2. AUCKLAND'S LIFELINES

This section provides an overview of the lifeline utilities in the Auckland region, how they work and where the network vulnerabilities are.

2.1 Defining 'Critical' Utility Assets

Each lifeline utility in the Auckland region has categorised its assets as Criticality 1, 2 or 3 (***nationally, regionally*** or ***locally*** significant). The approach is summarised in Figure 2-1 and detailed *in* ***Error! Reference source not found.***. In general, the criticality approach takes into account the number and type of customers affected, both directly and indirectly, if an asset fails. For example, the fuel pipe to Auckland Airport may only serve a few large customers, but it would have a significant knock-on impact on a much larger number of international and national travellers if it was out of service for any length of time.

The Criticality 1 lifeline utility assets in Auckland are illustrated in Figure 2-2.

⇒ *Maps of critical lifeline utility assets can be downloaded by utility members at* *http://managers.aelg.org.nz/infrastructure-and-hazard-data/*

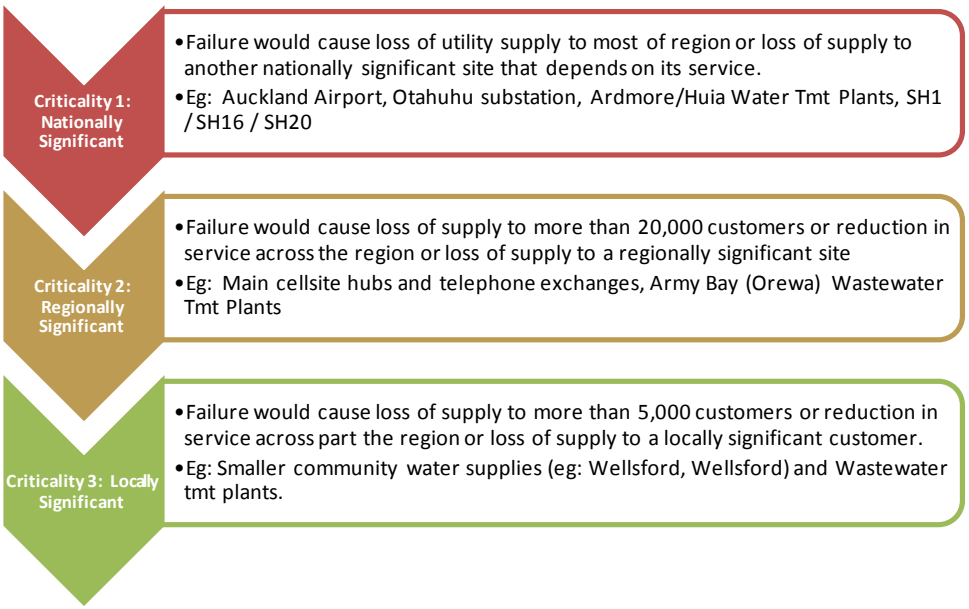

Figure 2-1: Defining Critical Utility Sites

Fuel

Most of Auckland's fuel comes from the NZ Refinery at Marsden point via the Refinery to Auckland pipeline. Petrol and diesel are then distributed by truck from the Wiri oil depot, which stores between 2 and 6 days supply of fuel for the region. Jet fuel is sent to Auckland International Airport by way of the Wiri to Airport Pipeline.

The Refinery, Pipeline and Wiri depot are all rated Criticality 1 because failure for more than 2-3 days would cause significant region-wide fuel shortages and potentially major disruption to air travel through the Auckland Airport. Because of the inter-connected nature of the national fuel network, the supply disruption would have knock-on impacts across the country.

Only two fuel stations in the region have backup generation on site. These have been rated as Criticality 2 as they would become critical in a major regional power outage.

⇒ *Find out more about Auckland's fuel supply in the Auckland fuel contingency plan which can be downloaded at* *http://managers.aelg/response-plans/*

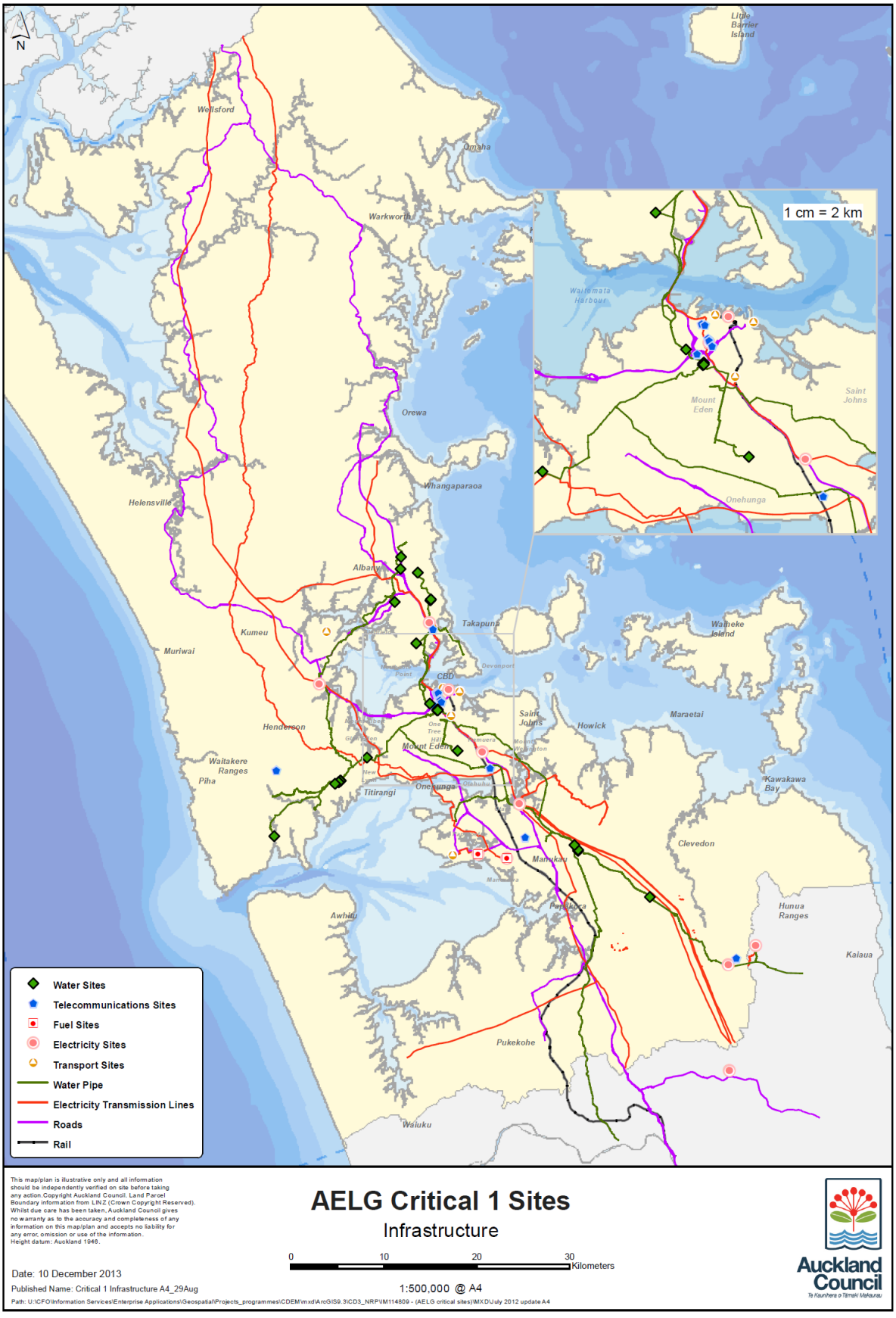

Figure 2-2: Criticality 1 Infrastructure Sites[1]

[1] *At time of report preparation, mapped critical sites data was not available for Vector, Telecom and Chorus lines data or Auckland Council stormwater and solid waste data.*

Transport

Ports of Auckland, the Auckland Airport, Britomart, Spaghetti Junction and the Auckland Transport Management Centre are all key transport hubs in the region and rate as Criticality 1.

Ports:

Businesses that depend on Ports of Auckland operations account for about a third of the region's economic activity, mostly through the ports in the CBD but a smaller port also operates at Onehunga. Wynyard Wharf is no longer used to store fuel for Waitemata Port. Seafuels Ltd now provides this service via their 3,900 tonne tanker, Awanuia, which collects fuel from Marsden Point and transfers it directly to customers' vessels.

Airports:

The Auckland Airport is the gateway for around 75% of New Zealand's overseas visitors with approximately 14 million passengers and 214,300 tonnes of freight passing through each year (12 months to July 2012).
Smaller airports that operate in Auckland include Hobsonville, Whenuapai, Ardmore, Dairy Flat and some on the Gulf Islands.

Rail:

Auckland's rail network is a single north-south trunk line with minor branches connecting to the CBD and the Port of Onehunga. In many instances the line consists of two or three tracks, but their close proximity means if one is damaged by a hazard the others are likely to be. Around 43,000 passengers commute by rail each day. The North Island track from the south into the CBD is rated as Criticality 1, with the track to the northwest and some of the key stations and depots rated as Criticality2. The imminent rail electrification will put passenger rail at high dependence on the electricity network.

Roads:

SH 1, 16, 18, 20A and 20 are considered Criticality 1 as they are the main routes through and across the region. Apart from those main highways, most of the roading network has sufficient redundancy such that if a single road is closed, alternative routes can provide adequate (albeit delayed) service. The congestion would be relatively localised. There are exceptions such as the key arterial of Green Lane and key motorway onramps such as Onewa Rd, which were classified as Criticality 2[2].

A number of roads are classified as Criticality 1 or 2 because they provide access to critical community sites such as the Port, Airport and Auckland Hospital.

Telecommunications

The telecommunications sector is one of the most complex of the lifeline utility sectors, partly because of the rapid change of technology, providers and user preferences, but also because of the level of inter-connectedness between the various providers which share parts of the network and exchange (voice and data) messages between networks.

Each of the current main providers (Telecom, Vodafone, TelstraClear) has some key hub sites in Auckland, where catastrophic failure could disrupt regional, national and international services. However, apart from these main nodes, most of the network has redundancy such that the network can be reconfigured to provide service if single lines or sites fail.

[2] Criticality 2 roads were considered to include roads that, if they were disrupted for 1 or 2 days, would add more than 1 hours travel time to over 20,000 vehicles.

Mobile (Cellular) Networks

There are 4 major building blocks to cellular networks.

- The **Cell Site** provides the local coverage, and a mobile phone will connect to the cell site with the strongest signal, usually, but not always the nearest cell site.
- **Transmission** links connect the cell site to the Aggregation Node and the Aggregation Node to the Exchange. The transmission links are fibre, copper or microwave radio (increasingly, transmission links are moving to fibre connections).
- The **Aggregation Node** is a Base Station Controller (BSC) for a 2G (GSM) phone or a Radio Network Controller (RNC) for a 3G phone. Transmission links then connect the aggregation point to the exchange.
- The exchange (**Mobile Telephony Exchange, or Strong Node**) is the brains of the operation; it makes the connection between the caller and the called. If the transmission links are broken, the call cannot be completed. It is not possible for a cell site to work in local mode.

The network operators in New Zealand operate several strong-nodes and these nodes are also connected by fibre transmission links. If these links are broken, the network functionality will be severely impacted. These links are therefore heavily protected with redundant links and automatic failovers.

Because of the dependence of telecommunication sites on electricity supply, there are a range of backups if mains supply fails:

- Strong-nodes are equipped with battery backup and fixed diesel generators
- Aggregation points are equipped with batteries and generator plus or fixed generators
- Cell sites are equipped with battery backup (between 4 and 12 hours depending on priority) and either fixed generators or generator plugs.
- The network operators hold their own portable generator stocks to maintain some basic coverage in a limited area.

Telecom and Vodafone maintain their own mobile networks, TelstraClear mobile customers use the Vodafone Network and 2 Degrees operates it's own network in main centres and uses the Vodafone Network in other areas.

Fixed Line Networks

Chorus operates a network of **Roadside Cabinets** which are a first aggregation point for Digital Subscriber Line (DSL) broadband connections and connection point for landline phone services. These cabinets operate from Mains electricity supply, backed up by approx 12 hours of battery backup. Some cabinets are provided with an external generator plug, depending on accessibility to the cabinet in all weather conditions, security of the local electricity supply, etc. It is Chorus' intention to allow the public to plug in their own generator and keep the phone/internet service running through extended power outages.

Chorus also operates telephone exchange buildings (**Local Exchanges**) which operate direct copper pair connections to customer premises'. These exchanges are in strengthened buildings and are equipped with battery backup and fixed diesel generators. Small rural exchanges are equipped with battery backup and a generator plug.

If an exchange becomes isolated from the nationwide network of exchanges, it will continue to operate in local mode, meaning that local phones will be able to call local phones from the same network. 111 service may be rerouted to a local number, such as the local police station or answered by a Chorus technician at the exchange building.

Links between exchanges are used for carrying long distance traffic such as tolls, fixed to mobile, international, 0800, 111 services etc. These links may be fibre cables, copper cables or microwave radio links.

Increasingly, other operators are installing fixed line exchange equipment as local loop unbundling[3] becomes the norm. For example, Vodafone has it's own equipment installed in exchanges throughout Auckland. TelstraClear

[3] The process of allowing multiple telecommunications operators to use connections from the telephone exchange to the customer's premises.

operates roadside cabinets for voice, broadband and data services, exchanges and points of presence throughout Auckland with battery backup and sockets for portable generator connection. TelstraClear equipment is installed in cabinets that are seismically braced for earthquake protection. This does offer the community some additional resilience where equipment from only one operator is impacted.

It is also common to wholesale links to other providers, for example a Vodafone or TelstraClear fixed line customer will use a Chorus connection where the Vodafone or TelstraClear network is not available. This increases the complexity, but not the resilience of the service.

Broadcasting - Radio

The broadcasters themselves (TV, radio networks) are also critical to the community before, during and after an event. The following radio stations are based in Auckland.

Broadcaster:The Radio Network (TRN)

Details can be found at http://www.radionetwork.co.nz/Stations
The AM services are broadcast from the transmission facility at Henderson.
The FM services are broadcast from the transmission facility at Sky Tower.

Broadcaster: Mediaworks

Details can be found at http://www.mediaworks.co.nz.
The FM services are broadcast from the transmission facility at Sky Tower.

Broadcaster: Radio New Zealand

Details can be found at http://www.radionz.co.nz/
The AM service is broadcast from the transmission facility at Henderson.
The FM services are broadcast from the transmission facility at Sky Tower.

The content for the FM broadcasters usually originates in the Auckland Studios, is carried to the local studio via various means (fibre, satellite or microwave) where local content is inserted (advertising, local news and weather) and then it is linked to the high transmission sites for broadcast.

Station	FM Frequency (MHz)
Mai FM	88.6
The Edge	94.2
George FM	96.8
The Rock	90.2
MORE FM	91.8
The Breeze	93.4
Solid Gold FM	93.8
Radio LIVE	100.6
Live SPORT	
Kiwi FM	102.2

Station	AM Frequency (KHz)	FM Frequency (MHz)
National Programme	756	101.0
Concert Programme		92.6

Broadcasting - Television

Television is transmitted from the following sites. The repeater receives its input signal from the parent and transmits on a different channel to the parent. The content is created/compiled in the studio by the broadcaster and is linked to the transmission sites using a chain of protected microwave links.

Call-sign	**Parent**	**Repeater**	**Repeater**	**Repeater**	**Repeater**
One	Waiatarua				
TV2	Waitatarua				
TV3	Waiatarua	Sky Tower			
C4	Waiatarua	Sky Tower			
Triangle	Waiatarua		Pinehill		Remuera
Maori	Waiatarua		Pinehill		Remuera
TAB/Trackside	Waiatarua		Pinehill		Remuera
Freeview HD	Waiatarua	Sky Tower	Pinehill	Waiheke	Remuera
Freeview DTH	Satellite				
Sky	Satellite				
Prime			Pinehill		Remuera

Broadcasting – Transmission Facilities

The transmission facilities are owned and managed as follows:

- Waiatarua, Waiheke and Pinehill are owned, managed and maintained by Kordia LTD.
- Sky Tower is managed and maintained by Johnston Dick Associates (JDA).
- Henderson is owned and managed by Radio New Zealand Ltd and maintained by their sub-contractors.

Transmitters require mains power to operate – either from the network or from standby generators. Pinehill, Waiheke and Remuera do not have standby facilities. Kordia sites typically have standby generators and 5 days of fuel.

Kordia provides a managed environment (watertight, ventilated, powered) with associated towers (antenna aperture) for others to locate their transmission equipment. This includes Police fire and ambulance communications, most FM broadcasters and all Television broadcasters and Kordia sometimes, but not always, maintain their equipment.

Linking, communications and supervisory systems run off 48 volts DC. This equipment is connected to batteries that are kept charged by either the incoming mains power or the genset. If the mains and the genset fail the batteries have reserve times typically 8 hours

All Kordia facilities are monitored from the Transmission Control Centre (TCC), located in Avalon, which is a 24/7 operation.

Electricity

The Auckland region has some of the highest load densities combined with relatively low levels of local generation of any region in New Zealand. Most of Auckland's electricity is supplied via the transmission grid from the south. About 70% of the peak electricity demand in the Auckland and Northland regions is supplied from generation south of the Bombay Hills and, as such, a reliable and robust transmission system is necessary. Southdown and Otahuhu natural gas fired power stations are the main generation inside the region, meeting about 30% of the peak electricity demand.

Eight 220kV circuits supply Auckland from the south over three different routes terminating at two major substations of Otahuhu and Pakuranga: Huntly to Otahuhu, Whakamaru to Otahuhu and Whakamaru to Pakuranga. Three 110kV circuits supply Auckland, terminating at Bombay.

Within the Auckland region electricity is supplied from a transmission network that consists of three layers: Transpower's 220 kV system, Transpower's 110 kV system Vector's network.

Within Auckland, five 220 kV circuits form a ring between Otahuhu, Pakuranga and Penrose substations on overhead lines and an underground cable. There is a 220 kV ring formed by a double circuit overhead line from Otahuhu to Southdown, Henderson and Albany, and a single circuit cable through Vector's tunnel from Penrose to Hobson Street, Wairau Road and Albany. Load can be supplied from these substations if any part of two rings fail. Takanini is connected to two of the 220kV circuits supplying Auckland.

A 110 kV network connects Otahuhu, Mangere, Mount Roskill , Hepburn Rd, Henderson and Albany, with an extension from Henderson to Wellsford. This network is on 110 kV double circuit overhead lines, and a line failure between Otahuhu and Henderson may cause a loss of supply.

There is a second 110 kV network from Bombay to Wiri, Otahuhu and Penrose. This network is on overhead lines, and a line failure between Bombay and Otahuhu will cause a loss of supply at Wiri.

Vector's 110 kV network connects to Transpower's system at Penrose, Hobson Street and Mount Roskill to feed the CBD. Some of this network shares Vector's tunnel with Transpower's 220 kV cable from Penrose to Hobson Street.

Substations and lines are categorised as Criticality 1 if failure would cause loss of supply to the CBD, critical customers (such as the Auckland hospital) or a large number of customers.

⇒ *Find out more detail on Transpower's, Vector's and Counties Power networks in their asset management plans, available at www.transpower.co.nz, www.vector.co.nz and www.countiespower.com.*

Gas

Auckland's gas is supplied via high pressure gas transmission pipelines from the Pohokura and Maui Gas Fields and other fields in Taranaki. A major failure at certain key sites such as the Rotowaro compressor station may result in significant curtailment of gas demand throughout the upper North Island. Auckland could be particularly affected due to its geographic location in relation to source supply and layout of the gas transmission pipelines north of Rotowaro. The gas transmission pipeline system is controlled from Vector's Gas Operations Control Centre in Bell Block, New Plymouth.

Dependent on pipeline conditions a significant volume of gas may be stored in the pipelines [line pack] and this, combined with demand curtailment (for which regulatory arrangements exist), may be sufficient to maintain minimum supplies (at least to residential customers) for part or all the periods taken to complete the repair of critical assets.

The two most critical gas delivery sites in Auckland are the Westfield and Papakura gate stations which act as points of supply in the region and feed the local downstream gas distribution networks. The two high pressure gas transmission pipelines supplying the region (200mm and 355mm diameter) provide some redundancy for each other – the region could be still be supplied with limited supplies if either of these pipelines as out of service.

⇒ *Find out more detail on Vector's pipelines and networks in their asset management plans, available at www.vector.co.nz.*

Water Supply

Auckland's metropolitan water supply is mostly supplied from the Hunua (62%) and Waitakere Dams (24%) and the Waikato River (11%). Future regional growth and security will be met by development of the Waikato source. The system holds 1-2 days treated water at average demand, however storage is not uniform across the region and impacts of supply failure will vary dependent upon the scenario. Failure of the major Hunua sources and/or Ardmore treatment plant for longer than 24 hours would cause service disruption and restrictions.

There is significant redundancy in the local reticulation although failure of some key trunk transmission watermains from the southern sources and across both Auckland and/or Greenhithe Harbour Bridges would cause widespread regional water outages or restrictions. These watermains are classified as Criticality 1.

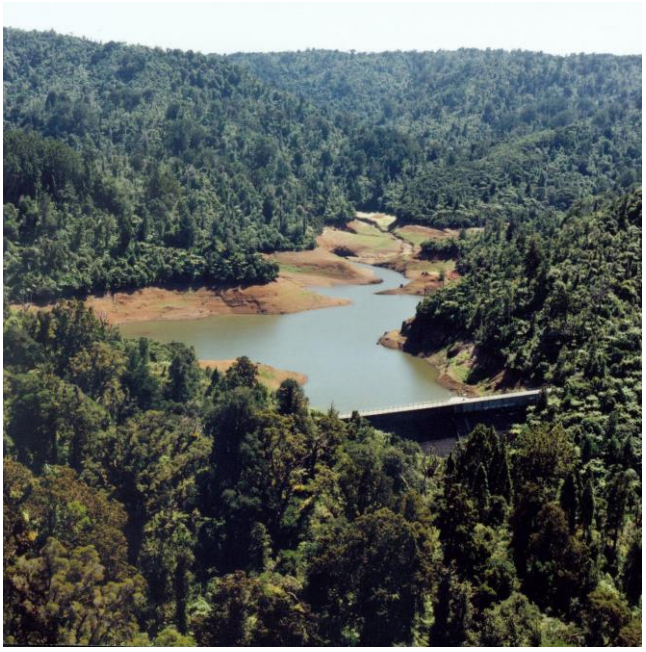

Figure 2-3: Upper Huia Dam during 1994 drought

Pukekohe, with a connected population of >20,000 is considered Criticality 2 and Watercare is currently undertaking a project of the connection of Pukekohe to the regional trunk system to improve supply security. Orewa and Whangaparaoa are connected to the regional trunk system.

A number of towns in Franklin and Rodney Districts are supplied by separate water supply systems, but these all supply less than 5,000 customers and are therefore considered Criticality 3.

Wastewater

The major wastewater treatment plants in the region are in Mangere (servicing most of the south, east and west areas of metropolitan Auckland) and Rosedale (servicing urban areas of the North Shore). These sites, and key trunk sewers feeding into these plants, are considered Criticality 2 assets. Failure of the treatment plants would not disrupt wastewater services to individual customers but would cause extended duration discharge of untreated sewage to the harbour with potential environmental and public health impacts.

A number of towns in Franklin and Rodney Districts are serviced by separate wastewater systems. Pukekohe and Army Bay (Whangaparoa) each service more than 20,000 customers and are rated Criticality 2.

⇒ *Find out more about Auckland's water supply and wastewater networks at www.watercare.co.nz*

Stormwater

The Auckland stormwater infrastructure serves a multitude of independent and relatively small catchments. There is an interrelationship of the stormwater system with the road and rail networks and, in older parts ofthe city, with the wastewater network.

Most catchments have short drainage paths to one of the many discharge points along the extensive coastline of the Hauraki Gulf, Waitemata, Manukau and Kaipara harbours. Few stormwater primary systems have been designed to cope with the largest storm events. In a major flood event, extensive local inundation can be expected as a result. Inundation from significant storm events, although likely to affect local major transport routes, businesses and private properties, is not generally expected to reach Criticality 3 rating. There is however potential for a stormwater failure to have impacts on locally, regionally or nationally important assets, for example a motorway culvert failure or blockage.

A number of larger catchments, for example the Kumeu River and the Wairau Stream through the commercial area on the North Shore have the potential to create regionally significant events. Those catchments which do not have adequate overland flow paths to a natural outlet and especially those that rely solely on soakage to the ground for stormwater disposal are particularly vulnerable to blockages generated from natural hazard events; volcanic ash, for example, can totally block and permanently damage the soakage. Catchments with stormwater devices that manage and control flood events to protect downstream property also have a higher risk.

Older areas of the city that still have combined stormwater/wastewater systems are vulnerable to volcanic ash ingress to the combined systems, which would likely cause blockages leading to combined sewer overflows to watercourses and downstream damage to pumps and treatment systems, and so present a higher level of risk.

Solid Waste

Solid waste collection and disposal is a vital part of protecting the public health of Auckland city.
The suppliers and staff who manage this business currently collect from approximately 520,000 properties. With the growth in Auckland about to increase significantly over the next 30 years, this shall put further important in regards to those that contract manage assets and infrastructure.

The key components of the Solid Waste Unit supply chain are as follows:

- Collection contractors, who collect the domestic solid waste from households and businesses
- Refuse transfer stations, where the waste is taken by the collection contractors (and members of the public) for sorting and sending on to landfills or to secondary processing/recycling plants
- Recycling plants, where the sorted materials are sent for further processing
- Landfills, where the left-over (non-recyclable) waste is taken for final disposal

If any of the above components of the supply chain should fail, this could lead to potentially serious health risks to the public.

2.2 Dependence by 'Critical' Community Services on Lifelines

A key focus of AELP-2 is to improve understanding, not just of the consequences of infrastructure failure, but also of the subsequent community and economic consequences of that failure. To keep the scope of the project manageable, it was decided to focus on sectors considered critical to the recovery of the community following a disaster. These sectors included lifeline utilities themselves, as well as (in no particular order):

- CDEM (including welfare)
- Fast Moving Consumer Goods
- Emergency services
- Health (hospitals)
- Banking

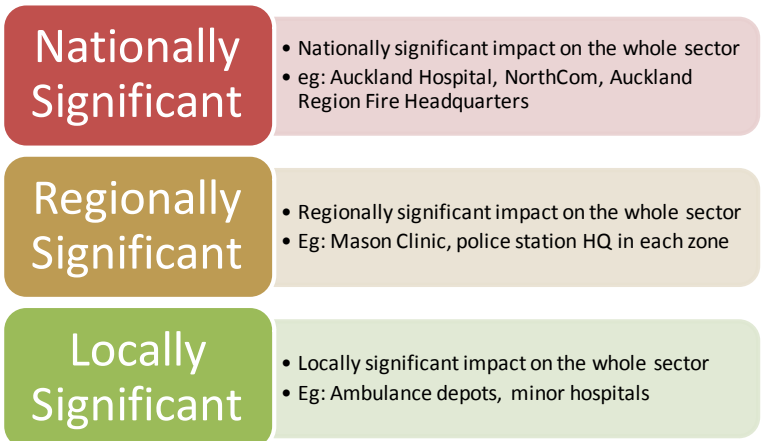

Figure 2-4: Defining Critical Community Sites

Each of these sectors were asked to identify which sites in Auckland were most critical for them to function, and categorised them as shown in Figure 2-4. Figure 2-5 shows the Criticality 1 community sites in the Auckland region.

⇒ *Maps showing Criticality 1 and 2 community sites are can be downloaded from* http://www.aelg.org.nz/members-area/aelp-2/critical-sites-lists.cfm

A workshop was held in May 2010 with representatives from a number of these sectors. The purpose was to understand the impact on their sector arising from failure of lifeline utility services. Table 2-5 summarises the findings.

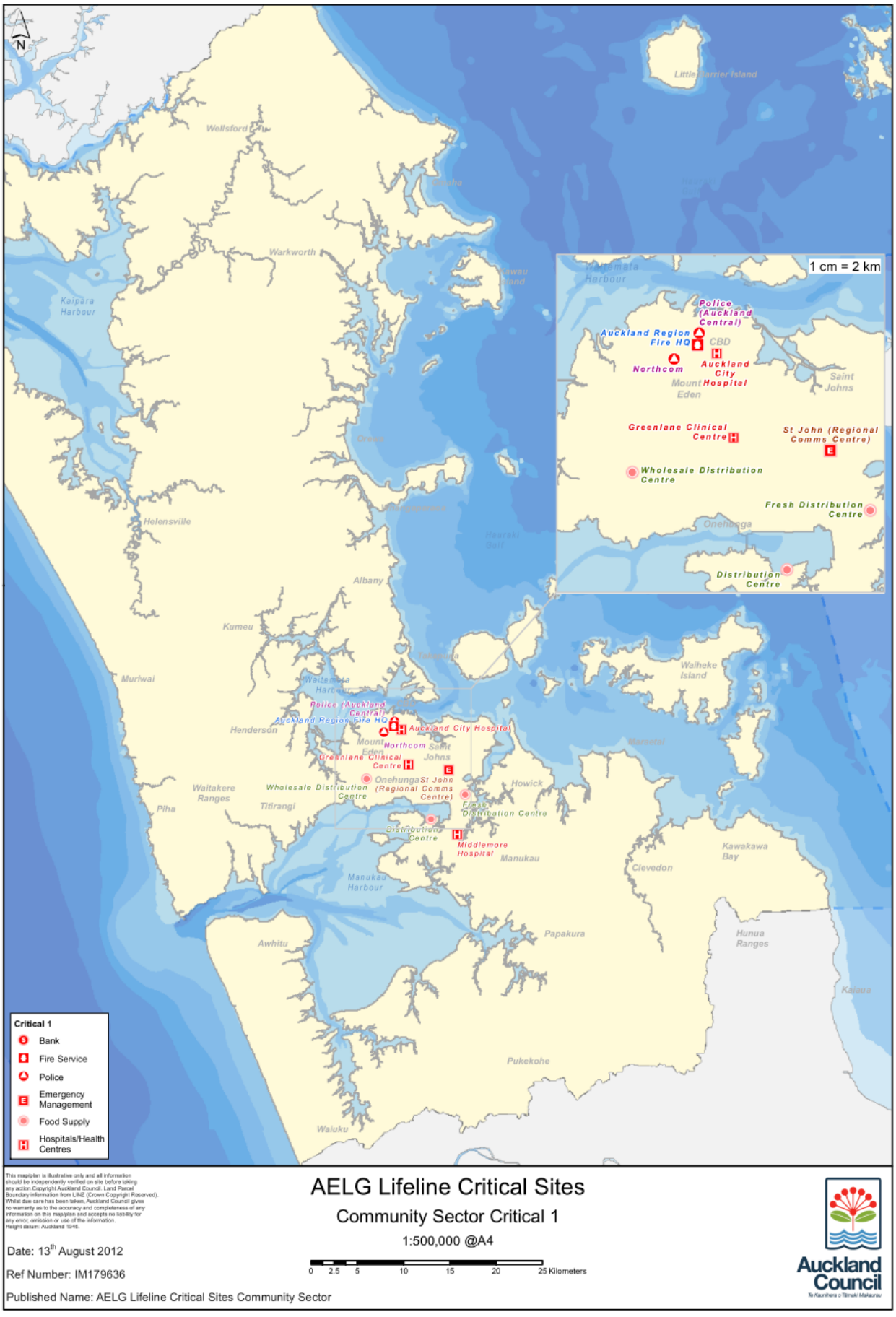

Figure 2-5: Criticality 1 Community Sites

	Health	Police	Fire	CDEM	Banking	FMCG	Broadcasting
Significant disruption / loss of regional water supply north of Flatbush. (Potential causes EQ/volcano, 3rd party, asset deterioration. Long electricity failure would also cause major problems).	4-8hrs storage on site then need to refill with tankers. Loss of supply for water flushing is main issue and would cause major disruption to hospital service. Looking to improve backup systems, eg: bore at Auckland hospital for non-potable flushing water.	No specific dependency for police operations, but would need to cater for staff sanitary / drinking water requirements.	Water carried on many trucks but in a prolonged supply would need to find alternative supplies (sea water last resort).	Community health / welfare issues will arise after 24 -48 hrs, will need to be able to provide access to drinking water.	No specific dependency for banking operations, but would need to cater for staff sanitary / drinking water requirements.	Would impact on fresh food preparation but would still be plenty of other food available in supermarkets.	No specific dependency, but would need to cater for staff sanitary / drinking water requirements.
Significant disruption to telecommunications service in CBD and national loss of diversity. **or** **Loss of international internet connectivity and data transmission.**	Affects ability to coordinate between DHBs.	Disruption to 111 system, unable to respond to emergencies. Internal emergency comms OK with radio network but BAU comms relies on cell network.		Radio network for CDEM comms but national warning system relies on cell network and increasing reliance on web for emergency status information and external comms.	EFTPOS relies on telco - can't access cash. Internet banking increasingly impt. Most banks rely on Southern Cross cable for banking transactions (done in AU).	Most purchases use EFTPOS, would cause major disruption. FMCG working with MCDEM on issue of distributing food as a social service in a disaster.	Highly dependent on telco sector for input data. Microwave linking transmission.
Major failure at Otahuhu substation - significant electricity supply disruption north of this point (Auckland and Northland). Most fuel stations will be inoperable. After 4-8 hrs, significant knock-on effect on telecomms/ water/wastewater also.	Can only operate at 50% capacity on generators. Major impact. After a couple of days will need more fuel for generators.	No specific dependency, however subsequent impact on telecommunications will have impact as described above. Lack of fuel supply would cause major disruption to services.		CDEM centres have back-up generation, but subsequent impact on telecommunications will have impact as described above.	Strategic sites have backup generation 2-5 days. But branches/ATMs don't so significant impact on cashflow. Also knock-on impact on telecommunications has impact as above.	Distribution centres have backup generators and stores have generators for lighting/tills but not refrigeration so long outage will cause food spoilage. Need fuel to maintain distribution to stores.	Major studios have generation (but if no power people can't watch TV anyway generally).
Major closure of SH1 - eg: at Harbour Bridge, Newmarket Viaduct, Mangere Bridge.	Major impact. Hospitals rely on a number of just-in-time deliveries (food, linen, etc) and patients need road access.	Major impact - chaos on roads. Disruption to ability to respond to emergencies.		Would be critical issue during an evacuation. Ports / airport are also important during recovery.	Some impact, eg: may limit cash movements eg: to ATMs.	Need road access to Distribution Centres and supermarkets. Generally 3-5 days food supply available in region.	Minimal impact.
Closure of Auckland Airport or Port.	Minimal	Minimal	Minimal	As above.	Airport closure might limit international cash movement.	Would need to be long-term to impact on food supply.	Minimal impact.

Table 2-1 Impact of Lifeline Utility Failures on Critical Community Sectors

2.3 Infrastructure 'Hotspots'

In 2007, the AELG carried out a project to identify areas in the region where a number of critical infrastructure assets converge. The GIS was used to analyse the number of assets in a localised area and their level of significance, to give an overall 'hotspots' score. Figure 2-5 shows the results of the 2007 analysis.

As part of the revised critical asset review carried out in 2010, lifeline utilities reviewed their criticality ratings at each hotspot site. This did not significantly change the findings shown in Figure 2-6, though the Bairds Rd site moved up in priority. Also, the Mangere Bridge (transport and water assets) and Greenhithe Bridge were added as hotspots.

Hotspot	Hotspot Name	Original Hotspot Number	Hotspot Rating
A	Auckland Harbour Bridge	HS011	Very High
B	Upper Queen Street	HS016	Very High
C	Church Street East	HS017	Very High
D	Panmure Bridge	HS020	Very High
E	Sylvia Park	HS014	Very High
F	Greenlane Roundabout	HS019	High
G	Great North Road	HS008	High
H	Makora Road	HS015	High
I	Newmarket Viaduct	HS012	High
J	St. Marks Road	HS021	High
K	Triangle Road	HS009	High
L	Mt. Wellington Highway	HS003	High
M	Wiri Station Road	HS001	High
N	Bairds Road	HS002	High
O	Upper Harbour Drive	HS010	High
P	Waikumete Road	HS006	Moderate
Q	New North Road	HS022	Moderate

Figure 2-6: Infrastructure Hotspots in Auckland

Lifeline utilities are able to use the findings in the following way:

- Incorporate the maps into emergency response planning arrangements, so that staff responding to failures at those sites can be aware of the significance of other utilities.
- Consider re-location as an option during future upgrades, if the risks warrant this.
- Carry out their own risk assessment at each site.

⇒ *The Hotspots report can be downloaded by AELG members at http://www.aelg.org.nz/aelg/index.cfm?78B4548C-14C2-3D2D-B916-EF4600283331*

The Hotspots analysis is being reviewed in 2013/14 using the latest critical assets data, and this report will be updated with that information when complete.

2.4 Infrastructure Interdependencies

Most critical community sectors rely on lifeline utilities to be able to function. The lifeline utility sectors are also highly interdependent on each other for their own service continuity. Table 2-2 summarises these interdependency requirements. During business-as-usual operations, electricity, telecommunications and transportation are the sectors most relied on by other utilities.

Dependence on Electricity

During normal operations, electricity is the utility that most others are dependant upon, and is required to operate all the other lifeline utilities to some degree. Because of this reliance, all other utilities have back-up generation(or have generator connection capability) at most of their critical sites and some also maintain diesel stocks. However, back-up mobile generator resources for other sites are generally sufficient to maintain a few sites only. A widespread regional power outage would, after varying periods of time, impact on telecommunications, water supply, wastewater, fuel supply and traffic management services.

Dependence on Telecommunications

Network failures in 2010 highlighted the high impact of telecommunications failure on some businesses, including utility businesses. However, most utilities could continue services at near full capacity without telecommunications. Some utilities would need to revert to manual operation and monitoring of facilities, and response to service requests would be impaired.

There is a high reliance on the cellular network for voice communications. This network may become overloaded during or shortly after an event. However the cooper, fibre and wireless infrastructure (including cellular) provides diversity and is very resilient. Most utilities use a combination of the above technologies to monitor their own infrastructure and some have their own dedicated network of links and radio.

Dependence on Transportation

Short-term road failures are unlikely to directly impede other utilities ability to provide service in business-as-usual operation. However, as with telecommunications failure, response to service requests and asset failures would be affected. Also, staff and other resources need to be able to access facilities and diesel and plant needs to be transported to construction sites, and this would become critical in longer-term road failures.

Only a long-term failure of ports and airports would impact other utility services, because imported supplies (such as water treatment chemicals) could be affected.

Dependencies change in an Emergency

In a major disaster, the following utilities become more critical:

- Telecommunications and roads – utility organisations need to coordinate their response and recovery efforts and access sites to do repairs or supply diesel. Some agencies have their own back-up communications networks (eg: radio, telephone/ SCADA communication systems).
- Telecommunications/broadcasting - for managing public information.
- If electricity is affected, diesel supply to critical sites (such as central city telecommunications hubs and water treatment plants) becomes critical. Even those sites with on-site diesel storage only hold a few days supply. Refueling of generators deployed to other critical facilities will become a significant logistical issue.

⇒ *Download the AELG reports 'Resources for Recovery' and 'Generator Review' to find out more about which critical resources utilities require for response and recovery operations.* http://aelg.org..nz/document-library/other-documents/

Dependence on	Electricity	Gas	Fuel	Tele-communications	Transport	Water / Wastewater
Electricity	Required at most facilities – generation, substations, etc.	Required at gas-fired generation plants.	Required for substation operation and vehicles.	Required for network monitoring and to coordinate emergency response.	Yes, for access to restore damaged sites.	For some cooling purposes, plus cleaning and fire fighting.
Gas	Electricity required to maintain supply at gas delivery points, though could still maintain reduced supply.	Not required.	Required for vehicles and to maintain supply at delivery points.	Required to maintain supply at delivery points.	Yes, for access to restore damaged sites.	Not required.
Fuel	Supply from Marsden to Wiri dependent on mains supply. Wiri oil depot has backup generation so can continue to fill trucks until stocks run out.	Refinery can operate without gas but environmental impacts.		Required to operate pipeline to Auckland.	Required for regional fuel distribution. Road access to Wiri particularly critical.	Fuel storage terminals cannot operate without water supply for fire fighting.
Telecom-munications	Required to operate all facilities. Most key sites have generator / battery backup. Customer phone systems usually need power.	Not required.	If power fails need diesel for generators. Need fuel for staff / contractor vehicles to respond to failures.	High level of sharing of networks, exchange of data, etc.	Yes, for access to restore damaged sites and refuel generators.	For some cooling system.
Transport	Required for traffic signal operation. Required for Ports and Airport operation though backup generation in place for critical functions.	Not required for operation, but need quick response to gas pipe failures in roads.	Not required for road network itself (only for vehicles and diesel for construction plant). Required for ships and planes. Jet fuel pipe to Auckland Airport is particularly critical.	Required to coordinate emergency response. Phone network used for networked traffic signal mgt.	Ports and airports require rail and roads to be operational to move freight and passengers.	Not required for operation, but need quick response to watermain failures in roads. Required to provide sanitary services for airport customers.
Water	Electricity required for for river/bore abstraction sources and WTPs & PS. Approx. 40% of consumers are dependant upon water supply pumped to reservoirs or direct to supply	Not required.	If power fails need diesel for generators. Need fuel for vehicles to undertake repairs and move staff.	Dependent upon cellular phone and radio telephone for SCADA network and to coordinate emergency response.	Yes, for access to geographically diverse and remote sites for operation and restoration to damaged sites.	Required to provide sanitary services for staff.
Wastewater Stormwater	Required at treatment plants and pump stations.	Required for WWTP operation but contingency plans exist.	As above.	As above.	As above.	As above.

Table 2-2: Lifeline Utility Interdependencies in Auckland

Legend:

Critical requirement to maintain service continuity during business-as usual.	Some impact on ability to function. Service response would be impaired, utility becomes more critical in an emergency.	Not required for operation.

2.5 Current Programmes in Place to Improve Resilience

This section has highlighted a number of concerns around the vulnerability of the infrastructure networks. However over the next decade there are a number of significant projects that will improve the region's infrastructure resilience.

Three very significant projects in terms of providing some redundancy for Criticality 1 assets are:

- The Hunua No. 4 watermain, which will provide some redundancy for Hunua No. 3 which currently carries most of the treated water from the Hunua supplies north into the isthmus, and will significantly improve security of water supply to Manukau West and Auckland Airport.
- The Auckland-North Auckland electricity transmission upgrade, which will provide better security of supply to the Auckland CBD, West Auckland, North Shore and Northland by providing a second 220kV route between Pakuranga and Albany, and the creation of two new Grid Exit Points.
- The linking of SH20 through from Manukau through to SH16, providing an alternate north-south motorway route across the region as well as additional redundancy to the airport.

Airport:

A number of planned projects include:

- 2 new fuel storage tanks at existing JUHI site completion April 2013.
- Second runway.
- Domestic terminal upgrade expected completion November 2013.

Fuel - Refinery and Pipeline

- Review of minimum power needs for alternative supply to maintain shipping and pipeline if 220kV lost in Northland at Refinery.
- Improved leak detection system upgrade installed.
- Upgrade of back up power supply at Densitometer site in Campana Road for extended power outage (7 to 8 hours) to be catered for.
- Submission to Auckland Plan regarding the need for a back-up of fuel transportation by way of rail from the North.

Road Network

Recently completed projects:

- Cavendish Drive (Manukau) upgrade has increased capacity as a safe route.
- Beaumonts Bridge Realignment project has improved capacity and strength as it is designed to higher design loading.
- Replacement of the following five rail overbridges: Bridge Street, St George Street, Browns Road, Jutland Road and Station/Lupton Road in South Auckland have increased its strength.
- Replacement of rail overbridge: Mt Wellington Highway in Central Auckland has increased its strength.
- Newmarket Viaduct replacement with a more seismically resistant structure.
- Victoria Park Tunnel provides an alternative north-south route.
- The new SH20 to SH1 link has increased capacity. New Bridges constructed as part of the link have increased strength.

Projects under construction and proposed projects to commence within a couple of years:

- SH16 North Western Widening and Improvements – part of the Western Ring Route.
- Nelson Street Improvements – Central Auckland.

Rail

- Construction of new Manukau Rail Station.

- Construction of Onehunga Rail Station.
- Rail electrification.
- Upgrade of railways and stations as part of railway electrification.
- New Parnell Train Station.
- CBD loop.

Ports

- Currently (2012) installing 3 large diesel generators at the Auckland port to improve resilience to electricity supply failures. These generators will provide sufficient electricity to power office buildings, IT systems, flood lighting and refrigerated containers but are unable to power the port's cranes. So in the event of a power supply failure the port will have to rely on ship's that either have their own cranes or have roll-on/roll-off capability for the loading/unloading of cargo. Standard container ships would be redirected to Tauranga.

Water

$2.2b of capital works over next 10 years including:

- Hunua No 4 watermain (Redoubt Road to Central City via Manukau/Mangere) – to meet regional growth 50 years; increase security of supply to West Manukau and AIA; provide headroom (redundant capacity) for transmission systems maintenance; geographical separation from Hunua No 2 and 3 watermains.
- Waikato Treatment Plant Capacity Expansion to 125MLD (from 75MLD) – to meet regional growth; provides improved redundancy for Southern Sources (Hunua Dams/Ardmore WTP).
- Waikato Source development to meet 50 year regional growth and provide redundancy for southern Hunua sources and Ardmore treatment plant.
- Wairoa Tunnel and Hunua No 2 and 3 raw water watermains seismic and structural upgrades – to ensure seismic resilience to critical assets conveying >60% of regions water supply that cross the Northern Wairoa fault in Hunua's.
- North Harbour No 1 watermain duplication of Upper Harbour crossing on Greenhithe Bridge.
- North Harbour No 2 watermain – meet 50 year regional growth in West Auckland, North Shore and Rodney provides redundancy for North Harbour No. 1.
- Increased reservoirs storage capacity across region –to meet regional growth; improve security of supply and provide emergency "buffer" storage. Runciman, Titirangi, Albany, Ponsonby, Hobsonville, Kumeu, Redoubt Rd.
- Upgrade of Huia and Waitakere WTP's – to meet water quality standards and improve reliability and supply system resilience reducing dependency upon southern sources in emergencies.
- Upgrade of Waitakere Headworks raw water transmission systems to replace ageing assets; provide seismic resilience and improve source reliability and security of supply.
- Connection of Franklin (Pukekohe/Patamahoe) and Kumeu/Haupai to regional trunk system to meet growth improve security of supply and water quality.
- Provision of permanent autostart standby power generation at the critical New Lynn pump station that provides for supply security for Western sources and treatment from Southern supply sources and augments peak demand and emergency capacity shortfall. Greville Road watermain and pump station that provides redundancy and security of supply to Northern suburbs of North Shore.

Wastewater

$2.4b of capital works over next 10 years including:

- Central Interceptor – to provide trunk systems capacity for regional growth and reduce overflows in storm events from Orakei Main Sewer and Western Interceptor and duplication of Manukau Harbour crossing.
- Northern Interceptor – investigation of "redirection" of North Harbour sewerage to utilize Rosedale WTP capacity; reduce load on Mangere and provide treatment redundancy.
- Wide range of projects at WWTPs to provide hydraulic and process capacity to improve reliability and meet regional growth and ensure environmental standards are achieved and maintained including resilience to natural hazard events.

Stormwater

The Auckland Council's Stormwater Unit, the network utility operator of Council's stormwater network, mitigates the risks of flooding by constructing and maintaining reliable, effective, sustainable and future proofed stormwater systems and networks.

Additionally the Unit develops Catchment Management Plans, Standards, Guidelines and Comprehensive Discharge Consents that incorporate best practice management techniques that help alleviate flooding.

Specific objectives/programmes in place that contribute to resilience include:

- Managing the stormwater network such that the number of blockages per 100 km of pipelines is less than 20 per annum.
- Reducing the number of habitable floors that are below the 100 year flood plain by at least 30 per annum.
- Completing an additional 5% of catchments with accurate flood hazard mapping per year over the duration of the Auckland Council Long Term Plan 2012-22 [LTP] such that 65% are completed by 1 July 2022.
- Undertaking capital works of $13 million dollars in value on flood alleviation works in the 2012/13 financial year and undertaking, subject to budget allocations, at least this value of works per annum during the duration of the LTP.
- Ensuring that the Stormwater Asset Management Plan is reviewed to incorporate any vulnerability identified from the assessments undertaken under Part B of this project.
- Amending, where required, the operational procedures for the stormwater network to improve the resilience of the network to any vulnerability identified from the assessment of the Volcano, Earthquake, Tsunami and Cyclone natural hazards under Part B of this project.
- Where feasible include in the programme of works to be established for the 2013/14 and 2014/15 financial years any urgent improvement works identified in the assessment of the Volcano, Earthquake and Tsunami natural hazards under Part B of this project.

Solid Waste

Information not available for this report.

Telecommunications

- Vodafone
  - Expanded fleet of portable generators with design improvements to support long-term deployments (i.e. increased fuel storage)
  - Introduction of cell-on-wheels (COWs) using satellite backhaul, improves speed and flexibility with which temporary coverage can be provided
  - Ongoing migration towards the use of pooling technologies in the core network over the next 3 years (allows redundant capacity in the core network to be accessed immediately on a failure – minimize downtime even from the loss of a site)
  - Upgrade of a number of key sites with permanent standby generators and bulk fuel capacity
  - Upgrading battery capacity for some roadside cabinets
  - Annual DR fail over to Wellington for critical customer support system

- Kordia
  - Constructed dual, geographically separate, fibre routes between our two main network hubs in Auckland – this increased the resiliency of our key services and in particular broadcast services;
  - Reconfigured the power system at the major network hub to increase resiliency. This included splitting the DC systems, the air-conditioning systems and the installation of an additional genset;
  - All core Digital Microwave Radio (DMR) antennas were made more resilient by affixing an additional side-strut. This increased their likely survival during a severe weather event – primarily wind; and

- All vertical structures, includes towers and monopoles, are maintained to the highest standards and have all been modelled, analysed and upgraded (strengthened) using the latest NIWA wind predictions and to AS/NZS 1170.02.2002

- *Telecom/Chorus data not available for this report*

Electricity

- Transpower upgrades to increase resilience of the National Grid to Auckland and Northland include:
  - New power link between Whakamaru and Auckland
  - Underground 220 kV cable circuit from Pakuranga to Albany to build redundancy
  - Installation of a +/- Mvar STATCOM at Penrose to maintain voltage during the milliseconds following unexpected outages
  - Upgrade of bus security at the Bombay 110kV Substation
  - 22kV and 33kV outdoor to indoor switchgear conversions
- Vector Electricity
  - Connection to two new GXP's at Hobson and Wairau as part of the NAaN (2014)
  - Seismic strengthening of all prone zone substation buildings (2012 – 2020)
  - Installation of 110kV ring in the CBD (2020)

⇒ *Find out more detail on North Auckland and Northland upgrade project at www.gridnewzealand.co.nz/naan-home*

Gas

- Additional paralleling of the high pressure gas transmission pipelines between Westfield delivery point and Southdown power station was completed in 2010. This provides additional capacity to the pelerine system and improves resilience by adding additional redundancy.
- Continual improvement of pipeline integrity processes and systems contributes to increasing the security of the pipelines to give greater resilience.
- Recently introduced regulatory arrangements designed to manage the long term security of supply of both the high pressure gas transmission pipelines and connected downstream gas distribution networks are now bedded in and have proved to be effective in practice.