wellington electricity™

Wellington Electricity

10 Year Asset Management Plan
1 April 2012 - 31 March 2022

Wellington Electricity

10 Year Asset Management Plan

1 April 2012 – 31 March 2022

Any comments or suggestions regarding the Asset Management Plan can be made to:

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This Asset Management Plan (AMP) has been prepared by Wellington Electricity Lines Limited (Wellington Electricity) for public disclosure in accordance with the requirements of the Electricity Distribution (Information Disclosure) Requirements 2008.

Information, outcomes and statements in this version of the AMP are based on information available to Wellington Electricity that was correct at the time of preparation. Some of this information may subsequently prove to be incorrect and some of the assumptions and forecasts made may prove inaccurate. In addition, with the passage of time, or with impacts from future events, circumstances may change and accordingly some of the information, outcomes and statements may need to change.

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Any person wishing to use any information contained in this AMP should seek and take expert advice in relation to their own circumstances and rely on their own judgement and advice.

Statement from the Chief Executive Officer

Wellington Electricity welcomes the opportunity to submit an updated Asset Management Plan (AMP) for the period 2012-2022. We confirm that this AMP has been prepared to meet the Commerce Commission's "Electricity Distribution (Information Disclosure) Requirements 2008".

Our operations have focused on maintaining the existing high levels of safety, reliability, service and performance the network assets provides to its customers. This has been supported by developing the investment we have made in our best-of-breed information technology platforms.

Committed to continuous improvement, we continued with an out sourced provision of maintenance and faults services and welcomed Northpower as the new Field Service Provider from March 2011. This change was targeted to align with a shift in business focus for asset maintenance management and performance towards a condition based risk management approach. The new Field Service Provider has developed complimentary systems during 2011 to meet the requirements of Wellington Electricity's delivery of maintenance and fault data into our information systems. This new approach to maintenance and fault management will enhance our forward decisions on life-cycle asset management.

Northpower have physically deployed a field services workforce from 1 March 2011 to deliver substantial efficiencies to our organisation.

The AMP confirms the organisation structure and business drivers that are supported through the policies and procedures to deliver best practice asset management. This includes a summary of the systems employed and an outline of processes adopted around maintenance, planning, investment, risk mitigation and outage management. A more detailed treatment of network development processes has been included which details the examples of projects under consideration and how the competing requirements are balanced and prioritised to set forward investment and work plans for both maintenance and capital expenditure. Project ranking has benefitted from the initial detailed condition information received through the new Field Services provider.

Network capacity generally appears adequate for the planning period based on maintaining modest forecast growth rates, load management systems remaining effective and with no large developments being disclosed at the time of AMP review.

The AMP has made a number of assumptions around the outcome of the continuing regulatory process, which creates some uncertainty with delays in decisions due to the need to seek materially better outcomes through a merits appeal process. The Plan positively forecasts that regulatory outcomes will continue to encourage lines businesses to be able to maintain assets and continue to invest capital on the basis of making a fair market return.

The resilience of network assets to recover from external events has been highlighted by events in Christchurch. The AMP includes an assessment of responses to improving network resilience with contingency plans to overbuild vulnerable sections or strengthen seismically prone buildings housing key assets, to ensure they are available for service following an event. Improvement has also been made with exercising and simulating response and recovery plans to ensure our staff and field contractors remain trained and capable to effectively responding to a crisis event.

Strongly linked to asset vulnerability to external events is the insurance cover of key assets. The international market has responded to recent elevated claim demand by increasing premiums and lowering asset cover. Lines Companies do not fully insure all assets, hence access to capital to recover and the sharing of risk with customers to carry higher insurance are key items to discuss and resolve with regulators, customers and government to ensure businesses are incentivised to plan and recover costs in the best interest of asset resilience and community supply recovery following a major event.

Capital risks also remain with new technology developments which have yet to be field proven or fully commercialised to deliver on their aspirational claims. Wellington Electricity continues to evaluate opportunities that would clearly benefit the efficient operation and effective utilisation of new technology that provides an equitable long term benefit to both shareholders and customers.

Our customers have been consistent in their feedback and are appreciative of a reliable network that is delivering services at affordable prices.

The control room will be transferred in-house from April 2012 to integrate the cross functional benefits of the state-of-the-art communication and control systems across the business. It is our belief that this will position Wellington Electricity to become an industry leader in asset management practices.

Being a member of the CKI/Power Assets Group allows Wellington Electricity the ability to access skills and knowledge from our other electricity distribution businesses around the world and have direct access to international best practice in asset management. In conjunction with our service companies and in alignment with its business strategy,

Wellington Electricity will continue to focus on the development of asset management strategies in parallel with the short to long term planning of the network to ensure that appropriate levels of capital and operational expenditures are made to deliver a safe, reliable and cost effective supply of electricity to consumers within the Wellington region.

We welcome any comments or suggestions regarding this AMP.

Greg Skelton

Chief Executive Officer

Contents

1. Summary of the AMP

AMP Purpose

This Asset Management Plan (AMP) has been prepared for the following purposes:

- To inform stakeholders of how Wellington Electricity plans to manage its electricity distribution assets in order to ensure that connected electricity consumers continue to receive electricity supply at a quality level which is reasonably priced and sustainable
- To provide a working plan for use by Wellington Electricity for the management of the network
- To satisfy the Commerce Commission's Electricity Distribution (Information Disclosure) Requirements 2008.

This AMP covers the 10 year period commencing 1 April 2012 and finishing on 31 March 2022. The plans described in this document for the year ending 31 March 2013 reflect Wellington Electricity's current business plan and are relatively firm for the next two to three years. Beyond three years the plans and strategies are reviewed annually and will be adjusted to incorporate any internal and external business environmental factors as they arise.

This AMP was approved by the Wellington Electricity Board of Directors on the 29 March 2012.

Assets Covered

Wellington Electricity's distribution network supplies the cities and council jurisdictions of Wellington, Porirua, Lower Hutt and Upper Hutt. A map of the supply area is shown in Figure 1.2. As of 31 December 2011, there were over 164,500 connected customers. The total system length (excluding streetlight circuits and DC cable) is 4,606 km, of which 61.8% was underground. Peak demands and energy distributed for the last four years is shown in Figure 1.1.

Year to	30 Sep 2007	30 Sep 2008	30 Sep 2009	30 Sep 2010	30 Sep 2011
System Maximum Demand (MW)	555	537	565	583	585*
System Energy Injection (GWh)	2,569	2,581	2,595	2,594	2,573

Figure 1-1 Peak Demand and Energy Delivery

* The system maximum demand for the period ending 30 September 2011 is an average of the top ten peaks during this period which were distorted by an extreme snow event on the evening of 15 August 2011. During this event the system peak reached 614MW for one half hour period, with higher than usual demand in the period either side. This is not reflective of a normal system demand.

Figure 1-2 Wellington Electricity Network Area

AMP Assumptions

The AMP is based on the following assumptions:
(Note that further details of the assumptions are provided in Appendix B)

Demand growth	Demand growth will continue to be lower than the national average and will remain steady through the forecast period with an annual growth of electricity consumption and demand between 0.5% and 1.0%.
Quality targets	The quality targets for the Wellington Electricity business in the period 2010 – 2015 will be maintained as per the Commerce Commission's decision paper on the default price path (November 2009).
Regulatory environment	The regulatory environment will encourage Wellington Electricity to continue to employ CAPEX and OPEX to invest in the network to maintain the quality targets.
Shareholders	Shareholders will be incentivised to invest in the network to allow the business to achieve market returns.
Economy	The commodity markets will remain stable during the forecast period limiting equipment price rises. Regional GDP growth will remain lower than the national average.
Business cycle	Wellington Electricity continually undertakes detailed assessments of network assets. It is assumed there will be no uncovering of any new information that changes the premise of network assets being in a reasonable condition.
Technology	There will be no dramatic changes that would result in a rapid uptake of new technology leading to higher expenditure or stranding of existing assets.

Network Reliability

The reliability of Wellington Electricity's distribution network is high by both New Zealand and international standards. Wellington Electricity plans to maintain supply reliability at current levels over the planning period. The average consumer connected to the network should only experience an outage lasting a little over an hour about once every two years, subject to severe storm events and high wind gusts which can frequently occur within the Wellington region. Wellington Electricity's asset management strategies and forecast levels of expenditure and investment are designed to achieve this by replacing assets that are at end of life and maintaining in service assets through to end of life.

Network Development

The forecast annual growth of electricity consumption and demand in the Wellington Electricity network area is between 0.5% and 1.0%. This is lower than the national average of around 2.0%.

During 2011 Wellington Electricity completed a zone substation load transfer project within the CBD to utilise spare capacity, and smaller 11kV feeder projects are expected to be undertaken in 2012 and 2013 to address isolated loading issues. However, as incremental load increases a new zone substation within the CBD area may be required later in the planning period (from around 2015 onwards). Other areas with identified capacity constraints are Mana-Plimmerton, Wainuiomata and the Johnsonville-Paparangi areas. Investment options including reinforcement of sub-transmission into these areas will be analysed and may be required inside the planning period. A reinforcement project for the Johnsonville area was completed in early 2012 and will defer the need for a new zone substation by up to five years, although land will be purchased in 2012 for this substation.

There is ongoing discussion with Transpower over grid security into the Central Park Grid Exit Points (GXP) and also the implementation of Transpower "Policy" projects including outdoor to indoor 33kV conversions at a number of GXPs in the Wellington area and the replacement of transformers at Central Park and Haywards.

Asset Replacement and Renewal

The design of the Wellington CBD network is biased towards obtaining high availability and reliability. The Wellington CBD area consists of many high voltage (HV) rings which provide for uninterrupted supply in the event of the loss of any one component. The Wellington Electricity network also comprises a high percentage of underground cabling with 66% of the sub-transmission circuits being cabled. Of this underground cabling 60km is of pressured gas filled construction, most of which was installed in the 1960's and is being reviewed as part of Wellington Electricity's approach to condition based risk management assessment of its assets. The "Stage of Life" analysis and risk assessment process has been revised for the three major asset types (33kV subtransmission cables, zone substation power transformers and primary distribution circuit breakers) applying a condition based risk management strategy. A number of projects have been identified from this work.

The high number of circuit breakers, the HV feeder rings and the predominance of cabling achieve the high levels of reliability but are asset intensive. As equipment condition factors change and the risk of failure increases, Wellington Electricity is forecasting a period of high capital expenditure on asset replacement and renewal being required to maintain present levels of reliability. Ongoing replacement projects on the Wellington network continue to address the condition of switchgear, transformers and other key supply assets.

Wellington Electricity has programmes in place to regularly monitor the condition of its older assets. This ongoing condition assessment indicates that existing assets are still serviceable and generally in reasonable condition for their age. Notwithstanding this, around 50% of forecast capital expenditure over the planning period is expected to be on the proactive asset replacement and renewal of older assets subject to their condition and risk criteria being met. This level of expenditure is designed to maintain present supply reliability.

Asset Management Systems

Since the last AMP, there has been continuous improvement in the Asset Management systems used and data collected by Wellington Electricity. The key Asset Management system objectives for 2012 are:

- Continuation of the programme to improve data quality in systems such as GIS and Gentrack
- Further development of the maintenance database to meet the business needs for asset condition information and to begin the planning for a business integrated maintenance management system
- Following the successful implementation of a new GE ENMAC control system, development of a stand-alone automatic load control system at the Network Control Room will be undertaken
- Relocation of the Network Control Room to the main office at Petone to better integrate operational and asset management functions and improve the exchange of information between these departments.

After the first year of the Field Services Agreement with Northpower, there has been good progress with the business processes that assist Wellington Electricity in filling the gaps of both missing and incorrect information as well as cleansing and validating the data in the Wellington Electricity Asset Management systems. Reporting of all maintenance activities is now in electronic format to aid in reporting and analysis by both the Field Service Provider and Wellington Electricity.

Risk Management

A major objective of the network development and lifecycle asset management plans is to mitigate the risks inherent in operating an electricity distribution business. Risk assessment therefore plays a major role in the prioritisation of network development and asset replacement projects.

The detailed design and operation of the network is not described in this AMP, but it is summarised at a high level to demonstrate it is in accordance with industry standard practices and procedures. These practices and procedures have been developed and refined over time to manage the risks and hazards associated with high voltage electricity distribution.

Wellington Electricity has continued to develop risk assessment methodologies that provide input to the planning of network development, maintenance strategies and project evaluation. This risk based approach has resulted in a number of projects that have been completed within the 2011/12 regulatory year (refer to section 8.6 for an example of one such project). .

Two major projects that will be progressed in 2012 and beyond, are the development of major event resilience network planning and a substation building seismic policy. Both of these projects have been driven by the events associated with the ongoing Canterbury earthquakes. In addition, detailed plans for bypassing damaged subtransmission cables are being developed, and seismic assessment and possible strengthening of high importance substations is being undertaken.

As part of its Business Continuity Management Policy, Wellington Electricity has Emergency Response Plans to cover emergency and high business impact situations. These plans are periodically reviewed and revised to best meet the business emergency management and response requirements.

Safety and Environmental Management

During 2011, Wellington Electricity realised significant improvement in its Quality, Safety and Environmental (QSE) performance through the initiatives which have been implemented, and expects to further improve performance from its programme of planned QSE improvements. Further details of these improvements can be found in Chapter 9.

In addition to improved risk management via reviewing and improving key controls, Wellington Electricity has achieved a milestone of over half a million contractor hours worked without incurring an injury which resulted in a Lost Time Incident (LTI). This means the LTI Frequency Rate for the 2011 calendar year is zero. Despite this achievement, ongoing safety management must be maintained and complacency cannot be allowed to creep in.

Wellington Electricity has also increased the contractor participation rates in the QSE reporting system. During 2011 reporting of safety, quality and environmental issues nearly trebled.

Fault Response during the August 2011 Snow Storm

2. Background and Objectives

2.1. History and Ownership Overview

Wellington Electricity is an electrical distribution business that supplies electricity to approximately 400,000 consumers through over 164,500 installation connection points (ICPs) in its network that covers the Wellington, Porirua and the Hutt Valley regions of New Zealand.

The ownership of Wellington Electricity has changed significantly since the early 1990's. At the start of the 90's, the Wellington City Council Municipal Electricity Department (MED) and the Hutt Valley Electric Power Board (HVEPB) merged their electricity assets. As part of the Energy Companies Act 1992 two new companies were formed, Capital Power and Energy Direct respectively. In 1996 the Canadian owned Power Company Transalta acquired both companies to form a consolidated Wellington Electricity Distribution Network business. Ownership was passed to United Networks in 1998, which Vector acquired in 2003.

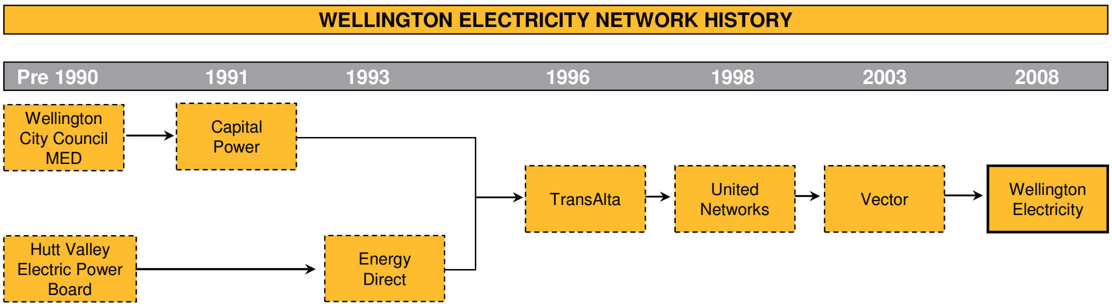

Figure 2-1 Wellington Electricity Ownership History

In July 2008 the network was purchased by Cheung Kong Infrastructure Holdings Limited (CKI) and Hong Kong Electric Holdings Limited (HEH) to create Wellington Electricity Lines Limited (Wellington Electricity). Since then Wellington Electricity has continued to establish the business systems for independent operation and control of the network. Hong Kong Electric Holdings Limited changed its name on 16 February 2011 to Power Assets Holdings Limited (Power Assets) to better reflect the international portfolio of assets.

CKI and Power Assets together own 100 per cent of Wellington Electricity with both companies being members of the Cheung Kong group of companies and listed on the Hong Kong Stock Exchange (HKEx).

Further information regarding the Wellington Electricity ownership structure is available at the website www.welectricity.co.nz.

2.2. AMP Purpose and Objectives

The primary purpose of the AMP is to communicate with consumers and other stakeholders Wellington Electricity's asset management strategies, polices and processes for effective and responsible management of the network assets.

Other goals of the AMP are to:

- Ensure that all stakeholder interests are considered and integrated into the business to achieve an optimum balance between levels of service and the cost effective investment while maintaining regulated service targets. The level of service is reflective of a customer price/quality trade off upon which appropriate pricing can allow the ability of Wellington Electricity to maintain, renew and replace the network assets to meet stakeholder quality needs. The Commerce Commission as the industry Economic Regulator has a part to play in recognising and ensuring that electricity distribution businesses achieve adequate levels of return on investment for their regulated asset base to maintain service quality to consumers;

- Provide a consolidated governance and management framework that encompasses the asset management and planning strategy in a 'live' document
- Address the strategic goals and objectives of the business by focusing on prudent life cycle asset management planning, stakeholder levels of service and appropriate levels of network investment which provide a sustainable and equitable return to the shareholders
- Provide a platform for monitoring and demonstrating continuous improvement in alignment with best industry practice.

The AMP is a key internal planning document and has become a consolidated repository for asset management planning. It is a dynamic document requiring continuous review and adjustment to align with the changes in the business environment.

This is a collectively produced document that draws from external stakeholders and from within the Wellington Electricity business. Contributions have been received from consumers surveyed during the year, field service providers and the following teams: asset and planning, operations and maintenance, capital works projects, quality, safety and environmental, commercial and finance and the executive. The document is approved for disclosure by the Wellington Electricity Board of Directors.

The AMP is compiled in accordance with the *Electricity Information Disclosure Requirements 2004* and the 31 October 2008 Amended Requirements.

2.3. Legislative and Regulatory Environment

Wellington Electricity's principal activity is providing electrical infrastructure and systems that effectively distribute electricity. It is an electricity operator pursuant to section 4 of the Electricity Act 1992. As an electricity operator Wellington Electricity provides electricity lines services to customers in its distribution supply area using its electricity supply system.

Wellington Electricity is subject to a range of legislative and regulatory obligations to ensure its network is safely and efficiently planned, constructed, operated and maintained and that the prices charged for its services fall within regulated thresholds. This includes obligations covering:

- Economic regulation under Part 4 of the Commerce Act 1986. Economic regulation relates to the methodology for:
    - Information disclosure - the purpose of which is to ensure that sufficient information is readily available to interested persons to assess whether the purpose of Part 4 is being met, and
    - Regulating revenues received from providing electricity lines services. This may be achieved either under a Default or Customised Price Path.

- Reliability of supply of electricity to consumers under the Final 2010-15 Electricity Distribution Default Price-Quality Path Determination (established under the Commerce Act 1986). Reliability is measured with reference to quantity of interruptions to supply (system average interruption duration index (SAIDI)) and the duration of interruptions to supply (system average interruption frequency index (SAIFI) limits).

- Price path compliance under the Final 2010-15 Electricity Distribution Default Price-Quality Path Determination.

- Price oversight under the Electricity Industry Act 2010 by the Electricity Authority. Price oversight relates to price setting and price movements, including the principles for price development.

- Connection of customers and embedded generators to the network. These obligations are established under Wellington Electricity's Use of System Agreements (UoSA) and are compliant with the Electricity Industry Act 2010 and the Electricity Industry Participation Code 2010 (Part 11).

- Quality of supply standards. This relates to voltage regulation, harmonic voltages and currents, voltage dips, voltage unbalance and flicker standards as per the Electricity (Safety) Regulations 2010 and AS NZS 61000 Electromagnetic compatibility (EMC).

- Employee and public safety under the Electricity (Safety) Regulations 2010 and the Employment Act 1992 to ensure that Wellington Electricity's network assets do not present a safety risk to staff, contractors or the public. Wellington Electricity monitors electricity related public safety as well as staff and contractor safety incidents around its public assets.

- Environmental obligations under the Resource Management Act 1991, the Building Act 1991, the Local Government Act 1974 (particularly with respect to works on roads), the Dangerous Goods Act 1974 and other relevant local authority bylaws. Wellington Electricity has an Environmental Management Plan which sets out its approach to environmental management of its network including in relation to: noise limits; sediment disposal; dust control; spill management.

- Vegetation management in accordance with Electricity (Hazards from Trees) Regulations 2003. This sets out clearance zones in which vegetation must not encroach.

Wellington Electricity has had regard for these regulatory and legislative obligations in developing the best practice asset management policies and procedures which underpin this AMP.

There are currently no regulated national security standards in force. However Wellington Electricity has developed its own security standards which specify the minimum levels of network capacity (including levels of redundancy) for its network. Wellington Electricity's security standards are discussed in section 5 of this AMP.

2.3.1. Economic Regulatory Environment

As noted above, Wellington Electricity is a regulated monopoly and its revenue requirements are subject to regulation by the Commerce Commission under Part 4 of the Commerce Act 1986.

Wellington Electricity's revenue requirements for Electricity Lines Services were established under the Final 2010-15 Electricity Distribution Default Price-Quality Path Determination made by the Commission on 30

November 2009 (2010-15 DPP Determination) for the regulatory control period 1 April 2010 to 31 March 2015.

Wellington Electricity recovers its notional revenue, calculated based on a price path form of regulation that applies a weighted average price cap (WAPC), through charges for the use of the distribution system (otherwise known as Electricity Lines Services charges). These charges are payable by customers and are collected via the customers' retailer.

Substantial changes have been, and continue to be, made to the regulatory framework since the commencement of the current regulatory control period. These changes may impact on the 2010-15 DPP Determination and therefore Wellington Electricity's 2011-15 notional revenue requirements, which underpins the projects and works programs set out in this AMP. Changes to the regulatory framework include:

- The development and publication of the Final Input Methodology Decisions (Final IM Decisions) in December 2010 setting. The final IM Decisions are important because they set out the rules, requirements and processes applying to the regulation of distribution services. The regulatory matters addressed under the Final IM Decisions include amongst other things: cost of capital, asset valuation and pricing methodologies

- Development of the Starting Price Adjustment Input Methodology (SPA Input Methodology). This is a critical component of the regulatory framework as it may impact on the initial prices underpinning the 2010-15 price path and therefore Wellington electricity's revenue requirement over the current regulatory control period. The Commission is proposing to publish the Final SPA Input Methodology decision by September 2012 and to decide whether to make a SPA decision during the current regulatory control period by November 2012

- Development of new information disclosure requirements for publication by May 2012. The Commission is proposing to finalise the new information disclosure requirements by May 2012. The new requirements will impact on all aspects of disclosure including the Asset Management Plan.

- Amendments to the Electricity Industry Participation Code including in relation to indemnity provisions

- Amendments to the model use of system agreement (MUoSA).

At the time of drafting this AMP, these regulatory changes had not been finalised. Wellington Electricity will need to assess the impact on its future revenue of these regulatory changes on its future revenue once they are finalised. This may require Wellington Electricity to review its future expenditure program and therefore the projects and work that are detailed in this AMP.

2.4. Interaction between AMP and Other Business Plans

Wellington Electricity's mission is

"To own and operate a sustainably profitable electricity distribution business which provides a safe, reliable, cost effective and high quality delivery system to our customers."

This mission sets the context for all strategic positioning and tactical action planning within the business which effectively drives the asset management planning and delivery.

The AMP incorporates information from internal business and asset management related documents which cascade down from the Business Plan and Strategy to the asset maintenance and lifecycle plans through to the annual Capital and Maintenance works delivery plans and programmes.

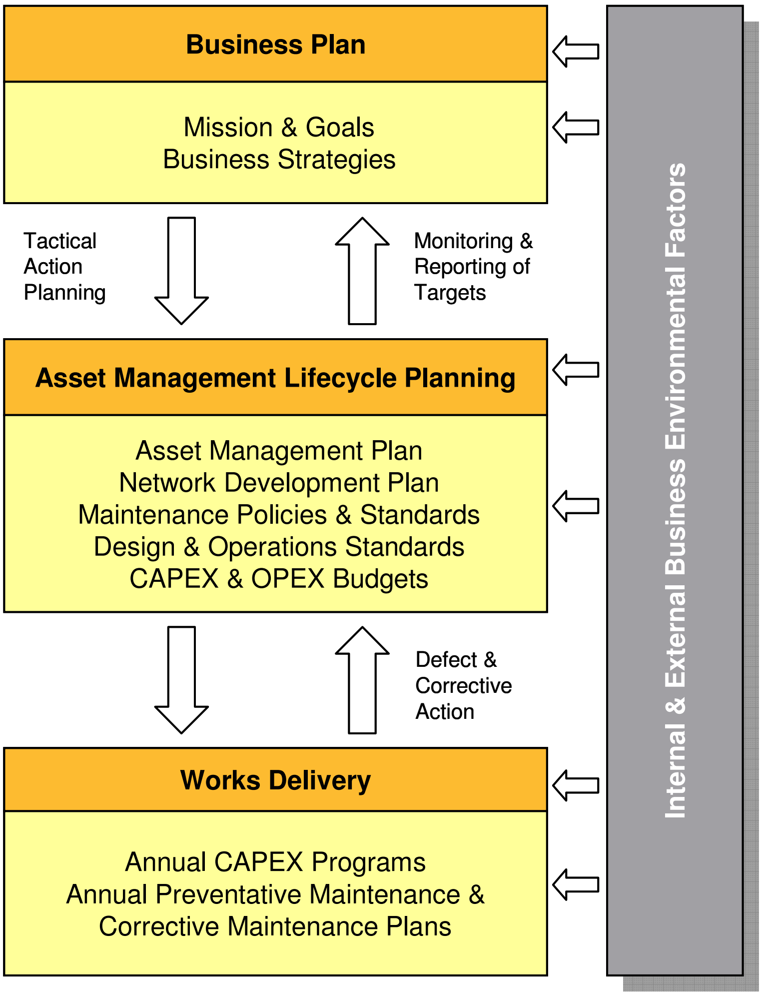

Figure 2-2 AMP Interaction with Business Planning

2.4.1. Business Plan and Strategy

Wellington Electricity's strategic business direction is supported by the Business Plan and aims to deliver a long-term sustainable business to all of its stakeholders.

WELLINGTON ELECTRICITY BUSINESS PLAN	
"To own and operate a sustainably profitable electricity distribution business which provides a safe, reliable, cost effective and high quality delivery system to our customers."	
INTERNAL BUSINESS ENVIRONMENT	**EXTERNAL BUSINESS ENVIRONMENT**
Financial	**Consumers**
Meeting our financial targets Manage our treasury responsibilities	164,500 reasons to provide effective and efficient service Understand our investment in their future for a quality service
People	**Regulatory**
Working safely Developing a great team & organisational culture Employees are aligned with business goals & direction Building strong relationships with our service providers Reputable employer	Commerce Act – Price/Quality Path reset & controls Electricity Act & Regulations Health & Safety in Employment Act **Economic** Business cycles post recession and pressure to maintain price stability
Assets	**Image & Reputation**
Meeting regulatory targets through prudent asset management Effective life cycle management of assets Appropriate risk management Engaged with our stakeholders	Well managed media and stakeholder communication Local people managing the business well with high quality service **Political** Responsibility of 4th largest ELB serving nation's capital Government & business leaders interested in affordable & reliable supply Managing local & regional council expectations

Figure 2-3 Wellington Electricity Business Plan

Wellington Electricity's Business Strategy is driven in response to both internal and external business environments and defines the company's actions and outcomes to meet the business mission.

The business strategies effectively 'shape' the AMP, taking into consideration the changing regulatory environment and the impacts upon Wellington Electricity meeting the needs and interests of its stakeholders.

BUSINESS STRATEGIES	
Safety - Our Primary Focus	Continuous review of incident reporting and engagement with Service Providers with their corrective actions, achieve Safety Management System accreditation and continuously enhance public safety management
Financial & Corporate	Generate an adequate return to shareholders Manage treasury outcomes
Network & Assets	Produce annual Asset Management Plan Produce annual Network Development Plan
Our People	Set personal & company objectives/targets for growth Stimulate & challenge our people
Regulatory	Establish appropriate business models Manage well all regulatory submissions
Service Providers	Manage and motivate all service providers to continuously perform safely ahead of contract requirements and KPI Expectations
Growth	Explore increased revenue opportunities Leverage ripple control for Demand Side Management opportunities
Image & Reputation	Support a positive public image through customer engagement Enhance reputation be delivering a consistent & quality service

Figure 2-4 Wellington Electricity Business Strategies

2.5. Planning Period Covered by the AMP

This AMP covers the 10 year period commencing 1 April 2012 to 31 March 2022 and replaces the April 2011 AMP. Plans for subsequent years of the planning period are likely to be affected by the outcomes of the continued development of the asset management reviews as well as changes to the internal and external environment in which Wellington Electricity operates. The AMP provides clear plans for the management of assets over the next 12 to 36 months, with plans for the subsequent three to seven years being broader and plans for the eight to ten year period being indicative only. This reflects the impact of uncertainty over the longer timeframes.

The AMP will be continuously reviewed in conjunction with the development of asset management strategies driven by:

- A greater understanding of the condition of the Network assets and risks
- Assessment of load growth and network constraints
- New and emerging technologies
- Changes to business strategy driven by internal and external factors

The AMP was approved by the Wellington Electricity Board of Directors on the 29th of March 2012.

2.6. Managing Stakeholders

2.6.1. Stakeholder Interests and Identification

Wellington Electricity has identified stakeholders, their interests and how interactions are managed by all of the business through a number of activities. The following tables identify the key stakeholders, how they are identified and what their interests are with Wellington Electricity.

Shareholders		
How are the interests identified?	What are their interests / expectations?	Accommodation of interests / expectations?
▪ Governance and Board mandates ▪ Board Meetings and committees ▪ Business Plan & Strategic Objectives	Shareholders expect a fair economic return for their investment. Shareholders expect the company to meet industry-leading operational and HSE standards. Shareholders look to maintain good working relationships with other key stakeholders in the business through engagement with our consumers needs and effective management of the network	▪ Customer initiated projects produce appropriate revenue levels to meet the cost of capital ▪ Meeting reliability and customer service levels

Consumers		
How are the interests identified?	What are their interests / expectations?	Accommodation of interests / expectations?
▪ Customer satisfaction and engagement surveys ▪ Feedback received via complaints and compliments ▪ Media related enquiries and sponsorship ▪ Price / Quality trade-off	The consumers connected to Wellington Electricity's network require a safe and reliable supply of electricity of acceptable quality at a reasonable price. While consumers generally appreciate that delivery of an extremely high quality of supply with no interruptions is unrealistic, expectations can differ as to the level of reliability and quality that can be considered acceptable.	▪ Meeting reliability and customer service levels ▪ Appropriate investment in the network ▪ Public safety initiatives ▪ Price / Quality trade-off

Retailers		
How are the interests identified?	What are their interests / expectations?	Accommodation of interests / expectations?
▪ Electricity Governance Rules ▪ Relationship meetings and direct business communications ▪ Via Use of Network Agreement terms	As retailers rely on the network to deliver the energy they sell to consumers, they also require the network to be reliable and electricity distribution services to be provided at a reasonable price. Retailers are reliant on electricity distribution services to conduct their business and therefore want Wellington Electricity to assist them in providing innovative products and services for the benefit of their customers.	▪ Meeting reliability targets ▪ Achieving customer service levels ▪ Consultation

Regulators		
How are the interests identified?	What are their interests / expectations?	Accommodation of interests / expectations?
▪ Commerce Act Part 4 and other legislation ▪ Relationship meetings and direct business communications ▪ Industry working groups ▪ Information disclosure	To ensure that the consumer achieves a supply of electricity at a fair price commensurate with an acceptable level of quality. Regulators need to provide an investment framework for business to make adequate returns on infrastructure.	▪ Meeting reliability compliance targets and controls for price and quality ▪ Compliance with legislation, engagement and submissions as required ▪ Monitoring information disclosures

Staff & Service Providers		
How are the interests identified?	What are their interests / expectations?	Accommodation of interests / expectations?
▪ Team and individual direct discussion ▪ Employee satisfaction surveys ▪ Relationship meetings and direct business communications ▪ Contractual agreements	Staff and contractors want job satisfaction, a safe and enjoyable working environment and to be fairly rewarded for the services they provide. Contractors also want assurance around work delivery continuity and the mitigation of working hazards by appropriate asset management planning.	▪ Health & Safety policies and initiatives ▪ Forward planning of work through asset management practises ▪ Performance reviews ▪ Life balance

Transpower		
How are the interests identified?	What are their interests / expectations?	Accommodation of interests / expectations?
▪ EIPC ▪ Relationship meetings and direct business communications ▪ Annual planning documents ▪ Grid notifications & warnings	Transpower obtain sustainable revenue earnings from the allocation of connected and inter-connected transmission assets. Wellington Electricity under the Electrical Industry Participation Code (EIPC) will operate and interface under instruction as and when required. Further assurance is required that all downstream connected distribution and generation will not unduly affect their assets.	▪ Implementation of Operational standards and procedures ▪ Appropriate investment in the network

Central & Local Government		
How are the interests identified?	What are their interests / expectations?	Accommodation of interests / expectations?
▪ Through legislation ▪ Relationship meetings and direct business communications ▪ Focus working groups	Local Councils require that appropriate levels of investment are made in the electricity network to allow for levels of local growth. Regional Councils require that both current and new network assets do not affect the environment. Central Government's interests are mainly managed through the respective ministries e.g. MED, DOL, to ensure the general public receive a safe, reliable and fairly priced electricity supply. All three require appropriate emergency response and contingency planning to manage a significant civil defence event.	▪ Compliance with legislation, engagement and submissions as required ▪ Emergency Response Plans ▪ Environmental Management Plans

Figure 2-5 Stakeholder Identification

2.6.2. Managing Conflicting Interests

Safety will always be a 'non negotiable' attribute when managing a stakeholder conflict. Wellington Electricity will not compromise the safety of the public, its staff or service providers.

Other stakeholder interests that conflict will be managed on a case-by-case basis. This will often involve consultation with the affected stakeholders and may involve the development of innovative "win-win" approaches that are acceptable to all affected parties. However Wellington Electricity is obliged to follow approved business policy to ensure it meets its obligations and responsibilities to deliver an electrical supply in accordance with all legislative requirements.

2.7. Wellington Electricity Structure and Asset Management Accountability

2.7.1. Governance

The Wellington Electricity Board of Directors is responsible for the overall governance of the business. The Board has approved capital and operational expenditure budgets and business plans for the 2012 calendar year. Information is provided to the Board as part of a monthly consolidated business report that includes health and safety reports, capital and operational expenditure vs. budget, reliability statistics against targets and consumer satisfaction survey results.

All network capital projects greater than $400,000 require approval from the Capital Investment Committee (CIC). The CIC comprises, as a minimum, one company director and the CEO. The CIC meets on a regular basis to review and approve projects and to be appraised of progress on approved projects.

2.7.2. Executive and Company Organisation Structure

The Wellington Electricity CEO leads the business management, implements the company mission and is accountable for overall business performance and direction.

International Infrastructure Services Company (IISC) is a separate infrastructure services company which provides services to Wellington Electricity.

Further services are contracted to Wellington Electricity through external service providers.

As Wellington Electricity is part of the CKI group of infrastructure companies, it can access skills and experience from across the world. For example, CKI's Australian group companies (which distribute electricity to over 1.8 million customers) have considerable knowledge and experience in electricity distribution business asset management including strategy and planning. This group has provided the IT systems and platforms into Wellington Electricity to allow synergy gains across the business. Being part of a larger CKI group of companies has provided Wellington Electricity with direct access to international best practice systems to support world class asset management.

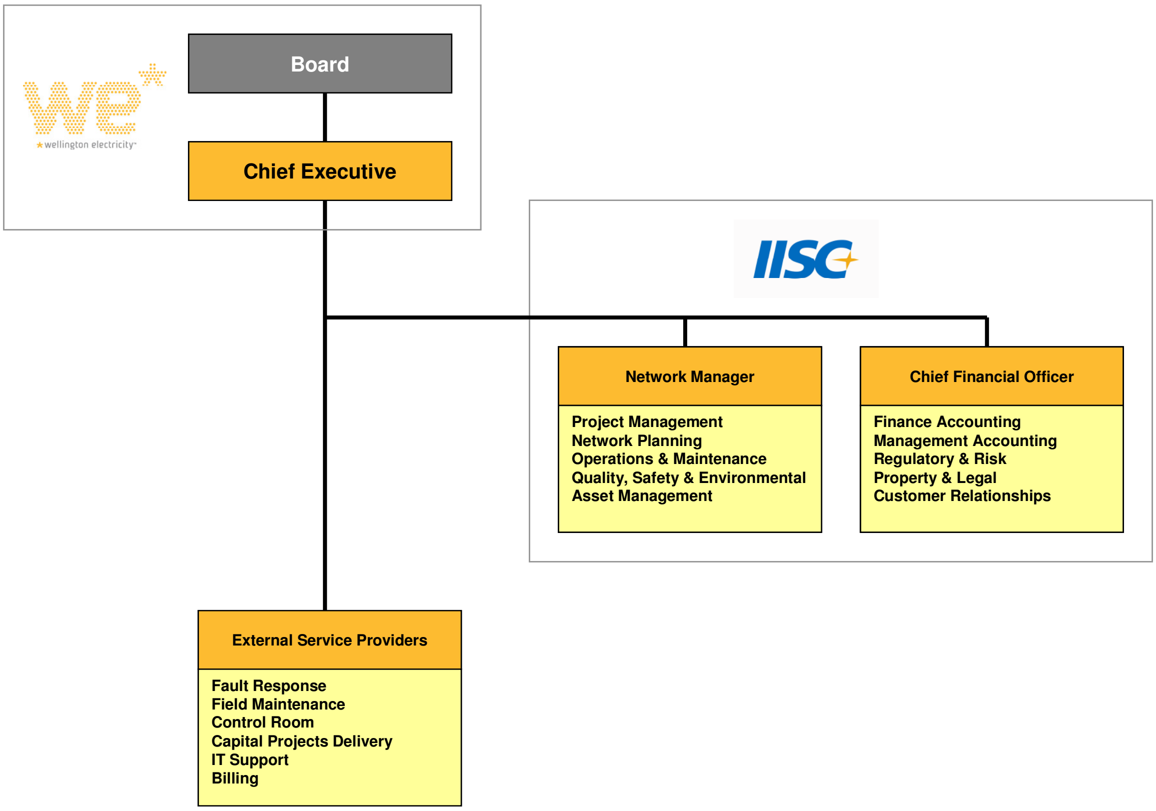

Figure 2-6 Wellington Electricity Organisation Structure

2.7.3. Network & Operations Team Structure and Asset Management Accountability

The management of network assets for Wellington Electricity falls under the accountability of the IISC Networks and Operations team, however the entire business has some direct or indirect interaction with the network assets on a daily basis.

The Wellington based Network Manager is accountable for the delivery of asset management services to Wellington Electricity. These services include asset planning, project management, capital expenditure delivery, operations and maintenance and safety, quality and environmental performance.

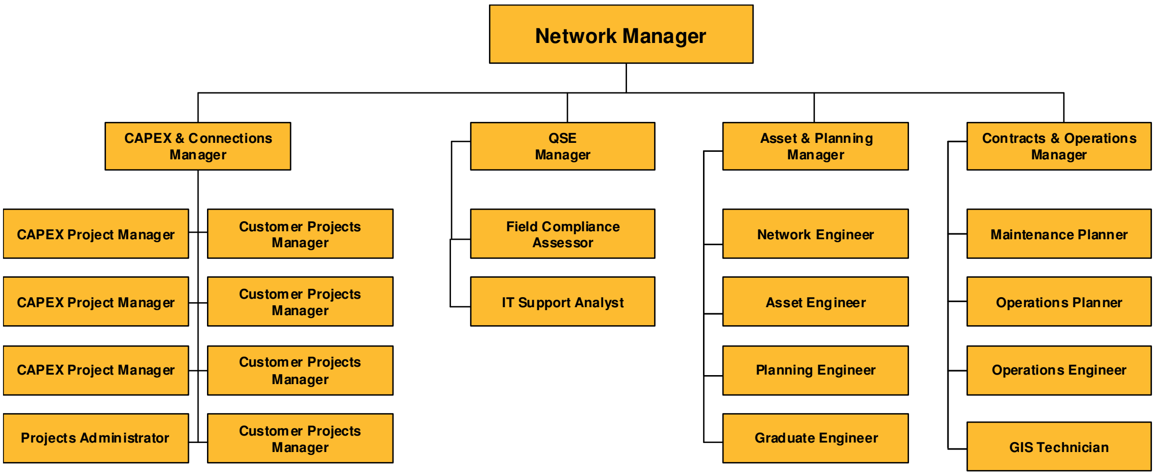

Figure 2-7 IISC Network and Operations Support Structure for Wellington Electricity

2.7.4. Finance and Commercial Team Structure and Asset Management Accountability

Financial and accounting support for the management of network assets is also provided for within the IISC structure for service delivery to Wellington Electricity. The Finance and Commercial team provides indirect interaction with the network assets through managing support systems on a daily basis.

The Wellington based Chief Financial Officer is responsible for all indirect asset management functions including customer service, retail services, regulatory management, legal and property management as well as financial modelling and accounting support services.

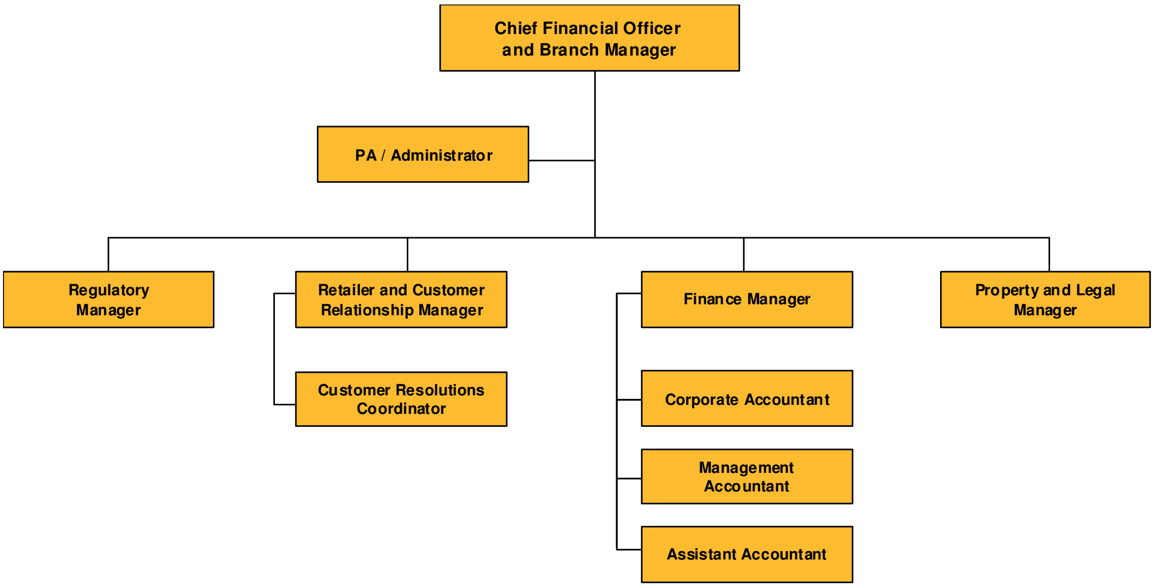

Figure 2-8 IISC Finance and Commercial Support Structure for Wellington Electricity

2.7.5. External Service Providers – Field and Network Operations

Wellington Electricity operates a contracted out-sourced field operations model on its network utilising a number of service providers for core field and network functions. A Request for Proposal (RFP) for the provision of field services (fault response and maintenance) was carried out by Wellington Electricity in 2010. A number of capable industry service providers were requested for an expression of interest prior to

RFP release. A total of nine companies were included in the RFP process with five respondents shortlisted. After a thorough RFP evaluation Northpower Ltd were successful in being appointed as Wellington Electricity's new Field Service Provider from early 2011.

The Field Services Agreement with Northpower has been designed to deliver a number of strategic objectives for Wellington Electricity. A particular focus is on alignment with the Wellington Electricity asset management strategies, to obtain a greater understanding of the condition of network assets and to improve the integrity of asset data with population into the Wellington Electricity information systems.

In summary, the out-sourced field operations and the approved Wellington Electricity service providers are:

<u>Fault Response and Maintenance (Northpower)</u>

- Fault Management – 24/7 response for fault restoration
- Preventative Maintenance – asset inspection and condition monitoring including capture, storage of asset condition data and reporting this information to the asset owner
- Corrective Maintenance – remedial maintenance on defective assets
- Value added services – safety disconnects and reconnects, on site cable mark-outs, sub-transmission standovers and provision of buried asset plans provided to third parties
- Minor connection services and livening
- Management Services – management of network spares, updating of Geographical Information Systems (GIS) and other supplementary services as required

Contestable Capital Works Projects (Northpower, Transfield Services and Lineworks)

- Customer initiated works – new connections, subdivisions and substations, undergrounding and relocations
- Network initiated works – asset replacement projects and cable/line reinforcements

Vegetation Management (Treescape)

- Vegetation Management – tree clearance programme, tree owner liaison and reactive availability
- This out-sourced contract is planned for re-negotiation in 2012

Network Control Room (Siemens Energy Services)

- Network Control Services – 24/7 management of Wellington Electricity's Network Control Room (NCR) at Haywards with relocation to the Disaster Recovery (DR) site at Central Park substation if necessary
- A strategic decision has been made to in-source the NCR back into the Wellington Electricity business in 2012. The strategy also includes the relocation of the NCR to the business office in Petone with the Haywards site continuing as a DR site and the disestablishment of the existing Central Park DR site

Contact Centre (Telnet)

- Contact Centre – providing a dispatch function for all HV and LV outages, management of customer and retailer service requests, outage notification to retailers and handling general enquiries
- This out-sourced contract is planned for re-negotiation in 2012

Wellington Electricity manages and audits service providers and also collates reports on network operations and maintenance performance and expenditure, customer satisfaction, safety statistics and network reliability.

Wellington Electricity will continue to review the extent that these activities remain out-sourced in order to achieve optimum asset management outcomes.

2.8. Asset Management Systems and Processes

Wellington Electricity's stakeholders have invested significantly in state of the art, best of breed IT systems. which places Wellington Electricity in a strategically strong position for establishing best practice asset management services to its customers.

2.8.1. Systems for Managing Asset Data

This section of the AMP identifies the key repositories of asset data used in the asset management process, the type of data held in the repositories and what the data is used for. Areas where asset data is incomplete are identified and initiatives to improve the quality of this data are disclosed.

2.8.1.1. SCADA

A GE ENMAC SCADA system was installed in 2009 during the business transition to provide real time operational management of Wellington Electricity's network. The ENMAC system was fully commissioned during 2011 following the separation of the automatic load control system. The ENMAC system provides a total integrated solution of SCADA, DMS (Distributed Management System) and OMS (Outage Management System) with the legacy Foxboro SCADA system fully separated from the ENMAC SCADA system to perform the automated load control functionality.

The SCADA system only provides operation, monitoring and control of the network at 11kV and above. Low Voltage (400 Volts or below) outages are managed by the GE ENMAC Calltaker system utilised by the Outage Manager at the Wellington Electricity Contact Centre. The Calltaker system electronically interfaces with the Field Service Provider's outage management system to dispatch field staff for fault response.

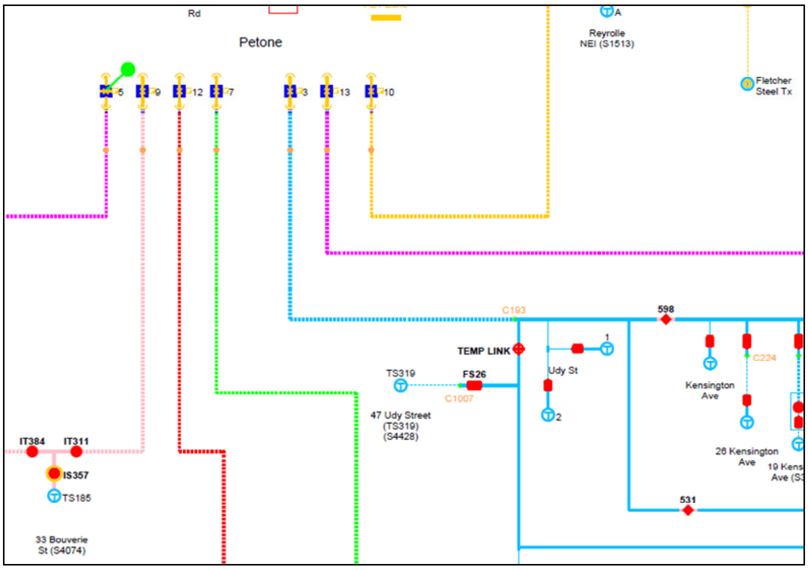

Figure 2-9 Screen shot of ENMAC SCADA/DMS system

2.8.1.2. Geographic Information System (GIS)

The geographic information system (GIS) is a representation of the system fixed assets overlaid on a map of the supply area. Wellington Electricity uses the GE Smallworld application for planning, designing and operating the distribution system and is the primary repository of network asset information. A process is in place to link asset condition data to the GIS information to further improve asset management outcomes by streamlining manual business processes into linked electronic database for more efficient information management which will aid engineering decision making.

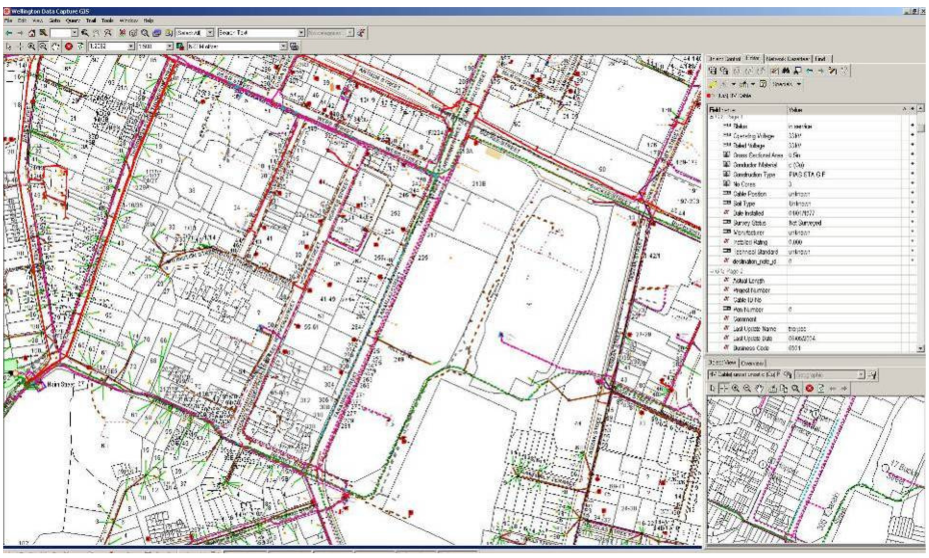

Figure 2-10 Screen shot of Smallworld GIS system

2.8.1.3. ProjectWise

Wellington Electricity stores all drawings and historic asset information diagrams in ProjectWise where users can access PDF files of all substation and system drawings.

2.8.1.4. DIgSILENT Power Factory

Power Factory is a leading network simulation tool used to model and simulate the electrical distribution network and analysis of load flows for development planning, reliability and protection studies. The Power Factory database contains detailed connectivity and asset rating information. Wellington Electricity has completed a review of the Power Factory model during 2011 to determine its accuracy and completeness and views this tool as a key part of optimising the network and planning development projects.

Following this review, the model will be progressively updated and processes will be developed to ensure it remains synchronised with the actual power system through such means as an automated cross reference with GIS which is presently being explored.

2.8.1.5. Cymcap

Cable rating information is derived via CYMCAP (cable ampacity and simulation tool) which is used to model the ratings of underground cables at all voltages for both existing cables in service and also for new developments.

2.8.1.6. DIgSILENT Station Ware

Station Ware is a centralised protection setting database and device management tool. It holds relay and device information, parameters and settings files. Station Ware interfaces directly to Power Factory to allow for protection discrimination studies to be carried out.

2.8.1.7. Hard Copies and Spreadsheets

Wellington Electricity inherited much of the asset condition information of the network in the form of hard copies and/or spreadsheets of inspection records and test results. These are stored in various locations, both electronically, or in hard copy. Examples of asset condition data and maintenance record data held include:

- Scanned and printed copies of inspection results
- Spreadsheets of transformer oil analysis
- Scanned copies and hard copies of historical cable test results

In some cases it has proven difficult to locate asset condition data records more than a few years old. Wellington Electricity has worked through the challenge of establishing electronic records into the new maintenance database in order to more effectively manage asset information for future decision making.

2.8.1.8. Maintenance Database

Wellington Electricity has developed a maintenance management database to store the maintenance history of network assets and to electronically capture maintenance data. Over 15,000 historic maintenance records from the period 2007 to 2010 were entered into this database at the time of the field services contractor transition. Maintenance data is regularly provided electronically by the Field Service Provider on completion of maintenance works such as condition assessments, inspection and test results and to record defects against the asset. The database has reporting functionality to enable Wellington Electricity to verify the work completed, as well as to plan future maintenance and replacement programmes based upon the historic inspection and condition assessment results. Wellington Electricity reviews the data to identify gaps with asset records and where priority actions are required on network assets, as well as to schedule future works.

The database, although functional to meet Wellington Electricity's current maintenance management requirements, is considered an interim solution. Further development is underway to develop the business rules and strategies needed to move towards an integrated maintenance management system. The asset data within the database can be migrated to the final maintenance management system once implemented.

2.8.1.9. GenTrack

GenTrack is an application designed to manage Installation Control Point (ICP) and revenue data as well as deliver billing services. GenTrack is populated and synchronised with the central ICP registry. It interfaces with the GIS and ENMAC systems to provide visibility of consumers affected by planned and unplanned network outages. GenTrack also interfaces to SAP for billing.

2.8.2. Financial Systems

SAP is the financial and accounting application used by the business as the commercial management platform. It is an integrated finance system for billing, fixed asset registers, payroll, accounts payable and general accounting.

2.8.2.1. Summary Table

	Physical attributes	Equipment ratings	Asset condition	Connectivity	Customer service
SCADA / ENMAC		✓		✓	✓
GIS	✓	✓		✓	✓
Project Wise	✓	✓			✓
Power Factory		✓		✓	
Station Ware	✓	✓			
Spreadsheets / hardcopy	✓	✓	✓		
Maintenance Database	✓	✓	✓		✓
GenTrack				✓	✓
SAP (Financial)					✓

Figure 2-11 Asset Data Repositories

2.8.3. Data quality

Wellington Electricity is continuously reviewing its business data to check the quality of the records in the above IT systems as some inconsistencies have been found between some of the data in different locations. Initiatives have been identified to establish one 'source-of-truth' system for each category of information, and the subsequent synchronisation of data between the various repositories. Work is continuing to identify and fix the ICP data management between various systems, as well as update network connectivity in GIS which is critical to ICP data management.

The Field Services Agreement has a number of business processes developed that over time will assist Wellington Electricity in filling the gaps of both missing and incorrect information as well as cleansing the data in the systems (with a particular focus on the GIS data).

2.9. Process Overview

The three main processes that Wellington Electricity uses as part of managing network assets are:

- Inspection and maintenance
- Planning
- Investment selection

The interaction of the processes is illustrated in the diagram below. Each of these processes and the asset works plan is described in detail in the following sections.

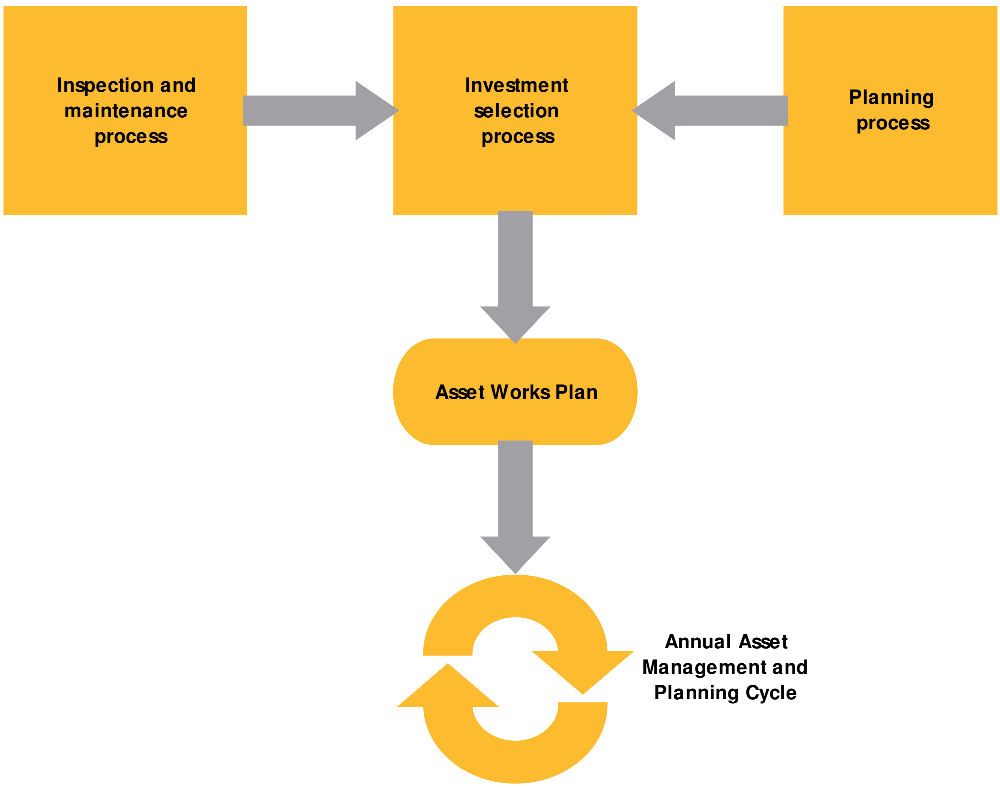

Figure 2-12 Asset Management Processes

A key output from these processes is the Asset Works Plan (AWP), which in turn feeds into the annual asset management and planning cycle. The AWP is discussed in more detail in a subsequent section of this chapter. The development of the AWP is ongoing, and is being continuously reviewed for input into the AMP process.

2.9.1. Inspection and Maintenance Processes

The existing asset inspection and maintenance process is centred around the Preventative Maintenance (PM) plan that is prepared annually by the Wellington Electricity engineering and maintenance groups. The PM plan lists all assets by group and details the inspection and routine maintenance activities that are required for them. Each type of asset has an associated standard driving the policy that details the scope and frequency of the inspection and maintenance required for that asset category. These standards and associated policies are discussed in more detail in Section 6 (Lifecycle Asset Management). The timing and scope of these activities are determined by a number of factors including:

- Safety (both operational and public)
- Condition (assets that show signs of deterioration may be inspected more regularly)
- Age (older assets may be inspected more regularly than new ones)
- Experience of how often inspections are required (e.g. for substation buildings)
- Type history (assets that have known issues may be inspected more regularly)
- Operation frequency (assets that have operated frequently under fault conditions)
- Risk (likelihood and consequence of asset unavailability)
- Manufacturers recommendations

The PM plan is then scheduled by the Field Services Provider into a PM programme. The Field Services Provider is responsible for implementation of the programme and is held accountable for this through their service contract. The Field Services Provider will inspect the assets, undertake a condition assessment of the asset or assets, identify any asset defects, carry out the routine maintenance and also carry out corrective maintenance (i.e. correction of issues uncovered during routine inspection) provided the total cost of this is under a threshold set by Wellington Electricity. The inspection and test results, condition assessments, defect assessments and work records are reported to Wellington Electricity on a regular basis with prescribed maintenance data recorded into the Wellington Electricity maintenance database. Wellington Electricity engineering staff analyse the maintenance data via the maintenance database and in discussion with the Field Services Provider may approve further corrective maintenance or initiate the investment selection process to address refurbishment and renewal works. Additionally, the cyclic review of asset performance (e.g. feeder performance) may initiate either corrective or project works. Further enhancements to the maintenance database will provide a greater analysis of defects, including the monitoring and detailed reporting of completed defects and aging defects.

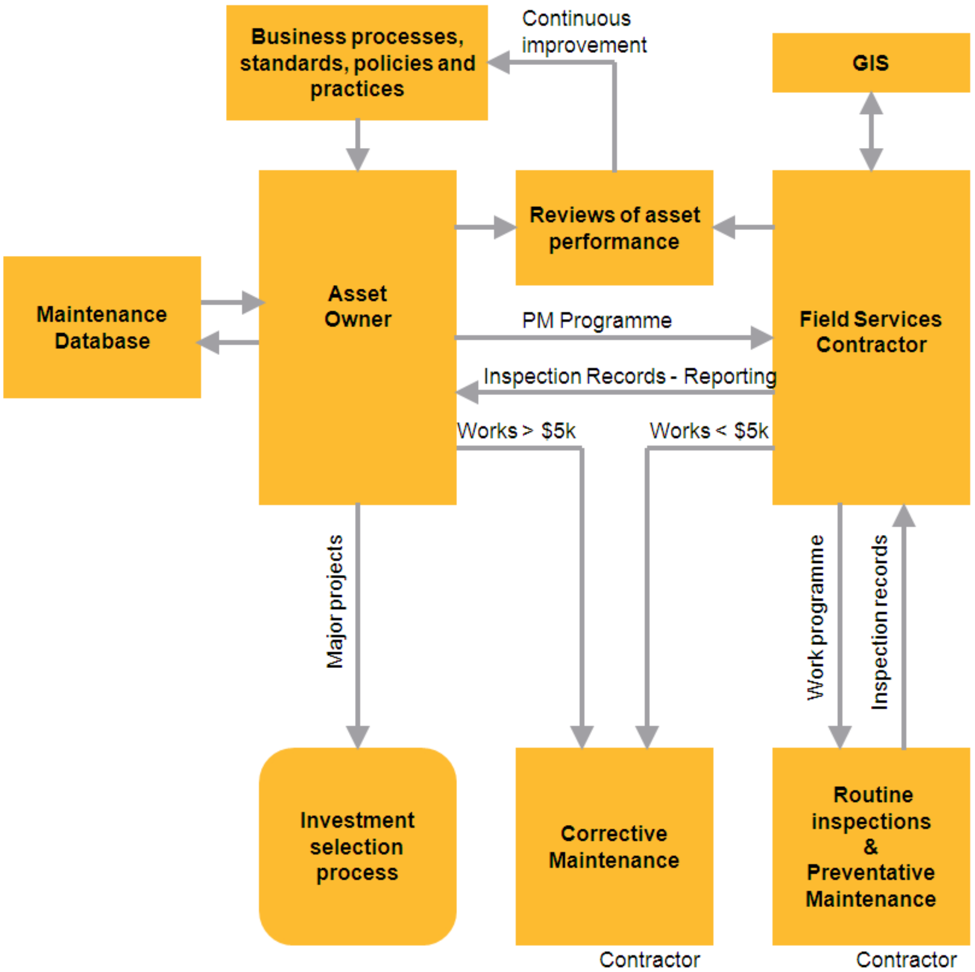

Figure 2-13 Inspection and Maintenance Process

2.9.1.1. Review of Inspection and Maintenance Process

Wellington Electricity is continuously reviewing its asset inspection and maintenance processes. A number of initiatives have already been identified that aim to improve data capture and records management such as identifying missing asset information in the GIS and other systems, updating equipment ratings and undertaking a condition assessment of the assets. Increasing the understanding of each type of equipment enables targeted maintenance programmes, or revisions to the standards to be made. The key initiatives being developed are associated with improving the way information is handled in conjunction with continually improving the maintenance standards. Maintenance standards are then updated as required to reflect new issues, or discovered defects and modes of failure.

2.9.2. Planning Process

Network constraints are identified by reviewing the capacity and the security of the network on a regular basis against network standards and policies. Should a constraint be identified, options for addressing it through reconfiguration of the network (e.g. by moving an open point) will be considered first. Should no reconfiguration options be available, then other options will be investigated as part of the investment selection process. Key inputs to the capacity and reliability review are the planning criteria and load forecasts. These are described in detail under separate headings in Section 5 (Network Planning).

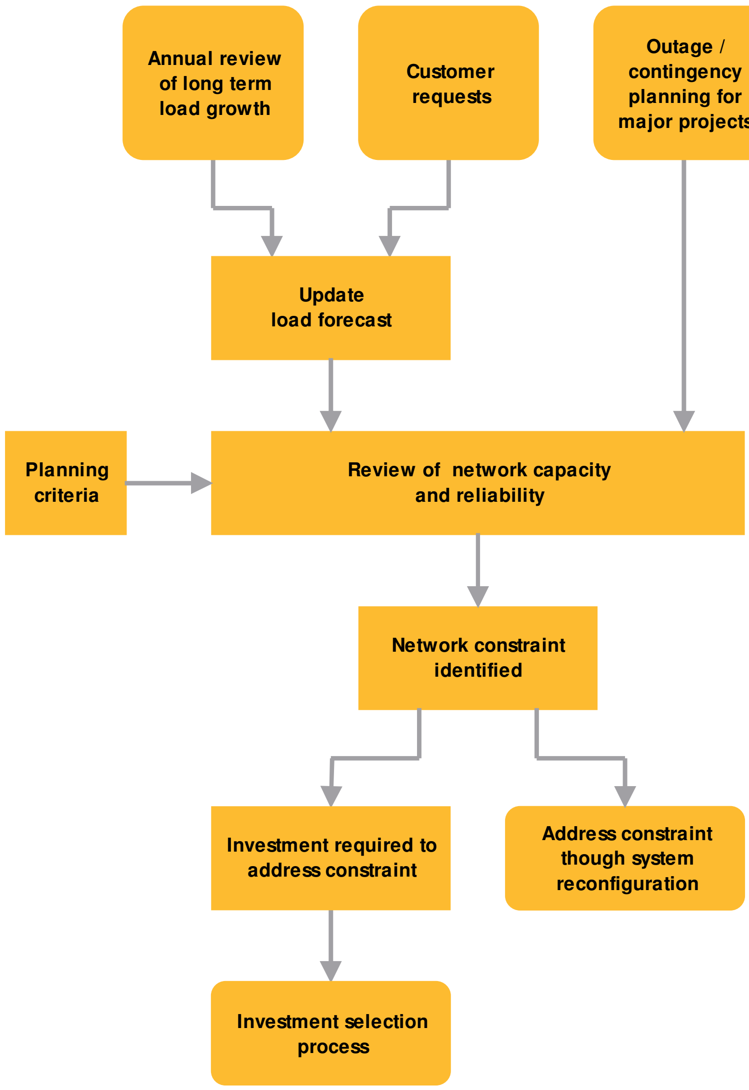

Figure 2-14 Planning Process

2.9.3. Investment Selection Process

This process describes the way in which network investments are taken from a high level need though to a preferred investment option that in turn results in a business case. It includes consideration of a long list of options, refinement of the long list to a short list of practicable options followed by detailed analysis and selection of a preferred option. The asset works plan is the repository for all potential network investments including those at the early ‘needs have been identified’ stage and ‘preferred option’ stage. This process is a refinement, rather than a replacement of existing processes as described in the previous AMP.

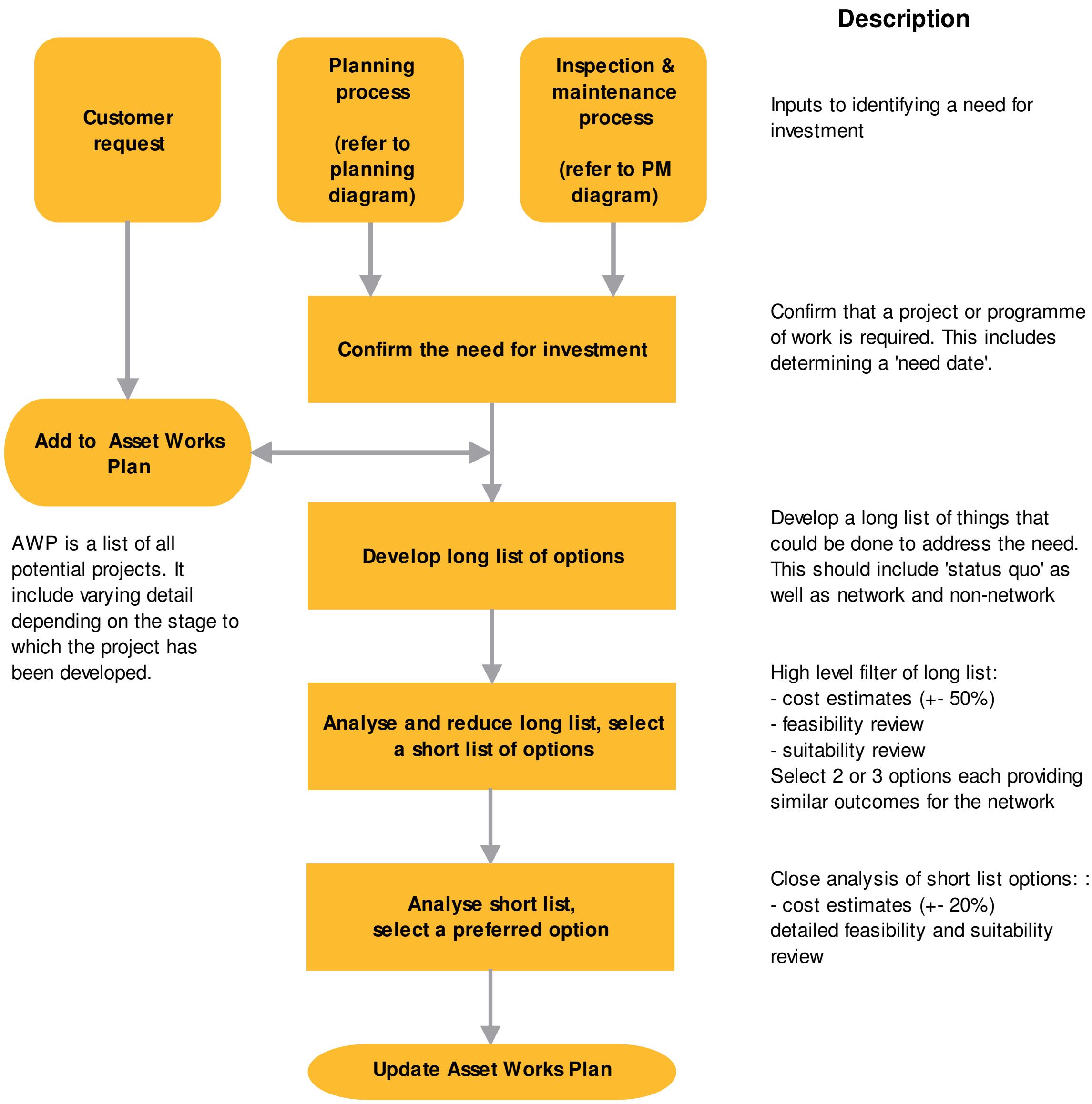

Figure 2-15 Investment Selection Process

2.9.4. Asset Works Plan

The Asset Works Plan (AWP) comprises a list of potential projects at the high level ‘need has been identified’ stage and at the ‘preferred option’ stage of the ‘Investment Selection Process’. The AWP is a dynamic list that includes dates of when projects are required. It includes projects up to ten or more years in the future and is continually updated and amended as new ‘needs’ are identified, project details are refined and projects are executed. Every year the AWP will be frozen and all projects identified for the next financial year developed to the ‘preferred option’ stage of the Investment Selection Process. This list of projects will then be prioritised. Following prioritisation, each project will be matched against the available budget for capital works and a list of projects for the following year (i.e. the capital works spend plan) will be prepared for both Board approval and CIC approval.

2.9.5. Processes for Measuring Network Performance for Disclosure Purposes

SCADA and ICP allocation information stored within the ENMAC database[1] is extracted using reporting tools to provide the business with fault (unplanned) and planned outage information. All relevant details of HV and LV faults are entered into the ENMAC fault log database, which will calculate the impact of each fault on SAIDI and SAIFI. Where supply is restored progressively through switching over a period of time, the switching sequence will be recorded and used as the basis for recording the actual SAIDI impact on customers. The ENMAC database may also be used to measure other performance metrics, for example the faults per 100 circuit-km performance indicator.

Information on the reliability of the network is available on an ongoing basis throughout the measurement period and will be regularly reported both within the business and to the Board through its monthly reports.

2.9.5.1. Unplanned Outages

The process for handling and recording the impact of unplanned outages is illustrated diagrammatically below.

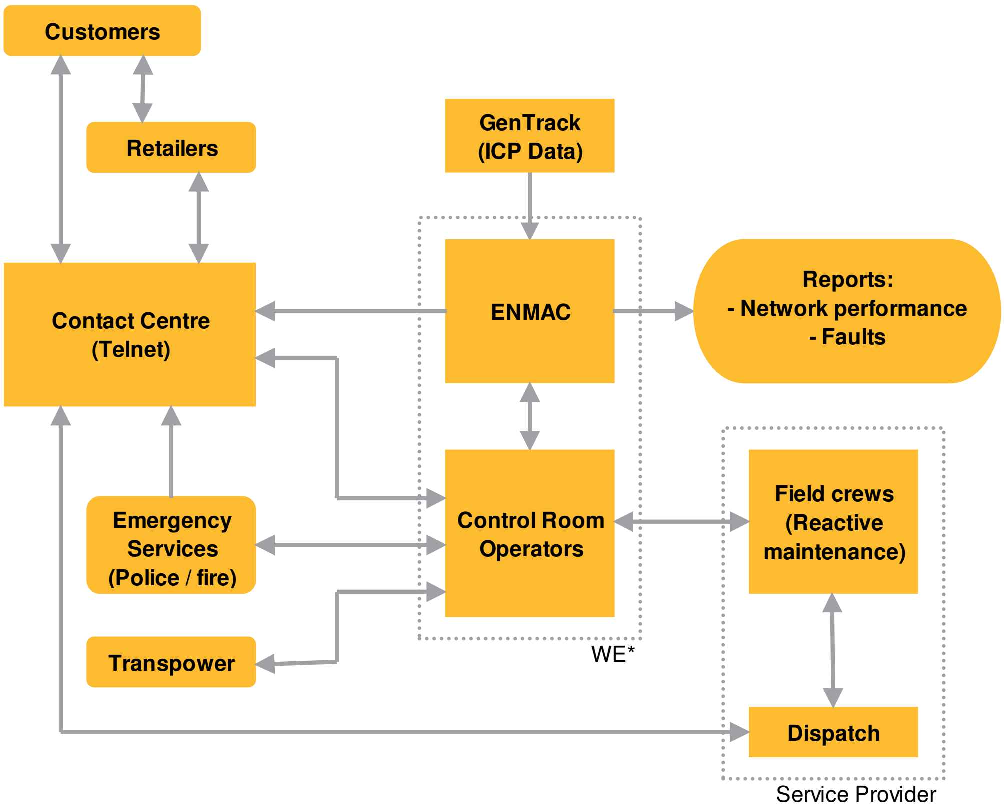

Figure 2-16 Unplanned Outage Process

The major components that comprise this system are:

- Contact Centre service provider
- Control Room: Operators and ENMAC

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[1] SCADA includes the status of circuit breakers and switches as well as system voltages and currents. ICP allocation information comprises connections made to each part of the network.

- Field service providers (fault response and maintenance)

Low Voltage Faults (400V or below)

Notification of a LV fault may be raised though calls from customers (either direct to the Contact Centre or via the customer's energy retailer). The majority of energy retailers have an electronic interface into the Wellington Electricity's ENMAC Calltaker system to directly input the LV fault details from the customer. Other options available to energy retailers are email and facsimile. The Contact Centre receives this information and sends it via the ENMAC Calltaker system to the Field Services Provider's dispatching system.

The Field Services Provider dispatches a faultman to the faulted customer(s). Updated information is fed back from the field to the Contact Centre via the outage management systems to enable the customer (via their energy retailer) to be kept informed of progress of the fault and its restoration.

High Voltage Faults (11kV or above)

Currently the Control Room via the SCADA system will identify a fault or tripping on the 11kV (or above) network thereby generating a fault within the ENMAC SCADA system. A dispatch request to the Field Services Provider for field response is automatically generated via the ENMAC Calltaker system.

As identification of the fault is carried out and supply is restored, the Control Room operators will (via the field crews) progressively update the fault log in ENMAC. Fault logs are available from ENMAC via a reporting tool. On a regular basis, these logs are interrogated and network performance statistics are obtained.

2.9.5.2. Planned Outages

Planning of outages for both maintenance and capital works is undertaken by the Field Services Provider and other approved capital works service providers in conjunction with Wellington Electricity.

For both maintenance and capital works the service providers must provide the outage requirements in a prescribed format to comply with the Wellington Electricity Operational Standards requirements such as the minimum prior notification periods to which the request must be made to the Control Room before the day of work. The Control Room will schedule the planned outage and develop the switching schedule and relevant test and access permits for return to the service provider before the day of the planned outage.

Maintenance Planners use the Preventative Maintenance plan to produce a forward schedule of planned works for the Control Room to assist in the optimisation of planned outages and to minimise the number and duration of planned outages on the network.

The Wellington Electricity customer services team discuss major outages, and outages that affect sensitive customers directly with those customers prior to the outage being confirmed. Following confirmation of an outage, the control room will liaise with the retailers (who notify all affected customers) to advise them in advance of planned works that will interrupt their supply. As the outage takes place, ENMAC is updated with switching operations. A log of affected customers, and the duration of the interruption to their supplies is recorded in ENMAC. This log is interrogated to determine network performance.

The planned outage process is illustrated below.

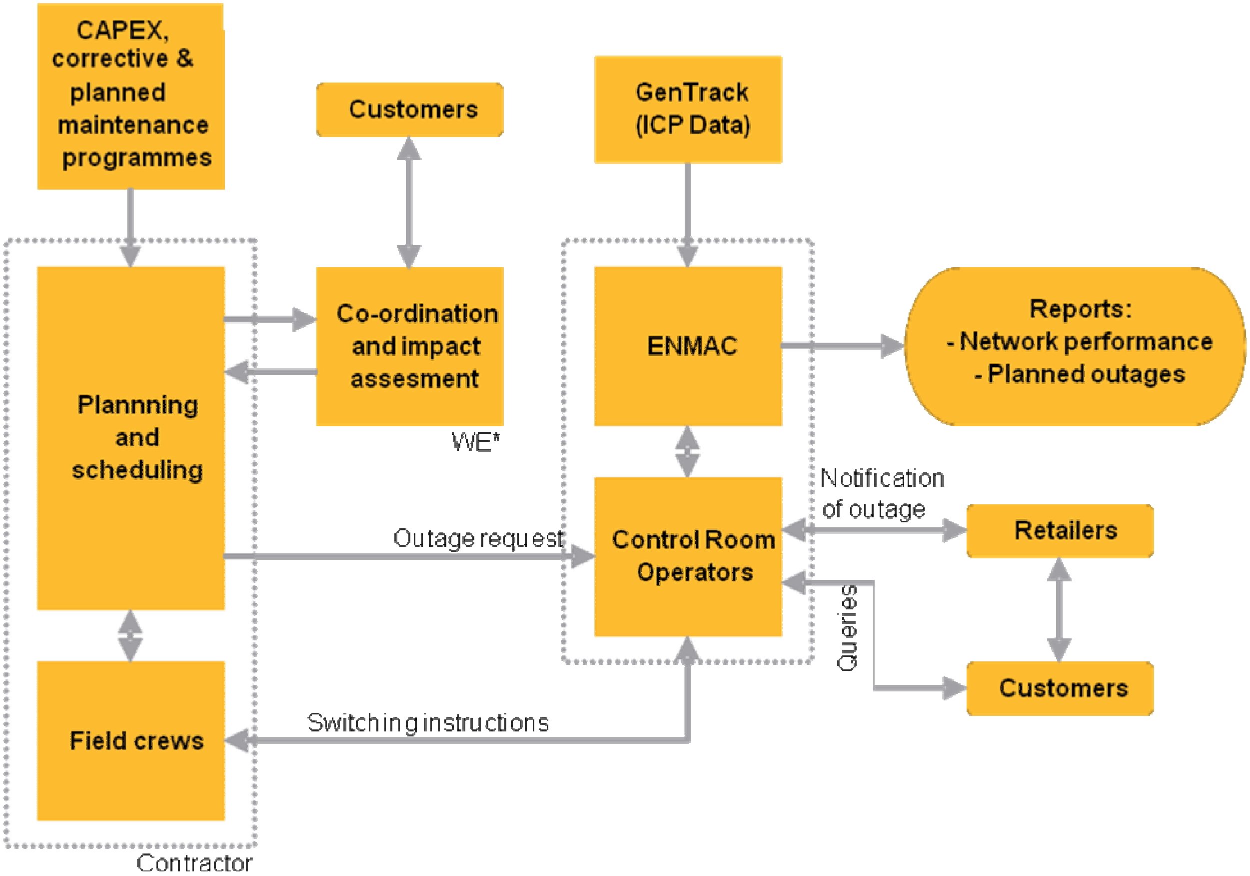

Figure 2-17 Planned Outage Process

3. Assets Covered

3.1. Distribution Area

Wellington Electricity's distribution network covers the cities of Wellington, Porirua, Lower Hutt and Upper Hutt. Wellington City is one of the major metropolitan centres in the country with high density commercial developments. It is also the seat of government and includes Parliament Buildings and the head offices of most government departments. A map of the network area is shown below.

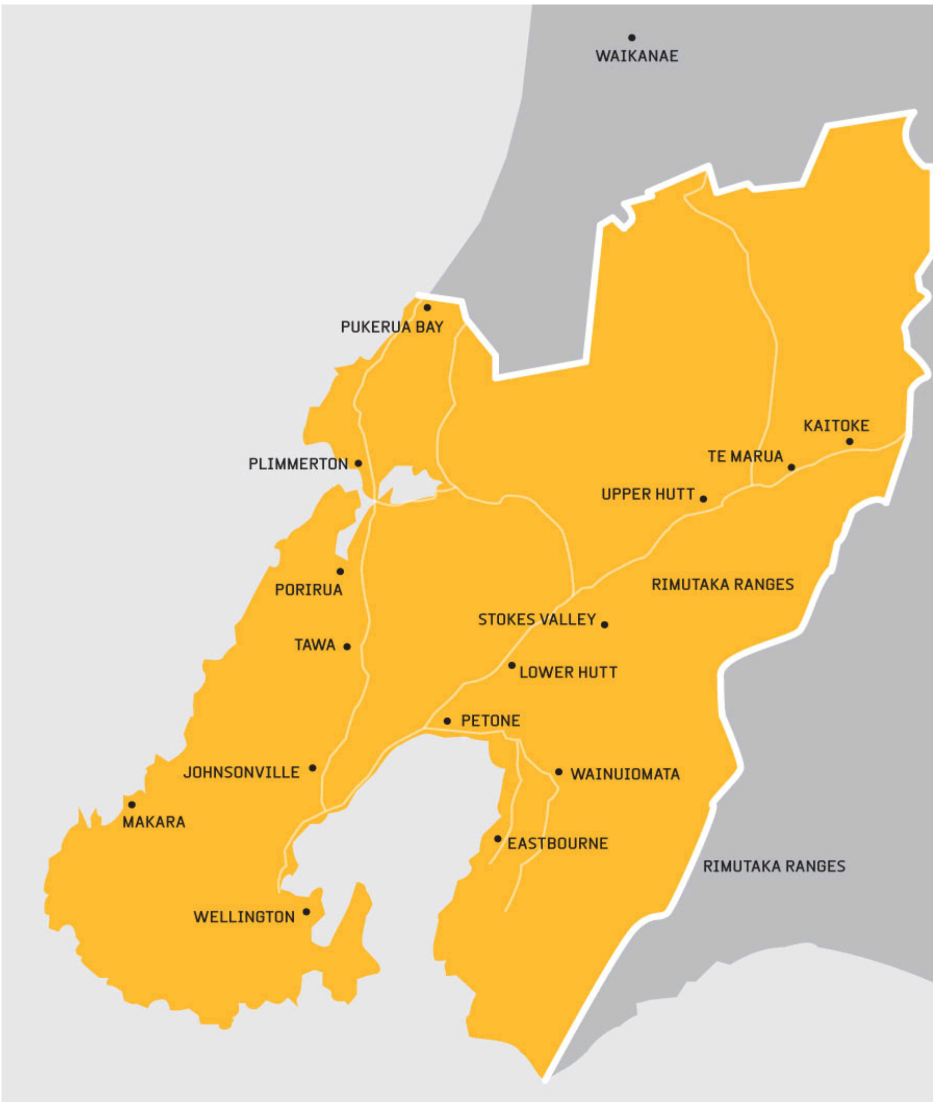

Figure 3-1 Wellington Electricity Network Area

As of 31 December 2011, there were over 164,500 connected customers. The total system length (excluding streetlight circuits and DC cable) was 4,606 km, of which 61.8% was underground.

The Wellington CBD is the largest business and retail centre for the region, although there are also significant retail centres in Lower Hutt, Porirua and Upper Hutt. Apart from the CBD there is widespread residential load throughout the area. This is interspersed with pockets of commercial and light industrial load.

The network area covers four local councils, namely Wellington City, Hutt City, Upper Hutt City and Porirua City. In addition to the local councils, the Wellington Regional Council covers the entire network area. The different council areas have varying requirements for permitted activities in relation to being an electrical utility, road corridor access and environmental compliance.

Major customers with significant loads include Parliament, Councils, Wellington Airport and Victoria University. Wellington Electricity also supplies the electrified suburban railway network and the trolley bus network. The supply area is notable for the absence of large industrial loads.

The trolley bus network is supplied through Wellington Electricity owned DC assets comprising 15 converter transformers, 19 mercury arc rectifiers, 2 solid state rectifiers and 53 DC circuit breakers. There are approximately 53 km of underground DC cables linking various DC substations. These DC assets are managed in accordance with a network connection and services agreement with NZ Bus Limited (the sole customer supplied by these assets) and are therefore not covered by this AMP.

3.2. Load Characteristics

Peak demands and energy distributed for the last five years is shown below.

Year to	30 Sep 2007	30 Sep 2008	30 Sep 2009	30 Sep 2010	30 Sep 2011
System Maximum Demand (MW)	555	537	565	583	585
System Energy Injection (GWh)	2,569	2,581	2,595	2,594	2,573

Figure 3-2 Peak Demand and Energy Delivery

The system maximum demand for the period ending 30 September 2011 is an average of the top ten peaks during this period which were distorted by an extreme snow event on the evening of 15 August 2011. During this event the system peak reached 614MW for one half hour period, with higher than usual demand on the period either side.

3.2.1. Typical Load Profiles

Typical load profiles for CBD and residential loads are shown below. These graphs illustrate that CBD loads are relatively even throughout the year with a slight trend towards a summer peak, and their daily profile is relatively flat though the day. Residential loads however are winter peaking with a pronounced dip in demand during the middle of a typical working day. Load profiles that are representative of urban and residential areas are shown on the following graphs of Nairn Street and Naenae zone substation demand respectively.

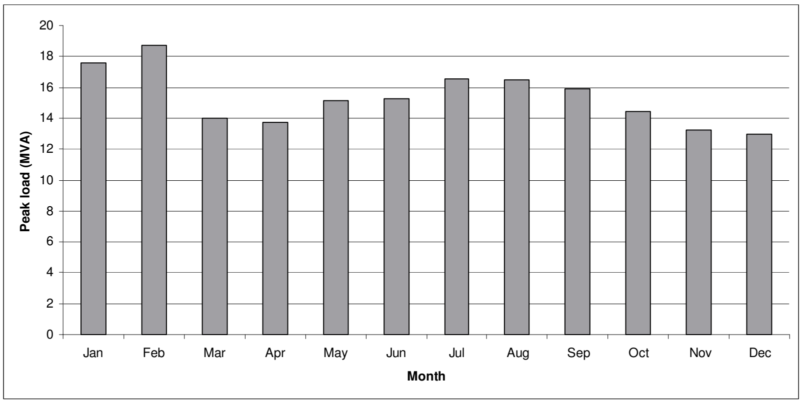

Figure 3-3 Typical CBD Monthly Peak Load Profile

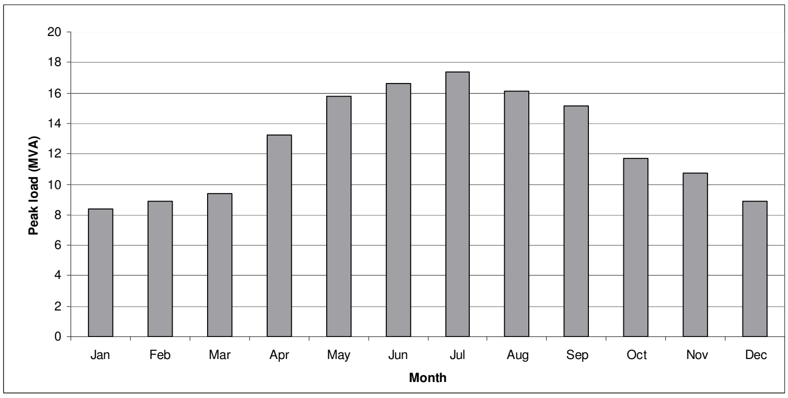

Figure 3-4 Typical Residential Monthly Peak Load Profile

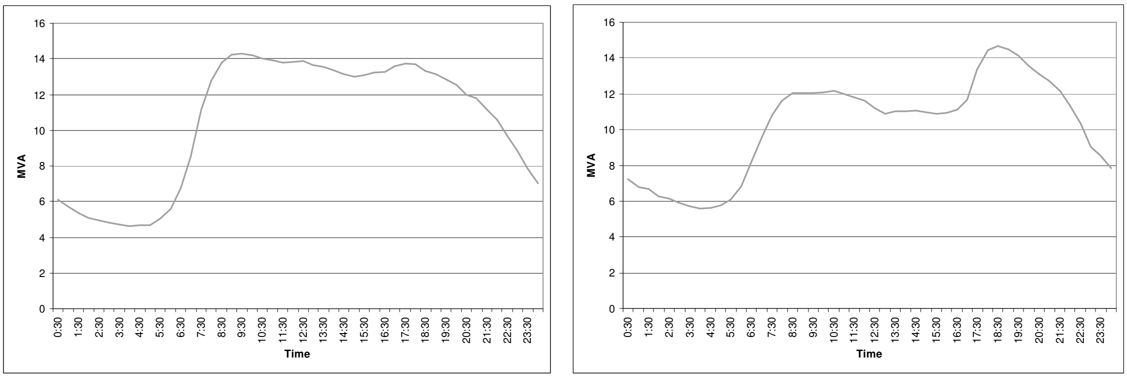

Figure 3-5 and 3-6 Typical CBD (L) and Residential (R) Daily Load Profile

3.3. Network Configuration and High Level Asset Description

Any electricity distribution system can be broadly categorised into primary and secondary assets. The primary assets carry the energy that is distributed to consumers, typically at higher voltages and currents. The secondary assets are an integral part of the distribution system and support the operation of the primary assets and include protection and control equipment, as well as communications systems.

3.3.1. Grid Exit Points

Wellington Electricity's network is supplied from the Transpower owned national transmission grid through nine grid exit points (GXPs), as shown in Figures 3-7 to 3-10. Central Park, Haywards and Melling supply the network at both 33 kV and 11 kV, and Kaiwharawhara supplies at 11 kV only. The remaining GXPs (Gracefield, Pauatahanui, Takapu Rd, Upper Hutt and Wilton) all supply the network at 33 kV only. The GXPs are described in more detail below.

3.3.1.1. Upper Hutt

Upper Hutt GXP comprises a conventional arrangement of two parallel 110 / 33 kV transformers nominally rated at 37 MVA each. Maximum demand on the Upper Hutt GXP in 2011 was 35.8 MVA. Upper Hutt GXP supplies Maidstone and Brown Owl zone substations via duplicated 33kV underground circuit connections.

3.3.1.2. Haywards

Haywards GXP comprises an unconventional arrangement of one 110/11kV transformer nominally rated at 20 MVA feeding an 11kV point of supply at the Haywards site, and one 110/33 kV transformer nominally rated at 20 MVA supplying Trentham zone substation via duplicate 33kV connections. Maximum demand at the 11kV and 33kV busses in 2011 were 18.4 MVA and 15.0 MVA respectively. A 5MVA transformer supplies the Haywards local service switchboard and also links the 33 and 11kV switchboards.

3.3.1.3. Pauatahanui

Pauatahanui GXP comprises a conventional arrangement of two parallel 110 / 33 kV transformers nominally rated at 20 MVA each. Maximum demand on the Pauatahanui GXP 2011 was 20.6 MVA. This is within the transformers 22 MVA cyclic rating, however load growth in this area is relatively strong and Wellington Electricity will review the adequacy of the existing arrangement within the planning period. Pauatahanui GXP supplies Mana and Plimmerton zone substations via single 33kV overhead circuit connections. Note that these two zone substations are linked at 11kV providing a degree of redundancy should one of the 33kV connections be out of service.

3.3.1.4. Takapu Road

Takapu Road GXP comprises a conventional arrangement of two parallel 110/33kV transformers nominally rated at 90 MVA each. Maximum demand on the Takapu Road GXP in 2011 was 93.6 MVA. This is close to the transformers cyclic rating. Takapu Road GXP supplies zone substations at Waitangirua, Porirua, Tawa, Ngauranga and Johnsonville via duplicated 33kV connections. These circuits leave the GXP as overhead lines across rural land and become underground at the urban boundary.

Transpower has advised that a secondary systems limit has been removed following alteration to the protection at this site, allowing the full cyclic n-1 capacity of 116 MVA to be utilised. Now this work is complete, there will be no capacity constraints at Takapu Road inside of the forecast period, subject to load growth continuing at present levels.

A review is planned for the Takapu Road GXP to consider how future load growth may be accommodated and whether the existing arrangement will provide the security appropriate for the Wellington Electricity network in the future. Transpower has advised that Takapu Road will be included in the second tranche of outdoor-indoor 33kV bus conversions to take place within the short term. Wellington Electricity is in discussion with Transpower about its requirements as a result of this upgrade.

3.3.1.5. Melling

Melling GXP comprises two parallel 110/33kV transformers nominally rated at 50 MVA each supplying zone substations at Waterloo, Naenae and Petone via duplicated 33kV underground circuit connections. It also accommodates an 11kV point of supply fed via two parallel 110/11kV transformers nominally rated at 25 MVA each, with a 32MVA cyclic rating following a protection constraint being addressed. Maximum demand on the Melling GXP in 2011 (including both 33kV and 11kV busses) was 70.2 MVA.

Melling GXP is located within a flood zone of the Hutt River and in recent times there have been two floods that caused damage at this site. Transpower redeveloped the site and moved all sensitive equipment, including the POS 11kV switchgear into a raised building. A flood barrier was erected to deflect floating debris away from Transpower's switchyard. Unfortunately this barrier will deflect debris into Wellington Electricity owned equipment such as 33kV cable risers and the Melling ripple plant (which may also be submerged in high water). Wellington Electricity has raised this issue with Transpower and together the risks at this site are being reviewed. The companies are also identifying and evaluating solutions to this problem including, if necessary, relocation of the Wellington Electricity owned ripple equipment and extension of the flood barrier.

3.3.1.6. Gracefield

Gracefield GXP comprises a conventional arrangement of two parallel 110/33kV transformers nominally rated at 85 MVA each. Maximum demand on the Gracefield GXP in 2011 was 54.9 MVA. Gracefield GXP supplies Seaview, Korokoro, Gracefield and Wainuiomata zone substations via duplicated 33kV connections. There are no issues with the Transpower owned assets at Gracefield GXP at present.

3.3.1.7. Kaiwharawhara

Kaiwharawhara is an 11kV point of supply where Wellington Electricity takes bulk 11kV supply from Transpower and distributes this via a Wellington Electricity owned switchboard within the GXP. Kaiwharawhara is supplied at 110kV via Transpower owned circuits from the Wilton GXP, and has two 20/40MVA transformers in service. These assets are owned by Transpower.

Kaiwharawhara supplies load at the northern end of the Wellington CBD such as Thorndon and surrounds, and also light commercial and residential load around Ngaio Gorge and Khandallah areas.

Maximum demand at Kaiwharawhara in 2011 was 35.7 MVA.

3.3.1.8. Central Park

Central Park GXP comprises three 110/33kV transformers, T5 (120 MVA), T3 and T4 (100 MVA units) supplying a 33kV bus. There are also two Transpower owned 33/11kV (25 MVA) units supplying local service and an 11kV point of supply to Wellington Electricity. Maximum demand at Central Park GXP in 2011 was 171.6 MVA, which is well within the N-1 rating of the supply transformers. However, due to not having a 110kV bus, should a contingency occur at times of high load that results in the loss of a 110kV infeed (i.e. a circuit or transformer outage), the loading is constrained by the rating of the remaining banks, i.e. 109 MVA. This risk is presently managed by a Special Protection Scheme, however in the medium term a change will be required. This is discussed further in Section 5 (Network Planning).

3.3.1.9. Wilton

Wilton GXP comprises two 220/33kV transformers operating in parallel, supplying a 33kV bus that feeds to zone substations at Karori, Moore Street, and Waikowhai Street. These transformers are nominally rated at 100 MVA each, and the maximum demand in 2011 was 53.2 MVA.

3.3.2. Embedded Generation

The network currently has a range of connected embedded generation including a number of connections of less than 10kW (typically residential), two landfill sites greater than 1 MW and a hospital with synchronised generation of approximately 8 MW. In addition, there are a number of customers with standby generation plant of varying sizes (typically less than 1 MW) which generally cannot be synchronised to the network.

There is a larger scale wind farm operated by Meridian (West Wind), connected into the Transpower 110kV system between Wilton and Central Park. Whilst not directly connected to the Wellington Electricity network, it may have an impact on ripple signal propagation and also the introduction of harmonics into the system. Wellington Electricity has undertaken discussions with Meridian over this potential impact and while there are currently no issues, the situation continues to be monitored.

Meridian Energy has recently obtained resource consent for the Mill Creek wind farm in the Ohariu Valley area which has a capacity of around 60 MW. If there was any connection to the Wellington network, or shared connection points, it would be at 33kV or higher.

A wind farm with an installed capacity of approximately 8 MW, located on the south coast of Wellington has been consented but development has halted for the time being. Wellington Electricity had previously worked with the wind farm developer on options for providing a connection into the 11kV network. This connection requirement may arise again in the short to medium term.

The Wellington Regional council has commissioned a number of small scale hydro generation plants at existing water facilities storage and pumping facilities around the region. These are in the order of 1 MW each.

3.3.3. Subtransmission

The 33kV subtransmission system is comprised of assets that take supply from the Transpower GXPs and feed a total of 28 Wellington Electricity zone substations, incorporating 54 33/11kV transformers. This 33kV system is radial with each feeder supplying its own dedicated power transformer, with the exception of Tawa and Kenepuru where two feeders supply four transformers (one feeder shared per bank at each substation). All 33kV feeders supplying zone substations in the Wellington area are underground while those in the Porirua and Hutt Valley areas are a combination of overhead and underground. The total length of the 33kV system is 203 km, of which 145 km is underground.

All zone substations have N-1 subtransmission supply at 33kV, generally with one supply from each side of a Transpower bus (where available). Plimmerton and Mana each have a single 33kV supply to a single power transformer, however they are connected together on the 11kV bus, and as a result they operate as an N-1 substation with a geographic separation of 1.5 km. At certain times the 11kV bus tie cable can be constrained, although load control and 11kV network switching can alleviate this constraint.

The 33kV subtransmission system is also backed up by a limited number of “express” 11kV circuits that perform a subtransmission function in that they do not supply any directly connected loads. These are used as backups to the 11kV supply at some zone substations and also to supply a number of 11kV switching nodes, which in turn are used as the source for 11kV distribution feeders.

A list of each zone substation’s capacity, incorporating 33kV cables and transformers, is provided in the section on demand forecasts.

Subtransmission circuits leaving the Wilton GXP

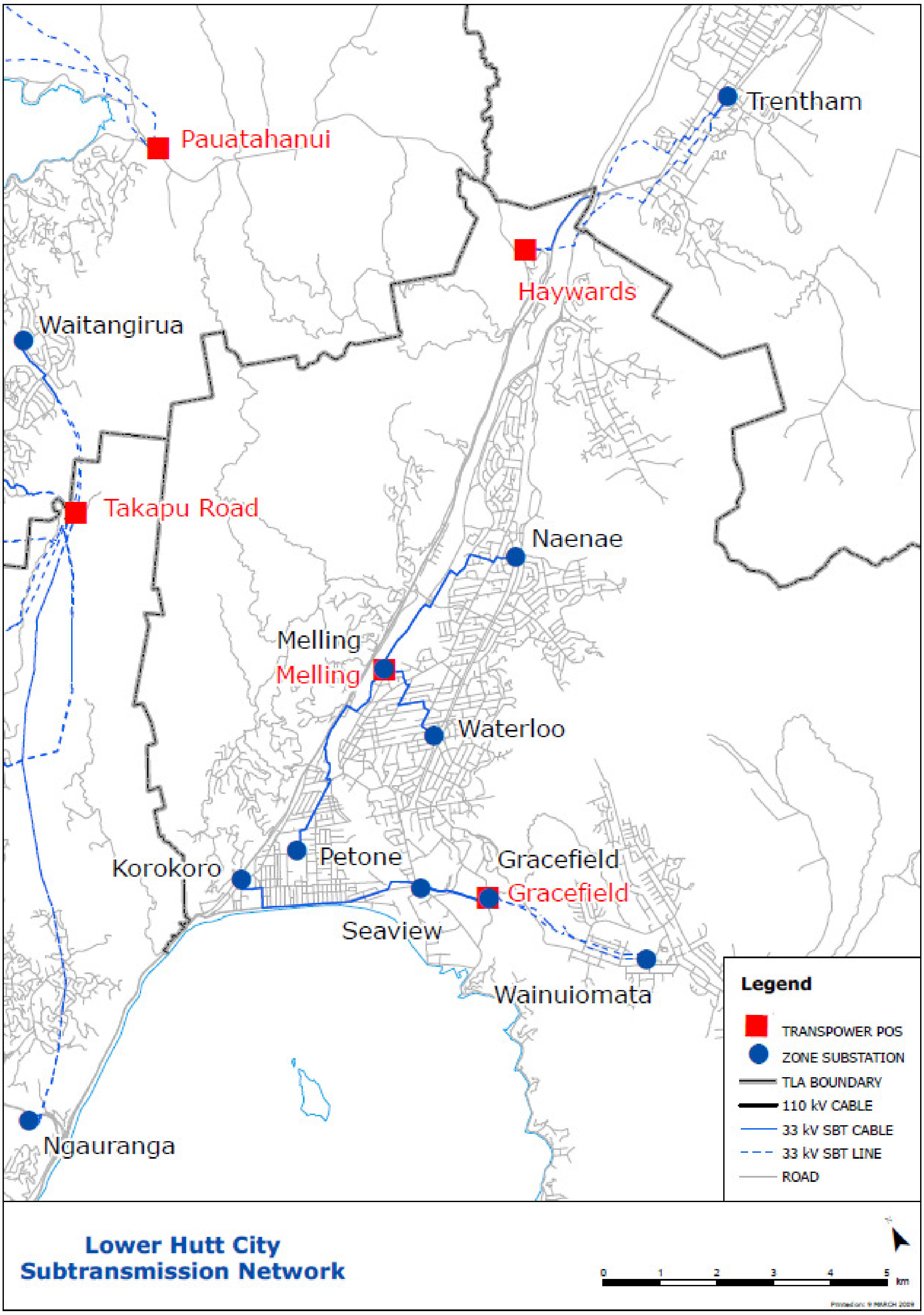

Figure 3-7 Lower Hutt Subtransmission Network

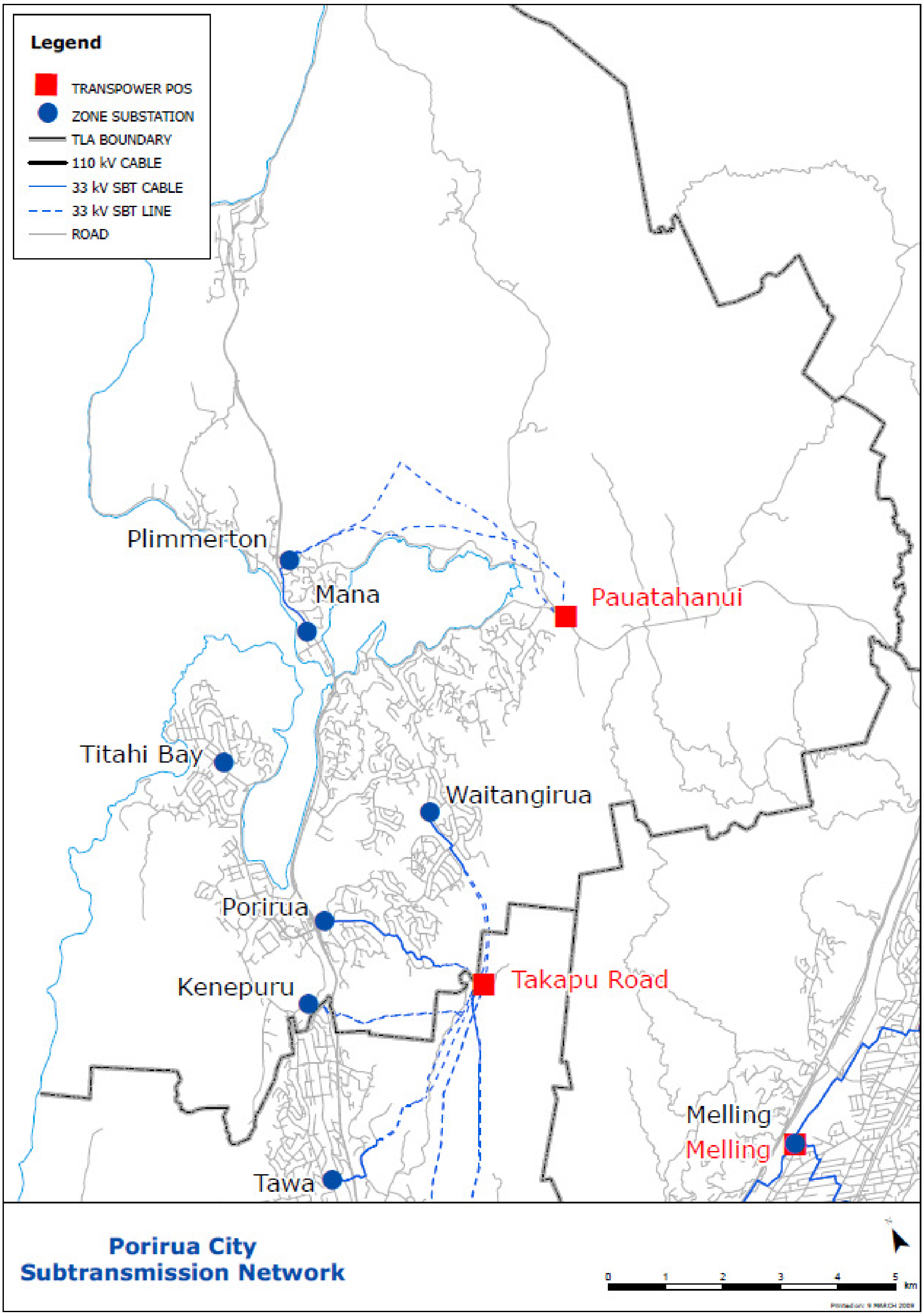

Figure 3-8 Porirua City Subtransmission Network

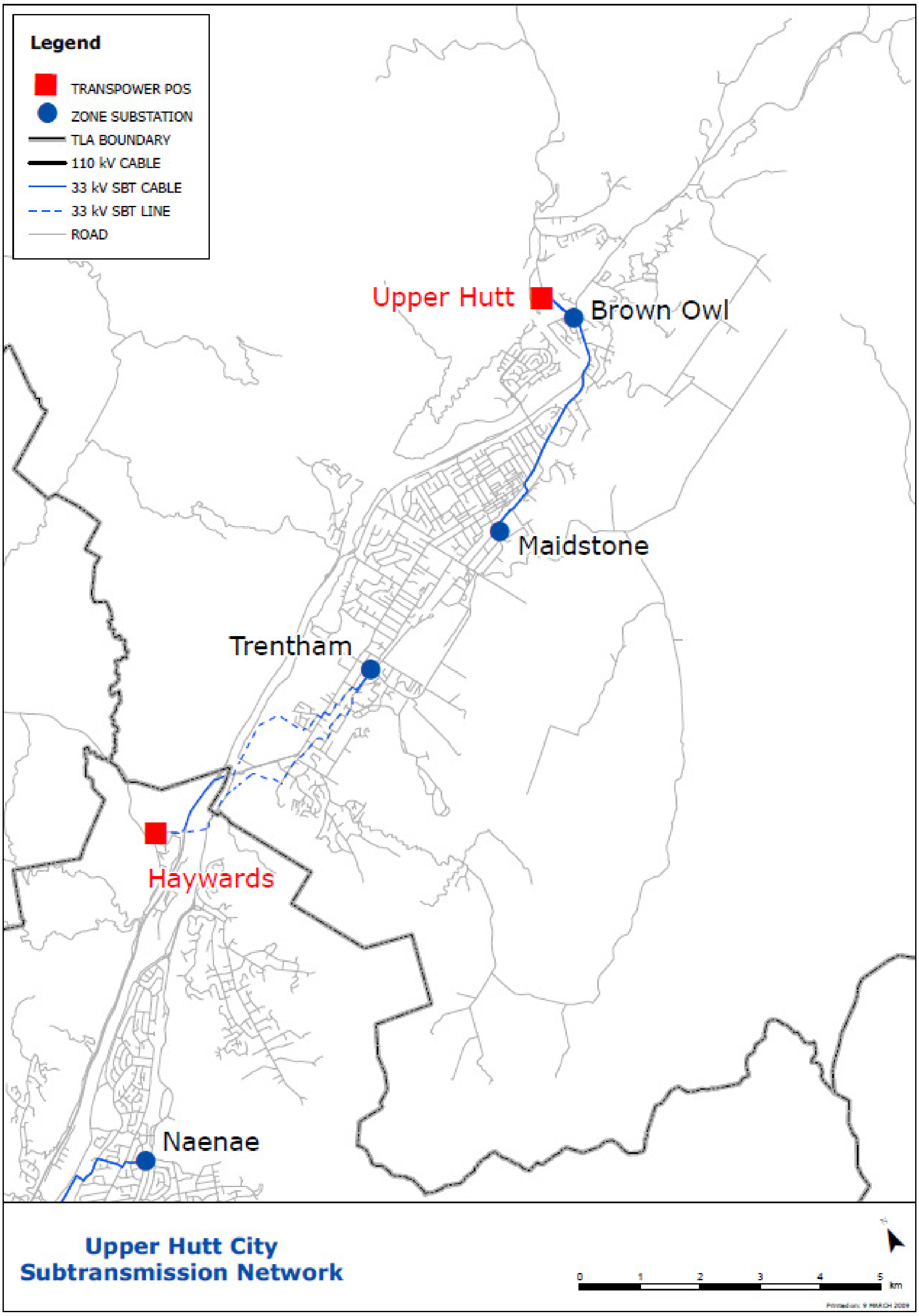

Figure 3-9 Upper Hut City Subtransmission Network

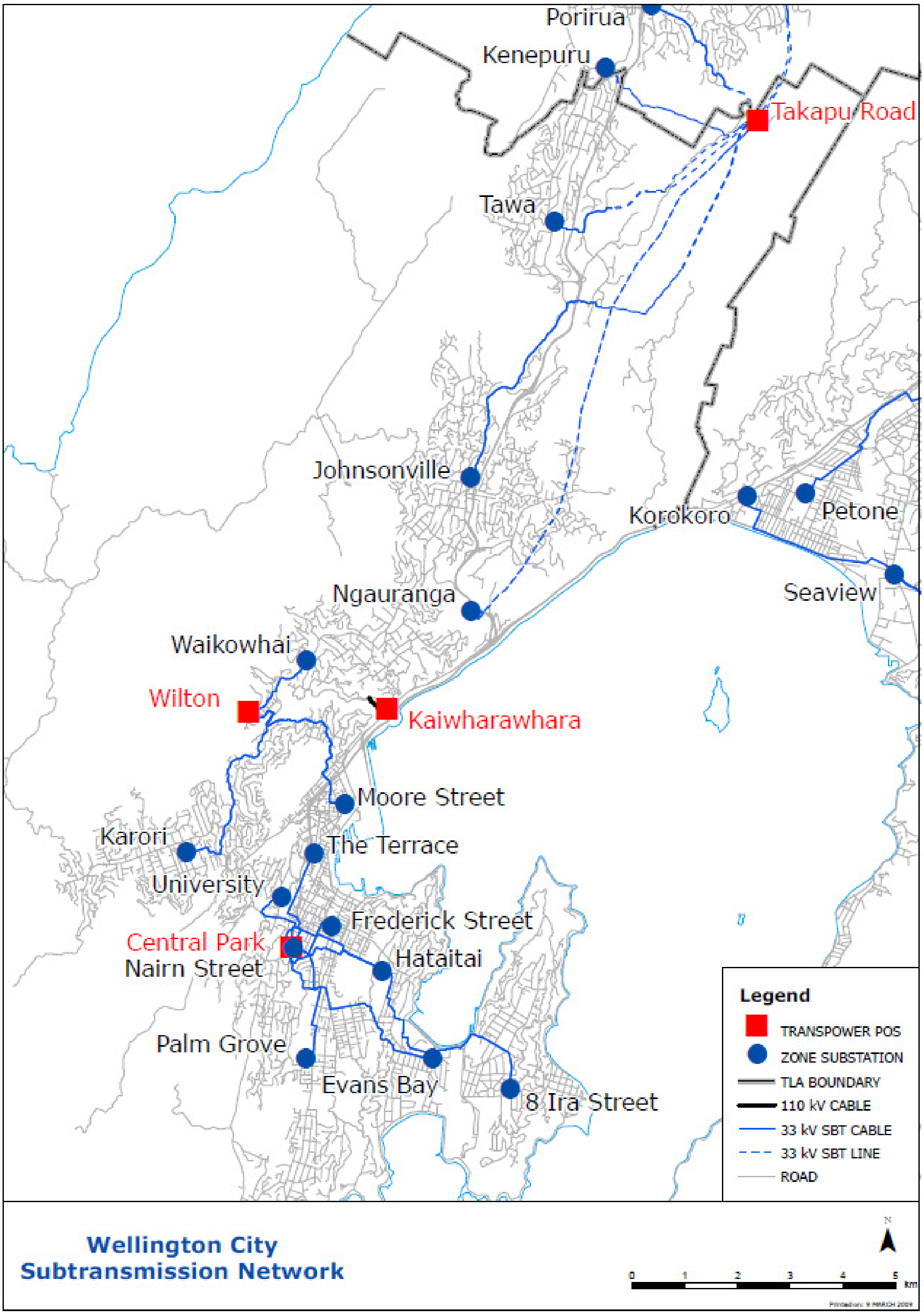

Figure 3-10 Wellington City Subtransmission Network

3.3.4. Distribution System

The 11kV distribution system is supplied from the zone substations, or directly from the grid in the case of the 11kV supply points at Central Park, Melling, Haywards and Kaiwharawhara. While some larger consumers are fed directly at 11kV, the system mainly supplies approximately 4,190 distribution substations (11kV/415V) located in commercial buildings, industrial sites, kiosks, berm-side and on overhead poles. The total length of the 11kV system is approximately 1,740 km, of which 66% is underground. In Wellington City, the 11kV network is largely underground whereas in the Hutt Valley and Porirua areas there is a higher proportion of overhead 11kV lines. The varying proportions of overhead and underground distribution on the different parts of the system reflect the different design philosophies of earlier network owners, as well as geography of the various areas.

Most of the 11kV feeders in the Wellington CBD[2] are operated in a closed ring configuration with radial secondary feeders interconnecting neighbouring rings or zone substations. This arrangement provides a high level of security and hence a high level of supply reliability. Most of the 11kV network outside the Wellington CBD, both in the Wellington City and Hutt Valley areas, comprises radial feeders with a number of mid feeder switchboards with circuit breakers and normally open interconnectors to other feeders so that, in the event of an equipment failure, supply to customers can be switched to neighbouring feeders. To allow for this, distribution feeders are not operated at their full thermal rating under normal system operating conditions.

There are approximately 1,790 11kV circuit breakers operating within the distribution system. Almost 400 of these are located at the zone substations and control the energy being injected into the distribution system. The remainder are located within distribution substations, mostly situated within or close to the Wellington CBD or in the Wellington City area, and allow the primary feeders in their respective areas to be operated in a closed loop arrangement. These circuit breakers are used to automatically isolate a faulted section of the network and to improve the ability to maintain an uninterrupted supply to all customers not directly connected to the faulted section. This is subject to cables having sufficient rating to carry extra load to support these contingent events.

The number of circuit breaker used in the distribution network is high in relation to other networks in New Zealand as illustrated in Figure 3-11.

[2] The CBD area is considered to be the commercial areas supplied by Frederick St, Nairn St, University, The Terrace, Moore St and Kaiwharawhara GXPs.

Network	ICP count (approx.)	CB count (approx.)	ICP/ CB ratio (approx.)
Vector Networks	520,000	1550	330
Orion NZ	190,000	800	240
Wellington Electricity	**164,500**	**1790**	**92**
Unison	107,000	270	400
WEL Networks	84,000	380	220
Aurora Energy	81,000	400	200
NorthPower	53,000	200	260

Figure 3-11 Comparison of Number of Circuit Breakers in Various Networks

The high number of circuit breakers in the Wellington Electricity network is a result of historic design practices aimed at delivering a very reliable network. The present network configuration will be reviewed to consider the opportunity for further system automation as equipment condition determines the need for replacement, and to include functionality that comes standard in modern equivalent equipment which may be at a higher level than the equipment it replaces. The economics for smart network developments will be considered based on a fair return for the investment in line with the improved customer services.

3.3.5. Distribution Substations

Throughout the distribution network there are approximately 4,190 distribution substations sites (3,490 owned by Wellington Electricity as standalone sites and 700 housed on consumer sites) with around 4,250 associated distribution transformers in service, as some sites have multiple transformers installed. Pole-mounted distribution transformers are typically less than 150kVA and are generally simple platform structures or hanging bracket type arrangements. Ground-mounted distribution substations include a range of designs from the more significant reinforced concrete block buildings that can accommodate single transformers (typically a switch unit and low voltage (LV) distribution panel or frame) up to larger style three-transformer, multiple circuit breaker (CB) switchboards and extensive LV distribution framing. The more compact substations are generally the kiosk style, with an LV frame, transformer and ring main unit enclosed in a metal canopy. Other common styles are stand alone, open fenced enclosures or fully enclosed within customer owned buildings.

In Wellington city the majority of the distribution transformers are ground mounted. The Hutt and Porirua areas are a combination of ground mounted and overhead installations. Individual capacities range from 5kVA to 2,000kVA and the weighted average capacity is approximately 300kVA.

Enclosure type	Quantity
Outdoor cage	279
Indoor	972
Padmount	1,119
Pole	1,817

Figure 3-12 Overview of Distribution Substation Types

3.3.6. Low Voltage Lines and Cables

Low voltage lines and cables are used to connect individual customers to the low voltage network supplied from the distribution transformers. The total system length is around 2,660 circuit-km, of which approximately 58% is underground.

Consumers are supplied via a low voltage fuse, which is the installation control point (ICP) used by the network to connect the consumer installation. This fusing is either an overhead pole fuse or located within a service pillar or pit near the consumers' boundary. Some other styles of fuse installation exist, however these are being progressively replaced following faults or when work is required on them.

In addition to service pillars there are approximately 400 link pillars on the network that allow isolation, reconfiguration and back feeding of certain LV circuits. These vary in age and condition and are being replaced in situations where their condition is poor and where they provide operational flexibility, or where the type of load served is sensitive to outages on the low voltage network, and back feeding will ensure compliance with service levels. In some cases, the LV network configuration has changed and there is no longer a requirement for a link pillar and they are removed if they have become unserviceable.

3.3.7. Secondary Systems

3.3.7.1. Protection Assets

Protection assets are used to automatically detect thresholds that indicate a potential equipment fault and to automatically issue control signals to disconnect faulted equipment. This ensures that the system remains safe, that damage is minimised, and also limits the number of consumers affected by an equipment failure.

On the HV system, there are more than 1,200 protection relays in operation. Around 95% are older electromechanical devices. The remainder are newer relays that use solid state electronic and microprocessor technology. Relays are generally mounted as part of the substation switchboard and are normally changed at the time of switchgear upgrade. At distribution level, 11kV fuses are used for protection of equipment.

On the LV system, fuses are used for the protection of cables and equipment.

3.3.7.2. Supervisory Control and Data Acquisition (SCADA)

The SCADA system is used for real time monitoring and to provide an interface to operate the network. SCADA can monitor and control the operation of primary equipment at the zone substations and larger distribution substations, as well as providing status indications from Transpower owned assets at GXPs. It is used to:

- Monitor the operation of the network from a single control room by remotely indicating key parameters such as voltage and current at key locations
- Permit the remote control of selected primary equipment in real time
- Graphically display equipment outages on a dynamic network schematic
- Transmit system alarms to the controller for action.

System information is collected by remote terminal units (RTUs) at each substation and is transmitted to a central master station located in a control room at Haywards substation through dedicated communication links. Control signals travel in the opposite direction over the same communications links.

3.3.7.3. Load Control

Wellington Electricity uses a ripple injection signal load control system to control selected loads at consumer premises such as water heating and storage heaters, to control street lighting and also to provide some tariff signalling as required by retailers using the network. From 2012 onwards, Wellington Electricity will also offer a controlled rate tariff specially for electric vehicle (EV) charging. This will be controlled using conventional ripple signals with the addition of an EV channel. The system is automatically operated by the master station at the Haywards Control Centre to control loads at peak times.

3.3.7.4. Communication

Operation of secondary systems requires the use of high security communication links between the master station and the different control points. Like most distribution businesses, Wellington Electricity operates its own communications system with a small number of communications links being leased from service providers such as Telecom, Vector Communications and Transpower.

Wellington Electricity's own network comprises mainly copper pilot cable with a small amount of fibre-optic and UHF radio infrastructure. Communications links leased from other service providers are either fibre-optic or radio links.

3.4. Categories of Assets and Age Profiles

3.4.1. Subtransmission Cables

Wellington Electricity own approximately 145km of subtransmission cables operating at 33kV. These cables comprise some 52 circuits connecting Transpower GXPs to Wellington Electricity's zone substations. Around 25 km of subtransmission cable is of XLPE construction and requires little maintenance. The remainder is of paper insulated construction, with a significant portion of these cables being relatively old pressurised gas or oil filled with either aluminium or lead sheath. A section of the subtransmission circuits supplying Ira St zone substation are fluid filled PIAS cables with copper conductors rated for 110 kV but operating at 33 kV. The lengths, age profile and spare holdings of this asset class are shown below.

Construction	Design voltage	Percentage	Quantity
Paper Insulated, Oil Pressurised	33kV	29%	42 km
Paper Insulated, Gas Pressurised	33kV	42%	60 km
Paper Insulated	33kV	6%	9 km
XLPE Insulated	33kV	17%	25 km
Paper Insulated, Oil Pressurised	110kV	6%	9 km

Figure 3-13 Summary of Subtransmission Cables

There are also 33kV rated oil cables supplying the Titahi Bay switching station from Porirua zone substation which are operated at 11kV. These are not counted in the subtransmission circuit length. These cables could in future be energised at 33kV if Titahi Bay was developed into a full substation and operated as subtransmission cables, although the likelihood of this occurring is low. Elsewhere in the network, there are abandoned 33kV cables being run at 11kV that will not be used as subtransmission again.

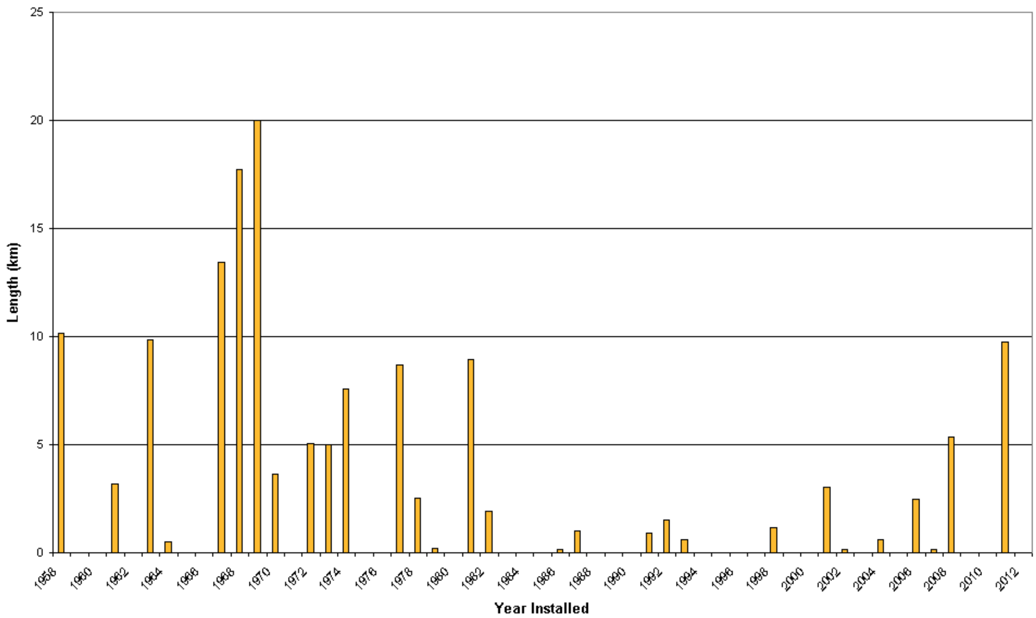

Figure 3-14 Age Profile of Subtransmission Cables

Strategic Spares	
Medium lengths of cable	It is necessary to hold medium lengths of oil and gas cable in store to allow replacement of short sections following damage. By holding oil and gas cable lengths, the Field Service Provider is able to undertake repairs without requiring termination and transition to XLPE cable.
Standard joint fittings	Stock is held by the Field Service Provider to repair standard oil and gas joints. These need to have a minimum stock level held. Where stock levels drop below minimum, replacement parts need to be sourced and if necessary be manufactured locally.
Termination/transition joints	Two gas to XLPE cable transition joints have been purchased and are held in storage to allow quick repair and alteration to gas cables using XLPE cables.

Figure 3-15 Spares Held for Subtransmission Cables

Full details of maintenance, refurbishment and renewal are covered in Section 6 (Lifecycle Asset Management).

3.4.2. Zone Substation Buildings

There are 30 major substation buildings, 28 of which are located at zone substation sites and 2 at major 11kV switching stations. The buildings generally stand alone and have switchgear, protection equipment, local AC and DC supplies installed inside. Some buildings also contain transformers and ripple injection plant. Wellington Electricity also has a large number of kiosk type distribution substations. These are covered separately later in this section as they form part the distribution substation asset class. The age profile of zone substation buildings is shown below.

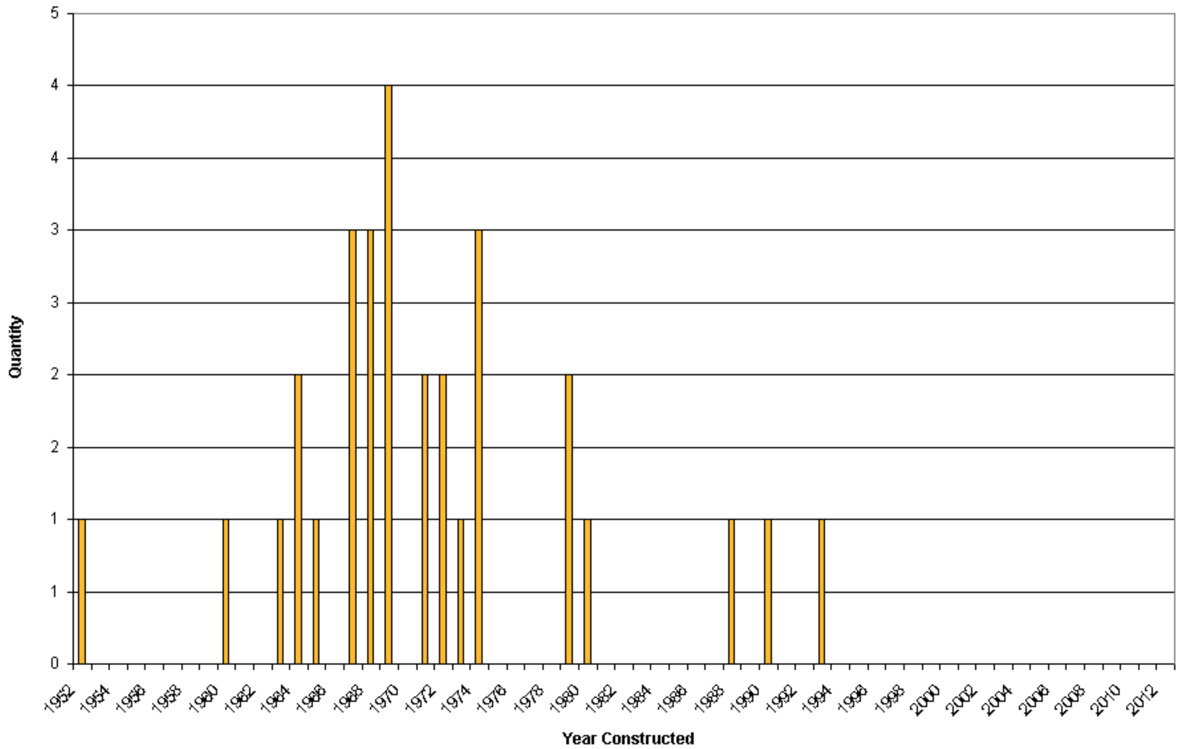

Figure 3-16 Age Profile of Zone Substation Buildings

The average age of the buildings is 40 years and they are generally in a good condition, however from time to time require maintenance or replacement of some components such as doors, roofs and spouting. Wellington Electricity is required to undertake seismic strengthening activities on buildings as required by the local councils on some of the older buildings. A seismic review and assessment has been undertaken on the majority of zone substation buildings. Remedial work has been undertaken as a result of this review, including securing plant inside substations.

In some cases, Wellington Electricity does not own the land under the zone substation and has arrangements in place for a long term lease with the landowner.

Full details of maintenance, refurbishment and renewal are covered in Section 6 (Lifecycle Asset Management).

3.4.3. Zone Substation Transformers

Wellington Electricity has 54 33/11kV power transformers in service on the network. All zone substation transformers are operated well within their specified ratings, are regularly tested and have condition assessments undertaken. Overall the transformer fleet is in a generally sound condition even though a number of transformers are reaching their end of design life of 55 years. However, based on their operating conditions and maintenance, it is expected that most transformers will continue to operate beyond their design life. Nevertheless older transformers require more intensive monitoring to assess and evaluate their condition. Estimated DP tests[3] on the transformers completed in 2009, using the Furan analysis method, indicate a high level of remaining life given the age. Whilst not as conclusive as taking internal paper samples, this is a good indicator of internal condition. Mechanical deterioration is an issue that needs to be monitored on older units, both for condition of external fittings, as well as internal components such as tap changer contacts and mechanisms.

The age profile for zone substation transformers is shown below.

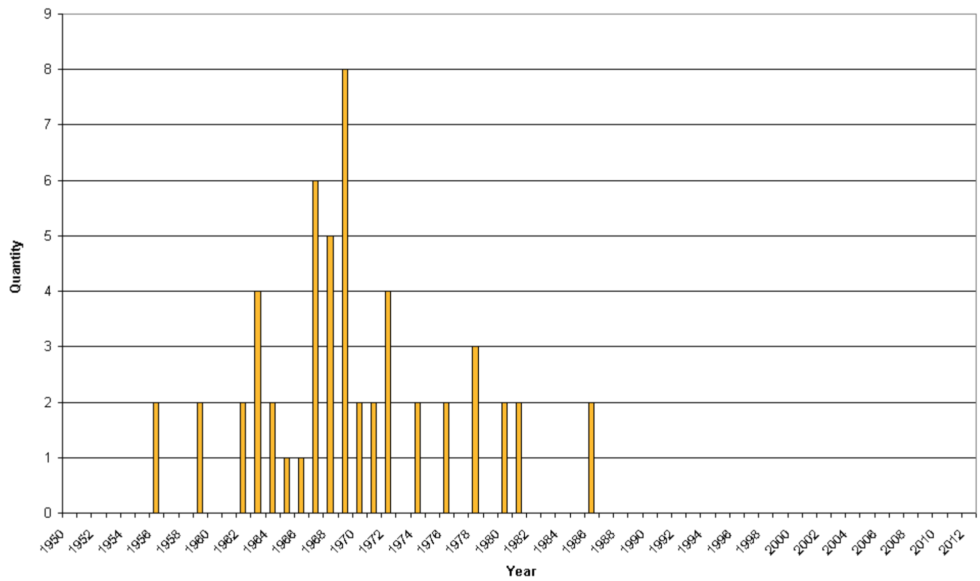

Figure 3-17 Age Profile of Zone Substation Transformers

The age profile indicates that the average age of the transformer fleet is reasonably high (around 41 years). Based on the assumption that zone transformers have a design life of around 55 years then all of the zone transformers have exceeded midlife and around 65% of transformers have exceeded an age of 41 years.

Wellington Electricity holds certain spares for the power transformers and tap changers in the system.

Strategic Spares	
Tap changer fittings	Wellington Electricity holds a number of spares for the tap changers on Zone substation transformers, typically contacts and related components. These components have high wear and are eroded by arcing during operations. Generally the components held are for tap changers that have not had recent maintenance and are therefore used in the next maintenance cycle. Where excessive wear is noted during maintenance, spares are ordered and held in stock for that model of tap changer. Spares are generally available for all models that are operated on the network.
Transformer misc. fittings	Various other transformer fittings have been identified and held for sites where having a transformer out of service for a prolonged period is unacceptable for minor repairs. Fittings include Buchholz relays, high voltage bushings etc. For major repairs a unit will be swapped out.

[3] Degree of Polymerisation, an indicator of dielectric strength of paper insulation.

Strategic Spares	
Spare transformers	There is one unit from Trentham that can be easily removed from service due to low loadings and ease of back feeding should a spare transformer be required. Should Wellington Electricity require a second spare transformer one of the units from Petone substation can be utilised. This area also has good 11kV backfeed options and low loadings. Trentham has external bushings and Petone has a cable box so there is a transformer for either situation. Other sites with low loading include Gracefield, Tawa and Kenepuru. In extreme cases, these sites can be evaluated for transformer removal.

Figure 3-18 Spares Held for Zone Substation Transformers

3.4.4. Substation DC Systems

The DC auxiliary systems provide power supply to the substation protection, control, metering, monitoring, automation and communication systems, as well as circuit breaker tripping and closing mechanisms. The standard DC auxiliary system comprises batteries, battery chargers, DC/DC converters and a battery monitoring system. Wellington Electricity has a number of different voltages: 24, 30, 36, 48, and 110V, largely for historical reasons, however has standardised on 24V for all new or replacement installations.

A range of spares is held, mostly chargers of different voltages that have been removed from sites over recent time. Batteries are available locally at short notice so these are not held.

3.4.5. Switchboards and Circuit Breakers

11kV circuit breakers are used in zone substations to control the power injected in to the 11 kV distribution network and also within the network to increase the reliability of supply in priority areas such as in and around the CBD. The largest single type is Reyrolle Pacific type LMT circuit breakers but other types are also in service in large numbers. There are approximately 1,790 circuit breakers forming 440 11kV switchboards on the Wellington Network.

An age profile of the circuit breakers is shown below.

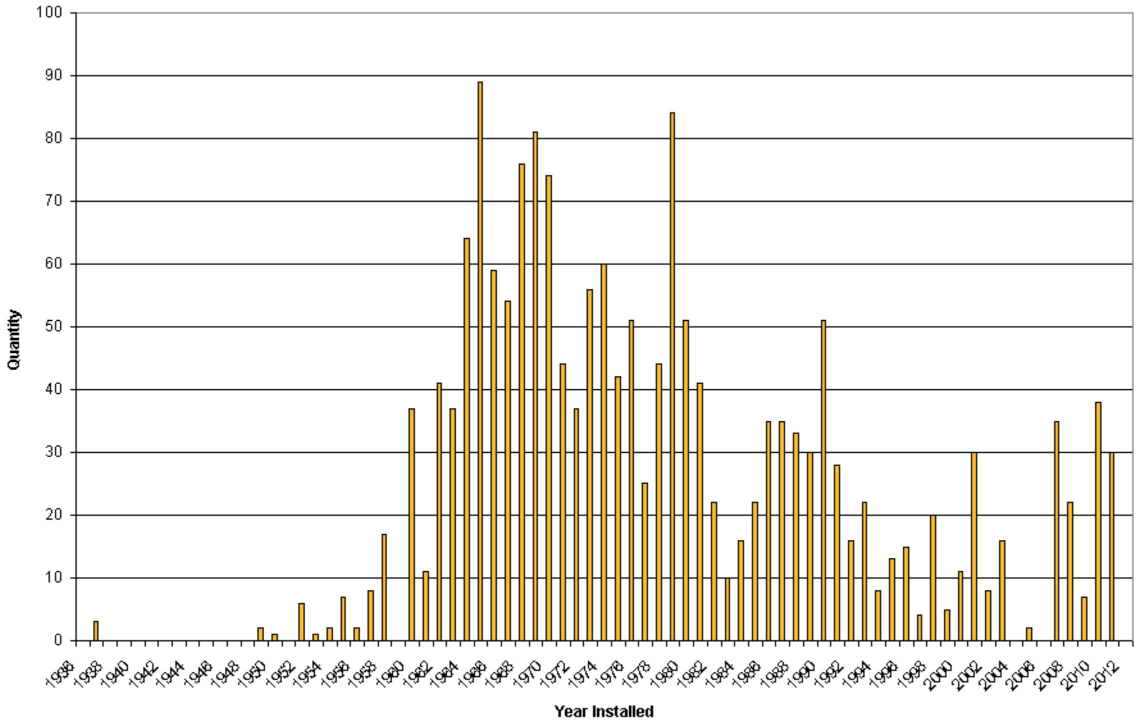

Figure 3-19 Age Profile for Circuit Breakers

The age profile indicates that the average age of circuit breakers in the Wellington Network is around 33 years, with the age of individual breakers ranging from relatively new to more than 50 years. The mix of circuit breaker technologies reflects the age of the equipment. The oil type circuit breakers are the oldest in the network followed by SF_6 and vacuum type circuit breakers. Most circuit breakers are oil insulated with relatively intensive maintenance regimes.

There are two 33 kV oil circuit breakers at Ngauranga which have been in service at this site for approximately 19 years. Having been installed in 1993 when the substation was constructed, they were originally manufactured in the 1960s. A protection scheme proposed for the subtransmission circuits from TP Takapu Rd will see these being made redundant and all circuit breakers remaining will be 11kV. Certain oil-type circuit breakers are approaching or have passed the end of their design life of 40 years. Inadequate fault level rating, equipment failures, lack of spare parts, and increased maintenance costs compared to newer SF_6 or vacuum equipment are areas of concern for this aging equipment.

Category	Quantity
33kV Circuit Breakers	2
11kV Circuit Breakers	1,791

Figure 3-20 Summary of Circuit Breakers

Given the high number of circuit breakers in service on the Wellington network, it is important to keep adequate quantities of spares to enable fast repair of minor defects. Some types of circuit breakers, such as early Statter and AEI, have limited numbers of spares available however there are low numbers of these types installed on the system. There are large numbers of spares held for the Reyrolle type circuit breakers and this is reflective of the number in service.

The largest quantity of circuit breakers on the network, used predominantly at zone substations, is Reyrolle type LMT. The large numbers of spares held for the Reyrolle type circuit breakers is reflective of the number in service. In addition the RPS Switchgear (formerly Reyrolle Pacific) factory is located in Petone which means that spares above those normally held by the network are available within short timeframes if required for LMT type switchgear.

Strategic Spares	
Circuit breaker trucks	At least one circuit breaker truck of each rating (or the maximum rating where it is universal fitment) is held for each type of withdrawable circuit breaker on the network.
Trip/Close coils	Spare coils held for each type of circuit breaker and all operating voltages.
Spring charge motors	Spare spring charge motors held for each voltage for the major types of switchgear in service (Reyrolle C gear, LMT, etc).
Current transformers and primary bars	Where available, spare current transformers and primary bars should be held to replace defective units. In particular 400A current transformers for Reyrolle LMT as this type of equipment has a known issue for partial discharge.

Figure 3-21 Spare Parts Held for Circuit Breakers

Full details of maintenance, refurbishment and renewal are covered in Section 6 (Lifecycle Asset Management).

3.4.6. Protection and Control Systems

Due to the closed-ring architecture of the central Wellington distribution network there are a large number of protection relays, the majority (close to 90%) of which are electromechanical type. Numerical type relays are the latest additions to the network but constitute only 10% of the population. Solid state or static type relays ranging in age from around 15 to 25 years represent around 4% of the total number of relays.

The average age of the protection relays on the Wellington network is around 33 years and it is estimated that around 400 or 30% of the protection relays are 40 years or over in age. Generally all protection relays are in good condition with the exception of PBO electro mechanical and Nilstat ITP solid state relays. These relays have performance and functionality issues, which had triggered an ongoing replacement programme under previous owners. The majority of PBO type relays were replaced in the old Hutt Valley area but few have been replaced in the Wellington City area.

Full details of maintenance, refurbishment and renewal are covered in Section 6 (Lifecycle Asset Management).

3.4.7. SCADA

Wellington Electricity's SCADA master station is located at the Transpower-owned Haywards substation. It is a GE ENMAC system installed in 2009 which became fully functional in 2011. The GE ENMAC system replaced a Foxboro (formerly Leeds & Northrup (L&N)) LN2068 system which was initially installed in 1986 and which still provides some functionality with an automated load management package. The Foxboro system will be retained in the short term to provide the automatic load control function until the GE ENMAC system is upgraded to undertake this function, or an alternative standalone system is implemented.

Wellington Electricity is investigating the replacement of the automatic load control system and an independent system may provide other benefits such as supporting demand-side management initiatives.

Data is communicated to the master station by remote terminal units (RTUs) that are located at the different control and monitoring sites. The age and technology of the RTUs varies and many are now obsolete. The protocols in use on the Wellington network are Conitel, DNP3.0 and IEC61850. Wellington Electricity has 252 RTUs installed in sites from GXP level down to small distribution substations. An age profile of SCADA RTUs is shown below.

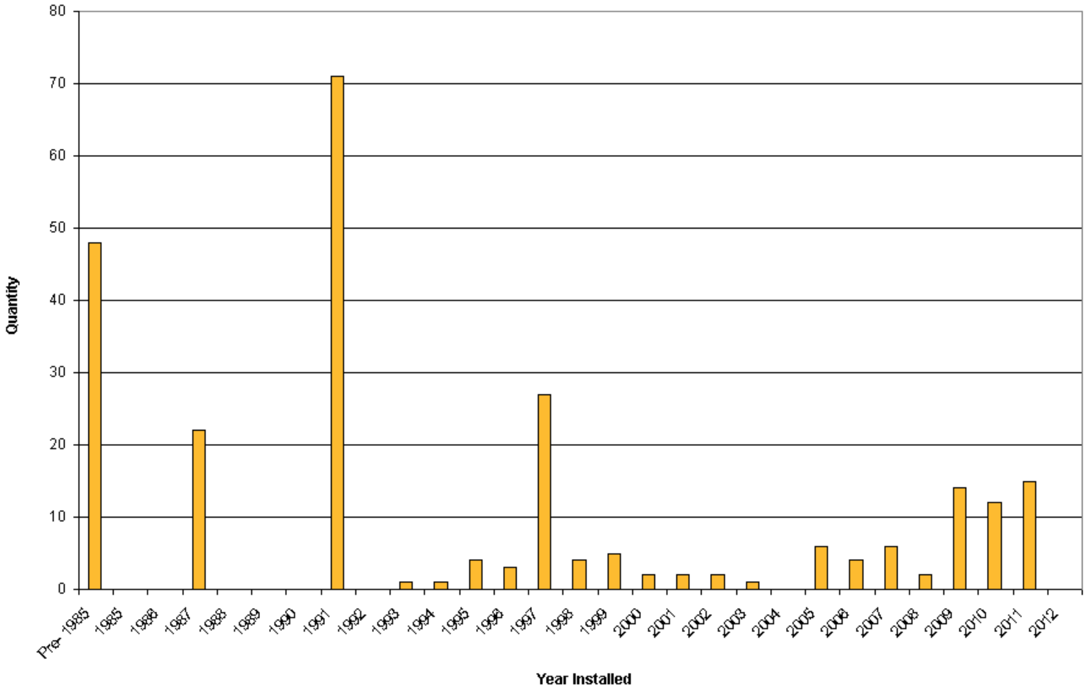

Figure 3-22 Age Profile of SCADA RTUs

Full details of maintenance, refurbishment and renewal are covered in Section 6 (Lifecycle Asset Management).

3.4.7.1. Substation Level TCP/IP Communications

Presently the substation level TCP/IP (a protocol used in data communications, Transmission Control Protocol/Internet Protocol) network hardware and communications circuits are leased from external service providers. The contract with the main service provider will expire in June 2012 at which point it is envisaged that Wellington Electricity will review these commercial arrangements. A draft communications strategy was developed in late 2011 which outlines the forward view of the business for all communications, of which network substation communications is a major part.

As substation sites are being upgraded or developed, and if IP network connections are available, the station RTU is upgraded and moved onto the substation TCP/IP network. Presently there are 40 sites (a mixture of zone and distribution substations) on the substation TCP/IP network.

There are two Siemens Power Automation System (PAS) units that act as a protocol converter between the Siemens IEC61850 field devices and that of the DNP3 SCADA master station. These units are designed to allow fail-over redundancy to prevent a single point of failure at the PAS. The use of the Siemans PAS unit was part of a previous network owner's protection and control strategy and Wellington Electricity has no plans to add further IEC61850 devices to the PAS system. The future of the PAS is under review and in time substation base equipment may be installed to eliminate the reporting of multiple sites through to the PAS.

Full details of maintenance, refurbishment and renewal are covered in Section 6 (Lifecycle Asset Management).

3.4.8. Load Control Systems

Wellington Electricity uses a ripple injection signal load control system to inject 475Hz and 1050Hz signals into the network for the control of selected loads at consumer premises such as water heating and storage heaters, to control street lighting and also to provide some tariff signalling as required by retailers using the network. There are 24 ripple injection plants on the network and these are located at GXPs and zone substations. The Wellington city area has a 475Hz signal injected into the 33kV network with one plant per GXP and two plants injecting at Kaiwharawhara 11kV point of supply. The Hutt and Porirua areas have a 1050Hz signal injected at 11kV at each zone substation. All ripple injection is controlled by the master station at the Haywards Control Centre. An age profile of ripple plant is shown below.

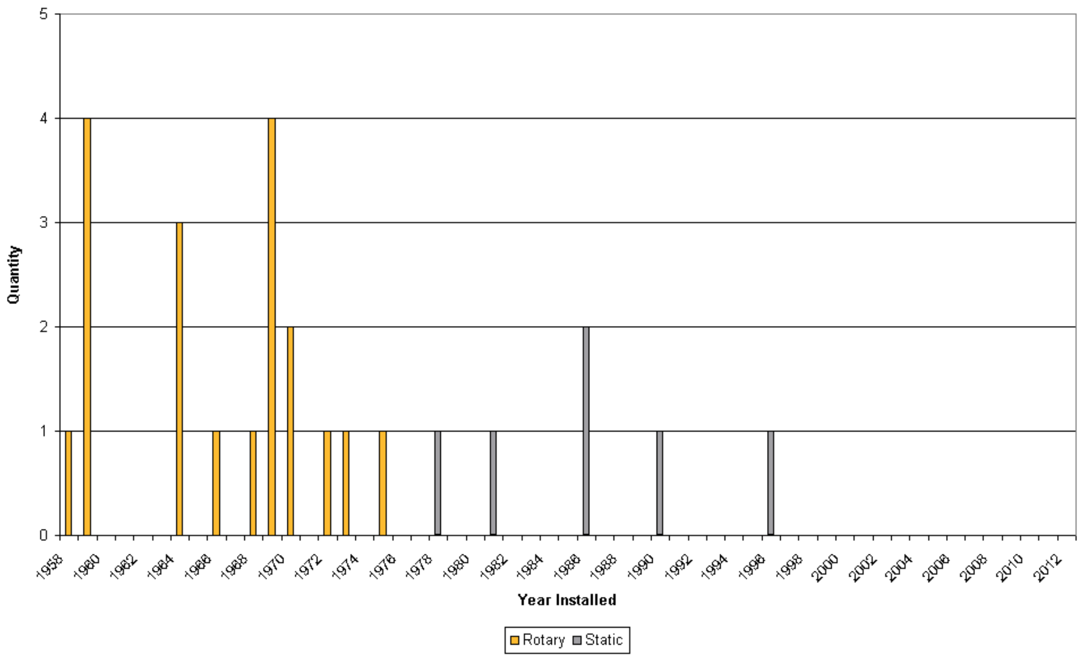

Figure 3-23 Age Profile of Ripple Plant

There is significant benefit in having a fully functional load control system and being able to control loads at peak times and to defer energy consumption by interruptible loads until times of lower demand on the system. This allows for better asset utilisation as the distribution network does not need to be oversized to allow for short duration peaks. Wellington Electricity does not own the ripple receivers installed at consumer premises and is experiencing decreasing levels of control as these devices fail and are not replaced by the asset owner (typically the retailer for the premises). Over time the network will continue to lose controllable load which may accelerate the need for investment in the distribution system. Wellington Electricity is encouraging retailers and metering providers to ensure investments and upgrades preserve the ripple control system due to its importance to managing loading on the network and transmission system.

Wellington Electricity believes ripple control is the most cost effective technology for load control due to the existing installed base and will continue to operate this system. Wellington Electricity also uses ripple control to participate in the Instantaneous Reserves market and for supporting the Transpower AUFLS (Automatic Under Frequency Load Shedding) system.

There are some small areas of network that receive DC bias load control signals, however these are being converted to ripple control where opportunities exist to do so.

Strategic Spares	
Injection plant	A spare rotary motor-generator set is held for the 11kV ripple system in the Hutt Valley area, rated at 24kVA. A spare solid state controller has recently been purchased to cover a failure at any of the four Wellington city locations. An assortment of capacitors and coupling cell equipment is held in store.
Controllers	A spare Load Control RTU Controller is kept as a strategic spare as the same type is used across the network.

Figure 3-24 Spares Held for Load Control Plant

Full details of maintenance, refurbishment and renewal are covered in Section 6 (Lifecycle Asset Management).

3.4.9. Overhead Lines

The overhead lines in Wellington Electricity's network consist of 30% wooden and 70% concrete pole lines. There are a total of approximately 52,000 poles in the network at present accommodating network assets or customer service lines. Wellington Electricity is reviewing its pole ownership policy for common service lines and has recently completed a pole survey to determine network and non-network poles. This work has resulted in the total number of poles owned by Wellington Electricity being confirmed at around 36,000 poles.

Pole Owner	Quantity
Wellington Electricity	36,121
Customer / Telecom	14,134
Wellington Cable Car	1,781
Other	306
Total	**52,342**

Figure 3-25 Summary of Poles

3.4.9.1. Poles

The average age of concrete poles is around 24 years. Although the standard asset life for concrete poles is 60 years, there are a number of concrete poles that have been in service for longer than this. The average age of wooden poles is around 36 years of age and nearly 36% of all wooden poles are older than 45 years, the standard asset life of wooden poles. Crossarms are predominantly hardwood and are generally in a fair condition. Crossarms have a shorter life than poles, especially concrete poles, and will generally require replacement approximately half way through the life of the pole.

Along with Telecom accessing the poles for their services, a previous network owner entered into agreement with Saturn (now TelstraClear) to support cable TV circuits from the majority of the network poles across the region. This is now causing problems for maintenance and operations due to congestion on the poles. Due to this congestion, Wellington Electricity must consider the impact and full life cycle costs of future access for wide scale attachment to poles. Each case will be evaluated on its own merits. An age profile of the poles on the network is shown below.

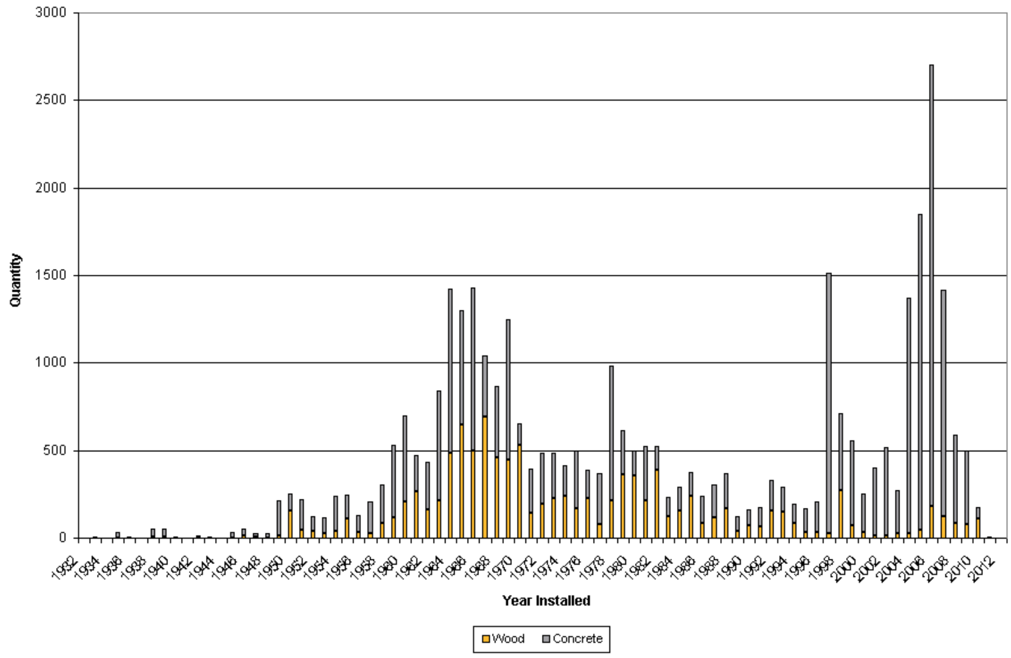

Figure 3-26 Age Profile of Poles

3.4.9.2. Lines/Conductor

Overhead conductors are predominantly copper (Cu), all aluminium conductor (AAC) and aluminium conductor steel reinforced (ACSR). New line reconstruction generally utilises all aluminium alloy conductor (AAAC). Where possible, low voltage aerial bundled conductor (LVABC) and, to a lesser extent, covered conductor thick (CCT) for 11 kV lines are used in areas susceptible to tree damage. An age profile of overhead line conductors is shown below.

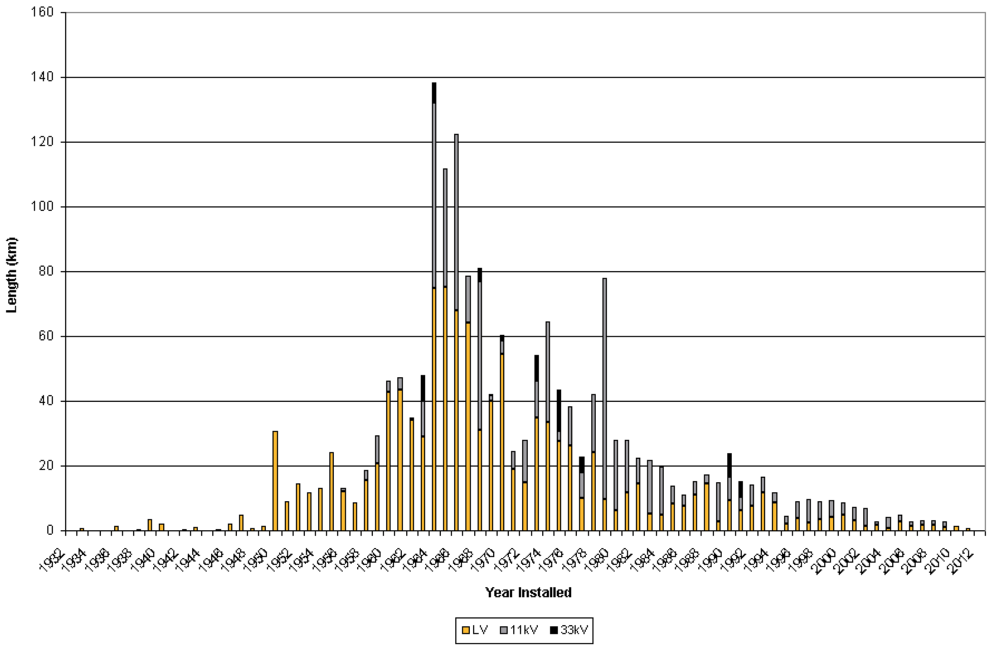

Figure 3-27 Age Profile of Overhead Line Conductors

Category	Quantity
33kV Line	58 km
11kV Line	598 km
Low Voltage Line	1,103 km

Figure 3-28 Summary of Overhead Lines

Full details of maintenance, refurbishment and renewal are covered in Section 6 (Lifecycle Asset Management).

3.4.10. Overhead Switchgear and Devices

There are 333 air break switches (ABS), 27 auto-reclosers, 170 knife links, 45 gas insulated overhead switches and a mix of expulsion type drop out fuses for breaking the overhead network into sections.

Most of the ABSs are more than 20 years old, are not cost effective to refurbish and generally range from fair to poor condition. Switch replacement occurs when poles or crossarms are replaced, or upon inspection results. Gas insulated load break switches are being used in strategic areas, and are equipped with motor actuation for future automation. Conventional air break switches are also widely used.

The majority of the 27 overhead auto-reclosers are oil filled, with only six being gas insulated.

Wellington Electricity has a single 400V voltage regulator that was installed in the mid 1980s which is now at end of their useful life due to environmental factors which have caused deterioration of the unit.

Fault passage indicators, both remote and local, have been installed at a number of major tee offs on the overhead lines. This practice will continue to aid fault detection to allow faster restoration of areas affected by interruptions.

Age profiles of these overhead line devices is shown below.

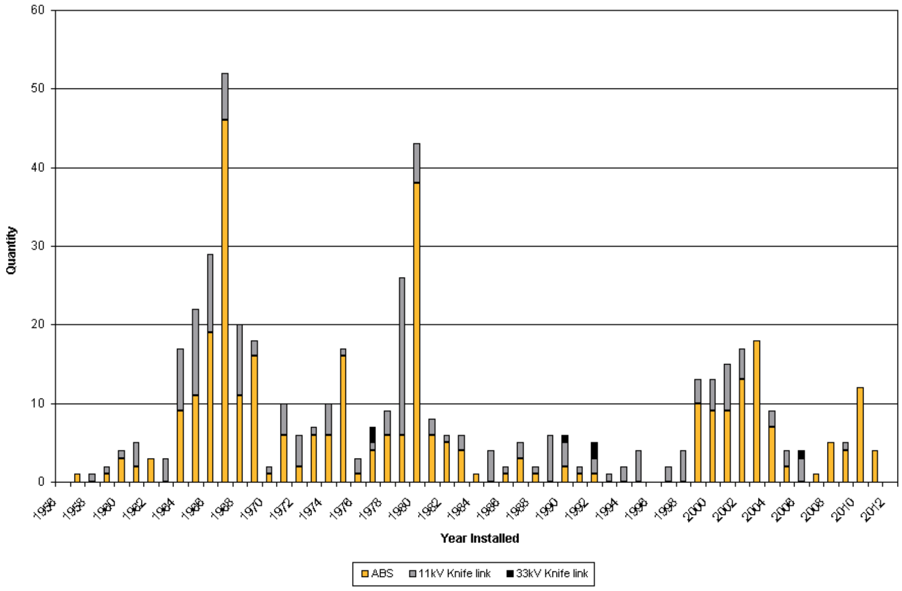

Figure 3-29 Age Profile of Overhead switchgear and devices

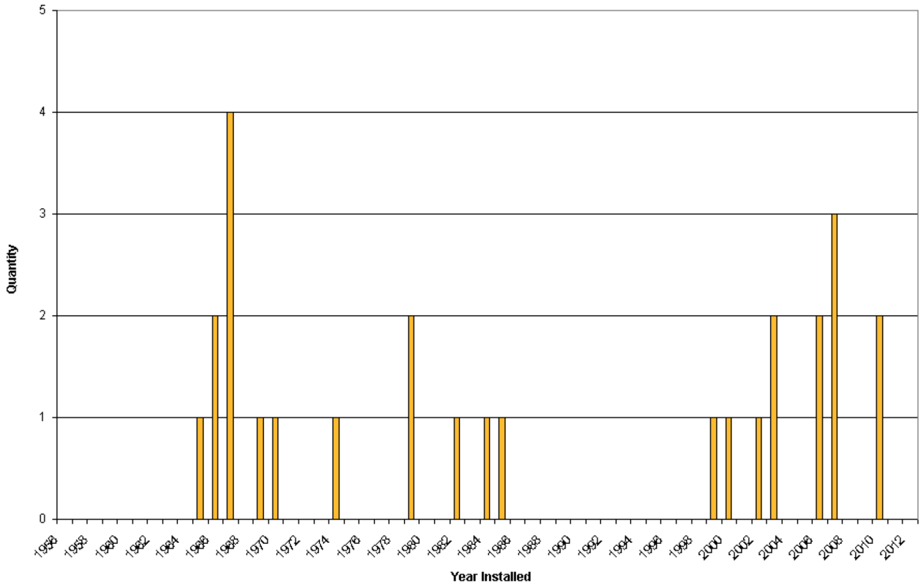

Figure 3-30 Age Profile of Overhead auto-reclosers

3.4.11. Distribution Transformers

Approximately 57% of the distribution transformer population is ground mounted and the remaining 43% is pole mounted. The pole mounted units are installed on single and double pole structures and are generally 3 phase units rated between 10 and 200kVA. The ground mounted units are also generally 3 phase units rated between 100 and 1,500kVA. Wellington Electricity holds a variety of spare distribution transformers, in serviceable condition, to allow for quick replacement following a major defect. Other than complete units, few other spares are held for this type of asset. The design life of a distribution transformer is 45 years, although in indoor environments a longer life may be achieved. In some outdoor environments a transformer will not reach this age. The age profiles of distribution transformers are shown below.

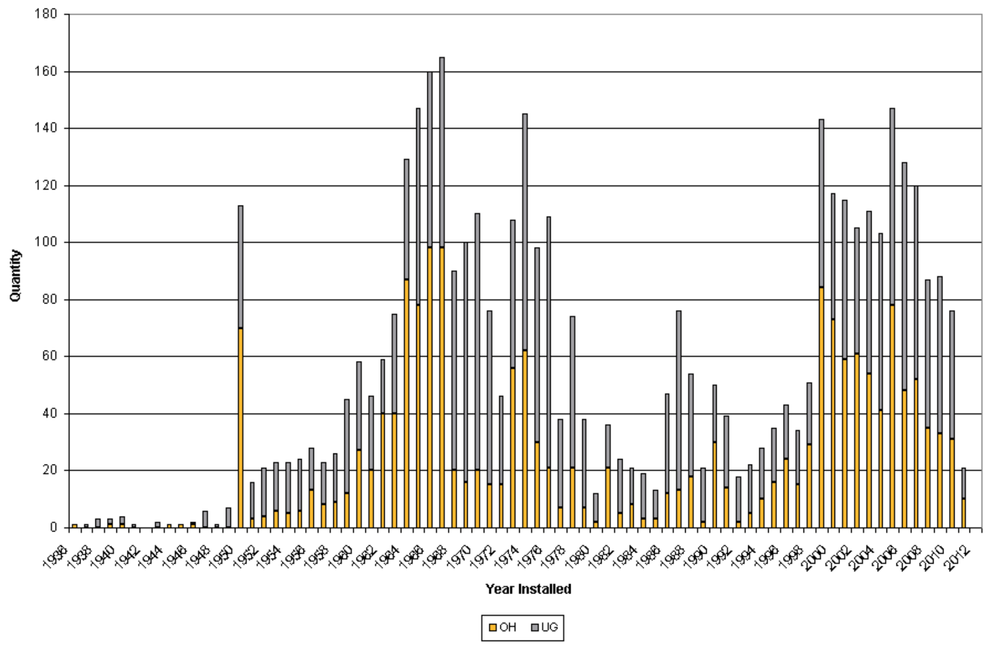

Figure 3-31 Age Profile of Distribution Transformers

In addition to pole and integral berm substations, Wellington Electricity owns 495 indoor substations and occupies a further 700 that are within customer owned accommodation (typically of masonry or block construction and occasionally wire cage construction) in the Wellington City and Hutt Valley areas. These are categorised under substation enclosures, although a large number are quite sizeable and reside on Wellington Electricity owned plots of land.

Category	Quantity
Distribution transformers	4,250
Distribution substations (total)	4,187
Wellington Electricity owned substations	3,483
Customer owned substation enclosures	704

Figure 3-32 Summary of Distribution Transformers and Substations

Full details of maintenance, refurbishment and renewal are covered in Section 6 (Lifecycle Asset Management).

3.4.12. Ground Mounted Distribution Switchgear

This section covers ring main units and similar switching equipment which is often mounted outdoors. It does not cover indoor circuit breakers which are widely used on the distribution network outside of zone substations. There are around 1,750 ground mounted switchgear units in the Wellington Electricity network, both of the Holec Magnefix type and conventional oil insulated ring main switches such as ABB, Long and Crawford, and Statter. Most of the older switchgear is oil insulated however the newer ones use SF_6 as the main insulating medium. Magnefix has a resin casing to provide insulation. The age profile of ground mounted switchgear is shown below.

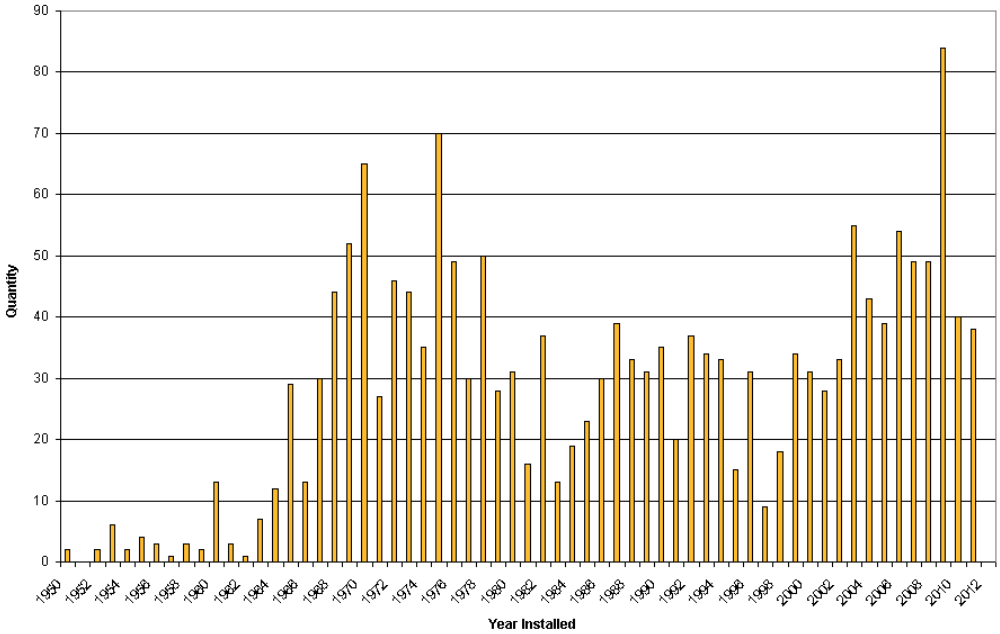

Figure 3-33 Age Profile of Ground Mounted Distribution Switchgear

The average age of the ground mounted switchgear is 23 years.

Category	Quantity
Ring Main Units	1,754

Figure 3-34 Summary of Ground Mounted Distribution Switchgear

Full details of maintenance, refurbishment and renewal are covered in Section 6 (Lifecycle Asset Management).

3.4.13. HV and LV Distribution System

Wellington Electricity's network has a relatively high percentage of underground cables, which has contributed to its relatively high level of reliability. The 11kV underground distribution system has normally open interconnections between feeders and feeders are segmented into small switching zones using locally operated ring main switches. In the event of a cable fault the faulted cable section can be isolated and supply to downstream customers can be switched to neighbouring feeders.

Wellington CBD is operated in a closed ring configuration with radial feeders interconnecting neighbouring rings or zone substations. This part of the network uses automatically operating circuit breakers, using Solkor differential protection between sites rather than manually operated ring main switches between switching zones. This results in higher reliability as smaller sections of network are affected by cable faults. However due to the nature of the CBD, any repairs required to the distribution system take considerably longer than standard replacement times. CBD repairs also incur considerable costs for traffic management and pavement reinstatement.

In rural areas, the lines are generally radial, with limited back feeds in areas such as Akatarawa, Paekakariki Hill and Wainuiomata towards the south coast. The use of auto reclosers and sectionalisers aims to reduce the impact on these feeders, an outage is likely to affect customers for the duration of the repair.

Category	Quantity
11kV cable (incl. risers)	1,139 km
Low Voltage cable (incl. risers)	1,553 km
Pillars and pits	14,875

Figure 3-35 Summary of Distribution Cables and Pillars

3.4.13.1. HV and LV Distribution Cables

Approximately 93% of the underground distribution cables are PILC and PIAS and the remaining 7% are newer XLPE insulated cables. PILC cables use a relatively old technology but are in good condition and have proven to be very reliable.

The majority of low voltage cables are PILC or PVC insulated and a much smaller number are newer XLPE insulated cables. In general the low voltage cables are in good condition.

An age profile of distribution cables of both voltages is shown below.

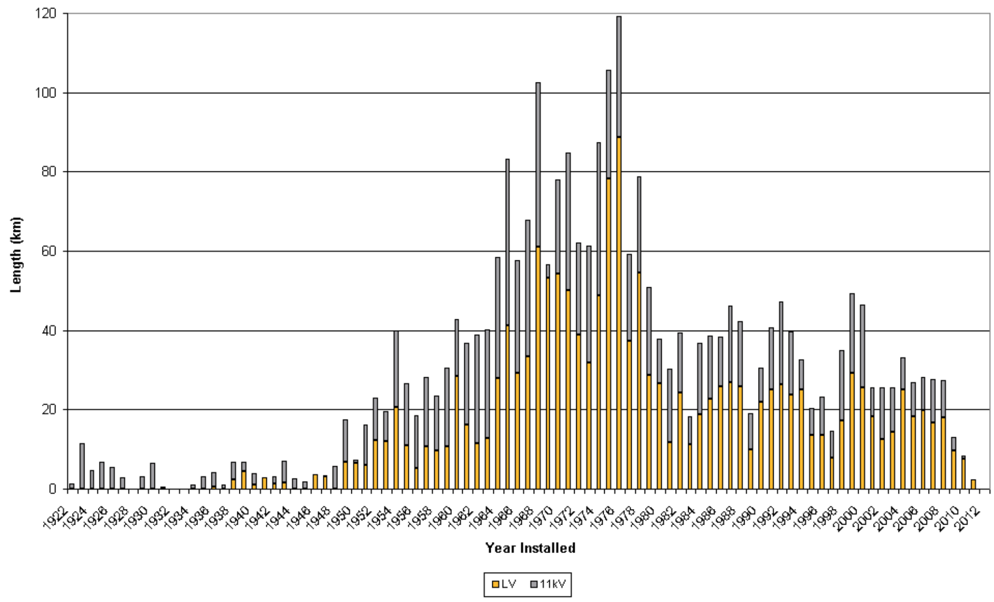

Figure 3-36 Age Profile of Distribution Cables

3.4.13.2. LV Pillars and Pits

Pillars and pits provide the point for the connection of customer service cables to the Wellington Electricity underground low voltage reticulation. They contain the fuses necessary to isolate a service cable from the network. Pits are manufactured from polyethylene as are most of the newer pillars. Earlier style pillars were constructed of concrete pipe, steel or aluminium. There are approximately 400 link pillars and pits in service on the Wellington network. These are used to parallel adjacent LV circuits to provide back feeds during outages, as well as providing the ability to sectionalise large LV circuits. A high level breakdown of types is listed below.

Type	Quantity
Customer service pillar	13,300
Customer service pit	1,160
Link pillars and pits	410

Figure 3-37 Summary of LV Pillars and Pits

3.4.14. Metering

Wellington Electricity does not own any revenue metering assets as these are owned by retailers and metering companies supplying consumers.

There are check meters installed at GXPs and a large number of Maximum Demand Indicator (MDI) meters installed in distribution substations. These are for operational and planning purposes only and are considered to be part of that asset.

3.4.15. Generators and Mobile Substations

Wellington Electricity does not own any mobile generators or substations. There is a fixed generator supporting the network control room at the Haywards substation. Wellington Electricity has shared use of a generator at the corporate office in Petone, however this generator is owned and maintained by others.

All generation required for network operations and outage mitigation is provided by the works contractor.

Wellington Electricity own a kiosk with 11kV switchgear installed and this is used in instances where switchgear replacement or other major works is occurring at a substation and the 11kV supply cannot be out of service for extended periods.

Wellington Electricity is evaluating where in the network private backup generation is installed that can be synchronised, particularly large generators in the CBD, and how this can be utilised for maintaining customer supply or assisting during network outages or Grid Emergencies.

3.4.16. Asset Category Value

The value of Wellington Electricity network assets is summarised by Optimised Deprival Valuation (ODV) category below:

Asset Category	Category Value (ODRC at 31 March 2011)
Subtransmission assets	$67.2 m
Zone substations	$45.3 m
Distribution LV lines and cables	$274.1 m
Distribution substations and transformers	$70.0 m
Distribution switchgear	$36.6 m
Other system fixed assets	$21.4 m

Figure 3-38 Asset Category Values

3.5. Asset Justification

The distribution system is designed to provide an electricity supply of sufficient capacity and reliability to meet the customer service levels for the load type and with consideration of the price/quality trade-off consumer groups are prepared to make. In addition, the network is planned and constructed with some additional capacity to cater for forecast load increases. This strategy (which is generally adopted by electricity network businesses) is an efficient approach to network development due to the high cost and long life cycles of electricity distribution assets.

Urban Network

The urban network, both in residential and business/CBD areas, is designed to support present and recent forecast loads, and to be operated within the disclosed service levels for the period of this AMP. Where shortfalls are identified, network reinforcement projects or demand side initiatives (or a mixture of both) may be undertaken. There are different network architectures between the old Capital MED and Hutt Valley areas, and as such there is a higher level of security in the Wellington CBD, and surrounding suburbs, which incorporates an increased number of circuit breakers and protection devices, a predominantly underground network due to the building density, as well as offering a high level of redundancy. This legacy system architecture is appropriate to meet the security criteria for the CBD and also reflects the significance of the Wellington CBD as being the centre of Government, Government departments and commerce and their reliance upon secure electricity supply. Supply is taken at 33kV to supply zone substations from Transpower GXPs. This is an industry standard voltage and is appropriate to minimise losses as well as carry the required loads. Distribution feeders are all 11kV, which is stepped down at distribution substations to 400V for distribution to consumer premises. In some areas, supply is taken from Transpower at 11kV where the load centre is close to the GXP. There has been reasonably low load growth in the Wellington network over recent years and the decline of manufacturing industry from the 1980s onwards has created headroom in some areas of the network, especially the Hutt Valley and Porirua areas. Despite this, changing load demands (apartment conversions, air conditioning etc) in the CBD has created some constraints that will require further network development.

Rural Network

The rural network is supplied at 11kV from urban zone substations and often a rural feeder passes through an urban area supplying load before entering a rural area. There are fewer back feed options for rural feeders and this is reflected in lower service levels. Less than 30% of the Wellington network is rural and the load served is very low density. There is no major rural sector in the Wellington area so loading and voltage is not an issue, however the exposure to weather and vegetation interference necessitates a large number of line reclosers, remote switches and sectionalisers to meet service level targets.

Voltage Levels

11kV has been the predominant distribution voltage as this was the original supply voltage from the Khandallah substation established in 1924 to supply Wellington and the subsequent development and connection of Melling and Central Park substations in the 1930s and 1940s.

33kV was introduced in the late 1950s for subtransmission when load growth exceeded the capacity of the 11kV system. Wellington Electricity has no intention in the short term to use other voltages for distribution or subtransmission.

110kV cabling was installed by the Wellington MED in the early 1980s to future proof supply capacity to the Eastern Suburbs area (incorporating Evan's Bay and Miramar), although this is presently operated at 33kV. Wellington Electricity is considering the use of 110kV in this area in the future, as described in Section 5 (Network Planning).

4. Service Levels

4.1. Consumer Orientated Performance Targets

4.1.1. Network Reliability

Network reliability is measured using two internationally recognised performance indicators, SAIDI and SAIFI, which taken together are indicators of the availability of an electricity supply to the average customer connected to the network.

- SAIDI[4] is a measure of the total time in a measurement year that an electricity supply is not available to the average consumer connected to the network. It is measured in minutes.
- SAIFI[5] is a measure of the total number of supply interruptions that the average consumer experiences in the measurement period. It is measured in number of interruptions[6].

These indicators include both planned and unplanned outages. On average, planned outages account for approximately 25% of the total number of outages every year but only contribute to 6% of the annual SAIDI minutes. Consistent with the approach taken by the Commerce Commission the following supply interruptions are not included in the measured performance indicators.

- Interruptions caused by the unavailability of supply at a GXP, or as a result of automatic or manual load shedding directed by the transmission grid operator[7], or as a result of some other event external to the Wellington Electricity network.
- Interruptions lasting less than one minute. In these cases restoration is usually automatic and the interruption will not be recorded for performance measure purposes, however, it is recorded in Wellington Electricity's systems for future analysis.
- Interruptions resulting from an outage of the low voltage network or a single phase outage of the 11kV distribution network. The Commerce Commission does not require these interruptions to be recorded for information disclosure or for the operation of the threshold control regime. In practice such interruptions do not have a material impact on measured system reliability and the business processes required to accurately record these interruptions and measure their impact are not cost effective.

Wellington Electricity has calculated reliability thresholds using the methodology set down by the Commerce Commission[8]. This method adopts a reference sat of reliability data taken from the period 1 April 2004 to 31 March 2009. The mean reliability over this period is set as the threshold for network and the mean plus one standard deviation become the limit. This method is applied to both SAIDI and SAIFI. The mean and limit values for Wellington Electricity calculated using this method are presented below.

---

[4] System Average Interruption Duration Index

[5] System Average Interruption Frequency Index

[6] Due to the effect of averaging, SAIFI is reported as a non integer number.

[7] The transmission grid operator has the authority to direct electricity distributors to shed load. This is necessary during emergencies to ensure that the power system continues to operate in a secure and stable state.

[8] Commerce Commission, Decisions paper on the initial reset of the DPP, 30 November 2009.

	2010-11	2011-12	2012-23	2013-14	2014-15
SAIDI threshold (mean)	**33.90**	**33.90**	**33.90**	**33.90**	**33.90**
SAIDI limit (mean + 1SD)	40.74	40.74	40.74	40.74	40.74
SAIFI threshold (mean)	**0.52**	**0.52**	**0.52**	**0.52**	**0.52**
SAIFI limit (mean + 1SD)	0.60	0.60	0.60	0.60	0.60

Figure 4-1 Reliability Thresholds (as defined by the Regulator)

Note 1: SAIDI is measured in minutes and SAIFI in average number of interruptions.

The thresholds have been calculated in accordance with the Commerce Commission's current requirements for the reporting of reliability and include the impact of major event days when the number of outages exceeded the ability of Wellington Electricity's contractor to respond in a timely manner. The impact of these major event days on the reported reliability can be significant – there were two major event days in 2003-04 when a SAIDI of over twice that recorded in a normal year was experienced. These events fall outside of the 'reference dataset' five year averaging period and hence are not included in the above table however should a similar event occur in the future, it would have a significant impact not only on this years SAIDI, but also on a rolling average.

Major event days are usually caused by environmental factors, such as severe storms, that are outside Wellington Electricity's direct control. They are relatively infrequent – Wellington Electricity has experienced only three major event days in the last eight years, two in 2003-04 and one in 2004-05. They generally have a much bigger impact on SAIDI than on SAIFI because during such events consumers may only experience one interruption but can be without power for hours or, in extreme situations, days.

The measured historic reliability of Wellington Electricity's network is illustrated in the graphs below. In broad terms, the graphs show that, under normal circumstances, the average consumer can expect one sustained interruption every two years and that this interruption will last a little over an hour.

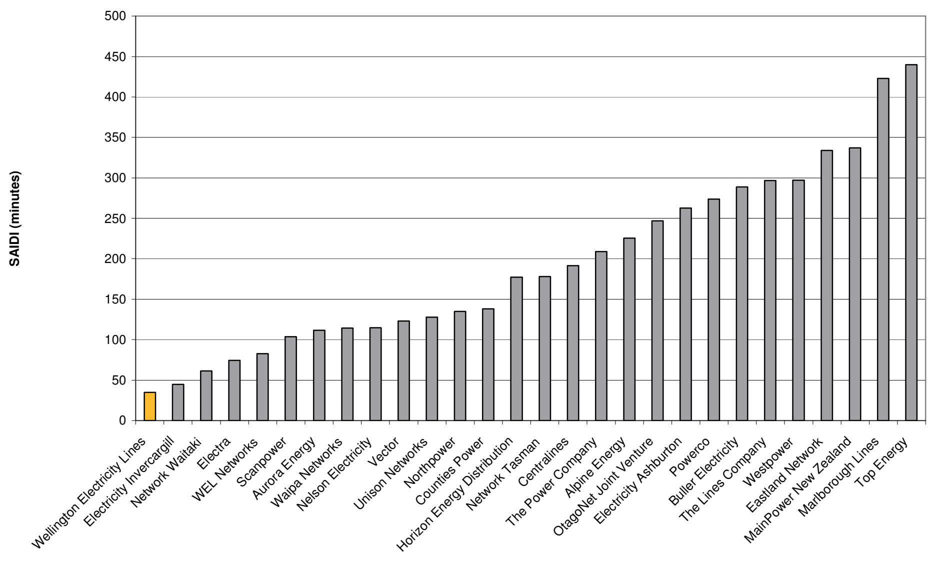

Figure 4-2 NZ Electricity Distribution Network performance 2010/11

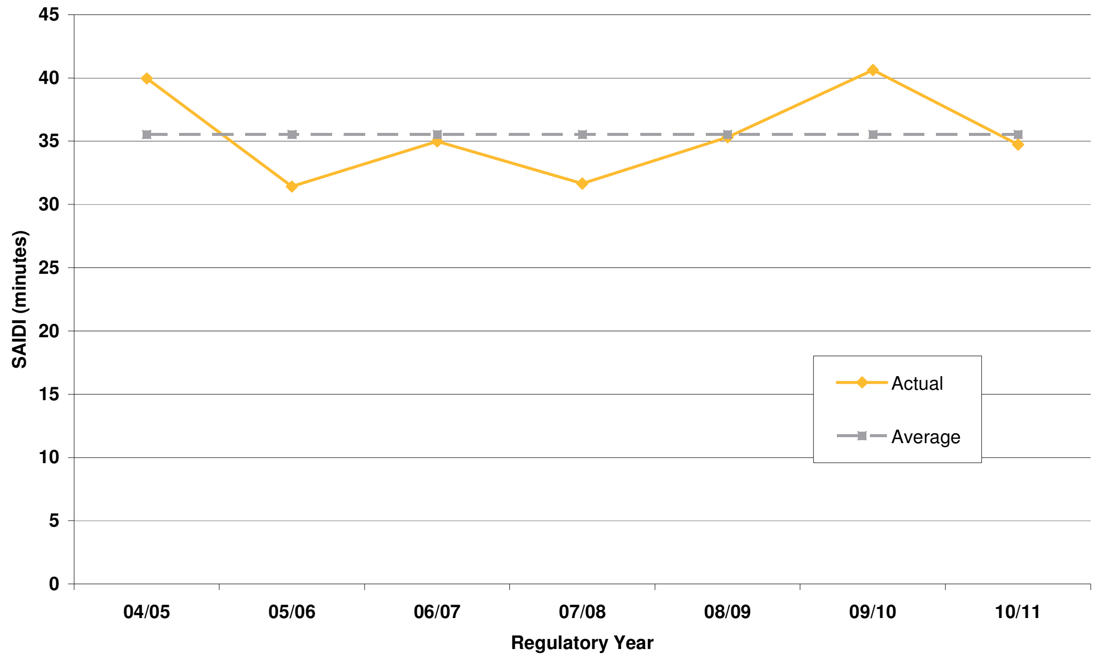

Figure 4-3 Historic SAIDI of the Wellington Electricity Network

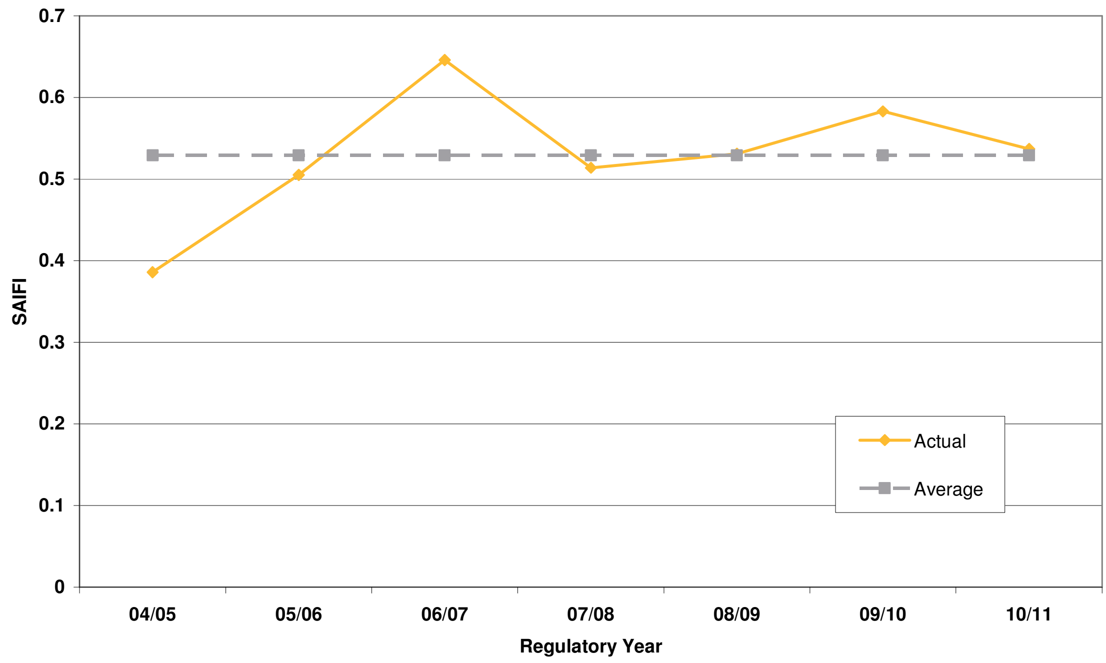

Figure 4-4 Historic SAIFI of the Wellington Electricity Network

4.1.2. Contact Centre Service Levels

Wellington Electricity has developed a set of key performance indicators and financial incentives that will serve as service levels with its call centre provider (Telnet) and these are set out below. Measurement is by way of the Telnet monthly online Executive Summary Report.

4.1.2.1. General Contact Centre Service Levels

SL	Service Element	Measure	KPI	2012 Target	2013 Target	2014-2021
A1	Overall service level	Average service level across all categories	80%	80%	80%	80%
A2	Call response	Average wait time across all categories	20 seconds	20 seconds	20 seconds	20 seconds
A3	Missed calls	Total missed /abandoned calls across all categories	4%	4%	4%	4%

Figure 4-5 General Contact Centre Service Levels

4.1.2.2. Customer Experience

All customer contact should contribute to customer satisfaction in dealings with the service provider when representing Wellington Electricity. Measurement is by way of a sample survey of calls (Call calibration).

SL	Service Element	Measure	KPI	2012 Target	2013 Target	2014-2021
D1	Specific Contact Centre experience	Wellington Electricity is properly represented during specific calls	Qualitative assessment 80%	80%	80%	80%

Figure 4-6 Customer Experience

Note D1: Contact Centre contribution to customer experience will be monitored as part of Wellington Electricity's monthly survey of Contact Centre calls. The relevant results of this survey will be discussed with Telnet with a view to constant performance improvement.

4.1.2.3. Energy Retailer Satisfaction

All energy retailer contact should contribute to energy retailer satisfaction in dealings with the service provider when representing Wellington Electricity. Measurement is by way of an annual survey.

SL	Service Element	Measure	KPI	2012 Target	2013 Target	2014-2021
E1	Overall retailer satisfaction with Contact Centre performance	Wellington Electricity is properly represented with retailer interaction	80% satisfied	80%	80%	80%

Figure 4-7 Energy Retailer Satisfaction

4.1.3. Customer Enquires and Complaints

Enquiries and complaints are channelled to Wellington Electricity via a number of avenues including retailers, service contractors, call centre and direct approaches. When an enquiry or complaint is received, it is entered into a central registry (SAP–CARE database). The target response time for enquires is eight working days and for complaints is ten working days. Failure to meet these targets will result in automatic prompting for seven days followed by internal escalation. Wellington Electricity is a member of the Electricity and Gas Complaints Commission (EGCC) and follows their process for dispute resolution.

4.2. Asset Management Performance Targets

Other performance targets used by Wellington Electricity relate to the efficiency with which Wellington Electricity manages its fixed distribution assets. The indicators have been selected on the basis that Wellington Electricity considers them particularly relevant to the operation and management of its assets. The selected asset performance targets use indicators that are required to be reported to the Commerce Commission under its information disclosure regime.

4.2.1. Standard Service Levels for Restoration of Power

Wellington Electricity's published 'Electricity Network Pricing Schedule' provides standard service levels for three different categories of customers as shown in the map below. These service levels are agreed to between Wellington Electricity and all of the retailers who are signatories to the use of network agreement. This agreement provides Wellington Electricity with financial incentives to not exceed the maximum restoration times detailed below.

	Urban	Rural
Maximum time to restore power	3 hours	6 hours

Figure 4-8 Standard Service Levels for Residential Customers

	Urban	Rural
Maximum time to restore power	3 hours	6 hours

Figure 4-9 Standard Service Levels for Business Customers

	CBD / Industrial	Urban	Rural
Maximum time to restore power	3 hours	3 hours	6 hours

Figure 4-10 Standard Service Levels for Industrial Customers

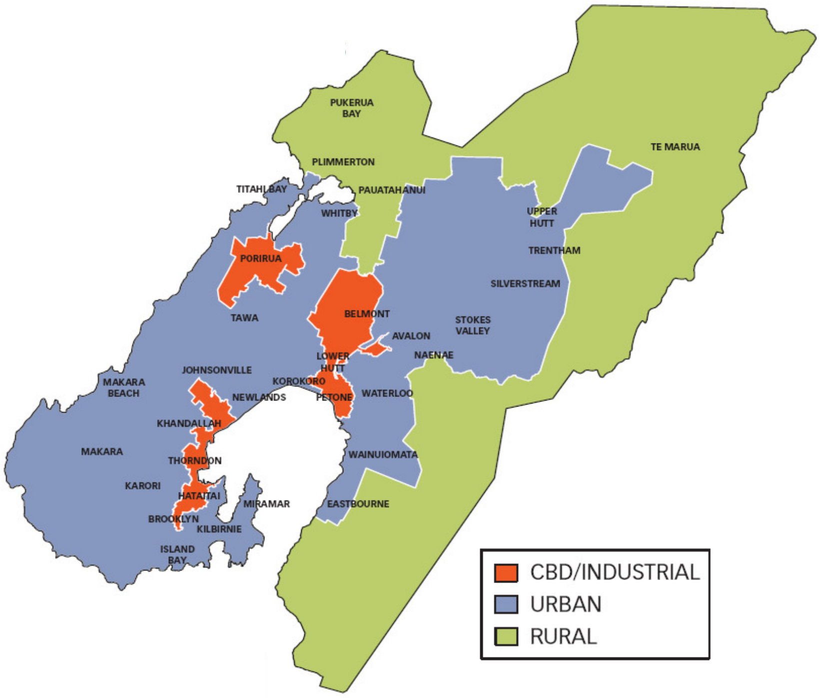

Figure 4-11 Standard Service Level Areas

Time taken to restore power is recorded in ENMAC. Refer to Section 2 (Background and Objectives) for details on how unplanned outages are recorded.

4.2.2. Faults per 100 Circuit-km

For the purpose of this performance indicator, a fault is considered an unplanned failure of an in-service line or cable asset on the subtransmission or high voltage distribution systems, irrespective of whether or not it causes a loss of supply to customers. Circuit-km relates to the total circuit length of the subtransmission and high voltage distribution systems, irrespective of whether the circuit is overhead or underground.

This is a measure of how well the system is designed and operated from a technical perspective. Wellington Electricity designs its network to withstand the environmental conditions to which it is exposed, particularly the severe Wellington winds and the high level of atmospheric salt contamination. As discussed in Section 6, Wellington Electricity has a preventive maintenance system in place whereby assets are regularly inspected to identify and remedy defects that could potentially cause an asset failure. Further, Wellington Electricity has a vegetation management system in place to reduce the number of faults resulting from trees coming into contact with overhead power lines. Faults are also subject to a root cause analysis aimed at identifying systemic issues that may be causing unplanned outages followed by projects that will address the issue. This performance indicator (faults per 100 Circuit-km) is a measure of the effectiveness of these asset management strategies.

The current target for the planning period is shown in the table below and has been set on the basis of the current performance of the network. It is intended to set targets for the planning period that reflect a continuation of the current level of asset performance.

2012-13	2013-14	2014-15	2015-16	2016-17	2017-18	2018-19	2019-20	2020-21	2021-22
11.25	11.25	11.25	11.25	11.25	11.25	11.25	11.25	11.25	11.25

Figure 4-12 Performance Targets for Faults per 100 Circuit km / annum

4.2.3. Asset Efficiency and Utilisation

Load factor is reflective of consumer demand profiles and the predominantly urban network leads to higher than average utilisation and load density. Wellington Electricity aims to maintain utilisation and loss ratios at steady levels in line with similar networks. Where assets are being replaced, consideration is given to reducing losses through selection of more efficient equipment, generally in the selection of transformers. The following table provides an overview of the efficiency of the assets utilised by Wellington Electricity compared with the industry average.

	Load factor %	Distribution transformer capacity utilisation %	Loss ratio %	Demand density kW/km	Volume density MWh/km	Connection point density ICP/km	Energy density kWh/ICP
Wellington Electricity	51.7	42.6	4.8	124.0	533	36	14946
Industry average	59.6	31.3	5.5	39.0	199	13	15231

Figure 4-13 Asset Efficiency and Utilisation

4.3. Justification for Targets

Wellington Electricity operates its distribution system in accordance with all relevant legal requirements, including the Electricity Act 1992, the Health and Safety in Employment Act 1992 and the Resource Management Act 1991. This legislation and subsidiary regulations have a significant influence on the way Wellington Electricity manages its assets. In the main the legal requirements are non-discretionary and therefore act as a constraint on the way in which the system must be managed (and the cost of managing the network).

Within these legal constraints, Wellington Electricity has discretion in managing its assets to meet the requirements of its stakeholders. It must ensure that the reliability of supply meets or exceeds the reasonable expectations of the retailers and consumers that use the network. Further, it must ensure that the assets are used efficiently if the conflicting expectations of stakeholders regarding price and profitably are both to be met in a reasonable way.

4.3.1. Consumer Survey

Wellington Electricity surveys its consumers to determine their expectations on a regular basis. The most recent survey was completed in December 2011 and involved sampling:

- All of the top 25 consumers
- A random sample of 25 of the top 26 to 130 consumers

- A random sample of 3,500 mass market consumers

The survey involved phoning consumers and asking a series of questions. Of the 3,500 mass market consumers, a total of 412 completed the survey - a response rate of 13%. The questions included:

- What is most important to consumers? (e.g. keeping power on, low prices etc)
- How well Wellington Electricity is performing?
- What price / quality tradeoffs are consumers prepared to make? (e.g. pay less for lower quality etc)

Graphs of the responses to these questions are provided below.

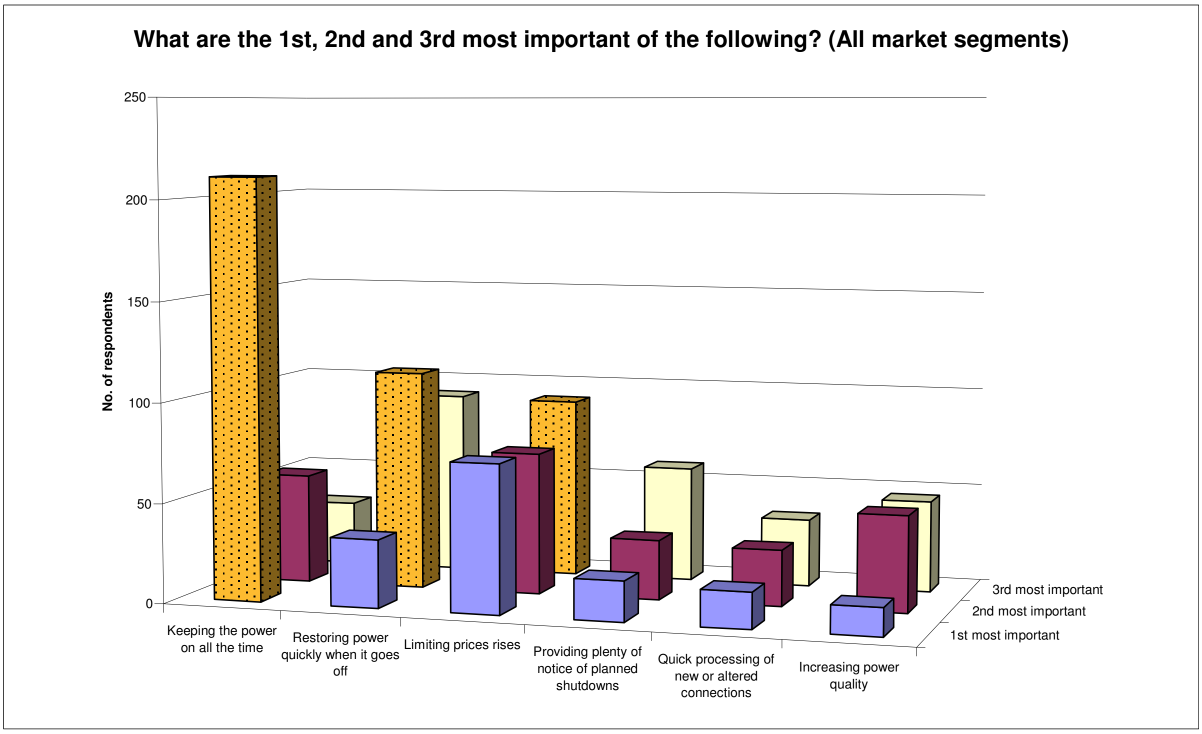

Figure 4-14 What is most important to consumers?

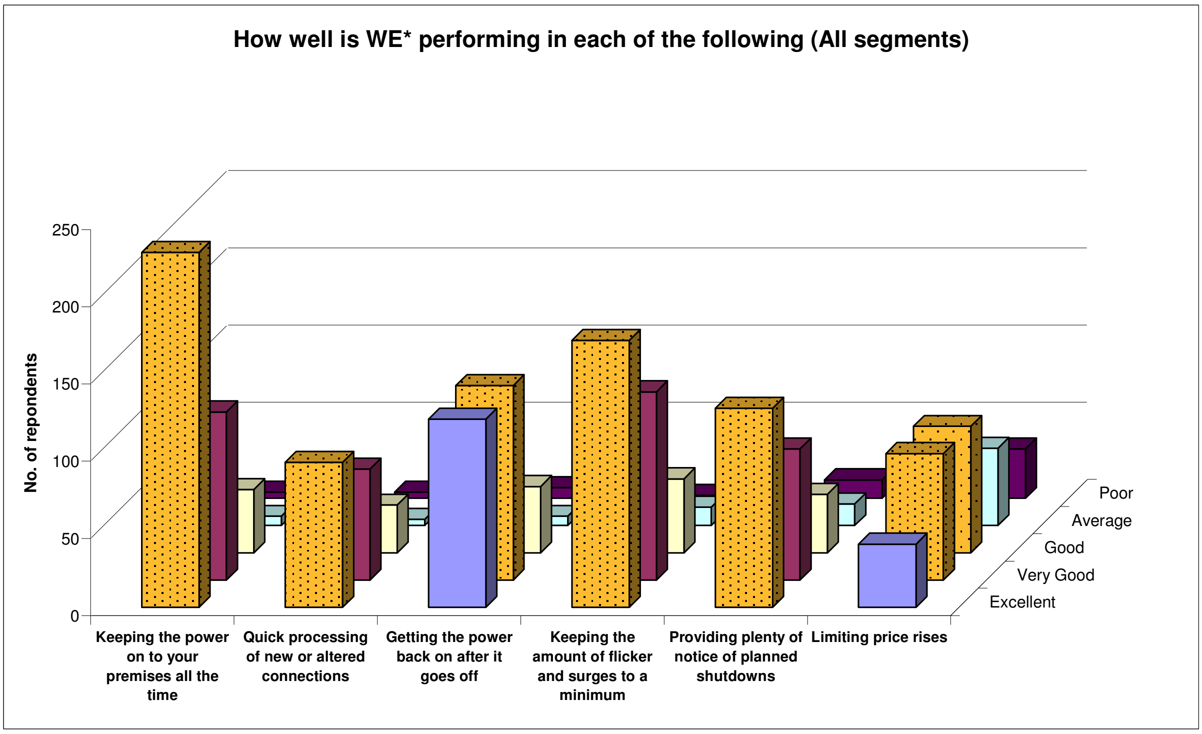

Figure 4-15 How well are Wellington Electricity performing?

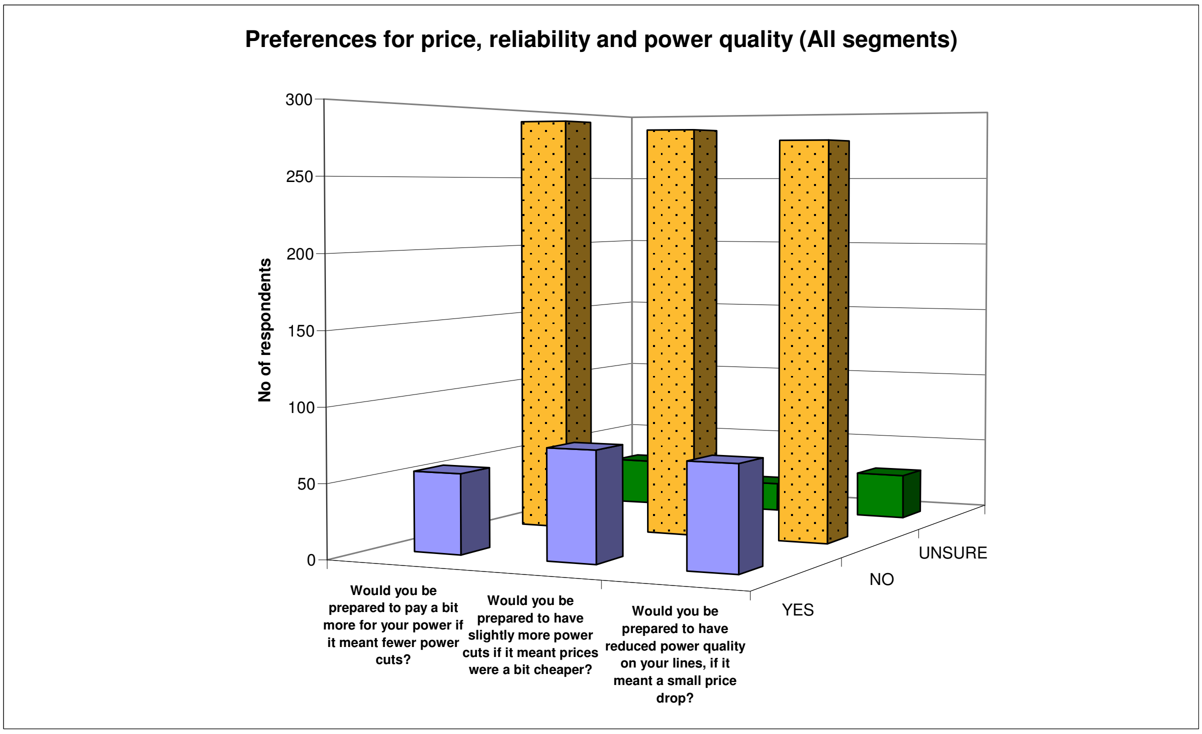

Figure 4-16 What price / quality tradeoffs are consumers prepared to make?

Key results from the survey are:

- Consumers in all segments regard continuity ('keeping the power on') and restoration ('getting the power back on') as the first and second most important components of electricity line services.
- Consumers across all segments regard Wellington Electricity's performance in regard to the above two components as either excellent or very good.

- Limiting price increases is the third most important component behind ‘keeping the power on’ and ‘getting the power back on’.
- The majority of consumers across all segments indicated a clear preference against paying either a bit less if it meant more power cuts or a bit more if it meant less power cuts, i.e. a strong preference for paying about the same line charges to have about the same reliability.
- The majority of consumers across all segments indicated a clear preference against paying a bit less to have more flicker or surge, i.e. a strong preference for having either the same or less flicker.

The survey shows that consumers are advising Wellington Electricity that:

- Efforts and resources should be focused on continuity and restoration
- Price increases matter less than maintaining the status quo on quality
- Present levels of quality are about right

These results are reflected in Wellington Electricity’s asset management approach of investing to maintain reliability at present levels. This approach focuses on managing an aging fleet of assets and replacing those assets that are at their end of life before they fail.

5. Network Planning

5.1. Planning Criteria and Assumptions

Network development planning is concerned with delivering network performance and security:

- In an economic and sustainable manner
- At a price level which is acceptable to customers
- Maintaining risk at a level which is acceptable to the Board.

The planning principles are encapsulated in a number of standards, with the key document being the security standard. The main planning principles are:

- Network assets will not present a safety risk to staff, contractors or the public
- All network assets will be operated within their design rating to ensure they are not damaged by overloading
- The network is designed to meet statutory requirements including acceptable voltage and Power Quality (PQ) levels
- Customer's[9] reasonable electricity capacity requirements will be met. In addition, the network is designed to include a prudent capacity margin to cater for foreseeable near term load growth
- Equipment is purchased and installed in accordance with network standards to ensure optimal asset life and performance as well as providing high levels of safety
- Varying security standards apply to different areas and customer segments, broadly reflecting customers' price/quality trade-off
- Network investment will provide an appropriate commercial return for the business.

All these competing priorities are balanced to find the right outcomes for Wellington Electricity and its stakeholders, which is typical of utility businesses.

Wellington Electricity has a number of key policies and standards underpinning its network planning approach. These policies and standards cover the following areas:

- Network security – specifies the minimum levels of network capacity necessary (including levels of redundancy) to ensure an appropriate level of supply service
- Service level – established as part of the Use of Network Agreement with retailers and customers. The service levels reflect expected restoration timeframes and fault frequencies
- Technical standards – ensure optimum asset life and performance is achieved (i.e. capital cost, asset ratings, maintenance costs and expected life are optimised to achieve overall lowest cost). Standardisation also reduces design costs and minimises spare equipment holding costs leading to lower overall project costs
- Network parameters – including acceptable fault levels, voltage levels, power factor, etc., providing an appropriate operating framework for the network.

To identify the network constraints within the planning period, the forecast peak load for future years contained within the moderate load forecast is compared with the capacity of the network equipment to produce a list of overloaded assets. This is done for both system normal (n) and contingency (n-1)

[9] This includes customers with non standard requirements where special contractual requirements apply.

conditions. Solutions to resolve asset overloads at times of forecast peak load are considered for inclusion in the capital budget submission if the relevant network planning criteria for the asset are violated.

Wellington Electricity plans to eliminate the constraints by implementing optimum solutions to the network which has been forecasted to be overloaded during normal conditions. In some cases the solution for contingency events for some components of the network may be delayed depending on response times, repair times and the consequences of the overload.

Typical repair times assumptions for main power system equipment are:

- Substation transformer - 5 days
- 33kV Underground cable - 9 days
- 33kV Circuit breaker - 3 days
- 33kV Overhead line - 10 hours

When the forecast load exceeds the security criteria, a constraint is defined and a suitable solution is sought. Projects required to avoid breaching the load thresholds established within the planning criteria are submitted for each year's capital budget and the ten year capital plan where:

- The overload cannot be eliminated by load transfers for distribution substations and distribution feeders
- Normal load is greater than a distribution substations normal capacity (a tolerance of 0.2 MVA is considered to allow for metering errors)
- Load during a contingency event is greater than a distribution substation's firm delivery capacity
- During a contingency event, the load at risk on the feeder is greater than 100A (i.e. approx 2MVA at 11kV)
- Normal load is greater than a sub transmission line's normal rating or the contingency load is greater than a sub-transmission line's emergency rating.

5.2. Prioritisation of Capital Works Projects

The processes described in this AMP invariably identify more potential work than can be accommodated by budgets or resources available to Wellington Electricity, hence the need for a project prioritisation process.

Every year, as part of the capital works budgeting process, the list of potential projects are reviewed for necessity and ranked. The detail of how projects are ranked and selected is a work in progress. The present method, which will be developed into a ranking tool, includes the assessment of a number of weighted project 'drivers' that are assigned values based on their assessed impact to Wellington Electricity. The drivers which assist with ranking projects are:

- Health and Safety
- Legal and statutory obligations
- Company policies and standards
- Risk to the network
- Environmental
- Financial value
- Quality of supply
- Strategic benefit
- Stakeholder satisfaction

A subset of the projects will be non-discretionary and will not be deferred. These projects include:

- Works necessary to ensure public and employee safety
- Works necessary to meet legal requirements.

However, where changes to legal requirements impose significant additional costs it may be necessary to undertake the required works over an extended period of time. This is usually agreed with the authority responsible for monitoring compliance with the changed requirement.

All other projects will generally be prioritised on the basis of benefit-cost ratios and risk analyses using an assessment of the project 'drivers' as outlined above. Projects that mitigate extreme or high risks to the business and projects with high benefit-cost ratios will be generally given the highest priority.

An example of the prioritisation criteria is shown in the risk example in Section 8 (Risk Management).

5.2.1. Current Prioritisation Process

Wellington Electricity's general prioritisation sequence for including projects in its capital expenditure programme is as follows:

- Essential safety or legal compliance
- Customer initiated projects
- Network integrity projects for meeting capacity requirements
- Reliability and security of supply projects
- Other economically attractive investments.

Wellington Electricity's top priority is to operate a safe and reliable network, and it prioritises those projects which provide safety and reliability benefits above others. However all projects must provide an appropriate return to shareholders either financially, in the case of asset replacement, network growth and reinforcement projects, or non-financial benefits such as safety, compliance or to meet regulatory requirements.

Customer driven growth projects generally result from the development of new subdivisions, commercial or industrial projects. Where possible, these projects are prioritised to meet customer's needs. These customer priorities (where Wellington Electricity has been advised in advance) are incorporated into Wellington Electricity's project execution schedules. Related to customer driven projects are those that are implemented to ensure that Wellington Electricity can meet the load capacity requirements on all parts of its network. In general no shortfalls in supply capacity would be tolerated. Network integrity projects are those that address the continued effective operation of the distribution network and include renewal and refurbishment projects.

Reliability and security of supply projects are focused on ensuring that the required reliability standards on the network are met and that security of supply standards are maintained.

Projects are prioritised in accordance with the risk that they are intended to address while the outcome of the planning process identifies actual and potential network security breaches. Security breaches are assessed in accordance with Wellington Electricity's risk matrix which considers the likely frequency and consequences of the breach[10]). The higher the risk assessment factor the higher the priority attached to a project.

Wellington Electricity may also consider other asset investment projects if these are demonstrated to provide an acceptable rate of return to shareholders.

5.3. Voltage Levels

Sub-transmission voltage is nominally 33kV in line with the source voltage at the supplying GXP. The voltage used at MV distribution level is nominally 11kV. The LV distribution network supplies the majority of customers at nominally 230V single phase or 400V three phase. By agreement with customers, supply can also be connected at 11kV or 33kV depending upon their load requirements.

Regulation 28 of the Electricity (Safety) Regulations 2010 requires that standard LV supply voltages (230V single phase or 400V three phase) must be kept within +/-6% of the nominal supply voltage calculated at the point of supply, except for momentary fluctuation. Supplies made at other voltages must be kept within +/-5% of the nominal supply voltage except for momentary fluctuation, unless agreed otherwise with the customers.

Design of the network takes into account the voltage variability due to changes in loading and embedded generation under normal and contingency conditions. All Wellington Electricity zone transformers are fitted with on-load tap changers (OLTC) to maintain the supply voltage within acceptable limits. Distribution transformers typically have an off-load tap changer which can be manually adjusted to maintain acceptable voltage in localised areas of low voltage distribution.

5.4. Security Criteria and Assumptions

The security criteria on which the design of the system is based is shown in Figures 5-1 and 5-2. This security criteria was adopted from the previous network owners and was the basis on which the network was designed and operated. There are no regulated national standards currently in force, however the EEA has produced a guideline which has similar principles. These security standards are consistent with industry best practice and are designed to:

- Match the security of supply with customers' requirements and what they are prepared to pay for
- Optimise capital expenditure (Capex) without a significant increase in supply risks
- Increase asset utilisation.

These security standards accept a small risk that customer supplies may be interrupted when a network fault occurs during peak demand times[11]. The length of time (based on percentage measures) when the sub-transmission network could not meet the N-1 security, and the distribution network did not have full backstop, was defined with different durations for different categories of customers. However, even in the event that an interruption should occur, limits are set on the maximum load that would be lost.

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[10] Frequency is a measure of how often breaches of the security standards are likely to occur. Consequences are a measure of the health and safety, reputation, customer impact and financial risk to Wellington Electricity of not addressing the problem

[11] A true deterministic standard, such as N-1, implies that supply will not be lost after a single fault at any time. The Wellington Electricity security standard accepts that for a small percentage of time, a single fault may lead to outages. By somewhat relaxing the deterministic standard, significant reductions in required asset capacity and redundancy levels become possible.

Type of Load	Security Criteria
CBD	N-1 with a break[2] for 99.5% of the time in a year. For the remaining times, supply will be restored within 3 hours following an interruption.
Mixed commercial / industrial / residential substations	N-1 with a break[1] for 98% of the time in a year. For the remaining times, supply will be restored within 3 hours following an interruption.
Predominantly residential substations	N-1 with a break[1] for 95% of the time in a year. For the remaining times, supply will be restored within 3 hours following an interruption.

Figure 5-1 Security Criteria for the Subtransmission Network

Type of Load	Security Criteria
CBD or high density industrial	N-1 with a break[2] for 99.5% of the time in a year. For the remaining times, supply will be restored within 3 hours following an interruption.
Mixed commercial / industrial / residential feeders	N-1 with a break[3] for 98% of the time in a year. For the remaining times, supply will be restored within 3 hours following an interruption.
Predominantly residential feeders	N-1 with a break[3] for 95% of the time in a year. For the remaining times, supply will be restored within 3 hours following an interruption.
Overhead spurs supplying up to 1MVA urban area	Loss of supply upon failure. Supply restoration dependent on repair time.
Underground spurs supplying up to 400kVA.	Loss of supply upon failure. Supply restoration dependent on repair time.

Figure 5-2 Security Criteria for the Distribution Network

1: A brief supply interruption of up to 5 minutes may occur following an equipment failure while the network is reconfigured.

2: A brief supply interruption of up to 1 minute may occur following an equipment failure while the network is automatically reconfigured.

3: In areas other than the CBD an operator may need to travel to the fault location to manually operate network switchgear, in which case the supply interruption could last for up to 1 hour.

While the reliability of the Wellington Electricity distribution system is high, notwithstanding the difficult physical environment in which the system must operate[12], it is uneconomic generally to design a network where supply interruptions will never occur, except where the consumer is willing to pay more for a specific supply. Hence the network is designed to limit the amount of time over a year when it is not possible to restore supply by reconfiguring the network following a single unplanned equipment failure. This approach

[12] Much of Wellington Electricity's supply area is renowned for its high winds. There can also be a high concentration of salt in the atmosphere, blown in from the sea.

recognises that the electricity demand on the network varies according to the time of day and season of the year, and that the time over which the system is exposed to its peak demand is very small during the course of a year. It also recognises that equipment must at times be taken out of service for planned maintenance and that, when this occurs, parts of the network are exposed to a lower level of security and, as a consequence, the potential for a higher risk of interruption. The security criteria and assumptions detailed above also highlight that some areas are supplied by spur lines, as this is the most efficient supply configuration, and these areas will lose supply on failure until the repair is completed. Network planning guidelines indicate how much load will be supplied by spur lines and determine at which point additional supplies or back feed points are considered for a supply area.

Wellington Electricity's network design and asset management systems also have regard for the time taken to restore supply following an interruption. When an unplanned equipment outage does occur, considerable effort is made to restore supply to customers not directly affected by the equipment fault by switching load to other parts of the network. However at times of peak demand, or where equipment is out of service for maintenance at the time of the unplanned outage, it may not be possible to switch all load in this way and maintain supply quality. In these cases an extended outage may occur with maximum restoration times as shown in Figure 5-1 and Figure 5-2.

The criteria generally do not apply to the low voltage network or to failures of connection assets used to supply individual customers, which are usually designed for 'n' security. In such situations an interruption will last for the time taken to make a repair.

The criteria also do not apply when multiple equipment outages affect the same part of the network or when major storms or other severe events have a high impact on the system and can stretch the capacity of Wellington Electricity or its contractors to respond in a timely manner. Wellington Electricity has emergency plans in place to prioritise response and repair efforts to assist mitigating the impact of such situations but when they occur, longer supply interruptions than shown in the tables are possible.

5.4.1. Capacity of New Plant

When planning an augmentation to the network to increase its existing capacity, it is necessary to determine the capacity of the new equipment to be purchased and installed. This often involves a trade-off between cost and the size of the increased capacity and the growth expected over the asset's service life because:

- If the capacity is too large either Wellington Electricity or its consumers have to pay the cost of any capacity that will not have been economically utilised before the equipment reaches the end of its economic life
- If the capacity is too small then premature asset replacement will be required and this generally increases costs.

Determining the optimum capacity is made more difficult by the fact that the economic life of most primary distribution assets is between 40 and 60 years and the difficulty of forecasting electricity demand over this period into the future other than from underlying growth averages.

Wellington Electricity uses the Commerce Commission's 10 year planning period as the starting point for making equipment capacity decisions and then takes the following into consideration:

- On the basis of the current load forecast, determine the maximum potential load on the equipment at the end of the planning period under the most severe operating condition that the network is planned to withstand
- Select the next highest standard equipment size as identified in Figures 5-3 to 5-5.

5.4.1.1. 11kV Switchgear

Application	Standard Ratings	Fault Rating
Zone incomer circuit breaker	1200A, 2000A	25kA
Zone feeder circuit breaker	630A	25kA
Dist feeder circuit breaker	630A	20kA
Dist transformer circuit breaker	200A	20kA
Ring main unit	400A minimum	20kA

Note 1: These are manufacturer's standard ratings.

Note 2: Existing equipment may have ratings different from those listed in the table.

Figure 5-3 Standard Ratings for 11kV Switchgear

5.4.1.2. 11kV Cable

Application	Standard Ratings
Feeders – backbone	300A minimum
Feeders – branch	200A minimum
Dist transformer	Match transformer

Note 1: Larger cable ratings may be employed on a case by case basis.

Figure 5-4 Standard Ratings for 11kV Cable

5.4.1.3. Distribution Transformers

Standard Ratings (kVA)
15, 30 50, 100, 200, 300, 500, 750, 1000
1500kVA upon request for special customer projects

Note 1: All distribution transformers: 11kV/400V delta-wye.

Note 2: These are manufacturer's standard ratings.

Figure 5-5 Standard Ratings for Distribution Transformers

It is important to note that this is only a starting point for making capacity decisions. An engineering and economic judgement is then made as to whether this size is appropriate taking other factors into account. Such factors include:

- Compliance with the network security criteria
- Margin between the required capacity and the next highest standard size
- Incremental cost of different equipment sizes
- Forecast rate of demand growth
- Back-up capacity to adjacent areas

5.4.1.4. 11kV Feeders

Most of the 11kV feeders in the Wellington CBD are operated in a closed ring configuration with radial secondary feeders interconnecting neighbouring rings or zone substations. This arrangement provides a high level of security and hence a high level of supply reliability. Most of the 11kV network outside the Wellington CBD, both in the Wellington City and Hutt Valley areas, comprises radial feeders with a number of mid feeder switchboards with circuit breakers and normally open interconnectors to other feeders so that, in the event of an equipment failure, supply to customers can be switched to neighbouring feeders. To allow for this, distribution feeders are not operated at their full thermal rating under normal system operating conditions. The feeder utilising factor at which Wellington Electricity currently operates the distribution feeders during normal and contingency operation is identified in Figure 5-6.

Feeder Operation	Normal Operation Loading (%)	Contingency Operation Loading (%)
Two Feeder Mesh Ring	50	100
Three Feeder Mesh Ring	66	100
Four Feeder Mesh Ring	75	100
Five Feeder Mesh Ring	80	100
Radial Feeder	66	100

Figure 5-6 11kV Feeder Utilisation During Normal and Contingency Operation

In certain cases customers may desire a level of security above that offered by a standard connection. Should this arise, Wellington Electricity will offer a range of alternatives that provide different levels of security at different prices (price/quality trade off). The customer can then choose to pay for a higher level of security to meet their needs for the load they are being supplied.

Given the relatively modest demand growth in its supply area, it is unlikely that Wellington Electricity would expose itself to optimisation risk by installing asset capacities greater than indicated by the above approach. Where specific customers request higher capacity levels than Wellington Electricity would typically provide, these can be provided subject to a satisfactory commercial arrangement.

5.5. Demand Forecasts

5.5.1. Methodology

Loads on individual feeders and zone substations are captured by the SCADA system while the load at each GXP is metered through the time of use revenue metering. This information allows Wellington Electricity to trend actual demands at the GXP, zone substation and feeder level and to project these trends into the future using an extrapolation analysis model.

Demand forecasting is carried out using a ‘bottom up’ approach, starting at the zone substation level. The first stage of this process involves extracting historical load data from SCADA. The load data is then graphically analysed and any uneven spikes or peaks replaced with an average value derived from five days before and after the period of abnormal demand.

The method used to determine the peak demand is a sustained loading that lasts for two hours and occurs at least five times during the year. This differs from the maximum load, which may occur only momentarily for 30 minutes or less, or as a result of abnormal system operations, and does not impact upon system ratings.

After calculating the peak demands from actual load data, future year loads are found by extrapolating the historical data into the future, to extent of the 10 year planning horizon. Known step changes are then applied to the forecasts. These steps may be the result of:

1. System reconfigurations where load has been moved between substations
2. Major developments that introduce large new loads onto the network
3. Changes to the Wellington Electricity load control system
4. New electricity generation that is expected to affect peak demand
5. Load reductions caused by movement of businesses or the closure of businesses.

A subjective review of the load forecasts for each zone substation is then undertaken. This comprises a check of the forecasts against local knowledge of network developments. Reviewers of the forecasts will include project managers and customer service staff who have a good overview of customer connection trends. Property developers and businesses may also be canvassed for information on plans that may result in introducing new loads to the network. Forecasts are modified if necessary to reflect this local knowledge. The zone substation load forecasts are then ‘rolled-up’ to the GXP level, taking diversification factors into consideration as the peak zone substation demands may not always occur at the same time as each other.

The Wellington Electricity ‘bottom up’ GXP forecasts are then compared to Transpower’s ‘top down’ GXP forecasts. It is understood that Transpower’s forecasts are derived from the national load and energy forecasts which take into account economic and population growth indicators. While this forecast is usually accurate at the national level, it can be difficult to break the national growth down to the GXP level which in turn can lead to discrepancies with ‘bottom up’ forecasts. Any significant differences between the two forecasts are investigated and addressed or explained.

Detailed forecasts for the planning period are provided in the next sections. They indicate that forecast growth in Wellington Electricity’s supply area is relatively low when compared to demand growth in many parts of the country, and this is supported when compared to figures provided by the NZ Institute of

Economic Research. The methodologies used by Transpower differ from Wellington Electricity's method and overstate the demand and growth at GXP level in Wellington.

5.5.2. GXP Demand Forecast

The forecast demand at each GXP supplying Wellington Electricity's distribution network is shown below.

GXP	System Maximum Demand MW [2] (including DG)									
	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
Central Park 33 kV	168.1	170.6	173.2	175.8	178.4	181.1	183.8	186.5	189.3	192.2
Central Park 11 kV	21.7	22.0	22.4	22.7	23.1	23.4	23.8	24.1	24.5	24.8
Gracefield 33kV	55.6	56.3	57.0	57.7	58.4	59.1	59.9	60.6	61.4	62.2
Haywards 33 kV	15.2	15.5	15.7	15.9	16.2	16.4	16.7	16.9	17.2	17.4
Melling 33 kV	46.2	46.6	46.9	47.3	47.6	48.0	48.3	48.7	49.1	49.4
Pauatahanui 33kV	20.8	21.1	21.3	21.6	21.9	22.2	22.4	22.7	23.0	23.3
Takapu Road 33 kV	94.7	95.9	97.1	98.3	99.6	100.8	102.1	103.3	104.6	105.9
Upper Hutt 33 kV	36.4	37.1	37.7	38.4	39.0	39.7	40.4	41.1	41.8	42.6
Wilton 33 kV	53.7	54.2	54.8	55.3	55.9	56.4	57.0	57.6	58.1	58.7
Kaiwhara'11 kV [1]	36.3	36.8	37.4	37.9	38.5	39.1	39.7	40.3	40.9	41.5
Haywards 11 kV	18.6	18.9	19.2	19.5	19.8	20.1	20.4	20.7	21.0	21.3
Melling 11 kV	24.7	25.0	25.3	25.6	25.9	26.2	26.6	26.9	27.2	27.6

1: Kaiwharawhara GXP has a summer peak. All other GXPs have a winter peak.

2: Base MD value for the projection is the actual for the year ending 31 December 2011.

3: Demand reduced on Central Park 33kV GXP due to load transfer from Frederick Street to Nairn Street zone substation.

Figure 5-7 GXP Demand Forecast

5.5.3. Zone Substation Demand Forecasts

Zone substation	Actual and Forecast Demand (MW, Calendar year)									
	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
8 Ira St	17.2	17.5	17.7	18.0	18.3	18.5	18.8	19.1	19.4	19.7
Brown Owl	15.9	16.1	16.3	16.5	16.7	16.9	17.2	17.4	17.6	17.8
Evans Bay	16.8	17.1	17.4	17.7	18.0	18.3	18.6	18.9	19.3	19.6
Frederick St	34.7	29.9	30.5	31.1	31.7	32.4	33.0	33.7	34.4	35.0
Gracefield	12.9	13.0	13.2	13.4	13.6	13.8	14.0	14.2	14.4	14.6
Hataitai	21.4	21.7	21.9	22.2	22.4	22.7	23.0	23.3	23.5	23.8
Johnsonville	22.6	20.0	20.4	20.7	21.1	21.5	21.9	22.3	22.7	23.1
Karori	16.9	17.1	17.4	17.6	17.9	18.1	18.4	18.6	18.9	19.1

Zone substation	Actual and Forecast Demand (MW, Calendar year)									
	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
Kenepuru	13.1	13.2	13.3	13.3	13.4	13.4	13.5	13.6	13.6	13.7
Korokoro	12.9	13.0	13.2	13.3	13.5	13.7	13.8	14.0	14.1	14.3
Maidstone	14.8	15.0	15.2	15.4	15.6	15.9	16.1	16.3	16.5	16.8
Mana-Plimmerton	20.6	20.9	21.2	21.5	21.9	22.2	22.5	22.9	23.2	23.6
Moore St	24.9	25.1	25.3	25.5	25.7	25.8	26.0	26.2	26.4	26.6
Naenae	15.7	15.9	16.1	16.3	16.5	16.7	16.9	17.2	17.4	17.6
Nairn St	16.9	21.2	21.5	21.9	22.3	22.6	23.0	23.4	23.8	24.2
Ngauranga	7.7	10.8	10.9	11.0	11.1	11.2	11.3	11.4	11.6	11.7
Palm Grove	27.5	27.9	28.4	28.8	29.3	29.8	30.2	30.7	31.2	31.7
Petone	6.2	6.3	6.4	6.5	6.5	6.6	6.7	6.8	6.9	7.0
Porirua	16.6	16.8	17.0	17.3	17.5	17.7	18.0	18.2	18.5	18.8
Seaview	14.8	14.9	15.1	15.3	15.5	15.7	15.9	16.1	16.4	16.6
Tawa	14.9	15.0	15.1	15.3	15.4	15.6	15.7	15.9	16.0	16.2
The Terrace	31.1	31.6	32.1	32.6	33.2	33.7	34.2	34.8	35.3	35.9
Trentham	14.3	14.5	14.7	14.9	15.1	15.3	15.5	15.7	15.9	16.2
University	26.9	27.4	27.9	28.4	28.9	29.4	29.9	30.5	31.0	31.6
Waikowhai	16.0	16.1	16.3	16.5	16.6	16.8	17.0	17.1	17.3	17.5
Wainuiomata	17.0	17.2	17.4	17.7	17.9	18.1	18.4	18.6	18.9	19.1
Waitangirua	14.9	15.1	15.2	15.4	15.6	15.7	15.9	16.1	16.3	16.4
Waterloo	18.0	18.3	18.5	18.8	19.0	19.3	19.6	19.8	20.1	20.4

Note 1: Smoothed actual demands are used for zone substation forecasts because short term peaks that result from operational switching of loads between substations can give a misleading impression of 'normal' loads.

Figure 5-8 Zone Substation Demand Forecast

5.5.4. High Load Growth Areas

Load growth is high in parts of the Wellington CBD with a growth rate of around 3.0% as a result of low organic growth but moderate sized step change loads. The main high load growth areas in the Wellington CBD are Wellington Central, Thorndon, Newtown and Te Aro. This growth is largely through the development of new buildings with high load densities, with many of these large developments having dedicated transformer capacity of 750kVA or greater. The demand in these areas is supplied by Frederick Street, The Terrace, Moore Street and Palm Grove zone substations. Currently The Terrace and Frederick Street zone substations are very highly loaded compared with other substations in the network as a result of only gradual increases over time. With no new zone substation capacity installed in over 25 years, this presents a constraint on the network. Most of the load demand in the CBD area is supplied by a meshed 11kV system with multiple feeds from a zone substation. As load within the CBD rises, the ability of the meshed system to respond to a single fault or event deceases as the loading on the remaining feeders may cause overloads, potentially leading to cascade tripping on feeders. Due to the high load demand in the CBD there are overloading issues that will need addressing within the short to medium term. These are discussed under constraints further on in this section.

Outside the Wellington CBD, there are few areas of high load growth due to the demise of industry and low levels of residential development. In relatively limited areas there is high loading on parts of the system, such as in the suburbs of Johnsonville and Churton Park as a result of housing developments over the past 10 years. Residential subdivision is continuing in these areas. Moderate load growth is also forecasted in the Porirua area, especially the Aotea subdivision and proposed subdivision plans north of Plimmerton, as well as continuing development in the Whitby area. Some of this demand growth at subdivision level is configured as an embedded network owned by others and the tariffs recovered do not always fully reflect the level of investment required to supply such loads. The level of load growth considered to be moderate to high on the Wellington network is still low by national standards.

There is the possibility of high load growth north of Upper Hutt due to a proposed development at Maymorn with an expected 1,800 dwellings being built over the next 10 years should Council re-zoning go ahead. Reinforcement of the 11kV system in this area, supplied from the Brown Owl zone substation, would be required.

It is expected that there will be moderate load growth in the industrial area of Upper Hutt currently supplied by the Trentham zone substation, as large, affordable sites are being developed for data centres and other high density loads. This load however can largely be accommodated by existing infrastructure which has been underutilised since the closure of vehicle assembly and tyre manufacturing plants in this area.

5.5.5. Low Load Growth Areas

With the exception of the areas identified above, the load growth is generally low and steady in most parts of Lower Hutt, Upper Hutt and Porirua with an average load growth rate below 1.3%, and around 0.70% in some suburbs. The distribution network is less constrained in these areas with adequate capacity and security during contingency events. The load growth in these areas is expected to follow historical trends with few constraints arising during the planning period.

Due to low load growth in the Lower Hutt region especially at Petone, Korokoro and Seaview zone substations, the current asset utilisation at these substations is very low. The poor asset condition, high asset age and low forecast load growth rate at the Petone zone substation provides an option for permanently transferring load to interconnecting neighbouring substations rather than replacing the aged asset.

5.5.6. Step Load Changes

Wellington Electricity has identified the following new major loads that may occur over the next few years.

Anticipated Start Date	Likely Peak Demand (MW)	Expected Load Factor (%)	Type of Demand	GXP	Likelihood
2012/13	5.5	0.35	Commercial	Central Park	Most Likely
2012/13	1.5	0.2	Residential	Central Park	Certain
2012/13	0.75	0.35	Commercial	Gracefield	Most Likely
2012/13	0.35	0.2	Residential	Gracefield	Certain
2012/13	0.5	0.2	Residential	Haywards	Certain
2012/13	1.0	0.35	Commercial	Melling	Most Likely
2012/13	1.0	0.35	Commercial	Pauatahanui	Likely
2012/13	0.5	0.2	Residential	Pauatahanui	Certain
2012/13	2.0	0.35	Commercial	Takapu Road	Most Likely
2012/13	2.5	0.25	Residential	Takapu Road	Certain
2012/13	4.5	0.35	Commercial	Upper Hutt	Most Likely
2012/13	0.5	0.3	Residential	Upper Hutt	Certain
2012/13	3.5	0.35	Commercial	Wilton	Most Likely

Figure 5-9 New Step Change Loads

These loads have been incorporated into the demand forecasts for the network as described in the previous section.

5.5.7. Embedded Generation and Demand Control

The load forecast figures provided are inclusive of any embedded generation and demand control operating at the time of the calculated peak. Further details on embedded generation and demand control is presented under separate headings.

5.6. Network Development – Options Available

The process that Wellington Electricity follows when analysing major network investment opportunities includes the long listing of options developed in accordance with the planning criteria outlined earlier in this section. The long list represents a range of possible solutions to address a clearly defined investment need. The long list of options will be relatively similar for most of the investment opportunities that occur on the network and projects will usually fall under one or more of the following headings:

- Do nothing (status quo)
- Network solutions such as:
    - Redistributing demand (e.g. network reconfiguration)
    - Reinforcing the network (this may include many sub-options)
- Non-network solutions such as:
    - Reducing network demand (e.g. energy efficiency, load control, demand side initiatives)

- Installing generation (e.g. distributed generation)

Non-network solutions are discussed in more detail in the following sections.

Each long listed option will have a cost estimate associated with it, a benefit in terms of how it addresses the need for reinforcement and an assessment of its feasibility. The long list will be ranked using the above criteria (i.e. cost, benefit and feasibility) in order to allow for a short list of options to be developed. The short list will typically be limited to two or three options that have roughly similar cost, benefits and feasibilities.

The implementation of this part of the network investment process is under continuous development. Once the process is embedded in the company, major investment projects will each have associated with them a long list of alternatives that had been considered.

5.7. Distributed Generation Policy

There is already a small but significant amount of generation embedded within the network. Wellington Electricity welcomes third parties investing in initiatives such as the installation of embedded generation that might defer the need for capital investment on the network. However if such investment is to achieve the required outcomes there are a number of issues that need to be managed. In particular:

- The risk of non-provision of service needs to be managed. There is little point in paying a third party for a service such as generation or load reduction if the service cannot be guaranteed at the time that the network demand is at a peak
- The service must comply with relevant technical codes and not interfere with other consumers
- Any payments made to third parties must be linked directly to the provision of a service that gives the required technical and commercial outcomes
- Commercial arrangements must be consistent with avoided cost principles
- Commercial agreements must be reached on other issues not directly related to any benefit provided to Wellington Electricity. These can include the cost of connection and payment of use of network charges.

If the issues above can be managed, and the despatch of generation can be co-ordinated with system peaks or constraints, then the use of embedded generation as part of a demand side management programme could bring real benefits to Wellington Electricity. The reduction of load in constrained parts of the network such as the CBD could defer network investment that may be required within the planning period.

Wellington Electricity has developed a distributed generation connection policy and has different procedures for the assessment and connection of distributed generation up to 10kW and over 10kW. These are in line with the Electricity Governance (Connection of Distributed Generation) Regulations 2007.

Information about connecting Distributed Generation is available on the Wellington Electricity website – www.welectricity.co.nz

5.8. Non-Network Solution Policy

Wellington Electricity's load control system is already used to manage peak demands on the network and therefore has the effect of deferring demand driven system augmentation. Wellington Electricity's tariff structure also relies upon retailers to offer time of use pricing and other supply products that provide an incentive for consumers to shift electricity consumption away from periods of peak network demand. The load control system provides significant benefits to the network by reducing peak demand and moving it to the shoulder periods. This has resulted in the significant deferral of network investment as well as providing an effective means of dealing with network loading during outages.

Other non-network solutions may include demand response, where consumers may be given an incentive to switch off demand at certain times when the network is approaching a period of constraint. For Wellington Electricity, the type of demand that may prove useful in deferring network investment is air conditioning plant in the CBD. Demand response is less likely to provide benefit in suburban areas as the loads are diluted amongst a large number of consumers and the load control system already provides a similar benefit.

Wellington Electricity has not pursued demand response to date because the load control system is so effective. Demand response will however be included as a long list option in any major network investment options analysis where it may be useful. Should it prove to warrant further investigation as a way of meeting the needs of an investment opportunity in the short term, then Wellington Electricity will pursue it accordingly. Notwithstanding this, a non-network solution policy that includes demand response will be developed over the longer term as Wellington Electricity progresses with establishing such systems and processes. Opportunities may exist under provisions in the Commerce Act however these options will need to be guided by the Commerce Commission.

5.9. Emerging Technologies

In recent times there has been much industry excitement around so called "smart grids" and smart technologies that will find their way into transmission and distribution networks, the metering and retail space, as well as at consumer level within homes and businesses.

As the topic is largely undefined and there are many different technologies emerging, Wellington Electricity is not actively pursuing smart grid projects or trials. By design, the Wellington Electricity network has a large number of features that may now be considered to be part of a "smart network". Such features include closed ring feeders with differential protected zones that trip out leaving healthy sections in service, on demand load control via the existing ripple control system, and a widely SCADA-ised network with over 230 sites offering remote control and indication.

To develop and maintain the network that Wellington Electricity presently operates in parts of the Wellington City area, providing a higher level of reliability than a conventional radial network requires a higher return to cover the higher costs of assets utilised. The price-quality trade off made now for the level of technology means that future increases to price to improve quality may be less than if this technology was not presently being used.

As new technologies emerge that may improve the ways in which Wellington Electricity may design, build, maintain or operate the network, they will be thoroughly investigated. New technologies will be implemented if the benefits to the network and stakeholders meet or exceed any additional costs incurred by installing and using them. Wellington Electricity specifies equipment which can in future be used with future technologies where it is practicable to specify at this time. Wide scale replacements of existing assets with new technology capable equipment is not economic and it will be introduced as existing assets reach their end of life or are replaced due to a requirement for a change in capacity or functionality.

5.10. Grid Exit Points - Constraints and Development Plans

The table below provides GXP capacities and forecast demands for the beginning and end of the forecast period. Figure 5-10 is intended to provide an indication of loadings on the GXPs.

GXP	Installed Transformers (MVA)	Cyclic n-1 Capacity (MVA)	System Maximum Demand MW [2] (including DG)	
			2012	2021
Central Park 33 kV	2x100 + 1x120	228	168.1	192.2
Central Park 11 kV	2x25	30	21.7	24.8
Gracefield 33kV	2x85	89	55.6	62.2
Haywards 33 kV	1x20	0	15.2	17.4
Haywards 11 kV	1x20	0	18.6	21.3
Melling 33 kV	2x50	52	46.2	49.4
Melling 11 kV	2x25	32	24.7	27.6
Pauatahanui 33 kV	2x20	22	20.8	23.3
Takapu Rd 33 kV	2x100	92	94.7	105.9
Upper Hutt 33 kV	2x37	37	36.4	42.6
Wilton 33 kV	2x100	106	53.7	58.7
Kaiwharawhara 11 kV	2x38	41	36.3	41.5

Figure 5-10 GXP Capacities

5.10.1. Central Park and Wilton Constraints

As indicated in Section 3 (Assets Covered), the Central Park GXP has the highest peak demand in the Wellington Electricity network.

There are three 110kV circuits from Wilton which supply three transformers (110/33 kV) at Central Park as shown in Figure 5-11. All three 110kV circuits into Central Park are supplied from the 110kV bus at Wilton and which is supplied by a single 220/110kV transformer (T8) and two 110kV circuits from Takapu Road GXP as shown in Figure 5-12. The West Wind wind farm connects into the double 110kV circuit to Central Park and is not considered as permanent source of supply due to intermittent supply output so cannot be factored into demand or security analysis. In addition, the tee configuration adopted by Transpower can impact on reliability of the 110kV circuits.

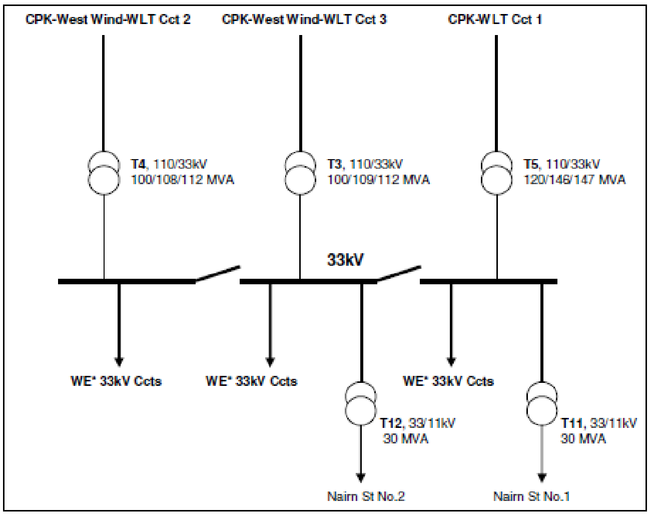


Figure 5-11 Central Park GXP Layout

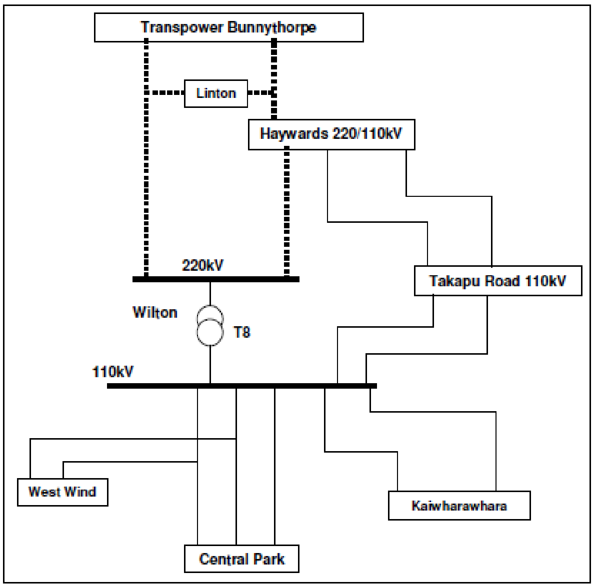


Figure 5-12 Transpower 220 & 110kV Network supplying Wellington Network layout

Due to there being no 110kV bus at Central Park, all three 110kV circuits are transformer feeders with Wilton circuit 1 supplying T5 (120MVA), Wilton circuit 2 supplying T4 (100MVA) and Wilton circuit 3 supplying T3 (100MVA). Should there be a double 110kV circuit outage, it is not possible to supply the entire Central Park load by the single remaining 110kV circuit from Wilton. As a result the security of supply to Central Park GXP is not true N-1 as System Operator rules limit the loading of the remaining circuits when one circuit is out of service.

There are operational constraints at Central Park which restrict the N-1 capacity of the 33kV system to 109 MVA due to having no 110kV bus at Central Park, and a requirement imposed by the System Operator to limit the post-contingency loading to the rating of a single 110kV branch. Load management would be required to prevent transformer overloading in this configuration in the event of a second circuit tripping, which reduces the permissible loading of the 33kV system to 109 MVA. In late 2010 a Special Protection Scheme (SPS) was installed at Central Park GXP to provide the load management automatically should one 110kV circuit or transformer be out of service, and the remaining load be shared by two transformers.

Wellington Electricity has raised a high level request (HLR) for an investigation into options for addressing the capacity issue with Transpower. Discussions on the outcome from the HLR and possible solutions will take place in 2012. This will also include discussions on the security need for an 110kV bus to alleviate the requirements for controlled load drop during contingencies. Due to the location of Central Park GXP, the type of load served and the risk associated with a loss of supply from this site, as well as the space constraints faced developing substations within the Wellington City area, close liaison has occurred between Wellington Electricity, Transpower and the Wellington City Council to develop a shortlist of workable solutions which the Council will be able to assist with implementing through zoning and land use decisions.

The three key issues Wellington Electricity faces with the Central Park GXP are:

1. Post contingency rating limit – as described above there is a requirement to have an SPS and controlled load shedding in the event that two of three transformers are out of service at this site. The SPS is required to be armed in the event that one transformer is unavailable.

2. Diversity of supply from this site – as the largest GXP in the Wellington Region, supplying over 170MW of load, there is a significant risk should the incoming circuits and transformers be unavailable for service, or in the event of a major 110kV bus fault at Wilton, or a complete loss of the Central Park GXP site due to fire, asset failure, or natural disaster.

3. Capacity for load growth in the CBD – there is a requirement to build a new zone substation in the Wellington CBD area within the planning period and given geographic constraints, supply from Central Park is the more sensible option (the cost, route and length would make installing 33kV circuits back to the Wilton GXP impractical). Given the high loading and low diversity, Wellington Electricity does not wish to connect more load (potentially another 20MVA) into this GXP.

The assets described above at Central Park and Wilton are owned by Transpower and any reinforcement to mitigate these constraints is undertaken by Transpower. However Wellington Electricity needs to drive Transpower to address the security of supply risks identified in the three key issues.

5.10.1.1. Prospective Options to Eliminate Constraints at Central Park and Wilton

There are few options available to mitigate the security of supply risks identified in the three key issues above.

<u>Option 1: Do nothing</u>

This option is not recommended as the existing constraints could cause a significant interruption of supply to the Wellington CBD and a large number of residential consumers in the Wellington City area. The social and economic consequence of this is generally unacceptable to the people of Wellington. Smaller outages on the transmission system in recent years, lasting only hours, have generated national media interest and been criticised by Wellington consumers, especially those within the business community. A sustained outage due to a major component failure would be disastrous for Wellington.

Option 2: Reconfiguration of 110kV circuits and installation of a 110kV bus at Central Park

The operational constraints at Central Park GXP could be reduced by installing a 110kV bus. Installation of a 110kV bus would remove the requirement for any type of load management plan or special protection scheme to be utilised should one 110/33kV transformer be out of service. This option will provide more operational flexibility at Central Park without compromising the reliability of the network. However before running the proposed 110kV bus closed at Central Park GXP, the line impedance of the existing three 110kV circuits should be considered and issues mitigated as the three incoming circuits are of different construction.

Installation of a 110kV bus at Central Park will not completely eliminate the risks of supply security into the Wellington CBD as a residual issue exists on the 110kV supply circuits. Although of lower likelihood than the single branch outage forcing a constraint, security of supply is still at risk for the following reasons:

- The configuration of the existing 110kV overhead circuits into Central Park share a common tower on their entry to Central Park. A catastrophic failure on this tower would result in the loss of all three circuits into Central Park.
- The 110kV circuits from Wilton to Central Park are on two separate routes with a double circuit line on one tower route and single circuit on a different tower route. Due to the high demand at Central Park two 110kV circuits are required to be in service at all times in order to supply the required peak demand. An outage on the double circuit line from Wilton affecting both circuits would result in reduced supply capacity to Central Park regardless of whether there is a 110kV bus at Central Park.
- All three 110kV circuits are supplied from the same bus at Wilton GXP. A full outage on the 110kV bus at Wilton would cause a complete loss of supply to Central Park. This has occurred in the past. Transpower have indicated a review is underway to improve the reliability of the Wilton bus, although the only way to guarantee supply reliability would be to physically split the 110kV bus at Wilton.

Option 3 – Provide an alternative supply into Central Park

The previous options mitigate operational risks at Central Park but there are residual security of supply risks unless diversity is added to the supply routes. There are two prospective routes for alternative 110kV supply into Central Park as explained below.

Route Option 1: Kaiwharawhara to Central Park GXP

Route option 1 would be to run new 110kV circuits from Kaiwharawhara to Central Park and form a closed ring between Wilton, Kaiwharawhara and Central Park.

Kaiwharawhara is presently an 11kV GXP Point of Supply with two 110/11kV power transformers supplied from Wilton by 110kV overhead circuits. There is presently no 110kV bus at Kaiwharawhara and due to space constraints at this site this option may not be feasible. Additionally the requirements to cable through the Wellington CBD from Kaiwharawhara to Central Park would be of significant cost given required cable size and operating voltage.

Route Option 2: Gracefield to Evans Bay Zone Substation

This option has been considered for at least the past 30 years by both the old NZED and the Capital MED. The Capital MED installed 110kV oil cables between Central Park and the Evan's Bay zone substation in the early 1980s. At present these cables are operated at 33kV and supply the 8 Ira St Substation but are terminated on overhead structures at Evan's Bay. By extending the overhead 110kV circuits from Gracefield GXP up to Camp Bay (Eastbourne) and then installing submarine 110kV cables across the harbour into Evans Bay zone substation a closed ring of 110kV is possible.

Two possible configurations exist – either develop a GXP at Evans Bay to supply the local area or bypass Evans Bay and close the ring between Gracefield and Central Park. Regardless of which configuration was selected, reconfiguration of the existing 33kV supply would be required at Evan's Bay involving the installation of a 33kV switchboard.

Gracefield GXP is supplied from Haywards by double 110kV overhead circuits and supplies Seaview, Korokoro, Gracefield and Wainuiomata zone substations.

Figure 5-13 shows the layout of a possible route from Gracefield to Evans Bay zone substation.

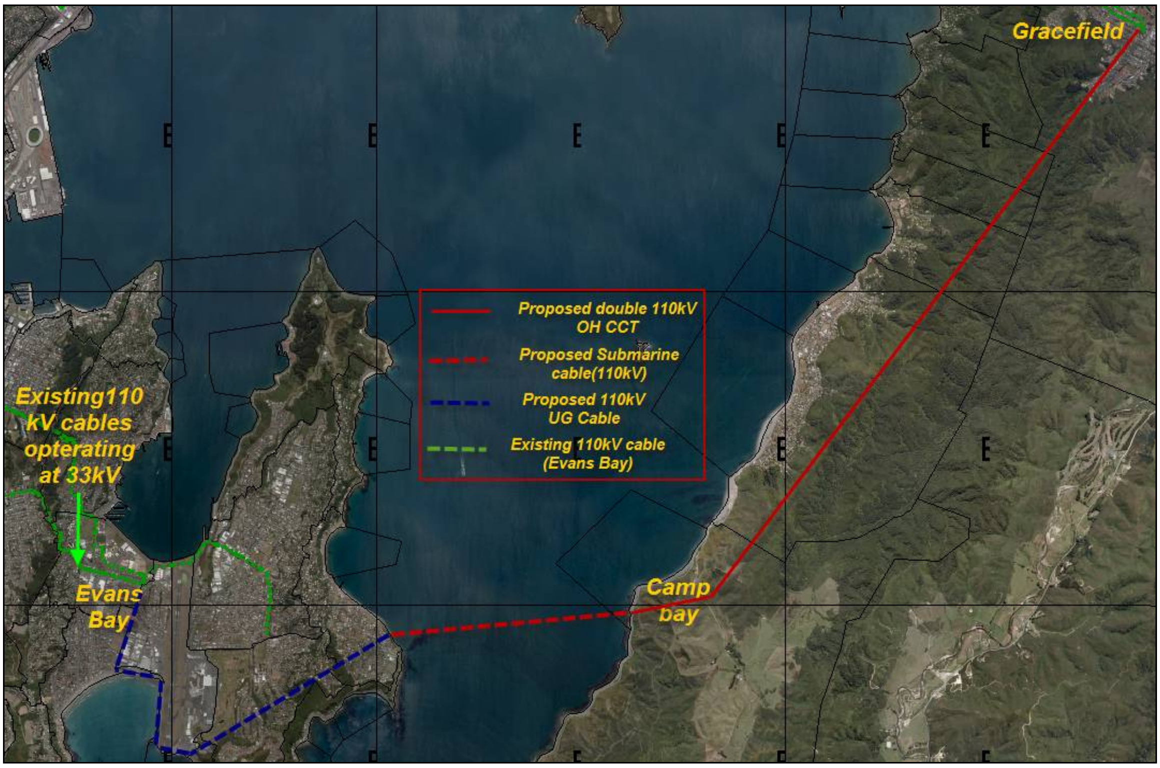


Figure 5-13 Possible Route from Gracefield to Evans Bay Zone Substation

Two significant drawbacks to this option are the capacity constraints on the 110kV circuits between Haywards and Gracefield, which would not provide sufficient capacity to supply the Wellington City area if extended around to Evans Bay and Central Park. Also the age of the existing 110kV cables between Central Park and Evans Bay are now 30 years old and would be around 40 years old by the time such a project was implemented. The system elements which lead to this option being considered are unlikely to be fit for purpose and significant investment may be required.

Options development for Central Park and Wilton are presently being completed by Transpower. Wellington Electricity is working closely with Transpower to ensure the needs of both companies and stakeholders are met.

5.10.2. Haywards

Currently there are two transformers at Haywards for 33kV and 11kV supply respectively. The 33kV supply to Trentham can be backed up from the Upper Hutt GXP (via the Maidstone and Trentham zone substations at 11kV) and the 11kV supply points backed up from the Melling GXP and the Trentham zone substation though the Wellington Electricity owned 11kV network.

Transpower has identified the need to replace the existing transformers at Haywards as a policy project in the short term and there are currently discussions underway as to what the optimal replacement configuration will be. Transpower recognises the level of security offered is lower than would be expected at such a site and routine maintenance on these existing assets is difficult due to the configuration. Several options have been discussed with Wellington Electricity and Transpower is now evaluating the following options:

- Replace the existing configuration (1x 11kV and 1x 33kV supply transformer)
- Replace with two supply transformers for each voltage (2x 11kV and 2x 33kV)
- Replace with one supply transformer for each voltage and one interconnecting transformer (1x 11kV, 1x 33kV and 1x 33/11kV transformer)
- Replace with two, three winding transformers to provide both 33kV and 11kV from the 110kV supply

5.10.3. Pauatahanui

The Pauatahanui GXP supplies the Mana and Plimmerton zone substations via a single 33kV overhead circuit connection to each substation. Mana and Plimmerton zone substations are linked at 11kV providing a degree of redundancy should one of the 33kV connections be out of service.

Pauatahanui GXP comprises a conventional arrangement of two parallel 110/33kV transformers rated at 20MVA each. The maximum peak demand on the Pauatahanui GXP in 2011 was 20.6 MVA. This is within the transformer emergency ratings and also cyclic ratings of 22MVA. The load growth in this area is relatively high and the transformer cyclic rating is forecasted to have around 2 MVA of shortfall at the end of the planning period.

In time, the additional load supplied from Pauatahanui will have an impact on the Transpower 110kV system north to Paraparaumu as Transpower have constraints on the overhead circuits. Discussions have been held with Transpower regarding the prospective load increases at Pauatahanui and the wider 110kV system issues.

As per Transpower planning documents, the peak load at Pauatahanui is forecast to exceed the transformers N-1 capacity by approximately 1 MW in 2012, increasing to approximately 8 MW in 2027.

Transpower has indicated in their Annual Planning Report that the 110kV constraint issue needs to be addressed in the medium term. This will allow additional load out of Pauatahanui and also upgrading of the existing 110/33kV transformers.

5.10.4. Takapu Road

The Takapu Road GXP comprises a conventional arrangement of two parallel 110/33kV transformers nominally rated at 90 MVA each. Maximum demand on the Takapu Road GXP in 2011 was 93.6 MVA. This is close to the transformers maximum rating. Takapu Road supplies zone substations at Waitangirua, Porirua, Kenepuru, Tawa, Ngauranga and Johnsonville each via double circuit 33kV. These circuits leave the GXP as overhead lines across rural land and become underground lines at the urban boundary.

The Ngauranga 33kV circuits utilise the old Takapu Rd – Khandallah 110kV line operating at 33kV which Transpower owns and maintains. Discussions around the ownership and connection of this line are ongoing as Transpower are open to divesting this asset. By owning the asset Wellington Electricity may derive more benefit when considering options for supply upgrades into the Johnsonville, Grenada and Newlands areas. There are however considerations to be made on the age, condition and location of the line as there is significant under-build on this tower line.

The installed 110/33kV transformer capacity at Takapu Road GXP is 100MVA with a possible N-1 cyclic capacity of 116MVA, however this is constrained due to a protection limitation. Following a request being raised by Wellington Electricity, Transpower have reviewed the protection situation and have temporarily increased the protection settings by installing summated over current and distance protection on the Takapu Road GXP transformers. This temporary protection will also improve the backup protection to the Wellington Electricity 33kV network supplied from Takapu Road. At the completion of this work the transformers N-1 cyclic ratings have been increased from 92MVA to 107MVA.

Transpower has notified that they will be replacing the Takapu Road GXP 33kV outdoor switchgear with indoor switchgear around 2014. During this outdoor to indoor conversion, a full review and upgrade of the substation protection will occur. The protection limits on Takapu Road GXP transformers will be further raised to provide full transformer N-1 cyclic ratings of 116MVA, which will result in no forecast capacity issues at Takapu Road GXP until 2030.

At the time of this upgrade, Wellington Electricity will upgrade all subtransmission circuit protection from the Takapu Rd GXP that it owns, including upgrading all differential protection schemes.

5.10.5. Wellington 220kV-110kV interconnection capacity

Presently, the 110kV and 220kV networks in Wellington are interconnected at Haywards and Wilton, and it has been identified that within the planning period another interconnecting bank will be required in the region, especially following the commissioning of the Pole 3 DC link.

As an alternative to this, an opportunity exists to install a subtransmission link on the Wellington Electricity network at 33kV to enable the transfer of load from the 110kV system (ex-Central Park) to the 220kV system (ex-Wilton) as required. Transpower and Wellington Electricity are currently working through this option to determine costs and feasibility. A benefit to Wellington Electricity is also the ability to move load away from Central Park at times when the incoming supply is constrained (N-1 events) and the SPS is armed, thus reducing the load at risk should a second contingent event occur.

If this option were to proceed, greater understanding of the trade-off of investing in the Wellington Electricity network as an alternative to an investment in the Transpower system would need to be explored.

If the proposal of constructing a new zone substation in Bond Street proceeds, then interlinking Bond Street (potentially supplied from Central Park) and Moore Street zone substations at 33kV level would potentially be the best option although the space constraints for installing a 33kV switchboard at Moore Street will need to be addressed.

The subtransmission link concept is estimated to be in the order of $7.5 to $10 million. This is not included in current expenditure forecasts due to the uncertainty of the work.

5.11. Zone Substations – Constraints and Development Plans

Figure 5-14 provides installed sub-transmission capacities and forecast demands for the beginning and end of the forecast period. This table is intended to provide an indication of loadings on the sub-transmission system.

Zone Substation	Transformer Cyclic Capacity (MVA)	Single Incoming Circuit Capacity (MVA)	Peak Season	Forecast Demand (MVA)	
				2012	2021
8 Ira Street	24	21/15	Winter	17.2	20.0
Brown Owl	23	19/13	Winter	15.9	18.1
Evans Bay	24	19/15	Winter	16.8	19.9
Frederick Street	36	28/20	Winter	34.7	35.8
Gracefield	23	17	Winter	12.9	14.8
Hataitai	23	20/10	Winter	21.4	24.1
Johnsonville	23	19/12	Winter	22.6	23.5
Karori	24	21/11	Winter	16.9	19.4
Kenepuru	23	19/14	Winter	13.1	13.8
Korokoro	23	18/12	Winter	12.9	14.5
Maidstone	22	18/10	Winter	14.8	17.0
Mana-Plmtn	16	27/23	Winter	20.6	23.9
Moore Street	36	33/29	Summer	24.9	26.8
Naenae	23	19/14	Winter	15.7	17.8
Nairn Street	30.1	25	Summer	16.9	24.6
Ngauranga	11	20/14	Summer	7.7	11.8
Palm Grove	24	18/14	Winter	27.5	32.2
Petone	20	19/13	Winter	6.2	7.1
Porirua	20	22/14	Winter	16.6	19.0
Seaview	22	21/13	Winter	14.8	16.8
Tawa	16	21/14	Winter	14.9	16.3
The Terrace	36	50/45	Winter	31.1	36.5
Trentham	23	20/14	Winter	14.3	16.4
University	24	32/28	Winter	26.9	32.1
Waikowhai	19	22/15	Winter	16.0	17.7

Zone Substation	Transformer Cyclic Capacity (MVA)	Single Incoming Circuit Capacity (MVA)	Peak Season	Forecast Demand (MVA)	
				2012	2021
Wainuiomata	23	22/12	Winter	17.0	19.3
Waitangirua	16	22/16	Winter	14.9	16.6
Waterloo	23	21/13	Winter	18.0	20.7

Figure 5-14 Zone Substation Capacities and Loadings

The majority of zone substation assets have sufficient capacity available throughout the planning period. There are six zone substations where the assets have capacity constraints at present, or constraints arising within the planning period. These zone substations are:

- Frederick Street
- Johnsonville
- Mana – Plimmerton
- Palm Grove
- The Terrace
- Wainuiomata

The capacity constraints are addressed in the following sections with a range of options presented.

5.11.1. Frederick Street

The Frederick Street zone substation has the second highest peak demand in the Wellington Electricity network. Load growth is high in the CBD as a result of land redevelopment and changes to building use, with a number of step change loads due to dedicated customer substations. The majority of this new load is in areas supplied by the Frederick Street zone substation.

A project has recently been completed to transfer load off Frederick Street onto the Nairn Street substation. Around 6 MVA of peak load has been shifted as a result of this project which has reduced the peak demand on Frederick Street to around 34.7 MVA. However the sub-transmission N-1 capacity will become constrained again within two to three years.

Options under investigation for resolving this constraint include:

- Replacement or upgrade of the existing subtransmission circuits by duplexing the existing cables and installing one new circuit to increase ratings. This option however will not entirely address the issues as capacity constraints would be transferred to the zone transformers and switchgear ratings.

- Further offloading of the substation at 11kV onto adjacent parts of the network. This is the least cost option however the 11kV system around the CBD has a number of capacity constraints and this would transfer the problems to other zone substations.

5.11.2. Additional 11kV Capacity in CBD

System demand is presently very high in the central Wellington area at both subtransmission and distribution level as a result of new developments and load growth over the past decade. This is largely being accommodated by existing capacity from Frederick Street, The Terrace, Moore Street and Kaiwharawhara substations. The 11kV distribution system is experiencing high loadings and there are limited options for increasing the 11kV capacity from the existing substations, both physically in terms of site constraints, but also upstream subtransmission constraints. From the load forecasts it can be seen that there is a requirement to have significant additional 11kV capacity in the CBD by around 2015 to address new and historic load growth.

Currently there are two detailed options under investigation by Wellington Electricity.

<u>Option 1 - Construction of a new GXP in the CBD with an 11kV point of supply</u>

One of the high level options Transpower has proposed to address the loading and diversity risks at Central Park is to construct another 110/33kV GXP in the Wellington CBD. Wellington Electricity has proposed to Transpower that if this option were selected it would be beneficial to install two three winding 110/33/11kV transformers instead of a 110/33kV transformer. Creating an 11kV point of supply with an 11kV switchboard at the GXP will provide additional 11kV capacity in CBD of potentially up to 30 MVA. If this proposal proceeds, it will off load the Frederick Street, The Terrace, Palm Grove and Moore Street zone substations at 11kV which are currently heavily loaded, as well as providing an additional GXP for 33kV supply to the CBD zone substations at Frederick St and The Terrace. High level planning and analysis is in progress with Transpower.

Installing three winding transformers at the proposed GXP would not only provide new capacity at 11kV but also at 33kV subtransmission level as well. This will allow reconfiguration of supply to the CBD zone substations to address constraints at subtransmission level, as well as reducing overall loading. This option would provide a solution to the present and forecast capacity issues on the Wellington Electricity network in the CBD until well beyond the planning period.

<u>Option 2 – Build a new zone substation in the CBD</u>

Wellington Electricity owns a bare land site in Bond Street. If a new GXP proposal with an 11kV point of supply option does not go ahead, Wellington Electricity would utilise this property to construct a 33/11kV zone substation with an installed capacity of 2x 30MVA. Figure 5-15 shows land owned by Wellington Electricity in Bond Street which could be used for a new zone substation.

The subtransmission supply to the proposed Bond Street substation would be provided from Central Park GXP through high capacity underground 33kV circuits as the route is through the CBD. An alternative option would be to supply the substation from the Wilton GXP, however the geographical location of Wilton, would require the sub transmission cables to be three times the length required from Central Park. The recommended option for subtransmission supply to the new zone substation in Bond Street would be from Central Park. This would however compound the loading and security issues at the Central Park GXP identified earlier in this section, and a firm plan for resolving these would need to be agreed between Wellington Electricity and Transpower before planning for the substation commenced.

In addition, a Bond Street substation could be interlinked with the Moore Street substation at 33kV by installing double 33kV underground circuits between the sites. This would provide security of supply not only to Bond Street and Moore Street substations but also to interconnecting substations supplied from Central Park should there be outage on Central Park GXP.

Figure 5-15 Land Owned by Wellington Electricity for Possible Substation in Bond Street

Figure 5-16 provides a high level cost estimate and time periods for this option of a Bond Street substation.

Option Description	Cost	Year investment is required	Duration of Solution
1. New 2X30MVA, 33/11kV zone substation in Bond Street (eight 11kV feeders)	$15 m	2015	Beyond 2030
2. Existing 11kV distribution network re-configuration around new Bond Street substation	$2 - $3 m	2015/16	Beyond 2030
3. Two 33kV Circuits from Central Park to Bond Street substation	$5 m	2015	Beyond 2030
Total estimated cost	**$22-23 m**		

Figure 5-16 Cost Estimate for Possible Substation in Bond Street

5.11.3. Petone Zone Substation Reinforcement

The existing Petone subtransmission circuits have been identified as being in poor condition through the 'Stage of Life' analysis and present a risk to the network and security of supply to the Petone zone substation load. The Petone zone substation is presently one of the most lightly loaded substations on the Wellington Electricity network. The maximum demand is approximately 48% of N-1 subtransmission capacity indicating the assets are under-utilised and investment in a like-for-like solution would be sub-optimal.

Given the low loadings at this site, and the ample capacity at adjacent sites (due to the reduction of industrial load in the areas over the past 20 years), the option to transfer load away from Petone, and decommission the subtransmission supply has been investigated. Load flow simulations with the Petone load transferred to neighbouring interconnecting zone substation feeders has also been carried out.

The network modelling suggests that it is possible to permanently transfer the Petone zone substation load to its neighbouring zone substation (Korokoro, Seaview and Melling) feeders, which are also lightly loaded until 2030, along with some 11kV reinforcement work. The main reinforcement work involves the up-rating of the Korokoro subtransmission cables which have their N-1 capacity limited to 18.2 MVA due to the presence of two 11kV feeder cables in the same trench in Te Puni Street. After relocating the 11kV feeder cables onto other side of Te Puni Street away from the subtransmission, the N-1 sub transmission capacity to Korokoro zone substation would be increased to their full rating of 22MVA.

This option will defer the investment required to replace the Petone subtransmission circuits and will provide better utilisation of the existing assets in the area. The estimated cost for replacement of the existing Petone 33kV cables would be around $10 million.

The estimated cost for permanently transferring Petone zone substation load to its neighbouring zone substations along by undertaking reinforcement work and decommissioning of Petone zone substation 33kV supply would be around $1.8 million and will not present any capacity constraints until past the end of the planning period.

5.11.4. Johnsonville

Johnsonville has experienced high load growth over the past decade as a result of residential development, which is ongoing, and has a current winter peak load demand of 22.6 MVA. Johnsonville zone substation is supplied by two 33kV circuits from the Takapu Road GXP, which start as an overhead line through rural land and then change to underground cables for the last 5 kilometres into Johnsonville. The subtransmission N-1 capacity shortfall is presently in the order of 2 to 3MVA at peak load time. A project to install new 11kV feeder interconnections with Ngauranga is underway and will be in place before the winter of 2012. This project will shift around 4 to 5MVA of peak load from Johnsonville to the Ngauranga zone substation. This will provide additional load transfer capacity and resolve N-1 security issues until around 2016 at forecast growth levels.

The northeast side of Johnsonville (Grenada Village) is experiencing load growth with an increased number of subdivisions in Grenada Village underway or being in the consenting process. This load growth along with the previous high levels of growth in Churton Park (to the north of Johnsonville) has led to a present capacity constraint in this area, which will continue to be an issue as future developments are completed. There are limited options for increasing 11kV capacity and security into these areas from Johnsonville.

Different options have been analysed and load flow simulation indicates it is not possible to run new 11kV capacity from the Tawa zone substation (to the north of Johnsonville) due to the geographic location and also its high utilisation factor. Johnsonville substation is already highly utilised and within five years will again be operating outside its security criteria. The best option, which is currently being developed, is the construction of a new zone substation to the north or north-east of Johnsonville by 2017, to supply the existing high loads and to allow for high load growth in this area.

If a new substation was constructed in this area, it will not only supply load growth in and around Grenada area but also off load Johnsonville feeders 2 and 3 and also Tawa Feeders 3 and 11.

The subtransmission supply to the new zone substation is proposed to be from the existing Takapu Road - Ngauranga overhead 33kV circuits which pass near this location. Emphasis will be on getting the zone substation site near to these overhead sub transmission circuits. These circuits are owned by Transpower, and Wellington Electricity may be required to take ownership of these to allow a connection from the lines. A 33kV switchboard would be required at the new substation to allow adequate protection and segregation of circuits continuing on to Ngauranga.

Detailed studies and land acquisition investigations will be undertaken during 2012 for this project. Figure 5-16 provides a high level cost estimate and time periods for the new zone substation.

Project Description	Cost	Year investment is required	Duration of Solution
1. Land investigation and land purchase north east of Johnsonville (Grenada Village)	$1.0 m	2012	Beyond 2030
2. Construction of new 20-20MVA, 33/11kV Zone substation in Grenada	$15 m	2017	Beyond 2030
Total estimated cost	**$16 m**		

Figure 5-17 Cost Estimate for Possible Substation for Grenada

5.11.5. Mana-Plimmerton

5.11.4.1 Zone Transformer Constraint

Load at the combined zone substations of Mana and Plimmerton can presently exceed the N-1 rating of the zone transformers at peak times. Back feed connections from neighbouring substations allow N-1 operation at present, but this capacity is being eroded over time. The Mana and Plimmerton zone substations have an 11kV tie cable between the two 11kV buses which is operated normally closed. During an outage on either of the zone transformers or one of the sub transmission circuits, the load is transferred by the existing 11kV tie cable and also at 11kV feeder levels as required. It has been known that at peak times the tie cable has tripped out of service on overload in the event of a subtransmission fault, although this is rare.

The existing transformers (ONAF cooling) at Mana and Plimmerton zone substations have cyclic ratings of 16 MVA each with 16.8MVA as the emergency two hour rating. The cyclic ratings of the existing transformers could be increased to around 20MVA by installing oil pumps and converting them to oil forced and air forced (OFAF) cooling transformers. The combined coincident peak of Mana-Plimmerton in 2011 was 20.6 MVA. The individual peak demand of Mana and Plimmerton in 2011 (winter) was 13.8 MVA and 6.9 MVA respectively.

Planning is under way to investigate the decommissioning of Petone zone substation due to very low loadings and poor asset condition. If this project proceeds, an option would be to shift one or both of the Petone zone transformers (rated at 20MVA) to the Plimmerton zone substation. Due to space constraints at the Mana zone substation a second transformer cannot be accommodated, however a higher rated unit could replace the existing transformer. By either upgrading to oil forced cooling, or relocating a Petone transformer to Mana and Plimmerton, firm capacity of 20MVA will be provided at these zone substations.

5.11.4.2 Mana-Plimmerton 11kV Tie Cable

The 11kV tie cable between Mana and Plimmerton has a capacity of 7.60MVA. The peak load of Mana zone substation is around 12.8MVA. Should the 33kV circuit supplying Mana zone transformer be out of service, the Mana peak load cannot be supplied from Plimmerton through the existing 11kV tie cable alone.

Figure 5-18 shows the layout of Mana and Plimmerton zone substations.

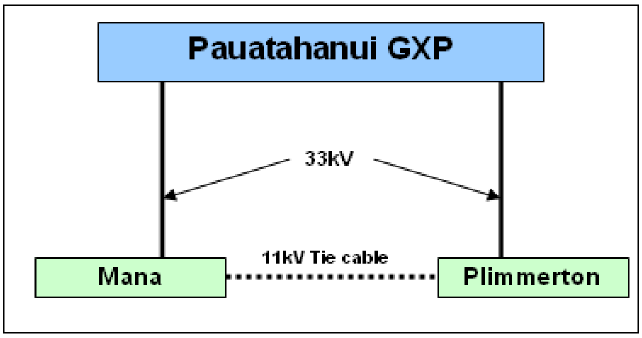


Figure 5-168 Mana-Plimmerton Connection Layout

During an outage under the present conditions, two things may occur – the loads are operationally managed through peaks or the load is transferred away by manual switching of the 11kV network. This results in not having true N-1 security at these sites.

There are two options considered to eliminate the constraints on the 11kV tie cable between Mana and Plimmerton.

<u>Option 1: Install a higher capacity Tie Cable</u>

This is a high cost option and requires a high capacity cable to be installed along State Highway 1 between the two sites.

There is presently one 11kV tie cable linking the two 11kV buses. This option would involve installing another high capacity 11kV cable as a second tie cable. However, installing high capacity 11kV cables will only supply the forecast Mana peak load up to around 2013, and, if operated as the only tie circuit (i.e. the existing tie cables are not used), could not supply the entire Plimmerton demand if the 33kV subtransmission supply is out of service. The existing 11kV tie cables could not be operated in parallel with the new cables because of load sharing imbalances as a result of the impedance differences.

To utilise both 11kV tie cables (existing and the proposed new cable), a reconfiguration of 11kV switchgear and the addition of a bus coupler would be required at the Plimmerton zone substation (as shown in Figure 5-19). The addition of a bus coupler is not possible at Mana zone substation due to space constraints. The proposed arrangement would split up the feeders and a special protection scheme will provide N-1 security of supply until around 2018 should the 33kV circuit supplying Plimmerton be out of service.

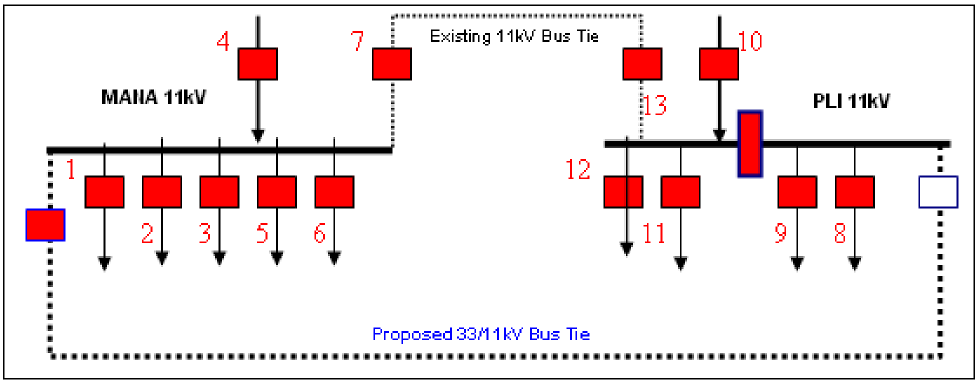


Figure 5-179 Proposed Option 1 Layout for Mana-Plimmerton

Figure 5-20 provides a high level cost estimate and time periods for the option of running a new cable between Mana and Plimmerton zone substations. High capacity single core cables have been used as the basis for the cost estimate to give the best possible rating from the new circuit. A lower cost, lower capacity three core cable could be used instead.

Project Description	Cost	Year investment is required	Duration of Solution
Install new single core, 630mm^2, Al, cables between Mana and Plimmerton zone substations	$2.7 m	2012-13	2017-18
Two new 11kV circuit breakers and one bus coupler at Mana and Plimmerton	$135,000	2012-13	2017-18
Special protection scheme	$75,000	2012-13	2017-18
Total Project cost (Option 1)	**$2.91 m**		

Figure 5-20 Cost Estimate for Option 1 Layout for Mana-Plimmerton

This option is not recommended because of the cost, poor relative benefits, and the likelihood that space constraints at Mana and Plimmerton would be an issue.

Option 2: Implementation of Special Protection Scheme

As an alternative to the installation of a new tie cable and switchgear reconfiguration at the Plimmerton zone substation, a special protection scheme (SPS) could be utilised to avoid overloading and allow for network reconfiguration under fault conditions.

A SPS with intertrip and close functions could be utilised to fully off load Mana Feeder 5 and 6 onto the Porirua zone substation following an outage on either the 33kV circuit or zone transformer at Mana to prevent the overloading of the 11kV tie cable. Implementing a SPS would manage the load through the existing 11kV tie cable. The residual loading would remain within the rating of the cable until around 2018 at current forecast growth rates.

Mana Feeders 5 and 6 have full backup from Porirua Feeder 2 and Titahi Bay Feeder 3 respectively. Implementing the SPS will ensure full backup capacity is available to Mana Feeders 5 and 6 from Porirua substation until 2018.

As part of the SPS, it is also recommended that a remote operated switch be installed at the 143 Mana Esplanade distribution substation to allow load transfer at 11kV feeder level between Mana and Plimmerton 11kV buses.

Project Description	Cost	Year investment is required	Duration of Solution
SPS installed at Mana and Plimmerton zone substations and converting switchgear at 143 Mana Esplanade substation to be remote operated	$250,000	2012-13	2017-18

Figure 5-21 Cost Estimate for Option 2 SPS for Mana-Plimmerton

5.11.6. New Zone Substation in Whitby/Pauatahanui Area

There is both high system demand and high load growth in the Whitby and Pauatahanui area due to large numbers of recent subdivisions as well as subdivisions currently in the consenting process. Due to the geographical location of the load centres in Whitby, it is difficult to install new 11kV feeders from the nearest zone substations (Waitangirua and Mana – which is also highly loaded). The best long term option to address this issue is the construction of new 2x 20-30MVA zone substation in the Whitby area. This would reduce loading on Mana, Waitangirua and Porirua zone substations and provide capacity for any future load growth. Subtransmission to the new zone substation would be taken from the Pauatahanui GXP. Figure 5-22 shows the preferred site location for the new zone substation.

Figure 5-22 Preferred Site for Possible Substation in Whitby Area

Project Description	Cost	Year investment is required	Duration of Solution
1. Land investigation and land purchase in Whitby for new zone substation	$1.0 m	2017-18	Beyond 2030
2. Construction of new 20-30 MVA zone substation in Whitby area	$15 m	2019-21	Beyond 2030
Total estimated cost	**$16 m**		

Figure 5-23 Cost Estimate for Possible Substation in Whitby Area

5.11.7. Palm Grove

The Palm Grove subtransmission N-1 capacity does not match the zone substation transformer firm capacity and has a shortfall of 4.0 MVA. The current peak load at Palm Grove zone substation exceeds the subtransmission N-1 capacity and also zone substation firm capacity as is shown in Figure 5-24. Peak demand at Palm Grove in 2011 (June) was 26.80 MVA. The load duration curve shows the load exceeds the N-1 rating for 2.7% of the time (during 2011) which exceeds the security criteria which requires N-1 for 98% of the time. Loading on this site is forecast to increase over time.

Load forecast analysis shows that loading in the CBD area is very high, and is continuing to grow as a result of step change load increases. Following the recent transfer of load from Frederick Street to Nairn Street, all CBD zone substations (Frederick Street, The Terrace, Nairn Street, Moore Street and Palm Grove) are roughly evenly loaded. As the load continues to grow, the CBD zone substations will be approaching their firm capacity at about same time. As mentioned earlier, capacity in the CBD is required to have an additional 11kV by around 2015. Assuming this is achieved, it will allow shifting some load from Palm Grove on to the CBD new zone substation. The subtransmission constraint at Palm Grove, which by this time will have a 4.8 MVA N-1 capacity shortfall, still remains to be addressed.

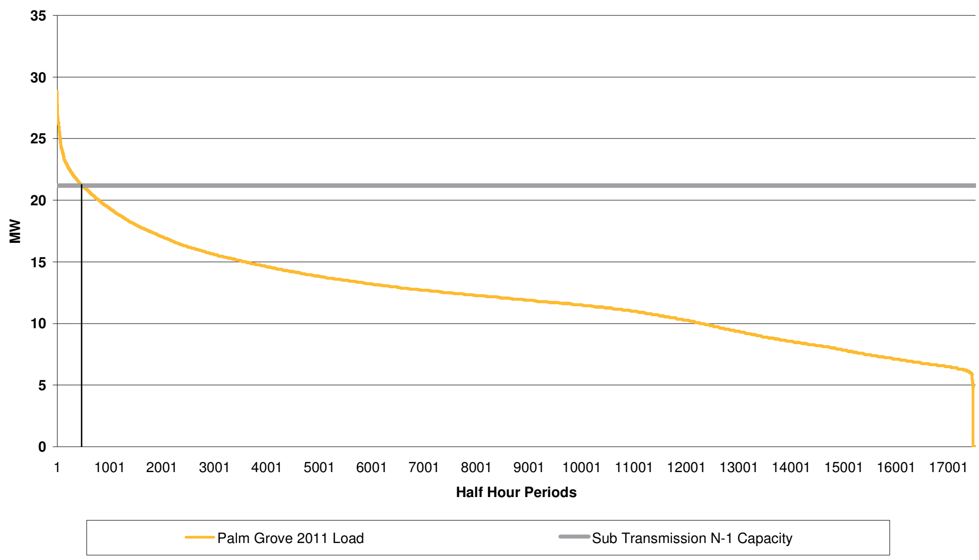


Figure 5-24 Load Duration Curve for Palm Grove Substation

The subtransmission link is old but in good condition and there is no intention to replace the link based on age or condition.

Two options exist to improve the rating of the Palm Grove subtransmission circuit:

1. Replace both existing circuits with new high capacity XLPE subtransmission cables between Central Park and Palm Grove. This is expensive and potentially not required as the existing cables are in reasonable condition for their age.

2. Install a new single 33kV XLPE circuit and run the two existing 33kV circuits in a duplex configuration. This is a lower cost, and preferred, option as it utilises the existing cables as well as providing an increased capacity to the substation. .

Figure 5-25 shows the proposed configuration for Palm Grove subtransmission circuits.

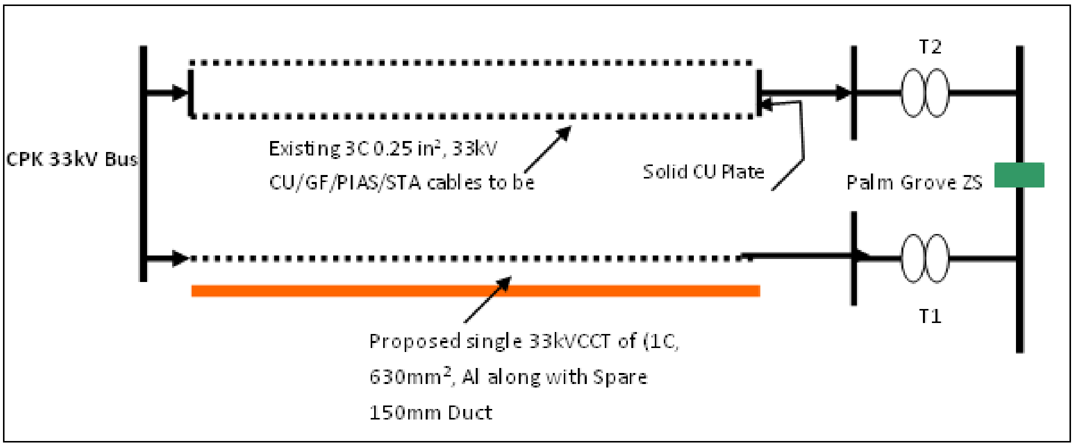


Figure 5-25 Proposed Configuration for Palm Grove Subtransmission Circuits

Option 2, as well as being less expensive than a full replacement, provides a solution with more capacity than the N-1 zone transformer capacity and matches transformer emergency capacity. Spare ducts (3x150mm for future second 33kV) are recommended for installation in the same trench with the proposed single circuit 33kV cable to allow for replacement of cables in the future.

Figure 5-26 provides a high level cost estimate for the preferred subtransmission circuit improvement at Palm Grove.

Project Description	Cost	Year investment is required	Duration of Solution
Installation of a single 33kV circuit between Central Park and Palm Grove (along with spare ducts for future replacement of existing circuit)	\$5 - \$7 million	2013-14	Beyond 2030

Figure 5-26 Cost Estimate for Option 2 Subtransmission Circuit

There is another identified constraint at Palm Grove with the 11kV distribution network not having any open points to allow paralleling between the zone 1 and zone 2 ring networks (i.e. each side of the 11kV bus).

Palm Grove zone substation is normally operated with a split 11kV bus configuration and there is no option available for shifting load between T1 and T2 buses at distribution network levels. This presents a risk during an outage on either of bus sections at Palm Grove. Currently there is adequate capacity to offload one side of each bus onto adjacent zone substations at 11kV, should the respective sides of the bus not be available, however a study will be undertaken to find options for linking the two sides of the bus together at 11kV in the distribution network.

In the short term a network load flow study will be undertaken to identify possible locations to install open points between two parts of the Palm Grove zone substation distribution networks to offer better operational flexibility at distribution level. As the solution has not been identified, there is no expenditure forecast available for this work which is likely to occur in the medium term.

5.11.8. Wainuiomata

Wainuiomata zone substation had a winter peak demand in 2011 of 17.0 MVA with a typical residential load profile. Wainuiomata zone substation is supplied from the Gracefield GXP by two 33kV overhead lines with a cable section at the GXP end. There are almost no 11kV back feed supply options available to this because of geographic constraints (Wainuiomata is in a separate valley to the rest of the Hutt Valley, divided by a large hill) with only one limited back feed at 11kV. This is generally not a problem as there is N-1 subtransmission supply, and only a GXP outage, an N-2 subtransmission event or an 11kV bus fault would cause an entire outage, all of which are considered to be very rare.

The present issues identified with the Wainuiomata zone substation are related to a mismatch of the subtransmission ratings.

The 33kV 'Wainuiomata A' line is de rated due to a small section of 33kV underground cable (3C, 300mm^2, Al, XLPE) on 33kV circuit 'A' which has a lower rating that the overhead line. A project is included in the 10 year expenditure plan to increase the rating of this circuit by installing a cable to match the existing overhead 33kV line ratings and zone transformers emergency ratings.

The initial section of underground 33kV cables (50m) at the Gracefield GXP are also constrained due to their small size (3C, 240mm^2, Al, PILC) and ideally require an upgrade to match them with overhead subtransmission ratings and zone transformer N-1 capacity. The subtransmission cables have a rating of 21.0MVA which creates an N-1 shortfall of 3.20MVA when compared to the zone transformer N-1 capacity (24.20MVA). These cables will be further constrained by 2021 when the peak load at Wainuiomata will be equal to the rating of the subtransmission cables.

A further constraint is with the 11kV incomer cables, which have a rating of 12.5 MVA but can be run up to 16 MVA as an emergency rating (two hours). The 11kV incomer cables will be constrained in the medium term (around 2015) and an upgrade will be required to match the other component ratings. The incomer capacity would be doubled by replacing the existing incomer cables by two per phase XLPE cables (1x1C, 630mm^2, Al, XLPE, 11kV) but it is not practical to add an existing cable to each of the existing circuits due to the different construction and capacities of the cables.

Figure 5- shows the Wainuiomata zone substation layout and highlighting existing constraints.

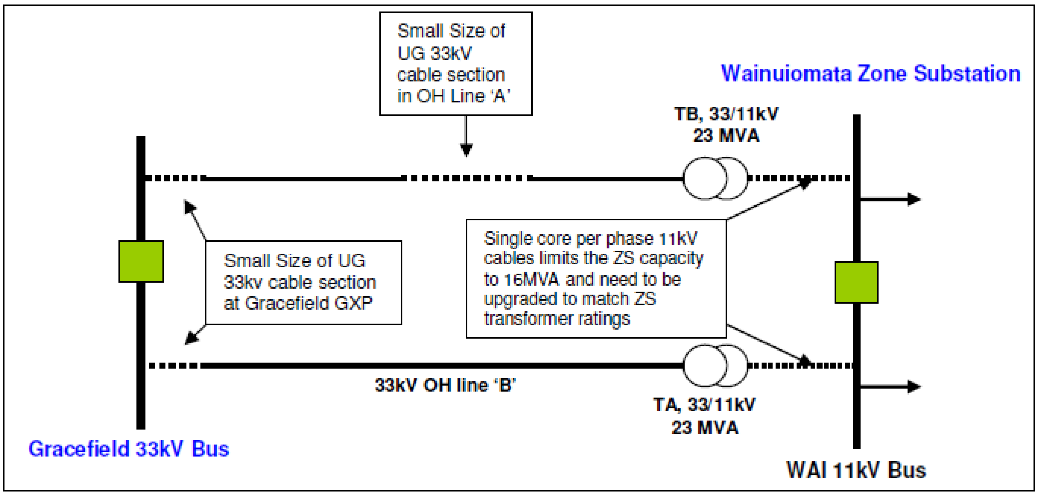


Figure 5-27 Wainuiomata Zone Substation Layout

Figure 5-28 provides a high level cost estimate for the proposed solutions for Wainuiomata zone substation.

Project Description	Cost	Year investment is required	Duration of Solution
1. Replacement of existing 11kV incomer cables with 1C, 630mm^2, Al, XLPE, 11kV cables (two per phase)	$150,000	2016	Beyond 2030
2. Replacement of 33kV cables on Wainuiomata sub transmission circuits at Gracefield GXP (100m)	$100,000	2019	Beyond 2030
3. Upgrade of mid-circuit cable section on 33kV Circuit 'A' (155m)	$150,000	2019	Beyond 2030

Figure 5-28 Cost Estimate for Proposed Solutions for Wainuiomata

5.11.9. Fault Levels at CBD Zone Substations

All CBD[13] zone substations are operated as a split 11kV bus system due to the high fault levels (as a result of low impedance supply transformers) and also due to protection limits (to limit the effect of a cascade tripping should a downstream 11kV meshed ring system fail to clear a fault correctly). The average fault level on an 11kV closed bus at CBD zone substations is around 15kA which is above the 11kV asset fault ratings both at zone substations and downstream. Due to the split bus system, there is a short break in the event of a subtransmission circuit outage and there may not be true "no-break" N-1 security of supply to CBD loads should one 33kV circuit or zone transformer be out of service. The Network Control Room has to close the bus section on the switchboard, or in some cases a faultman is required, which impacts on system SAIDI.

[13] The CBD area is considered to be the commercial areas supplied by Frederick St, Nairn St, University, The Terrace, Moore St, Palm Grove and Kaiwharawhara GXPs.

Operating the CBD zone substations in a closed 11kV bus configuration would provide "no break" security of supply should one 33kV circuit or zone transformer trip out of service. This may require alteration to existing protection settings and schemes. In some cases protection relays upgrade would be required at downstream 11kV sites to ensure there is no risk of cascade trippings back to the zone substation.

There are a number of different options available to mitigate the risk of high fault levels at CBD zone substations.

Increasing 11kV Switchgear Fault Ratings

This option involves increasing the fault ratings of the 11kV distribution switchgear at zone substations and downstream sites. To achieve this, all distribution switchgear would need to be replaced and given this high cost the option is not considered viable.

As an example, the fault level on the Frederick Street 11kV bus (when closed) is 16kA. Typically switchgear at zone substations of that era are 13.1kA (250MVA). Distribution equipment downstream is of similar rating. All new equipment being installed is rated at up to 25kA at zone substations, and up to 21kA at distribution substations with anticipation of being able to raise the fault levels in future.

High Impedance Zone Transformers

To reduce the fault level below 10kA, this option suggests installation of transformers with high winding impedance at CBD zone substations. CBD transformers are currently around 10-12% impedance, whereas a much higher impedance would be required to control fault levels. However the existing transformers at CBD zone substations are in good condition and are not due to replaced within the planning period. The benefit of this option is no additional equipment would be required and hence no space constraints would arise. The disadvantages are the high cost and very high losses in the zone transformers, as well as the premature replacement of assets.

Current Limiting Reactors and Resistors

Wellington Electricity's CBD high voltage network is over 95% underground and almost all faults are phase-to-earth faults in the event that insulation is compromised or damaged. An option to control fault levels would be limiting the earth fault current below 10kA at CBD zone substations. This could be achieved by the use of current limiting reactors or resistors, installed at CBD zone transformer neutral points.

Another alternative would be to install bus tie reactors at CBD zone substations on the 11kV bus. The advantage of this approach is that if the load is essentially balanced on the both sides of the bus tie reactor under normal operating conditions, the reactor has negligible effect on voltage regulation or system losses.

Figure 5-28 shows the typical arrangement of a bus tie reactor in a distribution system.

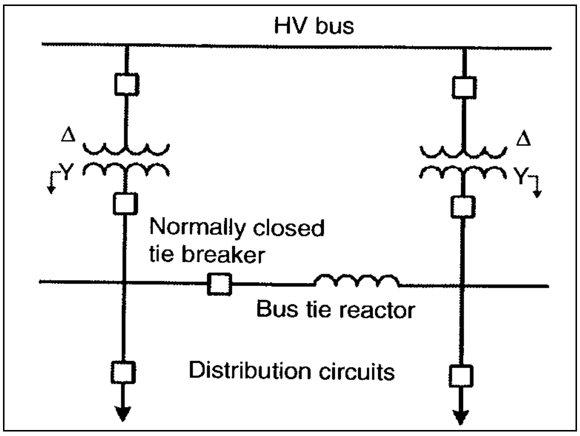


Figure 5-29 Typical Bus Tie Reactor Arrangement

There is a limitation to using bus tie reactors in CBD substations as the 11kV switchgear is of the metalclad type and connecting the bus tie reactor to this type of switchgear would be an issue as the two sides of the bus and the circuit breaker are fully enclosed and inaccessible. Generally, these devices are better suited to outdoor switchyards so an engineering study for these connections would be required.

The key points to be considered and addressed before installation of current limiting reactors or resistors are:

- Space availability
- Protection setting review as fault level will be lowered
- Protection discrimination and co-ordination review, possible upgrade of relays
- Sensitive earth fault protection might be required due to reduced earth fault current
- Physical connection to Metalclad switchgear at CBD zone substations (for bus-tie reactors)
- CBD meshed 11kV system co-ordination

To operate CBD zone substations in closed 11kV bus mode, current limiting reactors are considered to be the best option given that very little of the other substation plant, particularly the transformers, requires replacement at this time. Further planning and research would be required to determine appropriate device sizes for limiting earth fault current at the various CBD zone substations.

Figure 5-30 provides a project cost estimate bus fault level improvements.

Project Description	Cost	Year investment is required	Duration of Solution
CBD substation bus fault level improvements	$600,000	Annually from 2014 onwards	Beyond 2030

Figure 5-30 Cost Estimate for Bus Fault Level Improvements

5.12. 11kV Distribution System – Constraints and Development Plans

Figure 5-31 lists the 11kV feeders which, in 2017, are forecasted to be operating above 70% loading but of a duration which still meets the relevant security criteria for the feeder type.

Feeder		Zone Substation	Loading at peak time (2017)
BRO CB08	Clearwater Cres.	Brown Owl	71%
EVA CB01	69 Miramar Ave	Evans Bay	70%
EVA CB03	Batten St	Evans Bay	70%
HAY 2762	Kingsley Heights	Haywards	78%
JOH CB 06	Johnsonville	Johnsonville	70%
JOH CB 10	Johnsonville	Johnsonville	72%
KAR CB 02	Dasent St	Karori	71%
KOR CB 05	TAB Head Office	Korokoro	70%
KOR CB 12	Hutt RD C	Korokoro	70 %
MAI CB 06	Leisure Centre	Maidstone	77%
MEL CB 03	Boulcott Street	Melling	73%
MEL CB 11	Connolly St	Melling	70%
MOO CB 14	50 Thorndon Quay	Moore Street	76%
NGA CB 04	Jarden Mile	Ngauranga	78%
POR CB 05	Lyttleton Ave	Porirua	70%
TRE CB 12	Gower St	Trentham	73%
WAT CB 05	Brook St	Waterloo	78%

Figure 5-31 11kV Feeder Loading Forecast – Short Duration Peak Loading

Monitoring of these feeders will continue. If the duration or magnitude of the loading is found to exceed the security criteria for the feeder type, solutions will be identified for reducing the loading, or reinforcing the network to ensure compliance with the security criteria.

Figure 5-32 lists the 11kV feeders which, in 2017, are forecasted to be operating above 70% loading for sustained periods at peak time during normal operation and therefore are likely to be in breach of the security criteria for that feeder. These feeders have been, or are in the process of being, assessed for network reconfiguration and augmentation solutions to the high loading.

Feeder		Zone Substation	Loading at peak time (2017)
FRE CB 02	MONZ	Frederick Street	76%
FRE CB 03	Lorne St	Frederick Street	82%
FRE CB 07	21 Tory St	Frederick Street	100%
FRE CB 09	29 Barker St	Frederick Street	83%

Feeder		Zone Substation	Loading at peak time (2017)
FRE CB 12	21 Tasman St	Frederick Street	85%
FRE CB 13	Elizabeth St	Frederick Street	75%
IRA CB 02	33 Ludlam St	8 Ira Street	87%
GRA CB 02	Gracefield Rd A	Gracefield 11kV	77%
HAT CB 03	Taurima St#2	Hataitai	85%
HAT CB 05	Taurima St#1	Hataitai	78%
HAY 2722	Silverstream	Haywards 11kV	91%
KAI CB09	209 Hutt Rd	Kaiwharawhara	79%
KEN CB 09	Broken Hill Rd	Kenepuru	87%
KOR CB 09	Londons Rd	Korokoro	80%
MAI CB 11	42 Lane St	Maidstone	78%
MOO CB 02	National Library	Moore St	84%
NAE CB 06	Guinness St	Naenae	83%
PAL CB 01	312 Adelaide Rd	Palm Grove	77%
PAL CB 11	Parade	Palm Grove	90%
TAW CB 13	Oxford St	Tawa	73%
UNI CB 11	Epuni St	University	80%
WAN CB 05	Postage Drive	Waitangirua	90%
WAT CB 03	Hautana St	Waterloo	81%

Figure 5-32 11kV Feeder Loading Forecast – Sustained High Loading

The Frederick Street feeders identified will be reconsidered once peak loading and forecasting is known following the work completed in 2011-12 to off load these onto interconnecting neighbouring feeders.

A project has been budgeted in the 2012 spend plan to install a new feeder into the existing Frederick Street zone 1 ring to off load feeder 7, which is expected to be 100% loaded in 2017.

Palm Grove Feeders 1 and 11 have loading constraints which are linked with wider CBD supply capacity constraints. The building of a new zone substation in the CBD will allow these to be reconfigured. Presently there is short term solution available to off load some these feeders onto interconnecting neighbouring feeders by shifting open points.

Loading constraints on Waitangirua Feeder 5 are linked to a large subdivision development which will continue to grow over the coming years. As part of this work, significant reconfiguration of the 11kV network is required to supply the subdivision and to relocate existing overhead lines. This project is due to commence in 2012 or early 2013.

5.12.1. Operational Solutions to Identified High Load Feeders

Many of the high load feeders identified can be off loaded by shifting open points to utilise the existing capacity in adjacent feeders, without the need for further investment in the network. Figure 5-32 lists the constrained feeders which can be off loaded onto adjacent feeders.

Feeder	Load moved to	Forecast loading at peak time (2017)	
		Existing	Proposed
IRA CB 02	IRA CB04	87%	69%
HAY CB 2722	TRE CB05	91%	62%
KAI CB 09	KAI CB06	79%	66%
KEN CB 09[14]	TAW CB13	87%	68%
MAI CB 11	MAI CB02	78%	53%
UNI CB 11	NAI CB14	80%	70%
WAT CB 03	SEA CB12	81%	66%

Figure 5-32 Proposed Open Point Configurations to Reduce Loadings on Feeders

This proposed open point configuration would reduce feeder loadings below or close to 66% at peak load time. The remaining high load feeders not yet addressed require a solution such as reinforcement work to increase capacity, or to reduce the feeder loadings via other methods such as demand side management, temporary generation or other means.

5.12.2. Feeders Requiring Investment for Non-operational Solutions

The feeders which have constraints that cannot be easily resolved in the short to medium term by operational means, are likely to require network investment and reinforcement. A description of each of the major 11kV feeder reinforcement projects is discussed below.

5.12.2.1. Frederick Street Zone 1 Ring Reinforcement

The Frederick Street zone substation is presently the second highest loaded CBD substation on the Wellington Electricity network. This substation supplies some residential and predominantly commercial load in the CBD by two meshed distribution 11kV rings. The Frederick Street zone 2 ring has been split into two small rings and radial feeds, and a project completed in 2011 allowed 5 to 6 MVA of peak load to be permanently transferred to the neighbouring Nairn Street zone substation.

[14] Load shift from Kenepuru 09 to Tawa 13 to take place after the Tawa 13 cable upgrade (Refer to Section below)

The Frederick Street zone 1 ring has a peak demand of 18.1 MVA and has four feeders feeding into the ring. Figure 5-33 shows that the 21 Tory Street distribution substation carries most of the ring load due to the high utilisation of the 21 Tory Street 11kV bus. With the load centre being close to Tory Street, system impedances cause an uneven sharing of load through the 21 Tory Street substation.

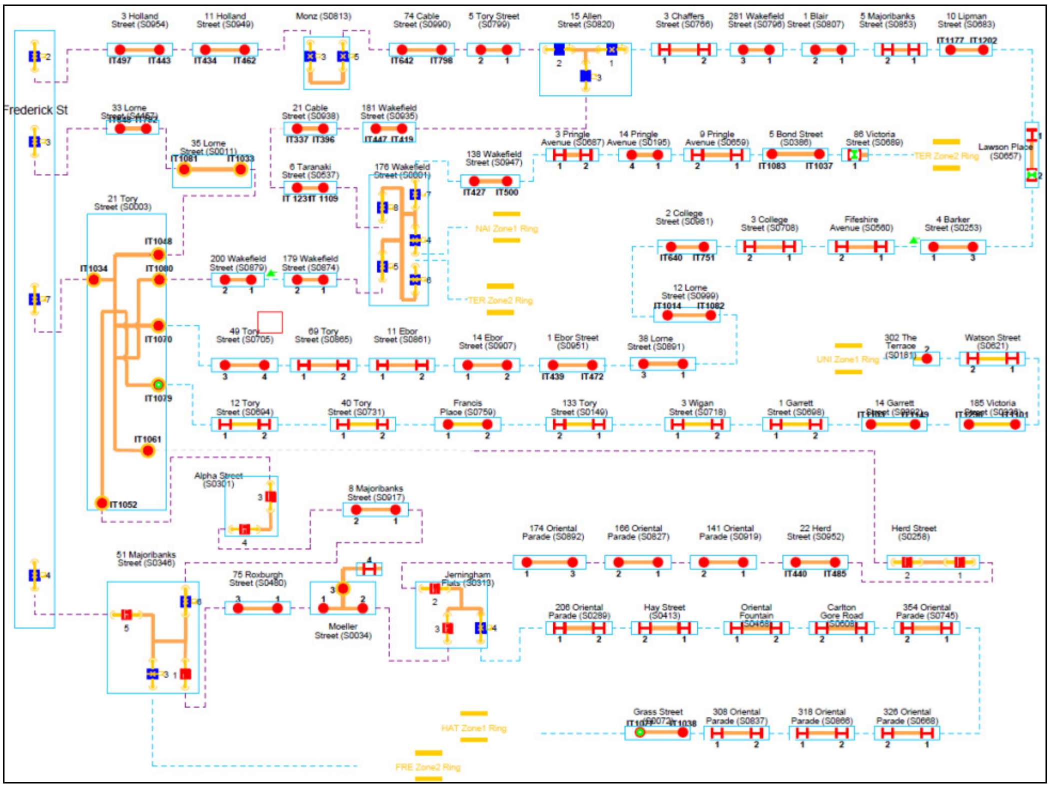


Figure 5-33 Frederick Street Zone 1 Ring Overview

There are currently four feeders (CB02, 03, 04 and 07) feeding into the zone 1 ring, with feeder 7 being the most heavily loaded. The loadings on the zone 1 ring feeders are uneven, with Frederick Street feeder 3 and 7 being more than 70% loaded at peak times. There is a high risk of cascade failure of the entire zone 1 ring should one feeder in the ring be out of service (i.e. subsequent feeders tripping on overload).

It is proposed to install a new 11kV circuit breaker at the Frederick Street zone substation along with installation of a new cable (three core 300mm^2, aluminium) in College Street. This would be operated as a radial feeder which, with some reconfiguration of open points, will pickup around 25% of the Frederick Street zone 1 ring load. This project will also reduce the existing cascade failure risk of ring feeders should one feeder be out of service at peak times on the remaining part of the zone 1 ring.

Figure 5-34 provides a cost estimate for the Frederick Street zone 1 ring reinforcement works.

Project Description	Cost	Year investment is required	Duration of Solution
1. Purchase and install new circuit breaker at Frederick Street zone substation including protection equipment	$85,000	2012-13	Beyond 2020

2. Install 3C, 300mm2, Al, XLPE, 11kV cable (370m)	$465,000	2012-13	Beyond 2020
Total estimated cost	**$550,000**		

Figure 5-34 Cost Estimate for Frederick Street Reinforcement Works

5.12.2.2. Gracefield Feeder 2

Gracefield Feeder 2 supplies the Eastbourne area which is mostly residential with a winter peak load demand of 3.4MVA. The full capacity of Gracefield Feeder 2 is 5.37MVA with loading of 65% at peak load times (2011) forecasted to grow to 77% by 2017. This loading (77%) is outside the planning and security criteria for this type of feeder.

There are two network options that would address the loading concerns at Gracefield. One option is to increase the capacity of the existing feeder and the second option involves shifting the load onto interconnecting feeders.

Increasing the feeder capacity involves replacing the existing 11kV feeder cable by installing a new three core 300mm^2, aluminium cable, which would require replacing more than 2 km of existing cable. This option of cable replacement is not an efficient solution due to the cost of installing such a length of cable.

The second option involves shifting a portion of the load from Gracefield Feeder 2 to Gracefield Feeder 8. Gracefield Feeder 8 follows the same route as Gracefield Feeder 2 but has lower loading. However the capacity of Gracefield Feeder 8 is limited due to around 500m of undersized three core, 95mm^2, aluminium cable installed between Seaview Wharf substation and Days Bay switching station.

This proposed plan is to shift the last six distribution substations at the end of Gracefield Feeder 2 onto Gracefield Feeder 8 by closing the normally open point CB03 at Days Bay switching station. This will reduce the loading on Gracefield Feeder 2 cable to below 66% at peak load time. Implementing the proposed plan requires replacement of the existing undersized cable on Gracefield Feeder 8 with three core, 185mm^2, aluminium cable before the proposed switching could be carried out.

Figure 5-35 provides the estimated cost to replace the undersized cable between Seaview wharf and Days Bay switching station.

5.12.2.3. Hataitai Feeders 3 and 5

Hataitai zone substation has a peak demand of 18.0MVA and supplies residential load in Hataitai and around Evans Bay Parade. There are two meshed 11kV rings which provide supply to the load in the area. The Hataitai zone 1 ring has two feeders and Hataitai zone 2 ring has three feeders each operating as a closed ring. The loading on Hataitai zone 2 ring is below 66% during peak load time but the loading on Hataitai zone 1 ring is above 66% during peak load time.

Both feeders of the zone 1 ring feed directly into the Taurima Street substation 11kV bus. The loss of supply risk to zone 1 ring is high due to the high load demand in this area. In the event of a single feeder tripping there may be a cascade tripping of the zone 1 ring as a result of overloading on the remaining feeder.

Another constraint, of high consequence but low probability, is that an unplanned outage on the Taurima Street substation 11kV bus would result in a total loss of supply to the entire zone 1 ring. There is limited 11kV back feed options that could support the entire zone 1 ring in the event of a bus outage at Taurima Street and not all supply may be restored following this type of outage. However, the possibility of an outage at the Taurima St substation is low as the switchgear was replaced in 2010.

Two options have been found to address the constraints on Hataitai feeders.

Option 1: New Feeder into 81 Hamilton Road Substation

This option involves utilisation of the spare circuit breaker (CB 02) at Hataitai zone substation to add another feeder into the existing zone 1 ring. The new feeder cable would be connected into the existing 81 Hamilton Road substation as shown in Figure 5-31. Switchgear replacement at this site to replace the Magnefix with a new Ring Main Unit would be required before installation of the new feeder. This new feeder would connect into a downstream radial part of the zone 1 ring and reduce the loading on the two existing feeders by around 11%. However with switching and reconfiguration of the system a significant amount of load could be supplied by this feeder.

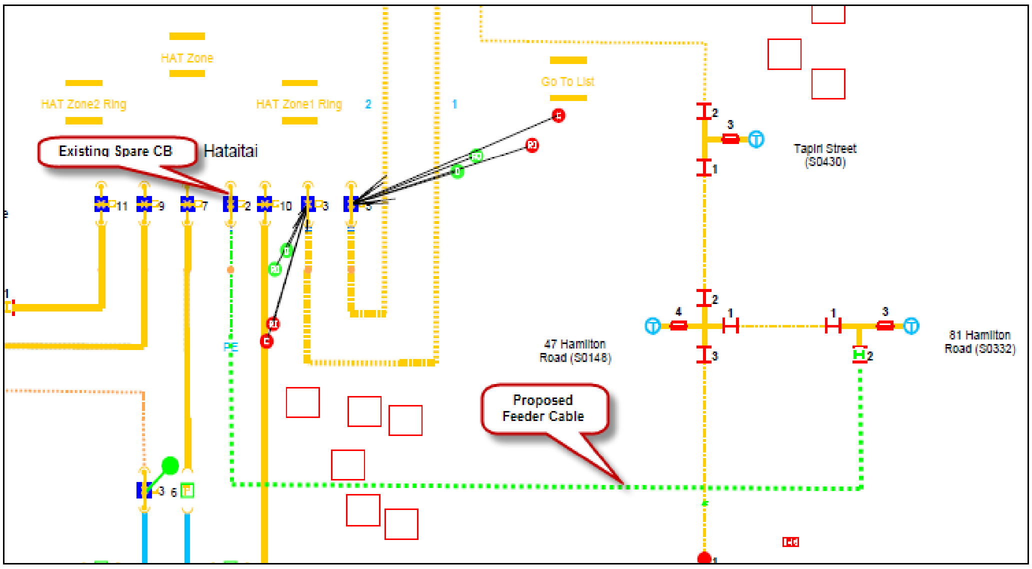


Figure 5-31 Proposed New Feeder into 81 Hamilton Road Substation

Figure 5-32 provides the estimated cost for this new feeder option.

Project Description	Cost	Year investment is required	Duration of Solution
Install new feeder at Hataitai zone substation by utilising spare circuit breaker 2 and installing cable into 81 Hamilton substation	$400,000	2012-13	Beyond 2030

Figure 5-32 Cost Estimate for Undersized Cable Replacement for Gracefield Feeder

The benefit of this option is the relatively low cost and no requirement for additional switchgear at the zone substation. The limitations of this option are less operational flexibility during an outage on the Taurima Street substation 11kV bus as it would still require Taurima Street substation 11kV bus to supply zone 1 ring load should one feeder be out service. Another limitation would be uneven feeder loadings on zone 1 ring feeders due to the load share across circuits of different impedance.

<u>Option 2: New Feeder into Waipapa Road</u>

This option is similar to option 1, with the only difference being to connect the proposed new feeder into the existing zone 1 ring in Waipapa Road substation. The proposed plan is shown in Figure 5-33.

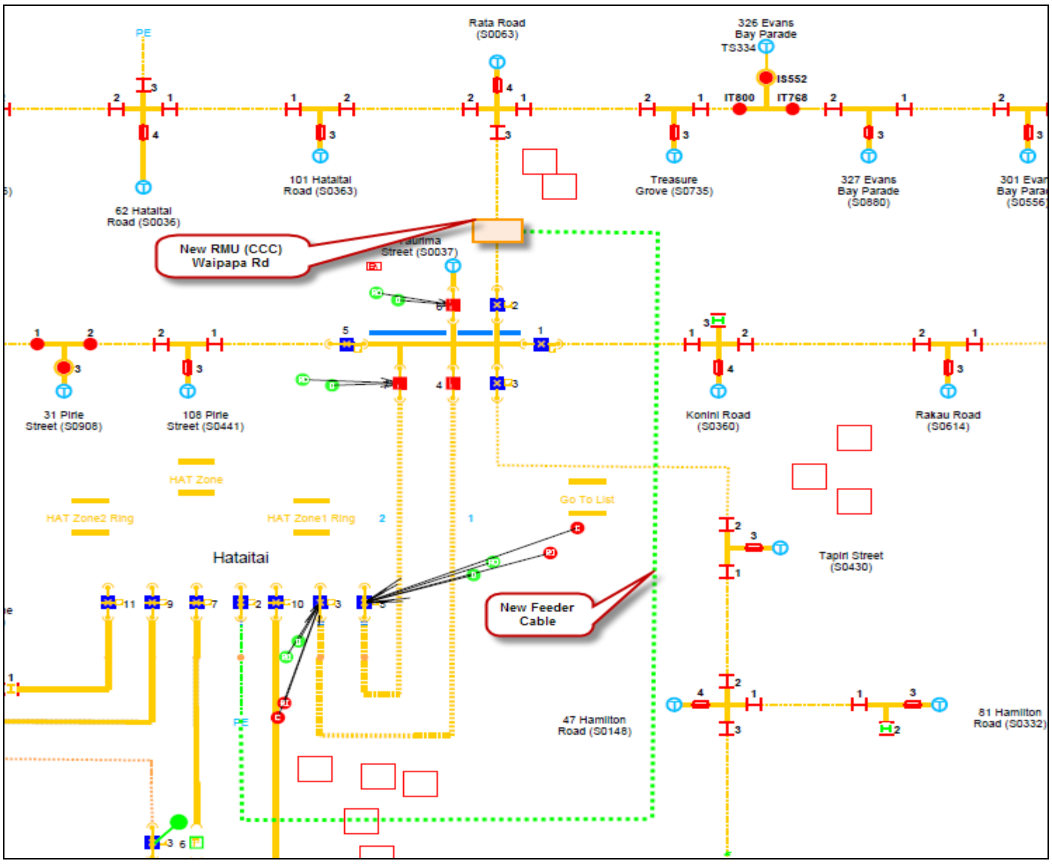


Figure 5-33 Proposed New Feeder into Waipapa Road Substation

This option is preferred because it provides the best solution to both operational and loading issues. The peak loading on the existing feeders in the zone 1 ring would be reduced by 25-30% and roughly an equal load shared by all three zone 1 feeders. Another advantage is that during an outage on the Taurima Street substation 11kV bus, it is possible to supply as much as 70% of the zone 1 ring peak load without any interruption or contingency switching.

The estimated cost for this option of a new feeder into Waipapa Road substation is shown in Figure 5-34.

Project Description	Cost	Year investment is required	Duration of Solution
Install new feeder at Hataitai zone substation by utilising spare circuit breaker 2 and connecting into zone 1 ring in Waipapa Road Installation of new switchgear at Waipapa Road	$380,000	2012-13	Beyond 2030

Figure 5-34 Cost Estimate for New Feeder into Waipapa Road Substation

5.12.2.4. Korokoro Feeder 9

Korokoro Feeder 9 supplies residential load around the Korokoro area and has a peak demand of 3.80MVA. The present loading on feeder cable is around 70%. This loading exceeds the planning and security criteria levels for this type of feeder.

One option is to reduce the loading on Feeder 9 by transferring load to adjacent feeders. There are two open points (Korokoro Feeder 4 and 7) available for offloading Korokoro 9 during planned switching and contingency operation, however the loading on these neighbouring feeders is high and as a result it is not possible to permanently shift load onto these feeders.

The second, and preferred, option is to install a new feeder cable and utilise the existing spare circuit breaker (CB8) at Korokoro zone substation to split the existing Feeder 9 load. The proposed new feeder 8 layout is shown in Figure 5-35. The expected load on the new feeder is expected to be less than 1MVA but any future development south of Korokoro will be able to be supplied from this feeder, as well as to accommodate load transfer from other feeders as load increases occur. The loading on Korokoro Feeder 9 after the load shift will be reduced by 25%. The new feeder would also provide additional capacity and provide a full backup to Petone Feeder 7 through peak load times if the Petone zone substation decommissioning project proceeds.

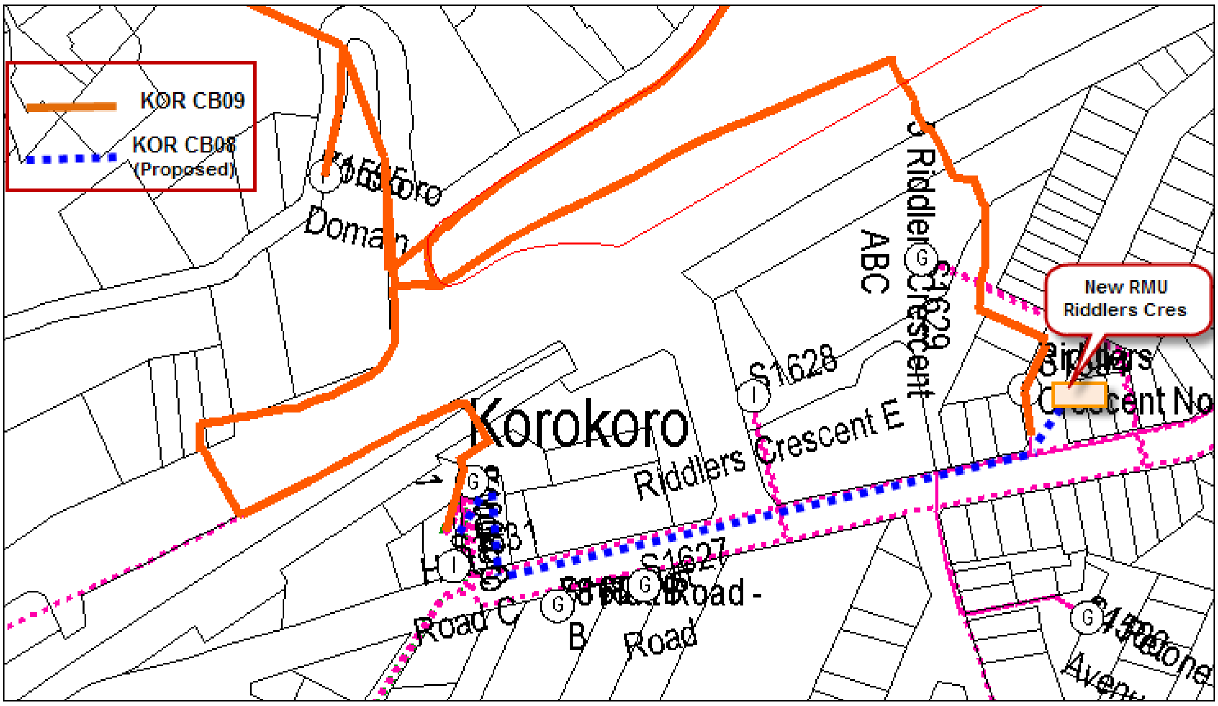


Figure 5-35 Layout of Proposed New Feeder at Korokoro Zone Substation

Figure 5-36 provides the estimated cost for this new feeder option.

Project Description	Cost	Year investment is required	Duration of Solution
Install a new feeder at Korokoro zone substation to Riddlers Cres including replacement of switchgear at Riddlers Cres.	$410,000	2012-13	Beyond 2030

Figure 5-36 Cost Estimate for New Feeder at Korokoro Zone Substation

5.12.2.5. Moore Street Feeder 2

Moore Street zone substation supplies part of the Wellington CBD area around Parliament, serving government offices and departments, large commercial buildings and the central railway station. It has a summer peak and a typically commercial load profile. Moore Street Feeder 2 is part of the Moore St zone 1 ring, which has two feeders (1 and 2) and presently has a peak demand of 4.10MVA. The winter peak loading at Moore Street Feeder 2 is below 66% due to higher feeder cable ratings in winter, but the summer peak loading is above 75% due to low feeder cable ratings and increased demand in summer. The loading on the zone 1 ring feeders is uneven with a load share of 37% on Feeder 1 and 58% on Feeder 2 respectively. During an outage on one of the Moore Street zone 1 ring feeders, the loading on the other feeder increases above 95%. This could result in an outage due to overloading of the remaining feeder if loading was unusually high immediately before the first outage, or as loads continue to grow. There are few options to mitigate this constraint as offloading the feeders to bring them within the 66% loading will transfer the loading issue to adjacent feeders.

Option 1: Convert to Radial Feeder System

This option involves converting the existing zone 1 ring feeders into open ended radial feeders and would require balancing of the feeder loads so that each feeder is evenly loaded and within the planning criteria limits of 66% loading. The radial feeders will provide lower reliability when compared to the present ring system. Additionally, there are limited back feed options available due to the high peak load on neighbouring feeders unless a new feeder is installed to increase overall capacity in the 11kV system in this area, and to off load other feeders to provide lower loadings and greater interconnection.

This option of converting the zone 1 ring feeders into radial feeders is not recommended as it would lead to reduced security of supply, and potentially poorer performance in this area of network compared to what is presently offered to consumers.

Option 2: New 11kV Feeder

This option involves the addition of a new feeder into the existing zone 1 ring from Moore Street zone substation, connecting into the system at the Freyberg Building substation. It requires installation of a new circuit breaker on the T1 side of the 11kV bus at Moore Street.

There are two possible routes to install the new feeder cable into the Freyberg Building substation, either along Mulgrave Street or along Molesworth Street. However along Molesworth Street is 160m longer than the Mulgrave Street route.

Load flow simulation suggests that a new feeder cable should be installed along Molesworth Street because it will provide roughly equal loadings on all the three feeders in the zone one ring, as a result of the increased impedance, even though it is the longer route and comes at a higher cost. Figure 5-37 provides the overview of proposed new feeder into the Freyberg Building substation.

Figure 5-37 Overview of Proposed New Feeder into Freyberg Building Substation

The benefits of this option are: evenly loaded zone 1 ring feeders, reduced likelihood of a cascade tripping should one feeder be out of service under the present configuration, and provision of additional capacity which is available for future load growth. By retaining the ring configuration the existing levels of security and reliability will be retained.

Figure 5-38 provides the estimated cost for this new feeder option.

Project Description	Cost	Year investment is required	Duration of Solution
1. Installation of a new feeder cable in Molesworth Street and connection into Freyberg Building substation	$600,000	2012-13	Beyond 2030
2. New circuit breaker with protection relays at Moore Street zone substation	$75,000	2012-13	Beyond 2030
3. Switchgear extension at Freyberg Building substation (addition of new circuit breaker)	$50,000	2012-13	Beyond 2030
Total	**$725,000**		

Figure 5-38 Cost Estimate for New Feeder into Freyberg Building Substation

5.12.2.6. Naenae Feeder 6

Naenae Feeder 6 has been found to have a capacity constraint and is limited to 3.72MVA due to the initial section of the feeder being an undersized cable (3C, 95mm^2, Al, XPLE). The feeder loading at peak winter times is above 75% and this section constrains the remainder of the feeder. Replacing this small section of cable with 3C, 300mm^2, Al, 11kV cable will increase the capacity of feeder by around 3.0-3.5 MVA. Figure 5-39 shows the cable section required to be replaced.

This constraint is currently a high risk because this undersized segment of feeder carries full load at all times and an outage on this section due to overloading would result in total loss of supply to whole feeder. Additionally, an increased rating will provide increased security to other Naenae feeders as this feeder will be able to offload those feeders during outages, whereas currently this is not possible.

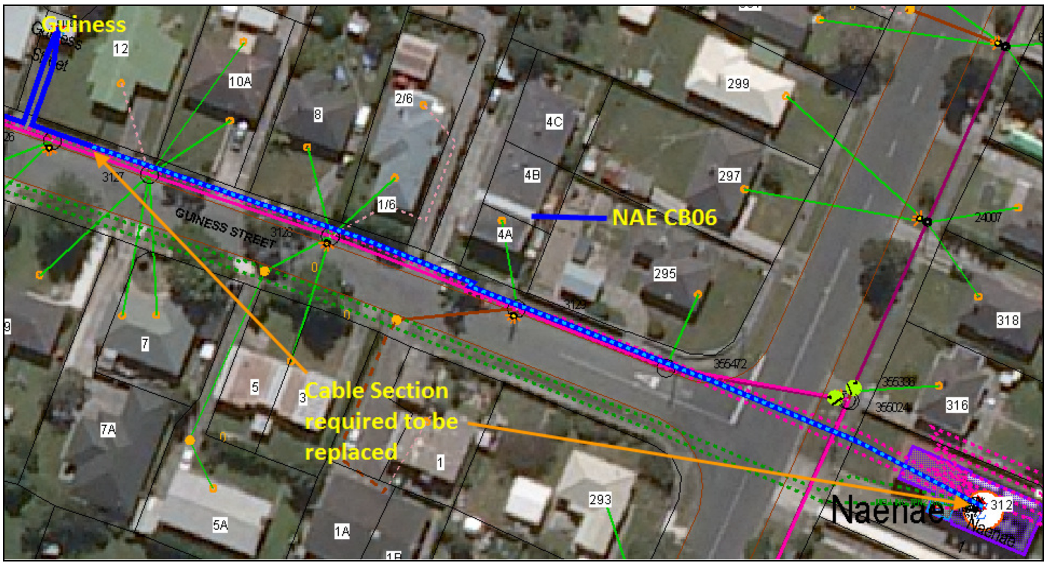


Figure 5-39 Overview of Proposed Naenae Cable Replacement

Figure 5-40 provides the estimated cost for this new feeder option.

Project Description	Cost	Year investment is required	Duration of Solution
Replace existing 165m of 3C, 95mm^2, Al cable with 3C, 300mm^2, Al, 11kV cable	$150,000	2013-14	Beyond 2030

Figure 5-40 Cost Estimate for Naenae Cable Replacement

5.12.2.7. Tawa Feeder 13

Tawa Feeder 13 supplies residential load on the north side of Tawa zone substation, with a peak demand of 2.41MVA. Though the peak load is not high, the capacity of the feeder is limited by the initial part of the feeder being undersized. The first 1.15km of this feeder has 95mm^2, aluminium cable which limits the capacity of the feeder to 3.72MVA. To improve the capacity of this feeder and reduce the constraints, the first section of Tawa Feeder 13 needs to be upgraded. The network standard size for feeders leaving zone substations is three core, 300mm^2, aluminium cable to provide the best rating for the front section of the feeder.

One option is to replace the existing 95mm^2, aluminium cable section and install new three core, 300mm^2, aluminium cable over the existing route in the same configuration up to the 4 Lyndhurst Street substation. This will increase the feeder capacity by 3.15MVA to around 6.8MVA. The total length of cable requiring replacement would be 1.15km.

The second option would be to install a new high capacity cable from the Tawa Feeder 13 circuit breaker and connect into Mascot substation as shown in Figure 5-41. The new cable will become the front section of the Tawa Feeder 13 feeder and the existing 95mm², aluminium (Al) cable will become the tail end of Tawa Feeder 13. The total length of proposed cable route is about 600m which is 415m shorter than the route required if replacing the existing cable as per option one. A shortcut can be taken by utilising walkways between blocks rather than following the road. It is also recommended as part of the works to install a new three way ring main unit outside the Tawa zone substation between the existing Tawa Feeder 13 cable (95mm² Al) and the proposed new cable, which will provide an alternative supply to the tail end of Tawa feeder 13.

The second option of installing a new feeder cable and connecting into the Mascot Street substation is recommended as it provides the best and lowest cost solution to the existing constraints and also provides additional capacity for future load growth in this area.

Figure 5-41 Overview of Proposed Tawa Feeder 13 Cable Reinforcement

The estimated cost for the preferred option of installing a feeder cable is shown in Figure 5-42.

Project Description	Cost	Year investment is required	Duration of Solution
Install a new cable from Feeder circuit Breaker 13 to Mascot Street substation and replacement of switchgear at this substation.	$550,000	2015-16	Beyond 2030
Install new three way ring main unit outside Tawa zone substation	$35,000	2015-16	Beyond 2030
Total	**$585,000**		

Figure 5-42 Cost Estimate for Tawa Feeder 13 Cable Reinforcement

5.13. Investment Programme - Growth, Customer Connections and Asset Relocations

Major network investment works covered in this section include new development works to maintain security levels driven by system growth, and to enable customer connection and asset relocation work to occur. Asset replacement and renewal projects to address asset age or condition are covered in Section 6 (Lifecycle Asset Management).

5.13.1. Major Network Investments for the Current Year

The following major projects and programmes of work are budgeted and expected to take place or commence in the 2012 calendar year.

5.13.1.1. 2012 Growth, Security and Reinforcement Projects

Mana-Plimmerton Zone Substation Reinforcement	
Driver: Growth Estimated cost: $250,000 Special Protection Scheme	The 11kV tie line between Mana and Plimmerton has capacity shortfall of 4MVA should the 33kV circuit supplying Mana zone transformer be out of service. A special protection scheme with inter trip and close would be required to manage the load during contingency situations.

Hataitai Zone 1 Ring Reinforcement	
Driver: Security, Growth Estimated cost: $380,000	High loading on existing zone 1 ring has potential risk of cascade failure, should one feeder be out of service in the ring. New feeder into the existing ring will share the load and also eliminate the potential for cascade failure of the ring.

Frederick Street Zone 2 Ring Reinforcement	
Driver: Security, Growth Estimated cost: $550,000	Reconfiguration of zone 1 ring and transferring some load on to zone 2 ring. Installation of new feeder into zone 1 ring to reduce the loading on zone 1 feeders.

Petone Zone Substation Reinforcement	
Driver: Condition Estimated cost: $1.8 million	Subtransmission cables supplying Petone zone substation have reached the end of their effective service life and suffer from age and condition issues. With the decrease of heavy industrial load in the Petone area, loadings on both Petone and Korokoro zone substations have decreased and both substations are underutilised. Proposed that Petone zone substation be converted to a switching station taking 11kV supply from Korokoro substation and supplying a reduced Petone area. Fringe areas can be offloaded to Seaview and Melling 11kV feeders.

Land for New Zone Substation North East of Johnsonville	
Driver: Growth Estimated cost: $1.0 million	Land investigation and land purchase north east of Johnsonville (Grenada Village) for new zone substation in 2017. Load growth around Johnsonville is very high due to construction of new subdivisions in and around Grenada Village area.

The Terrace to Moore Street Load Transfer	
Driver: Growth, Security Estimated cost: $250,000	Install a new feeder at Moore Street zone substation and transfer load from The Terrace to reduce loading on The Terrace and utilise capacity at Moore Street.

Moore Street Zone 1 Ring Reinforcement	
Driver: Growth, Security Estimated cost: $300,000	Install a new feeder into the existing ring to eliminate the risk of cascade failure, should one feeder in the ring be out of service when overloading may occur on the remaining feeders.

5.13.1.2. HV Reinforcement - General

This is an aggregated budget allowance of $750,000 for minor HV network reinforcement projects that are not able to be directly attributed to individual customers. Examples of such projects include installing a new 11kV cable section. Projects expected in 2012 include: installation of a new length of cable in Main Street Upper Hutt to replace an undersized section as switchgear is replaced, extension of the 11kV network and installation of a new distribution substation in the Lyall Bay area to replace an LV voltage regulator, and other small network reconfiguration and reinforcement projects.

5.13.1.3. LV Reinforcement - General

This is an aggregated budget allowance of $250,000 for minor LV network reinforcement projects that are not able to be directly attributed to individual customers. Examples of such projects include installing a new berm substation in response to network loading or voltage concerns, or a 400V cable reinforcement project.

5.13.1.4. Customer Growth and Relocations

These projects have been aggregated in the budget as per the categories below. Overall, the 2012 budgeted expenditure is slightly higher than the 2011 budget, reflecting a slight decline in the amount of enquiries for carrying out this type of work. In general this is being attributed to a partial recovery of the recent economic slow down.

<u>New Connections</u>

For the year ended June 2011, compared with the previous June year, the number of residential building consents issued was down 25%. This is a sign of a continuation of the slow economy which is having an impact on small residential developments.

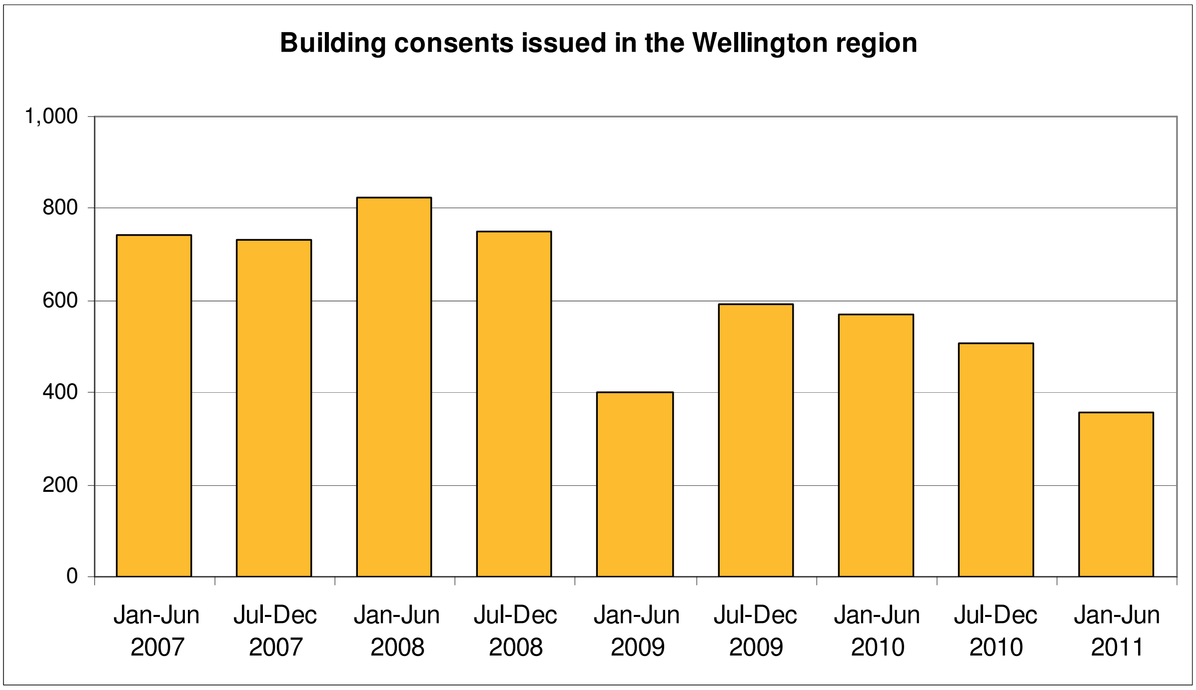


Figure 5-43 Number of Building Consents Issued in Wellington Region

It is forecast that in 2012 new connections requiring infrastructure will be fewer than 200, down on the 2011 number of 210. Balanced against this decline is Telecom's continuing program to provide telecommunications services from roadside cabinets, each requiring an electrical supply connection.

Substations

Increased expenditure in customer substations is being predicted due to plans for four large Wellington CBD developments, each requiring reinforcement above 2MVA. Overall it is predicted substation related spend including transformer capacity changes will closely match levels seen in the past 4 years.

Subdivisions

While the number of small and infill subdivisions look to remain at similar levels of previous years, local developers continue to show little appetite for large scale residential subdivisions (>100 lots). New industrial property development activity has all but ceased because of insufficient demand and surplus vacant sites. As such only one single business subdivision in Upper Hutt is being recognised in the 2012 expenditure. While a number of potential medium size subdivision projects have been identified it is expected that some may not be undertaken in the 2012 year. However this is offset by smaller subdivision projects being undertaken which were not allowed for in original expenditure. Overall it is predicted new subdivision connections will be around 300 in 2012 compared to over 350 lots being completed in 2011.

Streetlights

Expenditure is budgeted to install new infrastructure associated with the New Zealand Transport Agency's (NZTA) project to upgrade lighting on State Highway 1 between Johnsonville and Tawa. Note that replacement of existing streetlight network cabling is funded from network integrity.

As part of Wellington City Council's restoration project of the Golden Mile, old streetlights are being replaced with new, modern poles and lanterns. Areas to be upgraded are Manners Mall, Cuba Street, Willis Street and Adelaide Road. This is a good opportunity for Wellington Electricity to upgrade the existing streetlight network.

Capacity Changes

Expenditure associated with transformer upgrades or downgrades is included within the customer substation area of the Customer Connection forecasts.

Relocations

For 2012 NZTA will be investing little in Wellington Region infrastructure projects with corresponding minimal requirement for relocation of existing electricity network. In addition only minor relocation works have been identified by local city councils in 2012. An allowance for these and other customer initiated relocations has been made based on an average of the previous three years.

New customer service pillar being installed

5.13.2. Prospective Investments for 2013 – 2022

Projects included in this section are less certain in nature. Whether or not they proceed, and their timing, will depend largely on whether forecast load growth materialises. It is possible that over the period before construction of any project must be committed, Wellington Electricity may identify more cost effective, including non-network, approaches that will supply the required load in accordance with the planning criteria.

5.13.2.1. Prospective Investments for 2013 – 2016

In addition to budgeted programmes for minor network growth reinforcement, customer connection and asset relocation work, the following major projects have been identified for investment within the following four years of the period this plan covers. These projects are more certain in nature, with better developed solutions, although their exact timing may change based upon other risks being identified.

Korokoro Feeder 9 Reinforcement	
Driver: Growth, Security Estimated cost: $350,000 Year: 2013	The existing peak load on Feeder 9 cable is above 70%. Installing a new feeder by utilising spare Feeder 8 CB at Korokoro would off load Feeder 9 loading by 20-25%.

Reinforcement of 33kV Capacity at Palm Grove Zone Substation	
Driver: Growth Estimated cost: $5 - 7 million Year: 2013	Present load at Palm Grove zone substation exceeds capacity of the existing subtransmission cables and constrains other components such as switchboard and transformers. One option for addressing this issue is to connect the two existing cables in parallel to supply one transformer and to run a new 33kV XLPE cable circuit to supply the second transformer. This will allow the two transformers to be operated up to their full rated capacity. At this stage it is not intended to upgrade the two Palm Grove transformers so that the firm transformer capacity exceeds the current and forecast substation load. This project is linked to possible building of a new substation in the CBD as it will allow the feeders in all CBD and surrounding areas to be reconfigured thus reducing load on the Palm Grove substation, but not releasing installed capacity that is constrained by under-rated cables.

Naenae Feeder 6 Reinforcement	
Driver: Growth, Security Estimated cost: $150,000 Year: 2013	The initial section of feeder cable from CB6 up to the Guinness Street substation is 95mm^2 Aluminium which constrains the feeder which has peak loading above 75%. This cable section will be upgraded with 300mm^2 Aluminium which would increase the entire feeder rating by around 3MVA.

Gracefield Feeder 8 Reinforcement	
Driver: Growth Estimated cost: $400,000 Year: 2014	Gracefield Feeder 2 has high loading. To reduce loading capacity of Gracefield Feeder 8 is required to be increased by upgrading the existing 95mm^2 cable section (505m) and transfer load from Feeder 2 onto Feeder 8.

Palm Grove 11kV Network Reconfiguration	
Driver: Security Estimated cost: $500,000 Year: 2014	Currently there is no interconnection between 11kV distribution network supplied from T1 and T2 bus section. A project to be under taken for installing two open points between T1 and T2 11kV networks will allow load transfer between T1 and T2 bus section at distribution network level, which is not possible at present.

Tawa Feeder 13 Reconfiguration	
Driver: Growth Estimated cost: $400,000 Year: 2014	Feeder capacity is limited to 3.72MVA due to initial cable section being undersized. To raise the feeder ratings, a new high capacity cable would be installed and connected into Mascot substation. This also requires switchgear upgrade at Mascot Street substation.

CBD Zone Substation Fault Level Improvements	
Driver: Security Estimated cost: $850,000 Year: 2014	To reduce the fault levels at CBD zone substation in order to operate them as close 11kV bus system.

New Wellington CBD Zone Substation	
Driver: Growth Estimated cost: $20 million Year: 2015-16	It is envisaged that a new substation will be required during the planning period to reinforce the supply to the CBD. All substations supplying the CBD are heavily loaded and incremental upgrades can only defer the need for a more substantial reinforcement for a limited time. Investment in a single new zone substation may defer expenditure required to increase subtransmission and transformer capacity at multiple Wellington City zone substations around the CBD.

Wainuiomata Zone Substation 11kV Incomer cables upgrade	
Driver: Growth Estimated cost: $70,000 Year: 2016	Existing 11kV incomer cables are single core, $630mm^2$, Al, 11kV (one per phase) with 12.0 MVA capacity and 17-18MVA as emergency capacity. Installation of additional same size cables making two per phase to match the 11kV bus ratings.

5.13.2.2. Prospective Investments for 2017 – 2022

Listed below are prospective projects that may occur in the last five years of the planning period covered by this AMP. These have been budgeted unless otherwise stated, however the timing of the investment may vary depending upon factors such as load growth, technological advances, and whether investments with higher priority are required in this period.

Land for New Zone Substation in Whitby / Pauatahanui	
Driver: Growth Estimated cost: $1.0 million Year: 2017-2018	Land investigation and purchase in the Whitby area for a new zone substation due to load growth in the Whitby and Aotea areas which is steadily increasing the overall demand. Also more land is being developed for residential housing around Pauatahanui and Plimmerton. Timing of this purchase is dependant upon load growth and forecasting of when a new zone substation will be required.

Zone Reinforcement – University / Frederick St / Moore St / The Terrace	
Driver: Growth Estimated cost: $1-3 million per site Year: 2017-18	Following development of a new CBD zone substation, these substations are expected to require intra-zone reinforcement to provide acceptable security levels within their meshed 11kV ring systems. It may be determined that converting the meshed systems to radial feeders will provide adequate security and reduce the constraints in a more economic way.

Sub Transmission Link Between Wilton and Central Park	
Driver: Security Estimated cost: $5 million Year: 2018	Due to the security of supply issue to the Central Park GXP, and the need for a second interconnecting bank between the 110kV and 220kV system around Wellington, a subtransmission link to move load between Central Park (110kV) and Wilton (220kV) could defer transmission investment. The proposed 33kV link between Moore Street and The Terrace zone substations will give Wellington Electricity the ability to move between 30 and 40MVA of load between Wilton and Central Park GXP. Currently it is only possible to shift load at 11kV level (10-13MVA). This concept needs to be developed further as a potential “grid alternative project”, as it will defer transmission investment by Transpower.

Wainuiomata 33kV Cable Upgrade	
Driver: Growth Estimated cost: $0.5 – 1.0 million Year: 2018	33kV cable upgrade at the Gracefield GXP supplying the Wainuiomata overhead 33kV lines to utilise the full rating of the rest of the circuit. There is a small section of underground 33kV cable on Wainuiomata 33kV circuit A which will also be upgraded to match the overhead line and zone substation capacity.

Fault Level Improvements at CBD Zone Substations	
Driver: Security Estimated cost: $1.0 million Year: 2018-19	To reduce the fault levels at CBD zone substation in order to operate them as closed 11kV bus system it is proposed to trial technologies to reduce fault levels such as current limiting reactors and retrofit components to switchboards to improve fault ratings.

New Zone Substation in Whitby/Pauatahanui area	
Driver: Security Estimated cost: $15-20 million Year: 2020-21	Load growth in the Whitby and Aotea areas is steadily increasing, and more land is being developed for residential housing. Existing supplies from Waitangirua are expected to exceed their ratings and provide insufficient security for the increased loads towards the end of the planning period. Development of a substation in this area will also provide increased security to the Mana and Plimmerton areas which are expected to also require reinforcement earlier in the planning period.

5.13.2.3. Capital Expenditure Forecasts

From the details in the section above, Wellington Electricity's network development and growth capital expenditure forecast is shown in the table below. It includes the large projects described in Section 5.11 as well as expenditure on other growth related capital works such as customer projects and relocations. In comparison to asset renewal expenditure, the expenditure on growth projects is relatively modest, reflecting the low growth rates forecast. Expenditure on other line items generally reflects historic expenditure levels. The combined capital expenditure forecast is shown in Appendix A.

	2012/13	2013/14	2014/15	2015/16	2016/17	2017/18	2018/19	2019/20	2020/21	2021/22
Customer Connections	5,502	5,434	5,914	6,628	6,046	5,476	5,610	5,810	5,802	6,349
Growth	5,757	5,522	6,148	7,277	5,732	4,606	5,487	5,742	5,577	5,261
Asset Relocations	789	773	924	1,020	923	857	899	919	906	967
Total	12,048	11,729	12,986	14,925	12,701	10,939	11,996	12,471	12,285	12,577

Figure 5-44 Capital Expenditure Forecasts

From the table above, it can be seen that network development and growth expenditure is cyclic over the planning period. Notable network reinforcement projects are seen around 2012-2014 and 2016-2017 reflective of the prospective need for zone substation development to address existing constraints. Customer Connection expenditure is forecast to rise around the middle of the planning period. This reflects the increased development of residential areas as the economy comes out of recession and existing vacant land is fully developed which corresponds with a second wave of expenditure in network growth projects.

6. Lifecycle Asset Management

6.1. Asset Lifecycle Planning Criteria and Assumptions

This section provides an overview of Wellington Electricity's asset maintenance, refurbishment and replacement strategies over the planning period. The objective of these asset strategies is to ensure that the network is capable of meeting the consumer service level targets and to mitigate the risks inherent in running an electricity distribution network.

Generally, asset lifecycle management consists of the following:

- Routine asset inspections, condition assessments and servicing of in-service assets
- The evaluation of the results in terms of meeting customer service levels, performance expectations and risks
- Adjusting maintenance requirements, and equipment specifications to reflect known issues
- Repair, refurbishment or replacement of assets when required

The preventative maintenance programme is typically based on a time based cycle, with each asset type, or maintenance task across a group of assets having a set cycle. Some maintenance activities may have an intervention activity outside the normal time based programme either based on the number of operations undertaken by the asset (e.g. circuit breaker maintenance following fault trips) or based upon external testing results (e.g. tap changer maintenance based on oil tests). All inspections are undertaken on a time based cycle, which may vary for certain assets in each category based upon known issues and risks. In time, as condition assessment data improves for each asset category, planned maintenance cycles for some assets may be able to be extended as the risks associated with the assets may be reduced, conversely, some assets may need a shorter cycle due to their increased risks. Some assets, with a low value, low replacement cost and where the risks of failure are low, may simply be replaced at failure as this is more efficient than a full maintenance and refurbishment programme.

Electricity distribution assets do not have an infinite life and must eventually be replaced. Ideally assets should be replaced before they fail. However premature asset replacement is costly since it means that the service potential of the replaced assets is not fully utilised. Hence asset replacement requires the costs of premature replacement to be balanced against the risks of asset failure and the deterioration of supply reliability that will occur if assets are allowed to fail in service. There is a balance to be found, between the costs of maintaining an asset against the cost to replace it. Also for some asset types, it may be more cost effective, and have minimal impact on safety and service levels, to allow the asset to run to failure and replace on expiry of service.

Wellington Electricity uses the following criteria to determine whether an in-service asset should be replaced:

- The asset condition has deteriorated to the extent that there is a high risk that it will fail if left in service and repair or refurbishment is not practical or economic.
- The asset technology is obsolete and spare parts are no longer available.
- The asset presents an unacceptable risk to the environment or to the safety of public or operating and maintenance personnel.

- The maintenance cost of the asset over its remaining life is expected to be higher than the asset replacement cost.
- The asset failure creates a large impact to customer service or network reliability that would adversely impact our business reputation.

The remainder of this section focuses on the different asset classes and provides an insight into the condition and maintenance of each class with an overview of the specific asset class, maintenance programs and renewal and refurbishment programmes.

One of the key assumptions Wellington Electricity has based its maintenance and renewal programmes on is that the assets are old, but are generally in fair condition. This is due to sound maintenance programmes early in their service life and a better view will be known upon further condition assessment.

6.2. Stage of Life Analysis

During 2010, Wellington Electricity first undertook a "Stage of Life" analysis on three major asset categories, namely subtransmission cables, zone substation power transformers, and zone substation 11kV switchboards. In 2011, the "Stage of Life" analysis was updated with new information gained from inspection and test data, knowledge gained from operating the network for another year, and to reflect the completion of work which addresses age, condition or utilisation of those assets. Details of the outcome of this work are under the respective headings in this section.

The main feature of this analysis is to combine the disciplines of Asset Management with Network Planning to ensure optimal investment on the network. When considered holistically, factors such as age, condition and utilisation can provide an indication of where investment is required based upon total risk to the system. If these factors are considered independently, investment may occur in areas where the risk is not significant (for example an old transformer that has 100% back feed capacity is a lower risk than a better condition transformer where back feeds are not possible or constrained and load may be un-served following a failure).

Each of the factors of age, condition and utilisation are given weightings. The highest weighting is given to utilisation as the consequence of failure is more quantifiable than the likelihood of failure due to age or condition. Ultimately loading and back feed constraints have a longer term consequence if load cannot be supplied.

These three asset categories were selected as they present the highest risk to the system, they can be easily considered as discrete assets (compared to asset categories that may have thousands of items), and they represent the areas where investment will be the largest, often millions of dollars per single asset. It is not anticipated that discrete site "Stage of Life" analysis will be undertaken on any other categories. Other categories generally have a lower risk profile and will have renewal programmes driven by type issues, defect and condition information. There are also network policies created for those assets which include elements of "Stage of Life" analysis.

The factors in the "Stage of Life" analysis will change over time as work is completed on the network such as improving capacity or making more spare parts available for older switchboards.

One area to improve in the "Stage of Life" analysis in future is the optimal timing of investment. For some assets this is quite clear from an immediate need due to lack of back feed or exceptionally poor condition.

However for some assets where there is not an immediate need, the use of network investment decision making tools is required.

The result of the “Stage of Life” analysis for each of the three categories is provided in the relevant section below. The analysis does not aim to provide solutions but rather to identify areas where further investigation is required.

The “Stage of Life” analysis is a constantly changing assessment and needs to be updated on a regular basis, as has occurred in 2011. As the network changes and more or less capacity is available in certain areas, or as asset condition deteriorates or improves, or as spare parts are used up or made available from replacement work, the scores found in the “Stage of Life” analysis will change. As a result, any prospective investment arising from this analysis may vary over the planning period.

6.3. Maintenance Practices

As noted earlier, Wellington Electricity uses Northpower as its Field Services Provider to undertake and manage the network maintenance programme under a new Field Service Agreement. At the time of writing this AMP, Northpower are approaching a year of operation on the Wellington network.

The new field services contract brings a number of improvements to the way maintenance activities are undertaken on the Wellington Electricity network, and how corrective repairs and defects are managed and reported.

The scheduling of inspection and maintenance activities will now be driven by Wellington Electricity, rather than by the Field Services Provider as it was previously. This arrangement still enables the network owner to receive proposals from the Field Services Provider for further reliability centred investment above the present maintenance expenditure guideline set by the network owner.

The biggest and most significant change arising from changing to a new Field Service Agreement is a move towards condition based risk management of assets. This is achieved through improved condition assessment and defect identification during planned inspection and maintenance activities.

There is improved data reporting back to Wellington Electricity for determination and scheduling of maintenance or replacement activities. Combined with database query tools within Wellington Electricity, there is significantly improved visibility and tracking of maintenance tasks and test results received from the field. Further details of the asset management systems and processes are covered in Section 2.8 (Asset Management Systems and Processes).

Vegetation management is provided by Treescape in accordance with Wellington Electricity policies and in accordance with the Hazards from Trees Regulations 2003. Wellington Electricity is reaching the end of the first cut and trim programme, and in future tree owners will be responsible for maintaining their vegetation to a distance that provides safe clearance of subsequent growth. There is potential that this maintenance may not occur and vegetation related outages may start to increase again if tree owners neglect their obligations under the regulations.

The maintenance budget is categorised into the following areas:

1. Planned/Preventative Maintenance (PM) works – this PM plan is developed between the maintenance contractor and Wellington Electricity based upon the requirements in the maintenance standards and

asset quantities in service. The PM plan consists of routine inspections, as well as maintenance and servicing work undertaken on the network. The results of planned inspections, and also planned maintenance, drive corrective maintenance or renewal activities.

2. Corrective Maintenance works – this work is undertaken in response to defects raised from the planned inspection and maintenance activities, or from observations in the field. Generally the complete programme is unknown at the beginning of the financial year and budgets are set based on rolling averages from previous years, adjusted (if required) for any known defects beyond what would normally be expected. When common fault modes occur these may be progressed into an asset renewal programme to more efficiently manage the defect.

3. Reactive Maintenance works – this work is undertaken in response to faults or third party incidents and includes equipment replacement and repairs following failure or damage.

4. Management Fee and Value Added – this is to provide for the contractor management overhead and to provide customer services such as cable mark outs, stand over provisions for third party contractors, provision of asset plans for the 'B4U Dig' service etc.

5. Vegetation Management – covering planned and corrective vegetation work undertaken by Treescape.

The maintenance budget costs for 2012 are summarised at the end of this section.

6.3.1. Maintenance Standards

The following maintenance standards are referred to in this section. These standards have evolved from previous network documents and have been rewritten by Wellington Electricity to include additional requirements, including the previously mentioned condition and defect assessment requirements. These documents have been reviewed internally and also by senior engineers within another CKI group company, Citipower-Powercor, in Australia. Citipower-Powercor operates and manages electricity distribution networks in the Melbourne CBD and large parts of the state of Victoria, and has very well developed practices which add value to Wellington Electricity's maintenance standards. Some specialist standards, in particular earthing, have been developed internally and reviewed by industry specialists within New Zealand.

Standard	Name
EMS-300	Maintenance of Substation Fire Systems
EMS-301	Maintenance of Mineral Insulating Oil
EMS-302	Maintenance of Grid Exit Points
EMS-303	Maintenance of Subtransmission Cables
EMS-304	Maintenance of Zone Substations
EMS-305	Maintenance of Substation Buildings and Enclosures
EMS-306	Maintenance of Zone Substation Transformers

Standard	Name
EMS-307	Maintenance of 33kV Bulk Oil Circuit Breakers
EMS-308	Maintenance of 11kV Metalclad Switchboards and Circuit Breakers
EMS-309	Maintenance of Protection Systems
EMS-310	Maintenance of Distribution Substations
EMS-311	Maintenance of Ripple Injection Equipment
EMS-312	Maintenance of Traction DC Systems
EMS-313	Maintenance of Zone Substation Earthing Systems
EMS-314	Maintenance of Batteries and Chargers
EMS-315	Maintenance of Overhead Lines and Components
EMS-316	Maintenance of Fault Passage Indicators
EMS-317	Maintenance of Overhead Switches
EMS-318	Maintenance of Reclosers and Sectionalisers
EMS-319	Maintenance of Distribution Transformers
EMS-320	Maintenance of Distribution Earthing
EMS-321	Inspection and Maintenance of Poles
EMS-322	Maintenance of 11kV Ground Mounted Switchgear
EMS-323	Maintenance of Low Voltage Distribution Equipment
EMS-324	Maintenance of Communications Sites
EMS-325	Planned Maintenance Intervals

Figure 6-1 Maintenance Standards

6.4. Maintenance and Renewal Programmes

This section includes excerpts taken directly from the Preventative Maintenance programme, illustrating the maintenance activities undertaken for particular asset classes and their frequency. Commentary is provided on renewal and refurbishment policies or criteria plus known systematic issues associated with each asset class.

6.4.1. Subtransmission Cables

6.4.1.1. Maintenance Activities

The following routine planned inspection, testing and maintenance activities are undertaken on subtransmission cables:

Activity	Description	Frequency
Cable sheath tests	Testing of cable sheath and outer servings, continuity of sheath, cross bonding links and sheath voltage limiters.	2 yearly
Subtransmission - cable gas / oil injection equipment inspection	Inspection and minor maintenance of equipment in substations, kiosks and underground chambers.	6 monthly
Subtransmission - general maintenance, weekly patrol	General maintenance and management of subtransmission network.	Ongoing

Figure 6-2 Inspection and Routine Maintenance Schedule for Subtransmission Cables

In conjunction with the above routine maintenance, all oil filled and pressurised gas cables have pressure continuously monitored via the centralised SCADA system. This monitoring provides information that identifies cables where pressure is reducing and allows the situation to be promptly investigated. Leaks will occur either at joints, which can be rebuilt, or along the length of the cable which makes location and repair significantly more difficult.

One of the key tests is the sheath test, this will indicate where there is damage to the outer sheath and gives an early indication of where corrosion or further damage may occur (leading to leaks), as well as proving the integrity of the earth return path. Most of the subtransmission cables installed on Wellington Electricity's network are three core aluminium or lead sheathed, with very few circuits consisting of single core cables with wire screens.

Subjective condition assessment on cables with oil or gas pressurisation is difficult and quite limited, a number of techniques, including partial discharge testing, are not applicable to these types of cables. By their very nature, the pressurisation of the cables fills any voids in the insulation and prevents partial discharge. The main mode of failure of these cables is stress on the joints and resulting failures, as well as sheath failures allowing gas leaks and areas of low pressurisation along the length of the cable. Leaks however are detected through routine operations and the cable can be repaired before the electrical insulation properties are compromised.

The historic fault information for each cable, where known, is used to assess and prioritise the need for cable replacement, as well as determining the strategic spares are required to be held.

6.4.1.2. Cable Condition

Gas filled cables

Gas filled HV cables have been in use internationally since the 1940's and are still in service in many utilities in New Zealand and Australia. They have been proven to perform well when they are installed in benign environments that are not prone to disturbance or damage. Wellington Electricity however has many of its gas filled cables installed under busy roads in urban environments, through structures such as bridges and crossing earthquake fault lines. This therefore requires close monitoring of their performance to manage any deterioration and consequent reduction in levels of service. For example, most of the Evans Bay gas filled cables run under State Highway 1. These cables in particular have been repaired numerous times as a result of third party damage or through gas leaks being found. Vibration from traffic has been identified as a contributing factor to some mechanical failures.

When these cables develop a gas leak, they can usually be dug up and repaired without having to cut the cable. However when a more serious electrical fault occurs, a new section of cable will be necessary. On some occasions a transition joint is employed to join the pressurised gas cables to XLPE cables. These joints are relatively expensive at circa $100,000 each and therefore it is not expected that it will be economic to have a large number of such joints in a cable. The likely outcome of this is that economically for any replacement projects, long lengths of cable will be required for replacement rather than for a number of short lengths.

A brief summary of the gas filled cable circuits is listed below:

Circuit	Length (km)[15]	Year installed
Central Park - Evan's Bay	10.1	1958
Central Park - Frederick Street	3.1	1978
Central Park - Hataitai	4.7	1968
Central Park - Palm Grove	5.8	1967
Central Park - University	1.0	1986
Evan's Bay - Ira Street	5.1	1961
Melling - Petone	8.5	1963
Upper Hutt - Maidstone	10.7	1968
Wilton - Karori	7.3	1967
Wilton - Waikowhai Street	3.6	1962

Figure 6-3 Summary of Gas Filled Cable Circuits

The Evan's Bay cables are the oldest on the network and over time they have suffered from a number of leaks which have been repaired. These are however well supported by back-feed options and the load they support is predominantly residential.

The Petone gas cables have had, and continue to suffer from, heavy corrosion to the outer metallic sheath due to poor servings. These cables are lightly loaded due to decline in load around Petone with the closure of several large manufacturing plants. Network studies are being undertaken to determine if these cables

[15] Circuit length is the total of all parallel circuits, divide length by number of circuits for route length.

should be replaced, or if the load can be supplied from existing 11kV feeders in the area, reducing the need for subtransmission supply. A project will be undertaken in 2012 to address these issues.

Cable Joints

A known issue on some cables installed on steep terrain is where joints expand and contract under cyclic loading, and have been known to pull the conductor from the joint ferrule under contraction. This was experienced in 2010 when one of the old Moore Street gas cable circuits was out of service to enable maintenance by Transpower at the Wilton GXP. The consequence of this was significant given the type of load served (CBD, Government) and the unavailability of the second circuit. These particular cables supplying Moore Street were replaced in 2011.

X-raying of joints was undertaken during United Networks ownership, and little remedial work occurred as the problem had not proved to be significant. This mode of failure is experienced on average every 10 years, with the most recent occurrences being experienced on the old Moore Street cables which have now been replaced.

Cable Strikes

Wellington Electricity, like most lines businesses and other utilities, experiences a number of third party strikes on its underground assets each year. These impact on network performance, pose a serious risk to health and safety, and incur a large cost to repair. Unfortunately not all of these third party incidents are identified and reported at the time of the incident which may lead to future safety and network reliability problems.

To minimise the number of third party strikes, Wellington Electricity uses a service provider, B4U-DIG, to facilitate the provision of obstruction plans to contractors working in the area, with Northpower providing cable mark outs and standovers where appropriate. Wellington Electricity has targeted contractors working for large utility companies and Territorial Local Authorities (TLAs) with presentations educating them on the importance of cable location and excavation practices. This is further discussed in Section 9.6.(Public Safety Management System)

In addition, cable maintenance staff patrol the routes of key subtransmission circuits on a regular basis and note any activities that may impact upon underground services.

6.4.1.3. Renewal and Refurbishment

The need for cable replacement is determined and prioritised by a combination of the consequence of a cable failure, condition and performance assessments, analysis of failure and defect rates, and a comparison of the estimated cost of maintaining the cable in service with the cost of replacement, as well as system capacity for supporting load whilst the subtransmission circuit is under repair. These factors are considered in the “Stage of Life” analysis of subtransmission circuits.

Unfortunately for cables there are almost no options for refurbishment or extension of life once major leaks, discharge and electrical insulation breakdown has occurred. The solution in most cases is replacement of sections, or the entire length, of cable. Gas and oil filled cable require special transition and stop joints that range in cost from $100,000 upwards each. To relocate, replace sections or extend a cable would cost a minimum of $250,000 using this technology.

6.4.1.4. Subtransmission Circuit “Stage of Life” Analysis

During 2011, the “Stage of Life” analysis was updated on all subtransmission circuits, and a summary of the analysis is provided below.

Parameters Considered

The “Stage of Life” analysis method considers the attributes of each subtransmission cable circuit as defined over three categories, each containing a number of measurable properties. A rating between 1 and 10 is given to each property, with 1 being the most favourable (good) and 10 being the least favourable (bad).

Category	Property	Rating (normalised)
Age	Age	1 (good) to 10 (poor)
Condition	Total number of joints	1 (good) to 10 (poor)
Condition	Number of non-original joints	1 (good) to 10 (poor)
Condition	Joint density (Joints / km)	1 (good) to 10 (poor)
Condition	Environment that the cable is installed in	1 (good) to 10 (poor)
Condition	Assessment of cable condition (from field staff)	1 (good) to 10 (poor)
Condition	Assessment of sheath condition (from field staff)	1 (good) to 10 (poor)
Condition	Leakage history (for pressurised cables)	1 (good) to 10 (poor)
Utilisation	N-1 capacity shortfall	1 (good) to 10 (poor)
Utilisation	Residual capacity following transfer of load	1 (good) to 10 (poor)
Utilisation	Type of connected load	1 (good) to 10 (poor)

Figure 6-4 Categories, Properties and Ratings for Subtransmission Circuits

The ratings are normalised over all of the subtransmission circuits so that they can be used as a direct comparison between circuits. Ratings are then weighted as some properties have a greater impact on ”Stage of Life” than others.

Category Scores

The weightings allocated to each of the three main categories of age, condition and utilisation are as follows:

Category	Weighting
Age	10%
Condition	40%
Utilisation	50%

Figure 6-5 Category Weightings

The rationale behind these weightings is that age and condition are considered as asset related properties and together they are given equal weighting (i.e. 50%). Utilisation (also 50%) is considered as a planning related property. Age is considered to be less relevant to overall stage of life of the circuit than the condition parameters; hence it is given a rating of 10%, compared to 40% for condition.

Applying the above weightings to the normalised ratings of each category gives the following ranking of circuits requiring attention, ordered with the highest priority circuit (i.e. highest score) at the top of the list.

Zone Substation	Age score	Condition score	Utilisation score	Weighted Total score
Palm Grove	8.2	3.3	7.8	**6.0**
Petone	9.0	6.8	4.5	**5.9**
University	4.4	5.0	6.4	**5.6**
Evans Bay	10	7.9	2.0	**5.1**
Terrace	0.0	2.1	8.5	**5.1**
Johnsonville	5.4	4.8	4.8	**4.9**
Tawa	4.1	3.9	5.5	**4.7**
Frederick Street	6.2	2.9	5.8	**4.7**
Korokoro	4.7	3.7	5.3	**4.6**
Hataitai	8.0	4.5	3.3	**4.3**
Seaview	4.2	1.8	6.2	**4.2**
Maidstone	8.0	5.8	2.1	**4.2**
Ira Street	9.4	4.3	2.7	**4.0**
Porirua	4.9	1.5	5.7	**3.9**
Mana	3.6	3.1	4.6	**3.9**
Moore Street	0.0	2.0	5.9	**3.7**
Waikowhai	7.8	3.7	2.9	**3.7**
Wainuiomata	4.2	0.9	5.7	**3.7**
Ngauranga	3.4	2.0	4.9	**3.6**
Plimmerton	3.6	2.0	4.6	**3.5**
Waterloo	4.8	3.1	3.5	**3.5**
Waitangirua	5.4	3.3	3.1	**3.4**
Kenepuru T off	4.1	1.6	4.7	**3.4**

Zone Substation	Age score	Condition score	Utilisation score	Weighted Total score
Karori	9.0	4.2	1.4	**3.3**
Naenae	5.4	1.0	4.3	**3.1**
Brown Owl	5.5	1.4	3.5	**2.9**
Gracefield	4.2	0.7	3.9	**2.6**
Trentham	6.1	2.1	1.9	**2.4**

Figure 6-6 Stage of Life Category Scores for Subtransmission Circuits

Top Ranked Circuits

The top five circuits which have been identified as being most in need of attention are:

Subtransmission link	Ranking (1st = highest priority)
Palm Grove	1st
Petone	2nd
University	3rd
Evans Bay	4th
The Terrace	5th

Figure 6-7 Stage of Life Ranking of Subtransmission Circuits

Previous "Stage of Life" Analysis outcomes

From the previous "Stage of Life" analysis, three major projects were undertaken to address the highest risks on subtransmission network at that time:

1. Frederick Street Load Transfer – installation of 11kV cabling to transfer load from Frederick Street to the adjacent Nairn Street substation to address the security constraints on Frederick Street (N-1 capacity)

2. Moore Street subtransmission cable replacement – replacement of the entire double circuit 33kV gas cables from the Wilton GXP to Moore Street zone substation due to condition.

3. Johnsonville Reinforcement – Installation of increased 11kV interconnection with Ngauranga zone substation to address the security constraints on Johnsonville (N-1 capacity)

Outcome of the 2011 "Stage of Life" Analysis

Palm Grove

The Palm Grove subtransmission cables are old but in good condition. The utilisation of the cables is high which has resulted in it being prioritised in the top five circuits needing attention. Back feed options (N-1 and residual capacities) for Palm Grove are limited and should a subtransmission circuit fail at peak times, a short fall of about 6MVA will result. A new zone substation proposed for 2015 in the CBD will reduce loadings on inner city zone substations and should take care of this shortfall alongside load growth around Wellington CBD and city areas.

In the meantime a higher priority circuit breaker replacement project is being undertaken in Palm Grove as the risk, related to age and condition, cannot be mitigated effectively without replacement. This project was undertaken first as it was higher priority compared to the removal of the capacity constraint, and provides an opportunity to replace protection systems which will benefit future subtransmission capacity improvements.

Petone

The Petone subtransmission circuits are old and in poor condition, but are lightly loaded. An investigation into this subtransmission link shows the maximum demand is approximately 48% of N-1 subtransmission capacity, which indicates the assets are under-utilised. Given the low loadings at this site, and the ample capacity at adjacent sites (due to the demise of industrial load in the areas over the past 20 years) the option to transfer load away from Petone, and decommission the subtransmission supply, is a more viable solution as compared to investing in the subtransmission cables. A network analysis report supports this option and once approved for implementation will likely see the decommissioning of Petone zone substation subtransmission supply by permanently transferring its load to adjacent zone substations.

University

The cable sections of the University subtransmission link are at about mid life and in relatively good condition. Considering they have high joint density and supply the Wellington CBD area, this circuit is given a high rating in both age and condition categories. The University subtransmission link also has high numbers of non-original joints (second only to Evans Bay) indicating significant numbers of cable failures and has recently experienced a high profile cable fault. As a result an investigation is planned in 2012 for its possible upgrading, particularly the replacement of its gas cables.

Evans Bay

The Evans Bay subtransmission circuits are old and in poor condition, but are sufficiently lightly loaded that it is still able to provide back feed capacity to adjacent zone substations, and can be back fed with relative ease. The replacement of this circuit is likely to be deferred in favour of a more urgent circuit breaker replacement (to be undertaken in 2012) and power transformer replacement (in 2013). An investigation into this subtransmission link will be done in 2012 to identify options of investment in the cables. There is uncertainty around the developments of the Mt Victoria road tunnel where the cables presently run. No plans to replace the cables will be made until the future developments of the tunnel, and the potential of cost share with the NZTA for relocation, are known.

<u>The Terrace</u>

The Terrace subtransmission link is new and in good condition. Utilisation of the link is high which has resulted in it being featured in the top five circuits needing attention. No investigation or analysis has been carried out for The Terrace but this will likely to be resolved with a new zone substation in the CBD proposed for 2015. The new zone substation should take care of high utilisation issues including taking in load growths around Wellington CBD and city areas.

Subtransmission cable jointing in Wellington City

6.4.2. Substation Buildings and Equipment

6.4.2.1. Maintenance Activities

The following routine planned inspection, testing and maintenance activities are undertaken on substation buildings and related equipment:

Activity	Description	Frequency
Zone Substation - Routine Inspection	Routine visual inspection of zone substation to ensure asset integrity, safety and security. Record and report defects, undertake minor repairs as required. Thermal inspection of all equipment, handheld PD and Ultrasonic scan. Inspect and maintain oil containment systems, inspect and test transformer pumps and fans.	3 monthly
Grounds maintenance - Lump sum	General programme of grounds and building maintenance for zone substations	Ongoing

Activity	Description	Frequency
Fire Suppression System Inspection and Maintenance	Inspect, test and maintain fire suppression system (Inergen / gas flood)	3 monthly
Fire Alarm Test	Inspect and test passive fire alarm system	3 monthly
Fire Extinguisher Check	Inspect and change fire extinguishers as required	Annually
Test Zone Substation Earthing system	Test zone substation earthing systems	5 yearly

Figure 6-8 Inspection and Routine Maintenance Schedule for Zone Substations and Equipment

Routine quarterly zone substation inspections include the building and other assets such as lighting, fire systems, security systems, fans, heaters and safety equipment. The grounds and ripple injection spaces are also maintained to ensure access security, condition and safety. Where appropriate, annual building warrant of fitness inspections are carried out and any defects rectified. Building maintenance varies depending upon the site and minor defects are corrected as they are identified.

6.4.2.2. Renewal and Refurbishment

The substation building refurbishment program includes tasks such as roof replacement, exterior and interior painting, security and fencing improvements to maintain the assets in good condition on an as-needed basis.

Given the average age of substation buildings, Wellington Electricity is approaching a period of increased spend to replace doors, roofs and other building components. Deterioration from the natural elements has resulted in maintenance being uneconomic to address weathertightness issues, therefore these components are necessarily replaced in entirety. This work is critical to ensure ongoing reliability of electrical plant.

Seismic Compliance and Upgrades

In addition to routine maintenance, TLAs, under their Earthquake Prone Buildings Policy, undertake evaluations of buildings built prior to 1976 which include Wellington Electricity substation buildings. The outcome of the TLAs evaluation process, and Wellington Electricity's independent assessment, may require seismic improvement works on some of these buildings. The TLA allows a period of 10 years to reach compliance levels, however Wellington Electricity aims to complete upgrade work as soon as practicable following discovery of the risk. The scale of the reinforcing works undertaken can differ depending on the independent engineering advice.

Seismic investigations are also undertaken by Wellington Electricity prior to undertaking any major substation work which may lead to additional seismic strengthening works. Seismic reinforcing of substation buildings and how this risk is managed is further discussed in Section 8.10 (Network Resilience).

While these seismic projects are essential for the security and safety of the network they can be costly. During 2011, the 70 Adelaide Rd Substation had seismic improvements undertaken at a cost of around $210,000. Wellington Electricity is reviewing its policy on the categorisation, assessment and management of substation building seismic strength and requirements for reinforcing. The revised policy will clarify the business guidance on the risk and importance of each Wellington Electricity owned substation building. The policy will establish the priority of the reinforcement programme of works including capital expenditure forecasting over the planning period.

Wellington Electricity aims to achieve, as a minimum, the TLA requirements of >33% of the strength levels in the National Building Standard (NBS). Given the essential nature of these buildings it has been determined the highest strength level achievable will be obtained following a relevant cost-strength trade off analysis. In some cases it is neither practicable nor economic to achieve the target of >67% so a strength level between 34% and 67% is considered acceptable.

The known sites that require seismic upgrades (as a result of having strength < 33% of NBS) during the planning period are:

Substation	Year Identified	Year Scheduled	Estimated Cost
Chaytor St	2011	2012	$350,000
Newtown	2011	2012/13	$1,000,000
9 Duncan Tce	2011	2012	$250,000

Figure 6-9 Known Sites that Require Seismic Upgrade

Wellington Electricity has identified nearly 300 substation buildings of different types constructed prior to 1976 (when major design code changes occurred, potentially reducing the seismic risk) and is presently undertaking a risk analysis of each site to prioritise the sites for detailed engineering assessment and seismic improvements. During 2012 a prioritised site list will be produced. Initial estimates indicate that to achieve strength of 67% NBS for these buildings could cost in the order of tens of millions of dollars.

Managing the seismic building risk is a huge task and the improvements to these buildings will divert capital which would otherwise have been used for replacement of electrical distribution assets. Under the present regulatory default price path regime there is no opportunity to obtain extra funding for disaster resilience projects such as this, and seismic improvement projects may displace lower priority electrical projects. The short to medium term capital investment programme may alter significantly should a large number of buildings be found to be seismically non-compliant. Wellington Electricity will discuss with the Commerce Commission the most appropriate way to recover the cost of seismic reinforcing, for example via a price pass through process or similar.

6.4.3. Zone Substation Transformers and Tap Changers

6.4.3.1. Maintenance Activities

The following routine planned inspection, testing and maintenance activities are undertaken on zone substation power transformers:

Activity	Description	Frequency
Transformer oil test (TjH2B TCA)	Sample and test transformer oil using TjH2B TCA (Transformer Condition Assessment) method for power transformer main tank.	Annually
On Load Tap Changer (OLTC) oil test (TjH2B TASA)	Sample and test tap changer oil using TjH2B TASA (Tap Changer Activity Signature Analysis) method for power transformer OLTC.	Annually
Transformer Maintenance, Protection and AVR Test	De-energised transformer maintenance, inspection and testing of transformer, replacement of silica crystals, diagnostic tests as required. Gas injection for testing of buchholz. Testing of temperature gauge and probe. Confirmation of correct alarms. Test AVR and ensure correct operation and indications.	4 yearly
On Load Tap Changer (OLTC) Maintenance	Programmed maintenance of OLTC on a 4 yearly cycle if not maintained before as a result of test.	4 yearly

Figure 6-10 Inspection and Routine Maintenance Schedule for Zone Substations Transformers and Tap Changers

A programme of full oil analysis of all zone substation transformers and tap changers is undertaken by Wellington Electricity on an annual basis. Presently Wellington Electricity uses TjH2b analytical labs for oil analysis. TjH2b undertake a TCA and TASA test to measure dissolved gasses, particles, moisture and furans. These reports return a score of 1 to 4*, with 1 being normal and 4* being worst. Activities such as tap changer maintenance can be programmed based on these results as well as on time or operation based intervals. The TCA result and information in the report can be used to determine whether major maintenance or repairs need to be undertaken on the transformer. In the past two annual tests, only a basic oil dissolved gas analysis was undertaken, however full oil analysis will be undertaken again in 2012 to get full particle, dissolved gas and furan results.

6.4.3.2. Transformer Condition

Generally the condition of all transformers on the network indicates normal performance. Where evidence of heating or arcing is present, corrective maintenance is undertaken if economic, such as tightening or renewing internal connections outside of the core, or undertaking tap changer maintenance. By far, the most common issue is not electrical performance but rather mechanical problems with transformers. Examples include tap changer mechanism wear, contact wear, and similar problems associated with moving machinery. External condition includes leaking gaskets, fan and cooling system problems and for outdoor installations corrosion and weathering of the transformer tanks, especially the tops where water can pool at times.

Oil tests can also give an estimated Degree of Polymerisation (DP) value that can be used to provide an initial overview of the transformer condition, and signal the need for further maintenance, refurbishment or replacement. Estimated DP tests completed with the DGA oil tests in 2009 (furan analysis) show the majority of transformers to be above 450. It is proposed that once a transformer reaches 300 a paper sample will be taken to prove accuracy of the furan analysis and determine what further steps are required. A profile of estimated DP (as measured in 2009) vs. age, is shown below.

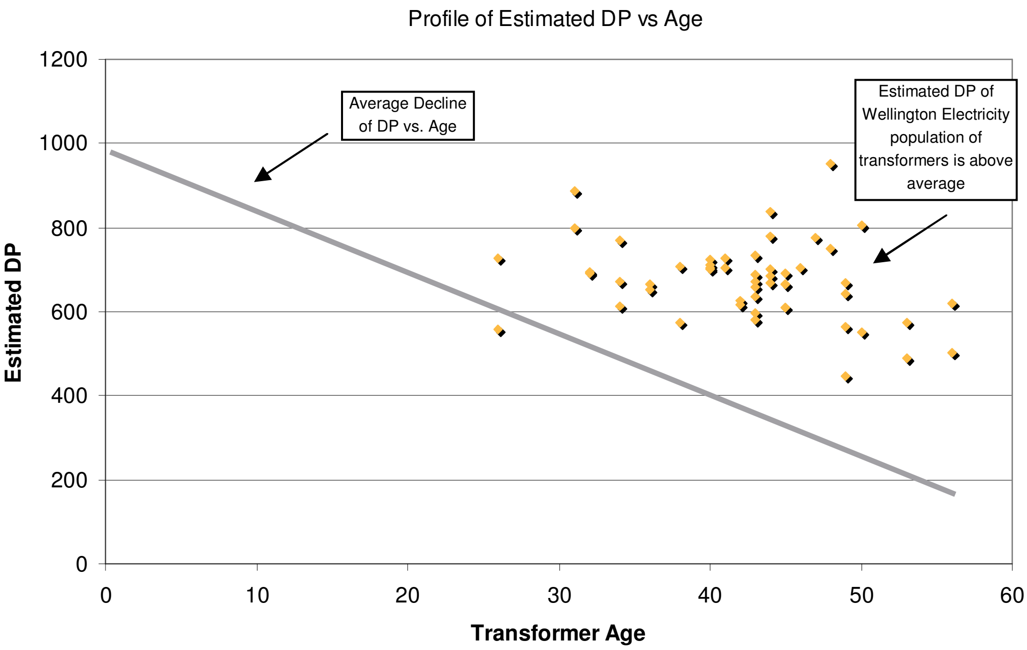


Figure 6-11 Profile of Estimated DP vs. Age (based on 2009 Testing)

From observation of maintenance and testing results, the following site specific issues are known to Wellington Electricity:

Evan's Bay

The transformers installed at Evan's Bay are two of the oldest on the network, having been installed in 1959. These transformers have experienced an increasing number of problems in recent years mostly relating to mechanical performance of the tap changer, and excessive leaks due to deterioration of valves, flanges, gaskets and radiators. Fortunately corrective works have been possible and the transformers returned to service. The high level of redundancy at this site makes a long duration transformer outage possible with minimal risk to supply. The poor mechanical condition of these transformers indicates they are near the end of their life and major repairs to address the issues are not economic. It is expected that these transformers will be replaced, or have transformers of better condition swapped into this location in the short term.

Ngauranga

Ngauranga has the two oldest power transformers installed in the Wellington Electricity network. These transformers are generally reliable however they have experienced problems with the tap changer diverter switches in the past. These issues will be monitored and corrective repairs will be undertaken as required.

Waikowhai Street

The transformers at Waikowhai Street substation are in good condition. They are however fitted with vertical Reinhausen tap changers which are the only two of this kind on the system. These are more difficult to maintain and are serviced on a 6-8 yearly cycle depending on the results of oil testing. The tap changers were last serviced in 2011 by a Reinhausen technician and it is expected that another 8 years of service can be obtained before major maintenance is required again.

The Terrace

The Terrace substation is located in the basement of the James Cook Hotel in central Wellington. The hotel was built around the zone substation and replacement or removal of a transformer could be challenging in the future. The transformers at this location are carefully monitored to ensure no major issues occur that may lead to removal being required.

Worn Contacts on Tap Changers

An increasingly common problem is worn contacts in tap changers, as previous maintenance has simply moved worn middle contacts to the lesser used top and bottom taps. Now it is being found that all contacts are worn and it is costly to replace the entire set of contacts in all tap positions. During 2011, and also planned for 2012, a number of transformers will have full tap changer contact replacement where the condition is found to be unsatisfactory.

6.4.3.3. Renewal and Refurbishment

Where a transformer is identified for relocation, refurbishment is generally performed if it is economic to do so, based on the condition and residual life of the transformer. A non-invasive test to determine the moisture content of the winding insulation is used to aid the economic decision regarding major transformer refurbishments.

Transformer replacement and life-maintaining refurbishments are prioritised through a combination of invasive and non-invasive tests and inspections to determine the condition of the transformer. Tests are carried out on the oil and winding insulation to provide an indication of probable remaining life of the transformer. Based on this a decision can be made in conjunction with functional, financial and performance requirements of the transformer on whether to retain the transformer in service, to refurbish the transformer or to replace it outright.

The following has been allowed for in the asset maintenance and replacement forecasts for the planning period:

- Transformer replacements at two zone substations
- Ongoing transformer refurbishment costs
- Ongoing preventative maintenance including testing and inspections.

Based on age information, and condition test results, replacement of at least two transformers can be expected to require replacement during the period 2012-2015. The replacement units need not be the oldest nor the worst condition, but where capacity and security constraints indicate a high risk associated with failure. All factors are considered in the replacement decision making which is covered in the “Stage of Life” analysis.

In some instances, where a power transformer is approaching, or at, its service half life, subject to condition assessment results, a refurbishment including mechanical repairs, drying and tightening of the core and associated electrical repairs can be justified. There are 8 - 12 transformers that are at a stage where refurbishment is still economic, and some that are showing slight signs of arcing which may require minor refurbishment to check and tighten electrical components. For the majority of the power transformers in the Wellington Electricity network, the testing and inspection programme will aid in getting the best life from the transformer and timing replacement of the unit. This may however not necessarily lead to full refurbishment.

6.4.3.4. Power Transformer "Stage of Life" Analysis

During 2011, the "Stage of Life" analysis was updated for all zone substation transformers and a summary of the analysis is provided below.

Parameters Considered

The "Stage of Life" analysis method considers the attributes of each power transformer as defined over three categories, each containing a number of measurable properties. A rating between one and ten is given to each property, with 1 being the most favourable (good) and 10 being the least favourable (bad).

Category	Property	Rating (normalised)
Age	Age	1 (good) to 10 (poor)
Condition	Estimated Remaining Life	1 (good) to 10 (poor)
Condition	Environmental Protection	1 (good) to 10 (poor)
Condition	Electrical Condition	1 (good) to 10 (poor)
Condition	Assessment of known issues (from field staff)	1 (good) to 10 (poor)
Utilisation	Load vs. Load Rating	1 (good) to 10 (poor)
Utilisation	Type of connected load	1 (good) to 10 (poor)
Utilisation	Number of ICPs served	1 (good) to 10 (poor)
Utilisation	Residual capacity following transfer of load	1 (good) to 10 (poor)

Figure 6-12 Categories, Properties and Ratings for Power Transformers

The ratings are normalised over all transformers so that they can be used as a direct comparison between transformers. Ratings are then weighted, as some properties have a greater impact on stage of life than others. The properties, along with the ratings and weightings applied to them, are described in detail below.

Category Scores

The weightings allocated to each of the three main categories of age, condition and utilisation are as follows:

Category	Weighting
Age	20%
Condition	50%
Utilisation	30%

Figure 6-13 Category Weightings

The rationale behind these weightings is that age and condition are considered as asset related properties and together they are given a higher weighting (i.e. 70%). Utilisation (30%) is considered as a planning related property. Age is considered to be less relevant to overall stage of life of the transformer than the condition parameters; hence it is given a rating of 20%, compared to 50% for condition. Condition has been given the highest weighting due to the complex nature of transformers, difficult and costly repairs, and the long lead time for replacement. This differs from subtransmission cables which can be (relatively) easy to repair for isolated condition problems.

Applying the above weightings to the normalised ratings of each category gives the following ranking of transformers requiring attention, ordered with the highest priority transformer (i.e. highest score) at the top of the list.

Transformer	Substation	Age score	Condition score	Utilisation score	Weighted Total score
Evans Bay 1	Evans Bay	9.5	5.0	4.8	5.9
Evans Bay 2	Evans Bay	9.5	4.7	4.8	5.7
Palm Grove 1	Palm Grove	8.0	3.1	8.2	5.6
Palm Grove 2	Palm Grove	8.0	3.1	8.2	5.6
Terrace 2	Terrace	8.2	2.7	8.0	5.4
Ngauranga A	Ngauranga	10.0	3.6	5.2	5.4
University 1	University	4.6	3.9	8.1	5.3
Mana A	Mana	8.8	3.7	5.6	5.3
Terrace 1	Terrace	8.4	2.4	8.0	5.3
Johnsonville B	Johnsonville	7.7	3.5	6.6	5.3
Frederick St 1	Frederick St	6.1	3.1	8.0	5.1
Frederick St 2	Frederick St	6.1	3.0	8.0	5.1
Johnsonville A	Johnsonville	7.7	3.2	6.6	5.1
Tawa B	Tawa	8.8	3.4	5.5	5.1
Tawa A	Tawa	8.8	3.3	5.5	5.1
Porirua B	Porirua	8.0	3.9	4.8	5.0
Porirua A	Porirua	8.0	3.9	4.8	5.0
Wainuiomata A	Wainuiomata	7.3	4.3	4.4	4.9
Waikowhai 1	Waikowhai	8.9	3.3	5.0	4.9
Plimmerton A	Plimmerton	8.8	3.2	5.1	4.9
Waitangirua A	Waitangirua	8.6	3.6	4.5	4.9
Maidstone A	Maidstone	7.9	3.8	4.5	4.8
Hataitai 1	Hataitai	7.9	2.8	5.9	4.7
Wainuiomata B	Wainuiomata	7.3	3.8	4.4	4.7

Transformer	Substation	Age score	Condition score	Utilisation score	Weighted Total score
University 2	University	4.6	2.6	8.1	4.6
Karori 1	Karori	7.5	3.0	5.4	4.6
Petone A	Petone	8.0	3.9	3.5	4.6
Karori 2	Karori	7.5	3.0	5.4	4.6
Petone B	Petone	8.0	3.8	3.5	4.6
Ngauranga B	Ngauranga	10.0	2.0	5.2	4.6
Maidstone B	Maidstone	7.9	3.3	4.5	4.5
Hataitai 2	Hataitai	7.9	2.4	5.9	4.5
Seaview A	Seaview	7.7	3.2	4.6	4.5
Seaview B	Seaview	7.7	3.1	4.6	4.5
Brown Owl A	Brown Owl	7.7	3.5	3.9	4.4
Waikowhai 2	Waikowhai	8.9	2.3	5.0	4.4
Waterloo A	Waterloo	7.1	2.7	5.3	4.4
Waterloo B	Waterloo	7.1	2.7	5.3	4.3
Gracefield B	Gracefield	7.1	3.8	3.3	4.3
Moore St 1	Moore St	6.8	2.7	5.2	4.3
Naenae A	Naenae	7.7	3.1	4.0	4.3
Waitangirua B	Waitangirua	8.6	2.2	4.5	4.2
Kenepuru B	Kenepuru	7.7	2.8	3.8	4.1
Brown Owl B	Brown Owl	6.1	3.3	3.9	4.1
Trentham B	Trentham	5.7	3.8	3.3	4.1
Kenepuru A	Kenepuru	7.7	2.6	3.8	4.0
Gracefield A	Gracefield	7.1	3.1	3.3	4.0
Korokoro B	Korokoro	6.4	2.9	4.0	3.9
Korokoro A	Korokoro	6.4	2.8	4.0	3.9
Moore St 2	Moore St	6.8	1.7	5.2	3.8
Trentham A	Trentham	5.7	3.2	3.3	3.7
8 Ira St 2	8 Ira St	5.5	2.3	4.6	3.6
Naenae B	Naenae	7.9	1.6	4.0	3.6
8 Ira St 1	8 Ira St	5.5	2.0	4.6	3.5

Figure 6-14 Stage of Life Category Scores for Transformers

Top Ranked Circuits

The top five transformers which have been identified as being most in need of attention are:

Transformer	Ranking (1st = highest priority)
Evans Bay 1	1st
Evans Bay 2	2nd
Palm Grove 1	3rd
Palm Grove 2	4th
Terrace 2	5th

Figure 6-15 Stage of Life Ranking of Transformers

Outcome of "Stage of Life" Analysis

Evans Bay

The Evans Bay transformers are old and issues related to their condition have lead to them being ranked in the top five transformers in need of attention. The Evans Bay transformers are proposed for replacement in the short term, potentially in 2013 or 2014, due to their deteriorating condition. A business case outlining the need for replacement, and detailing the options available, will be prepared during 2012.

Palm Grove

The Palm Grove transformers are old but in good condition. The utilisation score (as a result of the high winter loading) is high which leads to them being included in the top five. At this time no investigation or analysis has been carried out for Palm Grove to determine solutions for improving capacity or reducing loading. As it is a utilisation related issue, any solution would be considered a network development project rather than an asset renewal. It is likely that the solution to reduce loading will be associated with the construction of a new zone substation in the Wellington CBD currently programmed for 2015.

The Terrace

The Terrace transformers are reaching their end of design life, have very high utilisation but are in relatively good condition. Back feed options for The Terrace are limited and should a transformer fail at peak load time, a shortfall of 8.7MVA under N-1 conditions will result. There is approximately 9.6MVA of 11kV back feed capacity for the area which will address the present N-1 shortfall, however any significant load growth at The Terrace will result in a shortfall of back feed capacity. This will be resolved with the construction of a new zone substation in the CBD to reduce loading on this part of the network and provide increased 11kV capacity to meet load growth requirements of the Terrace.

6.4.4. Substation DC Systems

6.4.4.1. Maintenance Activities

The following routine planned inspection, testing and maintenance activities are undertaken on substation DC supply systems (battery banks):

Activity	Description	Frequency
Inspection and monitoring of battery & charger condition	Routine visual inspection of batteries, chargers and associated equipment. Voltage check on batteries and charger.	Annually
Comprehensive battery discharge test	Comprehensive battery discharge test for all batteries, measurement and reporting of results.	2 yearly (Zone only)

Figure 6-16 Inspection and Routine Maintenance Schedule for Zone Substation Battery Banks

Valve regulated lead acid (VRLA) batteries are now the only type of battery used. Maintenance is based on the recommendations of IEEE–1188 (IEEE Recommended Practice for Maintenance, Testing and Replacement of Valve Regulated Lead Acid Batteries for Stationary Applications).

6.4.4.2. Battery and Charger Condition

It was discovered in 2009 that a large number of batteries had been allowed to pass their end of service life replacement date. Some batteries had already failed in-service when called upon to operate substation devices during fault or switching conditions. As a result of this discovery, a comprehensive survey of battery installation dates was undertaken and, following replacement where required, there are now no batteries outside the manufacturer's design life. In some installations, where heat is excessive and cannot be controlled, the batteries are replaced earlier than usual due to thermal deterioration. This means that the overall condition of the battery population is now very good.

Battery chargers are also generally in good condition. The majority have SCADA supervision and the Network Control Room can know if the output has failed and initiate a repair. Given the low value and high replacement cost of battery chargers, they are only repaired where it is economic. Generally the chargers are at the end of their design life at the time of failure so replacement is readily justified.

6.4.4.3. Renewal and Refurbishment

Batteries are replaced using VRLA batteries either as they fail, based on condition assessment results, or when they exceed the manufacturer's design life. For a number of sites, with higher ampere-hour (Ah) demand, 10 year life batteries are available. For smaller sites, or communications batteries where the ampere-hour demand is lower, batteries are only available with 5 year lives. As part of primary plant replacements, Wellington Electricity is intending to standardise the voltages used for switchgear operation as well as communications equipment.

Since 2009, over 400 battery banks have been replaced on the Wellington Network. Going forward all batteries will be replaced every 4-5 years to ensure the standard design life of 5 years is not exceeded. Major replacement programmes will be required again in 2014 and 2015, although the replacement may be staged from 2013 onwards. Battery replacement between 2012 and 2013 will be minor with only around 150 banks requiring replacement (105 in 2012 and fewer in 2013).

Battery chargers generally have no serviceable parts, maintenance is limited and they are generally replaced upon failure with spares held locally. Some zone substations have an automated battery charger with supervisory monitoring which will alarm in the event of failure.

6.4.5. Switchboards and Circuit Breakers

6.4.5.1. Maintenance Activities

The following routine planned inspection, testing and maintenance activities are undertaken on metalclad switchboards and circuit breakers:

Activity	Description	Frequency
General Inspection of 33kV Circuit Breaker	Visual inspection of equipment, and condition assessment based upon visible defects. Thermal image of accessible connections. Handheld PD and Ultrasonic scan.	Annually
General Inspection of 11kV Circuit Breaker	Visual inspection of equipment, and condition assessment based upon visible defects. Thermal image of accessible connections. Handheld PD and Ultrasonic scan.	Annually
33kV Circuit Breaker Maintenance (Oil)	Maintenance of OCB, drain oil, ensure correct mechanical operation, dress or replace contacts as required, undertake minor repairs, refill with clean oil, return to service. Trip timing test before and after service.	4 yearly
11kV Circuit Breaker Maintenance (Oil)	Withdraw and drain OCB, ensure correct mechanical operation, dress or replace contacts as required, undertake minor repairs, refill with clean oil, return to service. Trip timing test before and after service.	4 yearly (Zone) 5 yearly (Distribution)
11kV Circuit Breaker Maintenance (Vacuum or Gas)	Withdraw CB and maintain carriage and mechanisms as required, record condition of interrupter bottles where possible, clean and return to service. Trip timing test before and after service.	4 yearly (Zone) 5 yearly (Distribution)
11kV Switchboard Major Maintenance (zone)	Full or bus section shutdown, removal of all busbar and chamber access panels, clean and inspect all switchboard fixed portion components, undertake condition and diagnostic tests as required. Maintain VTs and CTs. Return to service.	8 yearly (Zone) 10 yearly (Distribution)
11kV Circuit Breaker - Annual Operational Check	Back feed supply; arrange remote and local operation in conjunction with Network Control Room to ensure correct operation and indication.	Annually (Zone only)
PD Location by External Specialist	External specialist to undertake partial discharge location service, presently HV Diagnostics	Annually (Zone only)

Figure 6-17 Inspection and Routine Maintenance Schedule for Zone Substation Circuit Breakers

In addition to the routine maintenance programme above, oil circuit breakers are maintained as required following a number of fault operations.

Circuit Breaker Testing in Progress

6.4.5.2. Switchgear Condition

The switchgear installed on the Wellington Electricity network is generally in very good condition. The equipment has been installed indoors and has not been exposed to extreme operating conditions. Historically it has been well maintained which means that whilst the equipment is old, the majority of it is in good condition. In some locations, the type of load served, or the known risks with the type of switchgear mean that an enhanced maintenance programme is required whilst a replacement programme is undertaken, for example Reyrolle Type C and Yorkshire SO-HI switchgear.

Examples of poor condition assessment outcomes include partial discharge (particularly around cast resin components), corrosion and compound leaks visible externally and also arising from service activities slow or worn mechanisms or unacceptable contact wear. The majority of these observations either do not present a significant risk to the network, or can be easily remedied under Corrective Maintenance programmes.

The condition of zone substation switchboards is considered in the Circuit Breaker "Stage of Life" analysis.

6.4.5.3. Renewal and Refurbishment

Based on the condition assessment carried out as part of the preventative maintenance routine, assets are identified for replacement, or targeted inspection and maintenance programmes to manage risks until replacement is possible. A large number of older circuit breakers remain in place and provide good service as they are in excellent condition due to regular maintenance over the majority of their service life. Some of the older units are showing their age with pitch leaks and failing mechanisms.

Condition, performance, ratings and operational history across the industry are considered when determining the timing for replacement of a circuit breaker. However other drivers that influence the decision for replacement include safety, operability and co-ordination with modern equipment.

Following the implementation of the new planned maintenance programme in 2011, and the resulting improved condition assessment data being obtained, it is expected that by late 2012 there will be sufficient data to compile longer term renewal programmes by both equipment make and model (type replacement) and also individual units.

Specific programmes of replacement have been identified for the planning period as follows.

Reyrolle Type C

Reyrolle Type C circuit breakers were installed between 1938 and the late 1960's. Therefore the majority of units have reached the end of their effective service life. There are 105 units remaining in service on the Wellington network which are being replaced progressively, prioritised by condition and location. These circuit breakers need to be inspected for leaks (oil, compound) and thermal imaging and partial discharge inspections are undertaken on an annual basis. This inspection programme ensures defects or potential issues are detected early so corrective actions can be taken. Several units are not able to be operated due to mechanical failure. Replacements are based on the following programme:

Substation	No. of Circuit Breakers	Year installed	Replacement year	Estimated cost (2012)
9 Duncan Terrace	3	1938	2012	$ 185,000
Evans Bay Zone	12	1958	2012	$ 1,700,000
Cable Car Lane	5	1950	2012	$ 450,000
Hankey Street	9	1941	2012	$ 645,000
69 Miramar Ave	8	1954	2012	$ 615,000
Chaytor Street	7	1954	2012	$ 590,000
139 Thorndon Quay	5	1954	2013	$ 450,000
Karori Zone	11	1962	2013	$ 1,700,000
Kilbirnie	9	1956	2013	$ 650,000
9 Parkvale Road	9	1964	2013	$ 650,000
Gracefield Zone	13	1958	2014	$ 1,700,000
Cornwell Street	5	1945	2014	$ 450,000
Flag Staff Hill	5	1953	2014	$ 450,000

Figure 6-18 Proposed C-type Circuit Breaker Replacement Programme

Yorkshire SO-HI

Yorkshire SO-HI switchgear was installed during the 1970s and 80s in indoor kiosk type substations and there are approximately 130 units in service. SO-HI has a history of failing in service and a number of utilities have removed the equipment entirely, or had operational cautions imposed. The installations in the Wellington Electricity network are in secondary sites and a programme of inspection, testing and bus bar chamber cleaning is being implemented to reduce service failure risks.

Wellington Electricity has imposed an operational restriction on these units so they are not operated manually under fault conditions. The constraint has been evaluated against the potential impact on network performance. Wellington Electricity has reviewed all installations of SO-HI switchgear and in 2011 initiated a programme of replacement for switch units at sites identified as being higher risk initially, with a view to remove the entire population during the planning period.

The majority of SO-HI installations do not have protective elements enabled or remote control, and the units can be replaced with conventional ring main units. In a few cases the units have full protection and control, and are located on feeders with high cumulative SAIDI. These will be replaced with modular secondary class circuit breakers.

Replacement solution	No of Sites
Single 3/4 way RMU	25
Duplicate 3/4 way RMUs	6
Circuit Breakers	4

Figure 6-19 Proposed SO-HI Replacement Quantities

Priority will be given to the following sites based upon location, historic SAIDI, and customer numbers (potential SAIDI and SAIFI).

Sub No.	Location	Feeder	No. of switches	Customer building	Customers beyond	Feeder SAIDI (10 year)
S1059	Whitemans Rd	HAY 2722	4	NO	1311	10.19
S2988	Manchester Unity	JOH 11	3	NO	82	5.51
S3415	Mentor Lane	POR 9	3	NO	73	4.78
S1497	Scholes Lane	PET 07	3	NO	990	0.28
S3297	9 Semple St	POR 4	4	NO	152	0.12
S2867	Fraser Ave No 1	NGA 9	2	NO	488	4.95
S2904	Glenside	JOH 3	5	NO	451	4.26
S2448	Astral Towers	MAI 06	3	YES	836	1.45
S2561	Woolworths	MAI 06	3	YES	836	1.45

Sub No.	Location	Feeder	No. of switches	Customer building	Customers beyond	Feeder SAIDI (10 year)
S2559	Maidstone Mall	MAI 06	3	YES	750	1.45
S3294	W R Grace A	KEN 9	5	YES	250	0.71
S1066	Computer Centre / Sedul Bahr Rd	TRE 02	4	YES	13	0.09
S2544	Pfizer Laboratories	BRO 11	3	YES	1	1.66

Figure 6-20 Proposed SO-HI Replacement Priority Sites

Replacement year	No/Type of Sites	Proposed Budget
2012	2CB / 14 RMU	$1,250,000
2013	1CB / 10 RMU	$1,000,000
2014	7 RMU	$1,000,000

Figure 6-21 Proposed SO-HI Replacement Spend Plan

One site (Todd Motors) has a large, mostly unused switchboard following the closure of the motor assembly plant. Negotiation will be required with the new site owner to find the best solution for replacement of the switchgear. It is expected a number of ring main units can be deployed around the site to provide supply. The budget for this site is not finalised at this time as it is still in the planning stage.

Reyrolle LMT - Current Transformers (CTs)

Reyrolle LMT circuit breakers were installed on the network from late 1960s onwards. There are over 400 units in service. Partial discharge (PD) testing has indicated potential issues around the current transformers (CTs) / or the CT chamber on units with cast resin CTs. Full partial discharge testing (or handheld TEV testing) and corrective maintenance is undertaken on these circuit breakers when high levels of PD is detected.

Two sets of CTs have been replaced with mixed results. In one case the PD was reduced to a normal level, in the other there was no change, and the cast resin monoblock riser (cable box to CT) is suspected to be a likely contributor to PD levels. A further two CTs have been replaced in late 2011, however the site has not been retested to determine the success of the replacement at the time of writing this AMP.

Further investigation, as well as ongoing maintenance and replacement work, will improve the knowledge of the PD issues being experienced, and will help develop corrective refurbishment plans for this type of equipment. The estimated average cost of retro-fitting CTs is under $20,000 per set to address isolated instances. Year on year trending indicates the PD problem is not getting worse, but is maintaining a consistent level, albeit higher than desirable. The success of CT replacement is being evaluated and a programme to replace these components on affected units may commence from 2013 onwards should it prove to be successful in addressing the PD concerns.

Reyrolle LMT – Rotary Auxiliary Switch Failure

During 2011 a number of instances of circuit breaker "failure to operate" occurred under fault and switching operations. This was identified as being a result of contamination of the rotary auxiliary switch leading to false indications and also preventing operation due to the interlocking status being incorrect.

A sample was analysed by a laboratory and found to contain high levels of a styrene residue on the contacts, as well as oil and grime. Although no cause can be known as certain, it is suspected previous maintenance practices have introduced solvents which have released the glues and plastics inside the switch body. These have has migrated onto the contacts and act as an insulator, leading to the "failure to operate" issues.

The correct maintenance practices have been reinforced with the Field Services Provider, including corrective actions where a faulty unit is found. Dust covers are fitted to cleaned contacts to prevent dust and grime ingress.

6.4.5.4. Circuit Breaker "Stage of Life" Analysis

During 2011, the "Stage of Life" analysis was updated on all zone substation 11kV switchboards, and a summary of the analysis is provided below.

Parameters Considered

The "Stage of Life" analysis method considers the attributes of each switchboard as defined over three categories, each containing a number of measurable properties. A rating between 1 and 10 is given to each property, with 1 being the most favourable (good) and 10 being the least favourable (bad).

Category	Property	Rating (normalised)
Construction	Age	1 (good) to 10 (poor)
Construction	Number of Circuit Breakers	1 (good) to 10 (poor)
Condition	Partial Discharge Testing Results	1 (good) to 10 (poor)
Condition	Internal Condition assessment	1 (good) to 10 (poor)
Condition	Spares availability	1 (good) to 10 (poor)
Utilisation	Loading vs. load rating	1 (good) to 10 (poor)
Utilisation	Fault level vs. fault rating	1 (good) to 10 (poor)
Utilisation	Type of load served	1 (good) to 10 (poor)
Utilisation	Number of ICPs served	1 (good) to 10 (poor)
Utilisation	11kV back feed capacity	1 (good) to 10 (poor)

Figure 6-22 Categories, Properties and Ratings for Switchboards

The ratings are normalised over all of the switchboards so that they can be used as a direct comparison between switchboards. Ratings are then weighted as some properties have a greater impact on stage of life than others. The properties along with the ratings and weightings applied to them for are described in detail below.

Category Scores

The weightings allocated to each of the three main categories of construction, condition and utilisation is as follows:

Category	Weighting
Construction	20%
Condition	20%
Utilisation	60%

Figure 6-23 Category Weightings

The categories have been given these weightings on the basis that utilisation, in particular, will be one of the main drivers for remedial action to be taken on a switchboard. Wellington Electricity cannot operate equipment outside its ratings, or have underrated equipment that will affect the proper working of the system.

Construction and condition have equal weightings of 20% each, as neither by itself would be a major driver for remedial attention. Wellington Electricity has a number of medium sized switchboards in service in distribution substations that are over 60 years old. Minor defects or deteriorating condition alone can generally be resolved by partial replacement or increased levels of corrective maintenance. However when combined with high utilisation scores, construction and condition become more important in determining risks associated with each switchboard.

Applying these weightings to the normalised scores from each category allows an overall score to be derived for each switchboard, in turn giving a priority ranking.

Substation name	Switchboard type	Construction score	Condition score	Utilisation score	Total score
Frederick Street	LM23T	7.5	5.8	8.9	8.0
Evans Bay	C	9.3	7.1	6.7	7.3
University	LMT	5.7	4.8	8.5	7.2
Moore St	LM23T	8.7	4.8	7.2	7.0
Hataitai	LM23T	9.0	3.8	7.4	7.0
Kaiwharawhara	LMVP	5.0	3.8	8.7	7.0
Karori	C	9.1	7.6	5.5	6.7
Johnsonville	LM23T	8.8	3.8	6.7	6.5
Nairn Street	LMT	7.2	4.8	6.8	6.5
Gracefield	C	9.4	5.6	5.6	6.4
Porirua	LM23T	9.3	4.8	5.7	6.2

Substation name	Switchboard type	Construction score	Condition score	Utilisation score	Total score
Waterloo	LMT	8.1	2.8	6.7	6.2
Tawa	LM23T	8.9	5.8	5.2	6.1
Ira St	LM23T	8.1	3.8	6.1	6.0
Seaview	LM23T	9.1	2.8	5.9	5.9
Brown Owl	LM23T	8.7	4.8	5.2	5.8
Waikowhai	LMT	8.4	1.8	6.2	5.8
Naenae	LM23T	9.1	2.8	5.5	5.7
Waitangirua	LM23T	8.9	4.8	4.7	5.6
Petone	LM23T	9.1	2.8	5.2	5.5
Wainuiomata	LMT	8.7	2.8	5.1	5.4
Maidstone	LM23T	9.1	3.8	4.5	5.3
Korokoro	LM23T	8.3	3.8	4.6	5.2
Kenepuru	LM23T	8.4	2.8	4.8	5.1
Terrace	NX-PLUS	3.0	2.0	6.6	4.9
Titahi Bay	LMT	8.1	4.8	3.8	4.9
Trentham	LM23T	9.4	3.8	3.6	4.8
Mana	LM23T	6.4	4.8	4.1	4.7
Plimmerton	LM23T	7.5	3.8	3.6	4.4
Palm Grove	LMVP	1.6	0.0	6.5	4.2
Ngauranga	LMT	4.3	4.8	3.1	3.7

Figure 6-24 Stage of Life Category Scores for Switchboards

Top ranked switchboards

The top five ranked switchboards which have been identified as being in need of attention are:

Switchboard	Ranking (1st = highest priority)
Frederick Street	1st
Evans Bay	2nd
University	3rd
Moore Street	4th
Hataitai	5th

Figure 6-25 Stage of Life Ranking of Zone Substation Switchboards

Previous "Stage of Life" Analysis outcomes

From the previous "Stage of Life" analysis on zone substation switchboards, a major project was undertaken to address one of the highest risk switchboards on network at that time:

1. Palm Grove zone substation switchboard replacement – this Reyrolle Type C switchboard was approved for replacement based upon the age and high utilisation (over 9,000 ICPs and exceeding the N-1 incomer rating).

Outcome of 2011 "Stage of Life" Analysis

Frederick Street

Frederick Street features highly in this analysis as a result of its utilisation score. It has a loading of over 30MVA and supplies over 8,000 consumers in the CBD area. Being a CBD substation, the bus is operated split, reducing the prospective fault level. However under some switching conditions it is likely to exceed its fault rating. It is generally in sound condition, apart from some identified partial discharge activity around the CTs which is being resolved under corrective maintenance. This switchboard features highly due to the consequence of failure related to the size and type of load served.

This switchboard may be a suitable candidate for a retrofit upgrade using new components from RPS Switchgear to improve load and fault ratings. Early LM23T boards such as this have been re-rated by the manufacturer to 25kA based upon the fixed portion design. The replacement of circuit breaker carriages is required to achieve this rating, and new blast protection panels provide improved safety. At Frederick Street specifically, the installation of vacuum circuit breakers, improved protection with arc-flash detection, and replacement of the double 1200A incomer arrangement with single 2000A incomers will see the rating issue reduced.

The Frederick Street 11kV reinforcement project recently completed has moved some load away from this site, improving its utilisation score as the loading is reduced, but the residual utilisation is still high.

Evans Bay

Evans Bay is the oldest 11kV zone substation switchboard on the network, having been installed in 1958. It is past the end of its technical life and as a result scores highly in construction. The condition score is also high as it has limited spares and has a history of mechanical faults and poor tests. These condition scores are offset by the low utilisation score, as the number of ICPs, the type of load served and the overall loading are moderate.

This switchboard is also a suitable candidate for replacement following Palm Grove, due to age and condition. However following the removal of the Palm Grove substation, the spares availability will increase and the condition score has been reduced. A project will commence in 2012 to replace this switchboard.

University

University has relatively modern switchgear compared to the majority of Wellington Electricity zone substations, having been installed in 1988. The utilisation factor on this substation is the main reason it is included in the top five list. The substation has a fault level under closed bus situations that exceeds the fault rating of the switchgear, as well as supplying CBD load. The loading level is moderate.

This substation does not need switchgear replacement at the present time as the age and condition is good, however operational restrictions regarding the closed bus need to be observed. Following the evaluation of retrofit upgrades and re-rating at Frederick Street this may be able to be applied to University to improve fault ratings.

Moore Street

Moore Street scores highly due to both its construction (age, and number of circuit breakers), as well as its utilisation, as it supplies CBD load, is heavily loaded and has inadequate fault rating under closed bus operation. The condition score is low, therefore indicating few issues with the switchgear given its age.

A number of options exist for Moore Street, however as it is ranked fifth, investigation work at other substations, particularly around re-rating the fault level may allow an alternative to replacement at this site.

Hataitai

Hataitai moves up the priority ranking after upgrading of the Palm Grove switchboard. It is one of the oldest on the network and is Reyrolle Type LM23T switchgear. Hataitai scores highly on both construction and utilisation scores, as it is at the end of its technical life and has inadequate fault rating for closed bus operation. There are adequate spares available and no major or reoccurring issues have been identified with this switchboard.

Given the age of the equipment and limited ratings, while this switchboard is still a suitable candidate for replacement it will be further investigated in 2012 for options to improve its rating without replacement.

6.4.6. Substation Protection Relays

6.4.6.1. Maintenance Activities

The following routine planned testing and maintenance activities are undertaken on protection relays:.

Activity	Description	Frequency
Protection Testing for Electromechanical Relays	Visual inspection and testing of relay using secondary injection. Confirm as tested settings against expected settings. Update of test record and results into Protection Database	2 yearly (Zone) 5 yearly (Distribution)
Protection Testing for Numerical Relays	Visual inspection, clearing of local indications, and testing of relay using secondary injection. Confirm as tested settings against expected settings. Confirm correct operation of logic and inter-trip functions. Update of test record and results into Protection Database	2 yearly (Zone) 5 yearly (Distribution)
Numerical Relay Battery Replacement	Replacement of backup battery in numeric relay	2 yearly (Zone) 5 yearly (Distribution)

Figure 6-26 Inspection and Routine Maintenance Schedule for Zone Substation Protection Relays

Regular testing of protection relays is undertaken to determine correct operating functionality. Protection relay testing will continue on a regular basis and budgetary provision for this has been made in the maintenance expenditure projections.

The key focus of protection relay maintenance is to identify any equipment that is not operating correctly or has failed. In order to maintain network reliability performance it is necessary to identify these issues before a failed or mal-operating protection relay is required to operate. This is especially relevant with the large number of older electromechanical relays on the network.

Testing of the large number of differential relays on the network (Reyrolle SOLKOR, or similar) also serves to test the copper pilot cables between substations. Upon a failed test, the protection circuit is either moved to “healthy” pairs on the pilot cable, or the cable is physically repaired. Due to deteriorating outer sheaths on pilot cables, some early pilot cables are now suffering from moisture ingress and subsequent degradation of insulation quality. A grease filled pilot joint is now being used to block moisture from spreading though entire sections of cable.

Numerical relays, although equipped with self-diagnostic functions, are tested as shown in the table above. With more complex protection schemes coming into service, these need to be tested to ensure the correct functions and logic schemes are still operating as expected.

6.4.6.2. Renewal and Replacement

The majority of electromechanical relays are approaching the end of their technical life and ideally should be replaced over the next 10 years. However the economic impact of replacement with modern numerical protection relay equivalents is being carefully considered. Therefore, the replacement programmes that are in place generally focus on relay condition and coordination with other replacement programmes or projects especially for assets such as switchgear and transformers. At the time of primary equipment replacement the opportunity is taken to upgrade associated protection schemes to meet the current standards because the relays are usually mounted within switchgear panels as an integral system. To date, electromechanical relays have provided reliable service and are expected to remain in service for the life of the switchgear it controls – generally greater than 40 years. For newer numeric relays, it is not expected that the relay will provide the same length of service and a service life of less than the ODV standard life is expected.

The following programmes and projects have been allowed in the asset replacement and maintenance budgets.

- Ongoing replacement of PBO relays in conjunction with switchgear replacements in the short term, or individually where known risks exist. Sites with PBO relays will be identified in the maintenance programme over the next two years, and any replacement programme determined from then.
- There are around 10 Nilstat relays still in service which will need to be replaced, however they are in a Reyrolle Type C switchboard, so total replacement will occur in the short term (switchboard scheduled for replacement in 2014) and an individual replacement project is not justified.
- Ongoing zone substation and network protection and control replacement/upgrades for assets supplied from GXPs, particularly Takapu Rd, Haywards, Gracefield, Upper Hutt and Wilton as part of upgrades Transpower may undertake.
- Ongoing protection and control replacements/upgrades across the network as identified by asset condition monitoring.

6.4.7. Load Control Equipment

6.4.7.1. Maintenance Activities

The following routine planned inspection, testing and maintenance activities are undertaken on load control equipment. Wellington Electricity owns the injection plants located at substations and blocking cells at GXPs, but not any of the consumer receivers. As such the full end to end testing of the ripple system is not possible.

Activity	Description	Frequency
General Inspection	Check output signal, visual inspection, thermal image and partial discharge scan, motor generator test run	6 monthly
Maintain Ripple Injection Plant	Clean and inspect all equipment, maintain motor generator sets, coupling cell test and inspection	Annually
Blocking Cell Testing and Maintenance	Visual inspection, cleaning and maintenance of ripple blocking cells at GXPs as required	5 yearly

Figure 6-27 Inspection and Routine Maintenance Schedule for Ripple Plant

6.4.7.2. Renewal and Refurbishment

Wellington Electricity has no short terms plans to replace any ripple injection plant due to age or condition. Repairs and maintenance are undertaken as required, and the plant is generally reliable. Basic spares are held locally, and other items can be sourced from abroad as required, but with longer lead times.

In the Hutt Valley area, interconnectivity at 11kV allows ripple signal to be provided from adjacent substations in the event of failure. In the Wellington city area, there is dual plant located to supply each of the GXPs at 33kV, with two 11kV plants supplying the Kaiwharawhara 11kV point of supply.

As risk mitigation for the Wellington City area, a spare ripple converter unit was purchased in 2011 to be able to connect to any of the four city ripple injection locations in the event of a failure of the existing plant. The primary risk was the failure of one of the two converter units at Frederick Street as the remaining unit would not be large enough to provide adequate signal for all network configurations.

In the medium term, Wellington Electricity will look to replace older rotary plant installed on the 11kV system in the Hutt Valley and Porirua areas as these assets are approaching the end of their service life. It is likely that replacement may involve rationalisation of plant by installing larger plant at GXP level, using modern low frequency ripple signals, rather than high frequency injection at Zone Substation level. Whilst technically straightforward it may become a complex issue involving retailers and meter/relay asset owners.

The ripple control injection plant for the Central Park GXP area is a Brown-Boveri plant located at the Frederick Street zone substation and comprises two units operated in parallel. With one unit out of service, ripple signal strength is marginal in some parts of the network. This matter has been investigated and it is related to the increased load on the Central Park 33kV bus following the reconfiguration of supply to The Terrace substation from Central Park (previously from Wilton GXP), and the moving of the Central Park 11kV point of supply (Nairn St substation) transformers from the 110kV bus to the 33kV bus. The installation of a larger plant connected to the Central Park 33kV bus is not necessarily the best option. A move to a modern low frequency plant (resulting in better signal propagation) would involve changing adjacent GXPs to the same frequency to ensure ripple control is available under any supply configuration. The overall solution for this area is still being developed, although it is expected that investment will be required within the planning period.

There are some small areas of network that receive DC bias load control signals. This system is no longer supported and it is unknown how many consumer installations still use the DC bias system. It is proposed to decommission this system in the short term as projects allow the removal of the DC bias injection plant (typically located at distribution substations). Affected consumers will be moved to ripple load control. The process required, and the implications both in terms of technical and commercial arrangements, need to be fully worked through as this affects the incumbent metering owner's receiver assets.

6.4.8. Poles and Overhead Lines

6.4.8.1. Maintenance Activities

The following routine planned inspection, testing and maintenance activities are undertaken on poles and overhead lines:

Activity	Description	Frequency
Inspection and condition assessment overhead lines by zone/feeder	Visual inspection of all overhead equipment including poles, stay wires, crossarms, insulators, jumpers and connectors, switchgear and transformers. All HV and LV circuits by feeder. Recording and reporting, and minor repairs as required.	Annually
Concrete and steel pole inspections and testing	Visual inspection of pole, tagging and reporting of results.	5 yearly
Wooden pole inspections and testing (Deuar)	Visual inspection of pole, testing and analysis of pole using Deuar MPT40 test, tagging and reporting of results.	5 yearly
LFI inspections	Visual inspection of line fault passage indicator, testing in accordance with manufacturer recommendation.	Annually
LFI battery replacement	Removal of unit, assessment of condition and replacement of onboard battery, replacement onto live line using hot stick.	8 yearly

Figure 6-28 Inspection and Routine Maintenance Schedule for Poles and Overhead Lines

All overhead lines get an annual, visual inspection to determine any immediately obvious issues with the lines, condition of components such as crossarms and insulators, and to note any prospective vegetation, third party encroachments or safety issues. In addition, all connectors in the current carrying path get a thermal scan to identify any high resistance joints which may fail. These inspections drive a large part of the overhead corrective maintenance works, as well as contribute to asset replacement programmes for insulators and crossarms.

Soon after taking ownership of the Wellington network, Wellington Electricity identified shortcomings in the regular pole inspection and testing method being used on the network and initiated a review of industry practice with respect to pole inspections. This review was undertaken for the purpose of helping to define the options available for a regular pole inspection programme, with a particular focus on how wooden poles are inspected. The review concluded that any inspection method should include a test of the below ground condition of wooden poles and that the existing standard for pole inspection should be modified.

Three different methods for inspecting wooden poles were reviewed, namely:

- Digging around the pole to expose and allow inspection below ground level
- Pole Scan and Mole probe test
- Mechanical strength test using the Deuar MPT40 partial loading system.

Of the three methods reviewed, it was concluded that the Deuar MPT40 best satisfies the need for objectivity, repeatability and accuracy. This conclusion is supported by independent analysis and referees.

The Deuar testing programme commenced in the third quarter of 2011 and has so far has been effective, with the number of condemned poles being at expected levels. The programme also addresses concerns that the previous method was not picking up structural issues deeper at the base of the pole, and provides useful remaining life indicators. The efficiency of the programme is improving as operators become more familiar with the testing techniques.

6.4.8.2. Pole Condition

The poles on the Wellington Electricity network are generally in good condition as a large scale testing and replacement programme occurred between 2004 and 2006. Around half the poles are concrete, which are durable and in good condition. The remainder are timber poles which are tested and replaced in accordance with their serviceability index and visible structural defects.

Common condition issues with timber poles are deterioration of pole strength, either through internal or external decay, leaning poles, head splits and third party damage.

Common condition issues with concrete poles include cracks, spalling (loss of concrete mass due to corrosion of the reinforcing steel), leaning poles and third party damage.

A significant contributor to leaning poles on the Wellington network is third party attachments. There is an existing agreement to support telecommunications cables from TelstraClear and Telecom on network poles, and in some areas the additional loading exceeds the designed foundation strength leading to slight leaning of poles across the network. Many of these can be remedied with corrective maintenance to straighten the pole and improve the foundation design through blocking or compacting course metal around the pole base.

Wellington Electricity will finalise a standard for third party attachments to network poles during 2012. This standard is aimed to ensure future connections to poles for telecommunications infrastructure (for example) meet Wellington Electricity’s requirements and do not have an injurious effect on the network. It is expected that third party network operators will be required to contribute to the upgrade of network poles where there will be significant impact as a result of their connections.

6.4.8.3. Overhead Line Condition

All new insulators are of the solid core post type as they provide a higher level of reliability in polluted environments and lightning prone areas than the pin type insulator historically used on the network. Pin type insulators are no longer used for new 33 kV or 11 kV line construction. There is no programme to proactively replace existing pin type insulators. This will occur under system maintenance or when crossarms require replacement.

High wind loadings can sometimes result in fatigue failures around line hardware such as compression sleeves, line guards and armour rods on the older All Aluminium Conductor (AAC) lines that have historically been used on the Wellington network. Recent incidents have also shown fatigue problems with fittings supporting strain points. Conductor fatigue issues such as these cannot be visually detected, therefore it is proposed to take a sample of conductor and components from service and have these analysed by materials scientists to determine remaining asset life in order to plan for a proactive replacement program. Where a conductor issue is identified, All Aluminium Alloy Conductor (AAAC) will be used as a replacement material due to its increased strength and improved fatigue resistance.

It should be noted that steel reinforced conductors have not been widely used in the Wellington region due to high salt pollution causing shortened service life from corrosion of the steel core.

It has been observed that a number of Fargo sleeve type automatic line splices were failing in service. These sleeves are only suitable for a temporary repair and in some cases had been in service for over 10 years. The failure of these caused lines to fall and resulted in feeder faults. These are no longer used on the network and, where large quantities are found in a line, they will be replaced with compression type full tension sleeves or the area will be re-conductored.

6.4.8.4. Renewal and Refurbishment - Lines

Since 2009, Wellington Electricity has invested in renewal of overhead lines in two areas which were found to have particularly high SAIDI and SAIFI. Areas of Newlands (Ngauranga 4 Feeder) and Korokoro have now been reconductored, and have had all the line hardware, crossarms and poor condition poles replaced. These two feeders have had a significant improvement in performance since this work was completed.

During 2012 another section of the Ngauranga 4 feeder will be rebuilt and reconductored, and programmes of overhead line refurbishment will commence in Wainuiomata and Makara.

It is likely that similar reconductoring or area rebuild projects will occur as further issues arise on the network, or where there are increased instances of conductor or component failure. This work usually involves sections of line of only a few hundred metres up to several kilometres. Details of prospective overhead network renewal and refurbishment projects are covered later in this section under Feeder Performance.

Overhead line work in progress

6.4.8.5. Renewal and Refurbishment - Poles

Following inspection of poles, and failing the serviceability test, they are categorised as red tagged, or yellow tagged. Red tagged poles have a serviceability index of less than 0.5 or have a major structural defect, and are programmed for immediate replacement (3 months). Yellow tagged poles have a serviceability index of 0.5 to 1.0, or have moderate structural defects, and are programmed for replacement within 12 months. Crossarms are identified for replacement from the detailed line inspections.

With the introduction of the Deuar pole testing methodology, it is expected that a better assessment of pole strength and remaining life will occur, pole replacements will decrease over time, and poles that are replaced are the most “at-risk” on the network. Initial testing with the Deuar programme has produced similar replacement rates as previous methods, however many of the poles in the initial testing programme were prioritised as those with known low strength but were still serviceable at the time of the last test.

Concrete poles are replaced following an unsatisfactory visual inspection, with large cracks, structural defects, spalling or loss of concrete mass being the main criteria. All replacement poles are concrete, except where the location requires the use of timber for weight, access constraints or loading design.

It is expected that if a third party user of the poles wishes to extend their existing network or use Wellington Electricity’s overhead network as a carrier, such as a telecommunications company stringing aerial fibre optic cables, an assessment of existing poles will be required. Replacement will need to occur where design strength parameters are exceeded or height clearance issues are encountered on a cost share basis.

6.4.9. Overhead Switches, Links and Fuses

6.4.9.1. Maintenance Activities

The following routine planned inspection, testing and maintenance activities are undertaken on overhead switches, links and fuses:

Activity	Description	Frequency
Visual Inspection and Thermal Image	Visual inspection of equipment, and condition assessment based upon visible defects. Thermal image of accessible connections.	Annually
ABS Service	Maintain air break switch, clean and adjust contacts, check correct operation.	3 yearly
HV Knife Link Service	Maintain knife links, clean and adjust contacts, check correct operation.	3 yearly
Gas Switch Service	Maintain gas switch, check and adjust mechanism as required.	9 yearly
Remote Controlled Switch - Annual Operational Check	Bypass unit or back feed, arrange remote and local operation in conjunction with Network Control Room to ensure correct operation and indication.	Annually
Inspection and Testing of Earthing	Visual inspection of earthing system installation and mechanical protection, testing of individual and combined earth bank resistance.	5 yearly

Figure 6-29 Inspection and Routine Maintenance Schedule for Overhead switch equipment

All overhead switches and links are treated in the same manner, and are maintained under the preventative maintenance programme detailed above. Overhead HV fuses are visually inspected during both the annual overhead line survey and also at the time of transformer maintenance (for fuses supplying overhead transformers), however the large quantity and low risks associated with fuses does not justify an independent inspection and maintenance programme. Remote controlled overhead switches are operationally checked annually to ensure correct operation and indication, from both local and remote (SCADA) control points.

6.4.9.2. Condition of overhead switches, links and fuses

Generally, the condition of overhead equipment on the Wellington network is good. The environment subjects equipment to wind, salt spray, pollution and debris which causes a small number of units to fail annually. Common modes of deterioration are corrosion of steel frame components and operating handles, mechanical damage to insulators, as well as corrosion and electrical welding of contacts. In harsh environments, fully enclosed gas insulated switches with stainless steel components are now being used.

A problem has previously been identified with some types of expulsion drop out (EDO) fuses that are overheating, which as a result of the use of different metals is causing the pivot point on the fuse holder to seize and this is preventing the fuse holder from operating as designed. The situation is being monitored and, if warranted, a replacement programme will be put in place. Over the past two years this has not been an issue and therefore replacement only occurs as required.

The coastal environment around Wellington causes accelerated corrosion on galvanised overhead equipment components and where possible, stainless steel fittings are preferred as they have proven to provide a longer component service life.

6.4.9.3. Renewal and Refurbishment

There is no proactive programme to replace overhead switchgear or devices. Any renewal activity on these assets is driven from standard inspection rounds and resultant maintenance activities from the identification for corrective work. With the extensive pole and crossarm replacements undertaken over recent years, a large number of overhead switches have been replaced. Replacement generally occurs at the time of pole or crossarm replacement if the condition justifies replacement.

A small allowance is made in the CAPEX programme for HV switchgear replacement which funds any required replacements that do not occur in conjunction with other projects.

6.4.10. Auto Reclosers and Sectionalisers

6.4.10.1. Maintenance Activities

The following routine planned inspection, testing and maintenance activities are undertaken on auto reclosers and sectionalisers.

Activity	Description	Frequency
Visual Inspection and Thermal Image	Visual inspection of equipment, and condition assessment based upon visible defects. Thermal image of accessible connections.	Annually
Recloser and Sectionaliser - Annual Operational Check	Bypass unit or back feed, arrange remote and local operation in conjunction with Network Control Room to ensure correct operation and indication.	Annually
Recloser & Sectionaliser Service	Maintenance of recloser, inspect and maintain contacts, change oil as required, prove correct operation	3 yearly
Inspection and Testing of Earthing	Visual inspection of earthing system installation and mechanical protection, testing of individual and combined earth bank resistance	5 yearly

Figure 6-30 Inspection and Routine Maintenance Schedule for Auto Reclosers and Sectionalisers

6.4.10.2. Condition of auto reclosers and sectionalisers

The majority of the units in service are in good condition. From inspection activities the bases of a number of units have surface corrosion that can be addressed under the corrective maintenance programme. Testing of some recloser units in-situ is limited, and it has been found that several McGraw-Edison KFE reclosers have not been working as intended.

The operational performance of auto reclosers is evaluated from fault information, which indicates whether the unit performed as expected.

6.4.10.3. Renewal and Refurbishment

Presently there are no programmes underway to replace auto reclosers as there are no major issues with the majority of the assets. In recent years there have been reliability and automation projects undertaken, and as a result there are appropriately placed reclosers and sectionalisers in service.

One McGraw-Edison KFE recloser (Ohariu Valley) was replaced in 2010, and in 2011 another two units (Army Magazine and Moeraki) were found to be not operating correctly. In one case the recloser can be removed as there are only 50 consumers between the recloser and an upstream circuit breaker, as well as it being placed in a difficult to access location, which makes replacement uneconomic. In the other case a recommendation will be made to replace the unit if, following the testing and repairs undertaken, it is still found to not clear all faults.

A programme of replacement for KFE reclosers will be considered should more be found to fail to operate and are not able to be repaired economically.

Reyrolle OYT reclosers are now beyond their service life, and some have been known to mal-operate, leading to the zone substation feeder tripping. Upon re-energisation of the feeder the recloser continues its cycle and trips again. These units are simply replaced when this fault is found to be due to their age.

Other units will be replaced as required following unsatisfactory inspection or testing, or if the units are found to not operate correctly in-service.

6.4.11. Voltage Regulators

6.4.11.1. Maintenance Activities

The following routine planned inspection and maintenance activities are undertaken on voltage regulators:

Activity	Description	Frequency
Visual Inspection and Thermal Image	Visual inspection of equipment, and condition assessment based upon visible defects. Thermal image of accessible connections.	Annually
Inspection and Testing of Earthing	Visual inspection of earthing system installation and mechanical protection, testing of individual and combined earth bank resistance.	5 yearly

Figure 6-31 Inspection and Routine Maintenance Schedule for Voltage Regulators

6.4.11.2. Renewal and Refurbishment

Wellington Electricity has only one voltage regulator in service, operating at 400V. This unit has been identified as being in poor condition. It will be removed from service during 2012 once an 11kV reinforcement project and substation installation is completed to supply the 400V circuits in the area, eliminating the need for the voltage regulator.

6.4.12. HV Distribution Substations and Equipment

6.4.12.1. Maintenance Activities

The following routine planned inspection and maintenance activities are undertaken on distribution substations and associated equipment:

Activity	Description	Frequency
Inspection of Distribution Substations	Routine inspection of distribution substations to ensure asset integrity, security and safety. Record and report defects, undertake minor repairs as required. Record MDIs where fitted.	Annually
Grounds maintenance - Lump sum	General programme of grounds and building maintenance for distribution substations	On going
Fire Alarm Test	Inspect and test passive fire alarm system	3 monthly
Visual Inspection and Thermal Image (Ground Mount Transformer)	Visual inspection of equipment, and condition assessment based upon visible defects. Thermal image of accessible connections. Handheld PD and Ultrasonic scan.	Annual
Visual Inspection and Thermal Image (Pole Transformer)	Visual inspection of equipment, and condition assessment based upon visible defects. Thermal image of accessible connections.	Annual
Inspection and Testing of Earthing	Visual inspection of earthing system installation and mechanical protection, testing of individual and combined earth bank resistance	5 yearly

Figure 6-32 Inspection and Routine Maintenance Schedule for HV Distribution Substations and Transformers

Activity	Description	Frequency
Visual Inspection of Switchunit	Visual inspection of equipment, and condition assessment based upon visible defects. Thermal image of accessible connections. Handheld PD and Ultrasonic scan.	Annually
Switchunit Maintenance (Magnefix)	Clean and maintain Magnefix unit, inspect and replace link caps as required, test fuses, check terminations where possible.	5 yearly
Switchunit Maintenance (Oil Switch)	Clean and maintain oil switch unit, drain oil and check internally, check terminations and cable compartments. Ensure correct operation of unit. Refill with clean oil.	5 yearly
Switchunit Maintenance (Vacuum or Gas Switch)	Clean and maintain switch unit, check terminations and cable compartments. Ensure correct operation of unit. Check gas / vacuum levels.	5 yearly

Figure 6-33 Inspection and Routine Maintenance Schedule for HV Switch Units

6.4.12.2. Distribution Switchgear Condition

The switchgear installed on the Wellington Electricity network is generally in good condition and comprises both oil and gas insulated ring main units, as well as solid resin insulated equipment. Routine maintenance addresses the majority of minor defects, and on occasion a unit requires replacement when the condition is unacceptable. Common condition issues experienced include mechanical wear, both of the enclosure/body as well as operating mechanisms, electrical discharge issues or poor oil condition and insulation levels.

Some specific condition issues are noted below:

Solid Insulation Units - Magnefix/Krone

Magnefix switchgear is cleaned five-yearly, with targeted cleaning for a number of sites undertaken more frequently as a corrective maintenance activity. Magnefix switchgear is generally reliable however there are specific cleaning requirements to avoid tracking problems associated with the resin body casing due to the accumulation of dust and other deposits.

There have been recent experiences of Magnefix failures on the network due to a suspected termination failure mode. It is believed that the early style "figure 8" connectors on some older units (typically installed between 1968 and 1975) fail under heavy loads due to heating and thermo-mechanical problems. The failures have all been experienced on residential feeders with recent load growth, during the winter evening peak. A survey of older units has shown a number with low or leaking termination grease levels which may be a physical sign of heating in the connector. These units are prioritised for termination replacement using new connectors and heatshrink terminations if evaluation indicates the unit does not need replacement due to age, other conditions or operational factors.

Andelect SD Series 1

There is presently an operational restriction on Series 1 SD switchgear. This equipment is being replaced when it is identified as requiring defect repairs, or when opportunities exist to replace it in conjunction with other distribution assets. There have been no failures on this network with this type of equipment; however replacement due to age and known issues is prudent. Following a complete condition assessment as part of the routine inspection programme, the overall condition of these units will be known and a prioritised replacement programme will be established to replace these during the planning period.

Statter, and Long and Crawford

There are a number of Statter, and Long and Crawford type ring main switches installed on the Hutt Valley network. These have been installed in outdoor cage substations and are subject to harsh environments. Where possible these are being replaced in conjunction with other distribution upgrades due to age and condition. Some networks have experienced catastrophic failures of early Statter switches in outdoor environments. As part of the routine inspection programme, units in poor condition are identified and schedule for corrective repairs or replacement.

6.4.12.3. Renewal and Refurbishment

HV Distribution Switch Gear (Ground Mounted)

Note – This section excludes circuit breakers which are discussed in a previous section.

Any minor defects or maintenance issues are addressed on-site during inspections. This may include such maintenance as topping up oil reservoirs, replacing bolts, rust treatment and paint repairs. Major issues that cannot be addressed on site usually result in replacement of the device. Likewise, replacement of the device is carried out if it is unsafe or if it is uneconomic or impractical to undertake a repair on site. Wellington Electricity has an ongoing refurbishment and replacement programme for all ground mounted distribution switchgear. Provision is included in the asset replacement forecast to fund this programme. The drivers for replacement of ground mounted switchgear include:

- The assessed condition of the equipment
- The availability of spare parts
- The switchgear insulating medium
- The location on the network and consequence of failure.

The continued use of oil insulated switchgear has been reviewed and the decision made to make use of other types such as vacuum or gas (SF_6) insulated types in future. When any switchgear device fails, the reason for the failure is studied and followed up with a cost benefit analysis to determine the best option from repairing, refurbishing, replacing or decommissioning the device and others of the same type. There are several types of ring main switch that have identified issues around age, condition and known operational or historic issues. These include early Reyrolle oil switches (LDI, JKSS, IA18), AEI, Statter, Long and Crawford, and early Andelect switches. These will be replaced based on the risks associated with each type, and summarised later in the document (these programmes are in addition to the annual budget for switch replacement).

Low Voltage Distribution Switch Gear (Substation)

Low voltage distribution switchgear and fusing is maintained as part of routine substation maintenance and any issues arising are dealt to at that time. The Wellington city area has a large number of open LV distribution boards in substations, and a safety programme has been undertaken to cover these with clear Perspex covers, as additional sites are identified they are completed, with a small annual allowance made to capture and sites missed in the original programme.

The overall performance of LV distribution switchgear and fusing is good and there are no programmes underway to replace this equipment. All new installations use DIN-style fuse disconnectors which are safe, reliable and low maintenance.

Distribution Transformers

If a distribution transformer is found to be in an unsatisfactory condition during its regular inspection it is programmed for corrective maintenance or replacement. An in-service transformer failure is rare and if it should occur it is investigated to determine the cause. Based on this assessment a decision is made to repair, refurbish, or scrap the unit. Typical condition issues include rust, heavy oil leaks, integrity and security of the unit. Some minor issues such as paint, spot rust and small leaks can be repaired and the unit will be returned to service on the network. The refurbishment and replacement of transformers is an ongoing programme, which is provided for in the asset maintenance and replacement budget, however it is undertaken on a needs basis (condition, loading, etc) arising from inspection rather than by age.

In addition to the transformer unit itself, the substation structures and associated fittings are inspected and replaced as need be. Examples include distribution earthing, substation canopies and kiosk buildings. Some renewal may be costly and time consuming as a large number of berm substations in the Hutt Valley area are an integral substation manufactured during the 1970s and 80s by the likes of Tolley Industries. Replacement of these units will require complete foundation replacement and extensive cable works.

Given the high number of these in service, a compatible replacement unit is being developed with a transformer manufacturer to allow like for like replacement at much lower cost than complete replacement of the entire substation.

Wellington Electricity now uses a canopy type substation with independent components (LV switchgear, HV switchgear and transformer) as a standard for new installations where practicable, as opposed to integral substations. This allows for component replacement or upgrade, or canopy replacement, without affecting the entire installation and will reduce the overall life cycle cost.

Wellington Electricity has reviewed the construction standards for overhead transformers. Previously, transformers up to 300kVA were mounted on overhead structures. A number of electricity lines businesses have made a move away from mounting transformers above 150kVA due to seismic and safety concerns. Modern transformers of 150kVA and 200kVA are now lighter than old 150kVA units and the largest pole mounted transformer for replacement installations is 200kVA.

Distribution Cables

Maintenance of the underground distribution cable network is limited to visual inspections and thermal imaging of cable terminations. Cables are operated to failure and then either repaired or sections replaced. A more intensive maintenance regime is not considered cost effective, given that the network is generally designed so that supply can be maintained while cable repairs are undertaken.

A known issue on the 11kV network is a type of joint kit installed on early XLPE cables between 1980 and 1983 that did not adequately seal between XLPE and PILC cables on the outer sheath. These have been mostly remedied, however some may still exist. No active programme is in place to test or repair these joints however it is noted and in time if performance deteriorates then a programme may be initiated.

Cable replacements are prioritised based on a combination of fault history and frequency together with tests undertaken after earlier cable fault repairs. Cable replacements will be targeted at cables exhibiting high fault rates, or showing poor test results following a repair. The small number of natural polyurethane insulated cables is most likely to show high failure rates and hence this type of cable is more likely to be replaced following a cable fault. An allowance is made each year in the CAPEX programme to replace cable based upon historic trends and known defects.

Cable Terminations

Cable termination replacement is driven by visual inspection, either showing signs of discharge, or significant compound leaks, as well as analysis of fault rates. The exception to this is 11kV cast metal pothead terminations where analysis of fault rates, together with a risk assessment, has resulted in a decision to replace them with heat shrink terminations.

During recent years, there has been an increase in the number of older outdoor heatshrink terminations that have failed in-service. This is not yet a major concern as only a couple fail each year. Upon examination of the failed asset it appears that workmanship is often the cause, with sealing mastic at the lug end of each phase not appropriately applied, or the heatshrink not adequately shrunk down or cut back too far. Over time moisture ingress occurs and eventually the termination blows out at the crutch. The terminations were all in excess of 15 years old, and the heatshrink material had not failed. Reminders and training refreshers are given to staff following such findings.

6.4.13. Low Voltage Pits and Pillars

6.4.13.1. Maintenance Activities

The following routine planned inspection and maintenance activities are undertaken on low voltage pits and pillars, either for consumer service connection and fusing, or network low voltage linking:

Activity	Description	Frequency
Inspection of Service Pillars	Visual inspection and condition assessment of service pillar, minor repairs to lid as required.	5 yearly
Inspection of Service Pits	Visual inspection and condition assessment of service pit, minor repairs as required.	5 yearly
Inspection of Link Pillars	Visual inspection and condition assessment of link pillar, thermal imaging and minor repairs as required.	5 yearly
U/G link box inspection including Thermal Image	Visual inspection and condition assessment of link box, thermal imaging and minor repairs as required.	5 yearly

Figure 6-34 Inspection and Routine Maintenance Schedule for LV Pits and Pillars

Starting in 2011, Wellington Electricity has included a loop impedance test to check the condition of the connections from the fuses to the source in underground pillars. Where practical, damaged pillars are repaired but otherwise a new pillar or a pit is installed.

6.4.13.2. Renewal and Refurbishment

Pillars are generally replaced following faults or reports of damage. Pillars with a high likelihood of future repeat damage by vehicles are replaced with pits. When large groups of older pillars, such as concrete or 'mushroom' type, are located and their overall condition is poor they are replaced as repair is impractical or uneconomic.

There are a number of different variants of service connection pillars on the network that are being replaced in small batches, notably under-veranda service connection boxes in older commercial areas.

There is ongoing replacement of underground link boxes around Wellington City. Many have deteriorated to a point where they may not be safe to operate under some conditions or they may not provide reliable service. The link boxes are either being jointed through, where the functionality is no longer required, or they have been replaced entirely to provide the same functionality. These replacements are driven from an incident where a link box failed catastrophically, as well as the general poor condition of some of these link boxes which are now over 50 years old. A complete survey was undertaken in 2009 that provided condition assessment data to allow for renewal programmes in subsequent years. The majority of unserviceable link boxes have been replaced, so it is expected that fewer than 10 will require replacement during 2012. For the remainder of the planning period the link boxes will be replaced following an unsatisfactory inspection outcome.

An allowance is made each year in the CAPEX programme to replace service pillars that have become badly damaged, or replacement with pits in areas subject to vehicle damage. This budget is based upon historic trends but rarely exceeds 60 units per year.

6.4.14. SCADA

The SCADA system is generally self monitoring and as such is there is no preventative maintenance carried out on it. Master station maintenance is broken up into two categories: (a) hardware (b) software.

(a) Hardware support for both Haywards and Central Park (disaster recovery site) will be provided as required by Wellington based maintenance contractors.

(b) Software maintenance and support is to be provided by CHED services, part of Powercor, out of Melbourne via the TCP/IP linking between their control centres and Wellington Electricity's.

Existing RTUs do not have full back up and maintenance is based on failure. First line maintenance on the system is carried out as required by the maintenance contractor within the scope of its substation maintenance contracts. The substation level IP network is monitored and supported from within New Zealand by the respective service providers of the IP network infrastructure.

The network control centre at Haywards has a UPS system to provide backup supply to the master station and operating terminals. This is subject to a maintenance programme provided by the supplier of the equipment. In addition, this unit has dual redundancy of converters and batteries so provides a high level of supply security in the unlikely event of failure.

6.4.14.1. Condition Assessment of SCADA System Components

C225 RTU

There are 20 of this type of RTU in service on the network. Power supply failure is the most common failure mode with around one failure a year. Spares are held at a central location and repairs are carried out when possible. These are being replaced in conjunction with substation switchgear replacements and the redundant units held as spares.

C5 RTU

These RTUs are placed in very small distribution substations and there are six in service. These RTUs are no longer manufactured and are difficult to repair so as they fail they are interchanged with current technology alternatives.

Load Control PLC

There are 23 of this type of PLC in service on the network. Installed in 1996, these Toshiba PLC's are used to drive load control equipment. This type of PLC is an obsolete item however one spare is held for cases of failure. These will be addressed as part of any Load Control upgrade and are unlikely to be replaced outside of any other replacement programme.

Dataterm RTU

There are 7 of these in service on the network. These RTU's have an inherent design flaw in the analogue card which, over time, causes the analogues to "jump". This is repairable with the replacement of reed relays on the analogue card with an approximate cost of $500 per card. There are normally four cards per RTU and the cards fail at a rate of about five per year. These units are being replaced with Foxboro SCD5200 RTUs as zone substations are upgraded and moved onto the IP network.

Miniterm RTU

There are 63 of these in service on the network. These units fail at the rate of approximately two a year due to board level IC failure, with replacement ICs gradually becoming harder to source. These RTU's cannot be directly replaced by current technology, however spare units are becoming available as a result of the switchgear replacement works. There is no active programme for replacing these however they are being replaced in conjunction with substation switchgear replacements, or where a risk or shortfall is identified with having this type of RTU installed.

Common Alarms

There are 49 of these in service on the network. These are a custom built device, placed in minor "ringed" distribution substations to give an indication back to control room of a tripping event. They are prone to failure and there are no spares. On failure, the units are being replaced by current technology.

Siemens Power Automation System (PAS)

There are two PAS units that act as a protocol converter between IEC61850 field devices at three sites and that of the DNP3 SCADA master station. These two PAS units are configured to fail-over between units to prevent any interruption should one unit develop a fault. There are no short term plans to implement more IEC61850 devices onto the network so few changes are planned for the PAS system, although as part of the overall communications strategy these devices may be replaced or removed from the system.

6.4.14.2. Asset Renewal and Refurbishment

The asset replacement budget also provides for the ongoing replacement of obsolete RTUs throughout the network. Obsolete RTUs that may present a significant impact on network reliability are being targeted first with special attention being paid to the zone and major switching substations.

Where there is an RTU which exists at a zone substation or major switching points in the network that is adjacent to the existing TCP/IP network, consideration is given to upgrade equipment to allow TCP/IP connection in order to continuously improve communication system reliability.

Further, the TCP/IP infrastructure will also allow other substation based equipment, such as security alarms etc., to efficiently communicate with distant receive devices.

Master Station

As detailed earlier in this document, the SCADA master station has been replaced with a GE ENMAC system. This new unit will last at least 15 years, so no major expenditure is foreseen during this planning period on the master station. Elements of the existing Leeds and Northrup 2068 master station will be retained in the short term to run the automatic load control packages. This will in time be integrated with the ENMAC system.

Siemens Power Automation System (PAS)

The PAS unit acts as a protocol converter between IEC61850 field devices and that of the DNP3 SCADA master station. In the short term, a project may be undertaken to separate the three sites from the PAS. Substation base equipment could be installed which consists of SCD5200 RTUs than can convert the substation 61850 protocol directly to DNP3. This is still being investigated and no budget provision has been made at this time.

Remote Terminal Units (RTUs)

All Foxboro C25 and C225 remote terminal units (RTUs) at GXPs were replaced during 2011 for two reasons:

1. The new GE ENMAC SCADA master station has no automatic load management facility and in order to implement this, the present Foxboro L&N2068 master station will be required to be maintained in the short term to provide the load management system. This was achieved with the use of SCD5200 RTUs at the GXPs providing information to both master stations.

2. The upgrade coincides with Transpower's move to TCP/IP networks and the resulting loss of the serial link presently used by Wellington Electricity from GXPs back to Haywards.

The substation RTU replacement programme will start with the 6 sites in the Wellington city area that have Plessey Dataterm RTUs installed. Three of these sites: Evans Bay, Karori and Palm Grove, have Reyrolle Type C gear switchboards that are targeted for replacement between 2011 and 2014. At these sites the RTU upgrades will occur at that time as part of the switchboard upgrade project. The remaining three sites (Frederick Street, Hataitai and Ira Street) are targeted for replacement alongside these upgrades, however as spares are made available from the first sites, the remaining sites may be able to be kept in service longer if input and output (I/O) capacity and functionality constraints are not present.

There is no medium-long term programme to replace RTUs at distribution substations, as these sites generally have a lower risk profile than GXPs and zone substations. However where a risk or need is identified, the RTU upgrade will be scheduled. In 2012 the 25 Mein Street substation, with a hospital and Distributed Generation connected is scheduled for RTU replacement and migration to the IP network. The 25 Mein Street RTU replacement did not occur during 2010 and was considered in the 2011 renewal programme but was deferred due to the large scale RTU upgrade at GXPs occurring during that year. Additionally, sites that have switchgear upgrades may have an RTU upgrade, however these are incorporated as part of the specific project and evaluated on a case by case basis.

From 2013 onwards, Wellington Electricity will commence the replacement of the remaining C225 RTUs installed at 19 zone substations with an aim to complete all replacements by 2018 (by which time the units will be at end of their service life).

The medium term replacement plan for substation RTU replacement is shown below

Site	Site type	Present RTU	Proposed RTU	Driver	Replacement year
Palm Grove	Zone Substation	Dataterm	SCD5200	Switchgear Replacement	2012
25 Mein Street	Distribution Sub	Miniterm	SCD5200	Insufficient I/O	2012
Frederick Street	Zone Substation	Dataterm	SCD5200	Insufficient I/O	2012
Mana	Zone Substation	C225	SCD5200	AVR Upgrade	2012

Site	Site type	Present RTU	Proposed RTU	Driver	Replacement year
Plimmerton	Zone Substation	C225	SCD5200	AVR Upgrade	2012
Petone	Zone Substation	C225	SCD5200	Protection Upgrade	2012
Evans Bay	Zone Substation	Dataterm	SCD5200	Switchgear Replacement	2013
Maidstone	Zone Substation	C225	SCD5200	GXP Protection Upgrade	2013
Brown Owl	Zone Substation	C225	SCD5200	GXP Protection Upgrade	2013
Karori	Zone Substation	Dataterm	SCD5200	Switchgear Replacement	2014
Hataitai	Zone Substation	Dataterm	SCD5200	Age	2014
8 Ira Street	Zone Substation	Dataterm	SCD5200	Age	2014

Figure 6-35 Proposed RTU Replacement Programme

Analogue Radio Replacement

It has been identified through the work on the Network Communications Strategy that there is a risk associated with the age and configuration of the analogue radio network that is used for a number of field devices. An upgrade of the repeaters located at Mt Climie and Mt Kaukau, as well as a secondary repeater at Stokes Valley, may be undertaken within the medium term. With this system upgrade, communications components at the field devices, such as radio modems, may also require upgrading. This work needs to be developed further and is not presently budgeted in a specific year. The estimated order of cost for this work is $250,000 to $300,000.

6.5. Asset Renewal and Refurbishment Programme

6.5.1. Asset Replacement Projects for Current Year

The major asset replacement projects (greater than $100,000) that Wellington Electricity is planning to complete in the 2012 period, as detailed in Section 6 (Lifecycle Asset Management), are summarised below:

Pole Replacement Programme	
Driver: Asset Integrity and Safety Estimated cost: $2.0 million	A new wood pole testing programme (the Deuar method) is already in place ensuring that tagging of poles is more discriminating. Replacement of red and yellow tagged poles will continue in 2012, managed as packages of work following inspection. This work includes replacement of associated pole hardware.

Evans Bay 11kV Switchboard Replacement	
Driver: Asset Integrity and Safety Estimated cost: $1.7 million	Following the "Stage of Life" analysis of zone substation switchboards, the Evans Bay substation switchboard was found to have the highest consequence of failure due to high loading, given its age and condition. Full replacement of this switchboard and associated protection, control and secondary systems is planned to commence in 2012 and be commissioned in 2013.

Reyrolle Type C Replacement	
Driver: Asset Integrity Estimated cost: $4.1 million	This project involves the replacement of Reyrolle C-type 11kV switchgear at the following distribution substations: Chaytor Street, 69 Miramar Avenue, Hankey Street, Cable Car Lane and 9 Duncan Terrace

Yorkshire SO-HI Replacement	
Driver: Asset Integrity Estimated cost: $1.25 million	This project is the first stage of a proposed four year programme to replace Yorkshire SO-HI 11kV switchgear from distribution substations on the network. It is expected that 13 of the highest priority sites will be addressed in 2012.

Lock Replacement Programme	
Driver: Asset Integrity and Safety Estimated cost: $100,000	Wellington Electricity has an ongoing programme of lock replacement on all HV distribution assets. This is to ensure safety and integrity of the asset and network by having one series of controlled keys in service.

Zone RTU Upgrade (Frederick Street)	
Driver: Asset Integrity Estimated cost: $150,000	This project is to replace the zone substation RTU with an SCD5200 RTU and upgrade to TCP/IP communications as the existing RTU is at the end of its service life and has no spare I/O for planned upgrade work.

25 Mein St RTU Replacement	
Driver: Asset Integrity Estimated cost: $100,000	This project is to replace the substation RTU at 25 Mein Street with a SCD5200 RTU and upgrade to TCP/IP communications as the existing RTU is at the end of its service life and has insufficient I/O.

Haywards SCADA Battery System Upgrade (24V DC)	
Driver: Asset Integrity Estimated cost: $100,000	This project is to upgrade the Haywards SCADA Master Station DC and battery system with new components.

Mana/Plimmerton VRR Replacement	
Driver: Asset Integrity Estimated cost: $200,000	Replacement of 20 year old PLC based tap changer controls with a specialist power Voltage Regulating Relay (VRR) at Mana and Plimmerton zone substations.

Wainuiomata 7 Overhead Line Rebuild	
Driver: Asset Integrity Estimated cost: $190,000 – Stage 1	Following poor performance on the Wainuiomata Coast Road areas, line rebuild of Wainuiomata 7 feeder will occur in a 10-stage project, with Stage 1 commencing in 2012. This involves the rebuild of around 2.1kms of line.

Ngauranga 4 Overhead Line Rebuild	
Driver: Asset Integrity Estimated cost: $160,000	Following performance improvements on Ngauranga 4 resulting from an overhead rebuild around Glanmire Road, it has been identified that the overhead network and conductor on the first section from Ngauranga to Newlands is in poor condition and leads to poor performance of the feeder. Reconductoring of this section and associated line hardware will be undertaken in 2012

Karori 2 Overhead Line Rebuild	
Driver: Asset Integrity Estimated cost: $160,000	The Karori 2 feeder towards Makara has historically performed poorly, especially during adverse weather. The terrain is harsh and exposed in places, as well as being covered in dense vegetation making access difficult. This first stage (of nine) involves the rebuild of around 1.3kms of overhead 11kV line to address reliability concerns arising from hardware condition.

In addition to the specific projects above, Wellington Electricity also makes provision for programmes of replacements that arise from condition assessment programmes during the year, a list of programmes with a forecast cost greater than $100,000 are listed below:

Driver	Programme	Forecast cost
Asset Integrity	Transformer and Canopy Replacement	$750,000
Asset Integrity	Cable and Conductor Replacement	$300,000
Asset Integrity	Distribution Switchgear Replacement	$700,000
Asset Integrity	Protection and Secondary Systems	$75,000
Asset Integrity	Crossarm Replacement	$250,000
Safety	Earthing Upgrades and Compliance	$300,000
Safety	LV Pillar and Pit Replacement	$100,000

Driver	Programme	Forecast cost
Safety	Cast Metal Cable Pothead Replacement	$150,000

Figure 6-36 Asset Replacement Programme

6.5.2. Prospective Asset Replacement Projects for 2013 – 2017

The projects included in this section are less certain in nature. Whether or not they proceed, and their timing, will largely depend on the risks to the network that need to be mitigated, and the relative risk compared with other asset replacement projects. The timing of asset renewal projects is directly related to the risks associated with the works, and changes to these alter the timing of the projects. It is assumed that the rate of deterioration, aging, and the increases of load remain constant. Should the loading or type of load served significantly change, and hence increase in the consequence of failure, or if the asset deteriorates faster than expected, then renewal may need to be brought forward. Conversely, should the risk level decrease, then the project may be able to be deferred until later in the planning period, or an alternative found. These projects are aimed at ensuring existing service levels are maintained in a sustainable manner, and in line with the surveyed feedback from consumers.

33kV Cable Replacement	
Driver: Asset Integrity Estimated cost: $15 million	A number of subtransmission circuits with utilisation constraints will be addressed under Network Augmentation projects. However several in the top 10 have age and condition constraints. At least one set of circuits is expected to require complete replacement during this medium term period, and a medium section of at least one other set will require replacement due to condition.

Zone Substation Transformer Replacement	
Driver: Asset Integrity Estimated cost: $2.0 million	Zone substation transformers (33/11kV) are expected to need replacement in at least one zone substation based upon age and condition, with Evans Bay the most likely.

Pole Replacement Programme	
Driver: Asset Integrity and Safety Estimated cost: $7.0 million	Replacement of red and yellow tagged poles will continue. This work includes replacement of associated pole hardware. Use of the Deuar pole test method and the decrease in the numbers of wooden poles is expected to produce a decline in the rate of replacement in the medium term.

Karori 11kV Switchboard Replacement	
Driver: Asset Integrity and Safety Estimated cost: $1.7 million (2013)	The Karori substation switchboard was found to have a high consequence of failure due to high loading, given its age and condition. Full replacement of this switchboard and associated protection, control and secondary systems is planned to commence in the medium term.

Gracefield 11kV Switchboard Replacement	
Driver: Asset Integrity and Safety Estimated cost: $1.7 million (2014)	The Gracefield substation switchboard was found to have a high consequence of failure due to high loading, given its age and condition. Full replacement of this switchboard and associated protection, control and secondary systems is planned to commence in the medium term.

Various 11kV Switchboard Refurbishments	
Driver: Asset Integrity and Safety Estimated cost: $3.0 million (2013-2015) ($0.5 million per site)	A number of zone substation switchboards were found to have a high consequence of failure due to high loading, but not particularly old age or poor condition. Full replacement of these switchboards is not justified, and retrofit components with higher ratings can be used to reduce the risks and provide a mid life refurbishment extending the overall life. Upgrades of associated protection, control and secondary systems is planned. The sites are Frederick Street, University, Moore Street, Hataitai, Kaiwharawhara and Johnsonville.

Reyrolle Type-C Replacement	
Driver: Asset Integrity Estimated cost: $5.4 million	This includes for the ongoing programmed replacement of Reyrolle C-type 11kV switchgear. This will target the remaining circuit breakers on the network in the medium term (to 2014).

Yorkshire SO-HI Replacement	
Driver: Asset Integrity Estimated cost: $2.0 million	The continued replacement of Yorkshire SO-HI switchgear will occur during this period.

Load Control Plant Replacement	
Driver: Asset Integrity Estimated cost: $3.0 million	Concerns have been raised around reliability and performance of early solid state ripple injection plant in the Wellington City area. During the medium term it is anticipated that plant at three locations will require upgrade to a modern low frequency. The plan for this is under development, however this investment has been allowed for in the budget forecasts.

In addition to the specific projects indicated above and programme allocations for undefined annual projects, the following table gives indicative asset category investment that is not yet defined, however is estimated due to asset age and known condition across the category.

Investment driver	Asset category	Investment
Asset Renewal	Distribution Switchgear Replacement	$5.0M
Asset Renewal	SCADA and RTU Replacement	$1.0M
Asset Renewal	Distribution Transformer Replacement	$3.0M

Investment driver	Asset category	Investment
Asset Renewal	Substation Buildings and Seismic Improvements*	$1.0M - $10M+
Asset Renewal	Distribution Cable and Conductor Replacement	$2.0M
Asset Renewal	Zone Substation Switchboard Replacement	$1.5M
Safety	Cast Metal Pothead Replacement	$0.3M
Safety	Earthing Compliance Upgrades	$1.2M
Safety	Asbestos Removal	$0.3M
Reliability	Reliability Improvement Projects	$0.5M

Figure 6-37 Prospective Asset Replacement Programme 2013-2017

This investment profile is to maintain existing service levels, over time as condition information becomes better known, the category split may change.

* The costs associated with substation building seismic improvements are largely unknown and are likely to vary substantially as more seismic risks are identified.

6.5.3. Prospective Asset Replacement Projects for 2018 – 2022

Asset replacement and renewal projects that are listed in this section are less specific that the previous sections and are more uncertain in nature. There are few specific projects identified at this time, and the prospective investments are broken down as far as asset category only. As risks and needs change on the network, individual projects will change, however to maintain safety, security and reliability levels that the consumers are presently prepared to accept in their price/quality trade-off decision, the following investment levels will be required over this period. In addition, there will be programme works across each category to allow for unscheduled projects in each year.

Investment driver	Asset category	Investment
Asset Renewal	Pole Replacement	$5.0M
Asset Renewal	Subtransmission Cable Replacement	$25.0M
Asset Renewal	Load Control Plant Replacement	$6.0M
Asset Renewal	Power Transformer Replacement	$8.0M
Asset Renewal	Distribution Switchgear Replacement	$9.0M
Asset Renewal	SCADA and RTU Replacement	$0.5M
Asset Renewal	Distribution Transformer Replacement	$5.4M
Asset Renewal	Substation Buildings and Seismic Improvements*	$1.0M - $10M+
Asset Renewal	Distribution Cable and Conductor Replacement	$7.0M
Asset Renewal	Zone Substation Switchboard Replacement	$3.0M

Investment driver	Asset category	Investment
Safety	Earthing Compliance Upgrades	$2.0M
Reliability	Reliability Improvement Projects	$0.5M

Figure 6-38 Prospective Asset Replacement Programme 2017-2021

This investment profile is to maintain existing service levels, over time as condition information becomes better known then the category split may change to reflect the changing risks.

* The costs associated with substation building seismic improvements are largely unknown and are likely to vary substantially as more seismic risks are identified.

6.6. Asset Renewal and Replacement Expenditure

For clarity, the forecast provided below does not include the cost of operating the network from the Network Control Centre at Haywards and does not include other non-maintenance related operational expenditure. Asset replacement and refurbishment costs are shown below. It can be seen that the line item on which Wellington Electricity proposes to invest the most capital expenditure is asset replacement and renewals. This reflects the increasing age of the asset base.

Category	2012/13	2013/14	2014/15	2015/16	2016/17	2017/18	2018/19	2019/20	2020/21	2021/22
Asset Replacement and Renewal	15,050	16,222	16,425	15,215	17,462	19,563	18,871	18,136	17,741	18,783
Reliability, Safety and Environment	653	504	472	446	523	560	530	521	532	556
Subtotal - Capital Expenditure on Asset Replacement and Safety	**15,703**	**16,726**	**16,897**	**15,661**	**17,985**	**20,123**	**19,401**	**18,657**	**18,273**	**19,339**
Routine and Preventative Maintenance	5,226	5,223	5,219	5,216	5,212	5,209	5,206	5,203	5,200	5,200
Refurbishment and Renewal Maintenance	600	600	600	600	600	600	600	600	600	600
Fault and Emergency Maintenance	5,628	5,628	5,629	5,630	5,630	5,631	5,632	5,633	5,633	5,633
Subtotal - Operational Expenditure on Asset Management	**11,454**	**11,451**	**11,448**	**11,446**	**11,442**	**11,440**	**11,438**	**11,436**	**11,433**	**11,433**

Figure 6-39 Lifecycle Asset Management Expenditure Forecast – 2012 to 2022 ($000 real as at 31-03-11)

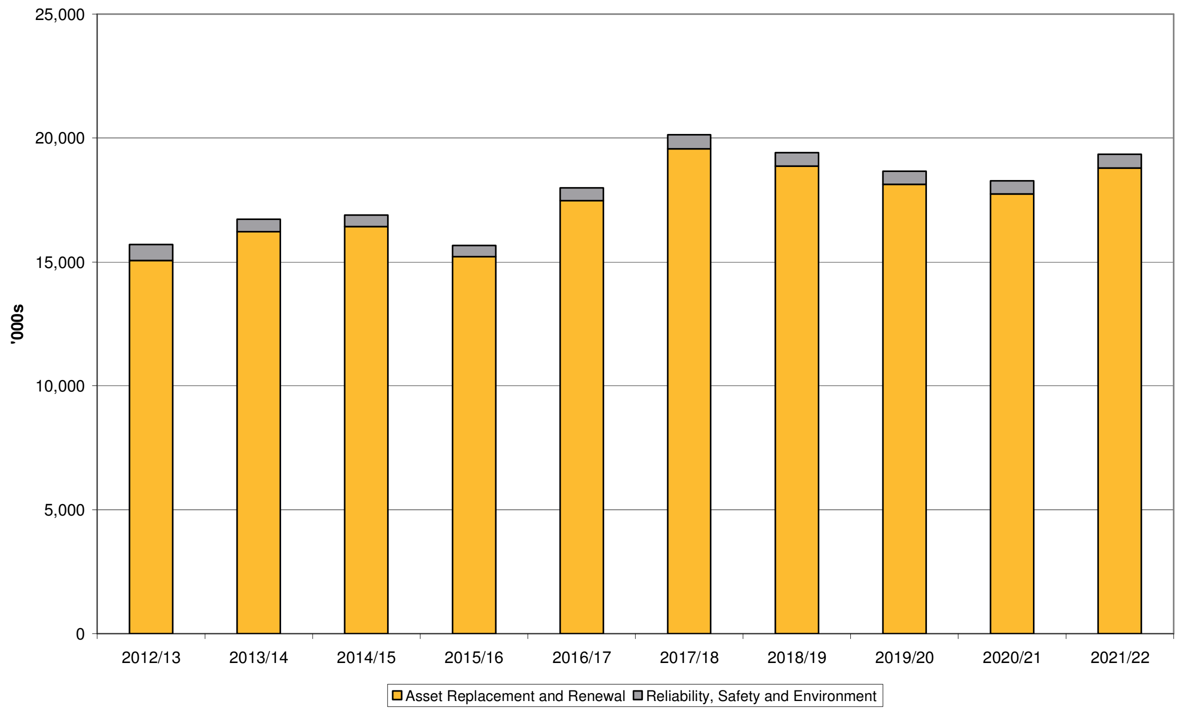


Figure 6-40 Lifecycle Asset Management Capital Expenditure Forecast – 2012 to 2021

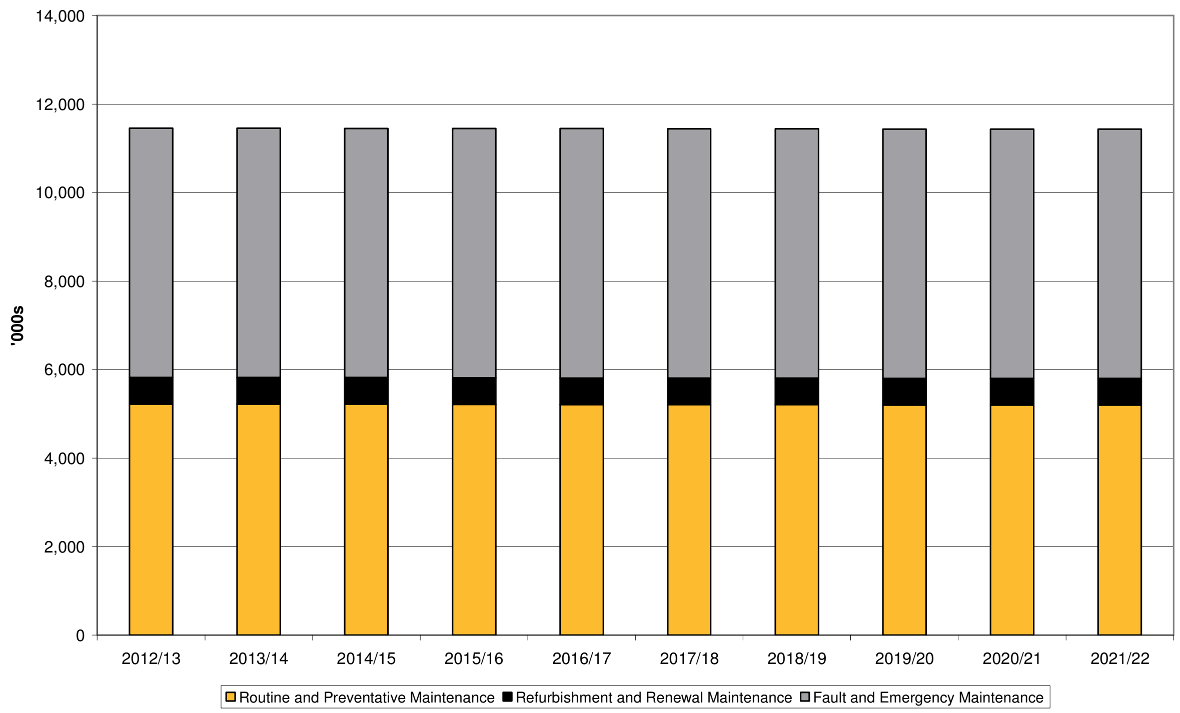


Figure 6-41 Lifecycle Asset Management Operational Expenditure Forecast – 2012 to 2021

7. Network Performance

In addition to the management of assets at the component level, Wellington Electricity also monitors the performance of asset groups at the feeder level. The root cause analysis is part of the investigation to improve systems, standards and procurement. This provides a useful input to the asset maintenance process as it identifies feeders that are experiencing the most unplanned outages and hence may require remedial action to be undertaken in order to maintain network reliability.

Performance will also be compared with the security of supply standard to check that expected outage times are being met. In some cases, the terrain, exposure to elements or vegetation may conspire to result in multiple faults. Review of network configuration to reduce impact is considered as part of post-fault reviews.

7.1 Network Performance Analysis

Wellington Electricity has undertaken targeted quality level improvement in the areas which have the highest impact on quality. The following initiatives were introduced:

- Strong focus on corrective maintenance
- Improvements in record keeping
- Continued vegetation management - a current issue is tree owner's failure to comply with the second cut policy which affects network reliability
- Improvements in implementing post fault follow up actions by the field services provider - meaning "No Fault Found" incidents were investigated and remedied where possible
- Work with councils and civil contractors to reduce the number of third party incidents, as well as providing improved access to services such as "B4U Dig", cable markouts and safety standovers. Aside from this, a general downturn in the economy saw reduced work occurring around the network.

These initiatives contributed to WELL's compliance with its reliability threshold for SAIDI and SAIFI in the 2010/11 regulatory year as set out by the Commerce Commission as shown in the table below:

Reliability metric	Threshold 2010/11	Actual for 2010/11
SAIDI	40.74	34.738
SAIFI	0.6	0.537

Figure 7-1 WELL Reliability 2010/11

The SAIDI and SAIFI performance of the 2010/11 regulatory year is shown in the graphs below.

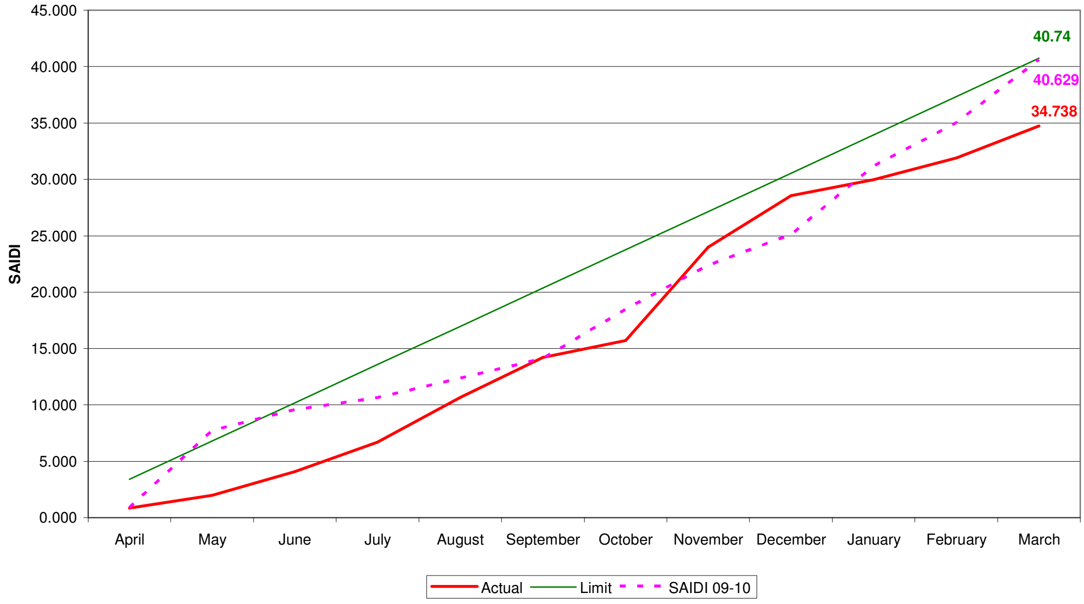


Figure 7-2 Network SAIDI 2010/11

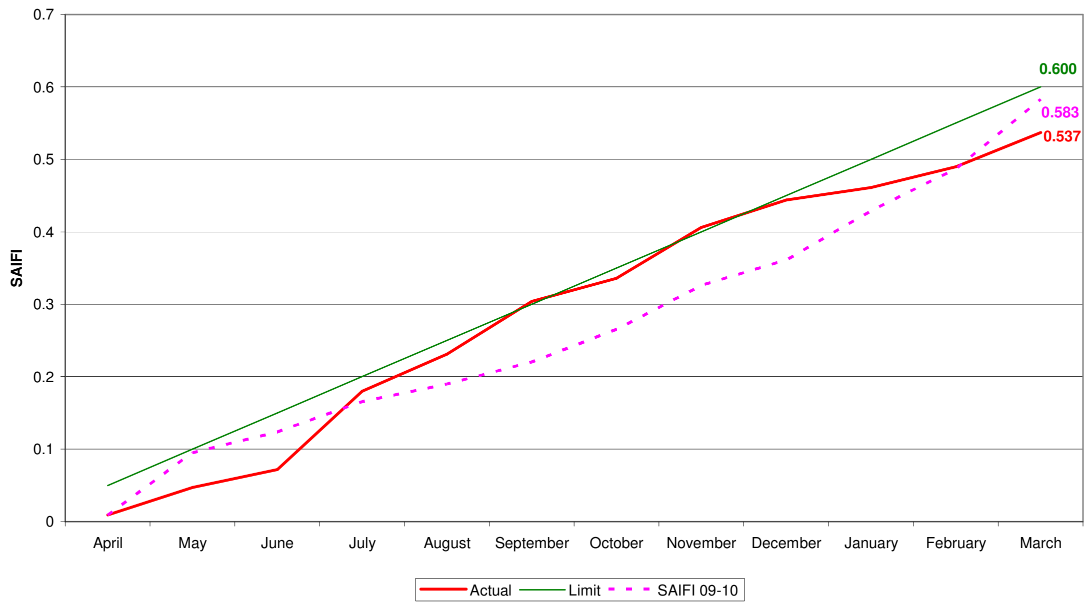
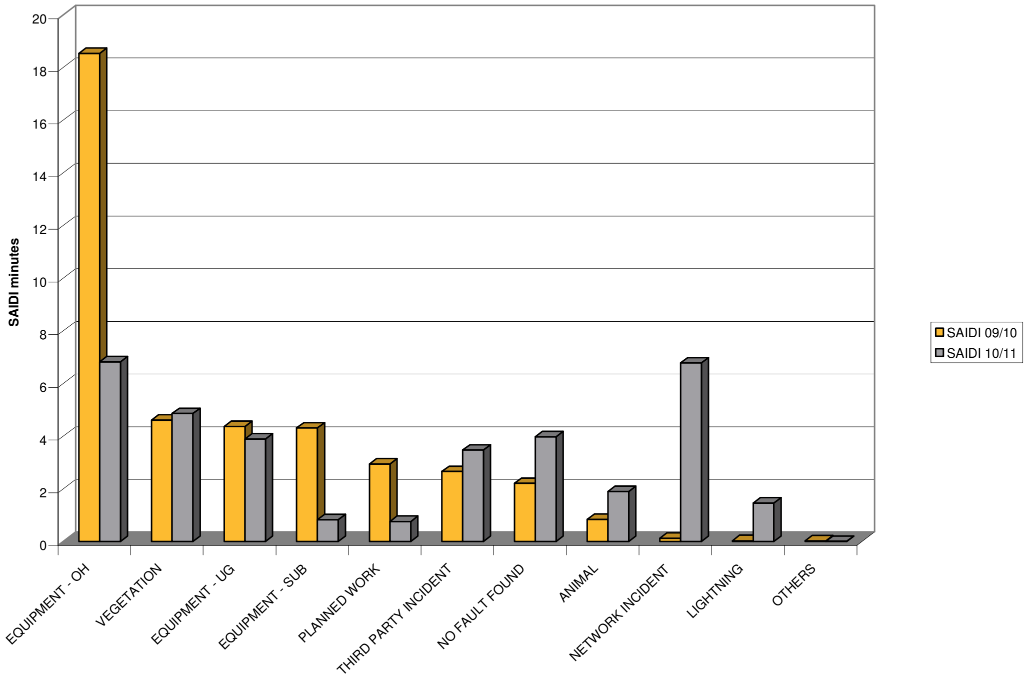


Figure 7-3 Network SAIFI 2010/11

This is the first assessment period under the Commerce Act (Electricity Distribution Default Price-Quality Path) Determination 2010 which applies from 1 April 2010 to 31 March 2015.

The Wellington network has improved significantly both in SAIDI and SAIFI in 2010/11 in comparison to 2009-10 performance. The SAIDI and SAIFI have improved by 5.89 minutes and 0.046 respectively, or a decrease of 946,693 customer minutes lost, compared with the previous year. The major contributor for this is a reduction in equipment overhead, equipment underground and equipment substation failures. There were also fewer customer interruptions arising from planned work as the use of generators and/or other means of back feeding and live line techniques were carried out whenever possible to minimise customer interruption.

The chart below provides a breakdown of the fault types experienced across the Wellington network in 2010/11, with a comparison to the previous period.



Fig

ure 7-4 Network SAIDI by Fault type

Fault cause	Contribution 2009/10	Contribution 2010/11	Improvement
Equipment - Overhead	62%	17%	46%
Vegetation	16%	12%	4%
Equipment - Underground	15%	10%	5%
Equipment - Substation	15%	2%	12%
Planned work	10%	2%	8%
Third party incident	9%	9%	0%
No fault found	7%	10%	-2%
Animal	3%	5%	-2%
Network incident	0%	17%	-17%
Lightning	0%	4%	-4%
Others	0%	0%	0%

Figure 7-5 Fault Cause Contributions

From the chart and table above, the faults that have contributed to the improvement of network reliability can be clearly identified and these will be further discussed in this section.

7.1.1 2010/11 Network Reliability Improvements

In the 2009/10 regulatory year, one of the major factors which caused the high SAIDI of 40.628 minutes was increased outages from a higher than usual number of weather related events adversely impacting on the performance of the overhead network. Overhead equipment failures recorded 18.5 SAIDI minutes or equivalent to 45.6% of the total network SAIDI for the year. To address these issues, in 2010/11 a strong focus was put on the maintenance of overhead lines, more particularly on the worst performing feeders of the network. Ngauranga feeder 4, for example, was the top worst performing feeder. In response, the feeder was subject to a more detailed inspection and an overhead line refurbishment was carried out on the section of the feeder which has the most number of faults in the last 5 years. This refurbishment included replacement of conductor, cross arms, insulators and other line hardware.

Other feeders which had line improvement programmes undertaken were Johnsonville 10, Korokoro 9, Karori 2 and Plimmerton 11. These programmes included replacement of identified faulty insulators, cross arms, line links, connectors, jumpers, as well as major plant such as transformers. Tree pruning was also part of the maintenance programme, in addition to the planned vegetation management that was undertaken. The effectiveness of this approach was apparent in the SAIDI improvement in the area of overhead equipment failures as shown below.

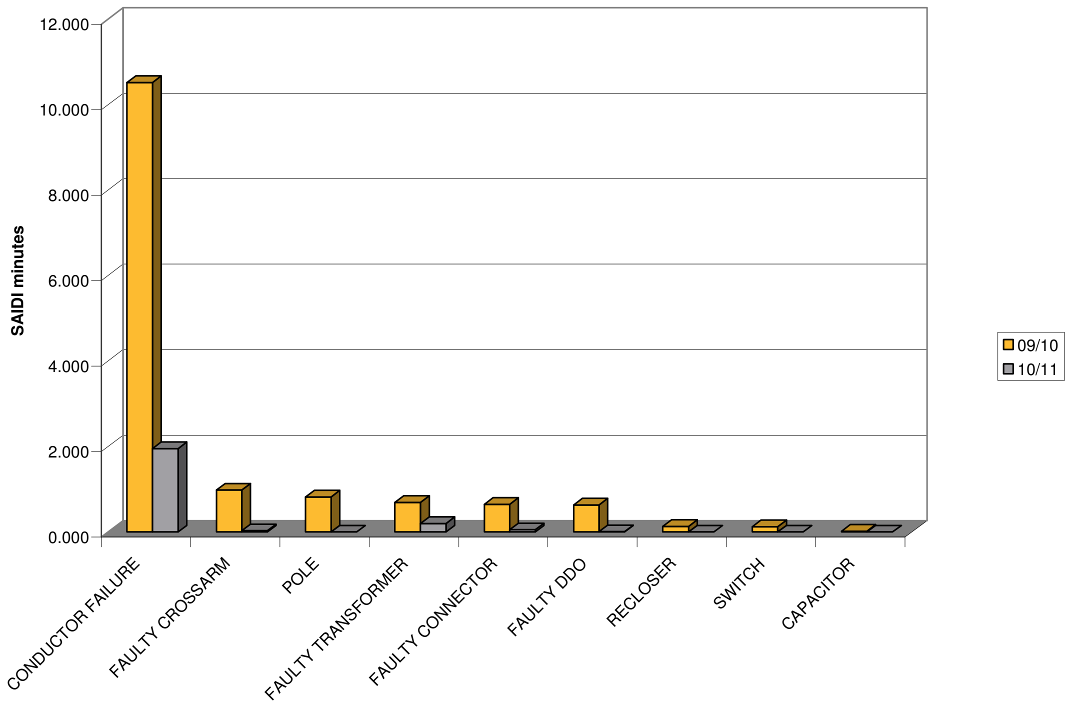


Figure 7-6 SAIDI Improvement– Overhead Equipment

The improvement can be seen more obviously in the frequency of customer interruptions (SAIFI) on the identified worst performing feeders of 2009-10 as shown in Figure 7-6 below. It should be noted that the line configuration of these feeders is mostly a combination of overhead lines and underground cables, and the majority of faults on these feeders were from overhead lines.

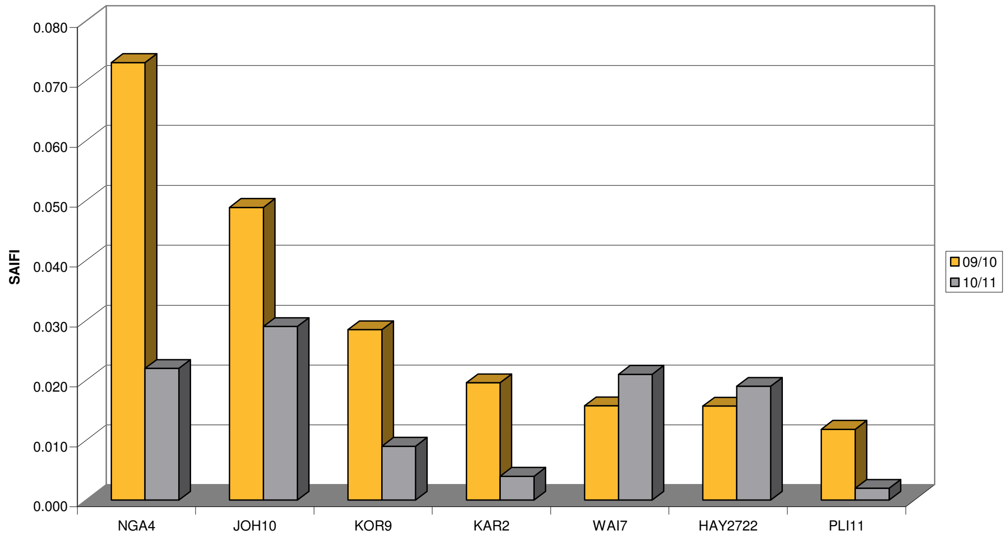


Figure 7-7 SAIFI – Worst Performing Feeders

Wainuiomata feeder 7 (WAI7) and Haywards feeder 2722 (HAY2722) show a slight increase in the frequency of interruptions in 2010/11, however these are attributed to tree related incidents, rather than overhead equipment failures. Vegetation management is being targeted on these feeders, and is discussed later in this section.

It is also noteworthy that the Wellington Region had fewer storm incidents in 2010/11 with only 13 days of wind gusts over 90kph and 38 weather related outages recorded In 2009/10, there were 23 days with winds over 90kph and 95 recorded outages.

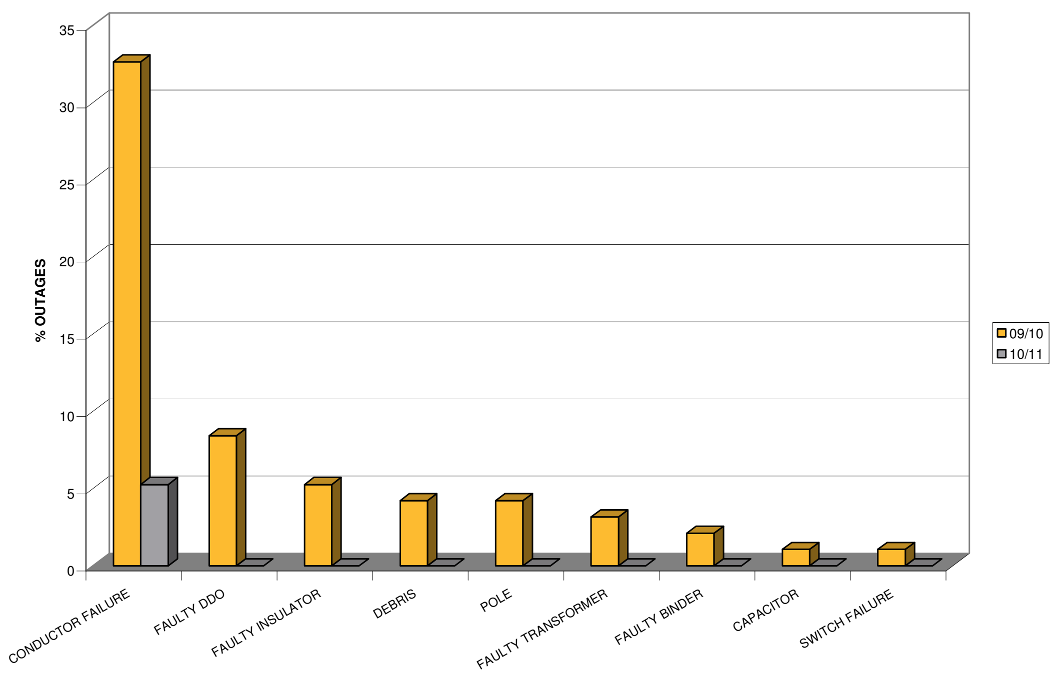


Figure 7-8 Weather Related Equipment Outages

7.1.2 2010/11 Network Reliability Decline

Although the network reliability improved in terms of SAIDI and SAIFI in 2010/11, other causes of failures which led to decreases in network reliability, were the focus of the 2011/12 reliability improvement programmes.

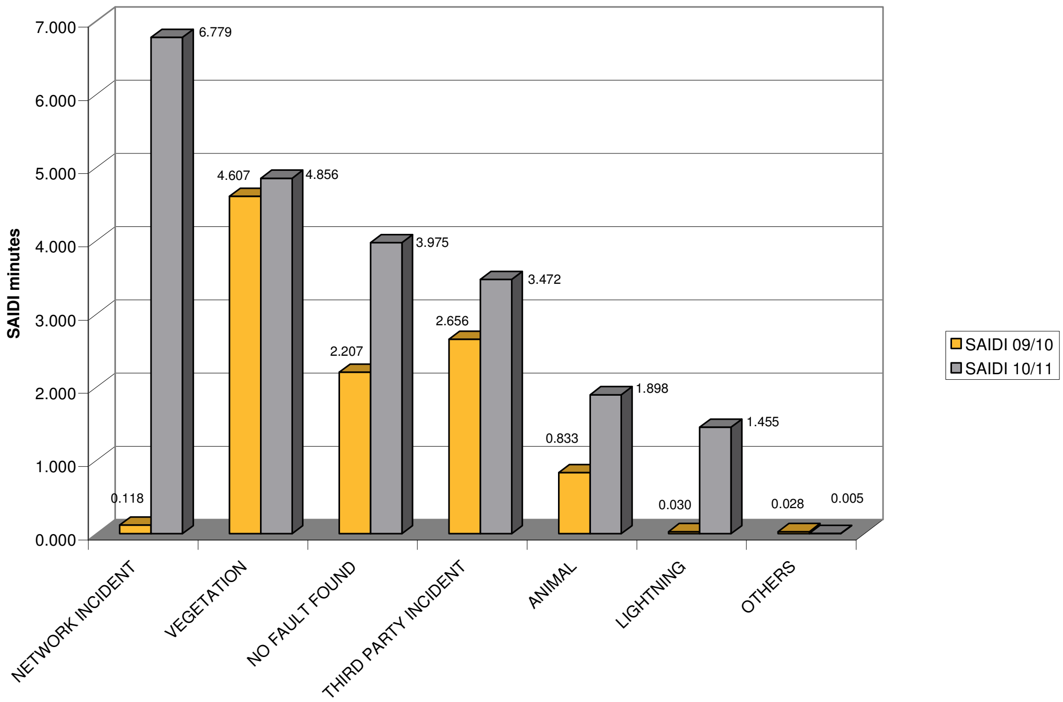


Figure 7-9 Reliability Decreases by Fault Type

Figure 7-9 shows that the largest increase in SAIDI was due to "Network Incident" faults. This rise was caused by one incident in particular which registered more than 6 minutes. The incident was a cable strike by a contractor undertaking work for Wellington Electricity immediately outside a substation which led to a prolonged substation outage. This should not be a recurring issue, however to minimise similar events, regular reminders of the safety requirements and standard works procedures have been made to all contractors working for Wellington Electricity.

Vegetation related outages have increased slightly because of the current issue of trees not being trimmed by landowners. Wellington Electricity has largely completed the (free) first cut and trim process of trees not removed because owners had declared an interest in them at that time. The trees are now legally the responsibility of the land owners under the *Electricity (Hazards from Trees) Regulations 2003* to maintain clearance from the power lines. Despite this, many owners are not trimming their trees in accordance with the regulations. Wellington Electricity and Treescape (as the vegetation management contractor) are working with these landowners and local authorities to address this issue. Wellington Electricity is also developing Memorandums of Understanding (MoUs) with TLAs to address roadside and council controlled vegetation.

"No fault found" outages have increased and, as the name suggests, it is difficult to find the cause and address the issues. Generally these faults are due to tree branches touching lines, debris falling on lines in strong winds, lines clashes and insulator flashovers which could not be found by the faultman doing a line patrol. Installation of line fault indicators may help in finding the location of the fault and make cause identification easier.

The increase in third party incidents is largely outside the control of Wellington Electricity given that the causes include vehicles hitting poles, cable strikes, vandalism and overhead contact incidents. Efforts continue to inform the public on safety around overhead lines and network assets, as well as providing advice for standovers and close approach permits.

Outages due to animals, such as birds and possums, are another 'uncontrollable' type event for Wellington Electricity. Fortunately preventive tools are available to minimise these faults such as use of possum guards and trimming of adjacent vegetation - activities that are carried out following an animal strike.

While lightning incidents in the Wellington region are very rare there was an increase in SAIDI as a result of this fault type. No action is planned in response to the increase as records from previous years indicate this is not a significant issue.

7.1.3 2011/12 Year to Date Network Reliability Performance

The performance of the Wellington network for the first six months of the 2011-2012 regulatory year is over the SAIDI and SAIFI YTD limits of 20.370 and 0.300 respectively. The network was heavily affected by the four days of severe weather that hit the region in August 2011 Ice and snow build up on lines combined with strong winds and lightning caused many outages throughout the region. Most affected customers were in rural areas and with roads were blocked by ice and snow and fallen trees it was difficult for response crews to restore power supplies. Transpower had two major outages at the in Gracefield substation which caused loss of supply to customers in the Seaview, Petone, and Wainuiomata areas. Approximately 13,500 customers were affected during this period. The SAIDI impact of this one severe weather period was over 6 minutes.

Lines down and broken poles during the August 2011 snow storm

7.1.3.1 Summary of Fault Causes

The summary SAIDI and SAIFI by fault cause is shown in Figure 7-10. Vegetation as a fault cause has the highest impact on SAIDI mainly because of the storm mentioned above. Vegetation as a fault cause has less impact on SAIFI because the areas affected were mostly rural where there are lower customer numbers.

Substation equipment failures as the major impact on SAIFI (and next highest for SAIDI) were mostly due to LMT Reyrolle switchgear failing to operate on fault. The most significant event was during a third party incident, when a car hit a pole at Eastern Hutt Road in Naenae. Naenae CB4 did not trip on fault, instead the incomer breakers tripped and took out the whole Naenae zone substation affecting 5,143 customers. The circuit breaker was found to have failed mechanically because of a skewed lever arm. This caused failure of the plunger to reach the proper lever position to open the circuit breaker. To address this fault cause, a technical bulletin was issued to contractors on guidelines and procedures for service maintenance on specific circuit breaker types..

The “no fault found” causes are again attributed to the storm which occurred in August. Most of the incidents related to this fault cause happened during stormy weather.

The underground equipment failures refer to underground cables and joint failures. The major outage which occurred in the network was a 33kV cable joint failure on the circuit between University zone substation and Central Park GXP. This fault affected 2,745 customers. Other failures were due to ageing conductors and minor 11kV cable faults although the level of underground cable faults experienced is not unusual for a network of this size.

The condition of overhead conductors is observed during routine inspections to, although fatigue is not always visible. Overhead equipment failures were minor outages mostly related to days of strong winds or stormy weather.

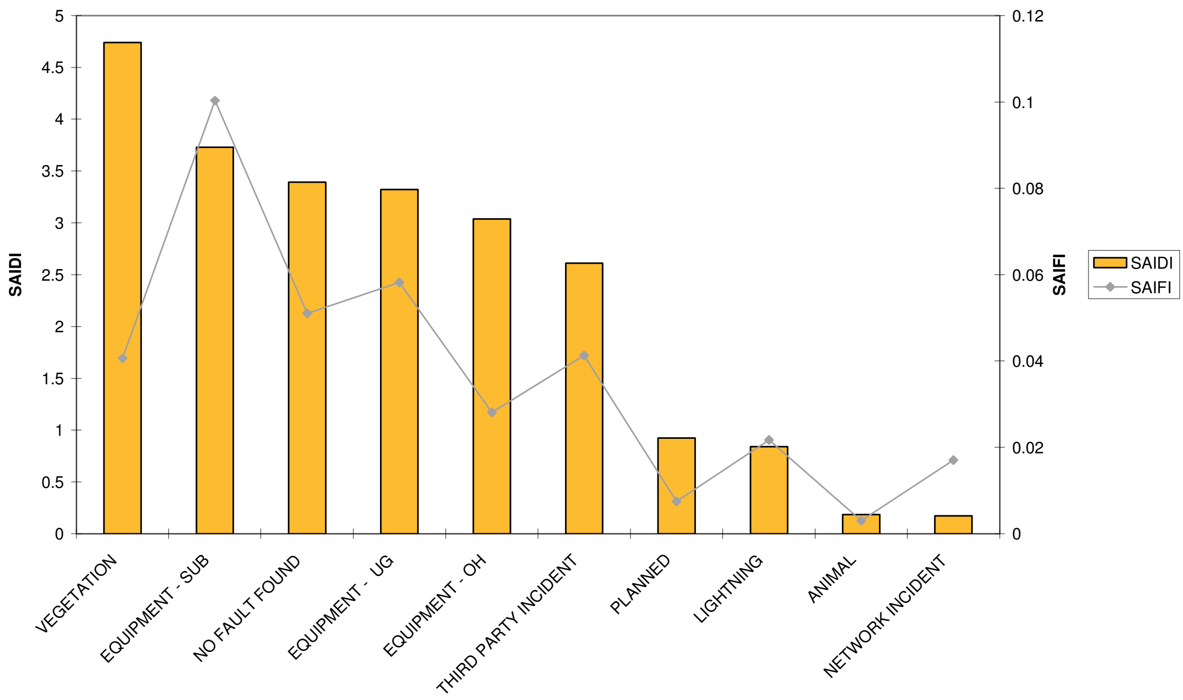


Figure 7-10 SAIDI and SAIFI by Fault Cause (April-September 2011)

7.2 Challenges and Solutions Identified in 2010/11

The following graph highlights some asset management challenges identified in the current regulatory year (2011/12 YTD included for interest).

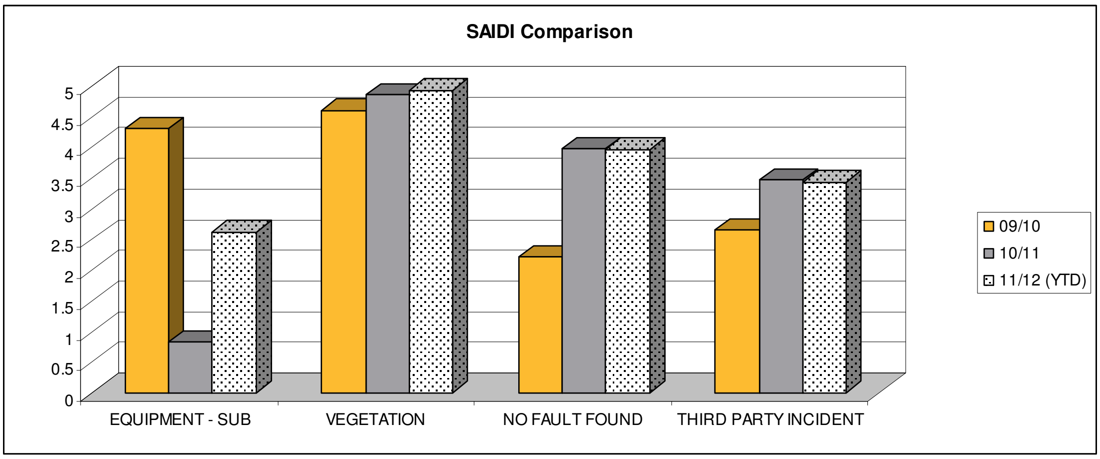


Figure 7-11 SAIDI by Asset Management Focus Areas

Substation equipment failures were not a focus area in 2010/2011 however this has been highlighted in the current year by the failure of LMT Reyrolle switchgear to operate under fault conditions (due to auxiliary switch issues). Wellington Electricity has set out initiatives to address this in Section 6 (Lifecycle Asset Management).

With regard to vegetation management, Treescape has continually made contact with the owners of the trees which are encroaching upon, and presenting potential hazards to, overhead lines. As detailed above, there are tree owners who have been reticent in meeting their obligations under the tree regulations.

'No fault found' outages usually occur on overhead feeders with the most common causes being tree branches touching lines during stormy weather, debris falling on the line and then clear and bird strikes. For every fault classified as a 'no fault found' cause, a line patrol is being carried out at the earliest opportunity to investigate the fault. Feeders with recurring 'no fault found' outages are subject to more thorough, targeted inspection regimes.

Wellington Electricity has commenced further education of the public regarding the hazards of power lines and network assets. In November 2011, a number of radio ads were launched to educate and remind the public regarding safety around electricity. The ads were targeted at the key causes of third party incidents such as vehicle contact, overhead line contact, and promoting the 'dial before you dig' service (specifically to reduce the number of underground cable strikes)..

7.3 Maintenance Activities

Both planned and corrective maintenance activities are being undertaken on a larger scale than has occurred over the preceding 5 years. This has driven a higher SAIDI and SAIFI contribution from planned work where live-line techniques cannot be used. The strategy is that reliability will be maintained in the long term through improved equipment condition.

7.4 Maintenance and Inspection Standards

Wellington Electricity has reviewed and improved upon previous maintenance standards and practices on its network, including condition assessment and asset information capture. By improving the inspection process, and through better analysis of data, investment and maintenance can be better focussed. For example, Wellington Electricity will be conducting a detailed survey of overhead lines and components in high wind areas to see whether their integrity is sufficient to meet the higher wind loads seen during 2010/11.

7.5 Worst Performing Feeders

In 2010/11, Wellington Electricity's approach to finding the worst performing feeders on the network was based upon the feeder performance over a five year period. There were three categories considered, SAIDI, SAIFI and the number of interruptions a feeder experiences in a year. The top ten feeders from each category were subjected to more intense scrutiny.

Determining which feeders were the "worst performing" was based on whether a feeder was featured in each of the three categories, or if the feeder performance had deteriorated in the last regulatory period in any of the three categories.

The worst performing feeders were identified as Ngauranga 4 (NGA 4), Korokoro 9 (KOR 9), Wainuiomata 7 (WAI 7), Karori 2 (KAR 2), Johnsonville 10 (JOH 10), and Plimmerton 11 (PLI 11). Reliability improvements and corrective maintenance programmes were carried out on these feeders and the results are significant as shown in the graphs below.

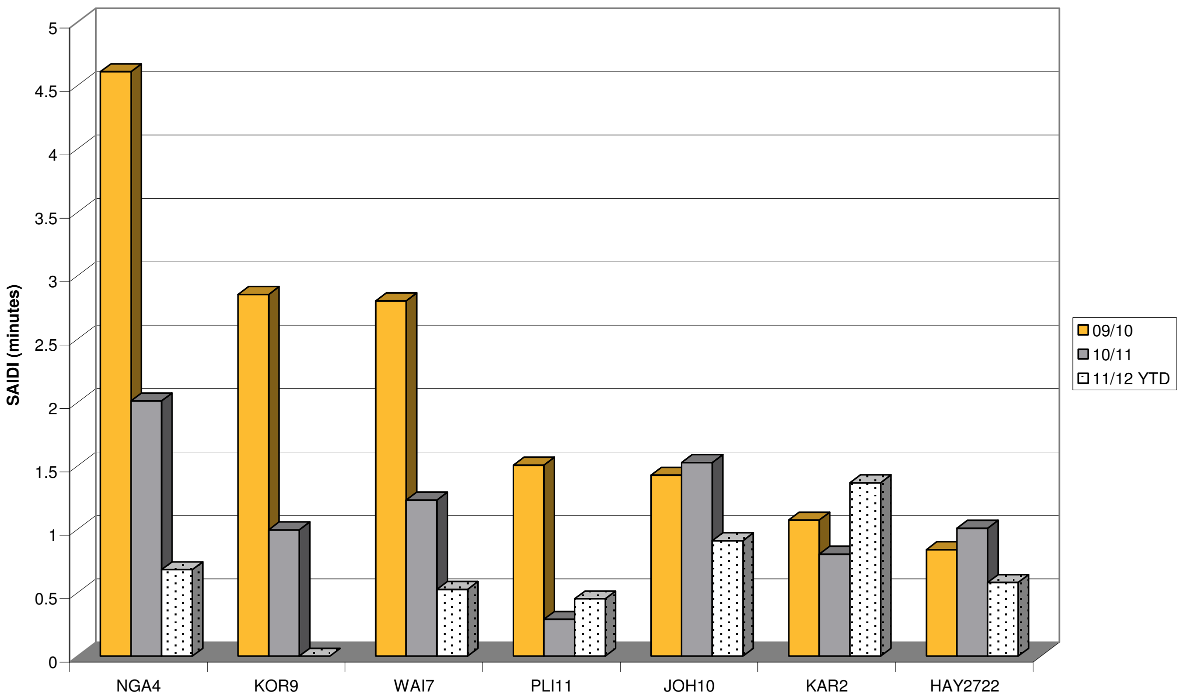


Figure 7-12 Worst Performing Feeders (2010/11 with 2011/12 YTD) - SAIDI

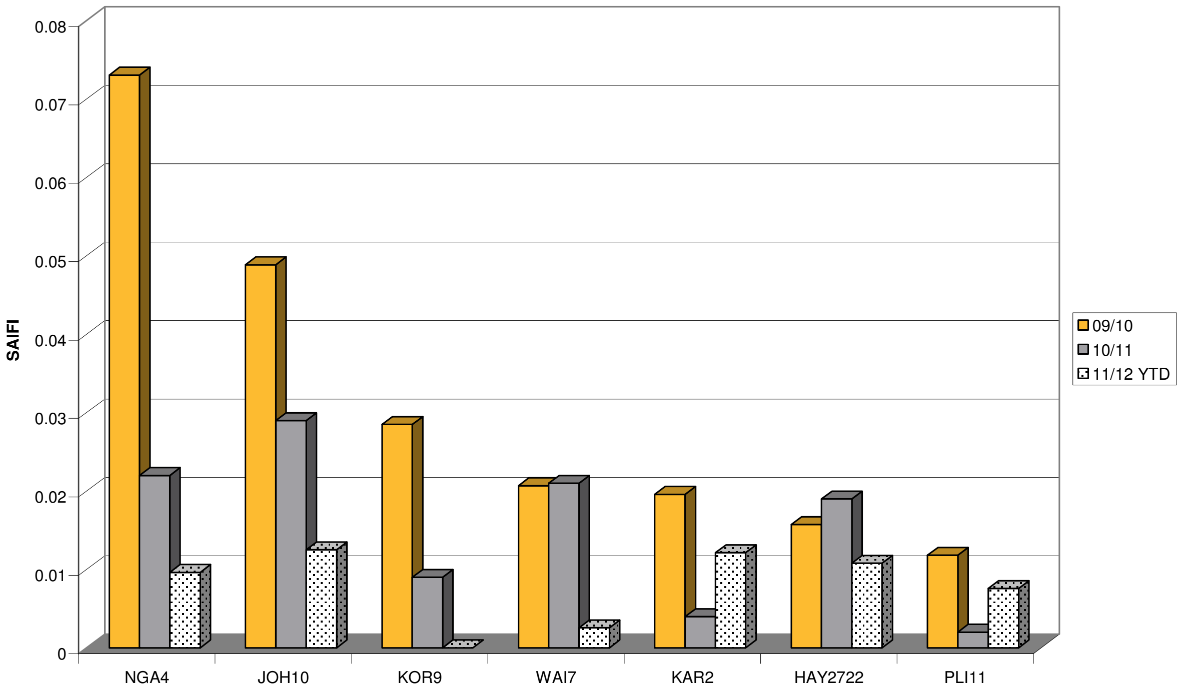


Figure 7-13 Worst Performing Feeders (2010/11 with 2011/12 YTD) - SAIFI

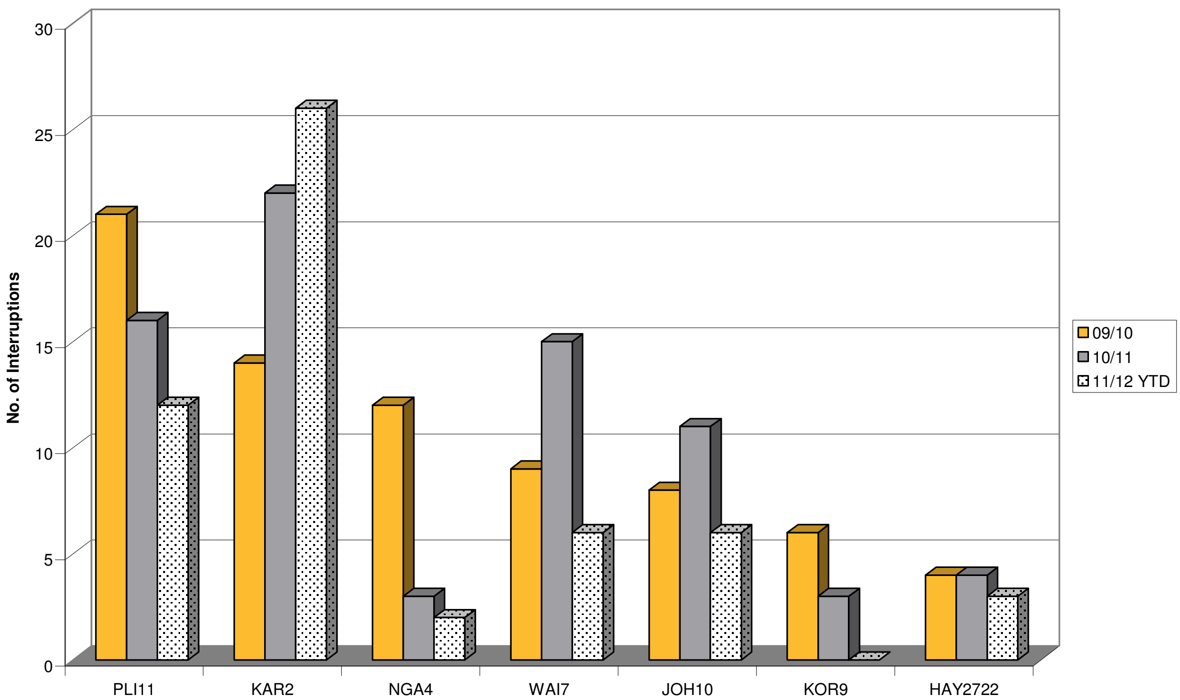


Figure 7-14 Worst Performing Feeders (2010/11 with 2011/12 YTD) - No. of interruptions

Although, the worst performing feeders identified last year have improved in terms of SAIDI and SAIFI as a result of targeted actions, increased reliability programmes previously identified will still be carried out to ensure there is no decline in performance.

The method used to determine the worst performing feeders for 2011/12 regulatory period was a different approach than the previous period. The current performance of each feeder (from 1 March 2011 – to date) was compared to the previous two years. Any significant increase in SAIDI and SAIFI or the number of interruptions meant a feeder was included in the list. The identified worst performing feeders were grouped as follows:

- Feeders with high SAIDI and SAIFI and 5 or more interruptions since the beginning of the 2011/12 regulatory period: Brown Owl 8 (BRO8), Brown Owl 3 (BRO 3), Maidstone 10 (MAI10) and Trentham 8 (TRE8).
- Feeders showing significant increase in SAIDI or SAIFI and have 4 or more outages since the beginning of the 2011/12 regulatory period: Gracefield 2 (GRA2) and Plimmerton 8 (PLI8).

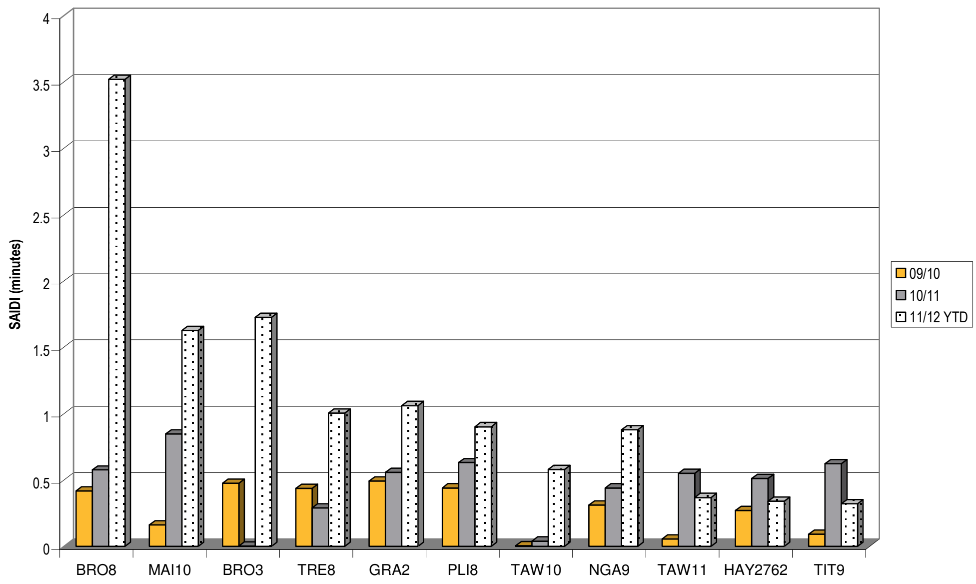


Figure 7-15 SAIDI of Worst performing Feeders (2011/12 YTD)

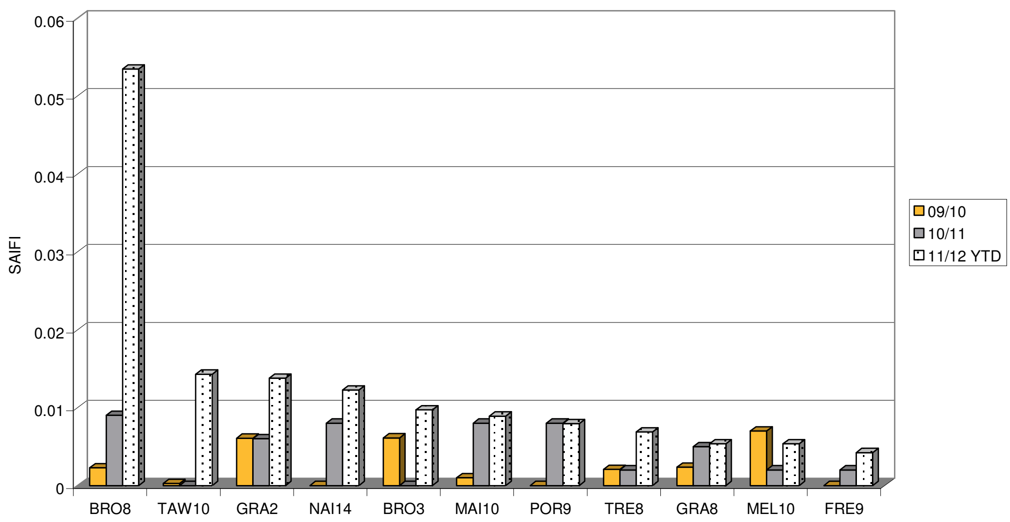


Figure 7-16 SAIFI of Worst Performing Feeders (2011/12 YTD)

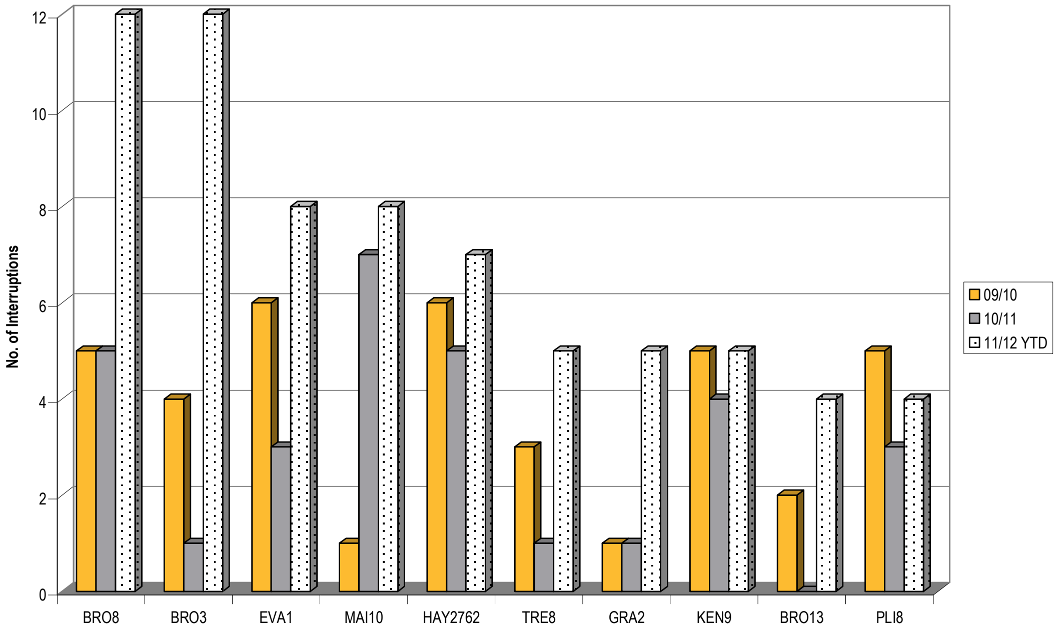


Figure 7-17 Interruption Count of Worst Performing Feeders (2011/12)

To summarise, worst performing feeders for 2011/12 are:

Feeder	2011-12 YTD Performance		
	SAIDI	SAIFI	No of Interruptions
Brown Owl 8	3.52	0.053	12
Brown Owl 3	1.73	0.014	12
Maidstone 10	1.63	0.009	8
Trentham 8	1.00	0.007	5
Gracefield 2	1.06	0.014	5
Plimmerton 8	0.90	0.009	4

Figure 7-18 Worst Performing Feeders for 2011/12

Historic faults on these feeders are reviewed to determine if there is a common root cause that needs to be addressed. The remedial actions identified as part of this review are fed back into the maintenance process where the resulting activities are carried out either under corrective maintenance (OPEX), or as a network project (CAPEX), depending on the scope of the work required.

7.6 Reliability Improvement Programme

Brown Owl 8

Brown Owl 8 is a combination of underground cables (around the area of Brown Owl, Timberlea and Maoribank) and overhead lines (around the area of Maymorn and Mangaroa). There are 1,465 customers connected to this feeder. Most of the outages recorded on this feeder were from the overhead part of the feeder and were due to trees on the line during stormy weather. The vegetation issues are being managed by Treescape as a targeted vegetation management programme. A line circuit breaker at Moeraki Road isolates faults on the rural overhead section and keeps the number of customers affected by an outage to a minimum.

Gracefield 2

Gracefield feeder 2 has 1,014 customers connected to it and runs from Gracefield to Days Bay and Eastbourne. The circuit length is 11 km and is a combination of underground cables and overhead lines. The overhead lines supply five areas on the route, including Lowry Bay, York Bay, Sunshine Bay, Days Bay, and Eastbourne. When a fault occurs, the overhead network in each of these areas needs to be patrolled which is a time consuming process. To improve fault restoration, a remote controlled mid feeder switch with a fault indicator will be installed on this feeder to sectionalise and restore power immediately to half of the feeder. Line fault indicators will also be installed in strategic locations on the spur sections of this feeder to improve fault finding.

Trentham 8, Brown Owl 3 and Maidstone 10

Trentham 8, Maidstone 10 and Brown Owl 3 are feeders with a combination of underground cables and overhead lines. The overhead lines on Trentham 8 are in the Blue Mountains Road area, Maidstone 10 is in Whiteman's Valley and Brown Owl 3 supplies lines in Akatarawa Road, all of which are heavily forested. Most of the fault causes on these feeders in recent years have been due to trees on the line. These are priority feeders under watch by Wellington Electricity and Treescape.

Plimmerton 8

Plimmerton 8 is a 17 km feeder which is mostly overhead and runs from Plimmerton to Pukerua Bay. The faults which occurred in this feeder vary from tree branches on line and the failure of overhead line components such as insulators and crossarms. This feeder will be priority listed for a pole to pole inspection in 2012 to determine the asset condition.

7.7 Other Reliability Initiatives

All overhead feeders are subject to an annual inspection, and other network equipment is inspected and maintained at prescribed intervals. Other initiatives to improve the speed and accuracy of fault finding and restoration include:

Fault Passage Indicators

Line fault indicators are used widely on the overhead network and earth fault indicators are used on the underground network. These aid in the identification of faulty sections of the network and are particularly useful in areas that are difficult to access or where long outgoing feeders have many spur lines and tee points. .

Line Circuit Breakers / Autoreclosers

Auto reclosers are used on most rural feeders to provide a fast, automated reclose function to clear transient faults such as bird strike, vegetation or line clashes in stormy weather. The use of automatic reclosers in strategic areas of the network also reduces the number of customers affected in the event of a permanent fault on that feeder.

Remote controlled overhead switches

Remote overhead switches are used to enable remote operation of the network by the Network Control Room, in conjunction with a faultman on the ground, to improve isolation and restoration times.

Removing equipment with operational restrictions

Across the network there are types of equipment with fault operation restrictions, in particular Yorkshire SO-HI switchgear. Being unable to operate these assets increases fault identification and response times.. Replacement of SO-HI is underway, with equipment on high SAIDI feeders being the priority.

8. Risk Management

8.1 Introduction

Risk management is an integral part of any business and therefore extends to the asset management process. The consequences and likelihood of failure, the performance of controls which are set to manage the identified risks need to be understood, reviewed and evaluated as part of the asset management function.

Risks associated with network assets are evaluated, prioritised and dealt with as part informing the principles and assumptions for setting the network development, asset maintenance, refurbishment and replacement programmes.

The controls for each risk are considered in developing standard work practices. The level of control to lower each risk to an acceptable level will differ depending upon the risk tolerance of key stakeholders and the circumstances and environment in which the risk may occur.

Risks controls associated with system assets are managed:

- Proactively - reducing the probability of asset failure through the capital and maintenance work programmes, insurance strategies and enhanced working practices
- Reactively - reducing the impact from a failure through business continuity planning and through the development of an efficient fault response capability.

High probability, low impact risks and conversely low probability, high impact risks are managed through a combination of Wellington Electricity's network planning and design, asset maintenance, fault response and emergency response strategies. Sections 5 and 6 of this AMP describe the network planning and asset maintenance strategies in some detail. In addition, Wellington Electricity's design standards, which are not described in detail in this AMP, are aligned with industry best practice and aim to take account of the weather and the seismic environment in the Wellington area. Further, Wellington Electricity has contingency procedures in place to restore power in a timely manner should an asset failure cause a supply interruption.

While it is impractical and uneconomic to design an electricity network that is immune to all risks, low probability, high impact events can occur that are either outside the network design envelope or require a response that is beyond the normal capacity of Wellington Electricity and its service providers. For such events Emergency Response Plans have been adopted and these are detailed later in this section.

8.2 Risk Accountability and Authority

Wellington Electricity's Board of Directors provides governance for the business risk management, reporting as a part of its corporate responsibility via the Audit and Risk Committee. The Audit and Risk Committee are updated biannually by the business as part of regular management reporting functions in line with the risk reporting framework.

Wellington Electricity's Senior Management Team (SMT) monitors the effectiveness of the risk controls providing a report for the CEO to present to the Directors. Each individual risk control is allocated to a Manager as the risk control owner. The risk control owner is responsible for ensuring that the control for each risk is clearly understood within the business and the risk controls are effective. Each risk control owner monitors the risk control and contributes towards the risk reporting framework.

In developing and implementing its risk management strategy, the CEO meets with senior management regularly to review business risks and controls. Strategic and operational risks categories are reviewed and reported in a risk register while more detailed operational risks are captured in risk control procedures and processes. The risk management strategy and process is aligned with other CKI group companies ensuring consistency across the wider global business.

8.3 Risk Framework

Wellington Electricity adopts the New Zealand Risk Management Standard AS/NZS 4360:2004 to provide a structured and robust methodology to managing risk. The risk framework provides a process for:

- Identification of the risk event, assessment of the potential causes and possible consequences of the event and quantification of the likelihood and consequence ratings to determine the inherent and residual risk ratings for the event.
- Identification of risk controls and assessment of the effectiveness and reliance of these controls to reduce or mitigate the risk – this generates the residual risk rating.
- Development of risk treatment plans to address unacceptable residual risk (high and extreme risks) or allow the business to accept a high risk activity.
- Creation of a risk register to capture the above information.

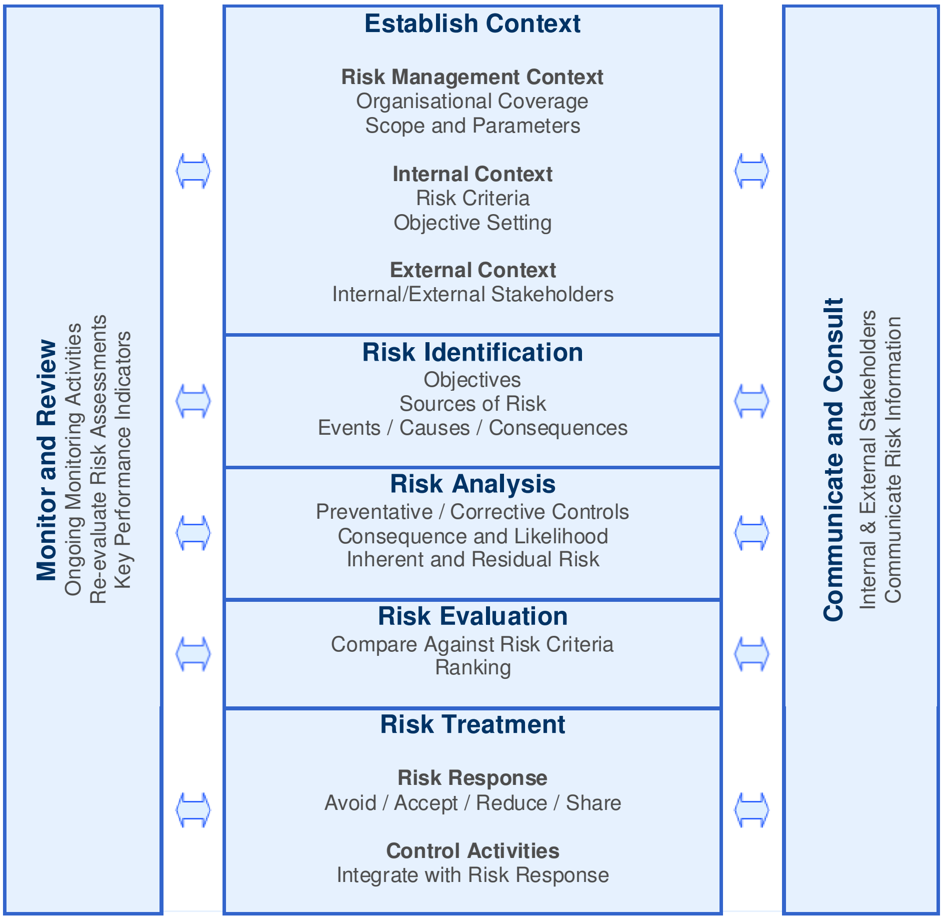


Figure 8-1 Risk Assessment Process

The objective of the risk treatment plan is to improve the control environment and to reduce any high residual risk as far as practicable. Appropriate risk treatment plans are developed as required, assigned to business risk owners and monitored to ensure that the business is taking proactive steps to mitigate the risk. These plans include a basic cost analysis to assess the practicability of the improvement options for existing controls and/or additional control initiatives to further reduce the risk to an acceptable level.

8.4 Risk Rating

The magnitude of the consequences of a possible risk event needs to be based on the ***most likely or most realistic*** impact on the business and its stakeholders. The following risk profiling matrix is used to determine the level of the risk or risk rating based on a function of consequence and likelihood.

LIKELIHOOD	CONSEQUENCE				
	Minimal	Minor	Moderate	Major	Catastrophic
Almost Certain	Medium	High	High	Extreme	Extreme
Likely	Low	Medium	High	High	Extreme
Possible	Low	Low	Medium	High	High
Unlikely	Negligible	Low	Low	Medium	High
Rare	Negligible	Negligible	Low	Medium	High

Figure 8-2 Levels of Risk Rating

Wellington Electricity uses the following consequence and likelihood criteria:

- Health & Safety (employees, public & service providers)
- Environment (land, vegetation, waterways & atmosphere)
- Financial (cash & earnings losses)
- Reputation (media coverage & stakeholders)
- Compliance (legislation, regulation & industry codes)
- Customer Service/Reliability (quality & satisfaction)
- Employee Satisfaction (engagement, motivation & morale)

The criterion is combined with a consequence scale, determining the level of consequence to the business of a particular risk ranging from minimal to catastrophic.

8.5 Risk Method Application

Controls are introduced to reduce/mitigate the likelihood or consequence of the risk with varying levels of effectiveness and reliance placed on the particular control. This helps reduce the inherent risk to a more acceptable residual risk.

Risk score	Inherent 9500 / Extreme	Residual 400 / High
Likelihood	95	25
	Almost Certain	Likely
Consequence	100	16
Compliance	Major	Minor
Customer Service / Reliability	Major	Minor
Employee Satisfaction	Major	Minor

Risk score	Inherent 9500 / Extreme	Residual 400 / High
Environment	Moderate	Minimal
Financial	$1m to $5m	$100k to $500k
Health & Safety	Major	Moderate
Reputation	Major	Minor

Figure 8-3 Example of Risk Scoring

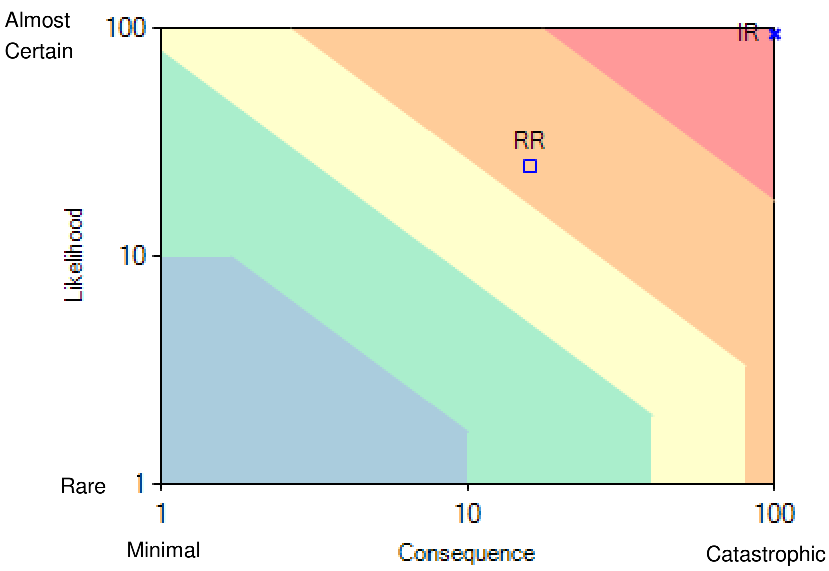


Figure 8-4 Example of Risk Methodology Application

8.6 Risk Application Example – Johnsonville Zone Reinforcement

8.6.1 Overview

As part of the ongoing analysis of network development planning it was evaluated that the subtransmission link between Transpower's Takapu Road Grid Exit Point (GXP) and Wellington Electricity's Johnsonville zone substation was not able to provide adequate capacity following an N-1 contingency event at times of high load. The N-1 capacity of the subtransmission link is constrained by the underground section of the circuit with a rating of 20 / 14.5 MVA (winter / summer). The peak load at Johnsonville zone substation is approximately 22 / 15 MVA (winter / summer) leading to a subtransmission N-1 shortfall in the order of 2 MVA for winter peaks. As part of the subtransmission link, the zone substation power transformers and incoming switchgear are also constrained, as the subtransmission circuits were matched to the capacity and rating of the transformers and switchgear.

Johnsonville zone substation is supplied by two 33kV circuits from the Takapu Road GXP, which start as an overhead line through rural land and then change to underground cables for the last 5 kilometres into Johnsonville. Should a subtransmission fault occur at or near peak demand periods, some load can be transferred to adjacent zone substations via the 11kV distribution system. Initial high level studies indicate that the capacity of the 11kV distribution system is limited and insufficient to allow for load transfer away from Johnsonville as loads begin to grow in the short to medium term.

The Johnsonville area is experiencing higher than average growth (1.5% vs. system average of 0.4%-0.5%) as it has a large number of residential subdivisions being developed. Growth is forecast to continue given its proximity to the motorway and Wellington City, and the presence of large tracts of undeveloped land. Commercial developments requiring loads in excess of 1MVA are currently in progress.

A detailed study was conducted which considered asset capability and loadings, network constraints, security and reliability criteria and overall business impacts.

8.6.2 Network Loading Constraints

Should a sub transmission circuit fault occur, the loading on the remaining circuit will be above cyclic ratings as illustrated in Figure 8-5. The most severe constraint is imposed by the winter cable rating, although summer cable rating limits are also an issue, although to a lesser extent. Transformer ratings are breached less frequently than the cable ratings. In the event of a cable or transformer outage, it is likely to be a long duration outage, with sustained overloading as subtransmission cables and zone transformers generally require long repair windows following a forced outage.

The 11kV distribution system has the ability to accommodate the temporary transfer of about 15% of peak load (3.0MVA) to adjacent substations by reconfiguring the open points. This type of temporary transfer however will compromise reliability due to increase in feeder loading of the adjacent feeders, increased customer numbers on the feeder leading to higher than normal SAIDI and SAIFI impacts and significantly reduced post-contingency network switching capacity.

In emergency conditions a further 2.0 MVA of load is estimated to be able to be dumped by offloading hot water load. This can be problematic to restore as the restored load will be much higher than the load initially dropped (as water cools down and thermostats switch back on). Both of these situations lead to no further capacity to deal with post-contingency events elsewhere in the area.

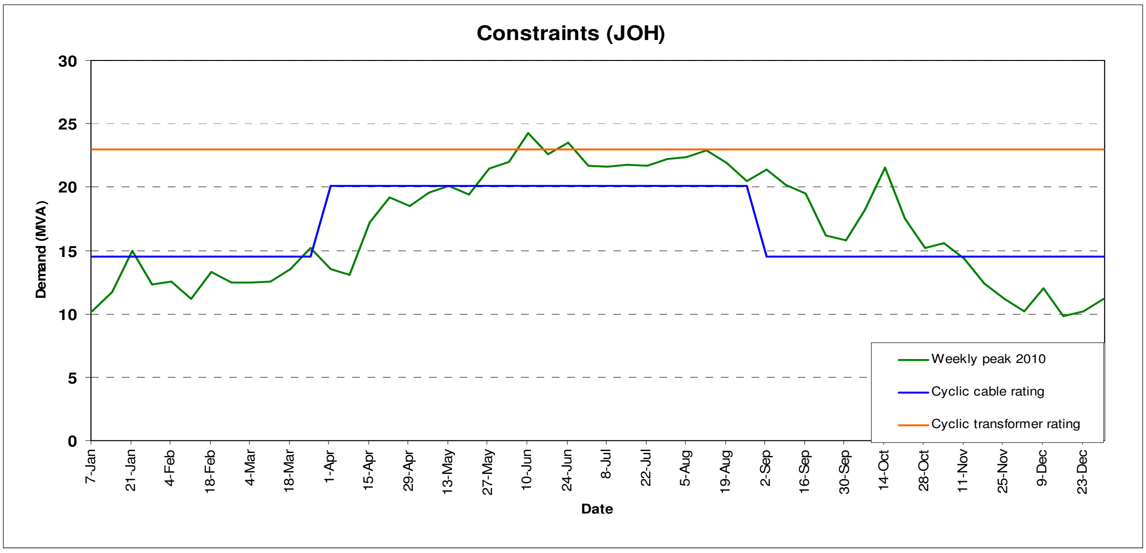


Figure 8-5 Johnsonville subtrans N-1 Equipment and Zone Tx Capacity Constraints (2010)

The constraint analysis illustrates that should a subtransmission cable be out of service at peak load times in the winter, the remaining cable will be loaded above its long term cyclic rating. The frequency and magnitude of operation above rating is high at present, and exceeds Wellington Electricity's security criteria

(Figure 8-6), and will increase as load growth continues in the area. Overloads will be more frequent during the winter period than in the summer.

Type of Load	Security Criteria
Mixed commercial / industrial / residential substations	N-1 with a break for 98% of the time in a year. For the remaining times, supply will be restored within 3 hours following an interruption.

Figure 8-6 Wellington Electricity's Security Criteria for Subtransmission Network

The load duration curve in Figures 8-7 and 8-8 illustrates that the overloading at Johnsonville has exceeded Wellington Electricity's network security criteria.

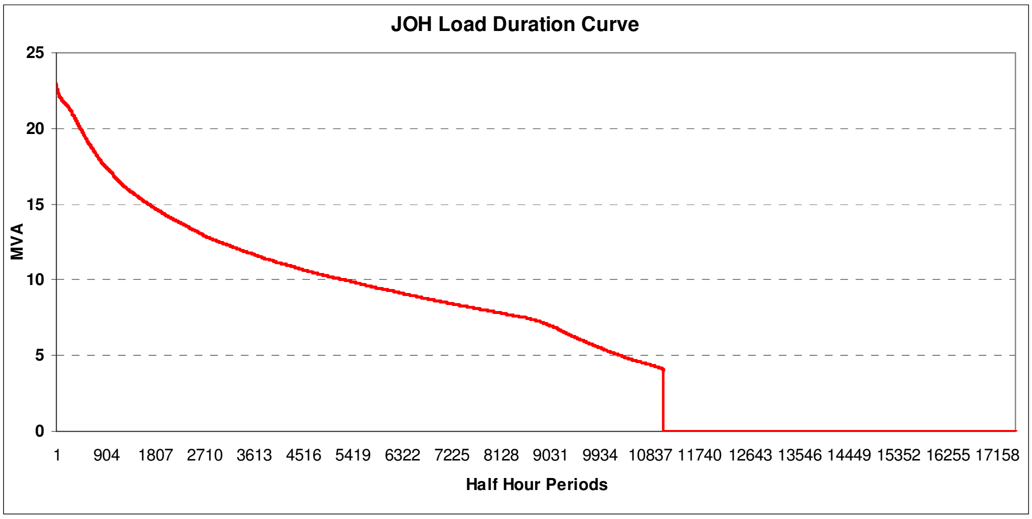


Figure 8-7 Load Duration Curve for Johnsonville Zone Substation

System Loading - Present	
Sub transmission single circuit rating	20.10 MVA
Circuit load at 98% availability	20.45 MVA
Subtransmission N-1 availability	97.5%

Figure 8-8 Wellington Electricity's Network Security Criteria Exceeded

8.6.3 Asset Capability and Loadings

There are two 11.5/23MVA 33/11kV transformers installed at Johnsonville, both were manufactured in 1969 and are in good overall condition as suggested by recent transformer and tap changer oil testing (DGA).

The 11kV switchgear comprises a board of 11 units of Reyrolle LMT with oil filled circuit breakers in acceptable condition. The switchgear fault rating is 13.1kA and the prospective fault current on the Johnsonville bus is 8.67kA thus well within switchgear ratings.

The 0.35in2 3c 33kV Al PIAS (paper insulated aluminium sheath) oil filled cables have circuit lengths of 5.05km and were installed in 1969.. These cables are generally reliable and have not experienced modes of failure similar to gas cables installed on the network. The overhead section of these circuits is constructed from 'Butterfly' 19/4.64 bare AAC conductor which has a rating of 31/45 MVA summer/winter. This line is of the same age as the cables and is in good condition with an adequate rating. The circuit constraint exists in the underground cable, and also the transformer ratings.

Winter	**Circuit**	**Maximum Continuous Ratings**		
Temp=15C	1	281A (16.1MVA)		
STR = 1.2 C m/w	2	281A (16.1MVA)		
		Long Term Cyclic Ratings		
	1	351A (20.1MVA)	**367A (21.0MVA)**	Out of service
	2	351A (20.1MVA)	Out of service	367A (21.0MVA)
Summer		**Maximum Continuous Ratings**		
Temp = 23C	1	193A (11.03MVA)		
STR =2.15 C m/w	2	193A (11.03MVA)		
		Long Term Cyclic Ratings		
	1	240A (13.7MVA)	**254A (14.5MVA)**	Out of service
	2	240A (13.7MVA)	Out of service	254A (14.5MVA)

Figure 8-9 Johnsonville 33kV Subtransmission cable ratings

The risks can be summarised as follows:

1. Should a subtransmission fault occur on one circuit during peak load times, there will be a shortfall in network capacity at the Johnsonville zone substation which may not be met through switching at 11kV. This shortfall will occur if the contingency coincides with peak load, and is forecast to get worse as load grows in the area.
2. New customer connection loads cannot be connected without adding to the loadings in the area, and therefore further compromising network security.
3. The disclosed security criteria for subtransmission supply to the Johnsonville zone substation has been exceeded and will continue to deteriorate as load grows.
4. Further transfer of load to other feeders without further network reinforcement will increase reliability issues, in particular with regard to customer numbers on each feeder impacting SAIDI and SAIFI metrics, as well as potentially overloading the 11kV network.

8.6.4 Reinforcement Risk Assessment Process

Non-network options including distributed generation and demand side management were considered however after evaluation were deemed not to be effective to address the risks identified at Johnsonville zone substation.

Three Network options were identified:

Option 1 - the installation of an additional 33kV sub transmission circuit from Takapu Rd GXP to Johnsonville zone substation to operate in parallel with the existing circuits, plus reinforcement of the 11kV switchboard and circuit breaker ratings by retrofitting new circuit breakers. This was discounted based on the current acceptable condition of network assets and cost.

Option 2 – Transfer load to a new zone substation. This option would involve building a new zone substation of a similar configuration to Johnsonville, located within the Grenada Village area, to move load away from existing zone substations. This new zone substation would provide capacity for the high levels of growth occurring north of Johnsonville.

The 33kV subtransmission supply for this new zone substation would be from the existing Ngauranga 33kV overhead line which is presently leased from Transpower. (Resource Management Consenting would be required for the 33kV route).

The benefits of this option are that it provides a long term solution to create more capacity, and improves network security through adding another in-feed to the high growth Johnsonville area. The disadvantages of this are the relatively high costs and long timelines associated with developing a new substation.

This option was not recommended as a short term solution for Johnsonville, as the development timeframe will be longer than ideal to address the immediate risks. However it will need to be considered in the medium term if load growth continues at the forecasted rates.

Option 3 – Transfer load to an existing adjacent zone substation. Ngauranga zone substation adjacent to Johnsonville has lower utilisation than Johnsonville and experienced lower growth in recent years and lower forecast load growth. Utilising this existing network capacity is a means of deferring major investment in new subtransmission capacity in the short to medium term.

This option involves reconfiguring the Johnsonville distribution feeders (JOH05 and JOH11) so that a portion of the 11kV load is supplied from a new 2.2km long Ngauranga feeder.

This option provides a medium term solution but as loads in the area continue to grow the N-1 capacity of the Johnsonville subtransmission system will once again be reached. A new zone substation (as per option 2) is forecast to be required north east of the existing Johnsonville substation in five years time. This time frame may be extended however if growth rates slow.

Option 3 was preferred and considered the most appropriate as it provides a short to medium term solution within a short construction time frame while also addressing the immediate network risk.

Figure 8-10 shows the risk likelihood for the preferred option 3.

	Inherent (existing system)	Residual (option 3)
Likelihood	Should either a subtransmission or distribution fault occur during peak load times, there will be a shortfall in network capacity at the Johnsonville zone substation which could not be met through switching or load control. This shortfall will only occur if the contingency coincides with peak load. **Classification** - Likely	The probability of a shortfall following the load transfer works is negligible. **Classification** - Rare

Figure 8-10 Risk Likelihood for Preferred Option 3

	Inherent (existing system)	Residual (option 3)
Financial consequences	Loss of revenue and potential claims for compensation from affected consumers **Classification** - < $100k	No consequences. **Classification** – No impact
Health & Safety consequences	No H+S consequences **Classification** – No impact	No consequences **Classification** – No impact
Environment consequences	No environmental consequences **Classification** – No impact	No consequences **Classification** – No impact
Reputation consequences	Blackouts will attract some negative media coverage. **Classification** - Moderate	No consequences **Classification** – No impact
Compliance consequences	No compliance issues **Classification** – No impact	No consequences **Classification** – No impact
Customer Service / Reliability consequences	Blackouts will affect consumers and impact on network reliability metrics. **Classification** – Moderate	No consequences **Classification** – No impact
Employee satisfaction consequences	No consequences **Classification** – No impact	No consequences **Classification** – No impact

Figure 8-11 Risk Consequence for Preferred Option

Risk Analysis	Inherent	Residual
Likelihood	**25**	**3**
	Likely	Rare
Consequence	**16**	**0**
Financial	<$100k	No impact
Health & Safety	No Impact	No Impact
Environment	No Impact	No Impact
Reputation	Moderate	No Impact
Compliance	No Impact	No Impact
Customer Service / Reliability	Moderate	No Impact
Employee Satisfaction	No Impact	No Impact
Level of Risk (Risk Rating)	**392**	**0**
	High	Not Assessed

Figure 8-12 Risk Analysis Table for Option 3

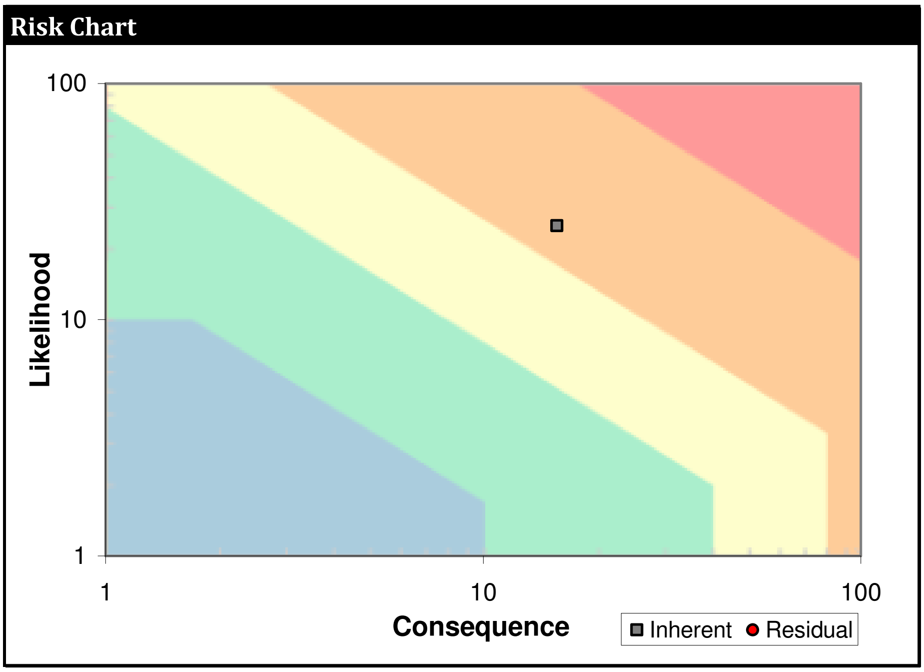


Figure 8-13 Risk Analysis Chart for Option 3

Note that the residual risk is zero and therefore does not show on the chart in Figure 8-13.

The outcome and recommendation of the risk analysis was collated into a business case and presented to the Capital Investment Committee in June 2011. The business case was approved and the cable reinforcement project was completed in January 2012.

8.7 Risk Based Approach to Asset Management

The AMP assists the decision making process for phasing out an asset through a planned replacement programme, or continuing in service supported with additional inspection and preventative maintenance activity. In addition to this, the prioritisation of capital works (refer to Sections 5 and 6) is based on an assessment of the risk that each potential project carries.

8.8 Risk and Hazard Identification

All staff members are encouraged to identify risks and hazards and raise these to the appropriate supervisor or manager. Risks are identified as part of the incident management process. New risks are added to the incident management register for evaluation, recommendation, action and close out. All risks that follow the incident management process will undergo root cause analysis to identify the underlying problem and appropriate mitigation action.

Business risk is managed through regular risk profiling workshops with the objective to identify and assess the risks which may impact on the business achieving its strategic objectives. Some risks which cannot be eliminated are assigned controls to minimise or mitigate the impact to the business should the risk occur.

8.9 Specific Network Asset Risk Controls

There are a number of areas within a network business where certain types of assets can exhibit performance which is sub-optimal, or they may deteriorate to an in-service failure point ahead of their expected life. Provided these issues are understood and monitored, the risk of in-service failure can be managed to a point where it is tolerable and controls can be put in place to reduce their impact should they occur.

Areas where monitoring programs or additional controls have been implemented around certain specific assets are discussed within this section of the AMP.

8.9.1 Zone Substation Battery Supplies

Battery supplies are of critical importance for the correct operation of substation and field devices. Battery banks are therefore important assets to regularly monitor and service to ensure the batteries remain in good serviceable condition.

Programmed maintenance and inspection to ensure healthy battery condition is in place with programmed replacement of DC battery banks at 80% of design life (typically in year 4 for a 5 year life battery). Refer to Section 6 (Lifecycle Asset Management).

8.9.2 Zone Substation Supply Security

The network is configured to maintain a level of redundancy at zone substation supply points so that continuity of supply can be maintained should a single element become unavailable for service. At peak demand times there can be insufficient capacity headroom to maintain the security level at some sites without the use of load control or reconfiguring the network connectivity to shift load to adjacent supply points.

These operational solutions are more efficient than investment in additional capacity however they need to be well planned and carefully thought through. Further monitoring and network reconfiguration plans to allow for load shifting during contingencies will be worked through for a number of substations during the planning period. Should load shifting not provide satisfactory security, then additional connectivity or capacity investment would be considered. Refer to Section 5 (Network Planning) for details of further options and potential programmes of work.

8.9.3 HV Gas Filled Cables

The pressurised gas filled sub-transmission cables system is generally operating reliably. The cables are mature and supported with gas replenishment which is remotely monitored. There are a small number of cables consuming larger volumes of gas. These will be inspected to identify and repair leaks and their condition will be assessed to determine if there are other remedial requirements. A major leak on a gas cable that necessitates removal from service for repair can take a number of weeks before the cable can be returned to service. Refer to Sections 5 (Network Planning) and 6 (Lifecycle Asset Management) for management of these assets.

8.9.4 HV Oil Filled Cables

There are a number of pressurised oil filled cables in service on the network which are monitored. The risk of oil being lost from a cable has been reviewed and all oil replacement is now undertaken with biodegradable oil. Refer to Sections 5 (Network Planning) and 6 (Lifecycle Asset Management) of the AMP.

8.9.5 Cast Metal HV Cable Terminations

A program is in place which systematically renews the older technology with modern materials to manage the known service problems from the cast iron and cast aluminium cable termination design.

8.9.6 High Voltage Switchgear

There are a number of high voltage switchboards within the network which are being programmed for end-of-life replacement. The circuit breakers will be monitored by routine inspection and any operational controls put in place to manage the equipment effectively prior to replacement. The replacement programme has prioritised the switchgear based on condition and operational capability. Refer to Section 6 (Lifecycle Asset Management) of the AMP.

8.9.7 Ripple Injection Plant

Wellington Electricity operates a ripple system to control network loads (via operating hot water storage outside peak demand periods) and to initiate functions such as public lighting. The consequences of the load control system being unavailable are being reviewed and a set of controls for this risk is being developed. Mitigation measures include maintaining a stock of critical spares and investigating the commercial justification for investment in additional plant or alternative means of providing similar control.

8.9.8 Earthing and Neutral Connection Integrity

Earthing and neutral connections perform important electrical functions for service quality and safety. The network earthing system is regularly inspected and tested however the neutral integrity is difficult to assess and problems are addressed on discovery. A review of neutral connector performance will be undertaken should the frequency of neutral integrity problems increase above the present low incident levels.

8.9.9 Utilities Sharing Wellington Electricity Poles

The Government's broadband fibre roll out will require evaluation of the risks introduced from attaching additional services to power poles and the affect this will have on foundation strength, wind loading, structure integrity as well as operational considerations. A review of the consequences of supporting additional assets will be evaluated and the liabilities introduced allocated through contract to the parties introducing the additional services.

8.10 Network Resilience

The Wellington region is a seismically active area with known fault lines. There is a risk from liquefaction in some areas and risk from tsunami in low lying coastal areas. Due to the events of the Christchurch earthquakes in September 2010 and February 2011 there has been increasing social and business awareness on the need for a safe and reliable electricity supply and the community need to restore power as safely and quickly as practically possible following a major event.

Wellington Electricity's network assets date back to early the 1900's and over the intervening years design codes and building practices have been revised as materials, and construction techniques have improved. Wellington Electricity has developed Emergency Response Plans to recover from various network incidents and events. Wellington Electricity has Crisis Management and Major Event Management Plans in place to recover to a significant event, including earthquakes, and supplemented by other supporting plans described in detail in Section 8.12.

8.10.1 Seismic Reinforcing of Equipment and Buildings

Wellington Electricity has continued to be proactive in surveying and identifying any potential seismic issues with regards to the network buildings and assets. Major equipment within zone substations such as transformers and switchgear, service transformers and battery stands have been seismically restrained. Also any heavy loose equipment has been removed from substations and relocated to a centralised store. Ongoing maintenance inspections and notified defects from site visits will continue to identify any assets requiring further seismic support.

Figure 8-14 Zone Substation Power Transformer Seismic Restraint Footing

Substation building installations generally comply with the relevant building code applicable at time of construction. All TLAs conduct assessments of all buildings within their region that have been built or strengthened to pre-1976 structural design codes to ensure compliance with their Earthquake Prone Buildings Policy initiated in 2006. This policy was driven by changes under the Building Act 2004 which covers all building types and requires older buildings to have the performance capacity of at least one third (33%) of that of a new building. A building is evaluated using the Initial Evaluation Process (IEP) as set out in the New Zealand Society for Earthquake Engineering Recommendations for the assessment and Improvement of the Structural Performance of Buildings in an Earthquake.

Wellington Electricity has received 22 IEPs from Wellington TLAs to date. Of these buildings, 5 have been identified as potentially earthquake prone. Consequently, Wellington Electricity engaged independent structural consultants to review the buildings' resilience. The independent structural consultants assessed 3 of the LTA notified earthquake prone buildings to be above the required 33% of the National Building

Standard (NBS). Of the remaining 2 non-compliant substation buildings, one has received seismic strengthening (70 Adelaide Road, Newtown) including the construction of a new concrete wall behind the existing façade which was completed in 2011, meeting 67% of the NBS.

Figure 8-15 Adelaide Road Substation Seismic Reinforcing in progress

The remaining substation building is currently being evaluated and planned for appropriate seismic strengthening commencing later in 2012. A third substation building independently assessed by Wellington Electricity is also planned for seismic strengthening in 2012. This is also discussed in section 6.4 (Maintenance and Renewal Programmes)..

Wellington Electricity has engaged a structural consultant, who has previously designed seismic reinforcing for both Orion and Transpower substation buildings, to assist in the development of a seismic reinforcing guideline standard for Wellington Electricity owned substation buildings. This guideline will outline the basic parameters of effective and practical seismic strengthening construction based on sound principles employed for buildings that successfully withstood the impact of the Christchurch earthquakes in September 2010 and February 2011.

Accordingly, Wellington Electricity is reviewing its policy on the categorisation, assessment and management of substation building seismic strength and requirements for reinforcing based on the performance of substation buildings in response to the recent Christchurch earthquakes. The revised policy will clarify the business guidance on the risk and importance of each Wellington Electricity owned substation building and establish the priority of the reinforcement programme of works including capital expenditure forecasting over the planning period.

Wellington Electricity's other design and construction standards and specifications comply with current seismic design codes. Typical issues in respect of the new codes are tie down of distribution transformers (older transformers may have their wheels chocked) and older brick buildings that do not meet current seismic codes. Newer berm type substations are bolted to concrete plinths which have been placed on a formed flat ground platform. No specific restraint has been integrated into these installations.

Wellington Electricity continues to capture risk mitigation works in its network planning and is active in forming and maintaining coordinating relationships with key local area utilities and national disaster response organisations.

8.10.2 33kV Overhead Emergency Corridors

Underground sub-transmission cables utilising gas and oil filled technologies can be vulnerable to seismic events. Repair to extensively damaged gas and oil filled cables could take a number of months, which is unacceptable. Wellington Electricity has engaged with Wellington City Council (WCC) to specifically address this issue in the event of an earthquake and to develop the protocols regarding the emergency installation of overhead 33kV lines should sub-transmission cables become unavailable for an extended period following a major event.

Wellington Electricity has engaged a design consultant to carry out 33kV temporary overhead route planning and line design to supply CBD zone substations from Transpower GXPs in case of damage to underground sub-transmission cables during an earthquake or any other catastrophic event. The selection of the proposed routes shall consider all risks within their immediate vicinity such as earthquake prone buildings, vegetation, topography, ground conditions and ease of access for construction.

The key outcome from the planning and design will be a set of defined 33kV overhead line emergency corridors and appropriate support structures that will be socialised with WCC for consideration of implementing within the District Plan emergency provisions. Engagement with the remaining Wellington area councils will commence following the Wellington CBD study.

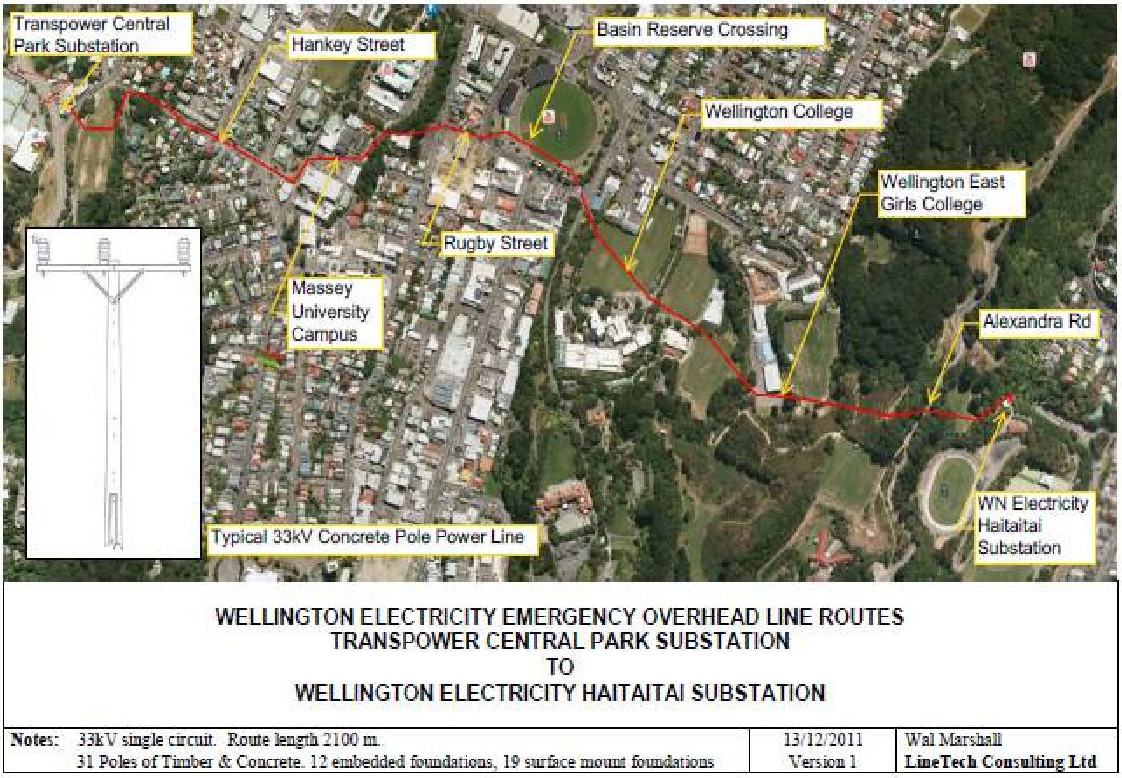


Figure 8-16 33kV Emergency Overhead Line Corridors (Example only)

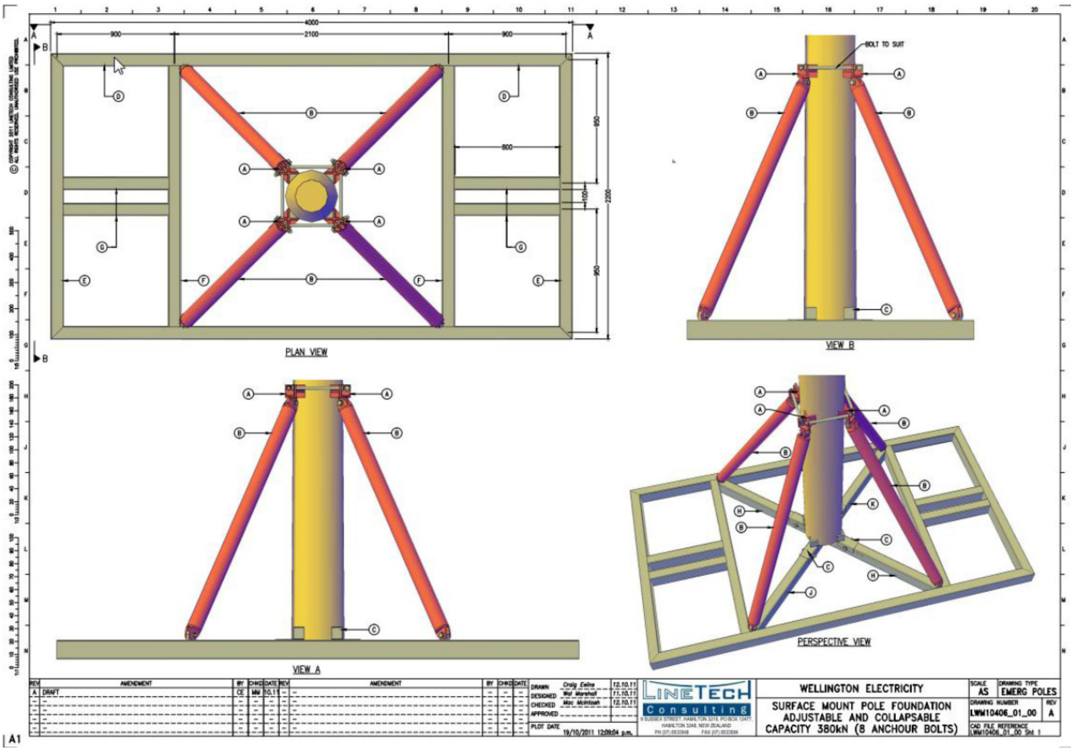


Figure 8-17 33kV Pole Structure Supports (Example only)

8.11 Insurance

8.11.1 Insurance Cover

Wellington Electricity renews its insurances in two tranches. The Industrial Special Risks (ISR) Insurance which includes material damage and business interruption cover is renewed annually as at 30 June.

The Company's general products and liability insurance is renewed annually is at 30 September. These insurances include: general, products, pollution, electro-magnetic radiation, financial loss (failure to supply), and professional indemnity.

The renewal process for all insurances commences four to six months prior to the expiry of existing policies in conjunction with the appointed broker and the expertise of the wider CKI Group. Insurances are generally placed at least 10 business days prior to the policy expiry date.

According to analysis by Munich Reinsurance Company, the global insurance and re-insurance markets absorbed record insurance losses of $US105B from 2011 associated with the tsunami in Japan, earthquakes in New Zealand and floods in the US, Australia and Thailand. Going forward insurance premiums for ISR insurance for loss affected areas, including New Zealand are expected to increase significantly. This was observed in 2011 and further increases are likely in 2012 as there is reduced capacity in the global insurance market for insuring New Zealand based risks.

In 2011 Wellington Electricity commissioned two reports to assist in quantifying its insurance risk and requirements and to help mitigate insurance premium increases.

GNS Science was engaged to present its estimates of the potential earthquake and tsunami losses to insured assets. This report indicated a low probability of a significant seismic event from known earthquake faults and in any event estimated losses were within existing insurance limits. This report is being updated in April 2012 to assist with the June 2012 insurance renewal.

Aon Global Risk Consulting (AGRC), part of Aon Risk Solutions, assisted Wellington Electricity in modelling 3 business interruption (BI) loss scenarios - loss of a major GXP (terminal station), loss of a major zone substation, and a significant earthquake event. Results confirmed that the existing BI insurance cover is appropriate. The BI modelling will also be updated in April 2012 to reflect Wellington Electricity's updated building plant and machinery valuations.

Wellington Electricity will continue to leverage off the buying power of the wider CKI Group to obtain lower priced insurance premiums than could be achieved on a standalone basis in New Zealand. Capacity to cover NZ based risks within the Australian and New Zealand markets has reduced following the Canterbury earthquakes. Accordingly Wellington Electricity has engaged other markets, notably the London market, to ensure appropriate insurance cover is maintained.

8.11.2 Risk and Recovery of Increased Insurance Premiums

Wellington Electricity only insures 20% of the estimated asset replacement cost of network assets, covering key strategic assets. There are significant costs to increasing insurance cover beyond this. The Commerce Commission, through the default and customised path regimes, do not allow for this additional cost to be adequately recovered. This enables customers to pay lower prices. Following the Christchurch earthquakes, Wellington Electricity is currently engaging with the Commission to seek clarity about how the risk from uninsured assets is best managed. This could be through either an additional risk premium on the regulated return on investment i.e. through increased lines charges or through Government providing funding post a major event such as an earthquake.

The significant increase in insurance premiums experienced in 2011 and forecast for the next few years has led to further discussions and consultation with the Commission around recovery of the increased costs being incurred to reduce the impact on customers from unplanned events. Under the current default price-quality path, there is no clear mechanism for distribution businesses to be able to fully recover these costs, with only CPI increases able to be recovered. The Commission has indicated that it will allow distribution businesses to pass through the increase in insurance premium costs to customers. This is important for Wellington Electricity to be able to earn a return on investment sufficient to fund the forecast expenditure contained in this AMP. At the time of writing the Commission has yet to confirm how the increase in insurance premium costs will be fairly recovered.

8.12 Emergency Response Plans

As part of the Business Continuity Framework Policy, Wellington Electricity has a number of Emergency Response Plans (ERPs) to cover emergency and high business impact situations. All of the ERP's require annual simulation exercises to test the plans and procedures and feedback any areas for improvement. All of the ERP's shall be periodically reviewed and revised to best meet the emergency management and response requirements of Wellington Electricity.

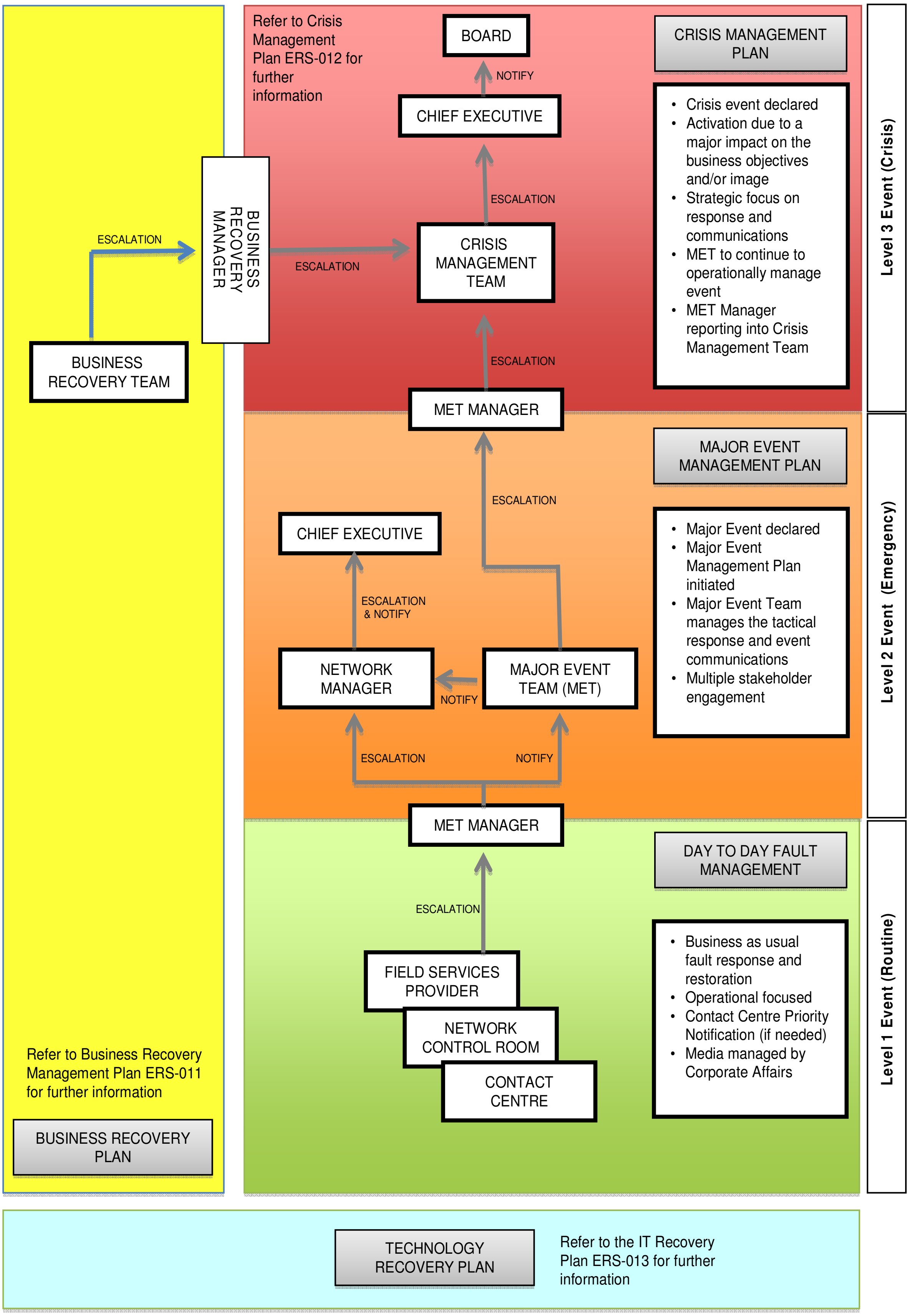


Figure 8-18 Emergency Response Escalation Framework

8.12.1 Crisis Management Plan

The purpose of the Crisis Management Plan (CMP) is to ensure that Wellington Electricity is prepared for, and responds quickly to, any crisis that occurs or may occur on its network. The CMP defines the structure of the Crisis Management Team and the roles and responsibilities of staff during a crisis.

The CMP contains detailed contact lists of all key stakeholders who may contribute to or be affected by the crisis.

8.12.2 Major Event Management Plan

The purpose of the Major Event Management Plan (MEMP) is to ensure that Wellington Electricity is prepared for, and responds quickly to, any major event that occurs or may occur on its network. The MEMP defines a major event and describes the actions required and the roles and responsibilities of staff during a major event.

During 2011 and 2012 major event simulation exercises have been carried out to stress test the MEMP process and the major event team roles and responsibilities. These tests have identified a number of gaps that will assist in the continuous improvement of the MEMP and how well Wellington Electricity responds to a major event.

A particular focus of the MEMP is how the internal and external communications is managed. The plan contains detailed contact lists of all key stakeholders who may contribute or be affected by the major event.

The MEMP can escalate to a crisis and then be managed in accordance with the CMP.

8.12.3 Business Recovery Management Plan

The purpose of the Business Recovery Management Plan (BRMP) is to ensure that Wellington Electricity is prepared for, and responds quickly to any event that interrupts the occupancy of its corporate offices in Petone and clearly states how such a business interruption would be recovered and escalated to a crisis if required. This includes the mobilisation of the Business Recovery Event Centre at the Wellington Electricity Disaster recovery site at Haywards.

A desktop simulation exercise was completed in 2011 which assisted in the identification of the necessary business recovery infrastructure provisions and key business recovery timeframes.

8.12.4 Storm Response Plan

The purpose of the Storm Response Plan is to ensure that Wellington Electricity is prepared for and responds to a storm or potential storm that may impact on the network. The Storm Response Plan describes actions required and responsibilities of staff during a storm emergency and focuses on systems and communications (internal and external) to restore supply to customers.

The regional weather patterns are monitored by the Wellington Electricity Network Control Room (NCR) on a daily basis using Metservice real-time information. The Storm Response Plan is declared by the NCR if a storm warning or severe weather warning is declared by the Metservice for the Wellington region.

If the Storm Response Plan is activated then a ‘Storm Warning’ mode is invoked which signals the necessary preparation for Wellington Electricity, the NCR and the field service providers to prepare and provision in advance of the storm. The NCR will declare a 'Storm Stand Down' once the storm has passed and the network is back to a normal state. The Storm Response Plan can escalate to the MEMP if required.

8.12.5 Emergency Evacuation Plan

The purpose of the Emergency Evacuation Plan is to ensure that the NCR is prepared for, and responds quickly to any incident that requires the short or long term evacuation of the NCR and re-establishment at the disaster recovery site.

8.12.6 Civil Defence Emergency Management (CDEM) Plan

As an electricity distribution business providing essential services, Wellington Electricity belongs to the Lifeline Utilities group. There is an emphasis in the Civil Defence Emergency Management Act 2002 on ensuring that lifeline utilities provide continuity of operation, particularly where their service supports essential CDEM activity.

Wellington Electricity has prepared the CDEM Plan to comply with the relevant provisions of the CDEM Act. It provides information for the initiation of measures for saving life, relieving distress and restoring electricity connections.

This CDEM Plan follows the four 'Rs' approach to dealing with hazards that could give rise to a civil emergency:

- Reduction - identifying risks and developing plans to reduce these risks
- Readiness - developing emergency operational contingency plans
- Response - actions taken immediately before, during or after an emergency
- Recovery - rehabilitating and restoring to pre-disaster conditions.

8.12.7 Pandemic Preparedness Plan

The purpose of the Pandemic Preparedness Plan is to manage the impact of a pandemic related event by:

- Protecting employees as far as possible from spread of disease
- Create a safe working environment
- Maintain essential business functions with reduced staffing levels if containment is not possible.

The Pandemic Preparedness Plan is reviewed annually by the Wellington Electricity QSE manager.

8.12.8 Other Emergency Response Plans

- IT Recovery Plan (in development)
- Priority Notification Procedures to key staff and contractors
- Total Loss of a Zone Substation Plan
- Loss of Transpower Grid Exit Point Plan (Transpower Plan)
- Emergency Load Shedding Plan
- Participant Outage Plan (as required by the Electricity Authority)

- Call Centre Continuance Plan

In addition contingency plans are prepared as necessary detailing special arrangements for major or key customers.

9 Health, Safety and Environmental

Wellington Electricity aims to ensure that:

- All employees and contractors can undertake their work in a safe environment
- That members of the public are protected from harm by the operation, maintenance and improvement of our assets
- That environmental impacts are assessed and minimised.

To enable this, Wellington Electricity has developed a comprehensive set of health and safety policies and procedures and prioritises safety as a core business value.

9.1 Health and Safety Policy

Summarising the Health and Safety Policy, Wellington Electricity endeavours to:

- Ensure healthy and safe outcomes are the priority for all business decisions
- Take all practicable steps to provide a safe and healthy work place for all our people, contractors, the public and visitors
- Monitor and continuously improve our health and safety performance
- Communicate with our people, contractors, customers, and stakeholders on health and safety matters.

The policy will be achieved by:

- Ensuring regular monitoring and review of the Company Health and Safety Management System
- Complying with, all relevant legislation, regulation, standards and codes of practice
- Developing systems which identify, assess and document controls for workplace hazards
- Providing and mandating use of PPE equipment to assist with achieving health and safety outcomes
- Accurately reporting, recording and learning from all incidents and near misses
- Consulting, supporting and encouraging participation from employees on issues to assist their understanding of the collective responsibility for their health and safety outcomes.

All Wellington Electricity employees and contractors are required to personally manage their own and other people's safety by adhering to safe work practices, making appropriate use of plant and equipment (including protective clothing and equipment), promptly managing controls for assessed hazards and reporting of incidents, near misses and accidents.

9.2 Environmental Policy

Summarising the Environmental Policy, Wellington Electricity endeavours to:

- Ensure the sustainability of the environment is considered as part of business decision making
- Monitor and continuously improve environmental performance
- Communicate with employees, contractors, customers, and stakeholders on environmental matters

- Be regarded by employees, contractors and the community as operating in an environmentally responsible manner and acting as a good corporate citizen.

The policy will be achieved by:

- Comply with environmental legislation
- Promote a culture of environmental responsibility among both employees and contractors to ensure they are aware of their environmental obligations
- Minimise adverse environmental impacts of waste and pollution from assets and operational activities
- Use materials and resources efficiently, minimising waste to maximise their value to the current and future generations;
- Consult and communicate with employees, the community, government and regulatory authorities on significant environmental matters relevant to our activities
- Report annually on environmental performance and compliance against company targets.

All Wellington Electricity employees and contractors take all reasonable steps to ensure that all business activities provide an outcome which promotes a sustainable environment for future generations.

9.3 Health, Safety and Environmental Arrangements

Wellington Electricity's implements its health and safety arrangements through a suite of policies, standards and procedures which collectively form our integrated Quality, Safety and Environmental Management System. These documents are implemented and communicated with both employees and sub-contractors. The documented management system aims to ensure that the inherent risks which have been identified analysed and quantified can be effectively controlled, to acceptable levels and monitored.

9.4 Health, Safety and Environmental Performance

Wellington Electricity contractors achieved a second successive 12 month period with no lost time incidents during the 2011 calendar year. During this 24 month period a total of over 500,000 contractor hours were worked with zero incidents resulting in serious harm. The Lost Time Injury Frequency Rate (LTIFR) for Wellington Electricity was zero throughout the whole of 2011. Wellington Electricity is aware that following this previous level of performance, complacency must not be allowed to creep into work practices, which may lead to incidents occurring on the network.

In addition to maintaining a LTIFR of 0 for the year, Wellington Electricity also implemented initiatives aimed at increasing the number of near miss and incidents being reported by its contractors. When compared with data from the previous year, 2011 saw overall health, safety and environmental event reporting increase by 70% (up from 115 to 196) while reporting of near miss events increased by 44% (up from 102 to 147). This increase in near miss reporting has also been realised against a re-definition of incident types which has resulted in a number of events which were previously classified as near miss, now being recorded as incidents. This allows more accurate trending and analysis of events to drive improvements.

Wellington Electricity received no environmental infringement notices from TLAs during the period since the last AMP was disclosed. Wellington Electricity routinely monitors the activities of contractors working on its network. Inspections or assessments are predominantly undertaken by a Field Assessor and the team of Project Managers.

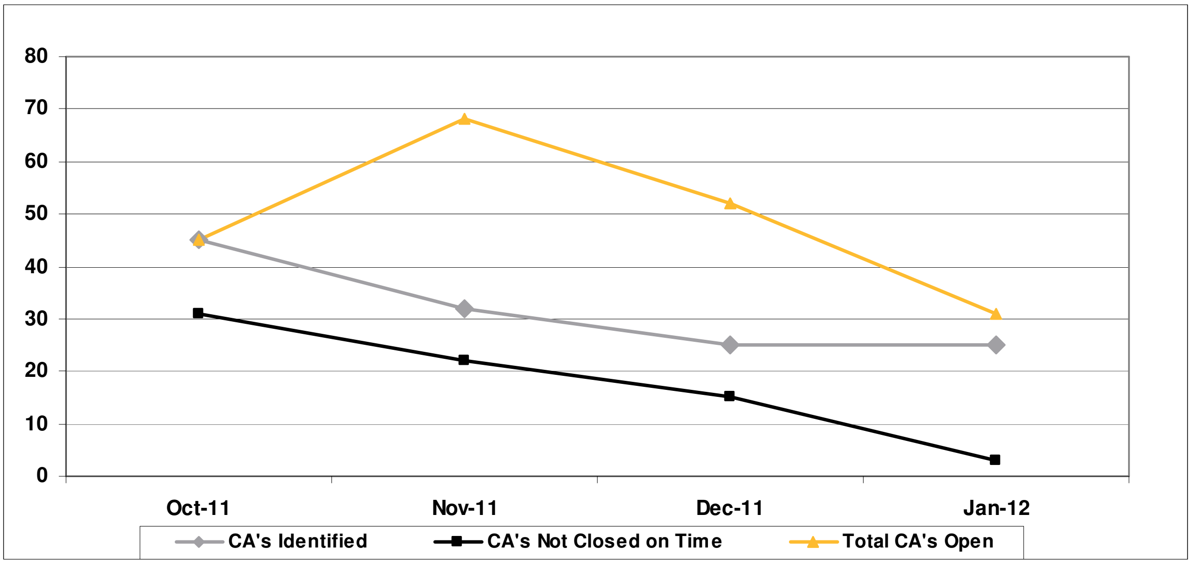


Figure 9-1 Analysis of Corrective Action Identification and Closure

Improvements made during 2011 to the contractor assessments process have enabled improved performance reporting in this area. Figure 9-1 above shows the total number of quality, safety and environmental Corrective Actions (CAs) identified each month; the total number of CAs which were closed within agreed timescales and total number of CAs which are open at the time of reporting.

An initiative was launched in 2011 aimed at increasing the number of employees undertaking inspections of contractors on the network. The term "Site Safety Visit" was coined to describe these types of assessments. During 2011, 58 Site Safety Visits were undertaken resulting in a number of safety improvements being identified and implemented.

All asbestos-covered cables and DC circuit breaker arc chutes are located within non-publicly accessible substations and are only accessed by Wellington Electricity approved contractors with the appropriate competencies. The asbestos-covered cables are primarily short lengths used to connect switchgear and transformers. Surveys have been conducted to identify all asbestos cables and all asbestos cables have been tagged on the actual cable itself. The asbestos hazard has been inspected and the type of asbestos analysed has been categorised as a low risk.

The Petone zone substation site in Bouverie Street was previously a gas works site and has been identified as having ground contamination. An environmental assessment study has been carried out, which concluded that the risk to general site users from contamination is low and the risk to local groundwater or surface water is also low. Additionally an environmental management plan has been developed to manage the site contamination going forward.

9.5 Health Safety & Environmental Improvements

Continual improvement is one of Wellington Electricity's core values and sets the scene within the organisation as to how work should be approached. The document management system is currently undergoing a detailed review process to ensure currency of the health and safety documents being used by the business and to ensure continual improvement of these. During 2011 a significant number of health and safety related documents went through the document review and improvement process and a similar amount of work is planned for 2012. This ongoing review ensures that health and safety risk controls are being continually assessed to ensure that they are appropriate to the nature and size of the risk, they are being adhered to and that the performance outcomes are within expected limits.

Core health and safety processes which have been reviewed and improved during 2011, to ensure accuracy and currency, and to incorporate industry best practice include:

- *Safe Work Practices Manual* - Defines the essentials necessary to maintain an injury free environment. These practices reflect the basic approach necessary for Wellington Electricity and its contractors to identify and eliminate accident causes.

- *Contractor Prequalification* – This details the evidence required to be submitted to Wellington Electricity for assessment and prior approval for any contractors wishing to work on our network.

- *Work Type Competency* – Once a contractor has achieved pre-qualification from Wellington Electricity, this process defines the minimum levels of knowledge, experience and proficiency required of their employees to undertake specific tasks on or near the Wellington Electricity network. This process is applicable to all people working on or near the Wellington Electricity network.

- *Public Safety Management System Framework* – Defines the arrangements in place to fulfil the requirements of NZS 7901:2008 Electricity and Gas Industries – Safety Management Systems for Public Safety. This includes risk assessment, analysis and control, inspection and monitoring, review and improvement, emergency arrangements and communication and awareness initiatives.

- *Asbestos Management Policy and Initiatives* – This policy acts as a guide that advises on location, type and state of the asbestos on the network. This policy serves as a hazard management guide for Wellington Electricity contractors and employees alike. When work is being undertaken where asbestos is present, the policy will allow for better project management and enable appropriate procedures to be developed. The asbestos policy is supported by the asbestos register.

- A project is planned for 2012 to replace all asbestos lined DC circuit breaker arc chutes including the replacement of two DC mercury arc rectifiers.

- *Contractor Field Assessment* - Defines the activities involved in assessing the safety, quality and environmental aspects of work being undertaken by contractors on the Wellington Electricity network and outlines how non-conformances shall be actioned and closed-out.

- *Incident Management* – Defines the reporting and management requirements for all incidents which impact or have the potential to impact Wellington Electricity. This includes reporting, classification, investigation, escalation, notification and follow up processes.

9.6 Public Safety Management System (PSMS)

As demonstrated throughout this AMP, Wellington Electricity has extensive policies, standards and processes around maintaining a safe and reliable network which includes the assets that are installed in the public areas and managing the assets to ensure they do not pose a significant risk to public safety,

Regulation 47 and 48 of the Electricity Safety Regulations (ESR) 2010, require electricity distributors to implement and maintain a safety management system for public safety. In order to demonstrate compliance with this requirement, Wellington Electricity has developed a Public Safety Management System (PSMS) framework policy document which outlines the policies, procedures and guidelines relevant to the safe design and management of the assets. The framework aims to demonstrate the safety and integrity of our assets and the minimisation for the potential, and consequence, for failure as required by New Zealand

Standard Electrical and Gas Industries – Safety Management System (NZS 7901:2008). In order to demonstrate compliance with NZS 7901, both Stage I and Stage II Assessments were undertaken by an independent auditing company. An action plan has been developed to address the four partially attained areas identified during the audit. Wellington Electricity is expecting to gain certification to NZS 7901 during early 2012.

Wellington Electricity invests significant resources to raise awareness in the community of the potential risk of living and working near electricity assets. These resources include:

9.6.1 Stay Safe around Electricity – School Safety Programme

The Stay Safe programme is an electricity safety programme aimed at primary school aged children and delivered in the classroom at primary schools around the Wellington Region. The programme is designed to deliver safety messages that will inform and educate children on how they can remain safe around Wellington Electricity assets. The programme targets schools in areas that have been identified as being most at risk.

Delivery of the programme includes providing children with an information pack which includes a workbook and safety brochures. The workbook invites children to visit the *Electricity Safety World* website. Information regarding the Electricity Safety World Website is described below.

9.6.2 Third Party Contractor Network Safety Presentations and Mail Outs

In order to prevent third party contact with the Wellington Electricity Network, the Quality Safety and Environmental Manager periodically delivers safety presentations to civil contracting companies. The safety presentation is targeted to make these contractors aware of their obligations under the Electricity Act and various related regulations and codes of practice and what they must do in order to stay safe when working near or around the network.

These presentations are often delivered to groups of contractors at the premises of their principals. Past presentations have been held for the contractors of the WCC, NZTA and Water Utility Capacity.

From time to time Wellington Electricity sends out letters to various contractor sectors, particularly in response to known infringements, regarding safety around the network.

9.6.3 Media Advertisements

Wellington Electricity has developed a series of safety messages which it can utilise in various communication channels including print or radio. These messages consist of a series of strap-line safety messages which are targeted around various network public safety issues. These safety messages include digging safely, trees and electricity lines, and general safety around the home and our network assets. A radio safety ad campaign began in November 2011. The adverts direct the listener to Wellington Electricity internet safety pages for further information.

9.6.4 Wellington Electricity - all need to work safely booklet

Wellington Electricity has produced a safety publication targeted at civil contractors and those working near but not accessing the Wellington Electricity network. This booklet *Wellington Electricity all need to work safely* is handed to those attending safety workshops and in mail outs to various contracting sectors that interface with the network.

9.6.5 Wellington Electricity Website and Electricity Safety World Website

Wellington Electricity has a well maintained and up to date website. Wellington Electricity has recently revamped the safety pages of its internet site to increase the usability of the site and improve access to information. The revamp was instigated to tie in with the radio safety ad campaign. The www.welectricity.co.nz safety pages provide a wealth of information to help the community stay safe around electricity, including information on: electrical shocks, electrical fires, electromagnetic fields, appliance safety, power line safety and fault reporting details.

The website also links to other safety sites and government safety agencies. Of note is a link to the Electricity Safety World Site which contains interactive safety games and information targeted at young children and parents regarding not only network safety, but also electrical safety around the home.

9.6.6 Value Added Services

Wellington Electricity has established a range of services to improve communication with members of the public with an aim of reducing the risk of public safety or property damage incident. These services include:

- A free call, 24 hour manned, call centre
- A free call number for provision of service location maps
- A free service location service for all network cables
- A free assessment for potential close approach to overhead lines and in many cases the provision of free additional services such as cover ups / safety disconnects
- Provision of a high load assessment service and cost only charge for any associated works.
- Card drops.

9.6.7 Territorial Local Authorities

Wellington Electricity works with a number of stakeholders that have an interest in the safety and security of the network. The TLAs are a group of stakeholders who engage or have some responsibility for contractors and other service providers that interface with the Wellington Electricity Network. As a result, Wellington Electricity works closely with organisations such as Wellington, Hutt, Upper Hutt and Porirua City Councils.

In engaging with these organisations Wellington Electricity hopes to be able to prevent situations arising such as building encroachment on the network, safer reinstatement in road reserves, improved traffic management outcomes and a better understanding of where it can mitigate risks to the public.

10. Performance Evaluation

10.1 Review of progress against the previous AMP

Appendix A provides a comparison of forecast financial performance against actual for the previous year financial year (1 April 2010 to 31 March 2011). The variance for CAPEX was 17.9% and the OPEX variance was -0.7% as shown in the summary below.

	Previous Plan Forecast ($'000s)	Actual ($'000s)	Variance ($'000s)	Variance (%)
OPEX	10,697	9,915	-782	-7.3
CAPEX	22,290	26,273	3,983	17.9
TOTAL	32,987	36,188		

Figure 10-1 Target vs. Actual Financial Performance for 2010/2011

The variation of 17.9% for CAPEX is attributed to a large 33kV sub transmission cable replacement project which not included in the previous forecast but was completed during 2011.

10.2 Evaluation of Performance against Target

The service targets that Wellington Electricity has adopted are described in detail in Section 4 (Service Levels). These targets include:

- Network reliability (SAIDI, SAIFI)
- Contact Centre Service Levels
- Power Restoration times
- Faults per 100 circuit-km.

10.2.1 SAIDI & SAIFI

The comparison of target and actual SAIDI and SAIFI for the year 2010/2011 is provided below.

	Target 2010/11	Actual 2010/11	Variance
SAIDI	40.7	34.74	-14.7%
SAIFI	0.60	0.537	-10.5%

Figure 10-2 Target vs. Actual Network Reliability for 2010/2011

The targets for 2010/11 were set based on the historic averages of SAIDI and SAIFI reliability data for the period 2004 to 2009. This is illustrated in the SAIDI graph for the period since 2004, which is provided below.

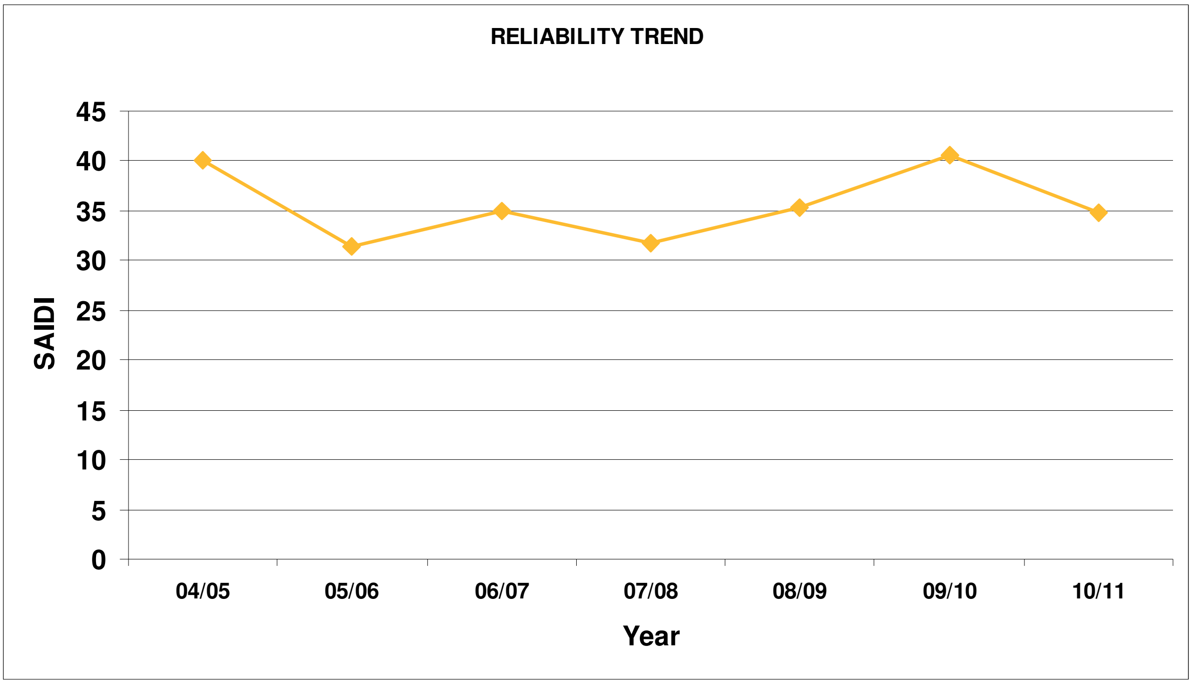


Figure 10-3 Historical SAIDI for Wellington Network 1998 to 2010

2010/2011 Quality Threshold Performance

Wellington Electricity has complied with its reliability thresholds for SAIDI and SAIFI in the 2010/11 regulatory year as set out in the table in Figure 10.2.

10.2.2 Contact Centre Service Level

A - General Contact Centre Service Levels

SL	Service Element	KPI	Actual 2010/11
A1	Overall Service Level	80%	91.3%
A2	Call response	20 seconds	13.50 seconds
A3	Missed calls	4%	0.90%

Figure 10-4 Target vs. Actual General Contact Centre Service for 2010/2011

B - Customer Experience

SL	Service Element	KPI	Actual 2010/11
D1	Specific Contact Centre experience	80%	90.4%

Figure 10-5 Target vs. Actual Contact Centre Customer Experience for 2010/2011

C - Energy Retailer Satisfaction

SL	Service Element	KPI	Actual 2010/11
E1	Overall retailer satisfaction with Contact Centre performance	80%	94%

Figure 10-6 Target vs. Actual Contact Centre Retailer Satisfaction for 2010/2011

10.2.3 Power Restoration Time

	Less than 3 hours	More than 3 hours	More than 6 hours
Maximum time to restore power	77.45%	15.69%	6.9%

Figure 10-7 Performance - Power Restoration Time for 2010/11

10.2.4 Faults per 100 Circuit Kilometre

	Target 2010/11	Actual 2010/11
Faults per 100 circuit kilometre	11.0	11.9

Figure 10-8 Performance – Faults per 100 Circuit KM for 2010/2011

The faults per 100 circuit kilometre actual were higher than target due to a slightly higher number of faults during the 2010/11 period, however the number of faults that caused an interruption to supply remained steady.

10.3 Gap Analysis and Identification of Improvement Initiatives

During the past year, Wellington Electricity has reviewed many aspects of its asset management strategy and field service provision, and made a number of significant changes. Progress against the gaps identified in the last AMP is shown in the table below. Despite generally good progress against identified gaps, not all areas were addressed and these will be carried forward for action in 2012.

2011 Section	2011 Gap Item	Description	2012 Progress	Comment
2.8.1	ENMAC Implementation	Following the commissioning of the GE ENMAC SCADA system in 2011, Wellington Electricity shall continue to evaluate the functionality from the system allowing the full value to be extracted to better enhance the network real time operations.	Complete	ENMAC has been fully commissioned for control of the network during 2011.

2011 Section	2011 Gap Item	Description	2012 Progress	Comment
2.8.1	Automatic Load Control System	A needs and benefits analysis needs to be undertaken to review the use and future options for automatic load control, as part of the overall load management / ripple strategy. An evaluation process will be conducted on the appropriate load control system replacement for the legacy Foxboro load control system.	No progress	Due to the large commitment with commissioning of the ENMAC SCADA system during 2011, no progress was made on the assessment of the automatic load control system. The Foxboro system is still in place and fulfils its purpose.
2.8.1	Maintenance Management System	Development of the business rules and processes that are required under our maintenance policies, strategies and programmes to drive the development and implementation of an integrated maintenance management system to replace the maintenance database.	In progress	Improvements made to the Maintenance Database to reflect current processes, but still requires work to scope the detail for a full maintenance management system. This is scheduled for 2012.
2.9	Field Services Agreement Implementation	The continued development and enhancement of the asset risk based condition assessment and defect management processes with the Field Service Provider to ensure the strategic intent and delivery is obtained from the Field Services Agreement	Complete	Northpower took over the Field Services contract in March 2011 and are well established operating on the Wellington Network generally fulfilling the needs of the contract in the areas of asset maintenance and condition assessment.
2.9	Data validity and improvement	Dedicated project initiatives will be conducted to address the data validity for both the ICP and GIS data within the Wellington Electricity information systems. Leverage from the processes provided within the Field Services Agreement will assist in the filling of data gaps and general cleansing of the asset data.	In progress	ICP data is being updated (refer next item) and major plant information is being updated following inspection and maintenance tasks. A key focus area is the LV connectivity and ICPs due to high consumer impact.
2.9.5	ICP verification	Improvement of the of ICP data integrity by reviewing the business process relating to ICP management to ensure the correct ICPs are attributed to the correct assets and the linkage exists between systems to validate the accuracy of ICPs.	In progress	Around 25% of ICPs have been traced out and "reconnected" to the correct supply assets in GIS. Process in place to ensure correct connectivity at the time of livening.
2.9.5	Low Voltage Network Management	The Field Services Provider in conjunction with Wellington Electricity shall develop a LV network management plan to provide a works authority request process for all Wellington Electricity approved service providers accessing the LV network and to ensure the upkeep of the LV network system configuration is kept current in the Wellington Electricity	Complete	A low voltage network management plan has been developed between Wellington Electricity and the Field Service Provider outlining the process and requirements for accessing and operating the LV network.

2011 Section	2011 Gap Item	Description	2012 Progress	Comment
		information systems.		
3.4	Spares Management	The requirements for network critical, emergency and general stock spares needs to be reviewed, and identification of required spares needs to occur. Many of the spares held needs to be evaluated, existing spares may become obsolete and potentially additional spares may be required.	In Progress	Network Spares Management Policy in place, full inventory stock take completed in 2011. Some improvements still in the areas of storage and handling of spares and further rationalisation of spares held are required.
5	Design and Construction Standards	Wellington Electricity has a range of old standards and designs from previous owners that are satisfactory, however these need to be reviewed, updated and compiled into a Design and Construction Manual. These now need to consider design for public safety.	In Progress	Some standards and relating to underground construction have been updated, still work required on overhead and substation standards.
5.4	Prioritisation Tool for Capital Works Projects	Ongoing development on existing processes for the prioritisation of Capital works projects, including implementation of a tool for the assessment of drivers such as network risk, financial benefit and option analysis and prioritisation.	No progress	No progress on development of a system or tool for prioritisation. High level scoping undertaken but will be completed in 2012. Individual projects assessed independently against risk criteria and drivers.
5.1	Emerging Technologies	Develop plans to detail how emerging technologies will impact upon, and can be incorporated into, the existing network.	Complete	Guidelines for the connection of electric vehicles and connection of distributed generation have been drafted for public information. A paper on the integration of smart meters, and smart meter data has been developed.
5.11	Network Development Plan	Wellington Electricity will develop a Network Development Plan to outline all the known constraints and improvements to be undertaken in the Planning area	In progress	A draft Network Development Plan has been developed during 2011, and will be revised and finalised during 2012.
6	Asset Lifecycle Planning	Develop and refine a "whole of life" management plan for each individual asset category to develop the existing knowledge, plans and programmes of work in the lifecycle asset management section.	In progress	Management plans for some asset categories have been drafted by are still under development for distribution type assets (RMUs, Dist. Transformers, etc).
6.4.8	Pole Testing	With the proposed introduction of the Deuar testing method for wood poles, the maintenance regimes and standards relating to poles will require revision.	Complete	The inspection and testing standards have been updated and the Deuar testing programme has been implemented.

2011 Section	2011 Gap Item	Description	2012 Progress	Comment
6.4.14	Communications Strategy	Develop a full communications strategy for development and replacement of network infrastructure communications for SCADA and Protection, and other business communications needs.	In progress	A good draft has been produced during 2011 and will be finalised in 2012 and elements will be implemented.
8.1	Emergency Response Plans	Ongoing development and testing of Major Event Management Plan, Business Continuity Plan and other emergency response plans.	In progress	Simulation testing of MEMP and business recovery, further stress testing and simulation of BCP shall be carried out in 2012.
8.1.4	Public Safety Management System (PSMS)	Wellington Electricity will continue development of its PSMS and associated processes in preparation for the 2012 audit in accordance with the 2010 Electricity Safety Regulations.	Complete	A Public Safety Management System assessment to stage 2 level has been completed. Some ongoing development and improvement will occur during 2012.
9.2	Network Performance Evaluation	Better categorisation of outage durations of < 3hours, 3-6 hours and > 6 hours for Urban and Rural customers.	Complete	Fault records are capturing the type of areas served (rural/urban) as well as duration of outage.

Figure 10-10 Review of Performance Against Gaps Identified in the 2011 AMP

Following the review of the 2011 AMP by the Commerce Commission, a number of improvement areas were identified which have been addressed in this 2012 AMP. These include:

<u>Service Levels</u>
Section 4 now includes future year targets for service levels relating to call centres service levels, customer enquiries and complaints, and inclusion of asset utilisation metrics.

<u>Network Development Planning</u>
This whole section has been revised for the 2012 AMP and addresses areas of partial compliance from the 2011 review.

<u>Expenditure forecasts, Reconciliation and Assumptions</u>
The assumptions this AMP is based on and their impact to the AMP have been summarised in this revised AMP.

There are still gaps and improvement initiatives that have been identified in a number of key business areas. These gaps and areas for improvement are referred to throughout the AMP in the sections where they occur and are summarised below:

Section	Item	Description
2.3	New Draft Information Disclosure requirements	Pending the outcome of the new Information Disclosure requirements by the Commerce Commission, significant changes may be required to the AMP and the asset and financial systems and data used by the business.

Section	Item	Description
2.7.5	Field Services Agreement Implementation	Building on the implementation of the new Field Services Agreement in 2011, ongoing development and enhancement of the asset risk based condition assessment and defect management processes with the Field Service Provider will continue to ensure the strategic intent and delivery is obtained from the Field Services Agreement. A review shall be carried out regarding the vegetation management strategy in association with the development of a new vegetation management contract.
2.8.1	Automatic Load Control System	Following the implementation of the ENMAC SCADA/DMS system in 2011, a needs and benefits analysis will be undertaken to review the use and future options for automatic load control, as part of the overall load management / ripple strategy.
2.8.1	Maintenance Management System	Ongoing development of the business rules and processes that are required under our maintenance policies, strategies and programmes to drive the development and implementation of an integrated maintenance management system to consider the replacement of the maintenance database with a proprietary maintenance management system.
2.8.3	Data validity and improvement	Following on from data cleansing and data quality improvement work carried out in 2011, further initiatives are underway to address the data validity for both the ICP and GIS data within the Wellington Electricity information systems. Leverage from the processes provided within the Field Services Agreement assist in the filling of data gaps and general cleansing of the asset data.
2.9.1	Maintenance and Defect Process	Further enhancements to the maintenance database will provide a greater analysis of defects, including the monitoring and detailed reporting of completed defects and aging defects. Improvements to reporting will be made during 2012, including a revision of the process to monitor defects and field service delivery of corrective actions.
3.4	Spares Management	Following implementation in 2011 of the spares management policy, work is required in 2012 to rationalise the spares held and procure additional spares as required.
5.1	Design and Construction Standards	Wellington Electricity has a range of old standards and designs from previous owners that are satisfactory, however these are in the process of being reviewed, updated and compiled into a Design and Construction Manual. Design for public safety will be a key part of the review process.
5.2	Prioritisation of	Ongoing enhancements to the existing processes for the prioritisation

Section	Item	Description
	Capital Works	of Capital works projects, including the assessment of drivers such as network risk, financial benefit and option analysis and prioritisation. Development and implementation of a prioritisation or ranking tool will occur during 2012.
5.11	Network Development Plan	Wellington Electricity has developed a draft Network Development Plan to outline all the known constraints and improvements to be undertaken on the network. This will be reviewed and finalised during 2012.
6	Asset Lifecycle Planning	Continue development of and refine “whole of life” management plans for each individual asset category to develop the existing knowledge, plans and programmes of work in the lifecycle asset management section.
6.4.2	Substation Building Seismic Policy	Review of Seismic Reinforcing of Buildings policy and the development of a seismic reinforcing guideline standard for Wellington Electricity owned substation buildings, and development of the prioritised list of buildings for assessment and where necessary strength improvements to derive an investment profile for the planning period.
6.4.8	Telecommunications on poles policy	Development during 2012 of a Telecommunications on poles policy to provide guidance to third parties wishing to install fibre and other communications circuits on network poles.
6.4.14	Communications Strategy	Finalise and implement the communications strategy for development and replacement of network infrastructure communications for SCADA and Protection, and other business communications needs.
8.9	Specific Network Asset Risk Controls	Further development of the Risk Management Standard AS/NZS 4360:2004 within the assessment of the inherent and residual risk of specific network asset controls
8.10.1	Seismic Reinforcing of Equipment and Buildings	Review of Seismic Reinforcing of Buildings policy and the development of a seismic reinforcing guideline standard for Wellington Electricity owned substation buildings.
8.10.2	33kV Overhead Emergency Corridors	Completion of the planning and design of the defined 33kV overhead line emergency corridors and appropriate support structures
8.12	Emergency Response Plans	Ongoing testing and enhancement of the Emergency Response Plans with a focus on the Crisis Management Plan and the IT Recovery Plan
9.5	Health, Safety and Environmental	Asbestos Management Initiatives - Project completion for the replacement of all asbestos lined arc chutes in the DC circuit breakers.

Section	Item	Description
	Improvements	Polices, Procedures and Standards – A number of other health, safety, wellbeing and environmental documents are programmed to be reviewed and improved this year including: Work Place Hazard Assessment, Fit for Work Policy, Environmental Management Plan. Work Type Competency (WTC) Training – Designed to support our amended WTC Standard, a number of training and assessment courses will be developed in line with our WTC categories. These assessment courses are aimed at supporting contractors in assessing the competency of their employees who are working on, or near, the Wellington Electricity network. 3rd Party Communication – A series of presentations will be undertaken with TLAs, contractors and other stakeholders with the aim of increasing awareness of the risks associated with working near our assets. Incident Data Management, Analysis and Performance Reporting – A review of the data management requirements for incident reporting will be undertaken. The aim of the review will be to identify options to improve the data management and reporting systems. Contractor Audit and Inspection Review –The review will look at the systems and processes supporting out contractors self assurance. Amongst other things the review will cover the; level of resources, training and competency of assessors, culture of improvement, effectiveness of corrective actions, timeliness of closure and management review. The aim of the review is to identify opportunities for improving contractor assurance, for sharing knowledge and eliminating any bad practices.
9.6	Public Safety Management System	Completion of the SMS stage 2 audit action plan and gain certification to NZS 7901 within regulatory timeframes.

Figure 10-11 Gaps and Improvements Identified in the 2012 AMP

Wellington Electricity aims to address these gaps and areas for improvement over the coming years by refining existing processes or adopting new processes, enhancing information systems to extract the full value to the business and to improve the data integrity, continuing to build asset condition information and holistically challenge and enhance the asset management strategies to meet both business and stakeholder requirements.

Appendix A Expenditure Forecast and Reconciliation

ASSET MANAGEMENT PLAN REQUIREMENT: EXPENDITURE FORECAST AND RECONCILIATION ($000 real as at 31 March 2011)

For initial forecast year ending 31/03/2013

Ten Yearly Forecasts of Expenditure

	Actual	Previous AMP forecast	Forecast									
Year Ending	31/03/2011	31/03/2012	31/03/2013	31/03/2014	31/03/2015	31/03/2016	31/03/2017	31/03/2018	31/03/2019	31/03/2020	31/03/2021	31/03/2022
Capital Expenditure: Customer Connection	4,829	8,137	5,502	5,434	5,914	6,628	6,046	5,476	5,610	5,810	5,802	6,349
Capital Expenditure: System Growth	1,533	3,786	5,757	5,522	6,148	7,277	5,732	4,606	5,487	5,742	5,577	5,261
Capital Expenditure: Asset Replacement and Renewal	17,528	13,880	15,050	16,222	16,425	15,215	17,462	19,563	18,871	18,136	17,741	18,783
Capital Expenditure: Reliability, Safety and Environment	567	665	653	504	472	446	523	560	530	521	532	556
Capital Expenditure: Asset Relocations	1,816	1,295	789	773	924	1,020	923	857	899	919	906	967
Subtotal - Capital Expenditure on asset management	**26,273**	**27,763**	**27,751**	**28,455**	**29,883**	**30,586**	**30,686**	**31,062**	**31,397**	**31,128**	**30,558**	**31,916**
Operational Expenditure: Routine and Preventative Maintenance	5,344	6,021	5,226	5,223	5,219	5,216	5,212	5,209	5,206	5,203	5,200	5,200
Operational Expenditure: Refurbishment and Renewal Maintenance	600	674	600	600	600	600	600	600	600	600	600	600
Operational Expenditure: Fault and Emergency Maintenance	3,971	5,083	5,628	5,628	5,629	5,630	5,630	5,631	5,632	5,633	5,633	5,633
Subtotal - Operational Expenditure on asset management	**9,915**	**11,778**	**11,454**	**11,451**	**11,448**	**11,446**	**11,442**	**11,440**	**11,438**	**11,436**	**11,433**	**11,433**
Total direct expenditure on distribution network	**36,188**	**39,541**	**39,205**	**39,906**	**41,331**	**42,032**	**42,128**	**42,502**	**42,835**	**42,564**	**41,991**	**43,349**

Overhead to Underground Conversion Expenditure No overhead to underground conversion expenditure included in the above expenditure.

Variance Analysis

	Actual	Previous AMP	% Variance	
	31/03/2011	31/03/2011		
Capital Expenditure: Customer Connection	4,829	5,704	-15.3%	Note 1
Capital Expenditure: System Growth	1,533	2,395	-36.0%	Note 2
Capital Expenditure: Asset Replacement and Renewal	17,528	13,609	28.8%	Note 3
Capital Expenditure: Reliability, Safety and Environment	567	475	19.4%	Note 4
Capital Expenditure: Asset Relocations	1,816	1,240	46.5%	Note 5
Subtotal - Capital Expenditure on asset management	**26,273**	**23,423**	**12.2%**	
Operational Expenditure: Routine and Preventative Maintenance	5,344	5,778	-7.5%	
Operational Expenditure: Refurbishment and Renewal Maintenance	600	645	-7.0%	
Operational Expenditure: Fault and Emergency Maintenance	3,971	4,817	-17.6%	Note 6
Subtotal - Operational Expenditure on asset management	**9,915**	**11,240**	**-11.8%**	
Total direct expenditure on distribution network	**36,188**	**34,663**	**4.4%**	

Notes:

1. The variance compared to forecast is due to a large number of commercial substations and subdivisions not proceeding in 2011 due to economic drivers
2. The variance compared to forecast is due to savings gained on several large projects and lower growth than expected
3. The variance is due to a large 33kV sub transmission cable replacement project in 2011
4. The variance compared to forecast is due to a higher number of third party damage incidents on the network
5. The variance compared to forecast is due to several unplanned cable relocations in 2011
6. The variance is due to less incident related maintenance on the network

Appendix B Asset Management Plan Assumptions

Area	Possible impact and variation to plan	Assumption	Reason for assumption
Demand growth	Growth at higher levels may bring forward network reinforcement investment, or conversely a decrease in demand growth may lead to deferral of reinforcement investment	Demand growth will continue to be lower than the national average and will remain steady through the forecast period with an annual growth of electricity consumption and demand between 0.5% and 1.0% across the network	Measured system loadings and load analysis indicate minor load growth across the network. No identified major developments. Low to moderate levels of growth in the housing sector. Assumptions supported by NZIER reports.
Capital Expenditure - Customer Driven	Investment levels may increase or decrease in response to changes in demand for new connections from customers	The capital expenditure proposed for customer initiated projects will remain within forecast levels	Overall customer market in residential sector is slow and steady. Minor levels of commercial development. Ability to recover upstream costs for larger investments or uneconomic supplies.
Capital Expenditure - Network Driven	Investment levels may increase or decrease in response to changes in known asset condition and possible increased requirements for asset replacement that cannot be accommodated in present plans, or catastrophic plant failure requiring a high one-off cost	The capital expenditure proposed for asset integrity and performance will continue at forecast levels, which assume a steady operating state.	The overall condition and rate of aging of network assets is steady and no "step change" in expenditure is expected. Regulated pricing limits available return on higher levels of investment at this time. Regulatory treatment of insurance, self insurance, resilience and seismic reinforcing expenditure remains uncertain.
Operational Expenditure - Routine Inspection and Maintenance	Any material change to the annual maintenance programme may lead to an increase, or decrease in the OPEX costs associated with inspection and maintenance.	The inspection and maintenance expenditure proposed will remain within forecast levels for the next 4 years. Although aging network assets, routine of inspection and servicing is not likely to change.	Field Services Agreement outlines maintenance programme for duration of the contract

Area	Possible impact and variation to plan	Assumption	Reason for assumption
Operational Expenditure - Reactive Maintenance	A change in the rate of failure of network equipment could lead to an increase in reactive maintenance requirements and costs. A change to the field service provider could lead to a higher cost of maintenance.	The reactive maintenance expenditure proposed will remain within forecast levels for the next 4 years. Aging assets may lead to higher levels of reactive maintenance required longer term.	Field Services Agreement has agreed rate for reactive maintenance. No apparent change in rate of failure of equipment.
Quality targets	Any increase in quality targets, or alteration in the assessment method, may lead to increased level of investment to improve network performance.	The quality targets for the Wellington Electricity business in the period 2010 – 2015 will be maintained as per the Commerce Commission's decision paper on the default price path, November 2009.	Quality targets are regulated and won't change until 2015. After 2015 changes may occur, especially with consultation and consumer desire for a more reliable system, with corresponding increase in return on investments to provide resilience and reliability.
Regulatory environment	A change to the regulatory environment may lead to increased or decreased ability to recover on investments. Investment levels will be adjusted to maintain regulatory compliance and to achieve a sustainable return on investments	Spending to meet regulated quality levels is factored into forecast expenditures. Whilst the regulatory environment will continue to encourage Wellington Electricity to invest in the network to meet the quality targets, the current uncertainty with starting prices under the default price path and the regulatory framework, means there is a risk that regulatory change will impact on total investment levels in the future. Specifically if prices are reduced there will be less funds available to invest in operating and capital expenditures under a default price path.	Quality targets are set for a five year period with the next review due in 2015.
Transmission Network	A change to the configuration or capability of the transmission system could lead to a requirements for increased levels of investment on the network to provide capacity or security in the absence of grid capability	The transmission grid, and grid exit point connections will remain unchanged apart from agreed projects.	Asset Plans from Transpower indicate no significant changes to the grid within the planning period. Ownership boundaries may change in time with review of customer connection assets by Transpower, and desire by lines companies to purchase and operate these assets.

Area	Possible impact and variation to plan	Assumption	Reason for assumption
Transmission Pricing	Changes to the methods of transmission pass-through pricing may lead to increased expenditure as grid alternative options become more attractive in a non pass-through environment	The transmission pricing methodologies will remain largely unchanged and the transmission pass-through pricing will remain in place.	Transmission pricing is regulated as a pass-through cost and our expectation is this will stay the same.
Shareholders	Changes to the regulatory environment and the allowed regulated return on investment impact on shareholders and may lead to either increased or reduced expenditure.	Shareholders will continue to be incentivised to invest in the network to allow the business to achieve market returns because the Commerce Commission will work towards achieving this outcome in 2012 by delivering a fair starting price outcome under the default price path, which will not negatively impact on forecast expenditures.	It is unclear what outcome will be achieved from clarifying the current starting price uncertainty with the Commerce Commission. Assumption has to be that this will deliver a reasonable outcome for shareholders.
Economy	An increase in the cost of raw materials and imported equipment could cause an increase in investment costs, or lead to deferral of projects to remain within budgets.	The commodity markets will remain stable during the forecast period. Regional GDP will remain lower than the national average.	Present economy is depressed, but global prices appear stable based on recent trends. Strong NZ dollar allows for steady materials costs.
Business cycle	The evolution of a business and its operating environment can impact on strategic decision making and overall approach.	The business cycle is in a steady state and as Wellington Electricity matures information about the quality of network assets continues to evolve. Whilst more mature assets require a higher level of maintenance there is no evidence to suggest that asset conditions will cause a material change to the asset management plan. This remains subject to further consultation with stakeholders and the Commerce Commission around large events which impact on business continuity and further strategic assessments of network resilience plans.	Until discussions with stakeholders and the Commerce Commission clarify impacts and expectations around resilience and business continuity plans, it is appropriate to continue to plan for a steady state business cycle.

Area	Possible impact and variation to plan	Assumption	Reason for assumption
Technology	Increased levels of network reinforcement may be required to accommodate sudden load increases at consumer premises resulting from demand side technologies, or significantly reduced loads may be seen that could defer investment if load reduction technologies are introduced to consumers	There will be no dramatic changes that would result in a rapid uptake of new technology by consumers leading to higher expenditure or stranding of existing network assets.	At demand side, displacement or disruptive technologies such as electric vehicles, vehicle-to-grid and distributed generation are still costly and unlikely to have high uptake. The areas of "smart" technology are not commercially viable over the period unless a return on their investment is built into the present DPP by the regulator
Public Safety	Assets in the public domain may require higher than average rates of replacement, or increased level of isolation from the public leading to higher costs, or reallocation of work programmes	That compliance with requirements for public safety management will not adversely impact upon the existing network assets located in the public domain	Implementation of public safety management system in the business, including compliance with NZS7901 and promoting a culture of incident reporting and safety awareness.

Appendix C Glossary of Terms

AAC	All Aluminium Conductor
AAAC	All Aluminium Alloy Conductor
ABS	Air Break Switch
ACSR	Aluminium Conductor Steel Reinforced
AMP	Asset Management Plan
CB	Circuit Breaker
CBD	Central Business District
CCT	Covered Conductor Thick
CEO	Chief Executive Officer
CHED Services	Cheung Kong Infrastructure Holdings Limited & Hong Kong Electrical International Electricity Distribution Services Pty Ltd
CIGRE	Conference Internationale des Grands Reseaux Electriques (International Council for Large Electric Systems)
CKI	Cheung Kong Infrastructure Holdings Limited
Cu	Copper
DC	Direct Current
DGA	Dissolved Gas Analysis
DTS	Distributed Temperature Sensing
EDO	Expulsion Drop-out
FPI	Fault Passage Indicators
GWh	Gigawatt Hour
GIS	Geographical Information System
GXP	Grid Exit Point
HV	High Voltage
ICP	Installation Control Point
IEEE	Institute of Electrical and Electronic Engineers
IISC	International Infrastructure Services Company (NZ Branch)
km	Kilometre
KPI	Key Performance Indicator
kV	Kilovolt

kVA	Kilovolt Ampere
kW	Kilowatt
LV	Low Voltage
LVABC	Low Voltage Aerial Bundled Conductor
MW	Megawatt
MVA	Mega Volt Ampere
NICAD	Nickel Cadmium Battery
Nilstat ITP	Protection Relay
ODV	Optimised Deprival Value/Valuation
O&M	Operating and Maintenance
PAHL	Power Asset Holdings Limited
PDC	Polarisation Depolarisation Current
PIAS	Paper Insulated Aluminium Sheath Cable
PILC	Paper Insulated Lead Cable
PLC	Programmable Logic Controller
PVC	Polyvinyl Chloride
RTU	Remote Terminal Unit
SAIDI	System Average Interruption Duration Index
SAIFI	System Average Interruption Frequency Index
SAP	Systems Applications and Processes
SCADA	Supervisory Control and Data Acquisition System
SF_6	Sulphur Hexafluoride
TASA	Tap Changer Activity Signature Analysis
TCA	Transformer Condition Assessment
VRLA	Valve Regulated Lead Acid Battery
W/S	Winter / Summer
XLPE	Cross Linked Polyethylene Cable