Attachment 1: Defining Critical Lifeline Utility Assets

Nationally Significant Assets (Criticality 1):

Impact of failure is:

- Loss of supply to most of the Auckland region, and/or significant impact on other regions, and/or reduction in service across the country.
- Loss of supply to a nationally significant customer (ie: sites listed on the 'critical sites spreadsheet that have a rating of '1' for site criticality).

Examples of Criticality 1 assets include:

- Otahuhu and Henderson substations and 220kV transmission cables north from Otahuhu
- Mayoral Drive telecommunications exchange
- Ardmore WTP, Huia WTP, Wairoa and Ardmore No 2 raw water tunnels, , Hunua No. 3 (Raw and Treated) and Huia No 2 watermains; North Harbour No 1 & North Shore No 1 & 2 watermains, Huia raw watermain , Smiths Tunnel, Huia Raw water aqueduct
- Mangere and Rosedale WWTPs
- State Highway 1 and 16
- Roads at 'hotspot' locations (because if they fail they take out other significant infrastructure)

Regionally Significant Assets (Criticality 2):

Impact of failure is:

- Loss of supply to more than 20,000 customers or reduction in service across most of the region.
- Loss of supply to a regionally critical customer (ie: sites listed on the 'critical sites spreadsheet that have a rating of '1' for site criticality).

Examples of Criticality 2 assets include:

- Other Transpower sub-stations. Vector/Counties Power substations supplying regionally critical customers.
- Watercare - Waikato Raw Water PS and WTP, Pukekohe WTP and major treated water pump stations, reservoirs and trunk mains. Wastewater Army Bay and Pukekohe WWTP and PS (top 15 by volume) and major sewer interceptors.

Locally Significant Assets (Criticality 3):

Impact of failure is:

- Loss of supply to more than 5,000 customers or reduction in service across part the region.
- Loss of supply to a locally significant customer.

Examples of Criticality 3 assets include:

- Smaller community water supplies (eg: Wellsford, Warkworth, Helensville, Waiuku) and Wastewater TP's (eg: Beachlands, Wellsford, Warkworth, Helensville, Waiuku).

All other assets (Criticality 0).

General principles in applying the methodology:

a) Criticality is defined only in terms of the consequence of failure such as the numbers and types of customers affected. The likelihood of failure is not relevant (eg: just because it is in a flood prone area does not make it critical).

b) If alternative arrangements can be put in place before serious financial and/or social problems emerge, either:
   - by the utility themselves, through network reconfiguration, or
   - by critical customers with alternative supplies on-site such as generators or water tanks then reduce the criticality rating down one rank. As part of this step, make a broad assessment of how long users can function using their own alternative supplies (if it is less than 2 days, that should not be considered to provide sufficient redundancy).

   Brief assumptions should be stated as to how 'sufficient redundancy' can be provided.

c) In determining the criticality level, assume that general demand is sustained (i.e. at this stage we are only considering failure of that asset alone rather than the broader consequences of a larger disaster).

Attachment 2: References

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Attachment 3: Earthquake / Structure Damage Matrix

Structure	Range of Ground Acceleration (PGA) and Modified Mercalli Felt Earthquake Intensities (MMI)							
	MMI ≤ VI 0.05 – 0.10g	MMI VI – VII 0.10 – 0.15g		MMI VII – VIII 0.15 – 0.20g		MMI > VIII > 0.20g		
	No risk of liquefaction	Minor Risk of Liquefaction		Some Risk of Liquefaction		Non-Liquefiable Soils		Liquefiable Soils
		Slopes A/B[1]	Slopes C/D	Slopes A/B	Slopes C/D	Slopes A/B	Slopes C/D	
PIPEWORK								
Moderately ductile pipes	Negligible	Negligible	Low probability	Negligible	Moderate probability	Negligible	Moderate probability	High probability
Low strength of low ductility pipes (includes underground services duct)	Negligible	Negligible	Low probability	Low probability	High probability	Low probability	High probability	High probability
Non-ductile pipes	Low probability	Low probability	Moderate probability	Low probability	High probability	Moderate probability	High probability	High probability
CONNECTIONS & FITTINGS								
Seismically designed (eg HDPE; steel pipe with expansion loops)	Negligible	Negligible	Negligible	Low probability	Low probability	Moderate probability	Moderate probability	High probability
Rubber joints (modern spun concrete or plastic pipes laid in ground)	Negligible	Negligible	Negligible	Low probability	Moderate probability	Moderate probability	High probability	High probability
Cement Joints (old; very common)	Negligible	Low probability	Moderate probability	Low probability	High probability	High probability	High probability	High probability
BUILDING STRUCTURES								
Modern multi-storey	Negligible	Negligible		Low probability		Low to moderate probability		Moderate probability
Older multi-level brick/masonry	Negligible	Moderate probability		High probability		Very high probability		Very high probability
Residential	Negligible (timber frame) to low probability (brick)	Negligible (timber frame) to moderate probability (brick); old brick chimneys break off		Low probability (timber frame) to high probability (brick); old brick chimneys break off		Low probability (timber frame) to very high probability (brick); old brick chimneys break off		High to very high probability
SERVICES								
Power lines/lamp posts	Negligible	Negligible		Low probability		Moderate probability		High probability
Pipe bridges	Negligible	Low probability		Moderate probability		High probability		High probability
CIVIL STRUCTURES								

Roads, Rail	Negligible	Negligible	Low probability	Negligible	Moderate probability	Low probability	High Probability	High Probability
Embankments	Negligible	Low probability	Moderate probability	Low to moderate probability depending on height	Moderate to High Probability	Moderate probability	High Probability	High Probability
Earth Dams	Negligible	Low probability	Moderate probability	Moderate probability	Not applicable	Moderate to High Probability	Not applicable	Not applicable
Concrete Dams	Negligible	Negligible	Low probability	Low probability	Low probability	Moderate probability	Moderate probability	Not applicable
Steel Tanks	Negligible	Negligible	Not applicable[2]	Low probability	Not applicable	Moderate probability	Not applicable	Moderate probability
Concrete tanks and reservoirs	Low probability	Moderate probability	Not applicable	Moderate probability	Not applicable	High Probability	Not applicable	High Probability
BRIDGES								
Modern	Negligible	Negligible	Negligible	Low probability	Low probability	Low to moderate Probability	Low to moderate Probability	Moderate to high probability
Old	Low probability	Low to moderate probability	Low to moderate probability	Moderate probability	Moderate to high probability	High probability	High probability	High probability
SPECIFIC INFRASTRUCTURE								
Auckland International Airport	Negligible	Negligible		Low probability; short shut down for repairs		Low to moderate probability; shut down for repairs		Moderate probability; shut down for repairs
Auckland Ports	Negligible (modern) to low probability (old)	Low (modern) to moderate probability (old)		Moderate (modern) to high probability (old)		High probability		Very high probability
Water supply dams, Waitakere and Hunua *Refer Civil Structures above and seismic/earthquake impact assessment. Watercare dams compliant with NZSOLD standards & MCE seismic performance.*	Negligible	Low to moderate probability		Moderate probability. Low risk of dam break; severe impact potential		Moderate to high probability. Moderate risk of dam break; severe impact potential.		Not applicable

[1]Slope classes: Class A slopes 0-7°, Class B slopes 8-15°, Class C slopes 16-20°, Class D slopes >20°

[2]Not applicable: Dams are unlikely to be constructed on liquefiable soils. Earth dams, tanks and reservoirs are unlikely to be constructed on steep slopes

Table A1: Earthquake Induced Damage to Structures Probability Matrix[1]

[1] Updated from the Auckland Engineering Lifelines Project Stage 1 Report – Part 1: Hazard Information, July 1997

Structure	Negligible	Low Probability	Moderate Probability	High Probability	
				Non-liquefiable Soils	Liquefiable Soils
PIPEWORK					
Moderately ductile pipes	Alignment may be disturbed	Some pipes stretched to yield point	Necking damage or tear (require replacement); leakage	Not applicable	Rupture or loss of anchorage
Low strength of low ductility pipes (includes underground services duct)	Alignment may be disturbed	Some cracked joints; minor leakage	Some joints ruptured; major leakage	Displaced joints; major leakage	Displaced joints; major leakage or loss of anchorage
Non-ductile pipes	Not applicable	Cracked pipes; minor leakage	Some joints ruptured; major leakage	Displaced pipes; major leakage	Displaced joints; major leakage or loss of anchorage
CONNECTIONS & FITTINGS					
Seismically designed (eg HDPE; steel pipe with expansion loops)	Minor movement	Minor yielding	Yielding and distortion of joints; minor leakage	Tear or rupture of joints; leakage	
Rubber joints (modern spun concrete or plastic pipes laid in ground)	Minor movement	Movement, particularly where sited within sloping or settlement prone ground	Joint leakage	Joint separated or sheared; major leakage	
Cement Joints (old; very common)	Minor cracking	Cracking; minor leakage	Cracking; major leakage	Joint displaced; major leakage	
BUILDING STRUCTURES					
Modern multi-storey	Suspended ceilings damaged; large windows broken	Minor cracking; minor spalling of beams	Some spalling and cracking; repair required; architectural ornaments fall	Moderate damage or permanent distortion	Serious damage and/or permanent distortion
Older multi-level brick/masonry	As above; cracking of plaster	Not applicable	Spalling of finish; cracking and damage to walls; damage to brick veneers and plaster or cement based linings	Serious damage; falling debris; panel collapse; possible floor collapse	Serious damage/total loss
Residential	Cracked finish (timber frame)	Some damage to chimneys; cracked finish; roofing tiles dislodged	Loss of chimney; cracked plaster; loss of panels; some windows crack; structural damage where founded on partially liquefiable soils	Falling debris; panel collapse; possible floor collapse; houses not secured to foundations shifted off brick veneers fall and expose frames	Total loss (brick or timber)
SERVICES					
Power lines/lamp posts	Minor loss of verticality	Some movement	Loss of support and yielding wires; some twisted or brought down	Power line breaks; posts brought down	
Pipe bridges	Minor yielding of abutments	Yielding of abutments; pipe moves out of alignment	Yielding of abutment; support bolt sheared	Loss of pipe support	

CIVIL STRUCTURES					
Roads, Rail	Minor distortion (rail only)	Movement in a downhill direction; visible distortion or cracking	Distortion to rails and cracking or scarp displacement of roads	Buckling of rails or loss of support; impassable scarps in roads	Loss of support
Earth Dams	Minor distortion	Measurable distortion (situation to be reviewed)	Visible scarps/cracks (urgent action required to prevent failure)	Large scarps or cracks resulting in leakage (civil defence alerted) *(extensive cracking and leakage @ PGA ≥ 0.3g)*	Not applicable
Concrete Dams	Not detectable	Increased seepage (situation to be reviewed)	Some spalling/cracking; increase in seepage(urgent action required to prevent failure)		Not applicable
Steel Tanks	Not detectable	Sign of yielding at pipe joints	Yielding at joints; distortion of base plates	Cracking of joints, elephants foot yielding at tank base	Tilting of tank
Concrete tanks and reservoirs	Not detectable	Increased weeping at joints; minor cracking and spalling	Leakage of joints (pre-cast tanks); cracking and leakage	Wide cracks formed; leakage; rupture of older tanks	Substantial settlements
BRIDGES					
Modern	Minor cracking	Minor cracking	Spalling; abutment damage	Lateral movement; los of alignment	Loss of span; loss of approach ramp; foundation damage; rotation
Old	Minor spalling	Spalling, loss of support	Spalling; loss of span	Damage; loss of span; collapse	Collapse
SPECIFIC INFRASTRUCTURE					
Auckland International Airport	*Pipework, connections and fittings, buildings, services and civil structures as above*. Not detectable	Some opening or closing of joints on concrete slabs (Note: for this to happen earthquake would need to be in close proximity).	Spalling at pavement joints; settlement of pavement (temporary closure)	*(buckling of concrete pavement @ PGA ≥ 0.3g; closure of airport)*	
Auckland Ports	*Pipework, connections and fittings, buildings, services and civil structures as above*. Minor movement of seawalls	Movement of seawalls	Settlement at edge of reclamation	Spreading and subsidence of reclamation; crane rails distorted	
Water supply dams, Waitakere and Hunua	*Pipework, connections and fittings, buildings, services and civil structures as above*. Not detectable	*See earth and concrete dams*	*See earth and concrete dams*	*See earth and concrete dams*	

Table A2: Earthquake – Induced Damage to Structures Consequence Matrix[2]

[2] Updated from the Auckland Engineering Lifelines Project Stage 1 Report – Part 1: Hazard Information, July 1997