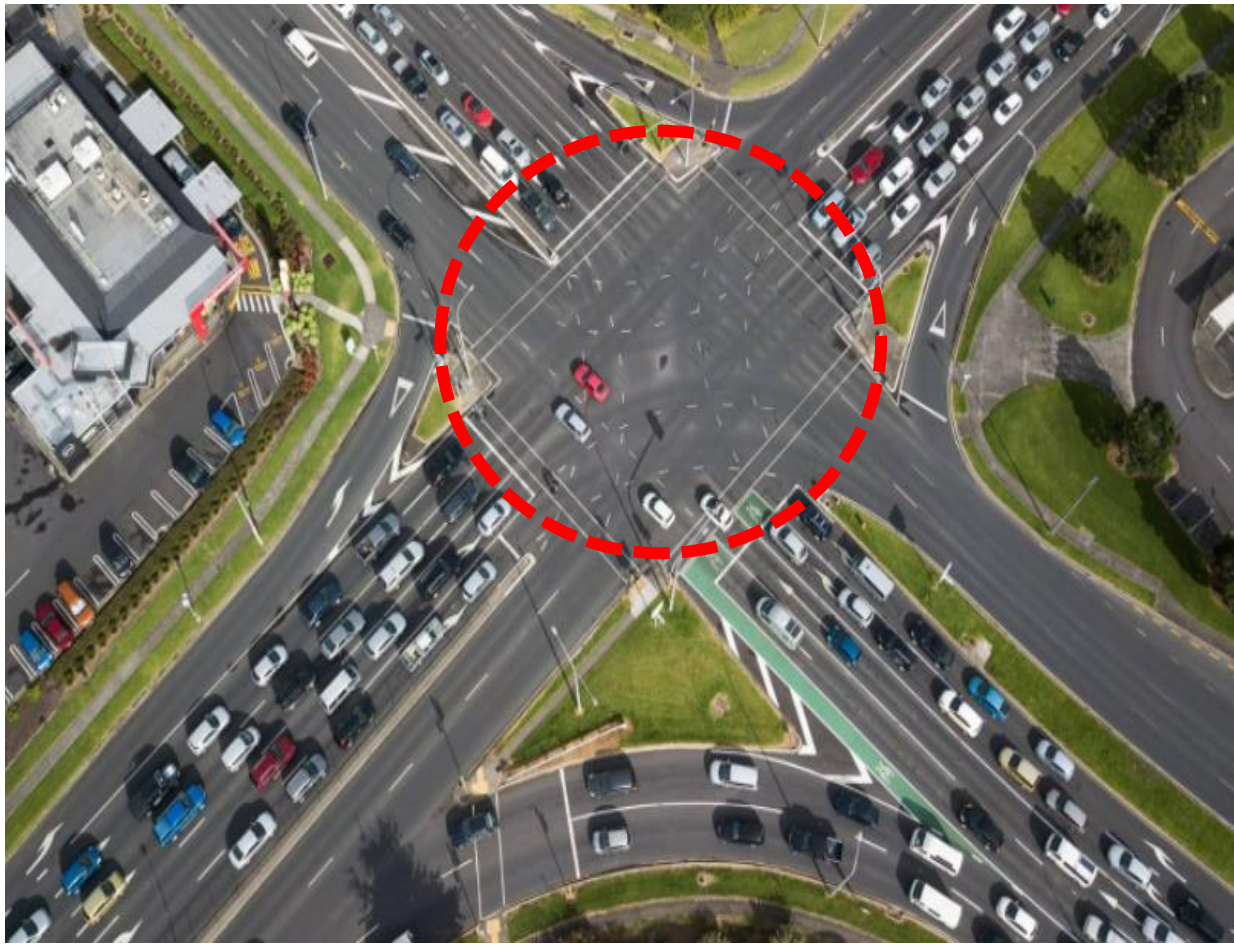
- Manufacturing & construction = 20.0% Co2-e
- Transport = 42.9% Co2-e (*up by 16.6% from 2005*)
- 90.5% were of road vehicle emission
- So we may not do road markings at all?

Influence of Poor markings:

- WLG SH DSi – 0.96 High Risk Intersections
- WLG SH DSi – 0.86 High Wear sites

Relevance:

- Road re-mark WRT lifecycle & benefit to carbon footprint reduction



Pavement Markings Renewals

- Condition
  - ❖ Poor & very poor
- Age
  - ❖ Remaining useful life
- Analyse & Programme
  - ❖ Risks
- Treat
  - ❖ Reseal
  - ❖ Reinstate or Re-mark

Our Carbon Equation

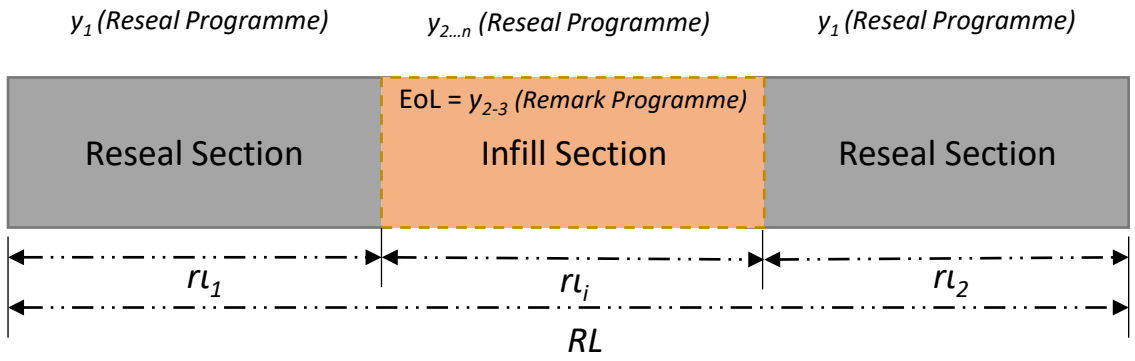
What is the Problem?

- Service levels
  - ❖ Markings continuity
- Delivery efficiency
  - ❖ Customer delay
- Value-for-money
  - ❖ Funding decision
- Sustainability
  - ❖ Carbon impacts

Our Carbon Equation

Infills Method

- Philosophy
  - ❖ Markings continuity without safety compromise
- Relevance
  - ❖ Cost-effective & sustainable asset lifecycle planning
- Development
  - ❖ Criteria, formulation, Analyses
- Implementation
  - ❖ Attribute & justification verdicts



1.
$$RC_{y_1,\ldots y_n} = \left(\sum rc_1,\ TC_1, cc_1\right) + \left(\sum rc_2,\ TC_2, cc_2\right) + \ldots + \left(\sum rc_n,\ TC_n, cc_n\right)$$

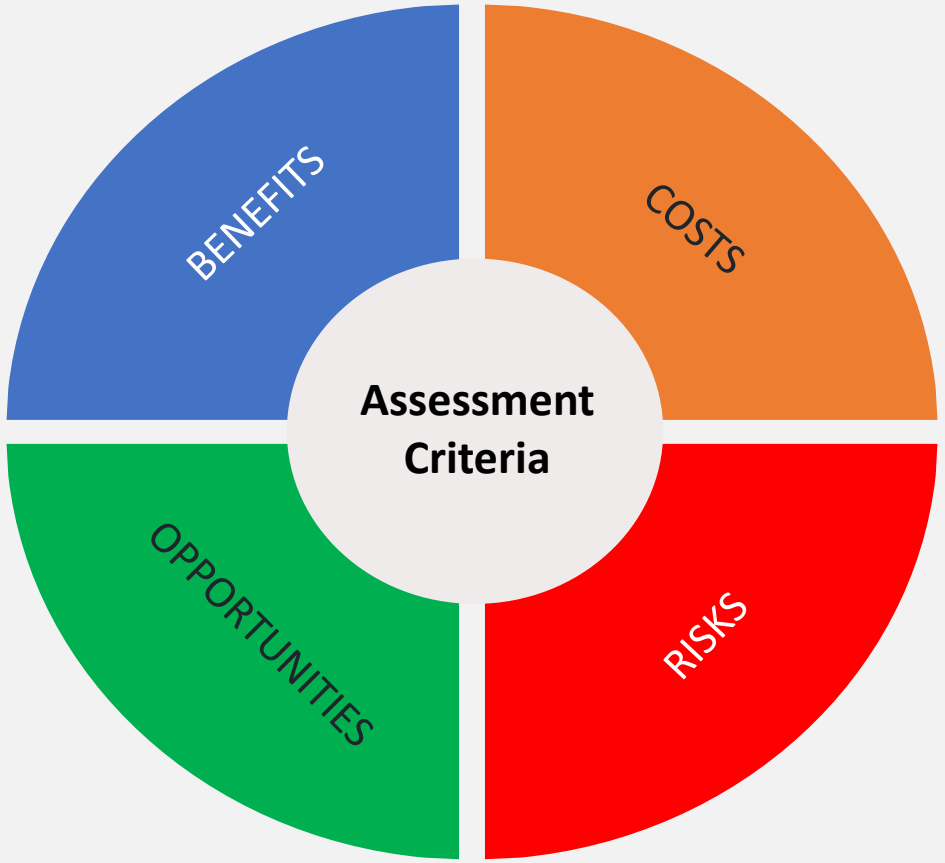
2.
$$RC_{i,y_1} = \left(\sum_{y_n=1}^{y_1} rc,\ TC,\ cc\right)^{y_n}$$

Our Carbon Equation

Criteria & Considerations

Primary & secondary benefits

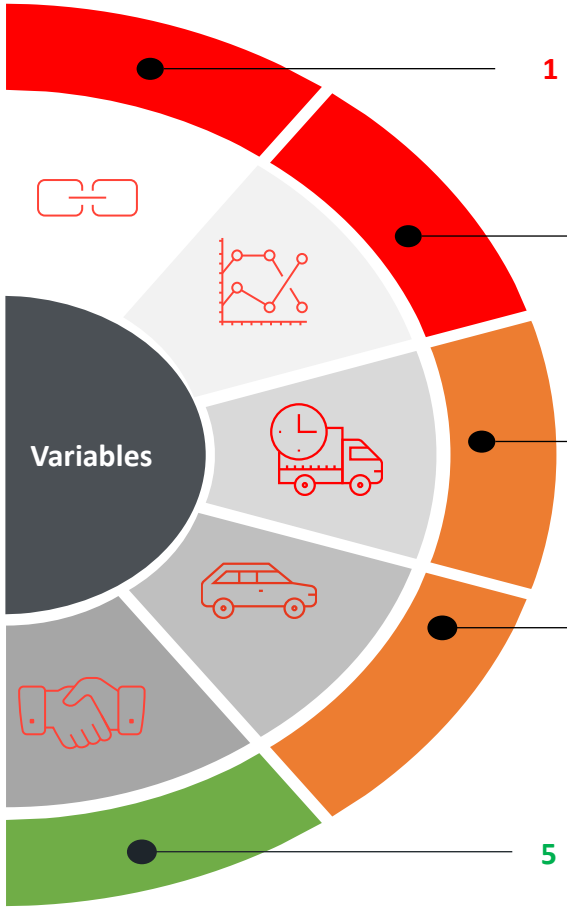
Optimisation, innovation



Installation, traffic, customer costs

Safety, reputation, asset service level

Criteria & Considerations



1

Infill length & reseal year:
- Max infill length ≤ 1000 m
- Reseal year not within 2 – 4 years

2

Road markings condition & remaining life:
- Poor – very poor
- 2 to 3 years EoL

3

Installation time frame & Traffic management cost:
- Total shifts (including infill) ≤ total shifts without infill
- Safety & operational cost of re-marks

4

End-user disruption (customer value-of-time (CVoT)):
- Derived from Waka Kotahi MBCM composite values ($/hr)

5

Net present value ($) & total carbon reduction (TCO_2):
- Discounted total reinstament costs (@ 4% discount rate)
- Light commercial vehicles – Diesel & emission factor per litre

Our Carbon Equation

General Process

Step 1

- Confirm site location & assessment criteria
  - *From reseal programme & road network data*

Step 2

- Are all criteria confirmed as true?
  - *If 'NO', end process! If "YES' continue to step 3!*

Step 3

- Derive & analyse costs/ monetised benefits considerations
  - *From delivery requirements, network data & MBCM*

Step 4

- Calculate markings renewal costs & confirm economic justifications
  - *If Negative 'NPV', end process! If Positive NPV continue to step 5!*

Step 5

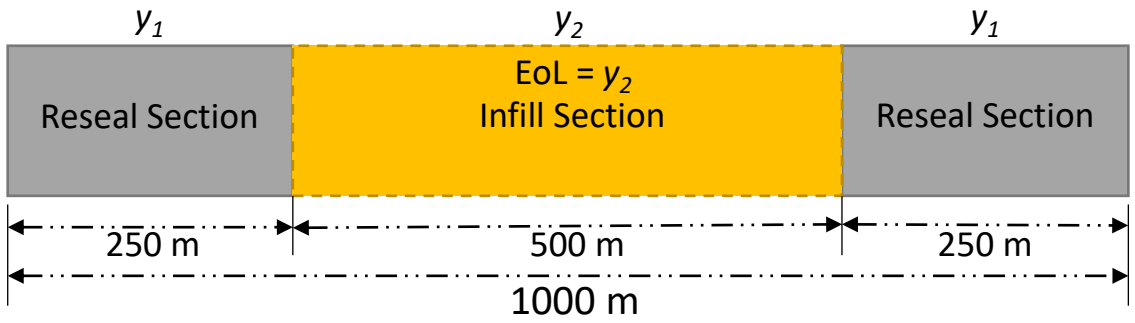
- Calculate total carbon reduction & confirm all renewal justifications
  - *From published GHG emission factors & justification templates*

Step 6

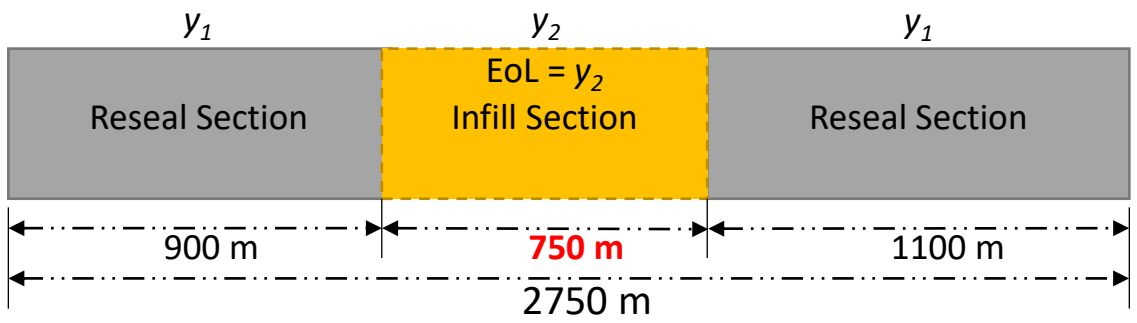
- Accept infill markings sites & approve renewal plan
  - *Communicate plan & continuous improvements*

Scenarios – Steps 1 - 4

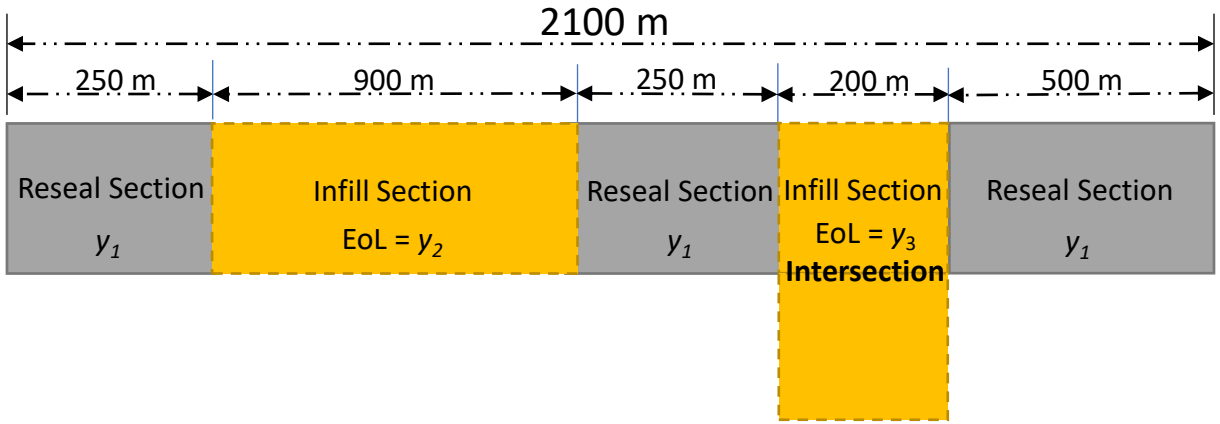
1a. 2 reseals & 1 infill



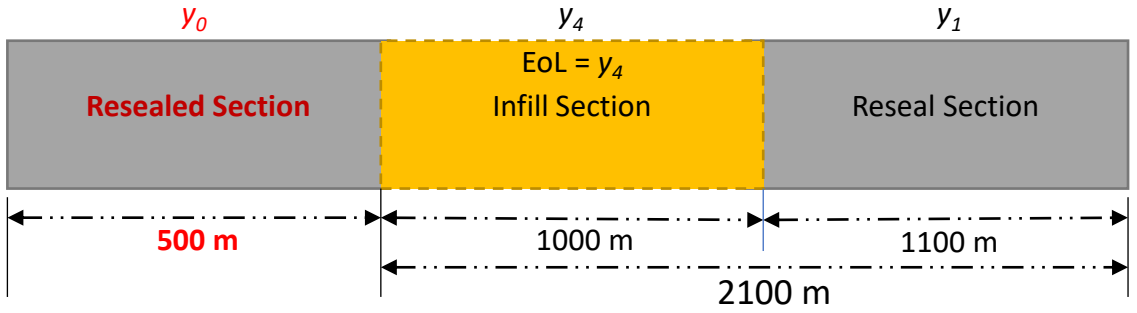
1b. 2 reseals & 1 infill (increased length)



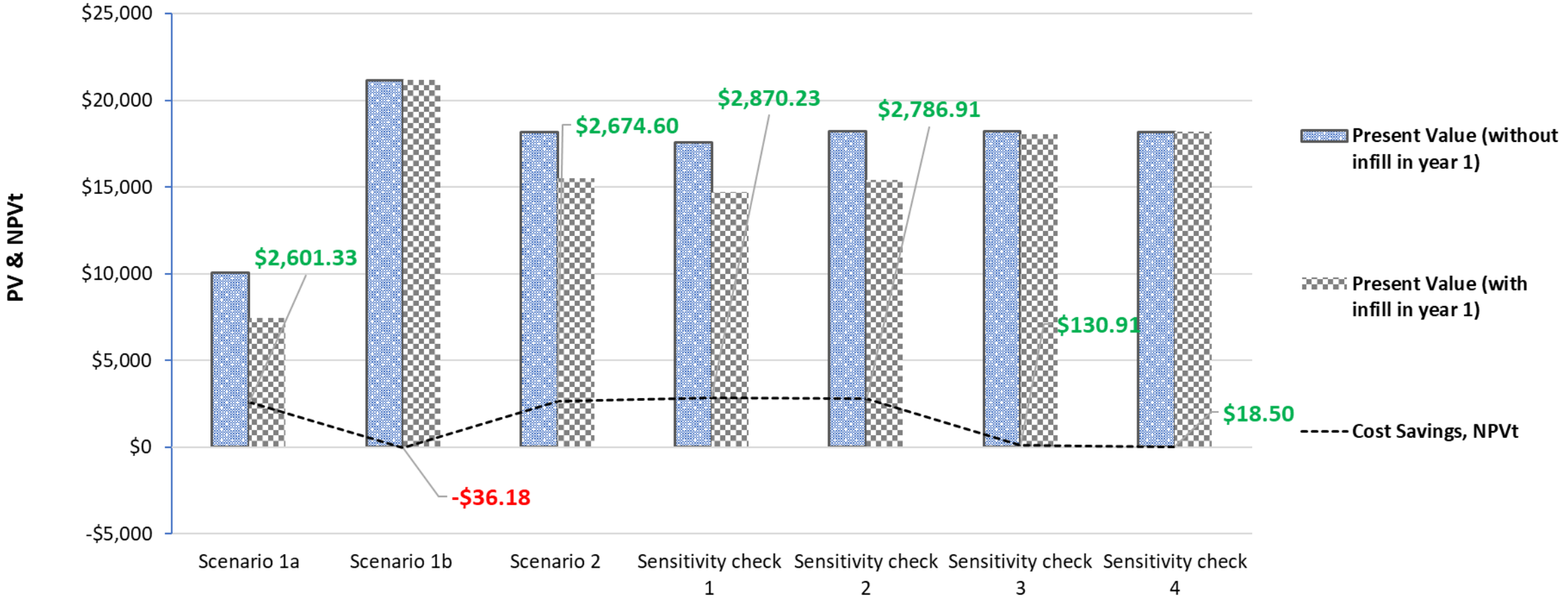
2. 3 reseals & multiple infills



Sensitivity Check

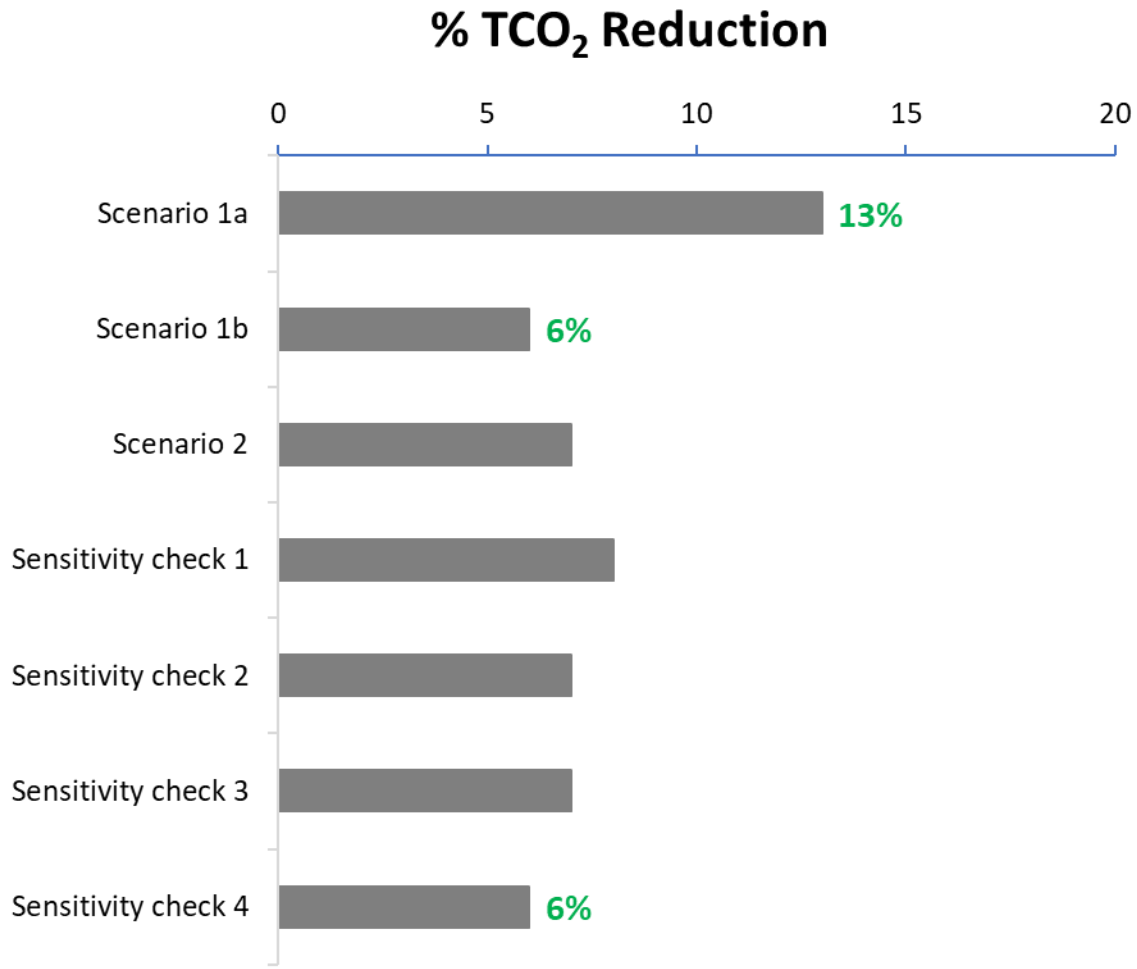


Scenarios – Steps 1 - 4



Carbon Impact – Step 5

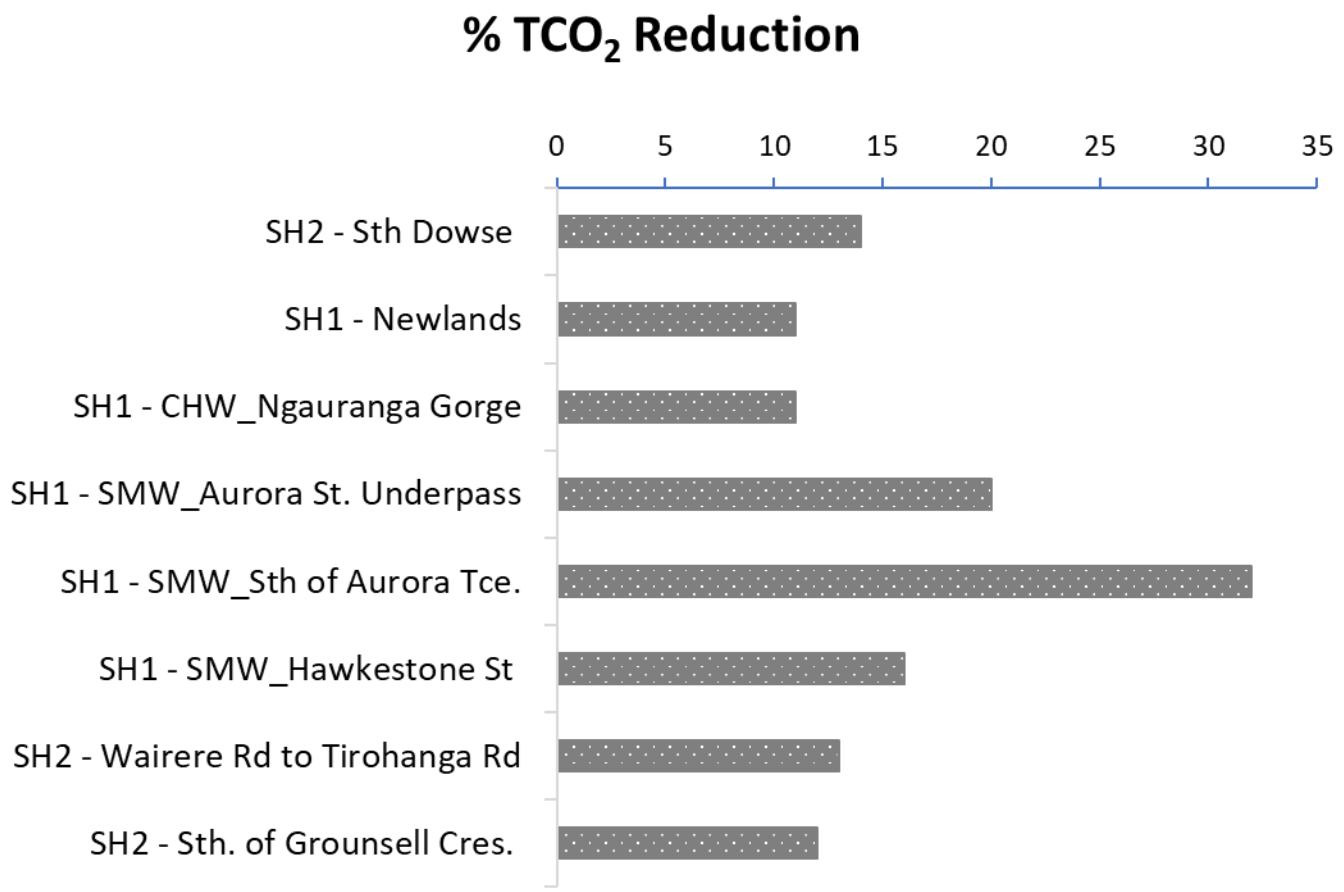
- Re-mark Lengths, m (i.e., reseal & infill lengths)
- EoI per Unit Marking, $tCO_2/km = 2.5 \times 10^{-1}$
- LCV-Diesel, $tCO_2/km = 2.7 \times 10^{-4}$
- Avg. Travel Distance to site, km = 80
- Diesel Emission Factor, $tCO_2/L = 3 \times 10^{-3}$



Carbon Impact – Step 6

- 21/22 AP Justification
- Asset Renewal Prioritisation
- 21-24 NLTP Funding
- Owner Investment Confidence

Avg. (mean) TCO_2 Reduction: 16.13%



RIMS
Roading Infrastructure Management Support

References:

- Akaa O, Douglas D, Arrowsmith D & Darnell M (2022) An asset management methodology for value-for-money reinstatement of pavement markings. *Infrastructure Asset Management*, 40. https://doi.org/10.1680/jinam.21.00026
- Akaa O, Douglas D, Arrowsmith D & Darnell M (2021) Asset management of high-performance structured markings. *New Zealand Road Markers Federation*, 30-35. https://issuu.com/roadmarkingnews/docs/newsletter_october_2021/30

Conclusion

- The ideal GHG reduction outcome could mean doing nothing, but ensuring road safety through markings renewal should include understanding the carbon impact to help us reduce GHG in the future
- Carbon footprint reduction is feasible alongside well-justified road markings renewals
- The Infills method including GHG outcome is sensitive to re-mark length and installation time
- The infills method supports value-for-money outcomes and can be part of a broader MCA for sustainable road infrastructure management decisions.
- Step Change from traditional markings reinstatement practice

Our Carbon Equation