

TRIALING A RESILIENCE ASSESSMENT FRAMEWORK ON CENTRAL AUCKLAND'S CRITICAL ROAD NETWORK

PROJECT #88

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What is Resilience ?



The concept of resilience is wider than natural disasters and covers the capacity of public, private and civic sectors to withstand disruption, absorb disturbance, act effectively in a crisis, adapt to changing conditions, including climate change, and grow over time.

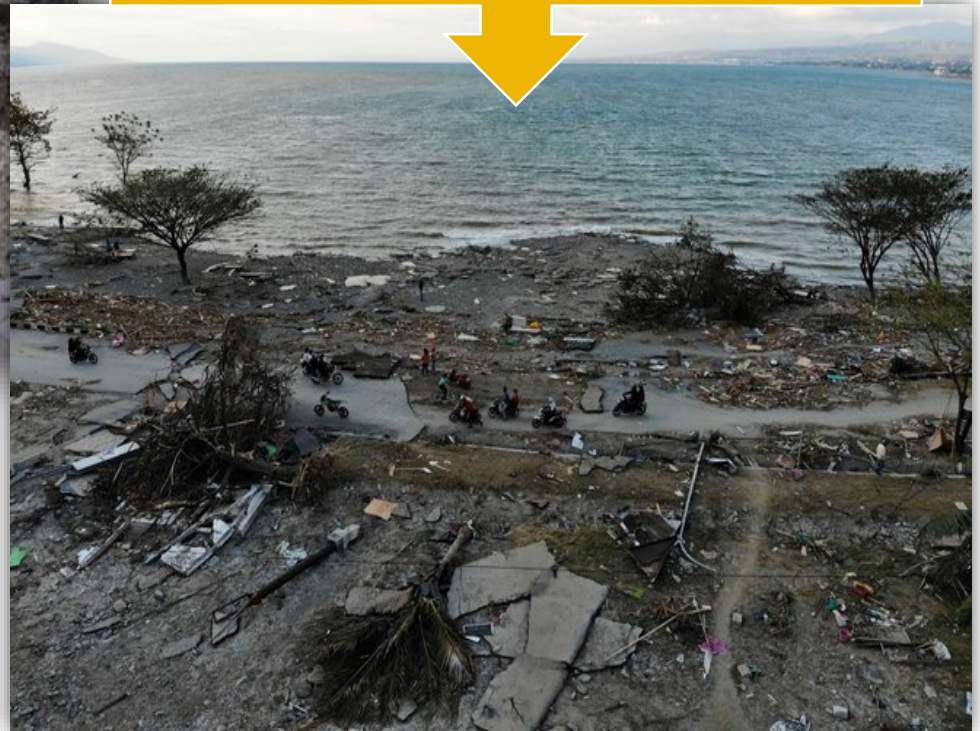
– (NIU, 2011, p. 14)

Why is Resilience Important ?

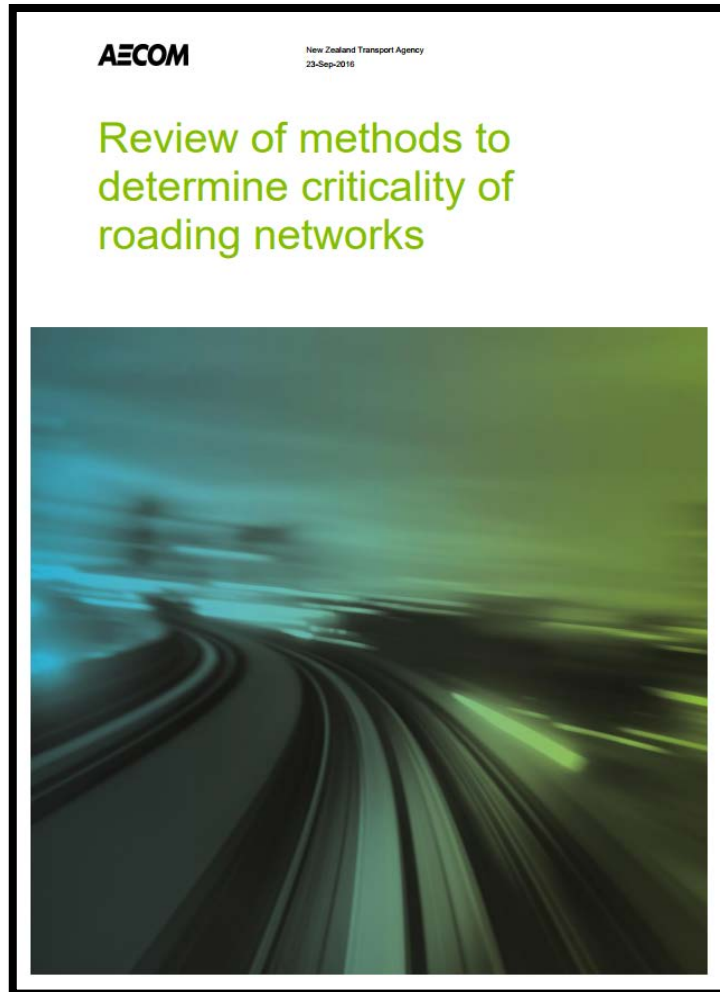


**Christchurch Earthquake
2011**

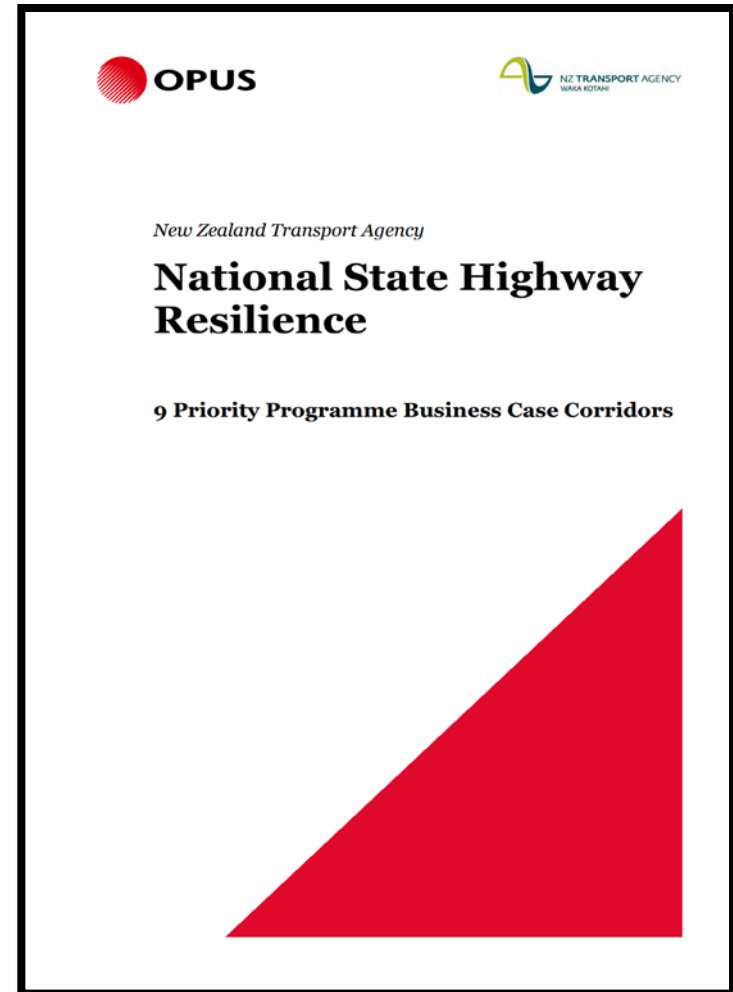
**Indonesian Tsunami
2018**



Resilience Assessment Framework

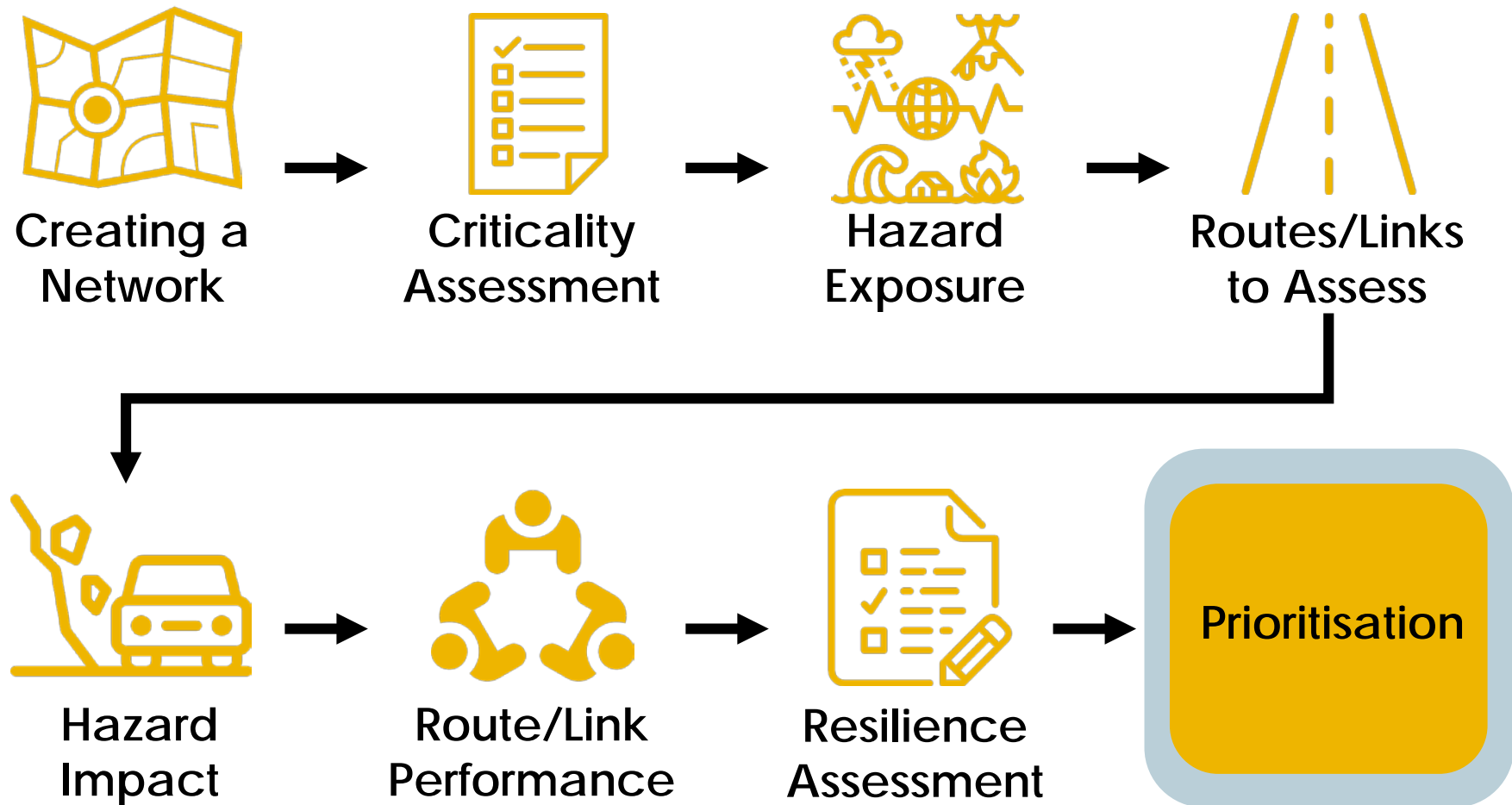


Source: Hughes, 2016

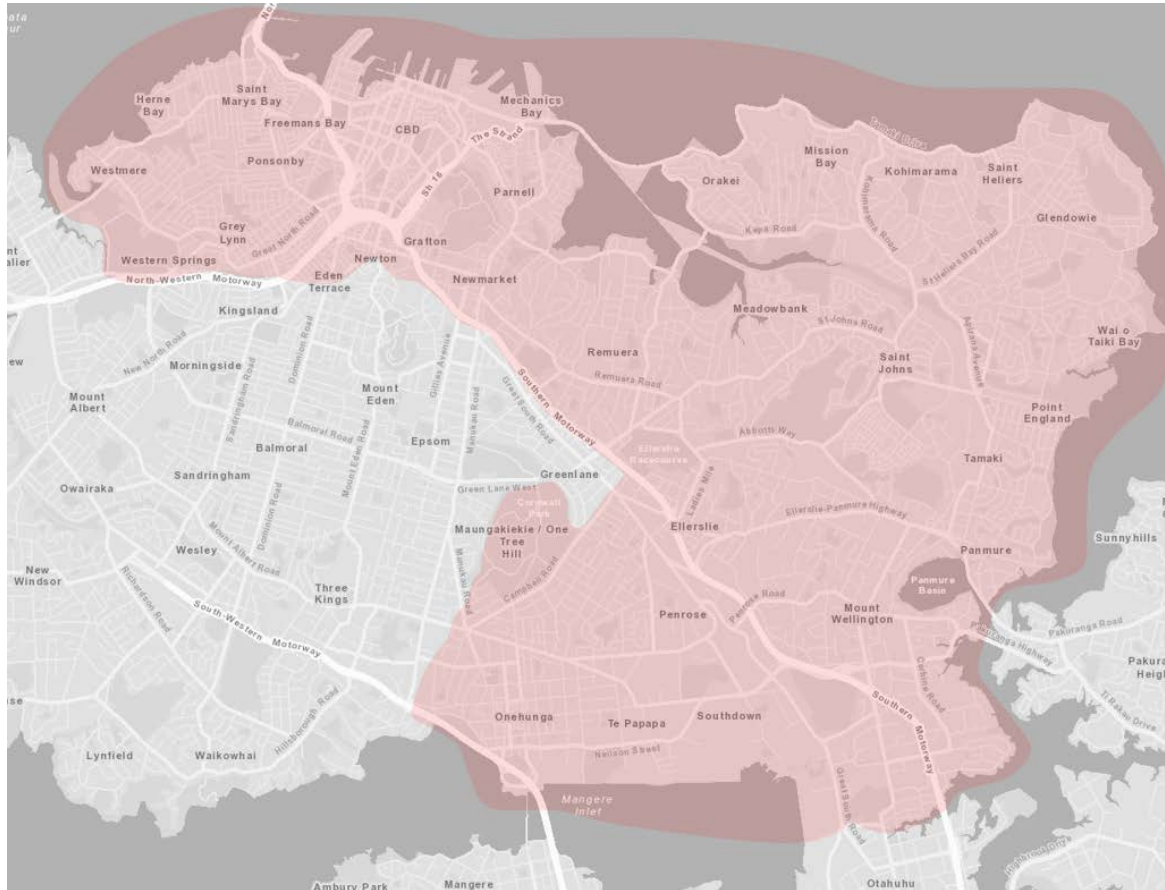


Source: Brabhakaran, 2016

Resilience Assessment Process



Creating a Network



Create
Network

Assess
Criticality

Hazard
Exposure

Assess
Routes

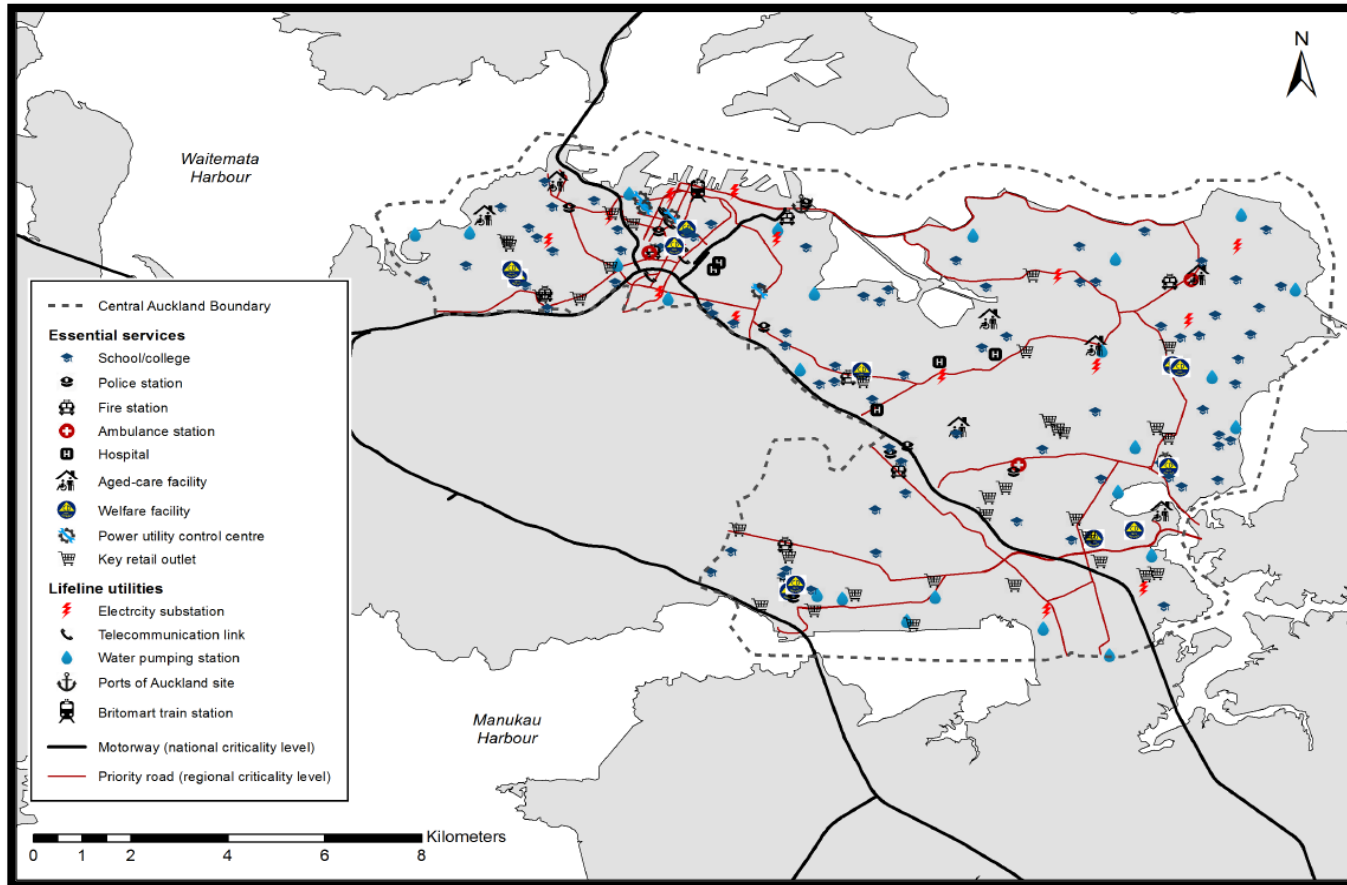
Hazard
Impact

Route
Performance

Assess
Resilience

Prioritise

Criticality Assessment



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Exposure

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Routes

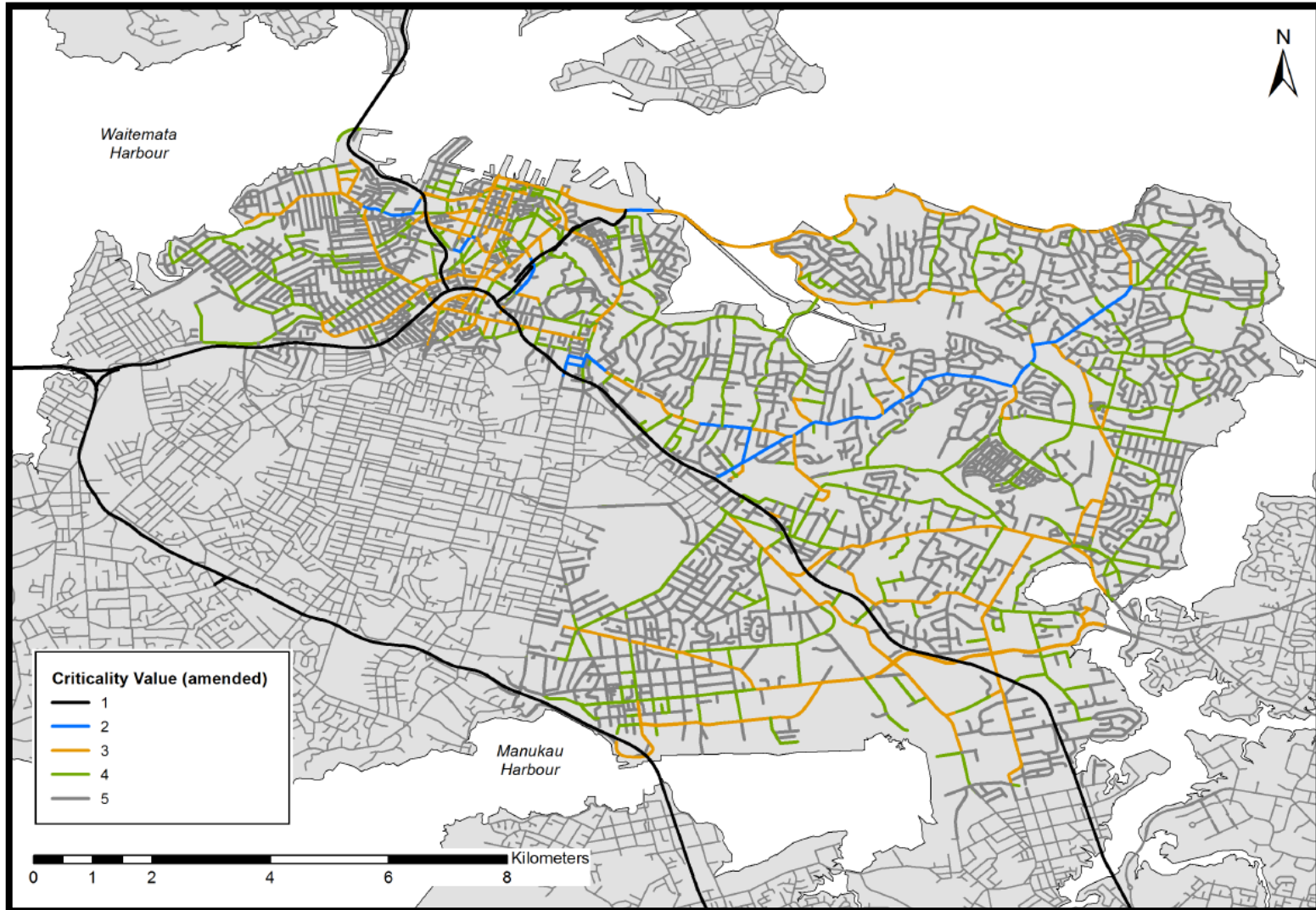
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Criticality Assessment



Hazard Exposure



Rain Storm



Earthquake

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Prioritise

Hazard Exposure



Tsunami



Storm Surge

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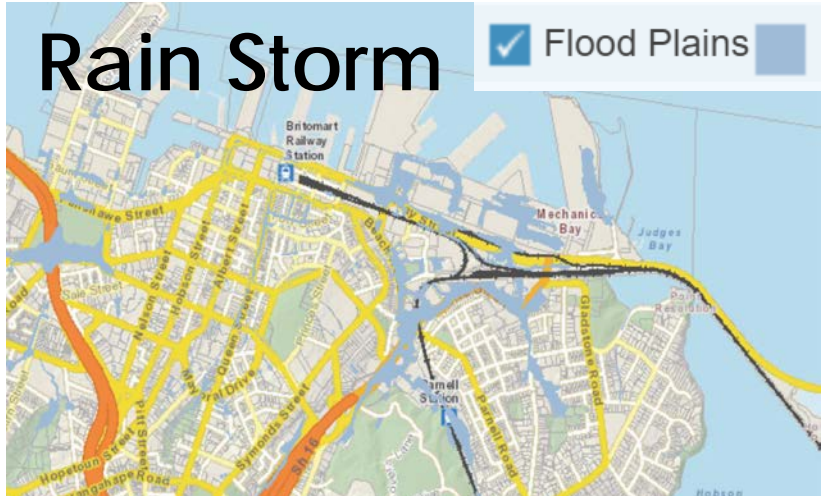
Prioritise

Hazard Exposure



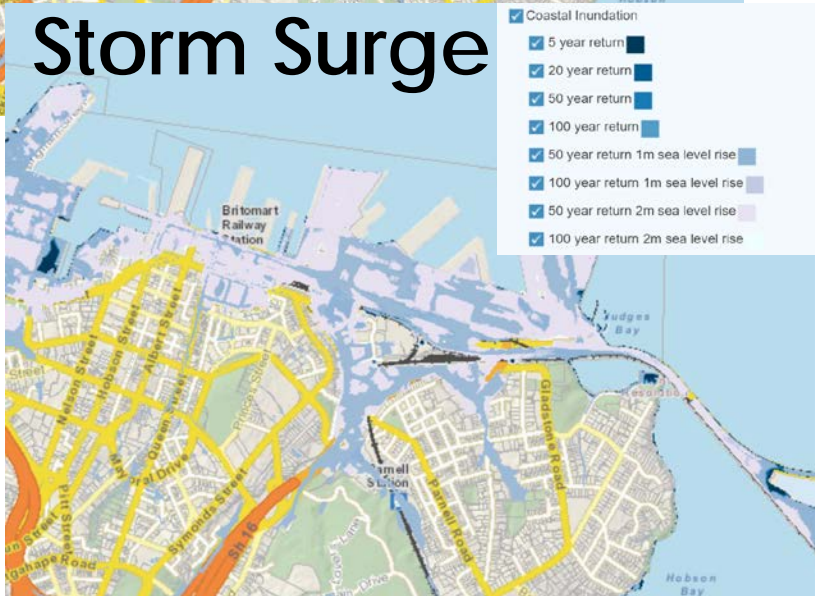
Rain Storm

Flood Plains



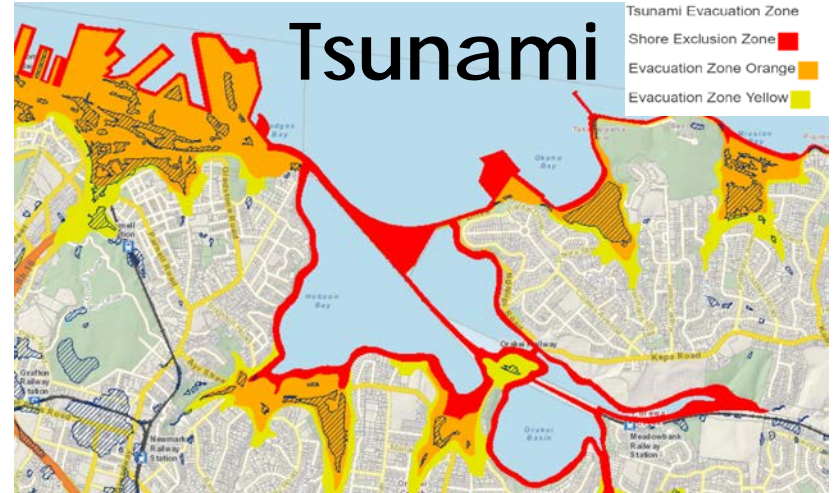
Storm Surge

- Coastal Inundation
- 5 year return
- 20 year return
- 50 year return
- 100 year return
- 50 year return 1m sea level rise
- 100 year return 1m sea level rise
- 50 year return 2m sea level rise
- 100 year return 2m sea level rise



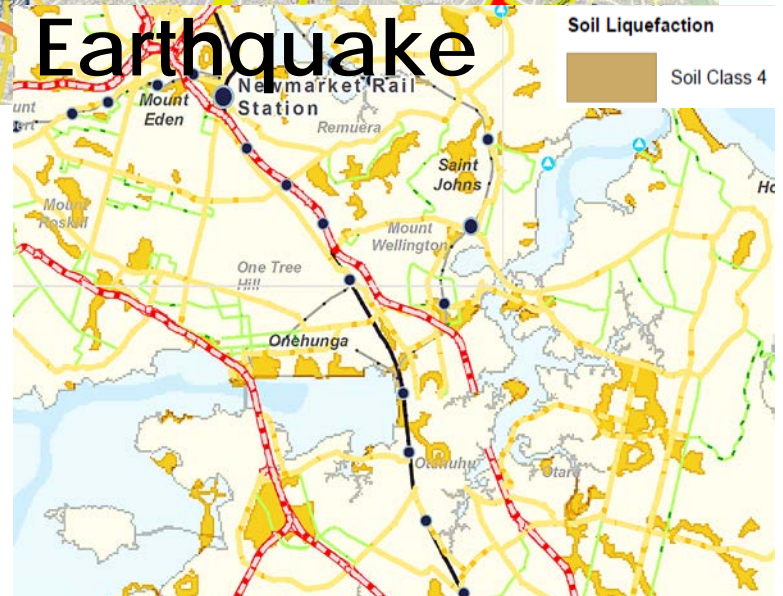
Tsunami

- Tsunami Evacuation Zone
- Shore Exclusion Zone
- Evacuation Zone Orange
- Evacuation Zone Yellow



Earthquake

- Soil Liquefaction
- Soil Class 4



Routes/ Links to Assess



**Criticality
Level**



**Hazard
Exposure**



**Historical
Impacts**

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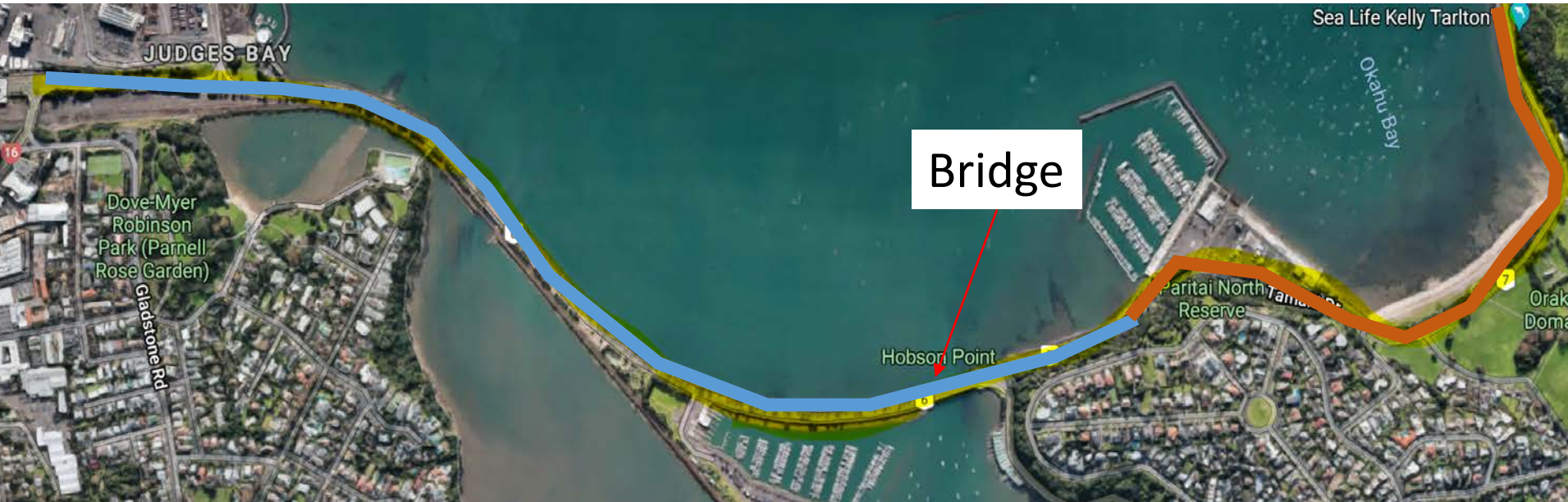
Routes/ Links to Assess



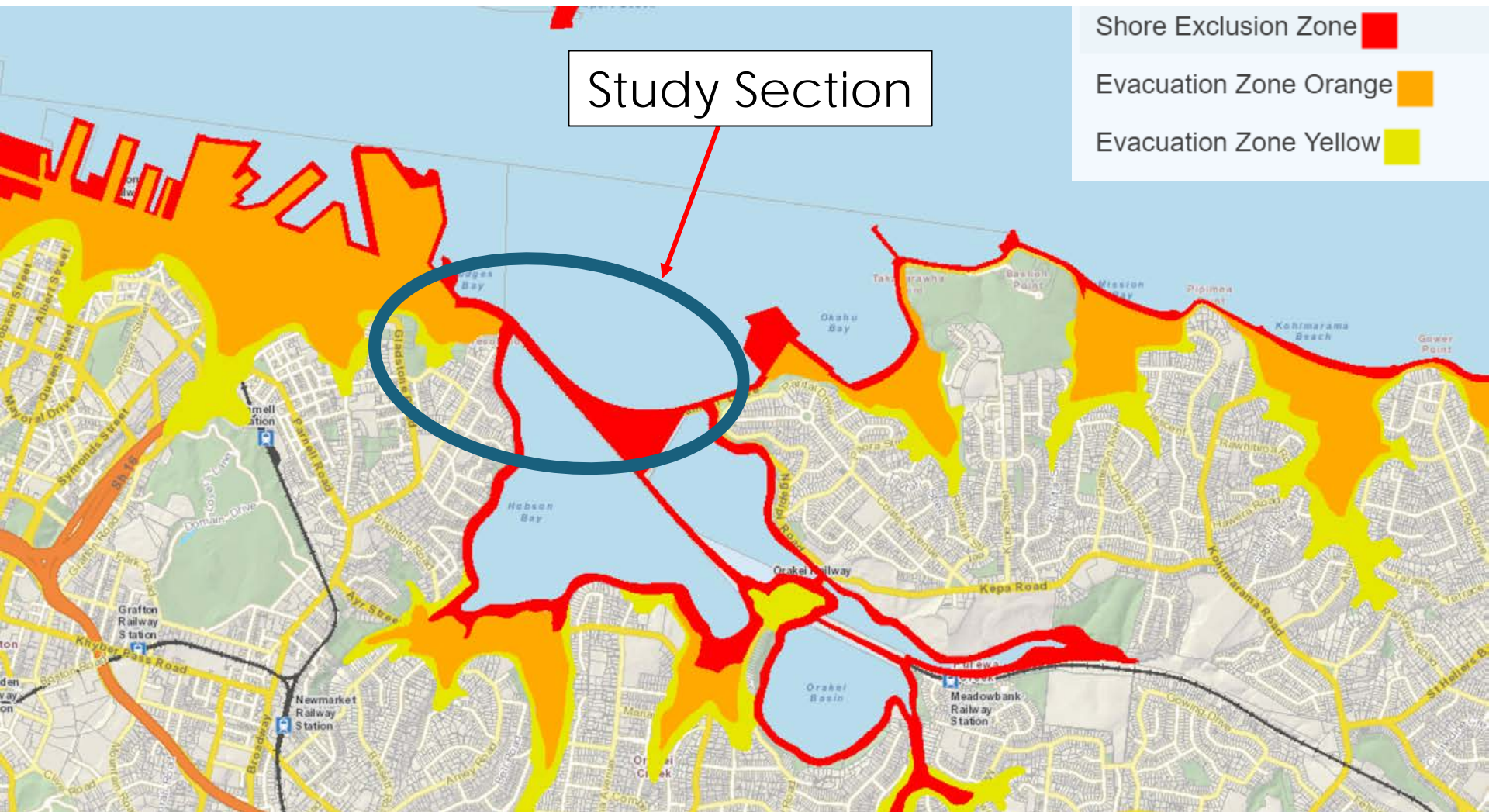
- Ngapipi Road
- Queen Street
- **Tamaki Drive**
- Lagoon Drive
- Onehunga Harbour
- Quay Street
- Remuera Road
- Jellicoe Road
- Parnell Rise



Tamaki Drive



Tamaki Drive



Study Section

Shore Exclusion Zone

Evacuation Zone Orange

Evacuation Zone Yellow

Hazard Impact



- Flat
- Windy
- Low lying
- Close to sea
- Slopes
- Bridge

Physical Road Characteristics



Hazard Impact



In the event of a tsunami, the bridge will be destroyed, disrupting connectivity to the rest of the road.

– Focus Group Discussion

Route Performance



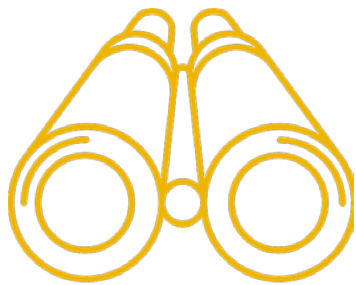
Table 1 Resilience states

| Resilience State | Description of State |
|--------------------|--|
| Damage state | Damage State represents the severity of damage to the road and represents the damage and cost of damage repairs. |
| Availability state | Availability State indicates whether the road section would be able to be used either at full level, at various reduced levels or not at all. This gives an indication of the degree of access on a link after an event. |
| Outage state | Outage State indicates the duration over which the road will be in the Availability State above. This gives an indication of the duration of loss or reduced access in links along the road network. |

Source: Brabhaharan 2016



Route Performance



Hazard Focus:
**Immediately after
tsunami**

| Availability Level | Availability State | Availability Description |
|--------------------|-----------------------------|---|
| 1 | Full | Full access. Road returns to normal operational state. |
| 2 | Poor | Available for slow access, but with difficulty by normal vehicles due to partial lane blockage, erosion or deformation. Temporary signalised lights or stop-go signage established. |
| 3 | Partial Carriageway Closure | Single lane access only with difficulty due to poor condition of remaining road. Limited service with no traffic lights, stop-go signage established. Partial access due to a portion of carriageway remaining closed. |
| 4 | Difficult | Road accessible single lane by only 4x4 off road vehicles. |
| 5 | Closed | Road closed and unavailable for use. |

Adapted from : Brabhaharan 2016



Route Performance



| Outage Level | Outage State | Damage Description |
|--------------|--------------|--|
| 1 | Open | No closure, except for maintenance |
| 2 | Minor | Condition persists for up to 1 day |
| 3 | Moderate | Condition persists for 1 day to 3 days |
| 4 | Short term | Condition persists for 3 days to 3 weeks |
| 5 | Medium term | Condition persists for 3 weeks to 3 months |
| 6 | Long term | Condition persists for > 3 months |

Adapted from : Brabhaharan 2016



Route Performance



| Disruption State | | | Outage State & Level | | | | | |
|-------------------------------|-------------|---|----------------------|------------|---------------|-----------------|------------------|----------------|
| | | | Open 1 | Minor 2 | Moderate 3 | Short Term 4 | Medium Term 5 | Long Term 6 |
| Availability State & Level | Full | 1 | None | None | None | None | None | None |
| | Poor | 2 | None | Limited | Limited | Limited | Moderate | High |
| | Single Lane | 3 | None | Limited | Limited | Moderate | High | Severe |
| | Difficult | 4 | None | Limited | Limited | Moderate | High | Severe |
| | Closed | 5 | None | Limited | Moderate | High | Severe | Extreme |

Adapted from : Brabhakaran 2016



Route Performance



| Disruption Level | Disruption State |
|------------------|------------------|
| 0 | None |
| 1 | Limited |
| 2 | Moderate |
| 3 | High |
| 4 | Severe |
| 5 | Extreme |

Adapted from : Brabhakaran 2016



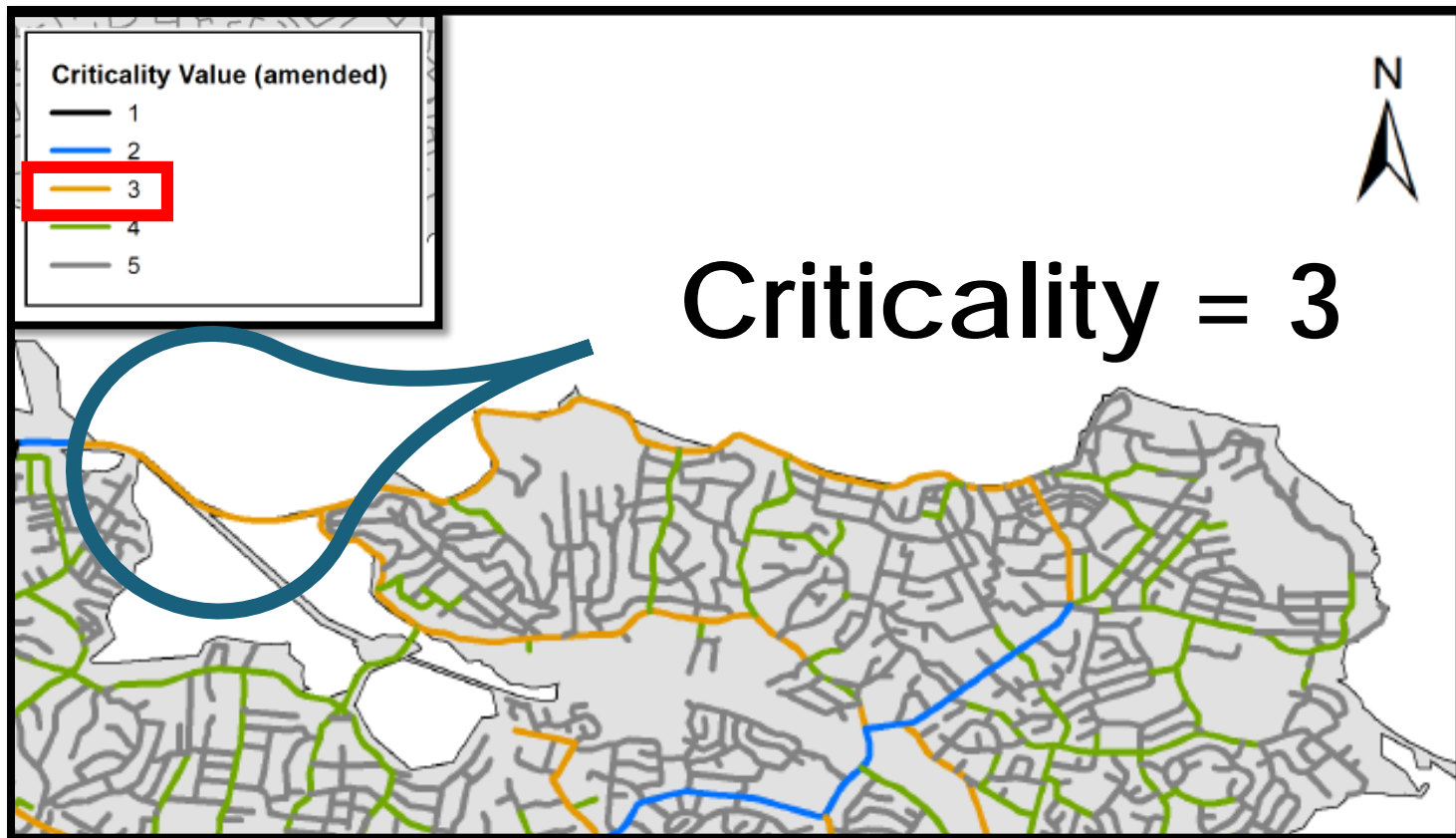
Route Performance



| Natural Hazard | Tamaki Dr (Judges Bay to Paratai North Reserve) | | | | | | | | Criticality | 3 |
|----------------|---|--------|--------------|--------|-------------------|--------|---------------------|--------|--------------|--------|
| | 1 Day | | 3 Days | | 3 Days to 3 Weeks | | 3 Weeks to 3 Months | | >3 Months | |
| | Availability | Outage | Availability | Outage | Availability | Outage | Availability | Outage | Availability | Outage |
| | 5 | 6 | 5 | 6 | 5 | 6 | 5 | 6 | 5 | 6 |
| Tsunami | Disruption State & Level | | | | | | | | | |
| | Extreme - 5 | | | | | | | | | |



Route Performance



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Resilience Assessment



| Resilience State | | | Road Criticality Level | | | | |
|--------------------------|----------|---|------------------------|--------------------|--------------------|-----------------|------------|
| | | | 1 | 2 | 3 | 4 | 5 |
| Disruption State & Level | None | 0 | Acceptable | Acceptable | Acceptable | Acceptable | Acceptable |
| | Limited | 1 | Acceptable | Acceptable | Acceptable | Acceptable | Acceptable |
| | Moderate | 2 | Minor Shortfall | Acceptable | Acceptable | Acceptable | Acceptable |
| | High | 3 | Moderate Shortfall | Minor Shortfall | Acceptable | Acceptable | Acceptable |
| | Severe | 4 | Major Shortfall | Moderate Shortfall | Minor Shortfall | Acceptable | Acceptable |
| | Extreme | 5 | Severe Shortfall | Major Shortfall | Moderate Shortfall | Minor Shortfall | Acceptable |

Note: Resilience State matrix still needs to be validated by Auckland Transport.



Resilience Assessment



| Natural Hazard | Tamaki Dr (Judges Bay to Paratai North Reserve) | | | | | | | | Criticality | 3 |
|--------------------|---|--------|--------------|--------|-------------------|--------|---------------------|--------|--------------|--------|
| | 1 Day | | 3 Days | | 3 Days to 3 Weeks | | 3 Weeks to 3 Months | | >3 Months | |
| | Availability | Outage | Availability | Outage | Availability | Outage | Availability | Outage | Availability | Outage |
| | 5 | 6 | 5 | 6 | 5 | 6 | 5 | 6 | 5 | 6 |
| Tsunami | Disruption State & Level | | | | | | | | | |
| | Extreme - 5 | | | | | | | | | |
| | Resilience State | | | | | | | | | |
| Moderate Shortfall | | | | | | | | | | |

Note: Resilience State still needs to be validated by Auckland Transport.



Resilience Assessment



| Tsunami | |
|--|--------------------|
| Road Name | Resilience State |
| Parnell Rise (Lower end of Parnell Rise) | Acceptable |
| Parnell Rise (Upper end of Parnell Rise) | |
| Quay St (East) | Minor Shortfall |
| Quay St (West) | Minor Shortfall |
| Ngapipi Rd | Acceptable |
| Tamaki Dr (Judges Bay to Paratai North Reserve) | Moderate Shortfall |
| Tamaki Dr (Paratai North Reserve to Okahu Bay) | Minor Shortfall |
| Tamaki Dr (Okahu Bay to St Heliers) | Minor Shortfall |
| Queen St (Victoria St to Britomart) | Acceptable |
| Queen St (K Rd to Victoria St) | Acceptable |
| Lagoon Dr | Acceptable |
| Jellicoe Rd | N/A |
| Remuera Rd | N/A |
| Onehunga Harbour | Minor Shortfall |

Note: Resilience States still need to be validated by Auckland Transport.



Prioritisation



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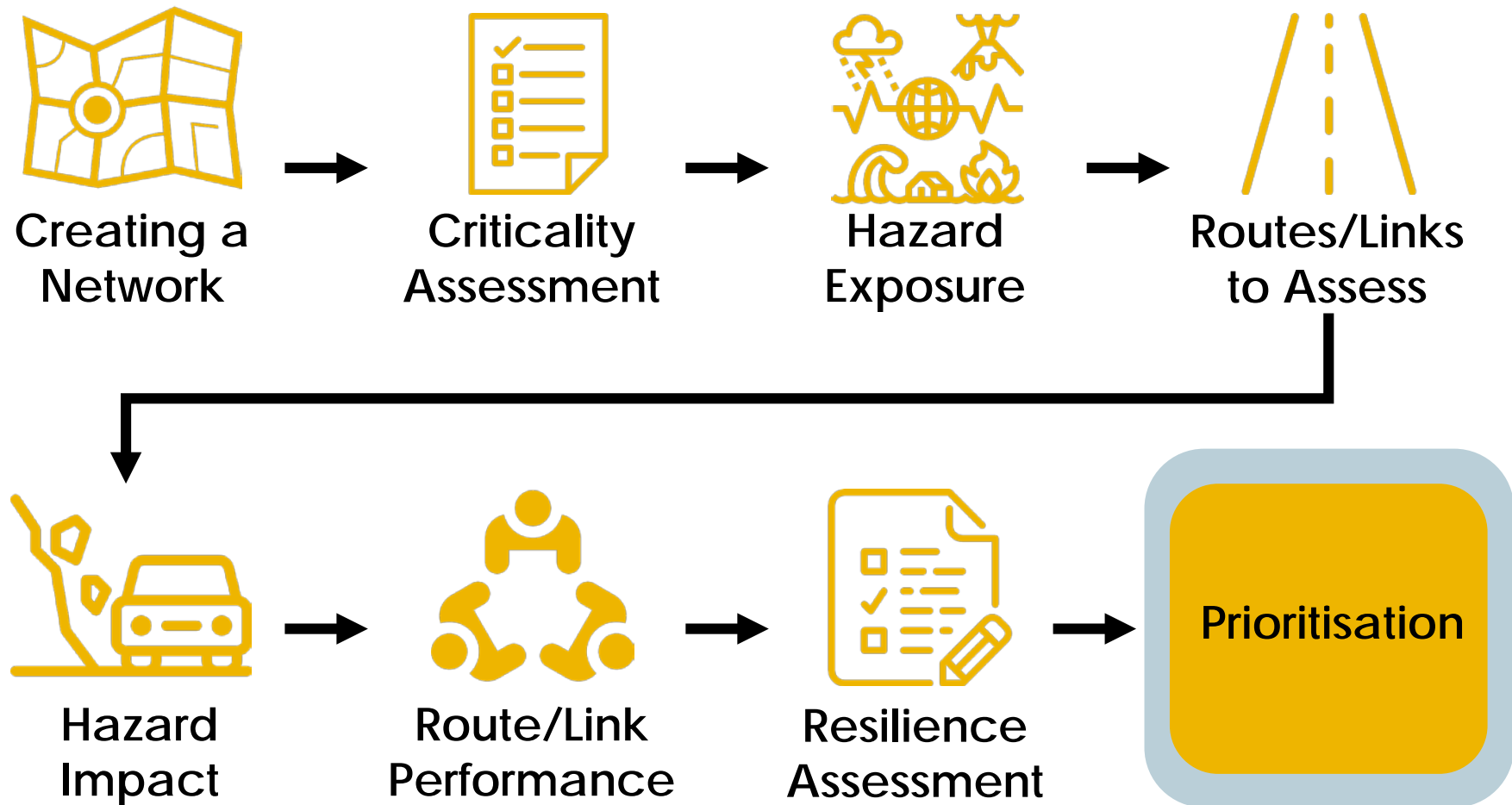
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Prioritise

Conclusions & Recommendations



Acknowledgements

Supervisor: Associate Professor Seosamh Costello

Auckland Transport: May Oo

**Auckland
Transport**
An Auckland Council Organisation



An aerial photograph of Toronto, Ontario, Canada, showing the city skyline, the CN Tower, and the surrounding water bodies. The image is used as a background for the text.

Questions

Thank you