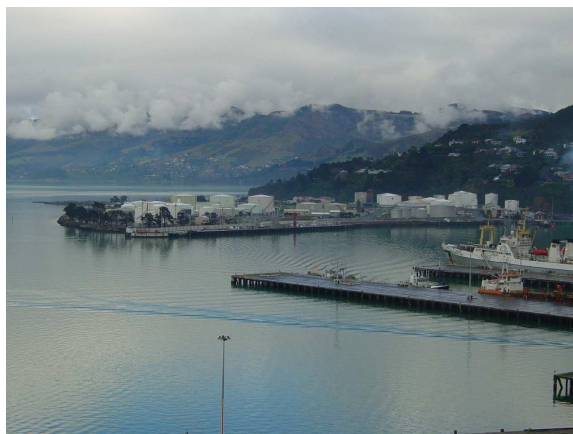


Canterbury Engineering Lifelines Group

Hazard Assessment for Petroleum Storage, Transportation and Supply - Update
October 2007

Stage 1

Overview



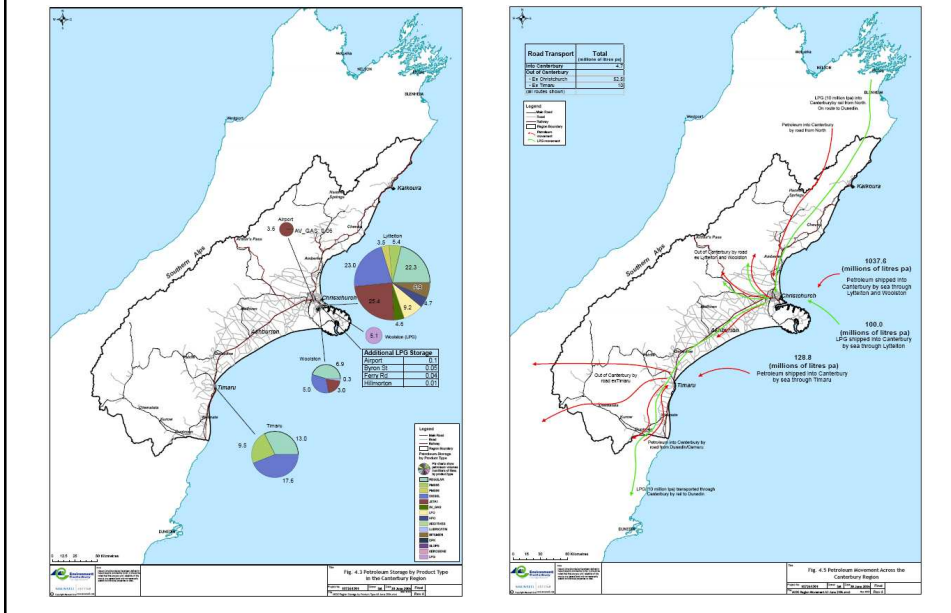
Study Brief: Stage 1 Summary

- Brief literature review
- Nature & location of petroleum storage
- Classification of petroleum products
- Volumes transported, key routes, crash data
- Scale, likelihood and impact of natural and technological hazard events on petroleum storage facilities
- Assess vulnerability of storage facilities to these events
- Develop methodology to assess and present risks
- Comment on risks and potential risk management measures

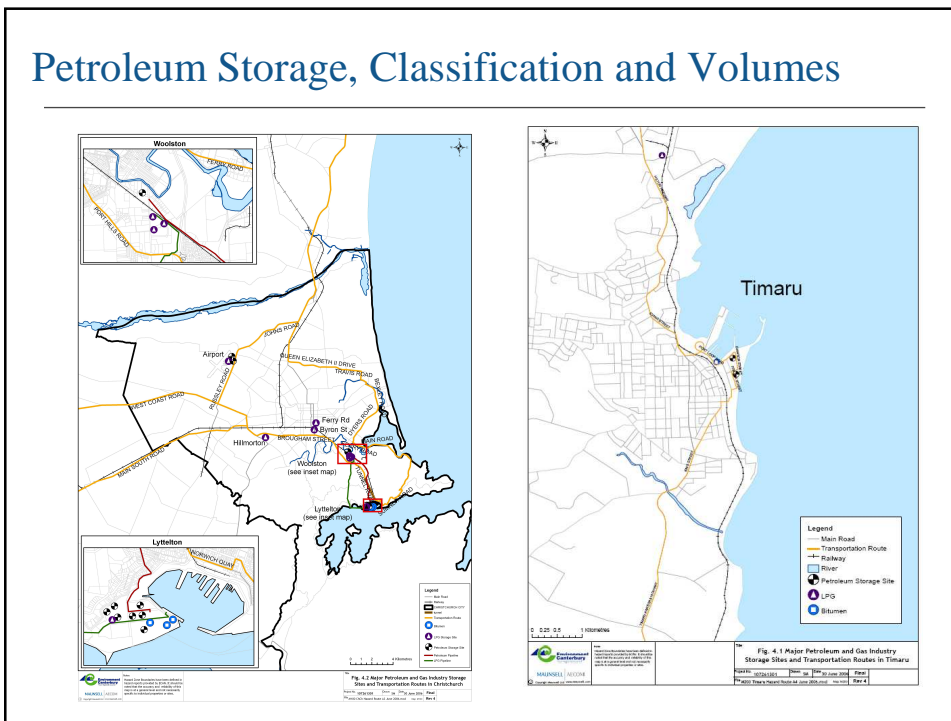
Stage 1 Approach

- Questionnaire and follow up contact with oil companies – good results for storage and distribution data
- Visits to key storage facilities in Christchurch and Timaru
- Digitised hazard information on GIS
- Development of the risk assessment framework for assessing hazards impacts
- Study is broadly focussed and captures much factual data, rather than detailed engineering investigations

Petroleum Storage, Classification and Volumes

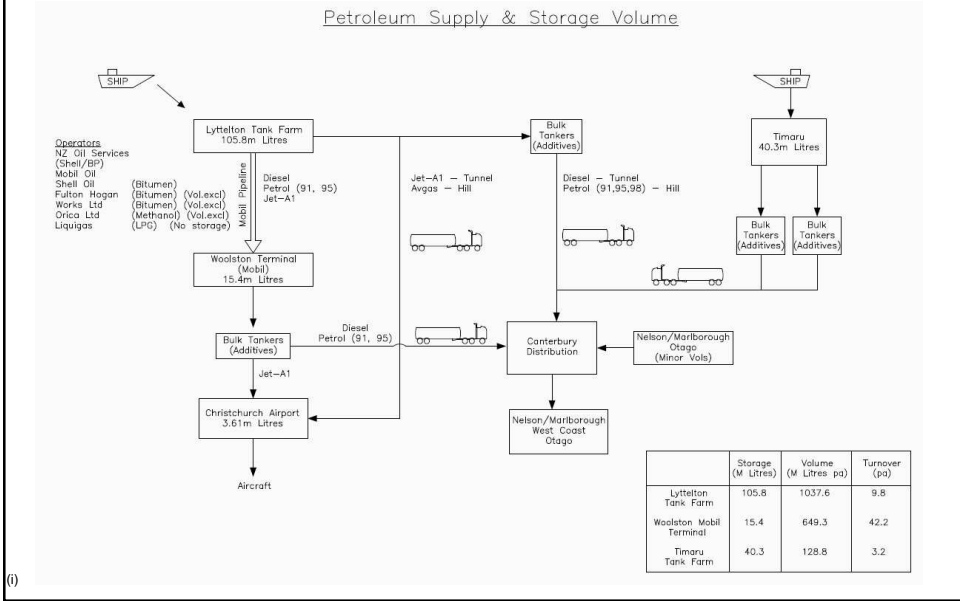


Petroleum Storage, Classification and Volumes



Petroleum Storage, Classification and Volumes

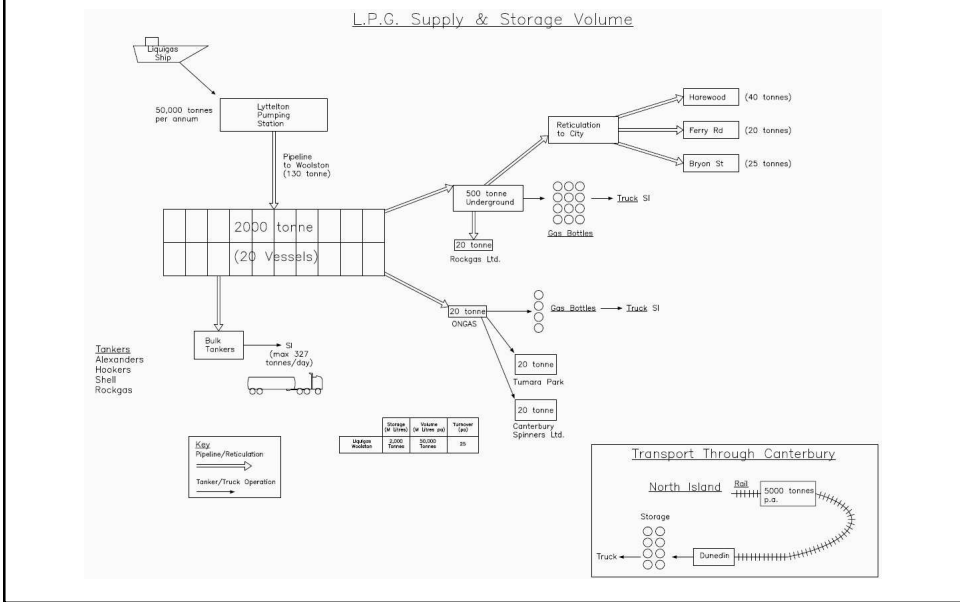
Schematic – excluding gas



(f)

Petroleum Storage, Classification and Volumes

Summary schematic – gas only



Hazard Events

| TYPE OF HAZARD | DESCRIPTION OF HAZARD EVENT |
|-----------------------|---|
| Natural Hazards | Flooding Earthquake (including liquefaction) Tsunami Slope stability Coastal flooding, storm surge and erosion Meteorological – eg wind, snow, lightning Fire (including wildfire) |
| Technological Hazards | Computer failure Power failure Telecommunications failure Personnel / Human factors Failure of water and wastewater systems Incidents (eg accident) Terrorism and Sabotage Biological / Pandemic |

Risk-Based Vulnerability Analysis

Summary

| Facility | Flooding | Seismic / Liquefaction | Tsunami | Slope Failure | Coastal | Meteorological | Fire | Computer failure | Loss of Power | Telecommunications | Personnel / Human | Water / Wastewater | Incidents | Terrorism | Pandemic |
|----------------------------|----------|------------------------|---------|---------------|---------|----------------|------|------------------|---------------|--------------------|-------------------|--------------------|-----------|-----------|----------|
| Lytelton Tank Farm | L | H | M | M | L | M | E | M | H | M | H | M | M | H | H |
| Woolston Mobil terminal | M | H | M | na | na | M | E | M | H | M | H | M | M | H | H |
| Mobil Pipeline | na | H | M | M | na | M | H | M | H | M | H | M | M | H | H |
| Woolston Liquegas terminal | M | M | L | na | na | L | M | M | M | M | H | M | M | H | H |
| Liquegas Pipeline | na | M | L | M | L | na | M | M | M | M | H | M | M | H | H |
| Rockgas Woolston | M | M | L | L | L | M | M | M | M | M | H | M | M | H | H |
| Christchurch Airport | M | M | na | na | na | M | M | M | M | M | H | M | M | H | H |
| Timaru Shell Tank Farm | L | M | M | na | L | M | M | M | M | M | H | M | M | H | H |
| Timaru Caltex Tank Farm | L | M | M | na | M | M | M | M | M | L | H | M | M | H | H |

Stage 1 Recommendations

1. Circulate non-confidential information to oil industry, CDEM, Lifelines stakeholders
2. Comment and verification from oil industry
3. Impacts of Personnel and Pandemic type issues
4. Staff issues in relation to Lifelines business continuity
5. Impacts of interdependencies and multiple hazard events
6. National supply and storage implications – CDEMG, oil industry, MCDEM
7. Increase sector cooperation re emergency supply arrangements
8. Regular communication CDEMG and oil industry
9. Flexible vs fixed joints at tanks
10. Geotechnical review of two pipeline routes over the Port Hills

Stage 1 Recommendations, continued

11. On-site emergency power generation at storage facilities, and manual gravity feed
12. Geotechnical database for LPC
13. Maintain up to date storage data and implementation progress
14. CDEMG to monitor risk reduction measures described
15. Communicate cascade failure effects to lifelines agencies for their planning, review sources of supply

Stage 2

Update – Distribution and Supply



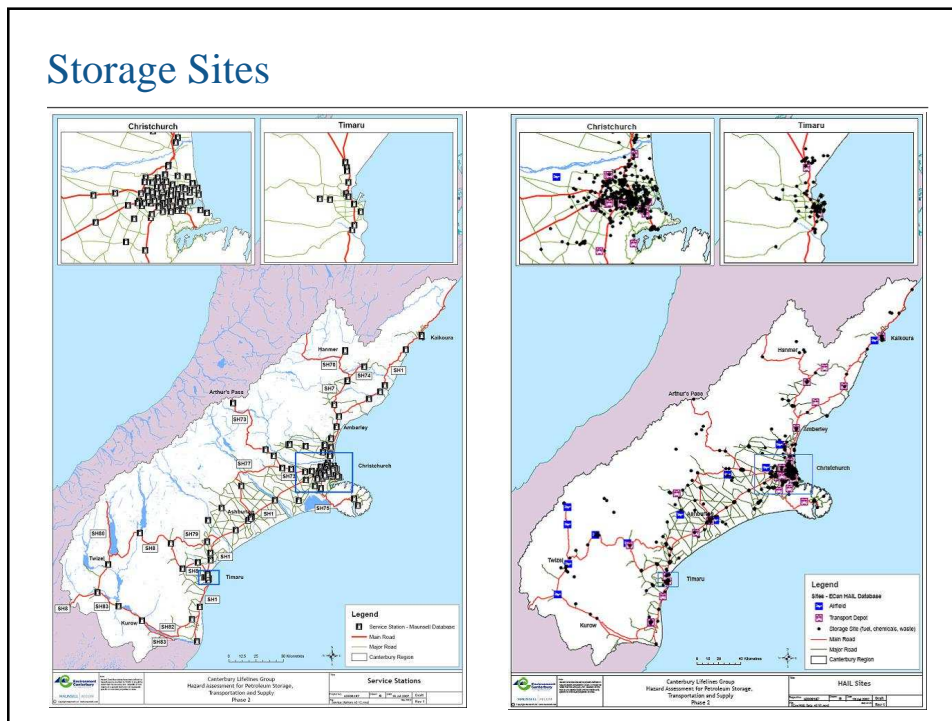
Study Brief: Stage 2

9. Discussion with petroleum companies, and collection of data on petroleum transportation and supply in the Canterbury region
10. Assessment of the vulnerability of petroleum transportation and reticulation between port facilities and depots to natural and technological hazards
11. Development of a scenario assessing the effects on the supply of fuel from an MM7 earthquake resulting in liquefaction in liquefaction prone areas
12. Development of scenarios assessing the impact of petroleum spillage on engineering lifelines, specifically telecommunications duct network
13. Integrating the hazard and vulnerability to assess the potential risk to the supply of fuel
14. Identify who the petroleum companies supply over 5,000 litres (tank size) to.
15. Identify the scale, likelihood and impact of potential hazardous events arising from the impact of natural and technological hazards on petroleum transportation and supply in the Canterbury region
16. Identify arrangements for the supply of petroleum fuel for emergency response vehicles (and aircraft) and to standby equipment for essential services (eg water supply / wastewater pumping) during a catastrophic emergency event
17. Obtain a copy of the certificate of safety for the Mobil Oil Lyttelton pipeline

Study Brief: Stage 2 continued

18. Identify how many mobile tankers are within Canterbury region generally, and determine delivery patterns to cities and rural areas and methods of fuel dispensation (i.e. by hose/nozzle) and if it is possible to obtain fuel from large tankers without electrical power
19. Identify the locations of manual mobile fuel dispensing equipment at the bulk fuel installations
20. Identify which petrol stations have means of dispensing fuel from underground tanks if no electrical power available
21. Identify which petrol stations have a pre-catastrophic event agreement in place to ensure supply during an emergency
22. Identify national/regional arrangements petrol companies have during emergencies to co-ordinate fuel supply to emergency services and to report to the Civil Defence Emergency Management Group Controller
23. Develop an appropriate methodology to, collect and compile the petroleum transportation and supply and natural and technological hazard information, integrate the petroleum transportation and supply and natural and technological hazard event information to assess the potential risk, and present the risk information in a clear and concise way.
24. Assess and comment on risks and potential risk management measures to assist in planning for risk mitigation and emergency management.

Storage Sites



Storage Characteristics

Service Station Volume (Litres)

| Volume City/District | Fuel Type | | | | | | Total |
|-------------------------|------------------|---------------|----------------|------------------|------------------|------------------|-------------------|
| | Diesel | Kerosene | LPG | Petrol 91 | Petrol 96 | Petrol 96/91 | |
| Ashburton | 349,660 | 11,659 | 19,500 | 265,500 | 183,400 | 282,730 | 1,112,449 |
| Christchurch | 2,152,950 | | 145,584 | 2,465,500 | 1,831,900 | 1,615,700 | 8,211,634 |
| Hurunui | 300,000 | | 7,000 | 130,000 | 59,000 | 282,184 | 778,184 |
| Kaikoura | | | 8,000 | | 35,000 | 221,000 | 264,000 |
| Mackenzie | 100,000 | | | 119,000 | 20,000 | 110,000 | 349,000 |
| Selwyn | 248,400 | 209 | 7,500 | 188,000 | 93,000 | 187,950 | 725,059 |
| Timaru | 532,550 | | 32,137 | 202,000 | 75,600 | 433,734 | 1,376,021 |
| Waimakariri | 110,000 | | | 110,000 | 60,000 | 109,400 | 389,400 |
| Waimate | 40,000 | | | 20,000 | 10,000 | | 70,000 |
| Waitaki | 105,000 | | | 105,000 | 80,000 | | 290,000 |
| Unknown | | | | 9,000 | 13,000 | | 22,000 |
| Total | 3,938,560 | 11,868 | 219,721 | 3,614,000 | 2,460,900 | 3,342,698 | 13,587,747 |

Storage Characteristics

Other Tanks Volume (Litres)

| Volume City/District | Fuel Type | | | | | | Total |
|-------------------------|----------------|-------------------|----------------|------------------|------------------|-------------------|-------------------|
| | AVGAS | Diesel | JET A1 | Kero | LPG | Petrol 96/91 | |
| Ashburton | | 808,284 | | 164,146 | 67,490 | 344,460 | 1,408,380 |
| Christchurch | 15,000 | 11,160,964 | 15,000 | 2,148,446 | 2,585,397 | 12,250,564 | 28,236,121 |
| Hurunui | | 339,090 | 24,300 | | 28,160 | 340,105 | 731,655 |
| Kaikoura | | | | | 0 | | 0 |
| Mackenzie | 43,638 | 199,067 | 188,654 | | 21,490 | 339,578 | 792,427 |
| Selwyn | | | | | 12,000 | | 12,000 |
| Timaru | 104,000 | 1,499,905 | 50,000 | 66,000 | 98,471 | 556,648 | 2,375,024 |
| Waimakariri | | | | | 8,000 | | 8,000 |
| Waimate | 0 | | | | | | 0 |
| Grand Total | 162,638 | 14,007,310 | 277,954 | 2,378,592 | 2,821,008 | 13,831,355 | 33,563,607 |

Storage Issues

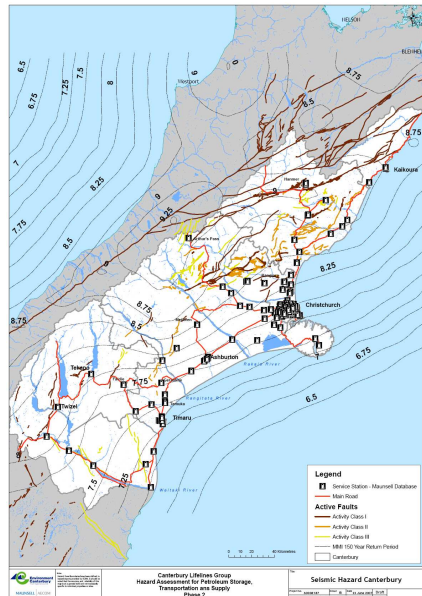
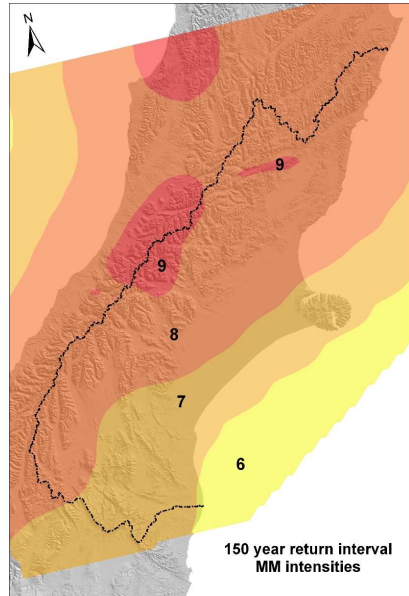
- Consistent data hard to get from multiple sources
 - Missing data
- Fuel leakage and groundwater contamination
 - Global trend to greater environmental protection
- More supply tanks above ground
- Fibreglass tanks vulnerable to earthquake damage – eg connections
 - Move towards more steel or contained fibreglass
 - Joint ductility important
- Service stations vulnerable – typically no power back-up
- No on-line data on actual fuel levels
 - 160 m litres maximum in bulk storage
 - At least 50 m litres in distributed storage

Transportation Characteristics

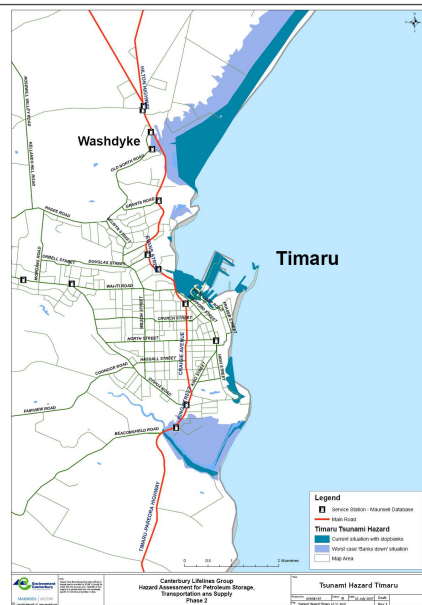
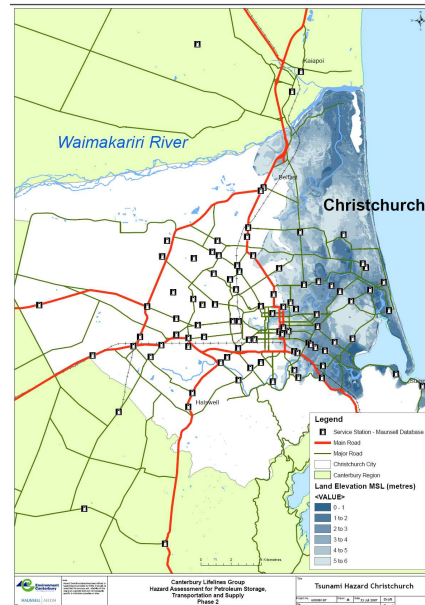
- Specialised transportation operators
- Modern vehicle fleets
- Typically 30 to 35,000 litre configurations
- Tankers are empty overnight
- Moving to cam-lock system only, nozzle pumps only for farm type deliveries
- Mobile tankers will become more important for emergency events



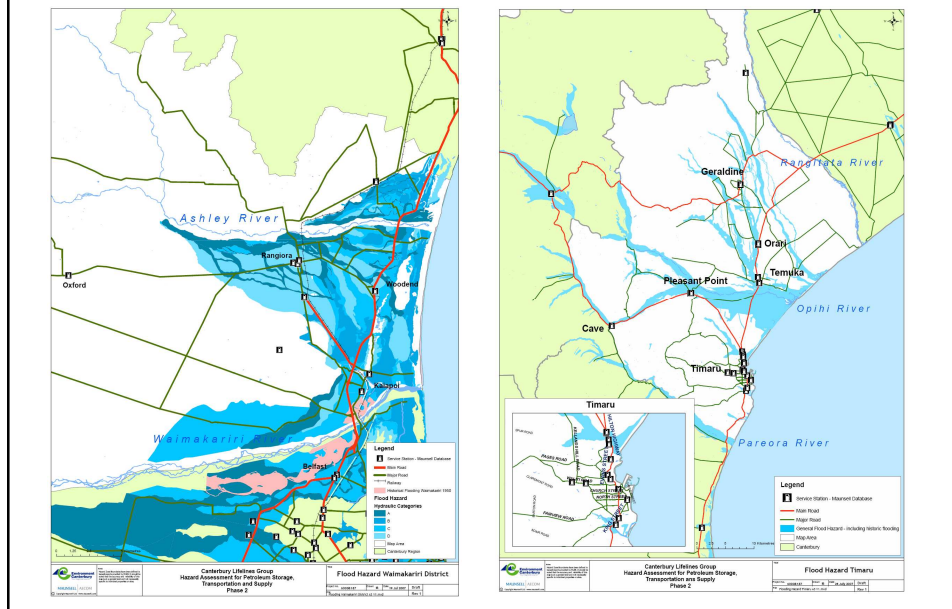
Seismic Hazard



Tsunami Hazard



Flooding Hazard (typical)



Effects of Hazards

- Transportation disruption
 - Multitude of effects
 - Snow a particular and regular issue
 - Low risk tolerance
 - Pandemic / people issues
 - Priority can be shifted – eg farm vs other deliveries
- Storage tanks
 - Seismic effects
 - No data on how well private above ground tanks are designed
 - Below ground tanks with low ductility subject to damage
 - Flooding / tsunami
 - Damage to dispensers
 - Flood level relative to height of vent pipe / quality of seals at filling points
 - Lack of stand-by power at service stations



Emerging Actions and Recommendations

- Add to Stage 1 recommendations
- Industry feedback and comment will be vital in finalising the study findings
- Industry developed mitigation actions for service stations
 - Framework to be proposed
- Back-up power capability in key service station sites
 - Retrofit if necessary
 - Arrangements with emergency services
- Database improvements
- Feed information into other lifeline utility and emergency services planning
- National industry based response planning arrangements
- Build on AELG Petroleum Contingency Plan with MCDEM
- Identify key lessons for other regions