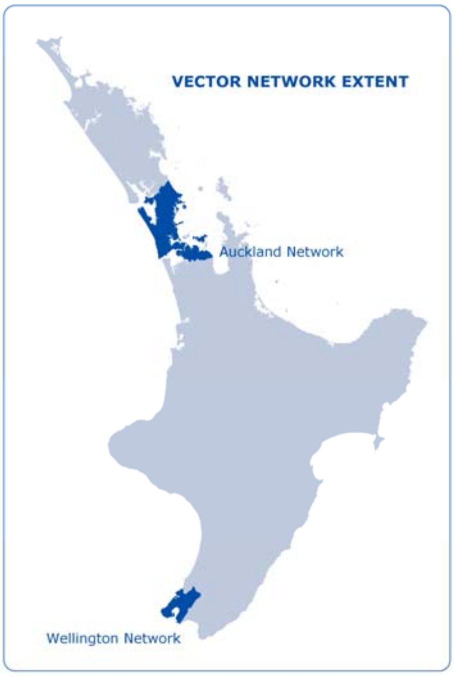
# 2007
# ASSET MANAGEMENT PLAN

This Asset Management Plan is based on the assumption that Vector is able to reach a satisfactory outcome with the Commerce Commission in respect of the Notice of Intention to Declare Control issued by the Commerce Commission on the 9 August 2006.

# ASSET MANAGEMENT SUMMARY

This plan is prepared to meet the disclosure requirements of Regulation 24 of the Commerce Commission Electricity Information Disclosure Requirements 2004 and subsequent amendments.

## THE VECTOR NETWORK




Vectors network comprises electricity distribution networks in the greater Auckland and Wellington areas supplying more than one third of New Zealand’s electricity peak demand.

## NETWORK SUMMARY

| | |
|---|---|
| Peak Demand | 2,242MW |
| Area Covered | 5,200km$^2$ |
| Customer Connections | 671,678 |
| Supply Points from Transpower | 22 |
| Zone Substations | 124 |
| Distribution Substations | 24,755 |
| Subtransmission Cables | 681km |
| Subtransmission Lines | 469km |
| HV Distribution Cables | 4,164km |
| HV Distribution Lines | 4,506km |

# REGULATORY ENVIRONMENT

The current regulatory Price Path and Quality thresholds regime finishes on 31 March 09. Further, the government is well advanced in its review of parts 4 4a and 5 of the Commerce Act which will likely result in changes to legislation.

Accordingly, as discussed with the Commerce Commission, due to the uncertainty of the regulatory framework and legislation, Vector has provided forecast ranges of capital and maintenance expenditure. The reason for this is that at this point in time key input parameters for the regulatory regime are not known or clear. Therefore, in the absence of these parameters it is not possible to forecast expected expenditure in line with clear regulatory objectives. Such input parameters include customer service objectives, quality targets, accounting treatment, valuation methodology and WACC.

Vector remains committed to working constructively with the Commerce Commission and government as these key regulatory issues are worked through. Once the regulatory legislation and key frameworks and inputs are clear vector will be able to predict future expenditure profiles more accurately.

Vector is also improving its understanding of the risks and opportunities associated with other Government policy objectives including the reduction of greenhouse gas emissions, improved energy efficiency, and increased distributed generation.

# PURPOSE OF THE ASSET MANAGEMENT PLAN

The purpose of this 2007 Asset Management Plan (AMP) is to describe how Vector will manage its network assets and investment to achieve its performance targets, strategic goals and commercial objectives.

Vector's AMP is provided to enable customer's and stakeholders to identify Vector's performance targets, its areas of business focus, forecast levels of maintenance expenditure and proposed capital investment to manage this asset base.

The plan identifies Vector's approach to network risk management and contingency planning. The AMP is an important part of Vector's engagement with consumers.

Vector's approach to asset management is one which seeks to strike a balance between the needs of our customer's, taking into account the regulatory environment.
Vector's asset management approach is to:

- Ensure that targeted standard service levels are met
- Provide a safe environment for operating personnel and the general public
- Proactively manage environmental issues
- Manage network assets to ensure they meet their required functionality, performance and value to ensure long term viability of the electricity network business

This AMP gives an overview to Vector's approach to maintenance, development, asset renewal and replacement within a highly regulated framework.

# REGULATORY FRAMEWORK

On 9 August 2006 the Commerce Commission issued a "Notice of Intention to Declare Control" over a disparity in prices charged to customers on the previous UnitedNetworks' network compared to the prices charged to similar customers on the Auckland network. Vector offered to rebalance the prices within a specified timeframe such that on 13 October 2006 the Commission announced "The Commissions preliminary view is that Vectors offer is, in principle, consistent with the objectives of the regulatory regime". The Commission still has to lift its "Notice of Intention to Declare Control".

The Commerce Act (Electricity Distribution Thresholds) Notice 2004 sets out the methodology for calculating the Price Path and Quality thresholds applicable from 31 March 2005 to 31 March 2009. After 31 March 2009 the target thresholds have yet to be defined, particularly around the "X" factor values as part of the "CPI – X" price path.

The Asset Management Plan requires Vector to provide a ten year view of how it will manage its network although the regulatory environment under which it will be operating is far from certain. As discussed with the Commission, Vector has addressed this uncertainty by showing the proposed capex and opex expenditure as a range from which a single scenario may be selected upon certainty around regulatory issues

## DATE AND PLANNING PERIOD

The AMP has been developed as part of the requirements of Regulation 24 of the Commerce Commission Electricity Information Disclosure Requirements 2004 (consolidating all amendments to 1 April 2007) and covers a period of ten years from 1 July 2007 until 30 June 2017.

The plan is a view at a point in time and does not commit Vector to any of the individual projects or initiatives, or to make those investments at defined points in time. These may be modified to reflect changing operational, regulatory or customer requirements and must be approved through normal internal governance procedures.

The AMP is an evolving document, the review of which is an ongoing process within Vector as improved knowledge is gained of our customers' expectations, asset capabilities and condition.

## APPROVED BY DIRECTORS

This plan was approved by the Directors of Vector Limited on the 29th August 2007. It represents a view at that point in time about how Vector proposes to manage its networks. Changes in the market, regulatory and policy environment and other factors outside of Vector's control may affect the timing, level and extent of the plans set out in this document. Nothing in this document should be taken as binding Vector to any particular policy, initiative or project referred to in this plan.

## ASSET MANAGEMENT SYSTEMS AND INFORMATION

Information systems are central to Vector's goals of providing customer service to prescribed levels. Decisions on asset performance, maintenance, and replacement, contractor responsiveness and optimisation of expenditure require timely and accurate information. Vector has a constant focus on ensuring accuracy and completeness of asset information.

To ensure international best practices are applied to asset management, Vector has staff members actively involved in international technical working groups such as CIGRE and ENA.

In keeping with the focus on best practice, Vectors asset management practices and performance are independently reviewed and benchmarked against international best practice by recognised overseas experts. This review is undertaken annually, with prior years being carried out by Dellwind Pty Ltd and the last by Siemens AG (Germany) in March 2007.

## NETWORK AND ASSET DESCRIPTION

Vector's network can be viewed as three networks:

- 110kV transmission network, which connects Transpower network to Vector network at bulk supply substations

- 33kV and 22kV subtransmission networks, which connect between Transpower Grid Exit Points (GXP) and Vector's geographically, distributed zone substations

- 22kV, 11kV and 6.6kV, and 400/230V distribution network linking customers to Vector's zone substations

Each part of the network is designed, operated and maintained to achieve the levels of reliability set out in this AMP.

## SERVICE LEVEL OBJECTIVES

Service for Vector is to understand what our customers' value, and meeting these requirements in a timely and commercially-effective manner.

Vector offers differing service standards depending on customer segment against which performance is measured.

The standards are set based on Vector's understanding of customer preferences and network capabilities associated with the delivery of these standards.

These service standards vary between regions reflecting legacy differences in network design, security standards, and consumers' expectations. Work continues to align these standards where practical.

Common to all network areas is the continuation of health and safety as an area of focus for the business. Vector's policy is to:

> *"Create and maintain a safe and injury free working environment for our employees, our contracting partners, our suppliers and the public we serve."*

Our safety goal remains:

> *"No lost time injuries to any person working on our network."*

## ASSET DEVELOPMENT AND MAINTENANCE PLANS

To meet the reliability and capacity requirements of customers, statutory requirements, environmental and safety issues, means that Vector needs to continually improve its asset management.

One approach used by Vector is to extend the use of existing assets through automation, load management or other non-asset development solutions to defer major capital expenditure, whilst ensuring reliability targets are not compromised.

Value-based asset maintenance, refurbishment and replacement programmes are critical to Vector. Asset maintenance plans are developed taking into account customer expectations, environmental considerations, operational performance, equipment condition and cost. Generic maintenance plans are developed for each asset type, but are applied based on performance requirements and criticality.

The underlying objective of the asset replacement programme is to identify where value can be gained through equipment replacement rather than incurring ongoing remedial and preventative maintenance costs.

Vector's continued focus on improved asset condition and network performance information will result in improved replacement/refurbishment decision making.

## RISK ASSESSMENT

Network risk is managed within Vector by:

- Reducing the likelihood of in-service equipment failure, through the capital and maintenance work programmes and enhanced working practices

- Reducing the impact of in-service equipment failure, through the application of appropriate network security standards, operational flexibility through robust network design, supported by contingency and emergency management plans. These plans have been developed under the framework of risk reduction, readiness, response and recovery

- The identification and management of risk is undertaken by all levels within Vector including the Board and Executive Risk Committees

## EVALUATION OF PERFORMANCE

Measurement and communication of performance measures is an integral part of Vector's management process. Network performance is tracked through the measures based on:

- Reliability
- Safety
- Power Quality
- Customer satisfaction
- Environmental impact

All employees and contracting partners are accountable for achieving the performance targets. Vector's contracting partners are incentivised through contractual terms to deliver against these targets, whilst Vector employees have performance measures included in their employment KPI's.

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GLOSSARY OF TERMS

| | |
|---|---|
| AAC | All Aluminium Conductor |
| AAAC | All Aluminium Alloy Conductor |
| ABC | Aerial Bundled Conductor |
| ABS | Air Break Switch |
| AMP | Asset Management Plan |
| ARC | Auckland Regional Council |
| BRC | Board Risk Committee |
| CAIDI | Customer Average Interruption Duration Index |
| CBD | Central Business District |
| CDEM | Civil Defence Emergency Management |
| CIGRE | Conference Internationale des Grands Reseaux Electriques (International Council for Large Electric Systems) |
| CCT | Covered Conductor Thick |
| Cu | Copper |
| DC | Direct Current |
| DFA | Delegated Financial Authority |
| DGA | Dissolved Gas Analysis |
| DMS | Distribution Management System |
| DNP3 | Distributed Network Protocol |
| DTS | Distributed Temperature Sensing |
| EBL | Electricity Business Line |
| ERC | Executive Risk Committee |
| ESAA | Electricity Supply Association of Australia |
| FPI | Fault Passage Indicators |
| GWh | Gigawatt hour |
| GIS | Geographical Information System |
| GIS | Gas Insulated Switchgear |
| GPD | Group Peak Demand |
| GPS | Global Positioning System |
| HRC | High Rupturing Capacity fuse |
| HV | High Voltage |
| Hz | Hertz |
| ICP | Installation Control Point |
| IEC | International Electrotechnical Commission |
| IEEE | Institute of Electrical and Electronic Engineers |
| IED | Intelligent Electronic Data |
| IP | Internet Protocol |
| IPC | Insulation Piercing Connector |
| km | Kilometre |
| kV | Kilovolt |
| kVA | Kilovolt Ampere |
| kW | Kilowatt |
| LTI | Lost Time Injuries |
| LTIFR | Lost Time Injury Frequency Rate |

| | |
|---|---|
| LV | Low Voltage |
| MEN | Multiple Earthed Neutral |
| MW | Megawatt |
| MVA | Mega Volt Ampere |
| n-1 | Security Standard |
| NICAD | Nickel Cadmium battery |
| Nilstat ITP | Protection Relay |
| ODV | Optimised Deprival Value/Valuation |
| ONAN | Oil Natural Air Natural |
| OSH | Occupational Safety and Health |
| PCLL | Post Contingency Load Limit |
| PDC | Polarisation Depolarisation Current |
| PI | Historical Storage Software Package |
| PIAS | Paper Insulated Aluminium Sheath Cable |
| PILC | Paper Insulated Lead Cable |
| PVC | Polyvinyl Chloride |
| RMU | Ring Main Unit |
| 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 |
| SREI | Safety Rules Electricity Industry |
| TASA | Tap Changer Activity Signature Analysis |
| TCA | Tap Changer Condition Assessment |
| TCP/IP | Transmission and Control Protocol/Internet Protocol |
| TLA | Territorial Local Authority |
| TLS | Transformer Load Simulator |
| TMS | Transformer Management System |
| TRIFR | Total Recorded Injury Frequency Rate |
| V | Volt |
| VRLA | Valve Regulated Lead Acid battery |
| VT | Voltage Transformer |
| XLPE | Cross Linked Polyethylene Cable |
| ZAIDI | Zonal Average Interruption Duration Index |

# 1. INTRODUCTION

## 1.1. VECTOR ASSET MANAGEMENT OVERVIEW

Vector continues to maintain a customer focused approach to effective asset management for its electricity customers in the Auckland and Wellington regions.

Vector strives to provide an appropriate level of quality defined in terms of safety, customer satisfaction, reliability and power quality.

The regulatory environment under Part 4a of the Commerce Act requires Vector to work within Price Path and Quality thresholds that have been set by the Commerce Commission and are operative until 1 April 2009. The Price Path thresholds limit price increases "CPI – X" while the Quality thresholds require Vector to maintain network outages to levels below target SAIDI and SAIFI numbers.

Vector has developed and implemented business systems and practices to meet its quality targets including:

- Regular customer surveys to measure Vector's performance against customer expectations and capture the results as company wide performance targets

- Contracts with field contracting partners that are structured to reflect Vector's own customer drivers, particularly in the area of network performance. These targets are also company wide performance targets ensuring Vector employees have a similar focus

- Ensuring world class health and safety, and environmental processes are in place by providing training to all staff; having zero tolerance for work place accidents and employing a world leader in safe work practices to annually audit Vector's practices; ensuring a company wide focus on safety through assessing staff and contracting partner performance with respect to specific Key Performance Indicators (KPIs) related to safety

- A business information unit utilising industry leading technology to gather, integrate and present information from a number of systems in a way that facilitates better understanding of Vector's network performance, enabling Vector to better plan and manage its assets.

- An annual independent review of Vector's asset management practices and processes by overseas experts to ensure they are aligned with international best practice. Siemens AG (Germany) conducted the last review in March 2007 with previous ones being carried out by Dellwind Pty Ltd (Melbourne)

The objective of the Asset Management Plan (AMP) is to describe how Vector will manage its network assets and investment in order to achieve its performance targets and strategic goals based on current information and forecasts.

Managing these objectives in the current environment brings its own set of challenges.

- Uncertainty around the outcome and the consequences of regulatory processes, has an impact on long term network investment profiles

- Increased reluctance on the part of the public and Territorial Local Authorities (TLA's) to accept infrastructure assets as a necessity to deliver the amenity benefits that the utility provides

- Reinforcement projects associated with network security, particularly at a zone substation or subtransmission level can require significant discrete investment. Where the investment is made in low load growth areas, it can take many years before the assets make a positive net return

- New Zealand's currency fluctuates against our overseas trading partners. A significant proportion of distribution equipment is sourced overseas making it subject to exchange rate fluctuations and metal price indices. Unusual world demand for electrical distribution equipment caused not only by growth in countries such as China and India but also asset replacement strategies from more established European countries is impacting on both the availability and prices of these commodities.

- Rising construction costs, particularly infrastructure spend, have contributed to increased pressure on constrained budgets. The New Zealand economy continues to run strongly with no immediate signs of abating

- The lack of adequate numbers of appropriately skilled field resources continues to create challenges executing projects in a timely manner. Field contractors have been actively recruiting and taking on trainees to supplement their staff, but there is still a shortage of specific skill sets , and scarce labour markets are leading to increased costs in this area

- Compliance costs continue to rise as our field activities come under increasing scrutiny from the TLA's. An increasing number of network distribution assets are becoming subject to consent conditions. Increasingly restrictive operating constraints such as hours of work and traffic management conditions are applied by the TLA's, translating into increased costs and feeding back through contractor's charges to Vector. These constraints are being applied by the Councils in an environment where there is increased pressure from these same Councils to place all assets underground

- Vector is only one part of the overall electricity supply chain to the end use customer and we are clearly dependent on upstream parties including Generators and Transpower to deliver. Security of supply into Auckland and Wellington continue to be areas of concern. While shortcomings of the supply in Wellington are being addressed, solutions surrounding capacity shortfall into Auckland have still to be finalised. Consumers do not differentiate between Transpower's or Vector's network when they do not have electricity at their premises. The successful delivery of power to the customer is dependent on the robustness of both Transpower and Vector's networks and firm generation capacity

- Construction timeframes can be long on some of the larger projects and accuracy of forecasting is crucial to ensure projects are delivered on time. The consequences of delivering a key infrastructure reinforcement project late can result in customers without electricity

- The introduction of the Trees Regulations, while bringing clarity round vegetation ownership responsibility, has resulted in a significantly increased vegetation management spend by Vector. It has also highlighted a reluctance on the part of some TLA's to put into effect these regulations.

- Relocating network assets to meet Territorial Local Authority and Transit NZ road widening and reconstruction projects is consuming considerable resource within Vector. This is expected to continue given Transit NZ's extensive motorway expansion projects in both Wellington and Auckland

- Extreme events such as storms test the robustness of the network. Storm related damage such as trees falling across lines can result in serious outages even though sound maintenance practices have been applied However, to maintain the network to a level where it is unaffected by extreme events is not only impractical but would come with an unacceptably high cost to the majority of customers.

- To mitigate the impacts of extreme events Vector has implemented contingency plans, both internally and with its contracting partners, to manage responses to these extreme events. Vector has a Storm Response plan that maps out the processes to be followed before, during and after the event. Generic Emergency Response Plans map out the processes for emergencies other than for storms

This AMP provides a view of Vector's approach to maintenance, network development, asset renewal and replacement. This may change over time as the operating environment changes.

Asset management at Vector is based around understanding the limitations of network assets, particularly aging assets. The objective is to enhance network capacity or replace aged assets in a timely manner so that a near continuous supply of electricity is available to consumers.

This is achieved by having sound information on which to base decisions. Vector has invested in a number of technology solutions that enhance the decision making process factoring in risk, timely and appropriate investment in the network, shareholders and customers' expectations.

The decision making systems that support the asset management processes include, but are not limited to, customer management systems, GIS, SAP financial system and SCADA.

The asset planning process prioritises the programmes for maintenance and development to balance risk, cost, customer service and operational efficiency.

The AMP describes Vector's asset management approach and outcomes. From this document, customers and stakeholders can identify and understand the rationale behind Vector's performance targets, areas of business focus, forecast levels of maintenance expenditure and capital investment. The plan also includes Vector's approach to the management of network risks and contingency planning.

## 1.2. NETWORK SUMMARY

Vector's networks supply more than one third of New Zealand's electricity peak demand. The distribution business involves the operation and maintenance of regional supply networks that covers the greater Auckland and Wellington regions - an area of approximately 5,200km$^2$.

| | |
|---|---|
| Peak Demand | 2,242MW |
| Area Covered | 5,200km$^2$ |
| Customer Connections | 671,678 |
| Supply Points from Transpower | 22 |
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| Subtransmission Cables | 681km |
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## 1.3. ASSET MANAGEMENT PHILOSOPHY

Vector's approach to asset management is designed to ensure a balance between the expectations of our customers, business objectives, regulatory framework and minimising the life time costs of maintenance and replacement. This is managed within an acceptable financial and technical risk envelope but the critical input is the regulatory environment especially as it relates to investment confidence and clarity on desired outcomes.

Vector will not compromise on safety or environmental compliance. Other aspects of asset management are prioritised on the basis of risk. With pressure on available resources there is always tension between expenditure on customer growth, network reinforcement and asset replacement. Vector endeavours to optimise its expenditure whilst meeting customer needs.

Vector will achieve this philosophy by:

- Meeting regulatory Price Path and Quality thresholds
- Ensuring that the required service levels are met
- Providing a safe environment for operating personnel and the general public
- Proactively managing environmental issues
- Managing the assets to achieve the design functionality, performance and value to enable the continuation of a viable long term network business
- Ensuring the network is managed to world class safety levels

Assets are operated and maintained to meet performance standards cost-effectively. Functionality and performance requirements are continually reviewed and revised to reflect changing operational and customer requirements on the network.

In line with Vector's approach to customer driven service provision, the asset management plans are continually refined from analysis of customer requirements, assessment of asset condition, and the risk and consequences of asset failure.

A flow chart of the philosophy is shown in Figure 1.1.

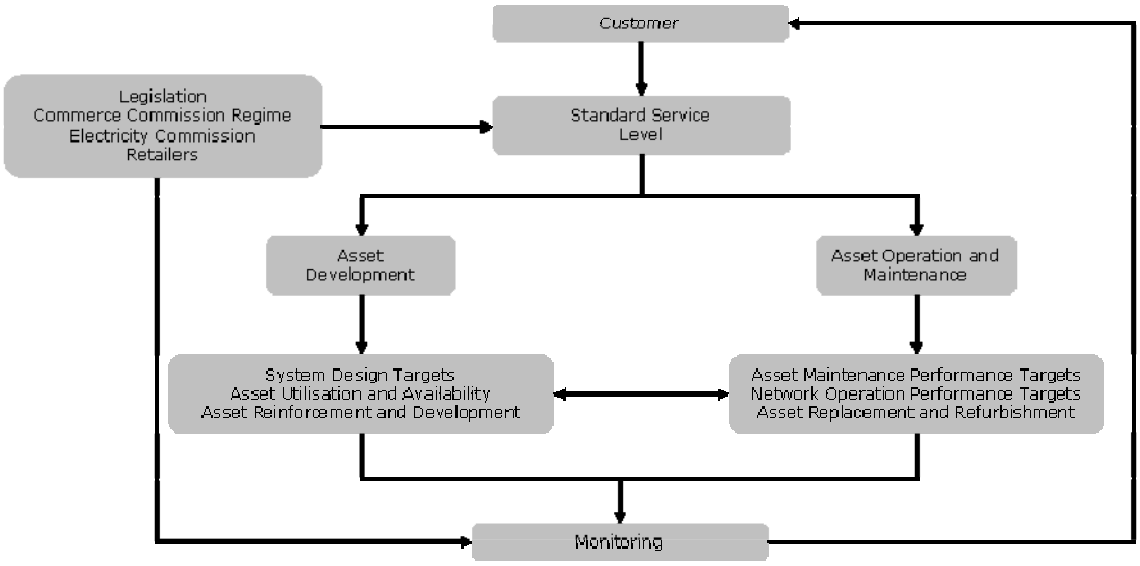



*Figure 1.1 Asset Management Philosophy*

## 1.4. ASSET MANAGEMENT PROCESS

Vector's asset management process is shown in Figure 1.2.

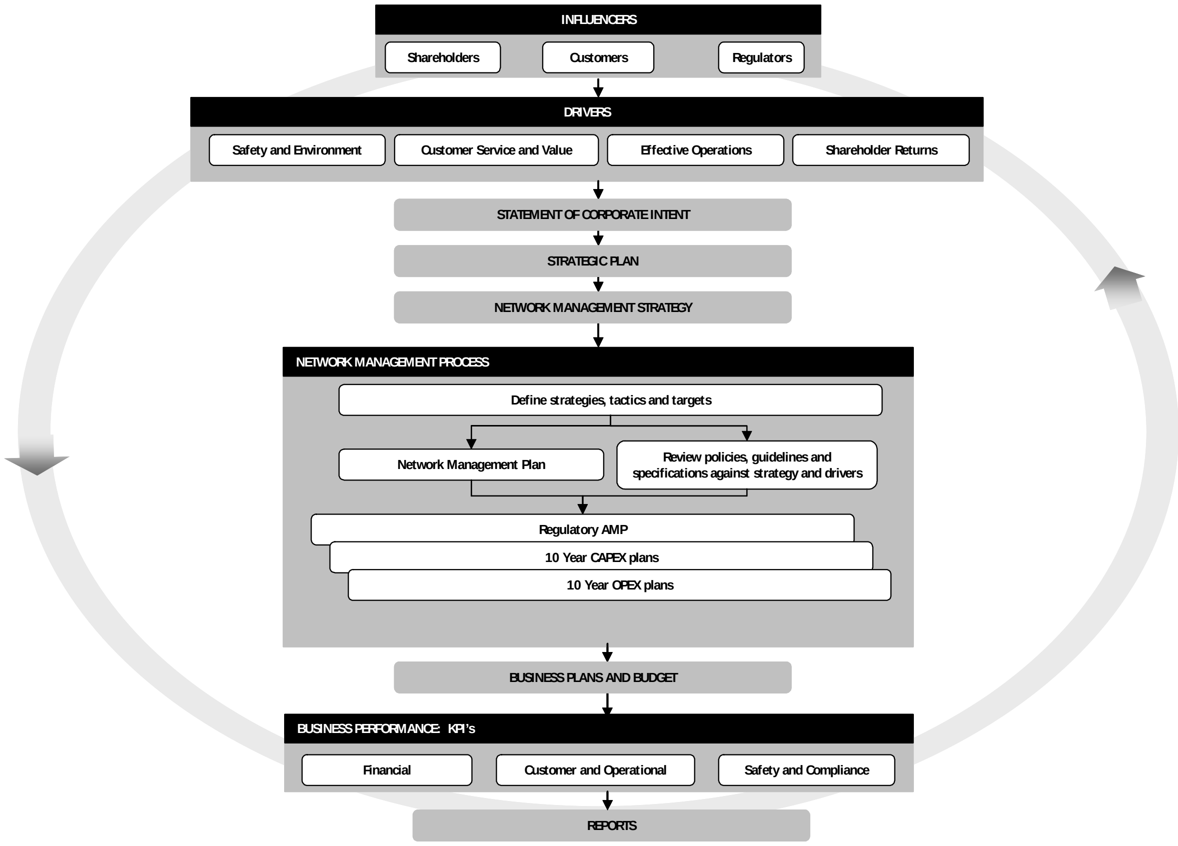



*Figure 1.2 Vector's Asset Management Process*

### 1.4.1. INFLUENCERS

- ***Shareholders***
  Vector is a publicly listed company, with Auckland Energy Consumer Trust retaining a 75.1% ownership and the remaining 24.9% owned by institutional and individual shareholders

  The provisions of the Companies Act and the New Zealand Stock Exchange Listing Rules require Vector to act in the interests of all shareholders and to treat all shareholders equally as a publicly listed company. Good asset management practices are an integral part of maintaining and enhancing the value of an infrastructure business to its shareholders, hence the AMP defines the technical approach to achieve these objectives. Areas of potential conflict between shareholder interests and asset management practices are addressed during the development of the AMP in order to maintain sustainable business performance

- ***Customers***
  Vector manages the electricity network to meet the needs of its customers and works with energy retailers on all three networks to manage customer issues

- ***Regulations***
  Statutory requirements impact on how Vector operates to meet its service delivery standards. The following statutes and all subsequent amendments are of particular relevance to this AMP:

  - *Commerce Act 1986*
  - *Electricity Information Disclosure Requirements 2004*
  - *Electricity (Hazards from Trees) Regulations 2003*
  - *The Electricity Act 1992 and Electricity Amendment Act 2001*
  - *Electricity Regulations 1997 and amendments*
  - *Electrical Codes of Practice 1993*
  - *New Zealand Standard NZS3000 1999*
  - *Australian/New Zealand Standard ANZS3000 2000*
  - *Health and Safety in Employment Act 1992*
  - *Resource Management Act 1991*
  - *Civil Defence Emergency Management Act 2002*
  - *Electricity and Gas Industries Act 2004*
  - *Electricity Governance Rules and Regulations*
  - *Local council district plans*

Other statutes apply to the business as a whole, but are peripheral to the asset management philosophy.

### 1.4.2. ASSET MANAGEMENT DRIVERS

- ***Regulatory Environment***
  The principle driver for Vector's asset investment and management is the regulatory environment. This is currently uncertain, hence this Asset Management Plan can only show broad outcomes. Once the regulatory environment is clear more definite investment and customer outcomes can be derived

- ***Shareholder Returns***
  Vector's objective is to manage its assets to meet the shareholders' requirements for a return on investment, preservation and enhancement of the value of the company, and community obligations

- ***Customer Service and Value***
  Vector's objective is to deliver improved customer value by matching the performance of both its assets and contracting partners to the performance its customers expect and are willing to pay for

- ***Effective Operation***
  Vector's objective is to manage the operation of its assets in such a way as to deliver the required performance at the lowest overall cost

- ***Health and Safety and Environmental Responsibility***
  Vector will at all times ensure its employees, contracting partners and customers' safety is not put at risk by the management of its assets. Vector will manage the network and act in an environmentally responsible manner

## 1.5. RELATIONSHIP WITH BUSINESS PROCESSES

The Asset Management Plan is directly influenced by a number of other policy documents and processes:

- ***Strategic and Business Plans***
  Vector has developed a strategic intent and a set of supporting organisational values. It has a documented business plan which details the strategic intent, budget and initiatives that will be undertaken by all functions and business lines during the forthcoming year.

- ***Network Management Strategy***
  This defines the approach and direction for network management in terms of network value, performance, revenue and customer expectations for service and quality

- ***Performance Targets***
  Performance targets are established for the company as part of the long-term and annual planning rounds. These include customer service, network performance and financial targets. These are cascaded down to individual business units and contracting partners

### 1.5.1. PLAN IMPLEMENTATION

The outputs from the asset planning process, which incorporates continual review of asset functionality requirements and customer feedback, are the operational, maintenance and capital work programmes.

- ***Asset Maintenance Plans/Schedules***
  For each customer area, asset or asset group, specific maintenance programmes are established annually, taking into account long-term strategic positioning

- ***Asset Development***
  For each customer area, capital works programmes are developed to ensure timely delivery of the projects necessary to meet network capacity and security criteria

- ***Equipment and Design Standards***
  Equipment and design specifications, based on the required functionality of the assets, are included in the Network Standards Manuals, policies and guidelines. These documents are continually reviewed to ensure the standards are based on current performance and functionality requirements, and to take advantage of new working practices and technology, to ensure minimum asset lifecycle costs

## 1.6. PLANNING PERIOD

This AMP covers a period of ten years from 1 July 2007 until 30 June 2017. The plan is a view at a particular moment in time based on available information and current projections. It does not commit Vector to any of the individual projects or initiatives set out in the plan. These may be modified to reflect changing operational, regulatory or customer requirements and must be approved through normal internal governance procedures.

The AMP is an evolving document, the review of which is an ongoing process within Vector. Vector encourages and welcomes stakeholder comment on the plan.

## 1.7. RESPONSIBILITIES AND ACCOUNTABILITIES FOR ASSET MANAGEMENT

Vector is the largest multi-network infrastructure and associated services company in New Zealand. Its business includes the ownership and management of:

- electricity networks in Auckland and Wellington
- gas transmission network
- gas distribution network company
- gas energy wholesaling and sales business
- gas processing and treatment plant in Taranaki
- LPG sales business
- electricity and gas metering business

- broadband communications business
- industry training business (Utilitech)

The company is structured into business units to focus on managing its core businesses. These business units are supported by centres of excellence providing the necessary supporting services to enable them to operate the respective core business effectively and efficiently. The electricity and gas businesses are each headed by a Divisional CEO who reports to the Group Chief Executive. The metering business and the telecommunications business are each headed by a General Manager. Supporting these three business units are four service functions, viz, finance, strategy, regulation and performance, information services, and legal services.

The management of the electricity assets is the responsibility of the Divisional CEO Electricity. Figure 1.3 shows the structure of the Electricity Business. Reporting to the Divisional CEO Electricity are six Divisional Managers.

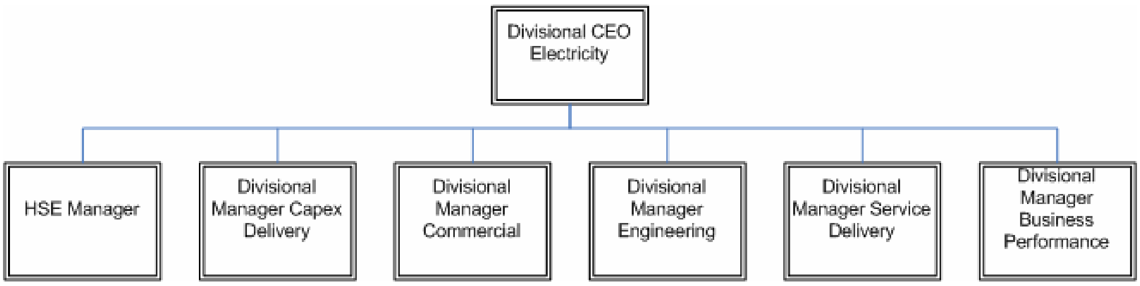



*Figure 1.3 Electricity Business Unit Structure*

The responsibility for identifying the planned work required on the network resides with the Divisional Manager Engineering. His team contains the personnel responsible for initiating long term capacity reinforcement projects, asset replacement and asset performance programmes. Annual budgets are approved by the Board with the underlying projects individually approved in accordance with assigned delegated financial authorities (DFA's). Management and Executive have pre-assigned expenditure commitment ranges for individual projects, with the Board approving expenditure above these levels.

Reinforcement, block replacement and customer initiated projects are managed by the Divisional Manager – Capex Delivery, The Divisional Manager – Service Delivery is responsible for managing the remedial and faults budgets, network operations and customer services.

All capital and remedial work is contracted to independent contractors. For the purposes of maintenance, managing faults and remedial works, three contractors (procured through competitive processes) are assigned four geographic areas in which to operate. Siemens Energy Services Ltd manages the networks in North and West Auckland, and Wellington, Energex (NZ) Ltd manages the Central

Auckland, and Northpower Ltd manages South Auckland. These contractors and several others compete for capital work across the regions.

Risks are captured by all staff into the risk register and assigned a classification in accordance with the "consequences" and "likelihood" of the event occurring. Appropriate staff members are assigned the responsibility to analyse the risk, identify solutions to eliminate, mitigate, or monitor and ensure these solutions are implemented. Regular reviews of the risk register are carried out separately by the Electricity Business Line Risk Committee, the Executive Risk Committee and the Board Risk Committee to ensure the risks are being adequately and appropriately addressed.

The risk processes are described in greater detail in Section 6

## 1.8. ASSET MANAGEMENT INFORMATION SYSTEMS

### 1.8.1. OVERVIEW

Decisions on asset performance, asset maintenance, asset replacement, customer responsiveness and optimisation of expenditure require current and accurate information. Enhancing the level of information Vector holds on its assets and network, together with implementation of tools to support the effective use of this information, continues to be a high area of focus.

The Geographical Information System (GIS) is one of the two physical asset registers. The other is the SAP Financial System which maintains a register of project costs against asset classes. While integration between the GIS and SAP registers exists, a single point of entry for asset information is being investigated. The GIS remains the central focus for asset information collected within Vector and information flows between the GIS and other corporate systems. Our contracting partners are accountable for the provision of accurate, timely asset maintenance and fault data into the GIS, and are contractually incentivised to do so.

Collection and validation of asset information using field computers (handhelds) is a key feature of Vector's information strategy.

### 1.8.2. GIS SYSTEM

The GIS system is the cornerstone of Vector's asset management information. This system is used to meet the following business needs:

- Performance monitoring of assets for customer management
- Analysis of asset performance
- Data for calculation of the network ODV

- Exported data files for import into network analysis applications
- Geographic based analysis of customer data
- Asset preventative maintenance and test recording
- Base data for asset maintenance scheduling
- Reference for asset location
- Network model for import into SCADA/DMS
- Vector's asset physical register link to SAP financial register

***GIS Upgrade***

The GE Energy "Smallworld" GIS has been updated to Version 4 over the course of the year making the latest functionality available to Vector. Mettenmeier have provided the customized software overlay over the "out-of-the-box" Smallworld product to allow ease of upgrades in the future. This reduces the level of support and customisation needed for upgrades in the future.

The new version of Smallworld will allow Vector to implement "proposed" networks on the GIS which will transition to "As Builts" during the project lifecycle.

***Common Landbase for all Networks***

All regions of the electric network are now on a common landbase platform. This makes comparison work much easier.

***Aerial photography for all networks***

Ortho-photography is now available on the GIS for all networks.

***Network Drawings***

All the Vector network drawings have been merged into Projectwise (Bentley). This has replaced the old Vector drawing register (Access Database) and UnitedNetworks previous version of Projectwise.

***Field Data Collection and Verification***

GIS based field applications have been developed and selectively implemented to allow the capture of inspections, tests and defects on some of Vectors assets. The data collected is used as part of Vector's preventative maintenance programme.

### 1.8.3. NETWORK ANALYSIS TOOLS

***DigSILENT PowerFactory***

Vector uses a specialised electricity network simulation software package, DigSILENT PowerFactory, for all power system related modeling and analysis. This software is currently being upgraded to a more flexible server version and tighter integration with the GIS is being reviewed.

The complete subtransmission and high voltage distribution network has been modeled, from Transpower grid exit points to the low voltage terminals of Vector's distribution transformers. The low voltage network has not been incorporated in the model. This model is used for load flow, short circuit, network reliability assessment, protection device coordination, network loss assessment and power quality analysis.

***CYMCAP***

CYMCAP continues to be used for calculation of ratings for underground cables.

***PI***

PI is a historical data storage and analysis tool used for evaluating network and feeder loadings, on an on-line basis. The new generation of protection relays has the ability to collect a multitude of information, such as current, voltage, power factor, power quality, etc. A selected list of these measurements is being recorded in the PI system for reference by network planning and operation.

### 1.8.4. SCADA SYSTEM

The (Telegyr) SCADA system has been upgraded to the latest version. This keeps the product current and fully supported. It also allows communication with field devices based on the latest protocols and moves into the "plug and play" environment. New field devices are connected automatically and configured by the system without the need for manual intervention. This reduces the risk of configuration errors in these complex devices.

The Foxboro SCADA system will continue to be used pending the outcome of a review to either upgrade the existing system, or replace with the Telegyr or similar system.

### 1.8.5. PROTECTION SETTING MANAGEMENT SYSTEM

The complexity of modern protection relays has increased significantly. Modern microprocessor based relays functionality has been enhanced by the inclusion of self-supervision capability. However, with the complexity of modern relays comes the risk of incorrect relay settings which can cause mal-operation of the protection system.

Vector has implemented a web-enabled Protection Setting Management System (PSMS) from DigSILENT. Benefits of this system are:

- Simplification and cost reduction of the protection setting process by providing seamless integration with DigSILENT PowerFactory power system analysis and protection setting / coordination software;
- Importing the manufacturer's specific protection relay setting files enabling increased data integrity for verification of the applied settings, protection system auditing as well as investigation of protection system operation;
- Formalising setting procedures (from initial setting preparation to final approval and setting application) with in-built controlled workflow and protection system documentation management, which will ensure that the applied protection settings are adequately managed, documented and accurately applied;

PowerWare also provides an industry standard interface (XML based) for data exchange with other applications and will be able to disseminate the protection data to other Vector IT applications.

### 1.8.6. PROTECTION SYSTEM - AUTOMATIC DIGITAL FAULT RECORD RETRIEVAL AND PRESENTATION

With the management system in place, the IP based protection relays are progressively being introduced into new zone substations, and protection replacement and upgrade programmes. An automated centralised digital fault record retrieval system with a web-based user interface has been implemented as part of Vector's substation IT system.

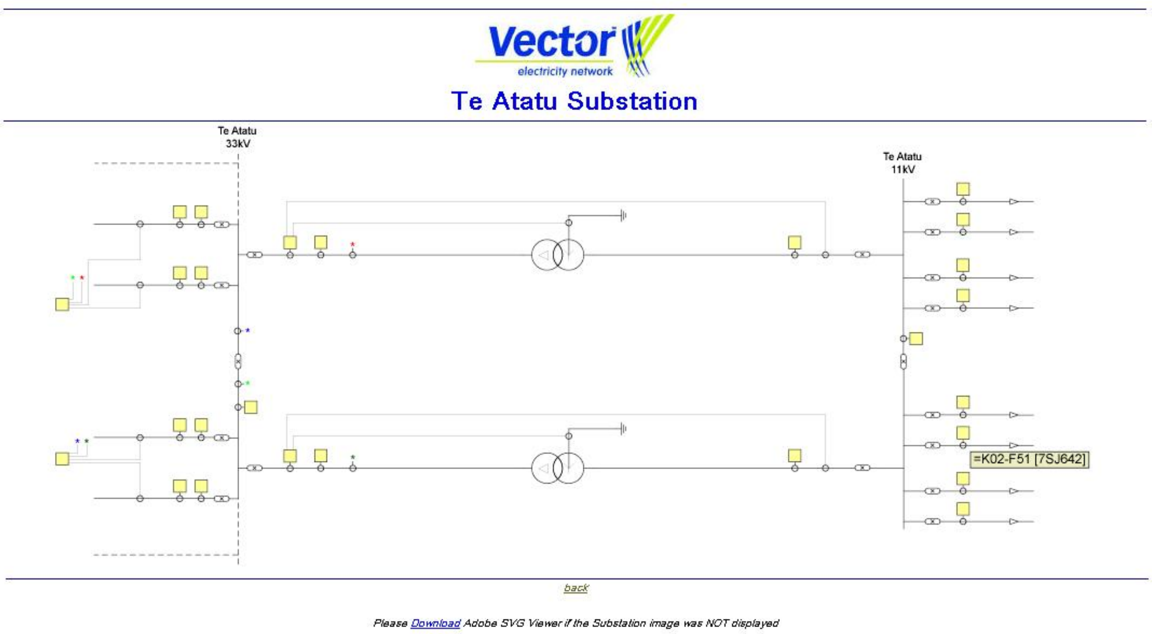



*Figure 1.4 Te Atatu Substation SLD*


*Figure 1.5 Relay Access*

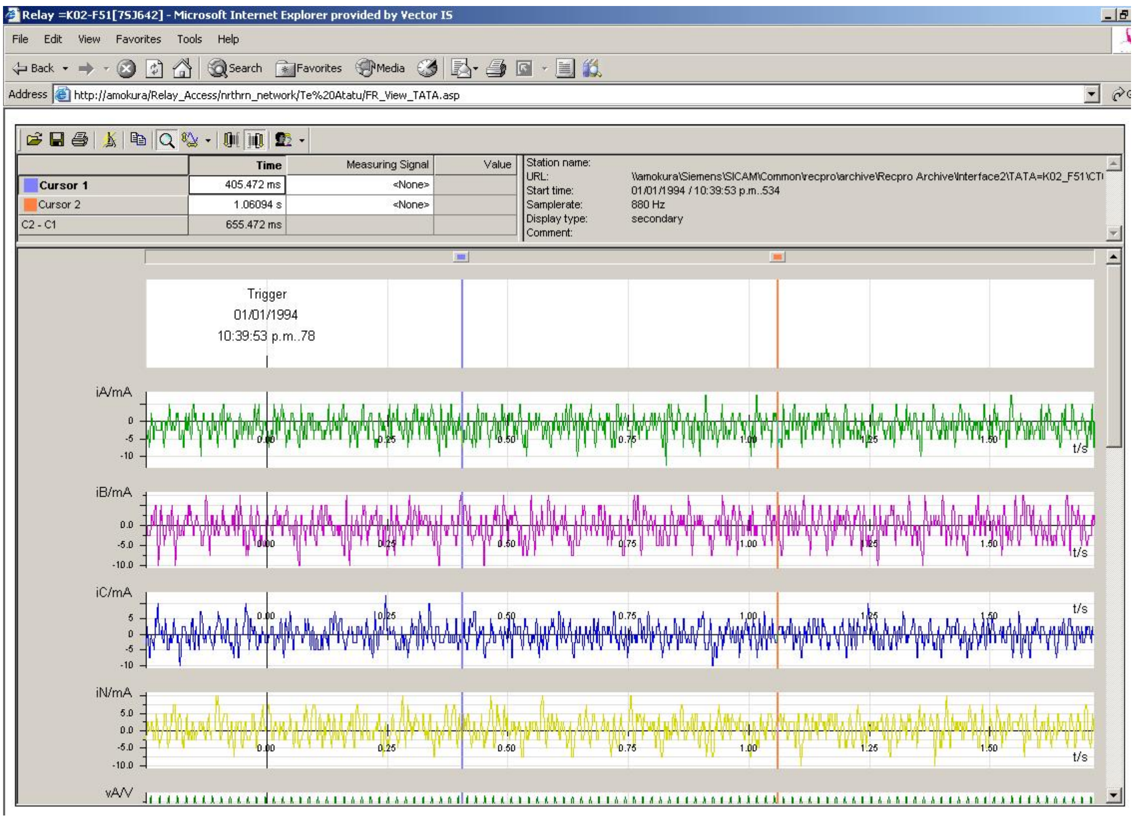



*Figure 1.6 Fault Recordings*

# 1.9. NETWORK PERFORMANCE REPORTING AND ANALYSIS

## 1.9.1. CURRENT SYSTEMS

Vector has continued to develop reporting and analysis tools to help track and understand the performance of the network. Access to this data is company wide, through Vector's intranet.

### ***Automated Daily Fault Reports***

Daily summaries of HV faults, similar to that shown in Figure 1.7 are automatically sent to staff within Vector and to zone based contractors.

**Vector Daily Outage Report**

Saturday, 31 March 2007

Click Here to check expected equipment returns

Click on the blue hyperlinks to go into further detail regarding an individual outage.

| KEY: | Cust Affec | Vector SAIDI | Max Time Off (mins) |
|---|---|---|---|
| | 0 | 0 | 0 |
| | 1-200 | 0-0.1 | 0-120 |
| | 201-500 | 0.1-0.5 | 120-150 |
| | 201-1000 | 0.5-1 | 150-180 |
| | 1001+ | >1.0 | 180+ |

**Unplanned Events**

| Event ID | Time | Region | System Level | Location | Substation | Main Reason | Sub Reason | Event Cust Affec | Vector SAIDI | Event Max Time Off |
|---|---|---|---|---|---|---|---|---|---|---|
| 191069 | 02:32 | Northern | Feeder | 40MURI | Waimauku | EQUIPMENT - OH | CONNECTOR | 2 | 0.000 | 73 |
| 191070 | 15:47 | Northern | Feeder | 38KAIP | Warkworth | EQUIPMENT - OH | CONDUCTOR | 36 | 0.005 | 85 |
| 191071 | 16:57 | Northern | Zonesub | 42WAIRAU | | EQUIPMENT - SUBSTN | CAPACITOR BANK | 0 | 0.000 | 0 |
| 191072 | 17:00 | Wellington | Feeder | MAI6 | Maidstone | THIRD PARTY INCIDENT | VANDALISM | 533 | 0.057 | 70 |

**Planned Events**

There were no recorded planned outages on this day.

*Figure 1.7 Automated Daily Fault Report – Summary Report*

The information in the email provides awareness of recent faults. Links to more detailed information are provided from within the email.

| UNPLANNED HV EVENT DETAILS | |
|---|---|
| **Event ID** | 191179 |
| **Date** | 18/04/2007 16:15 p.m. |
| **Region** | Auckland |
| **System Level** | Feeder |
| **Substation** | South Howick |
| **Location Code** | SHOW 3 |
| **Location Name** | MEADOWLAND DRIVE |
| **Main Reason** | VEGETATION |
| **Sub Reason** | TREE CONTACT |

| Operational Details | |
|---|---|
| **ZBC** | Northpower |
| **Contractor** | Northpower |
| **Operations Engineer** | Paul McLaughlin |
| **Field Person** | Ray Wilson |
| **Comments** | Emergency shutdown to remove tree branch from 11kV lines corner Point View Drive & Masons Rd. |
| **Service Request Nr** | 1-93812735 |
| **Defect Number** | |

| Location Details | |
|---|---|
| **Street Address** | POINT VIEW DRIVE |
| **Suburb** | EAST TAMAKI HEIGHTS |
| **Closest Asset 1** | Pole #216817 |
| **Closest Asset 2** | |

| Fault Trip Details | |
|---|---|
| **Fault Trips** | 0 |
| **Trip Device** | |
| **Device Nr** | |
| **Protection Operation** | OK |
| **Function** | |
| **Protection Comments** | |
| **FPI Operation** | Not Specified |
| **FPI Comments** | |

| Performance Measure for Event | | | |
|---|---|---|---|
| **Customer Mins** | 438 | **Vector Saidi** | 0.0007 |
| **Customers Affec** | 34 | **Vector Saifi** | 0.0001 |
| **Max Time Off for some customers** | 13 | **Customers over Restoration SLA** | 0 |

| Outage Detail by Feeder | | | | | |
|---|---|---|---|---|---|
| **Feeder** | **Service Level** | **Total Cust Affec** | **Max Time Off for some customers** | **Customers over Restoration SLA** | **Caused by Adjacent Circuit** |
| SHOW 3 | Rural | 34 | 13 | 0 | No |

| Outage Restoration Detail by Feeder | | | |
|---|---|---|---|
| **Feeder** | **Outage Time** | **Customers out at this time** | **Comments** |
| SHOW 3 | 18/04/07 16:32 p.m. | 28 | Part Point View Dr, Masons Rd & Caldwells Rd. |
| | 18/04/07 16:45 p.m. | 0 | All power restored |

*Figure 1.8 Unplanned HV Event Details*

***HV Outages Reporting***

A range of reports has been developed to provide access to information to support decision making on network performance improvement initiatives.

The reports allow access to 7 years history of HV fault events, analysed in a variety of ways. The reports allow users to easily change parameters to meet their particular information requirements. Figure 1.9 illustrates how fault information may be represented graphically

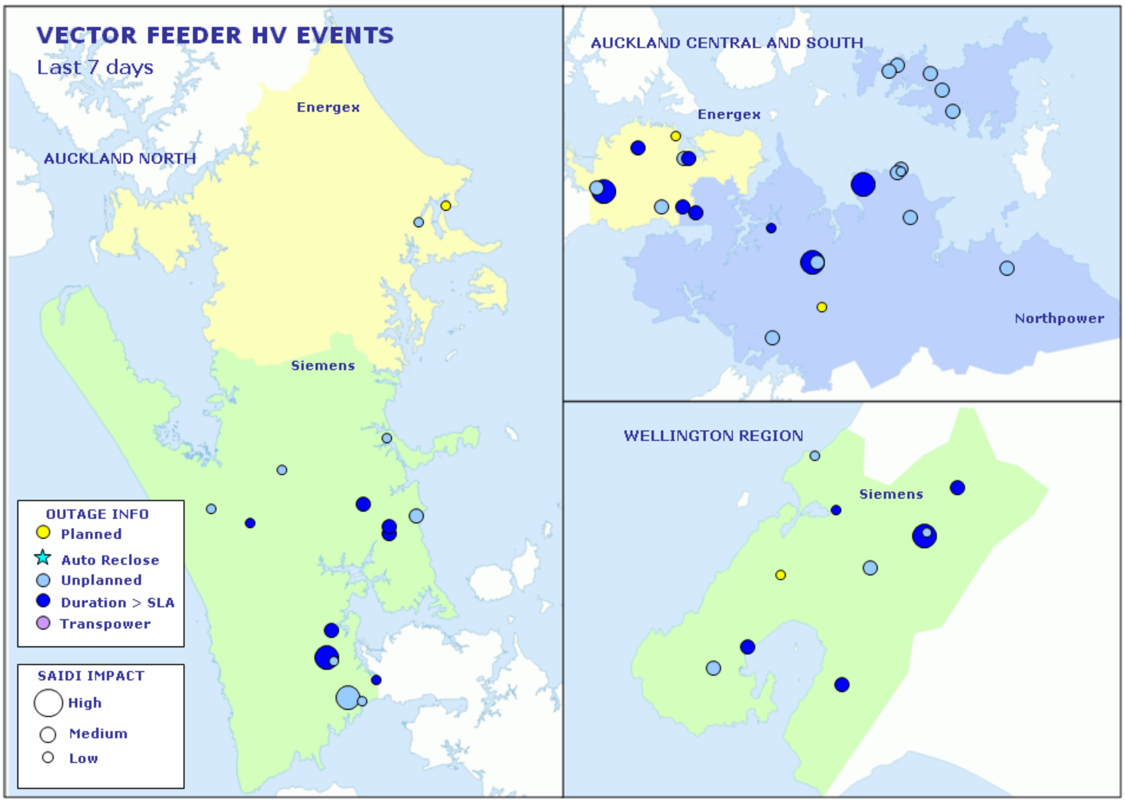



*Figure 1.9 Graphical Presentation of HV Outages*

## Faulted Equipment Tags

Click on the tag number to go into further detail regarding the individual fauled equipment

ALL tags from the 01 Jan 2007 to 20 Apr 2007

Click here to add a new tag

| Tag No | Service request No | HV event ID | ZBC | Feeder | Item Description | Date of failure | Major Reason | Sub Reason | Reason for failure | Person Investigating | Voltage |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 227 | 1-93300090 | | North Power | LV | Breach Joint | 10 Apr 07 | EQUIPMENT - UG | CABLE | TBD | Des Abercrombie | LV, 400 |
| 228 | 1-93262585 | 191104 | North Power | PAPA 1 | 3 core CU PILC STA cable | 08 Apr 07 | EQUIPMENT - UG | CABLE | Cores blown - TBD | Des Abercrombie | 11 kV |
| 224 | 1-92970241C | 191077 | Energex | DRIV 16 | HV cable joint 300mm PILCSTA | 02 Apr 07 | EQUIPMENT - UG | CABLE JOINT | TBD | Des Abercrombie | 11 kV |
| 221 | | 191078 | Energex | 38MATA | 11kV Pin Insulator | 02 Apr 07 | EQUIPMENT - OH | INSULATOR | Water had Rusted its stem and the rust had cracked the insulator! | Ross Mclennan | 11 kV |
| 219 | 1-92987393 | 191080 | Energex | ROSE 5 | HV cable termination - CU 95mm PILCSTA | 02 Apr 07 | EQUIPMENT - UG | CABLE TERMINATION | TBD | Des Abercrombie | 11 kV |
| 218 | 1-92970246C | 191076 | Energex | AVON 1 | 95mm CU PILCSTA cable | 01 Apr 07 | EQUIPMENT - UG | CABLE | TBD | Des Abercrombie | 11 kV |
| 220 | 1-92880381C | 191051 | Energex | FREE 17 | HV cable joint AL 399mm PILCSTA | 30 Mar 07 | EQUIPMENT - UG | CABLE JOINT | TBD | Des Abercrombie | 11 kV |
| 223 | | 0 | Siemens | LV | LV PILC cable | 24 Mar 07 | EQUIPMENT - UG | CABLE | TBD | Des Abercrombie | LV, 400 |
| 222 | 1-91995983 | | Siemens | LV | 70mm LV cable PVC | 23 Mar 07 | EQUIPMENT - UG | CABLE | TBD - Faulted under driveway | Des Abercrombie | LV, 400 |
| 225 | 1-92077138 | | North Power | LV | Breach joint | 13 Mar 07 | EQUIPMENT - UG | CABLE JOINT | Blown - TBD | Des Abercrombie | LV, 400 |
| 217 | 1-92025306 | | Siemens | | 70mm solid aluminium cable | 12 Mar 07 | EQUIPMENT - UG | CABLE TERMINATION | Overloaded! | Des Abercrombie | LV, 400 |
| 206 | 1-91994523 | 0 | North Power | MCEN 13 | Drop out fuse carrier | 12 Mar 07 | EQUIPMENT - OH | OTHER | Fuse holder mounting failure due to failed nut | Ross Mclennan | 11 kV |
| 215 | 1-91886448 | 190777 | Siemens | 20MOTU | 185 XLPE cable joint | 07 Mar 07 | EQUIPMENT - UG | CABLE JOINT | Joint failure! | Des Abercrombie | 11 kV |
| 207 | 1-91887127 | 190778 | North Power | BAIR 14 | 3 core 300 AL XLPE iser - Raychem | 07 Mar 07 | EQUIPMENT - OH | OTHER | Lug blown in half from heat/fault current - Nut and two washers have been installed between lugs | Ross Mclennan | 11 kV |

*Figure 1.10 Faulted Equipment Tags*

## Auckland Repeat Fault Count Report

| AssetID | Asset Type | ZoneSub | Repeat Fault Count | | |
|---|---|---|---|---|---|
| ⊟ 131381866 | Supply Point | SANDRINGHAM | 6 | | |
| 1-67325924 | 22/6/2006 22:30:00 | Low Voltage | Defective Equipment | Overload | Replace Blown 200A Fuse w/ 300A Fuse |
| 1-67303775 | 22/6/2006 21:00:00 | Low Voltage | Defective Equipment | Overload | Replace Blown 200A Fuse |
| 1-67237555 | 21/6/2006 21:29:00 | Low Voltage | Unknown | Unknown | Replace Blown Fuse |
| 1-67121897 | 20/6/2006 22:15:12 | Low Voltage | Defective Equipment | Overload | No power - replace 200A C/O |
| 1-62949326 | 2/5/2006 20:54:01 | Low Voltage | Defective Equipment | Overload | Replace Fuse_ replaced 200amp on yellow phase. load tested red- 68a yellow - 310a max. blue- 82a . all values varies_ but on yellow phase suspects either cable fault or overloading. NOTE: if we called aga |
| 1-62943328 | 2/5/2006 19:40:27 | Low Voltage | Defective Equipment | Overload | Replace Fuse_ HRC_ |
| ⊞ 344080 | Supply Point | MANGERE EAST | 6 | | |
| ⊞ 287060832 | Supply Point | GLEN INNES | 5 | | |
| ⊞ 267152 | Distribution Substation | SOUTH HOWICK | 5 | | |
| ⊞ 209264 | Distribution Substation | MANGERE EAST | 5 | | |
| ⊞ 287060755 | Supply Point | GLEN INNES | 5 | | |
| ⊞ 209212 | Distribution Substation | MANGERE EAST | 4 | | |
| ⊞ 631354 | Distribution Substation | WAIHEKE | 4 | | |
| ⊞ 208768 | Distribution Substation | ORAKEI | 4 | | |
| ⊞ 433696 | Distribution Substation | MANUREWA | 4 | | |
| ⊞ 366193 | Supply Point | MANUKAU | 4 | | |
| ⊞ 353315 | Supply Point | ST HELIERS | 4 | | |
| ⊞ 198793389 | Supply Point | PONSONBY | 4 | | |
| ⊞ 295855 | Supply Point | PAPAKURA | 4 | | |

*Figure 1.11 LV faults – Repeat Fault Count Report*

Figure 1.12 shows HV and LV fault incidence per kilometre to focus attention on those areas offering substandard performance. The shaded areas approximate to those covered by HV feeders.

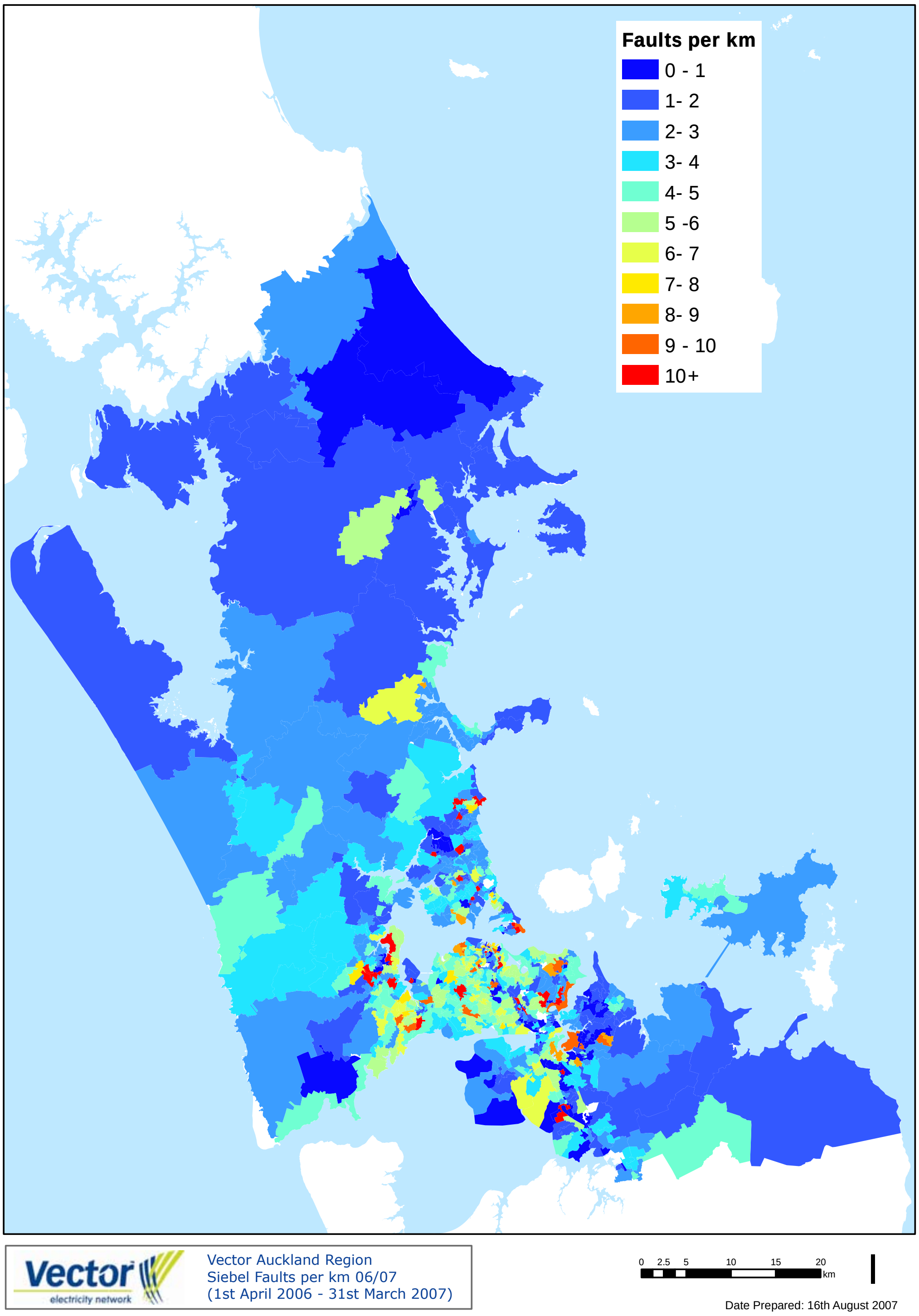
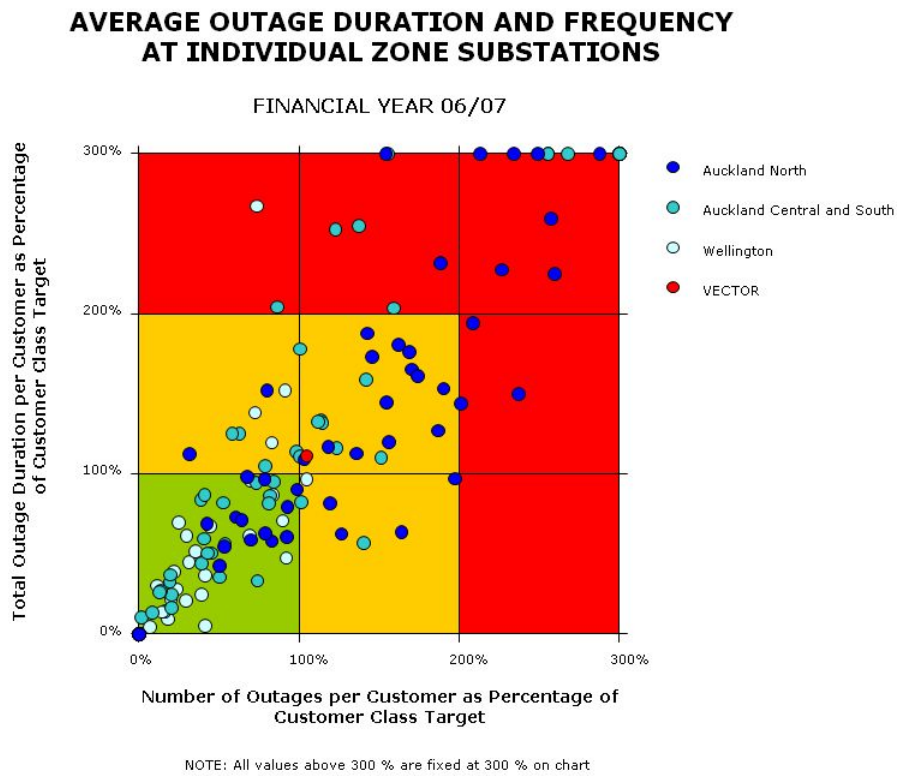



*Figure 1.12 Fault Incidence Normalised by Feeder Length*

### ***Reliability Reporting***

In addition to information on individual events, overall monitoring against performance targets is also reported.

These reports track performance against a variety of measures including SAIDI, SAIFI, CAIDI and Service Level objectives. Figure 1.13 is an example of innovative ways of presenting reliability results




| SUMMARY | | | |
|---|---|---|---|
| Nr of Substations : | 56 | 46 | 26 |
| VECTOR Target : | | | < 20 |

*Figure 1.13 Fault Frequency and Duration Report*

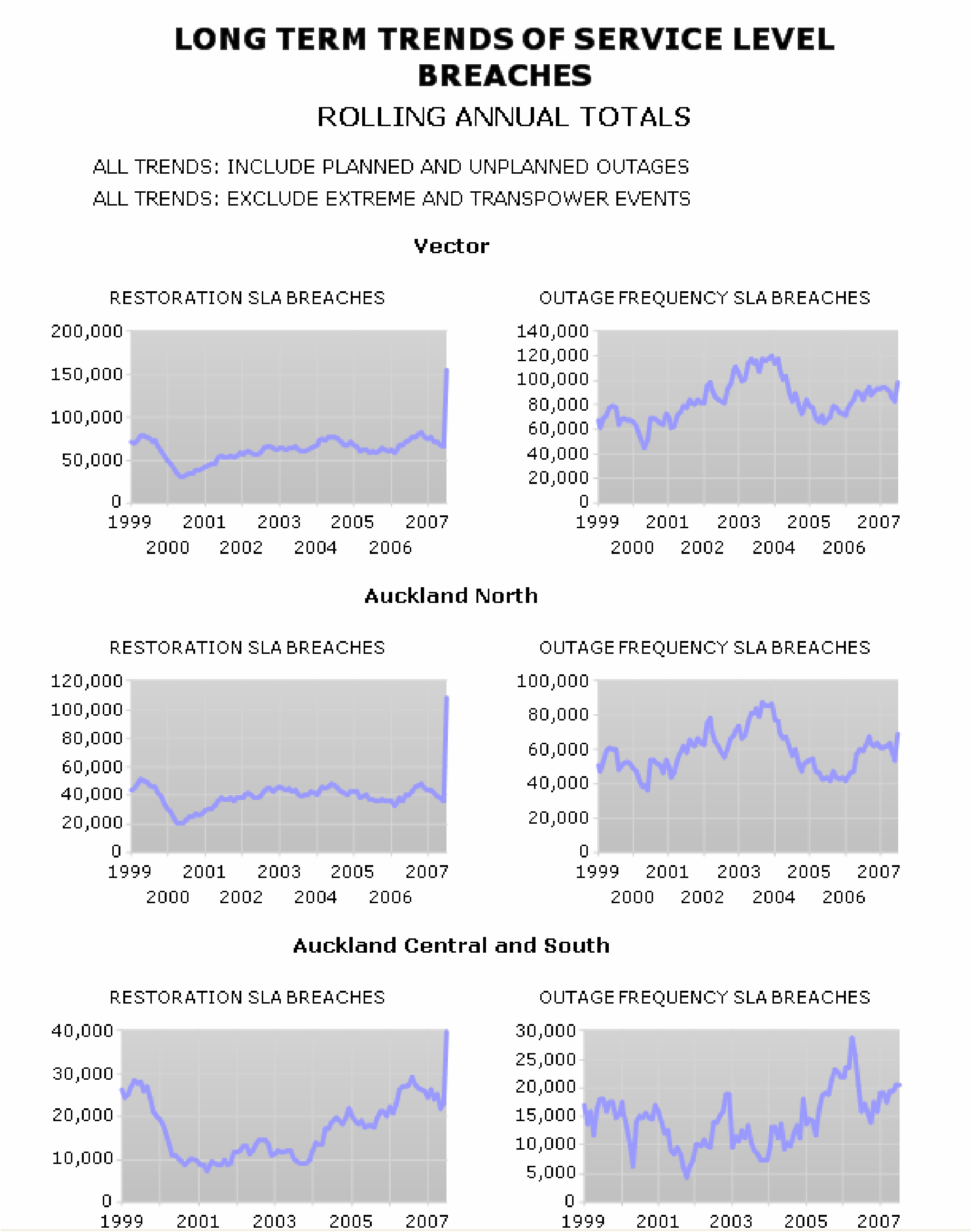



*Figure 1.14     Service Level Breaches Report*

## ***Analytical Reports***

Interactive reports have been implemented which allow staff to identify trends.

Figure 1.15 provides an example of feeder performance analysed across a number of measures. Colour is used to indicate relative ranking for each measure.

**WORST 15 FEEDER RANKINGS**

Based on performance for the year up to 20/04/2007

RANKED BY SAIDI

| ZBC | SLA TYPE | SUBSTATION | FEEDER | SAIDI | SAIFI | CAIDI | Frequency SLA | Duration SLA |
|---|---|---|---|---|---|---|---|---|
| Siemens | RURAL | Swanson | 31BETH | 1 | 2 | 246 | 35 | 2 |
| Siemens | RURAL | Henderson Valley | 15PIHA | 2 | 1 | 275 | 57 | 1 |
| Northpower | RURAL | Clevedon | CLEV 3150 | 3 | 9 | 173 | 73 | 3 |
| Siemens | RURAL | Spur Road | 29REDB | 4 | 8 | 206 | 149 | 4 |
| Siemens | RURAL | Laingholm | 18WOOD | 5 | 21 | 129 | 125 | 6 |
| Siemens | RESIDENTIAL | Te Atatu | 32HARB | 6 | 14 | 176 | 7 | 13 |
| Energex | RESIDENTIAL | White Swan | WSWA 7 | 7 | 4 | 314 | 27 | 63 |
| Siemens | RESIDENTIAL | East Coast Rd | 08ROSE | 8 | 5 | 317 | 1 | 142 |
| Siemens | RURAL | Spur Road | 29REDV | 9 | 15 | 243 | 77 | 26 |
| Siemens | RESIDENTIAL | James Street | 09HOGA | 10 | 92 | 67 | 52 | 27 |
| Siemens | INDUSTRIAL | Wairau Valley | 42BOND | 11 | 23 | 186 | 36 | 12 |
| Siemens | INDUSTRIAL | Woodford Ave | 19POMA | 12 | 13 | 272 | 5 | 22 |
| Siemens | RESIDENTIAL | Manly | 20SCOT | 13 | 11 | 306 | 6 | 24 |
| Energex | RESIDENTIAL | Orakei | ORAK 8 | 14 | 51 | 132 | 124 | 7 |
| Siemens | RESIDENTIAL | Hataitai | HAT7/ | 15 | 26 | 195 | 146 | 28 |
| Northpower | RESIDENTIAL | Mangere Central | MCEN 5 | 16 | 3 | 454 | 20 | 281 |
| Northpower | RURAL | Maraetai | MARA 7 | 19 | 141 | 49 | 145 | 10 |
| Siemens | RESIDENTIAL | Orewa | 26MAIR | 20 | 37 | 190 | 13 | 94 |
| Siemens | RURAL | Helensville | 13SOUT | 21 | 38 | 191 | 176 | 11 |
| Energex | RURAL | Wellsford | 39TEHA | 24 | 31 | 229 | 364 | 15 |
| Northpower | RESIDENTIAL | Manurewa | MANU 1 | 25 | 6 | 415 | 31 | 575 |
| Siemens | RESIDENTIAL | Atkinson Rd | 24OTIT | 27 | 27 | 242 | 2 | 122 |
| Energex | RURAL | Warkworth | 38MATA | 28 | 7 | 419 | 183 | 118 |
| Siemens | RESIDENTIAL | Manly | 20MATA | 29 | 16 | 352 | 10 | 76 |
| Energex | RURAL | Warkworth | 38SATE | 31 | 12 | 404 | 122 | 57 |
| Siemens | RESIDENTIAL | New Lynn | 37MARG | 32 | 303 | 8 | 355 | 37 |
| Siemens | RESIDENTIAL | Atkinson Rd | 24GOLF | 37 | 69 | 181 | 26 | 9 |
| Northpower | RESIDENTIAL | Manukau | MKAU 27 | 42 | 10 | 455 | 24 | 575 |
| Siemens | RESIDENTIAL | Waiake | 45FIRT | 43 | 105 | 121 | 66 | 5 |
| Northpower | RESIDENTIAL | Waiheke | WAIH 6 | 50 | 22 | 388 | 3 | 281 |

*Figure 1.15 Feeder Ranking Report*

Figure 1.16 was developed to assist in understanding the relationship between wind speed and fault frequency.

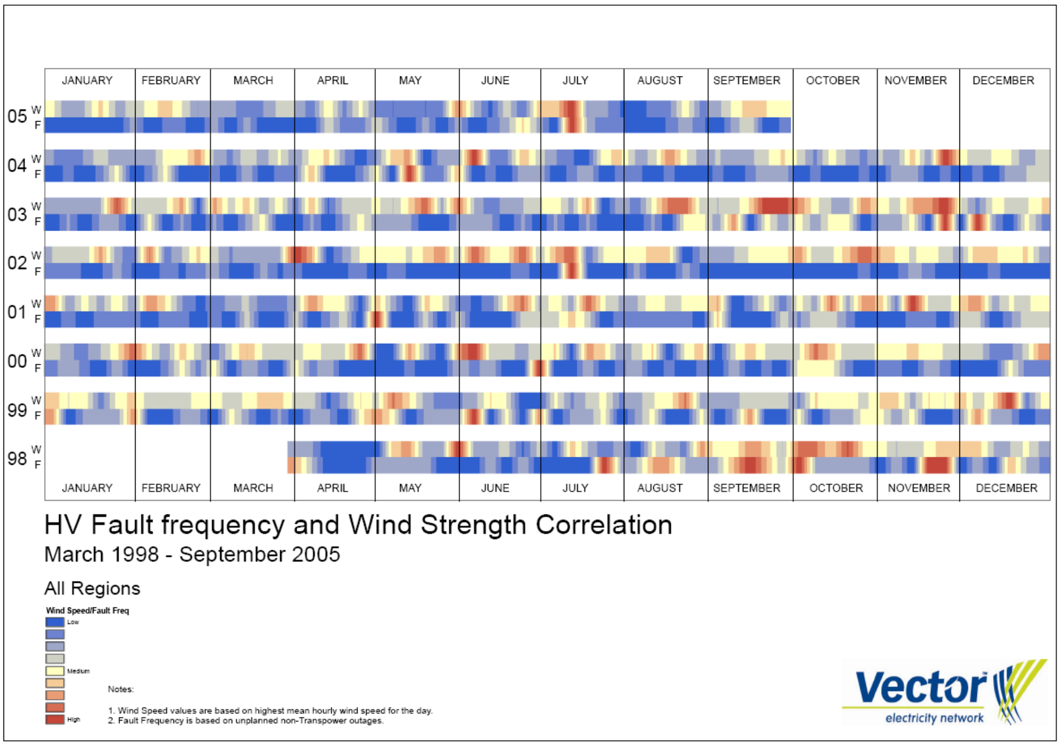



*Figure 1.16 Fault/Wind Strength Correlation*

## ***GIS Maps***

A large number of sophisticated maps are produced to assist with asset management decision making.

The analysis in Figure 1.17 was carried out to assist with understanding the relationship between customer satisfaction and network reliability.

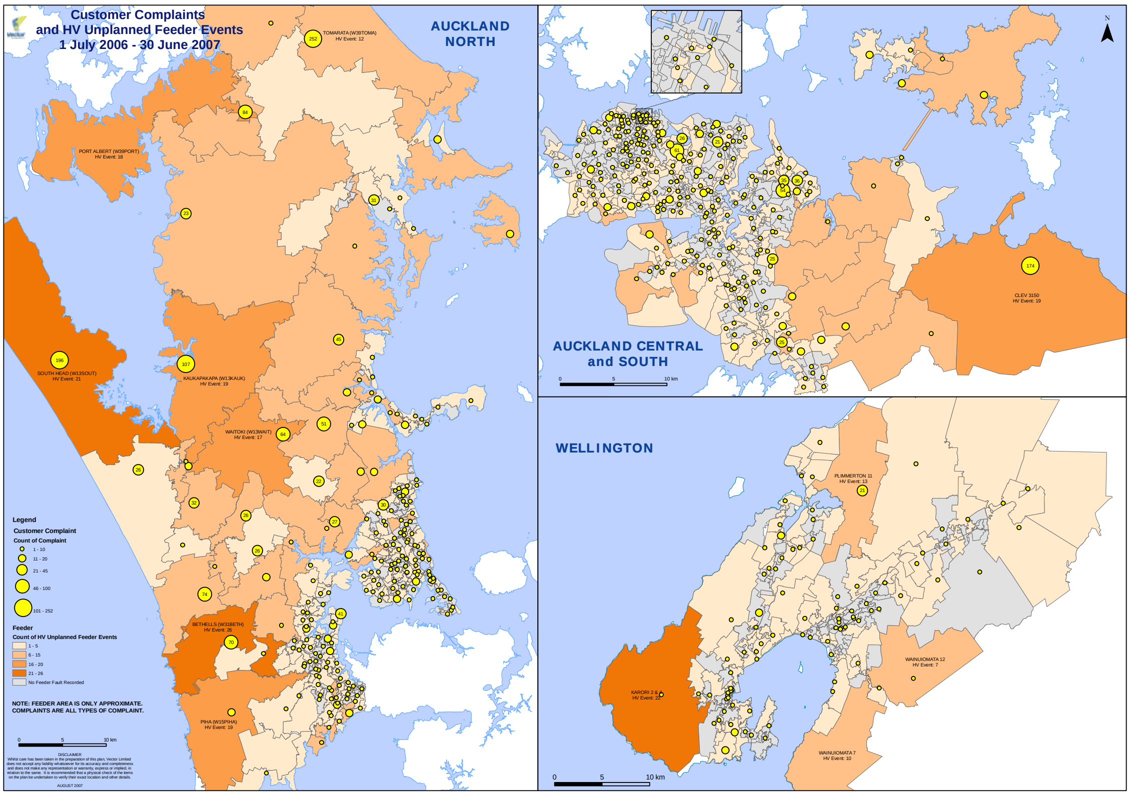



*Figure 1.17     Customer Complaints Reports.*

Figure 1.18 shows a graphical example of the vegetation management programme in Auckland.

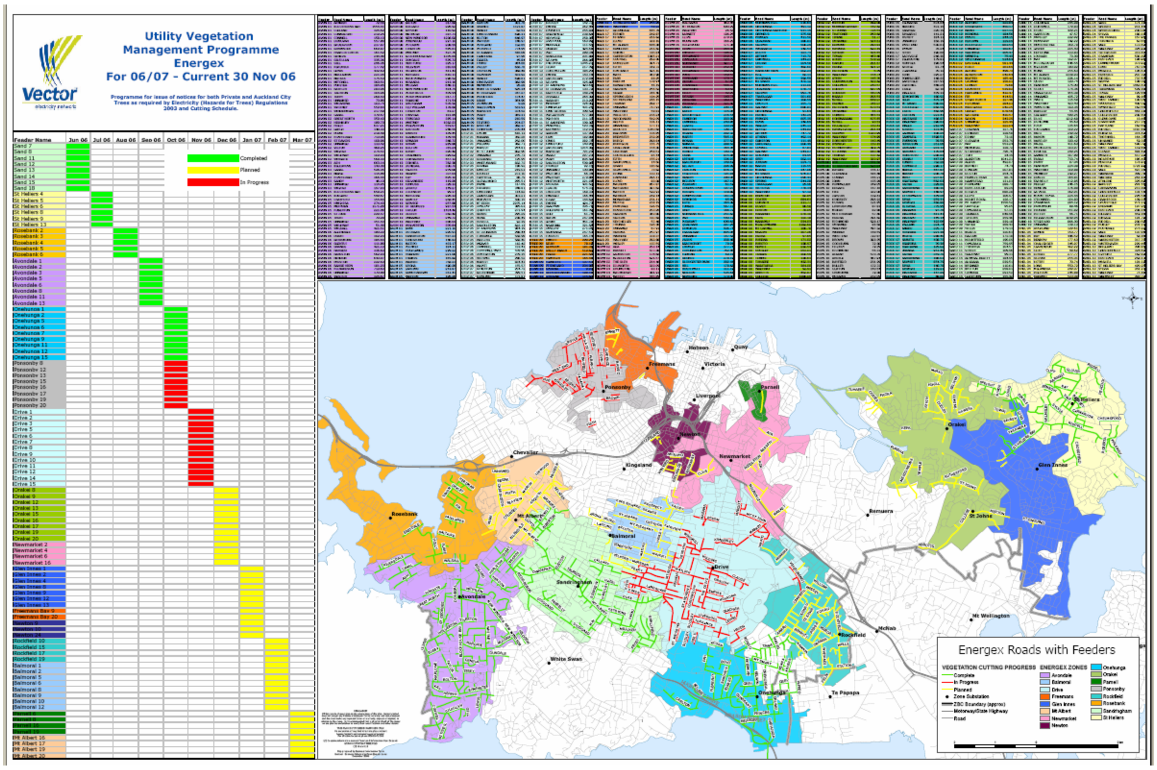



*Figure 1.18 Vegetation Management Programme*

# 2. NETWORK ASSETS

## 2.1. NETWORK OVERVIEW

The overall architecture of the network is shown in Figure 2.1.

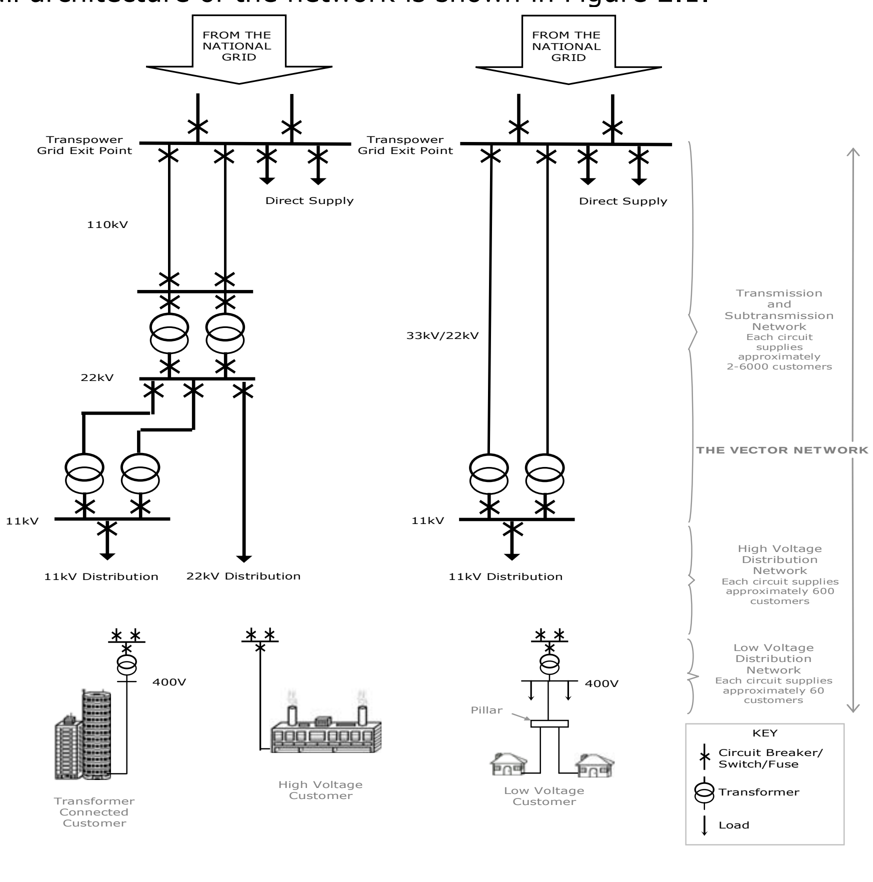



*Figure 2.1 Schematic of Vector's Network*

The network is made up of three component networks – transmission, sub-transmission and distribution. The 110kV transmission network connects Transpower's network to Vector's bulk supply substations.

The sub-transmission network connects the Transpower network at the grid exit points to zone substations, at 33kV or 22kV. Each substation serves a specific geographic area, with known asset and customer characteristics.

At the zone substations the voltages are further stepped down to 22kV, 11kV or 6.6kV. The distribution network carries the electricity to distribution transformers, or for some commercial high voltage customers, directly to their premises. At the distribution transformers, electricity is stepped down to 400/230V for final delivery to customers.

## 2.2. TRANSMISSION AND SUBTRANSMISSION NETWORK

The higher voltage transmission and sub-transmission network is designed to transfer large amounts of electricity efficiently. The network transfers electricity from Transpower's network via 22 grid exit points (GXPs), to 124 zone substations.

The grid exit points, their installed capacity and the 2006 peak demand are listed in Table 2.1.

| Network | Grid Exit Point | Installed Transformer Capacity (MVA) | Firm Capacity (MVA)[1] | 2006 Peak Demand (MVA) |
|---|---|---|---|---|
| **Auckland** | Mangere 110kV | | | 51 |
| | Mangere 33kV | 2*120 | 108 | 94 |
| | Otahuhu 22kV | 2*50 | 60 | 54 |
| | Pakuranga 33kV | 2*120 | 136 | 139 |
| | Penrose 110kV | | | 89 |
| | Penrose 33kV[2] | 2*160, 1*200 | 427 | 275 |
| | Penrose 22kV | 3*45 | 90 | 67 |
| | Roskill 110kV | | | 170 |
| | Roskill 22kV | 2*70, 1*50 | 141 | 105 |
| | Takanini 33kV | 2*150 | 123 | 115 |
| | Wiri 33kV | 1*100, 1*50 | 107 | 71 |
| | Albany 110kV | | | 142 |
| | Albany 33kV | 2*120 | 125 | 157 |

[1] Firm capacity is the cyclic capacity remaining after the loss of one transformer. Reinforcement is indicated if the load exceeds the firm capacity

[2] includes 22kV load

| Network | Grid Exit Point | Installed Transformer Capacity (MVA) | Firm Capacity (MVA)[1] | 2006 Peak Demand (MVA) |
|---|---|---|---|---|
| | Henderson 33kV | 2*120 | 135 | 100 |
| | Hepburn 33kV | 1*85, 1*100 | 133 | 138 |
| | Silverdale 33kV | 1*100 | | 67 |
| | Wellsford 33kV | 2*30 | 31 | 30 |
| | | | | |
| **Wellington** | Central Park 33kV | 2*100, 1*120 | 228 | 137 |
| | Gracefield 33kV | 2*100 | 89 | 56 |
| | Haywards 33kV | 1*27.5 | | 13 |
| | Melling 33kV | 2*50 | 52 | 46 |
| | Pauatahanui 33kV | 2*20 | 24 | 20 |
| | Takapu Rd 33kV | 2*100 | 123 | 88 |
| | Upper Hutt 33kV | 2*40 | 37 | 32 |
| | Wilton 33kV | 2*100 | 106 | 81 |
| | Kaiwharawhara 11kV | 2*40 | 41 | 37 |
| | Haywards 11kV | 1*20 | | 18 |
| | Melling 11kV | 2*25 | 27 | 25 |
| | Central Park 11kV | 2*25 | 36 | 17 |
| | | | | |
| **Lichfield** | Lichfield | | | 9 |

*Table 2.1 Transpowers Grid Exit Pointss*

A zone substation supplies typically between 2,000 and 6,000 customers. The subtransmission network consists of a combination of overhead lines and underground cables.

At the zone substations, the subtransmission voltages are stepped down to 11kV (or 6.6kV) to supply the distribution network. Zone substations are remotely controlled and monitored by a centralised Control Room via the SCADA system.

## 2.3. TRANSMISSION AND SUBTRANSMISSION DESIGN

The transmission network has been developed as a radial network.

Sub-transmission networks in central and south Auckland and Wellington have been designed as radial feeders, with one, two or three transformers at each zone substation. There are no ties between zone substations at sub-transmission level (other than in the CBD). The sub-transmission network in northern Auckland is a combination of radial and meshed feeders.

The future development of the sub-transmission system will be driven by the cost, reliability, design standards and customer service levels.

***Auckland Network***

Generally the load on zone substations in Auckland is kept below 30MVA, in order to keep the number and size of 11kV feeders within practical limits. In some cases where the load is relatively concentrated, the design maximum load can rise to 50MVA (e.g., in the CBD or in heavily industrial areas).

To avoid loss of supply for a single sub-transmission circuit fault, the allowable load on a substation is limited to the sum of the short-term ratings of the remaining healthy circuits. This limit also assumes that the load in excess of the cyclic rating of the equipment will be offloaded onto adjacent substations within three hours.

The sub-transmission network in the northern Auckland region is generally configured in a mesh formation. Security of the network is dependent on the power flow in the network under different contingency conditions. Except for the rural zone substations, a well interconnected 11kV network helps provide mutual backup for zone substations. An outage of one transformer would, in theory, overload the second transformer were it not for the ability to transfer load onto adjacent substations via the 11kV network.

***Wellington Network***

In the case of Wellington, each zone substation has dual transformers and subtransmission circuits, allowing an n-1 security standard to be achieved. The size of transformers in the Wellington region varies between 10MVA to 30MVA depending on the load density of the area the zone substation supplies.

The Wellington CBD is operated as a closed ring 11kV network offering high security. Outside this area the network is operated as open radial 11kV feeders which are generally supported by strong inter-ties between feeders. Rural feeders and those on the extremities of the network (e.g. new subdivisions) are the only 11kV feeders that cannot be interconnected with n-1 security

It should also be noted that due to fault level constraints, the transformers at eleven of the Wellington network zone substations cannot be operated in parallel.

## 2.4. DISTRIBUTION NETWORK

The function of the distribution network is to deliver electricity from the zone substation to customers. It includes a system of cables and overhead lines, operating at 6.6kV, 11kV, or 22kV, which distribute electricity from the zone substations to smaller distribution substations. Typically anywhere between one and 2000 customers are supplied by high voltage distribution feeders, the number determined by the load and level of security to be afforded.

At distribution substations, the electricity is stepped down to 400/230V and delivered to customers either directly, or through a reticulation network of low voltage overhead lines and cables. Approximately 30 to 150 customers are supplied from each distribution substation.

For larger loads, electricity may be delivered to the customer at 6.6kV, 11kV, 22kV or (for very large loads) 33kV. Four main categories of customer connection are offered and the final network connection type is determined through consultation with the customer. The connection types are:

- Single phase low voltage
  Typical of low capacity customers such as residential or small commercial, generally supplied from a shared distribution substation

- Three phase low voltage
  Typical of large residential, commercial or small industrial, generally supplied from a shared distribution substation

- Transformer connection
  Typically a large commercial or industrial customer where the load is sufficient to warrant a dedicated transformer but supply is provided at 400V

- High voltage connection
  These connections are generally associated with larger industrial customers or customers that warrant a number of distributed transformers on their premises. The electricity is supplied at a high voltage, typically 33kV or 11kV

## 2.5. DISTRIBUTION DESIGN

The distribution system (with the exception of the CBD) consists of interconnected radial circuits originating from zone substations. The design is based on the availability of feeder backstopping capacity, according to the security standards.

A distribution feeder fault may result in an outage, but in urban areas supply should largely be restored within two to three hours by switching carried out on the distribution network.

In the case of the Wellington CBD, the backbone 11kV network is constructed in the form of closed rings fitted. Radial feeders are connected to the closed ring networks to supply the load outside the CBD. These radial feeders are interconnected to allow backup under emergency conditions.

The distribution circuits are controlled by automatic circuit breakers at the zone substations. High voltage switches are installed at strategic locations on the network to provide operational flexibility and reduce the SAIDI impact of outages. A key focus is on the automation of these switches to improve reliability performance. For the distribution security targets see Section 3.

There are a number of large customers in the Auckland region connected to the network at high voltage. The ownership of the substations serving these customer's varies from site to site, but generally Vector owns the incoming switchgear and any protection equipment associated with it.

The customer usually owns the transformer(s), any outgoing switchgear and associated protection, and the building. With the exception of three customers, Vector owns all the distribution transformers in Wellington.

## 2.6. SCADA

Vector's SCADA consists of a number of subsystems. These have been installed over time and some of them are based on technology that has become obsolete, does not integrate well with the other business applications and is progressively being replaced.

### 2.6.1. INTEGRATION STRATEGY

The integration strategy enables Vector to implement technologies across the whole network, using standard communication protocols with the ability to easily migrate to a future overall SCADA system.

### 2.6.2. SCADA MASTER STATIONS

A Siemens Telegyr (PowerTG) master station has recently been deployed for monitoring and control of the central and southern Auckland electricity networks. This system is currently undergoing a software and hardware upgrade (more powerful processors and improved testing and staging).

A LN2068 SCADA master station, from Leads and Northrop, with Foxboro workstations are used on the northern part of the Auckland and Wellington electricity networks.

### 2.6.3. REMOTE TERMINAL UNITS (RTU)

Over time a number of different RTUs have been installed in Vector's network, many of which are now at the end of their technical life or are obsolete. Vector has embarked on a replacement programme enabling a standard RTU to be deployed across the network.

### 2.6.4. COMMUNICATION PROTOCOLS

A variety of SCADA communication protocols are presently used to communicate between the various SCADA systems and different type of Intelligent Electronic Devices (IEDs) installed on the network.

## 2.7. COMMUNICATION SYSTEM

Vector's communications network consists of differing architectures and technologies, some of which are based on proprietary solutions. The physical network infrastructure consists of a mix of optical fibre, copper wire telephone type pilot cables and third party radio communication systems.

The communications network is used for protection signalling, SCADA, operational telephony, access security, metering, remote equipment monitoring, and automation.

Vector is committed to an open-communications architecture based on industry standards. This has resulted in the adoption and deployment of Ethernet and Internet Protocol base communication technology.

## 2.8. POWER SYSTEM PROTECTION

The main role of protection relays is to detect network faults and initiate primary circuit isolation upon detection of abnormal conditions. Protection systems take into account the following principles:

- Reliability: the ability of the protection to operate correctly
- Speed: minimum operating time to clear a fault
- Selectivity: disconnection of minimum network sections in order to isolate the fault
- Cost: maximum protection at lowest cost

All new and refurbished substations are equipped with multifunctional Intelligent Electronic Devices (IED's). Each IED combines protection, control, metering monitoring, and automation functions within a single hardware platform. It also communicates with the substation computer or directly to SCADA central computers over the Internet Protocol (IP) based communication network using the industry standard communication protocols.

## 2.9. ENERGY AND PQ METERING

Vector's supply point energy and power quality metering system consists of a number of intelligent web-enabled revenue class energy and power quality meters. The meters communicate to the metering central software over an Ethernet based IP routed communication network.

The metering system provides Vector with essential information about quantity, quality and reliability of the power delivered to Vector's customers, and is currently used to:

- Improve asset utilisation by managing network peak demands
- Provide power quality and load data for network management and planning purposes
- Provide information to assist in the resolution of customer related power quality issues
- Contribute the power system stability by initiating instantaneous load shedding during under frequency events

## 2.10. LOAD CONTROL SYSTEM

Vector's load control system consists of a number of audio control frequency ripple control plants, pilot wire and DC bias systems, to manage network load. These assets offer the ability to:

- Control residential hot water cylinders and space heating (load shedding)
- Control street lighting
- Meter switch for tariff control
- Time shift load to improve network asset utilisation
- Time shift load to defer reinforcement of network assets
- Manage grid exit point demand charges from Transpower

Load control equipment utilises older technology, much of which is approaching end of life. In time there will be a convergence with newer metering technologies and it is anticipated that the audio frequency ripple plants will be phased out.

## 2.11. IMPROVEMENTS TO NETWORK DESIGN

The network design is periodically reviewed to ensure it includes improvements arising from feedback from customers, field contractors and network performance statistics. This approach allows for an optimised network architecture based on customer needs, return on investment, reliability and risk, to be continually refined.

Technological developments and innovation in areas such as distribution network automation are trialled on the network before wholesale implementation. Overseas and local technological developments are monitored as a means of continuously improving our knowledge of how the network's performance can be improved.

# 3. SERVICE STANDARDS

Service for Vector means understanding what our customers value, and delivering to those requirements within the limitations of budgetary constraints. Essential asset management objectives are to provide a safe, environmentally responsible, high quality, reliable supply of electricity, in compliance with all statutory and regulatory requirements to meet the changing needs of stakeholders.

The Commerce Commission's regulatory price-quality regime for electricity lines businesses is a major influence when considering these objectives. The stipulation of price and quality thresholds is an indirect control mechanism which tends to force short term decisions. Investment and service standard decisions are considered in the context of compliance with these thresholds.

Vector regularly engages its customers in all network areas to obtain feedback on what is important to them and how we can improve service. Research has shown a diverse range of customer expectations across the network but continues to highlight reliability, quality of supply and cost as priority values.

The following sections relating asset management objectives to service standards are as follows:

- Reliability
- Standard Service Levels
- Security
- Quality

## 3.1. RELIABILITY

Service reliability from the perspective of "keeping the lights on", is the outcome of how often electricity supply gets interrupted, and how long it takes to restore supply once interrupted. The key performance measures used to target, monitor, report and analyse network reliability are SAIDI and SAIFI.

SAIDI (System Average Interruption Duration Index) measures the average minutes without supply, prescribed as follows:

$$SAIDI = \frac{\text{Sum of the customer minutes lost}}{\text{Total number of customers}}$$

SAIFI (System Average Interruption Frequency Index) measures the average number of supply interruptions, prescribed as follows:

$$SAIFI = \frac{\text{Sum of the number of customers interrupted}}{\text{Total number of customers}}$$

SAIDI and SAIFI are high level network performance measures. Standard service levels, which are discussed greater detail in the following section, are customer performance measures.

**Reliability Targets**

Vector has aligned its SAIDI and SAIFI targets to match those introduced by the regulatory price-quality regime, and customer expectations expressing general comfort with the level of service being provided based on an understanding of price-quality ramifications.

The threshold targets are defined below. They are set in place until 1 April 2009, and we will endeavour to achieve the targets exclusive of extreme weather events.

The reliability thresholds were defined in the Commerce Act Electricity Distribution Thresholds Notice 2004, clause 6, which came into force on the 1 April 2004.

The SAIDI and SAIFI Threshold targets apply to Vector as follows:

a) Interruption Duration

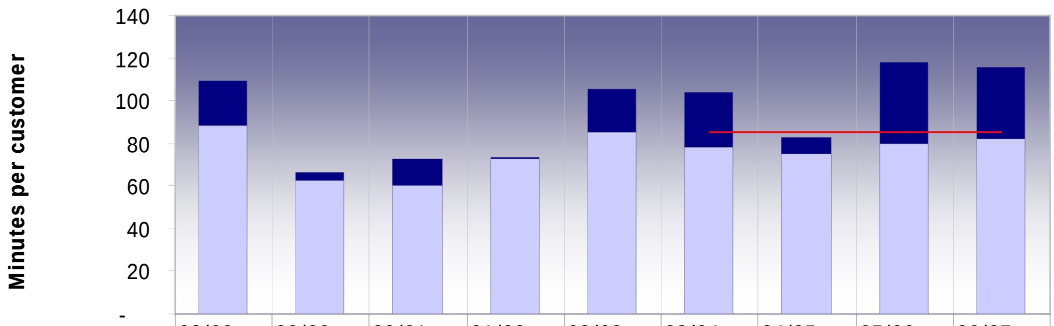
$$SAIDI_{Threshold} \le \left( \frac{SAIDI_{98/99} + SAIDI_{99/00} + SAIDI_{00/01} + SAIDI_{01/02} + SAIDI_{02/03}}{5} \right) \le 85 \text{mins}$$

b) Interruption Frequency

$$SAIFI_{Threshold} \le \left( \frac{SAIFI_{98/99} + SAIFI_{99/00} + SAIFI_{00/01} + SAIFI_{01/02} + SAIFI0_{02/03}}{5} \right) \le 1.31 \text{ints}$$

**Reliability Results**

As an electricity distribution business, Vector has a duty to demonstrate that no material deterioration in annual SAIDI or SAIFI has occurred, compared to the targets. Annual SAIDI performance for the last nine disclosure years is presented in Table 3.1. The light colours on the graph represent normal outages while the dark colours are attributable to extreme events. Transpower outages are not included.




| | 98/99 | 99/00 | 00/01 | 01/02 | 02/03 | 03/04 | 04/05 | 05/06 | 06/07 |
|---|---|---|---|---|---|---|---|---|---|
| | Regulation Benchmark | | | | | Threshold Regulation | | | |
| Extreme Weather | 21 | 4 | 12 | 1 | 21 | 26 | 7 | 38 | 33 |
| Vector | 89 | 63 | 60 | 73 | 85 | 78 | 75 | 80 | 82 |
| Total | 109 | 66 | 73 | 73 | 106 | 104 | 83 | 118 | 116 |
| Quality Threshold | | | | | | 85 | 85 | 85 | 85 |

*Table 3.1 SAIDI Performance*[3]

Due to the impact of extreme weather events, Vector's most recent year end 06/07 SAIDI performance finished at an overall 116 minutes. The regulatory assessment SAIDI threshold of 85 minutes has been exceeded. However, excluding Vector's extreme weather event criteria the normalised year end result would be 82 minutes, which is below the assessment threshold value of 85 minutes.

In explanation to the Commerce Commission, Vector has identified the following extreme weather event periods considered to be outside Vector's reasonable control.

[3] Threshold Regulation identifies the period from 1 April 2003 when the Price Path and Quality thresholds were operative. The Regulation Benchmark relates to the interval from 1 April 1998 to 31 March 2003 when the average of the annual SAIDI or SAIFI results was used to set the thresholds

| Auckland Network | | | | | |
| --- | --- | --- | --- | --- | --- |
| **Start Date/Time** | **End Date/Time** | **Hours** | **Faults** | **SAIDI** | **SAIFI** |
| 11/06/2006 18:00 | 13/06/2006 14:00 | 44 | 75 | 14.3 | 0.09 |
| 8/11/2006 21:00 | 10/11/2006 20:00 | 47 | 81 | 9.7 | 0.08 |
| 12/03/2007 23:00 | 15/03/2007 18:00 | 67 | 63 | 5.5 | 0.06 |
| 28/03/2007 7:00 | 30/03/2007 13:00 | 54 | 50 | 2.6 | 0.03 |
| | | | **Total Impact** | **32.1** | **0.26** |

*Table 3.2 Reliability Reporting - Auckland*

| Wellington Network | | | | | |
| --- | --- | --- | --- | --- | --- |
| **Start Time** | **End Time** | **Hours** | **Fault Count** | **SAIDI** | **SAIFI** |
| 11/06/2006 2:00 | 12/06/2006 23:00 | 45 | 7 | 0.4 | 0.01 |
| 18/06/2006 16:00 | 19/06/2006 18:00 | 26 | 5 | 0.1 | 0.00 |
| 3/10/2006 15:00 | 5/10/2006 14:00 | 47 | 7 | 0.3 | 0.00 |
| 23/10/2006 16:00 | 25/10/2006 14:00 | 46 | 7 | 0.1 | 0.00 |
| 13/11/2006 17:00 | 15/11/2006 17:00 | 48 | 12 | 0.4 | 0.01 |
| 14/03/2007 8:00 | 15/03/2007 16:00 | 32 | 9 | 0.1 | 0.01 |
| | | | **Total Impact** | **1.4** | **0.03** |

*Table 3.3 Reliability Reporting - Wellington*

Vector defines "extreme weather events" as a combination of wind speed (highest, 30min average, wind speed >50kph) with HV fault frequency (8 times or greater than the daily average)[4].

The occurrence of extreme weather events such as lightning strikes, storms/cyclones, and flooding has a major impact on SAIDI performance. In the case of Vector's (overhead) networks it is the high wind/heavy rain events that have the most impact.

The rationale for the number of interruptions as an "extreme event" trigger rather than SAIDI is that the sheer volume of faults causes response times to extend beyond typical repair times. Available field resources are unable to clear the faults faster than they are reported. Restoration times lengthen, compounded by the difficulty in reaching some fault locations, and delays in repair work caused by unsafe working conditions. Invariably during storm conditions, the contractor can only focus on ensuring the network is safe for the public (e.g. no live conductors on

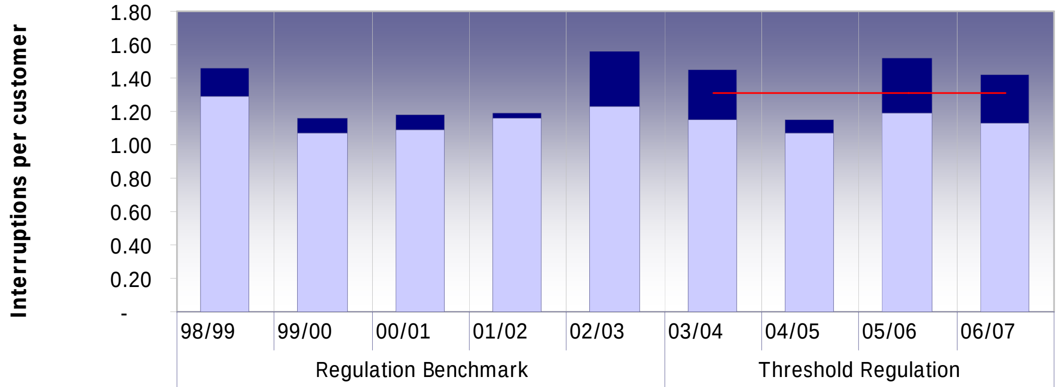
[4] OFGEM, the UK regulator, defines a Category 1 (medium event) as "Non-lightning events ≥8 and <13 times daily mean faults at higher voltage and <35% of exposed customers affected"

the ground) and it is only post-storm that restoration work can commence in earnest.

SAIDI is driven by the number of faults on the network, the number of customers affected by each fault, and the time taken to restore supply either by switching affected customers to an alternate supply after an interruption, or by repairing the fault. These in turn are affected by the network design and construction standards, equipment standards, management and performance of field staff, vegetation management, and condition of the network assets, in conjunction with external environmental factors (of which a number are outside the control of Vector, such as 3rd party damage and extreme weather).

Annual SAIFI performance is presented on the same basis in Table 3.4. The light colours on the graph represent normal outages while the dark colours are attributable to extreme events. Transpower outages are not included in the figures.

Vector's most recent year 06/07 SAIFI performance finished at an overall 1.42 interruptions. Again, due to the impact of extreme weather events, the year end result has exceeded the assessment SAIFI threshold of 1.31 interruptions.




| | 98/99 | 99/00 | 00/01 | 01/02 | 02/03 | 03/04 | 04/05 | 05/06 | 06/07 |
|---|---|---|---|---|---|---|---|---|---|
| Extreme Weather | 0.17 | 0.09 | 0.09 | 0.02 | 0.33 | 0.30 | 0.08 | 0.33 | 0.29 |
| Vector | 1.29 | 1.07 | 1.09 | 1.16 | 1.23 | 1.15 | 1.07 | 1.19 | 1.13 |
| Total | 1.46 | 1.16 | 1.18 | 1.19 | 1.56 | 1.45 | 1.15 | 1.52 | 1.42 |
| Quality Threshold | | | | | | 1.31 | 1.31 | 1.31 | 1.31 |

*Table 3.4 SAIFI Performance3*

Excluding the impact of Vector's extreme weather event criteria from the 06/07 SAIFI performance figures, the year end result would be 1.13 interruptions, below the assessment threshold value of 1.31 interruptions.

As segmented in Figure 3.1, weather (28%) has very significant impact on network performance, followed by equipment failures (28%), third party incidents, (15%), and vegetation, (13%).

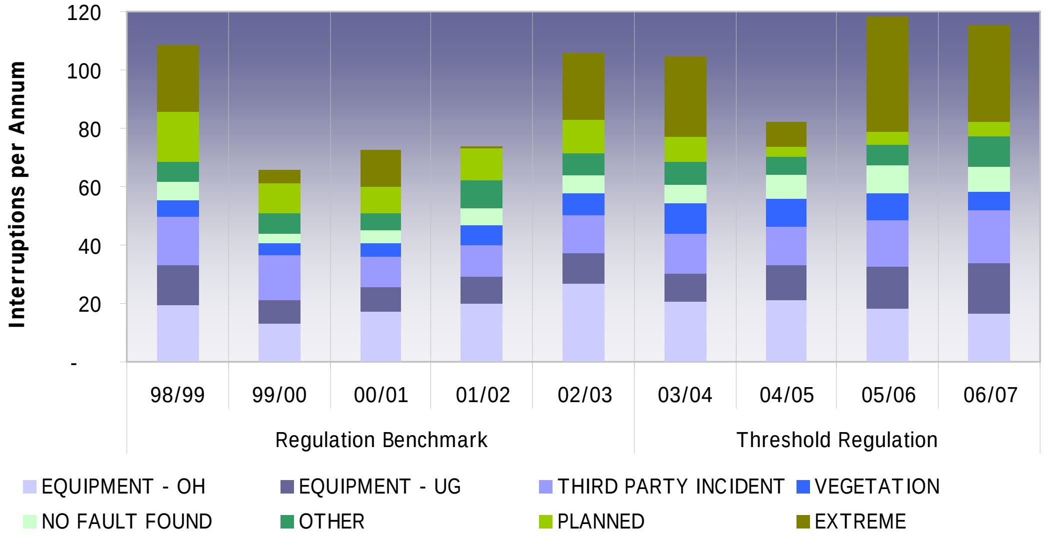



*Figure 3.1 Breakdown of Incident Causes (by SAIDI minutes)3*

Figure 3.2 shows the impact of events on the network that meet the criteria to be classified as "extreme events". The corresponding SAIDI contribution directly attributable to these events is also shown. While it is difficult to make generalisations from such a small sample of data, some inferences are evident:

- The number of extreme events and the SAIDI impact in the last five years is higher that any corresponding five year prior period
- With the exception of 2002/03 the number of extreme events during the five years when the SAIDI Threshold Benchmark years were set was the lowest it has been since 1994/95
- During the five years when the threshold benchmarks were set SAIDI, due to extreme events, was the lowest for two of those years since 1994/95

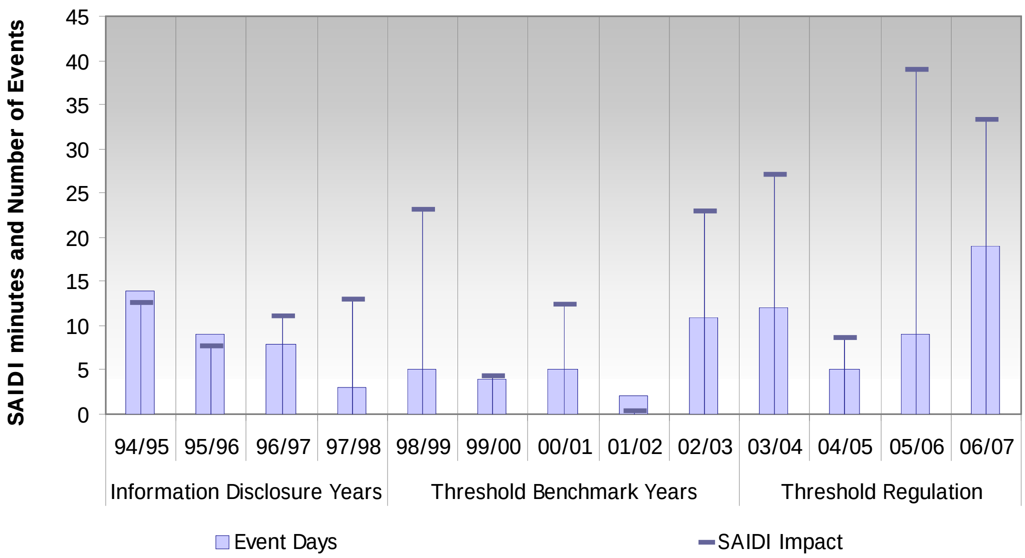



*Figure 3.2 Extreme Events - Number and Contributing SAIDI*

Figure 3.3 shows the long term SAIDI covering the years from 1994/95 to 2006/07. SAIDI for early years has been derived by recalculating SAIDI based on Information Disclosure data. Of significance is that the determination of the Quality thresholds (1998/99 to 2002/03) was based on SAIDI figures representing three of the lowest annual numbers from 1994/95 through to today. This has had the effect of skewing the Quality threshold to a figure much less than the long term average. As a result the Quality threshold for SAIDI is 85 minutes, compared to the long term average of 100mins.

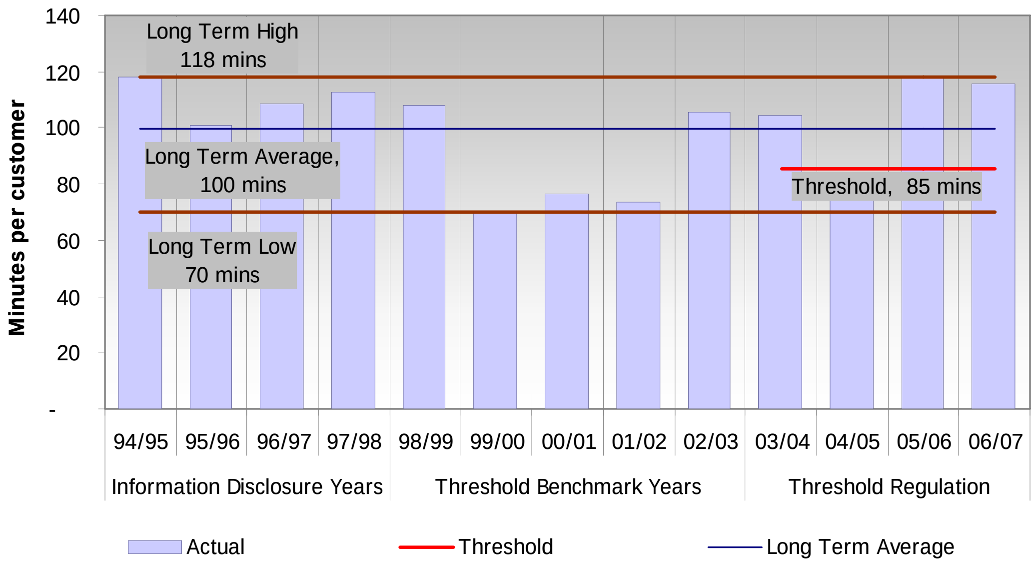



*Figure 3.3 Long Term SAIDI*

While extreme weather is beyond Vector's reasonable control, cost effective initiatives to improve SAIDI and SAIFI will continue to focus on:

- Reducing the number of unplanned events - Enhancement of procurement, installation, operation, maintenance and replacement techniques and practices to improve plant reliability and minimise external causal factors e.g. vegetation and third party incidents
- Reducing the number of customers exposed to an unplanned event - At the distribution level continue installing additional protection devices, such as fusing, circuit breakers, autoreclosers, and additional feeders. Major initiatives commenced during the 06/07 year include the planning and installation of 22 autoreclosers throughout the network. At sub-transmission level security enhancements such as additional zone substations, and additional supply redundancy, can make a significant difference
- Reducing the time customers are exposed to an unplanned event - Further improvements can be achieved through network automation, sectionalisers, fault indicators, additional response staff, and repair practices, such as temporary by-pass or alternative local generation. Significant projects

proposed or completed during the 06/07 year were the installation of 18 sectionalisers, and the addition of 36 network automated switches to aid in front line fault response

## 3.2. STANDARD SERVICE LEVELS

Our research shows a diverse range of customer expectations across each network, especially the impact and importance of reliability in terms of outage frequency and associated duration. To deliver against these diverse requirements Vector has aligned and translated the overall network reliability targets into standard service levels.

The standard service levels are based on two criteria; the time taken to restore power and the number of interruptions that may be experienced. As presented in Table 3.5 the standard service levels consider the network area, the customer type and service area. The standard service levels are indicative of what customers can expect for the price they pay via line charges. Large customers are able to contract for higher levels of reliability and quality where required.

| VECTOR STANDARD SERVICE LEVELS | | | | |
|---|---|---|---|---|
| **Network Area** | **Consumer Type** | **Service Area** | **Fault restoration time (hours)** | **Potential number of outages per year** |
| Central & southern Auckland networks | Commercial & Industrial | CBD | 0-2 | 0-3 |
| | | Industrial | 0-2 | 0-4 |
| | | Urban | 0-2.5 | 0-4 |
| | | Rural | 0-3 | 0-14 |
| | Business | Urban | 0-2.5 | 0-4 |
| | | Rural | 0-3 | 0-14 |
| | Residential | Urban | 0-2.5 | 0-4 |
| | | Rural | 0-3 | 0-14 |
| Northern Auckland and Wellington networks[5] | Commercial & Industrial | CBD | 0-3 | - |
| | | Industrial | 0-3 | - |
| | | Urban | 0-3 | - |
| | | Rural | 0-6 | - |
| | Business | Urban | 0-3 | - |
| | | Rural | 0-6 | - |

[5] Differing standards arises from legacy contracts with customers or Retailers

| VECTOR STANDARD SERVICE LEVELS | | | | |
|---|---|---|---|---|
| **Network Area** | **Consumer Type** | **Service Area** | **Fault restoration time (hours)** | **Potential number of outages per year** |
| | Residential | Urban | 0-3 | - |
| | | Rural | 0-6 | - |

*Table 3.5 Standard Service Levels: Reliability*

The difference in service levels are due to legacy clauses contained within the respective Use of Network Agreements with Retailers.

For network and asset management purposes, overall network reliability is translated into SAIDI, SAIFI and CAIDI targets for the following:

- Zonal Performance
- Feeder Performance
- Standard Service Level Performance

The SAIFI, fault frequency results are reviewed to understand if there is a particular asset or group of assets causing high fault frequencies, or a particular fault cause in an area. The results of the analysis can then be used to initiate revised preventative maintenance, asset refurbishment or replacement programmes, or other solutions if the fault cause is external, such as car versus pole or directional drilling.

The CAIDI fault duration results are reviewed to understand what is causing the high duration outages and what the potential solutions could be. Solutions range from restructuring of the fault crew response, automation, to the installation of fault passage indicators.

Internal reporting monitors service levels against targets to ensure that effort is directed to proactively highlight poorly performing areas and specific corrective actions taken to enhance reliability.

Our field contracting partners are incentivised under back-to-back performance clauses in their maintenance contracts to ensure the operation and maintenance of the network aligns with our own network reliability targets and standard service levels.

Annual Maintenance Plans are developed as a result of the review and analysis of SAIFI and CAIDI performance, and the Management Plan to achieve the target service level for the network.

## 3.3. SYSTEM DESIGN SECURITY

### 3.3.1. NETWORK SECURITY

Vector's approach to asset management and network planning has historically been driven by:

- Investment strategies and service offering improved value to customers and appropriate return to shareholders
- Customer needs, which vary by customer segment and are reflected by service level standards, are trending towards higher reliability and improved power quality
- Striving for least cost solutions (optimum asset utilisation) and optimum timing for capital expenditure
- Aligning risk management strategies with planning philosophy
- Continuously striving for innovation and optimisation in network design, and trialling leading-edge technology, such as remote switching technology to improve network performance
- Encouraging non-network and demand side solutions where practical

Vector uses a probabilistic approach to sub-transmission planning, but is aware that its success relies on a detailed knowledge of the condition and operational limits of the network, particularly when heavily loaded. Siemens AG (Germany) has advised Vector that the commonly accepted approach for network planning in Europe is deterministic (n, n-1). However they also acknowledged that the thresholds and approach adopted by Vector result in network outcomes that are very close to those produced by the conventional n-1 deterministic security levels. The probabilistic approach generally results in a deferral of investment compared to a deterministic approach.

The success of reliability based planning depends on the data and model used. Vector has selected DigSILENT PowerFactory as the analysis tool for this purpose. A combination of industry long-term averages and Vector data are used in this model.

The short-term goals for this model are:

- Comparing the network reliability with customer specified reliability requirements and costs

- Comparing delivered service levels against the standards to identify areas for improvement

- Improving asset utilisation and determining the optimum capital expenditure and network reinforcement window

- Demonstrating the relative improvement in reliability for different planning options

The long-term goals include assessment of the impact of ageing assets on the performance of the network. The reliability targets in Table 3.5 will continue to apply until the reliability based planning model is able to provide more customer and network specific service levels.

Successful application of probabilistic planning criteria is critically dependent on a comprehensive knowledge of the network loadings and the existence of a complete set of robust contingency plans, which Vector has.

The security criteria for the subtransmission network and the distribution network are described in Table 3.6 and Table 3.7

Network Transmission, Subtransmission and Distribution Reliability

| | **Type of load** | **Security Criteria<br>Single contingency only**[6] |
|---|---|---|
| 1 | Predominantly residential substations | Full backup available at all times. No interruption of supply for 95% of the time in a year. For central and south Auckland, any supply loss will be restored within 2.5 hrs in urban areas and 3 hours in rural areas. For north Auckland and Wellington, any supply loss will be restored within 3 hours in urban areas and 6 hours in rural areas. |
| 2 | Mixed commercial / industrial / residential substations | Full backup available at all times. No interruption of supply for 98% of the time in a year. For central and south Auckland, any supply loss will be restored within 2 hrs. For north Auckland and Wellington, any supply loss will be restored within 3 hours. |
| 3 | CBD or predominantly industrial | Full backup available at all times. No interruption of supply[7] for 99.5% of the time in a year. For central and south Auckland, any supply loss will be restored within 2 hrs. For north Auckland and Wellington, any supply loss will be restored within 3 hours. |

[6] Full backup can be provided via the sub-transmission or distribution network, or other means such as mobile generation

[7] Brief interruption acceptable if for no more than 1 minute

*Table 3.6 Subtransmission Network*

| | Type of load | Security Criteria[8][9] Single contingency only |
|---|---|---|
| 1 | Overhead spurs supplying up to 1MVA urban area | No back stop. Total loss of supply upon failure. Supply restoration upon repair time |
| 2 | Overhead spurs supplying up to 2.5MVA rural area | No back stop. Total loss of supply upon failure. Supply restoration upon repair time |
| 3 | Underground spurs supplying up to 400kVA | No back stop. Total loss of supply upon failure. Supply restoration upon repair time |
| 4 | Predominantly residential feeders | Full backup available 95% of the time in a year. Supply might be lost for 5% of the time in a year. |
| 5 | Mixed commercial / industrial / residential feeders | Full backup available 98% of the time in a year. Supply might be lost for 2% of the time in a year. |
| 6 | CBD or high density industrial | Full backup available 99.5% of the time in a year. Supply might be lost for 0.5% of the time in a year. |

*Table 3.7 Distribution Network*

The variation between different categories of customers is for three reasons:

- Reliability expectations of CBD, industrial and commercial customers are higher than residential
- Load profiles for different customer categories vary. Residential areas have peaks of typically less than three hours, so an outage which leads to an inability to supply all customers in a peak time is basically self-correcting. Commercial and industrial areas have much longer peaks
- These standards align with service level standards in Table 3.6 and Table 3.7.

This approach is to differentiate service levels among different categories of customers, such that Vector can focus on providing for their needs.

---

[8] Restoration of supply, in the event that there is an interruption, shall be targeted as per Table 3-3.

[9] There will be a supply interruption for every feeder fault, but supply will be restored through backup (except in the case of spurs)

## 3.4. POWER QUALITY

Selected businesses, such as those in manufacturing and service industries, have a high reliance on disturbance free power supply. One of the objectives of power quality monitoring is to identify disturbances that adversely impact on customer's equipment with the objective of identifying solutions.

The following strategies have been implemented to monitor and report power quality problems identified on Vector's network.

- Power quality monitoring equipment has been installed at selected grid exit points and zone substations

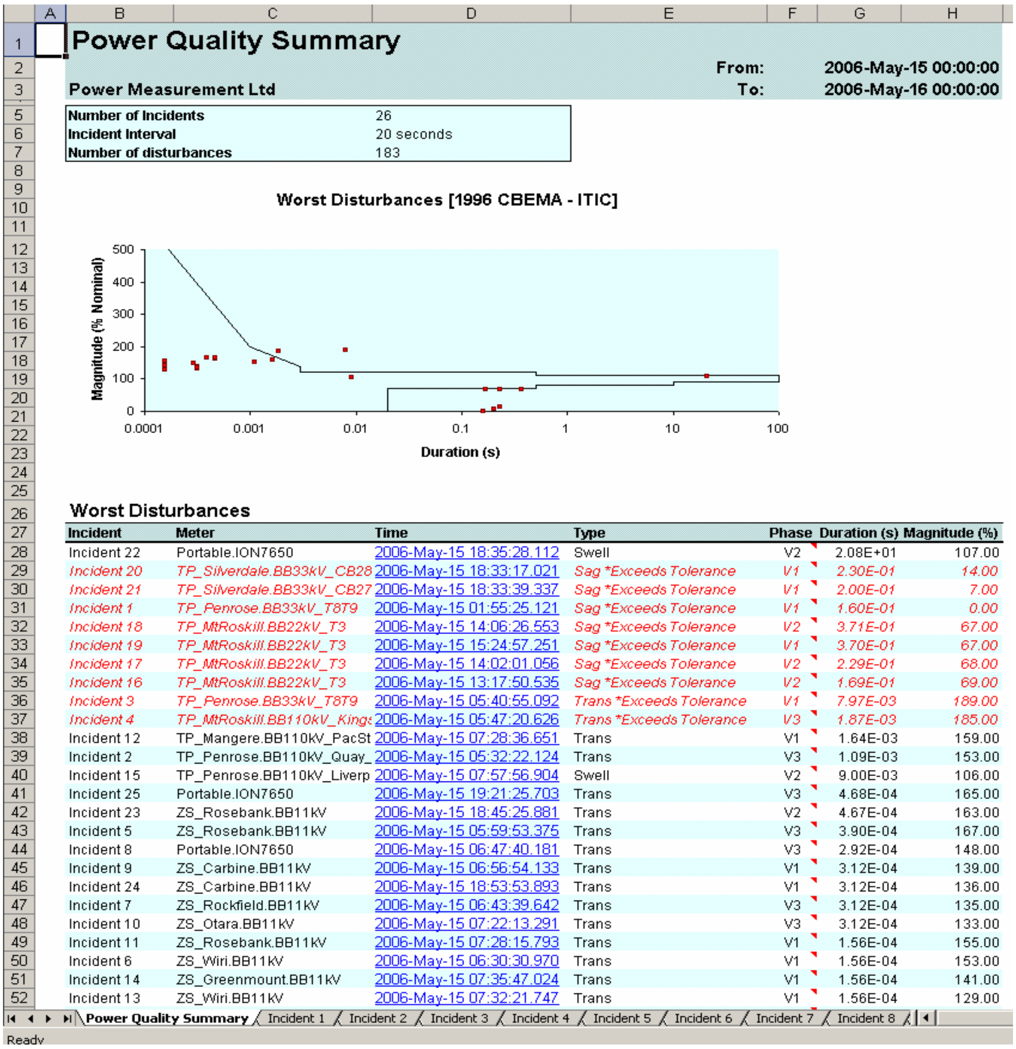
- An electronic mail system that automatically sends a power quality disturbance report in real-time to customers

- A web-based reporting system that makes real-time and historical power quality information available for diagnosis of customer's power quality issues

- Use of network modelling software and tools to predict the impact of power quality disturbances at customer's premises

- The availability of portable power quality instruments to investigate power quality related complaints

Examples of the manner in which power quality data can be presented are shown in Figure 3.4 and Figure 3.5



Power Quality Summary

Power Measurement Ltd

From: 2006-May-15 00:00:00

To: 2006-May-16 00:00:00

| | |
|---|---|
| Number of Incidents | 26 |
| Incident Interval | 20 seconds |
| Number of disturbances | 183 |



Worst Disturbances

| Incident | Meter | Time | Type | Phase | Duration (s) | Magnitude (%) |
|---|---|---|---|---|---|---|
| Incident 22 | Portable.ION7650 | 2006-May-15 18:35:28.112 | Swell | V2 | 2.08E+01 | 107.00 |
| Incident 20 | TP_Silverdale.BB33kV_CB28 | 2006-May-15 18:33:17.021 | Sag *Exceeds Tolerance | V1 | 2.30E-01 | 14.00 |
| Incident 21 | TP_Silverdale.BB33kV_CB27 | 2006-May-15 18:33:39.337 | Sag *Exceeds Tolerance | V1 | 2.00E-01 | 7.00 |
| Incident 1 | TP_Penrose.BB33kV_T8T9 | 2006-May-15 01:55:25.121 | Sag *Exceeds Tolerance | V1 | 1.60E-01 | 0.00 |
| Incident 18 | TP_MtRoskill.BB22kV_T3 | 2006-May-15 14:06:26.553 | Sag *Exceeds Tolerance | V2 | 3.71E-01 | 67.00 |
| Incident 19 | TP_MtRoskill.BB22kV_T3 | 2006-May-15 15:24:57.251 | Sag *Exceeds Tolerance | V1 | 3.70E-01 | 67.00 |
| Incident 17 | TP_MtRoskill.BB22kV_T3 | 2006-May-15 14:02:01.056 | Sag *Exceeds Tolerance | V2 | 2.29E-01 | 68.00 |
| Incident 16 | TP_MtRoskill.BB22kV_T3 | 2006-May-15 13:17:50.535 | Sag *Exceeds Tolerance | V2 | 1.69E-01 | 69.00 |
| Incident 3 | TP_Penrose.BB33kV_T8T9 | 2006-May-15 05:40:55.092 | Trans *Exceeds Tolerance | V1 | 7.97E-03 | 189.00 |
| Incident 4 | TP_MtRoskill.BB110kV_Kings | 2006-May-15 05:47:20.626 | Trans *Exceeds Tolerance | V3 | 1.87E-03 | 185.00 |
| Incident 12 | TP_Mangere.BB110kV_PacSt | 2006-May-15 07:28:36.651 | Trans | V1 | 1.64E-03 | 159.00 |
| Incident 2 | TP_Penrose.BB110kV_Quay_ | 2006-May-15 05:32:22.124 | Trans | V3 | 1.09E-03 | 153.00 |
| Incident 15 | TP_Penrose.BB110kV_Liverp | 2006-May-15 07:57:56.904 | Swell | V2 | 9.00E-03 | 106.00 |
| Incident 25 | Portable.ION7650 | 2006-May-15 19:21:25.703 | Trans | V3 | 4.68E-04 | 165.00 |
| Incident 23 | ZS_Rosebank.BB11kV | 2006-May-15 18:45:25.881 | Trans | V2 | 4.67E-04 | 163.00 |
| Incident 5 | ZS_Rosebank.BB11kV | 2006-May-15 05:59:53.375 | Trans | V3 | 3.90E-04 | 167.00 |
| Incident 8 | Portable.ION7650 | 2006-May-15 06:47:40.181 | Trans | V3 | 2.92E-04 | 148.00 |
| Incident 9 | ZS_Carbine.BB11kV | 2006-May-15 06:56:54.133 | Trans | V1 | 3.12E-04 | 139.00 |
| Incident 24 | ZS_Carbine.BB11kV | 2006-May-15 18:53:53.893 | Trans | V1 | 3.12E-04 | 136.00 |
| Incident 7 | ZS_Rockfield.BB11kV | 2006-May-15 06:43:39.642 | Trans | V3 | 3.12E-04 | 135.00 |
| Incident 10 | ZS_Otara.BB11kV | 2006-May-15 07:22:13.291 | Trans | V3 | 3.12E-04 | 133.00 |
| Incident 11 | ZS_Rosebank.BB11kV | 2006-May-15 07:28:15.793 | Trans | V1 | 1.56E-04 | 155.00 |
| Incident 6 | ZS_Wiri.BB11kV | 2006-May-15 06:30:30.970 | Trans | V1 | 1.56E-04 | 153.00 |
| Incident 14 | ZS_Greenmount.BB11kV | 2006-May-15 07:35:47.024 | Trans | V1 | 1.56E-04 | 141.00 |
| Incident 13 | ZS_Wiri.BB11kV | 2006-May-15 07:32:21.747 | Trans | V1 | 1.56E-04 | 129.00 |

Power Quality Summary / Incident 1 / Incident 2 / Incident 3 / Incident 4 / Incident 5 / Incident 6 / Incident 7 / Incident 8

Ready

*Figure 3.4 Automated Daily Power Quality Summary Report.*

The information in this report provides details on any event that caused voltage and current transients or voltage sags and swells in the network.

By drilling down into each monitor, the daily max/average/min of voltage, current, frequency, power factor, voltage unbalance, voltage total harmonic distortion (THD), current THD can be observed. The voltage sags captured by each monitor for the same period can also be viewed as a voltage sag magnitude-duration chart. An example of this is shown in Figure 3.5.

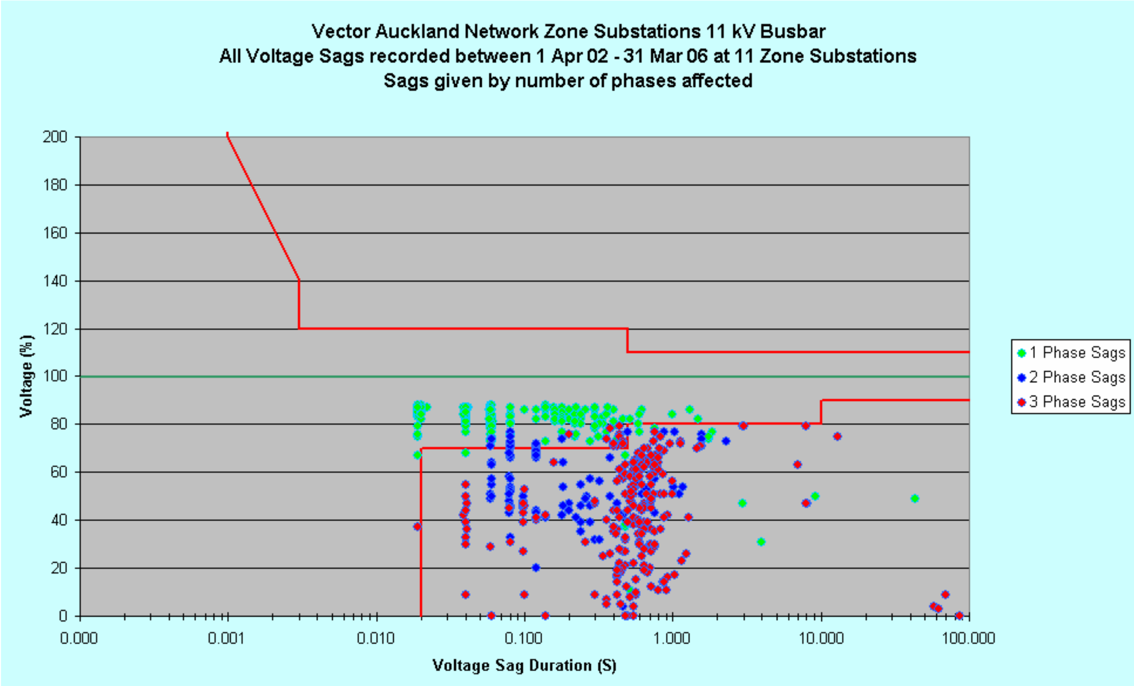



*Figure 3.5 11 kV Voltage Sag Magnitude – Duration Chart.*

### 3.4.1. FUTURE PLANS

***Power Quality Monitors.***

Future plans include:

- Installation of additional PQ monitoring instruments in the field. This is to gain increased knowledge of the quality of supply to customers
- Benchmark the quality of supply on the network and monitor changes over time
- Offer support to customers by assisting with solutions to Power Quality problems
- Developing an automated link between network events such as faults and data captured on the PQ instrumentation

# 4. NETWORK DEVELOPMENT

Network development's role is to find cost effective solutions to load growth related problems within an acceptable company risk profile. This profile is described via network security standards and is used as the criteria for identifying and initiating solutions to specific overloading problems. Not all solutions result in network reinforcement.

The electricity network must efficiently deliver power to customers in a manner that meets their needs for reliability, capacity and quality. This is achieved within the statutory framework by anticipating these needs through forecasting techniques that allows potential load related network problems to be addressed in a timely and cost effective manner.

Vector's approach is to consider options that maximise the utilisation of existing assets through automation, demand management, load redistribution across other feeders or substations, or other non-network asset investment solutions. Invariably these solutions are cheaper to implement and can defer major capital investment.

Network development capital expenditure is generally driven by growth and new connections, but regulatory compliance, safety and environmental issues, and the replacement of aging assets all contribute significantly to the capital spend

This section gives an overview of the major development projects planned for the network.

## 4.1. FORECAST GROWTH

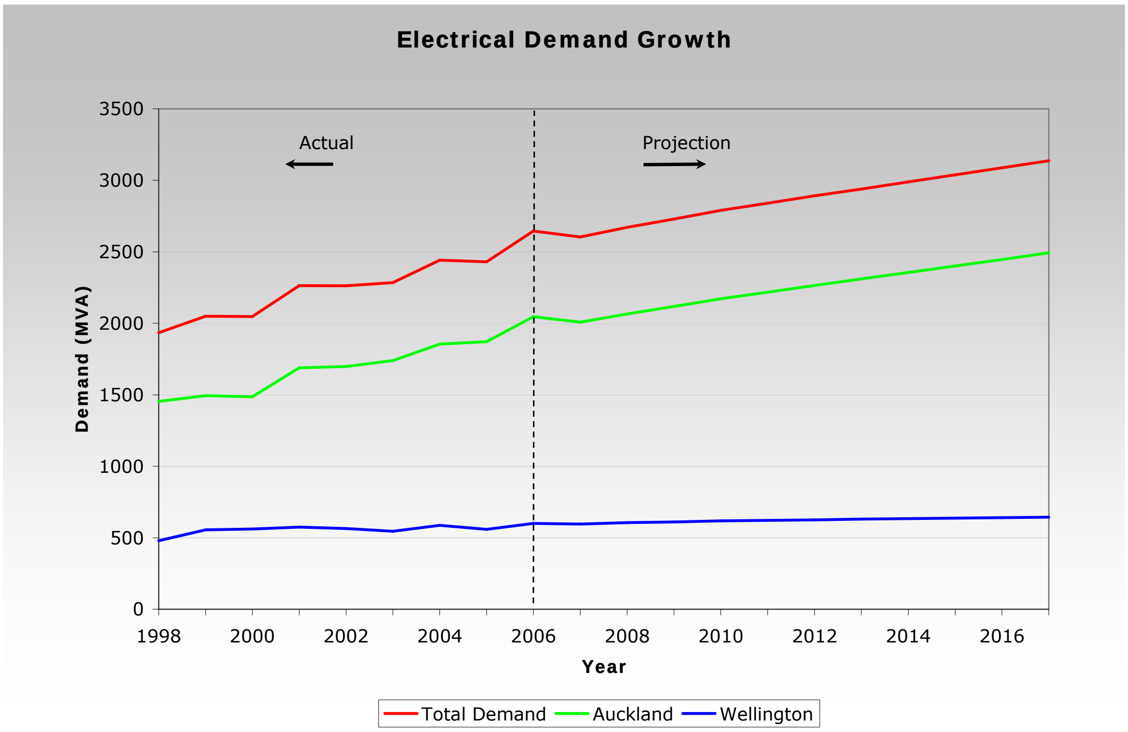



*Figure 4.1 Forecast Maximum Demand across the Network*

Figure 4.1 shows the forecast electricity demand across the network both at a regional level and an aggregated (non-coincident) level. The long-term forecast for Vector's total network shows an average demand growth rate across all networks of 2.0% per annum.

The forecasting technique used by Vector relies on historical zone substation and 11/6.6kV feeder load data captured via SCADA and stored in PI historical storage. Individual demographics (at feeder level) such as population growth, customer type, economic growth, land usage and district plan changes are applied to the load data to generate a demand projection over the planning period. Individual commercial developments and subdivisions are also factored in. The growth factor is calculated at both feeder and zone substation level.

The load forecast model takes into account larger embedded generators and network capacitors by removing them from the base year demand record prior to applying the growth factor. This allows the growth factor to be calculated without these distortions. Once the demand profile has been produced, embedded generation and network capacitors are added back to the forecast.

The output from this granular level load forecast can be used to determine a regional growth figure. To verify the bottom up approach, a top-down model compares the extrapolated trend-line derived from historical regional loads overlaid over the bottom-up trend line.

Growth trends are reviewed annually. Historical zone substation and feeder load information gathered over the previous five years is used to determine the starting load for the forecast. This approach removes short term weather distortions, as the objective is to capture the underlying long term growth rates. Seasonal variations are included through the interconnection of distribution feeders between zone substations and the ability to adjust feeder load by moving "open points".

Short-term maximum demand on Vector's network is primarily influenced by climate, particularly the severity of winter. Medium-term growth is driven mainly by population increases and commercial developments.

Vector's network comprises predominantly of compact urban load or CBD load with small rural communities scattered around the periphery of the network.

A measure of load diversity is achieved with residential customer's providing peaks in the morning and early evening, with the commercial load filling in the trough between these peaks. Clearly the mix of customer types on a feeder influences the size and duration of the peaks.

Figure 4.2 to Figure 4.5 shows the typical load characteristics for different categories of customer's.

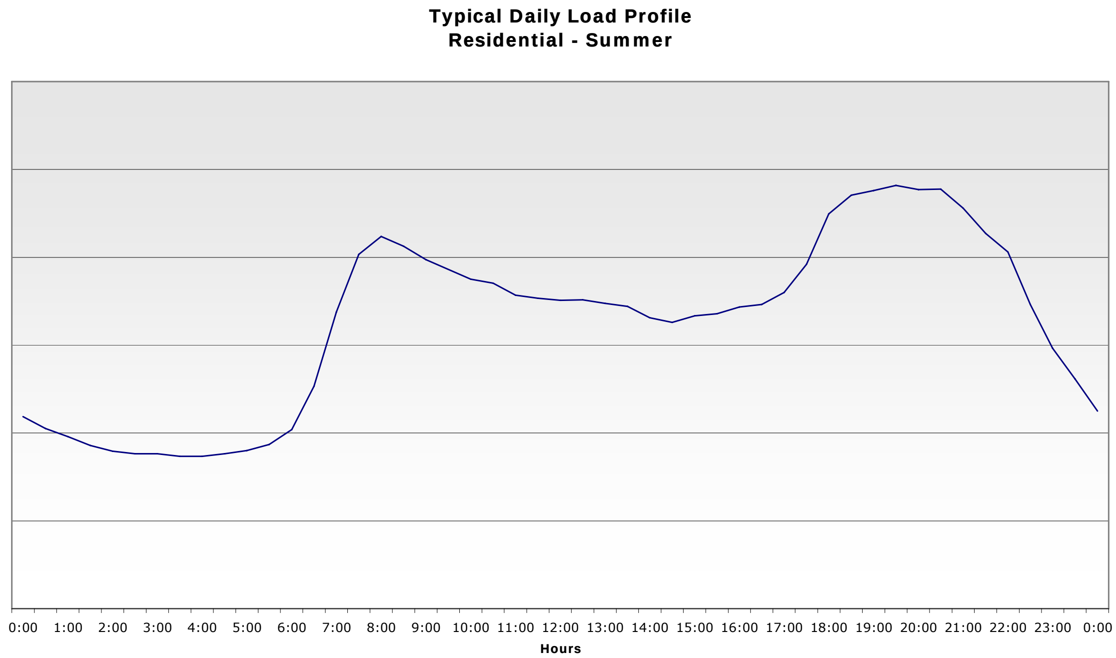



*Figure 4.2 Typical summer load profile for residential customers*

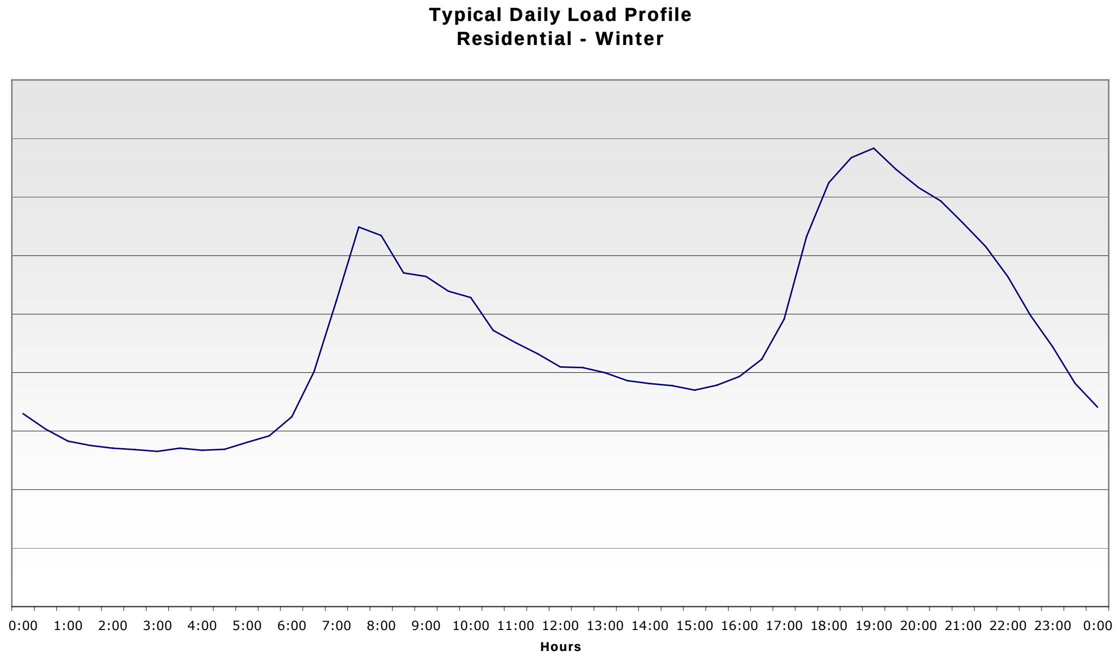



*Figure 4.3 Typical winter load profile for residential customers*

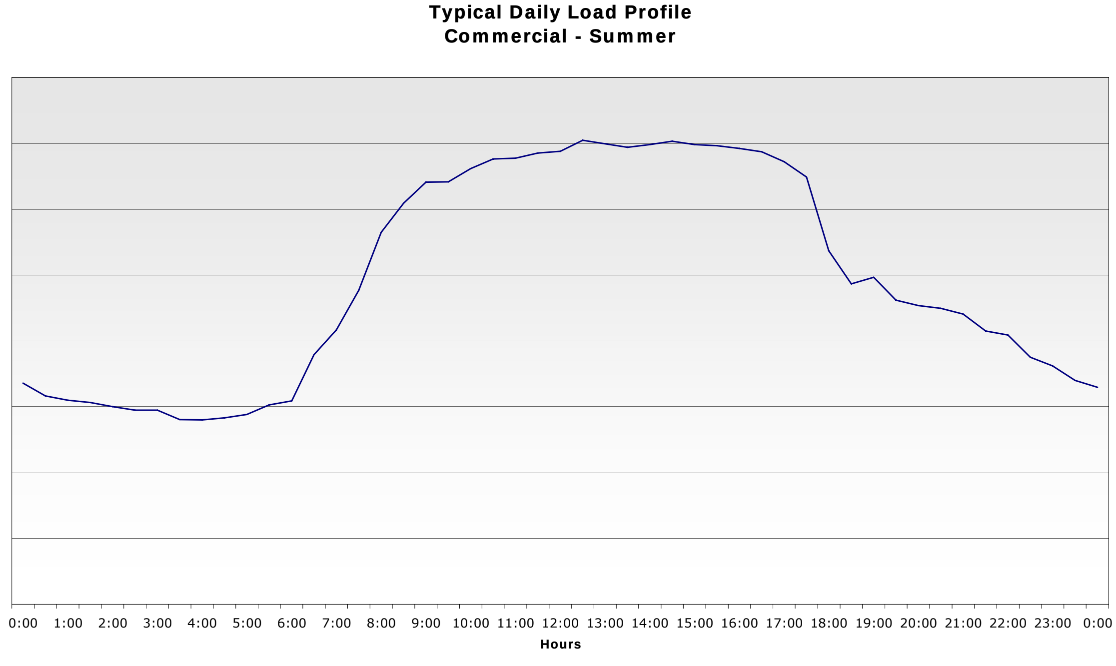



*Figure 4.4 Typical summer load profile for commercial customers*

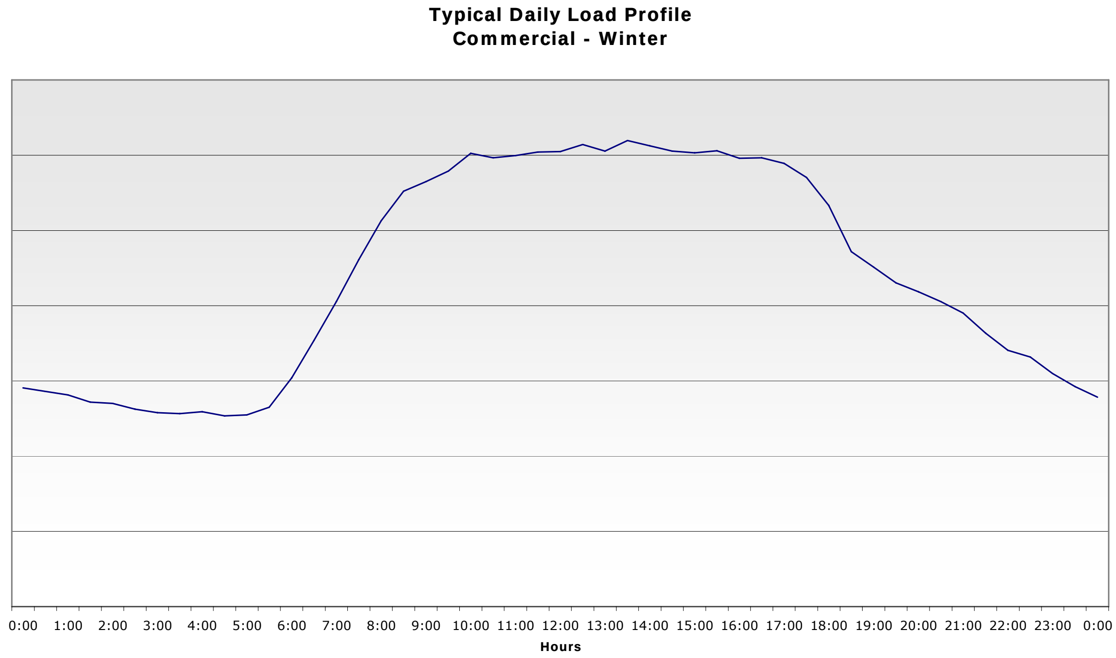



*Figure 4.5 Typical winter load profile for commercial customers*

Growing demand for residential air conditioning in summer, especially for residential use, is increasing overall electricity consumption and an area that is receiving close attention. Not only is this load unavailable for demand management through traditional load management systems, but residential air conditioning systems are relatively cheap to the customer and easy to install.

This load is creating summer peaks on a network that traditionally encountered winter peak. A close watch is being kept on summer loads and these are an integral part of the load forecasts. Reinforcement projects are planned and solutions implemented to ensure forecast loads do not exceed the system design security criteria outlined in Section 3.

### 4.1.1 DEMAND FORECASTS

The demand forecasts for zone substations on Vector's network are detailed in Table 4.2 and Table 4.3. These tables show the normal and cyclic ratings of the zone substation transformers and the associated maximum demand on each zone substation. All loads and transformer capacities are in MVA. Although a number of substations fail to meet "n-1" security at a subtransmission level (see column "meets "n-1" security in 2006"), these substations may be supported at a distribution level.

The figures in the "Distribution Backstop Shortfall" column represent the load that cannot be transferred to adjacent distribution feeders in the event of a major fault (e.g. zone transformer failure) which is coincident with the zone substation maximum demand. To restore supply to customers under these circumstances load must be shed through load control, voluntary load reduction or the installation of generators.

Network constraints can occur when the forecast load exceeds the equipment ratings. Where constraints are identified, projects are initiated and are listed in Sections 4.4 to 4.6. The load forecasts do not include load transfers arising from new projects. The peak demand and total energy delivered to each of the Vector networks during the 2006/07 year, are listed in Table 4.1

| **Network Area** | **Peak Demand (MW)** | **Total Energy Delivered (GWh)** |
|---|---|---|
| Auckland | 1671 | 8235 |
| Wellington | 544 | 2572 |
| Vector* | 2213 | 10,807 |

*coincident demand

*Table 4.1 Network Demand and Energy*

| Substation | Transformer ONAN Capacity | Voltage | Transformer ONAF/ODAF/OFAF Rating | Cyclic Rating | Actual 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 | Meets "n-1" security in 2006 | Distribution Backstop Shortfall |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Atkinson Road | 2*10 | 33kV | | 24 | 21 | 18 | 19 | 19 | 19 | 19 | 19 | 19 | 19 | 19 | 19 | 19 | N | |
| Auckland Airport | 2*20 | 33kV | 2*25 | 59 | 16 | 19 | 23 | 25 | 28 | 33 | 38 | 40 | 41 | 42 | 44 | 46 | Y | |
| Avondale | 2*15 | 22kV | 2*20 | 48 | 35 | 30 | 31 | 31 | 32 | 33 | 33 | 34 | 34 | 35 | 35 | 36 | N | |
| Bairds | 2*20 | 22kV | 2*20 | 48 | 23 | 26 | 26 | 27 | 27 | 28 | 28 | 28 | 29 | 29 | 30 | 30 | N | |
| Balmain | 1*12.5 | 33kV | | 12 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 11 | 11 | 11 | N | |
| Balmoral | 2*12 | 22kV | | 24 | 15 | 16 | 16 | 16 | 16 | 16 | 16 | 16 | 16 | 16 | 16 | 16 | N | |
| Belmont | 2*12.5 | 33kV | | 28 | 15 | 12 | 13 | 13 | 13 | 13 | 13 | 13 | 13 | 13 | 13 | 14 | Y | |
| Birkdale | 2*12.5 | 33kV | | 30 | 23 | 23 | 23 | 23 | 23 | 23 | 23 | 24 | 24 | 24 | 24 | 24 | N | |
| Brickworks | 1*12.5 | 33kV | | 13 | 10 | 10 | 10 | 10 | 11 | 11 | 11 | 12 | 12 | 12 | 12 | 12 | N | |
| Browns Bay | 2*12.5 | 33kV | | 28 | 20 | 20 | 21 | 22 | 23 | 23 | 24 | 25 | 25 | 26 | 27 | 28 | N | |
| Bush Road | 2*12 | 33kV | 2*24 | 42 | 28 | 31 | 33 | 35 | 37 | 38 | 39 | 40 | 41 | 43 | 44 | 45 | N | |
| Carbine | 2*15 | 33kV | 2*20 | 42 | 27 | 25 | 25 | 25 | 26 | 26 | 26 | 27 | 27 | 27 | 28 | 28 | N | |
| Chevalier | 2*18 | 22kV | | 31 | 18 | 18 | 18 | 19 | 19 | 19 | 19 | 20 | 20 | 20 | 20 | 21 | Y | |
| Clevedon | 1*5 | 33kV | | 6 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | Y | |
| Coatsville | 1*11.5 | 33kV | | 12 | 8 | 8 | 9 | 9 | 9 | 9 | 9 | 10 | 10 | 10 | 10 | 10 | N | 3 |
| Drive | 2*15 | 33kV | 2*20 | 48 | 37 | 22 | 22 | 22 | 22 | 23 | 23 | 23 | 23 | 24 | 24 | 24 | N | |
| East Coast Road | 1*12.0 | 33kV | | 24 | 14 | 12 | 12 | 13 | 13 | 13 | 14 | 14 | 14 | 15 | 15 | 15 | N | 6 |
| East Tamaki | 2*15 | 33kV | 2*20 | 48 | 19 | 19 | 20 | 20 | 20 | 20 | 21 | 21 | 21 | 22 | 22 | 22 | Y | |
| Forrest Hill | 1*12.5 | 33kV | | 15 | 14 | 13 | 13 | 13 | 14 | 14 | 14 | 14 | 14 | 14 | 14 | 14 | N | |
| Freemans Bay | 1*15 + 1*18 | 22kV | 1*20 + 1*18 | 31 | 20 | 21 | 21 | 22 | 22 | 22 | 23 | 23 | 24 | 24 | 25 | 25 | N | |
| Glen Innes | 2*12 | 22kV | | 24 | 17 | 17 | 17 | 18 | 18 | 19 | 19 | 19 | 20 | 20 | 20 | 21 | N | |
| Greenmount | 2*20+1*12 | 33kV | 3*20 | 71 | 38 | 43 | 44 | 45 | 47 | 48 | 49 | 50 | 51 | 52 | 54 | 55 | N | |
| Hans | 2*15 | 33kV | 2*20 | 43 | 29 | 28 | 30 | 30 | 31 | 31 | 32 | 32 | 33 | 33 | 34 | 34 | N | |
| Hauraki | 1*12.5 | 33kV | | 13 | 9 | 7 | 8 | 8 | 8 | 8 | 8 | 9 | 9 | 9 | 9 | 10 | N | |
| Helensville | 2*7.5 | 33kV | | 18 | 14 | 13 | 13 | 14 | 14 | 14 | 15 | 15 | 15 | 16 | 16 | 17 | N | |
| Henderson Valley | 2*12.5 | 33kV | 2*14 | 28 | 23 | 23 | 24 | 25 | 25 | 26 | 26 | 27 | 27 | 28 | 28 | 29 | N | |
| Highbury | 1*12.5 | 33kV | | 15 | 10 | 10 | 10 | 10 | 10 | 10 | 11 | 11 | 11 | 11 | 11 | 11 | Y | |
| Hillcrest | 2*12 | 33kV | | 48 | 19 | 15 | 15 | 16 | 16 | 16 | 16 | 17 | 17 | 17 | 17 | 18 | N | |

| Substation | Transformer ONAN Capacity | Voltage | Transformer ONAF/ODAF/OFAF Rating | Cyclic Rating | Actual 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 | Meets "n-1" security in 2006 | Distribution Backstop Shortfall |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Hobson 110/11kV | 2*25 | 110kV | | 60 | 28 | 30 | 30 | 31 | 32 | 33 | 34 | 35 | 35 | 36 | 37 | 38 | N | |
| Hobson 22/11kV | 1*10+1*12 | 22kV | 2*15 | 33 | 13 | 13 | 14 | 14 | 15 | 15 | 15 | 16 | 16 | 17 | 17 | 18 | Y | |
| Hobsonville | 2*12.5 | 33kV | | 32 | 23 | 22 | 23 | 24 | 24 | 25 | 25 | 26 | 26 | 27 | 27 | 28 | N | |
| Howick | 3*20 | 33kV | | 62 | 43 | 42 | 42 | 42 | 43 | 43 | 43 | 43 | 43 | 44 | 44 | 44 | N | |
| James Street | 2*12.5 | 33kV | | 32 | 25 | 24 | 24 | 24 | 25 | 25 | 25 | 26 | 26 | 26 | 26 | 27 | N | |
| Keeling Road | 1*15 | 33kV | 1*24 | 24 | 11 | 11 | 11 | 12 | 12 | 12 | 12 | 13 | 13 | 13 | 13 | 14 | N | |
| Kingsland | 2*15 | 22kV | 2*20 | 48 | 30 | 26 | 27 | 27 | 28 | 28 | 28 | 29 | 29 | 29 | 30 | 30 | N | |
| Laingholm | 2*7.5 | 33kV | | 17 | 10 | 10 | 10 | 11 | 11 | 11 | 12 | 12 | 12 | 12 | 13 | 13 | N | |
| Lichfield | 2*20 | 110kV | | | 9 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | Y | |
| Liverpool | 3*15 | 22kV | 3*20 | 72 | 48 | 51 | 52 | 53 | 55 | 56 | 58 | 59 | 60 | 62 | 63 | 64 | N | |
| Mangere Central | 2*16.5 | 33kV | 2*20 | 57 | 25 | 26 | 26 | 27 | 27 | 28 | 29 | 29 | 30 | 31 | 32 | 32 | N | |
| Mangere East | 2*15 | 33kV | 2*20 | 46 | 29 | 27 | 27 | 28 | 28 | 29 | 30 | 30 | 31 | 31 | 32 | 33 | N | |
| Mangere West | 2*30 | 33kV | | 71 | 15 | 18 | 19 | 19 | 20 | 21 | 21 | 22 | 22 | 23 | 23 | 24 | Y | |
| Manly | 2*12.5 | 33kV | | 30 | 25 | 26 | 28 | 29 | 31 | 33 | 34 | 35 | 36 | 37 | 38 | 39 | N | 4 |
| Manukau | 2*15+1*16.5 | 33kV | 3*20 | 56 | 28 | 32 | 33 | 35 | 36 | 37 | 39 | 40 | 41 | 43 | 44 | 45 | Y | |
| Manurewa | 3*16 | 33kV | 3*20 | 71 | 58 | 55 | 56 | 57 | 58 | 59 | 60 | 61 | 62 | 63 | 64 | 65 | N | |
| Maraetai | 2*15 | 33kV | | 24 | 7 | 6 | 6 | 6 | 6 | 6 | 6 | 6 | 7 | 7 | 7 | 7 | Y | |
| McKinnon | 1*15 | 33kV | 1*19 | 24 | 11 | 12 | 13 | 15 | 16 | 17 | 18 | 19 | 20 | 22 | 23 | 24 | N | |
| Mcleod Road | 1*12.5 | 33kV | | 16 | 14 | 12 | 13 | 13 | 13 | 13 | 13 | 13 | 14 | 14 | 14 | 14 | N | |
| McNab | 3*20 | 33kV | | 57 | 46 | 47 | 47 | 48 | 49 | 49 | 50 | 51 | 51 | 52 | 53 | 53 | N | |
| Milford | 1*12.5 | 33kV | 1*14 | 14 | 11 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 11 | 11 | 11 | N | 3 |
| Mt Albert | 1*12 | 22kV | | 14 | 10 | 10 | 10 | 10 | 11 | 11 | 11 | 11 | 11 | 12 | 12 | 12 | N | |
| Mt Wellington | 2*15 | 33kV | 2*20 | 48 | 24 | 23 | 24 | 25 | 25 | 26 | 26 | 27 | 27 | 27 | 28 | 28 | N | |
| New Lynn | 2*12.5 | 33kV | | 30 | 16 | 14 | 15 | 15 | 15 | 15 | 16 | 16 | 16 | 16 | 17 | 17 | N | |
| Newmarket | 3*15 | 33kV | 3*20 | 70 | 44 | 55 | 58 | 62 | 63 | 65 | 66 | 67 | 68 | 70 | 71 | 72 | N | |
| Newton | 2*12 | 22kV | 2*16 | 38 | 17 | 16 | 16 | 17 | 17 | 17 | 18 | 18 | 19 | 19 | 19 | 20 | N | |
| Ngataringa Bay | 1*12.5 | 33kV | | 14 | 8 | 8 | 8 | 8 | 8 | 8 | 8 | 8 | 8 | 8 | 8 | 8 | N | |
| Northcote | 1*12.5 | 33kV | 1*16 | 15 | 10 | 11 | 11 | 11 | 11 | 11 | 11 | 11 | 11 | 11 | 11 | 12 | N | |

| Substation | Transformer ONAN Capacity | Voltage | Transformer ONAF/ODAF/OFAF Rating | Cyclic Rating | Actual 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 | Meets "n-1" security in 2006 | Distribution Backstop Shortfall |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Onehunga | 2*11 | 22kV | 2*15 | 26 | 23 | 24 | 24 | 25 | 25 | 26 | 27 | 27 | 28 | 28 | 29 | 29 | N | |
| Orakei | 2*14.5 | 33kV | 2*18 | 43 | 34 | 34 | 35 | 35 | 36 | 37 | 37 | 38 | 39 | 39 | 40 | 41 | N | |
| Orewa | 2*20 | 33kV | | 30 | 21 | 21 | 23 | 25 | 27 | 28 | 30 | 32 | 34 | 36 | 38 | 41 | N | |
| Otara | 2*15 | 22kV | | 35 | 25 | 25 | 27 | 28 | 29 | 31 | 32 | 33 | 35 | 37 | 38 | 40 | N | |
| Pacific Steel | 2*25 | 110kV | 2*40 | 80 | 59 | 58 | 61 | 63 | 66 | 69 | 71 | 74 | 77 | 79 | 82 | 84 | N | |
| Pakuranga | 2*16.5 | 33kV | 2*20 | 48 | 26 | 24 | 24 | 24 | 24 | 24 | 25 | 25 | 25 | 25 | 25 | 25 | N | |
| Papakura | 2*15 | 33kV | 2*20 | 44 | 25 | 23 | 24 | 26 | 27 | 27 | 27 | 27 | 27 | 27 | 27 | 28 | N | |
| Parnell | 2*12 | 22kV | | 26 | 16 | 12 | 13 | 13 | 13 | 13 | 13 | 13 | 13 | 13 | 14 | 14 | Y | |
| Ponsonby | 2*9 | 22kV | 2*12 | 27 | 16 | 17 | 17 | 17 | 17 | 17 | 17 | 17 | 18 | 18 | 18 | 18 | N | |
| Quay | 2*15 | 22kV | 2*20 | 48 | 27 | 28 | 29 | 30 | 31 | 32 | 32 | 33 | 34 | 35 | 36 | 37 | N | |
| Remuera | 2*15 | 33kV | 2*20 | 48 | 35 | 35 | 35 | 36 | 36 | 36 | 37 | 37 | 37 | 38 | 38 | 38 | N | |
| Riverhead | 2*7.5 | 33kV | | 18 | 12 | 12 | 12 | 13 | 13 | 13 | 13 | 14 | 14 | 15 | 15 | 15 | N | |
| Rockfield | 2*15 | 33kV | 2*20 | 48 | 25 | 22 | 23 | 23 | 23 | 24 | 24 | 24 | 24 | 25 | 25 | 25 | N | |
| Rosebank | 2*16 | 33kV | 2*21.5 | 52 | 25 | 26 | 26 | 27 | 27 | 27 | 27 | 27 | 28 | 28 | 28 | 28 | N | |
| Sabulite Road | 2*12.5 | 33kV | | 26 | 20 | 20 | 20 | 21 | 21 | 22 | 22 | 22 | 22 | 23 | 23 | 23 | N | |
| Sandringham | 2*16 | 22kV | 2*20 | 47 | 24 | 23 | 23 | 23 | 23 | 24 | 24 | 24 | 25 | 25 | 25 | 25 | N | |
| Simpson Road | 1*7.5 | 33kV | | 9 | 7 | 8 | 8 | 8 | 8 | 8 | 8 | 9 | 9 | 9 | 9 | 9 | N | |
| Snells Beach | 1*7.5 | 33kV | | 9 | 6 | 6 | 6 | 6 | 6 | 6 | 6 | 6 | 6 | 7 | 7 | 7 | N | 3 |
| South Howick | 2*15 | 33kV | 2*20 | 47 | 27 | 26 | 27 | 27 | 28 | 28 | 28 | 29 | 29 | 29 | 30 | 30 | N | |
| Spur Road | 1*12.5 | 33kV | | 14 | 16 | 13 | 14 | 15 | 16 | 17 | 17 | 18 | 19 | 20 | 20 | 20 | N | |
| St Heliers | 2*15 | 33kV | 2*17.5 | 42 | 23 | 22 | 23 | 23 | 23 | 23 | 23 | 24 | 24 | 24 | 24 | 24 | N | |
| Sunset Road | 2*12.5 | 33kV | | 30 | 20 | 22 | 22 | 23 | 23 | 23 | 24 | 24 | 24 | 24 | 25 | 25 | N | |
| Swanson | 1*12.5 | 33kV | | 15 | 13 | 13 | 13 | 14 | 14 | 15 | 15 | 15 | 16 | 16 | 16 | 17 | N | 1 |
| Sylvia Park | 2*20 | 33kV | | 48 | 4 | 4 | 6 | 8 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | Y | |
| Takanini | 2*15 | 33kV | | 36 | 23 | 23 | 24 | 25 | 26 | 27 | 28 | 28 | 29 | 30 | 30 | 31 | N | |
| Takapuna | 1*24 | 33kV | | 24 | 9 | 9 | 9 | 10 | 10 | 10 | 10 | 10 | 11 | 11 | 11 | 11 | N | |
| Te Atatu | 2*12.5 | 33kV | | 28 | 19 | 17 | 17 | 17 | 18 | 18 | 18 | 19 | 19 | 19 | 20 | 20 | N | |
| Te Papapa | 2*15 | 33kV | 2*20 | 46 | 26 | 23 | 23 | 24 | 24 | 24 | 25 | 25 | 25 | 25 | 26 | 26 | N | |

| Substation | Transformer ONAN Capacity | Voltage | Transformer ONAF/ODAF/OFAF Rating | Cyclic Rating | Actual 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 | Meets "n-1" security in 2006 | Distribution Backstop Shortfall |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Torbay | 1*12.5 | 33kV | | 13 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 11 | 11 | 11 | 11 | N | |
| Triangle Road | 2*10 | 33kV | | 24 | 22 | 20 | 21 | 21 | 22 | 23 | 23 | 24 | 25 | 25 | 26 | 26 | N | |
| Victoria | 2*20 | 22kV | 2*20 | 40 | 24 | 25 | 25 | 26 | 27 | 27 | 28 | 29 | 29 | 30 | 31 | 32 | N | |
| Waiake | 1*12.5 | 33kV | | 15 | 10 | 9 | 9 | 9 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | 10 | N | |
| Waiheke | 2*12.5 | 33kV | | 30 | 9 | 10 | 10 | 10 | 10 | 11 | 11 | 11 | 11 | 12 | 12 | 12 | Y | |
| Waikaukau | 1*7.5 | 33kV | | 9 | 11 | 9 | 9 | 9 | 10 | 10 | 10 | 10 | 10 | 10 | 11 | 11 | N | |
| Waimauku | 1*7.5 | 33kV | | 8 | 6 | 6 | 7 | 7 | 8 | 8 | 8 | 8 | 8 | 8 | 9 | 9 | N | 3 |
| Wairau | 2*12.5 | 33kV | 1*16+1*12.5 | 32 | 30 | 25 | 25 | 25 | 25 | 26 | 26 | 26 | 26 | 27 | 27 | 27 | N | |
| Warkworth | 2*7.5 | 33kV | | 18 | 16 | 14 | 15 | 15 | 15 | 15 | 15 | 16 | 16 | 16 | 16 | 16 | N | |
| Wellsford | 2*7.5 | 33kV | | 18 | 9 | 8 | 8 | 8 | 9 | 9 | 9 | 9 | 9 | 9 | 9 | 9 | N | |
| Westfield | 3*15 | 22kV | | 52 | 31 | 32 | 32 | 32 | 33 | 33 | 33 | 34 | 34 | 35 | 35 | 35 | N | |
| White Swan | 3*15 | 22kV | | 39 | 33 | 33 | 33 | 34 | 34 | 35 | 35 | 36 | 36 | 36 | 37 | 37 | N | |
| Wiri | 3*20 | 33kV | | 70 | 40 | 43 | 45 | 47 | 49 | 50 | 52 | 54 | 56 | 58 | 59 | 61 | N | |

*Table 4.2 Load forecast for Auckland Network*

| Substation | Transformer ONAN Capacity | Voltage | Transformer ONAF/ODAF/OFAF Rating | Cyclic Rating | Actual 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 | Meets "n-1" security in 2006 | Distribution Backstop Shortfall |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 8 Ira St | 2*16 | 33kV | 2*20 | 19 | 15 | 15 | 15 | 15 | 15 | 15 | 15 | 15 | 15 | 16 | 16 | 16 | Y | |
| Brown Owl | 2*11.5 | 33kV | 2*23 | 19 | 15 | 16 | 16 | 16 | 16 | 16 | 16 | 16 | 16 | 16 | 16 | 16 | Y | |
| Evans Bay | 2*20 | 33kV | | 36 | 15 | 16 | 16 | 16 | 16 | 16 | 17 | 17 | 17 | 17 | 17 | 17 | Y | |
| Frederick St | 2*18 | 33kV | 2*30 | 50 | 37 | 37 | 38 | 39 | 39 | 40 | 40 | 41 | 41 | 42 | 42 | 43 | N | |
| Gracefield 11kV | 2*11.5 | 33kV | | 19 | 14 | 13 | 13 | 13 | 13 | 13 | 13 | 13 | 13 | 13 | 13 | 13 | N | |
| Hataitai | 2*11.5 | 33kV | 2*23 | 19 | 19 | 19 | 19 | 19 | 19 | 19 | 19 | 19 | 19 | 19 | 19 | 19 | Y | |
| Haywards 11kV | 1*20 | 33kV | | 20 | 18 | 17 | 17 | 17 | 17 | 17 | 17 | 17 | 17 | 17 | 17 | 17 | N | 4 |
| Johnsonville | 2*11.5 | 33kV | 2*23 | 19 | 24 | 23 | 23 | 23 | 23 | 23 | 24 | 24 | 24 | 24 | 24 | 24 | Y | |
| Kaiwharawhara | 2*40 | 33kV | | 80 | 37 | 37 | 38 | 39 | 39 | 39 | 39 | 40 | 40 | 40 | 41 | 41 | Y | |
| Karori | 2*20 | 33kV | | 38 | 20 | 20 | 20 | 20 | 20 | 20 | 20 | 20 | 20 | 20 | 20 | 21 | Y | |
| Kenepuru | 2*11.5 | 33kV | 2*23 | 23 | 14 | 14 | 14 | 14 | 15 | 15 | 15 | 15 | 15 | 15 | 15 | 15 | Y | |
| Korokoro | 2*11.5 | 33kV | 2*23 | 25 | 15 | 13 | 13 | 13 | 13 | 13 | 13 | 13 | 13 | 13 | 13 | 13 | Y | |
| Maidstone | 2*11 | 33kV | 2*22 | 35 | 18 | 16 | 16 | 16 | 16 | 16 | 16 | 16 | 16 | 16 | 16 | 16 | Y | |
| Mana-Plimmerton | 2*10 | 33kV | 2*16 | 32 | 19 | 19 | 19 | 19 | 19 | 19 | 19 | 19 | 19 | 19 | 19 | 19 | N | |
| Melling 11kV | 2*25 | 33kV | | 50 | 26 | 22 | 22 | 22 | 22 | 22 | 22 | 22 | 23 | 23 | 23 | 23 | Y | |
| Moore St | 2*30 | 33kV | | 46 | 27 | 31 | 35 | 36 | 39 | 40 | 41 | 42 | 43 | 44 | 45 | 46 | Y | |
| Naenae | 2*11.5 | 33kV | 2*23 | 19 | 17 | 16 | 16 | 16 | 16 | 16 | 16 | 16 | 16 | 16 | 16 | 16 | Y | |
| Nairn St | 2*25 | 33kV | | 60 | 18 | 19 | 19 | 20 | 21 | 21 | 21 | 21 | 21 | 21 | 21 | 22 | Y | |
| Ngauranga | 2*10 | 33kV | | 26 | 8 | 8 | 8 | 8 | 8 | 8 | 8 | 8 | 8 | 8 | 9 | 9 | Y | |
| Palm Grove | 2*20 | 33kV | | 23 | 28 | 28 | 28 | 28 | 28 | 28 | 28 | 28 | 28 | 28 | 28 | 28 | N | 2 |
| Petone | 2*10 | 33kV | 2*20 | 20 | 12 | 12 | 12 | 13 | 13 | 13 | 13 | 13 | 13 | 13 | 13 | 13 | Y | |
| Porirua | 2*10 | 33kV | 2*20 | 20 | 16 | 17 | 17 | 17 | 17 | 18 | 18 | 18 | 18 | 19 | 19 | 19 | Y | |
| Seaview | 2*11 | 33kV | 2*22 | 30 | 16 | 17 | 17 | 17 | 18 | 18 | 18 | 18 | 18 | 18 | 18 | 18 | Y | |
| Tawa | 2*10 | 33kV | 2*16 | 32 | 15 | 15 | 15 | 15 | 15 | 15 | 16 | 16 | 16 | 16 | 16 | 16 | Y | |
| Terrace | 2*30 | 33kV | | 46 | 29 | 30 | 31 | 31 | 32 | 32 | 32 | 33 | 33 | 33 | 34 | 34 | Y | |
| Trentham | 2*11.5 | 33kV | 2*23 | 20 | 13 | 13 | 13 | 13 | 13 | 13 | 13 | 13 | 13 | 13 | 13 | 13 | Y | |

| Substation | Transformer ONAN Capacity | Voltage | Transformer ONAF/ODAF/OFAF Rating | Cyclic Rating | Actual 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 | Meets "n-1" security in 2006 | Distribution Backstop Shortfall |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| University | 2*20 | 33kV | | 44 | 26 | 27 | 27 | 28 | 28 | 28 | 28 | 28 | 29 | 29 | 29 | 29 | N | |
| Waikowhai St | 2*16 | 33kV | | 31 | 20 | 20 | 20 | 20 | 20 | 20 | 20 | 20 | 20 | 20 | 20 | 20 | N | |
| Wainuiomata | 2*11.5 | 33kV | 2*23 | 36 | 17 | 17 | 17 | 17 | 17 | 17 | 17 | 16 | 16 | 16 | 16 | 16 | Y | |
| Waitangirua | 2*10 | 33kV | 2*16 | 32 | 13 | 13 | 13 | 13 | 14 | 14 | 14 | 14 | 14 | 14 | 14 | 14 | Y | |
| Waterloo | 2*11.5 | 33kV | 2*23 | 21 | 21 | 18 | 18 | 18 | 18 | 18 | 18 | 18 | 18 | 18 | 18 | 18 | Y | |

*Table 4.3 Load forecast for Wellington Network*

## 4.2. NETWORK INVESTMENT

Vector invests in its network to:

- Provide additional capacity for growth
- Replace assets which have come to the end of their economic lives
- Ensure the assets comply with health, safety and environmental statutory requirements
- Maintain and improve the service provided by the network

To ensure sound investments are being made, projects are evaluated against a range of drivers important to the company. Typical examples may be risk, safety, return on investment and available funds. In a financially constrained environment this process provides an unbiased project selection tool.

A new solution may incorporate the use of (but is not limited to):

- Demand side management
- Embedded or distributed generation (interconnected or behind-the-load)
- Non-traditional technologies

Most alternative solutions, such as automation and load management, provide incremental increases in capacity at a fraction of the cost of traditional, capital intensive solutions.

These solutions are an efficient way of deferring traditional investment and reduce the risk of large traditional investments being stranded, especially in low load growth areas.

### 4.2.1. NETWORK CONSTRAINT MANAGEMENT

As load grows the capacity of existing assets is consumed. Eventually network constraints arise where the load on existing assets compromises Vector's service standards. Network constraints are geographically constrained, time-of-day dependent and are relieved as soon as further capacity is provided through investment.

Constraints occur at all parts of the network, from transmission, and subtransmission to the distribution network.

Management of these constraints is either through capital investment or by:

- Reconfiguring the network to reduce the load in the constrained area. This process is used frequently and is achieved by moving feeder "open points" to equalise the load across feeders. Ultimately as load increases, opportunities to move "open points" diminish resulting in equipment overload or feeder outages unless reinforcement is implemented

- Encouraging customer's to shed load at peak times

- Load control. This is used extensively to manage feeder loads against equipment overload, particularly during network faults or during winter or summer peaks

- Local generation. There is no robust mechanism for initiating generation on a widespread scale as a means of reducing feeder peak loads. While we have agreements with selected customers e.g. Wellington Hospital, to supply generation capacity, there is no formal process in place to coordinate wholesale generation. Vector has however acquired two mobile generator connection units that can be deployed to cover large outage areas when required

- Automated switching. This is generally installed to initiate rapid restoration following a fault rather than load transfer or investment avoidance

A list of proposed projects to alleviate capacity and security constraints are outlined in Sections 4.4 and 4.5

### 4.2.2. NON-TRADITIONAL INVESTMENT SOLUTIONS

Non-traditional investment solutions fall into the following areas:

**Increasing the utilisation of existing assets**

- Improved control of network assets (remote controlled and automated switches)
- Real-time monitoring and rating of assets
- Targeted maintenance programmes

**Demand Management**

- Embedded generation (both new generation and use of existing generation – e.g. CBD buildings with emergency generators)
- Customer load management; real-time access to sheddable loads in peaks
- Customer demand reduction; through price signals, demand reduction programmes; run by Vector or third parties
- Energy storage devices
- Peak demand pricing

**Customer investment**

- Investment in site equipment (power factor correction, voltage conditioners etc)
- Insurance to cover risks
- Determining specific service levels

New technologies are emerging in all of the above areas.

### 4.2.3. DISTRIBUTED GENERATION

Distributed generation refers to energy production embedded within the distribution network. It includes production from power plants, customer back up generators and smaller generation technologies such as solar panels, micro wind turbines and fuel cells.

Vector has prepared and published guides on its web site, detailing the application and approval process for customer's who wish to install embedded generation on the distribution network.

Vector employs distributed generation as a non-traditional investment solution that is considered and applied where appropriate. Vector is also investigating micro-wind generation and solar hot water heating as ways of controlling peak demand.

### 4.2.4. EMBEDDED GENERATION

The following embedded generation (greater than 1MW) sites are connected to the Vector network

- Wellington Hospital
- Auckland Hospital
- Greenmount Landfill Power Station
- Rosedale Landfill Power Station
- Redvale Landfill Power Station
- Whitford Landfill Power Station
- Silverstream Landfill Power Station

### 4.2.5. THIRD PARTY SERVICE PROVISION

Vector recognises that third parties can provide some of the above investment solutions. Vector encourages third party service provision through the communication of:

- The required outcome the solution must provide

- The area the solution is required

- The timeframe in which the solution is required

Vector’s policy is to compensate third parties for the provision of services, including distributed generation, so long as:

- The risk of the non-provision of the service can be managed so that it does not breach Vector’s service standards

- The provision of the service complies with Vector’s technical codes and does not interfere with other Vector customers

- Payments to contracting partners are linked directly to the provision of the service which gives the correct commercial outcomes

- Commercial agreements are reached on connection, including use of network costs

Compensation is based upon the actual benefit received by Vector. To ensure Vector receives the maximum value from these investments it seeks to:

- Set prices through a competitive process

- Ensure timeframes are short to enable other solutions to emerge over time

#### 4.2.6. LARGE CUSTOMERS

Vector has a number of large customer sites at various locations in its network. The following are those customer sites with demand above 5MVA:

- Fonterra Cheese Factory at Lichfield
- Auckland International Airport
- Mangere Waste Water Treatment Plant
- Owens Illinois
- Fisher & Paykel Appliance Factory at East Tamaki
- Pacific Steel
- Ports of Auckland
- Laminex Penrose
- Coca Cola Amatil (NZ) Limited
- Naval Base, Devonport
- Carter Holt Harvey, Penrose
- Masport Limited
- Westfield NZ Limited – Albany, St Lukes, Manukau, Queensgate

#### 4.2.7. NETWORK OPTIMISATION

In Vector's 2004 ODV of electricity networks, optimisation was conducted in accordance with the ODV Handbook's specifications and guidelines. The optimisation process involved determining if individual items could be eliminated or reduced to a lower value or lower capacity item that still provided the required service levels. The planning horizons specified in the ODV Handbook have been used to determine forecast loadings on assets when conducting optimisation determinations.

Optimisations were determined to apply to some assets within the following asset classes:

- Zone Substation (Power) Transformers
- Subtransmission cables and overhead lines
- HV Distribution substations
- HV Distribution switchgear
- HV Distribution transformers
- HV Distribution cables and overhead lines
- LV Distribution cables and lines (including streetlighting circuits)

For the 2004 ODV, Vector recorded $76.7m of optimisation.

#### 4.2.8. UNECONOMIC LINES

In 2013 the Electricity Act removes the obligation for lines companies to supply customers connected to uneconomic lines. Vector is reviewing the impact on its business and to its customers. No decision has been made at this time.

## 4.3. ASSET DEVELOPMENT

A number of areas within the Vector network are at risk of having their supply security criteria breached. Prior to capital investment the following options are considered:

- Increased asset utilisation, through advanced automation, or dynamic equipment ratings
- Load management including demand-side management
- Level of acceptable risk
- Asset performance improvement
- Customer requirements and customer based solutions
- Capital investment meeting commercial objectives

Projects are prioritised in accordance with the following criteria:

- Safety, regulatory or environmental issues
- Risk and consequences of project deferral
- Impact on customers
- Project deferral opportunities based on other options
- Rate of return on investment
- Performance and operation of the network
- Synergies with other projects
- Availability of capex funds

A capex programme is compiled based on:

- Solution adopted to address the issue or constraint
- Timing of the solution
- Cost of the solution

Within the network investment assessment process, network reliability and security of supply, were specifically included to value the improvement in service level. These drivers look at the existing delivered service level and evaluate the improvements that the project will deliver against the service level standards.

A list of the more significant projects is contained in Section 4.4 for projects that require capital investment to address network security constraints. Due to the uncertainty of outcomes created by the regulatory environment surrounding asset investment, some of the projects that have been identified may be deferred.

The projects have been summarised according to broad cost bands (i.e. between $1 and $5 million, and > $5 million). Projects costing less than $1 million and minor 11kV reinforcement projects have not been individually listed.

"Committed" projects are those that have been approved through internal governance processes and have been assigned a budget. Those projects with a "Proposed" status have yet to be approved and are still considered to be in the planning stage.

The "timescale" against each of the projects indicates the target commissioning date but can be subject to re-prioritisation and approval by governance processes.

## 4.4. AUCKLAND CUSTOMER AREA

### 4.4.1. GROWTH IN THE AUCKLAND AREA

This area covers Auckland City, Manukau City, North Shore City, Waitakere City, Rodney District and parts of Papakura District,

Residential demand is expected to increase in central Auckland with the development of new apartments and refurbishment of offices into apartments. Residential growth in the Manukau City (Flatbush development) and Takanini/Alfriston areas is also high due to planned residential subdivisions. With the motorway from North Shore to Orewa (which is being extended to Puhoi), it is expected that significant residential developments will take place in areas north of Silverdale. Areas north of the Whangaparaoa Peninsula and west of Henderson are predominantly rural residential. Elsewhere residential growth in the Auckland network is expected to be low, with infill housing being the major form of development.

Industrial and commercial development is expected to continue in Wiri, Manukau Avondale and around East Tamaki (Highbrook), with large retail developments in Mt

Wellington and in the vicinity of Auckland airport. On the north and west Auckland networks commercial and industrial developments will continue around the Albany Basin, Takapuna, Glenfield, Henderson and Te Atatu areas.

The following figures show the proposed projects on the Auckland network.

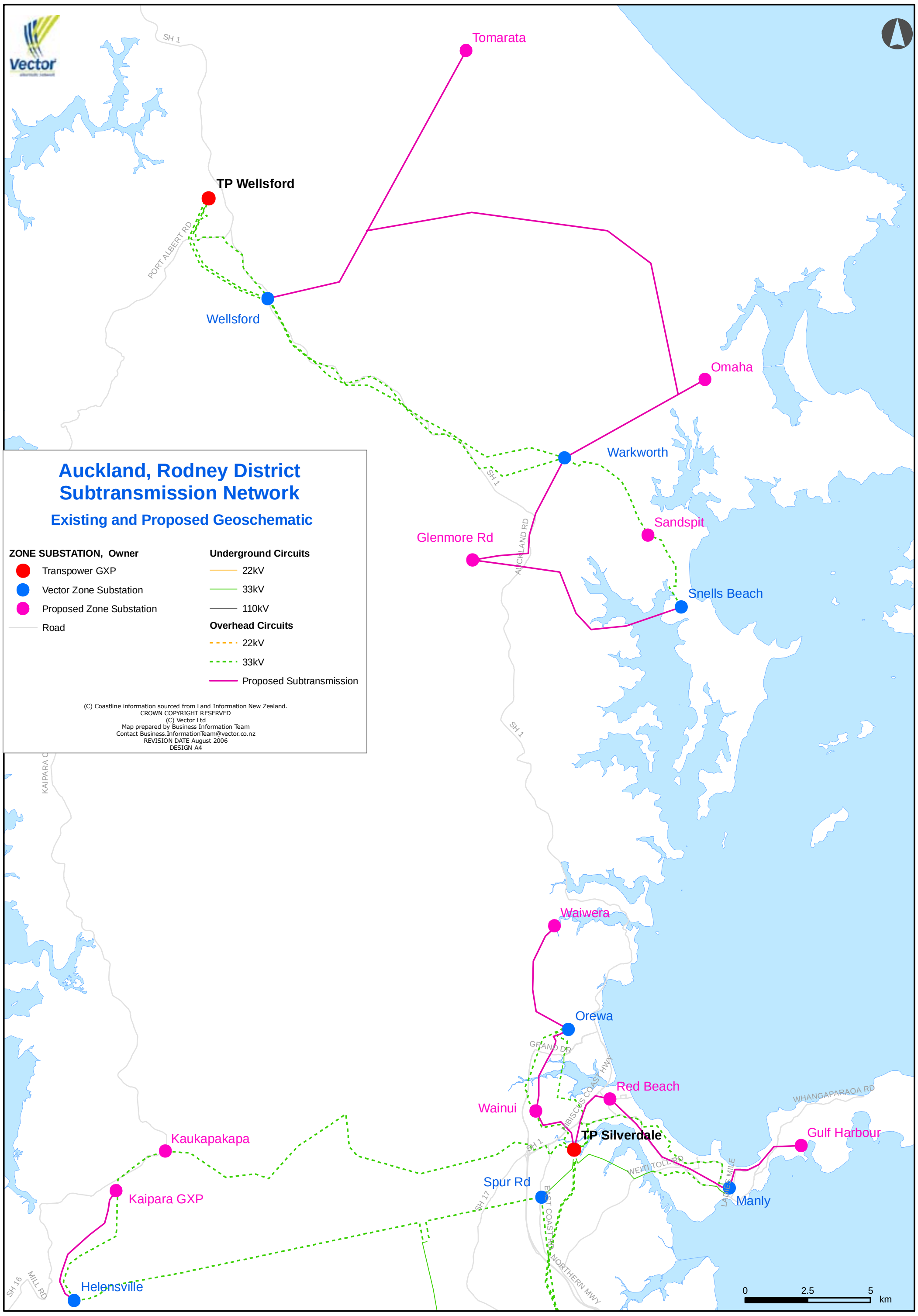



*Figure 4.6 Proposed projects in Rodney District*

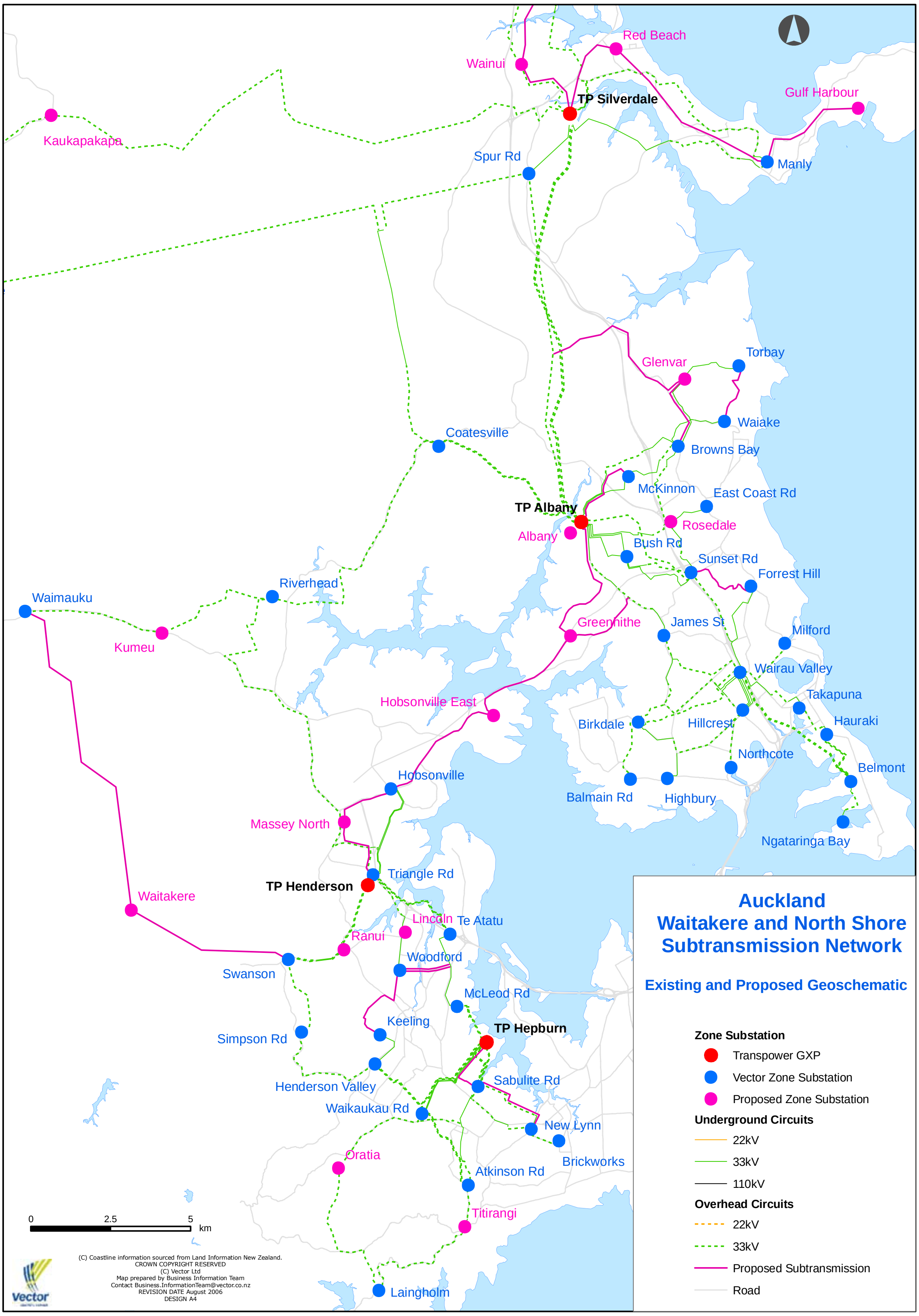



*Figure 4.7 Proposed projects in Waitakere and North Shore*

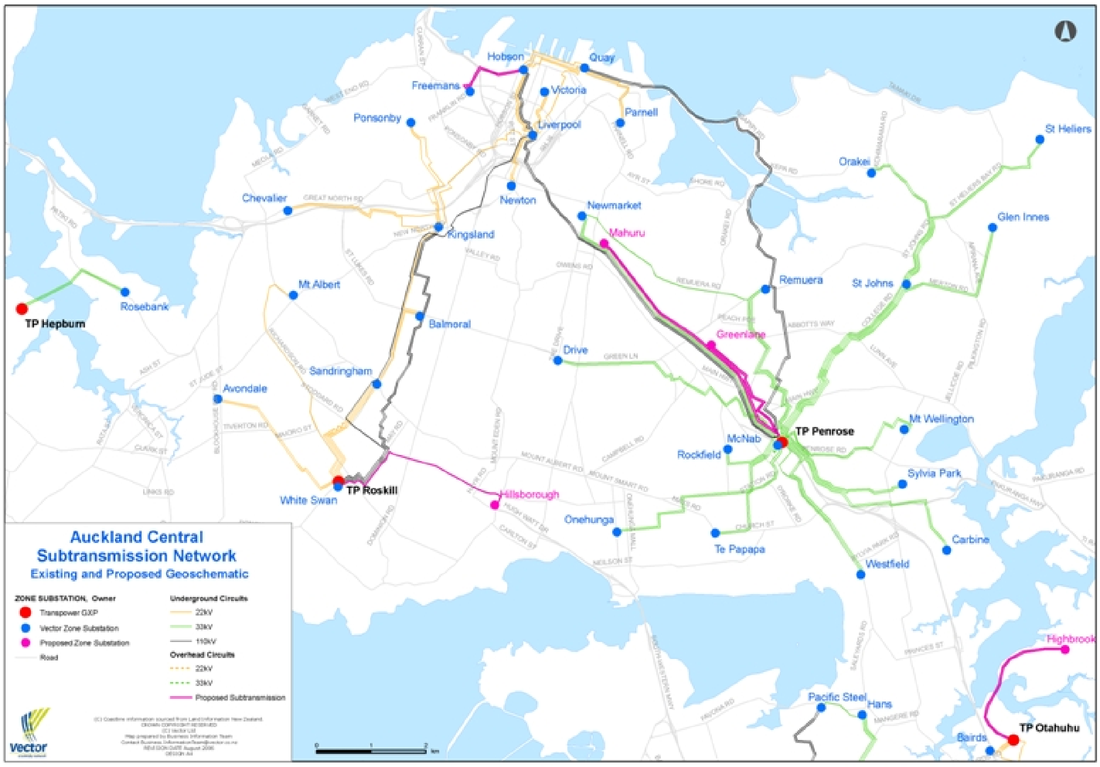



*Figure 4.8 Proposed projects in Auckland*

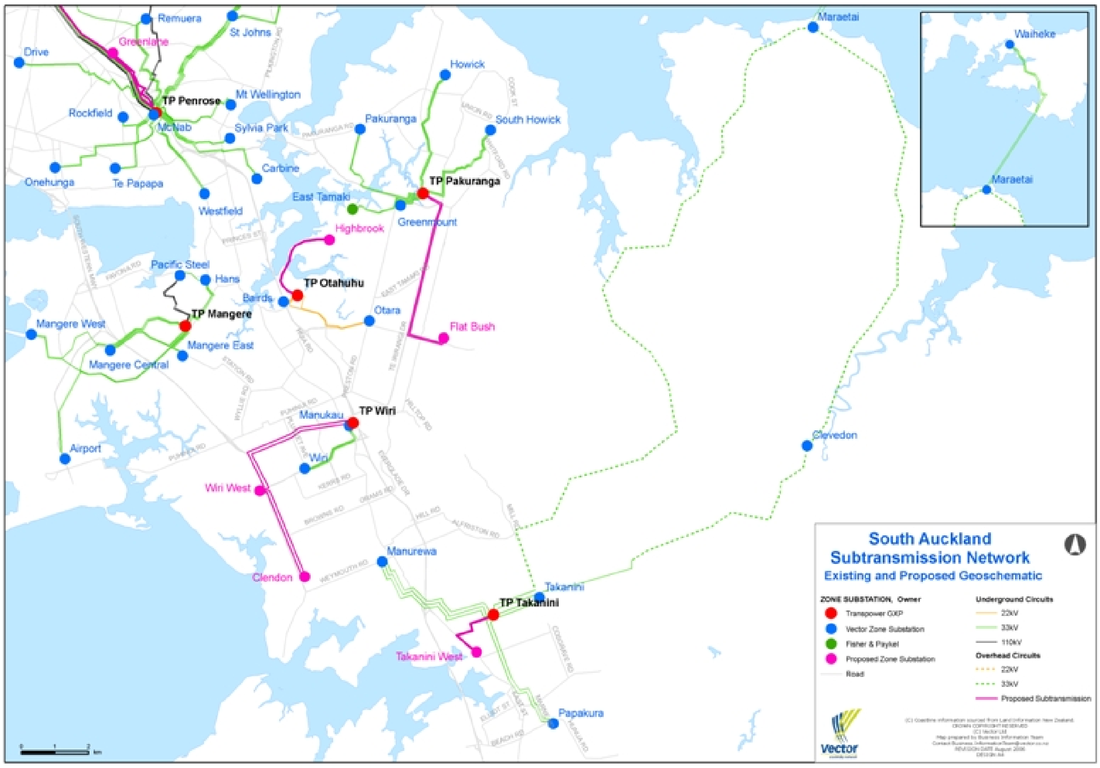



*Figure 4.9 Proposed projects in South Auckland*

### 4.4.2. ISSUES AND OPTIONS IN THE AUCKLAND AREA

Projects currently under way or planned to start in the Auckland region

#### A1: East Tamaki (Highbrook Area)

| | | |
|---|---|---|
| *Project* | *Highbrook Industrial subdivision Stage 2 & 3a* | |
| *Driver* | *Growth* | |
| *Timescale* | *2007* | |
| *Status* | *Committed* | *Estimated capital $1-5 million* |

Development at Highbrook is well underway. The planned saturation load is 25MVA (as required by the property developer). The initial load is supplied via two 22kV rated overhead lines connected to Otahuhu GXP 22kV switchboard.

A 22kV switchboard (effectively a 22kV zone substation) will be established at Highbrook. This 22kV switchboard will be supplied by two new 22kV cables laid from Otahuhu grid exit point providing an N-1 capacity of 25MVA and six 22kV open ring feeders are planned. The 22kV cables will be commissioned in the current year along with the Stage 2 of the development. The last stage of the development, Stage 3, is scheduled for reticulation this financial year

#### A2: Auckland CBD

| | | |
|---|---|---|
| *Project* | *Auckland CBD 11kV to 22kV load transfer* | |
| *Driver* | *Growth* | |
| *Timescale* | *On-going* | |
| *Status* | *Committed* | *Estimated capital $1-5 million* |

Following the completion of the 22kV backbone distribution network, load will be transferred from the existing 11kV network to the new 22kV network. This project will relieve the heavily loaded 11kV network and maintain the supply capacity and security in the Auckland CBD.

#### A3: Remuera Area

| | | |
|---|---|---|
| *Project* | *Remuera 11kV reinforcement* | |
| *Driver* | *Growth* | |
| *Timescale* | *2007* | |
| *Status* | *Committed* | *Estimated capital $1-5 million* |

This project is to install two new 11kV feeders to reinforce the existing network in Remuera. The completion of the project will relieve heavily loaded feeders from Remuera zone substation.

## A4: Auckland CBD

| | | |
|---|---|---|
| *Project* | *Fanshawe Street 22kV distribution network* | |
| *Driver* | *Growth* | |
| *Timescale* | *2007* | |
| *Status* | *Committed* | *Estimated capital $1-5 million* |

This project is required to meet the long term development at Auckland city's north-western area around Fanshawe Street and the Tank Farm. It is proposed to install two 22kV feeders from Hobson zone substation along Fanshawe Street to the Air NZ building.

## A5: Te Papapa Area

| | | |
|---|---|---|
| *Project* | *Te Papapa area 11kV reinforcement* | |
| *Driver* | *Growth* | |
| *Timescale* | *2007* | |
| *Status* | *Proposed* | *Estimated capital $1- 5 million* |

Load growth has caused a security shortfall in the Te Papapa area. This project proposes a new 33kV circuit, initially operated at 11kV, to reinforce the network, as part of the long term plan to reinforce Onehunga substation.

## A6: Ponsonby and Chevalier Areas

| | | |
|---|---|---|
| *Project* | *Upgrade Ponsonby and Pt Chevalier substations to 11kV* | |
| *Driver* | *Growth* | |
| *Timescale* | *2008* | |
| *Status* | *Committed* | *Estimated capital >5 million* |

Ponsonby and Pt Chevalier substations are currently the last substations operating at 6.6kV within Vector's networks. Marginal load increases have pushed a number of 6.6kV feeders above their security limits. Uprating the network voltage from 6.6kV to 11kV is a cost effective solution, particularly as it increases the capacity of the existing network and offers enhanced security through interconnection with adjacent 11kV network.

A new 22/11kV transformer is required for Pt Chevalier along with replacement dual rated 11/6.6kV/400V transformers in the Pt Chevalier area. The existing Ponsonby transformers are already dual rated.

## A7: Warkworth Area

| | | |
|---|---|---|
| *Project* | *Install ex-Coatesville transformer at Warkworth* | |
| *Driver* | *Growth* | |
| *Timescale* | *2007* | |
| *Status* | *Committed* | *Estimated capital $1-5 million* |

To address capacity constraints at Warkworth substation, it is proposed to install the spare transformer from Coatesville substation in Warkworth. Warkworth substation will then have 3x7.5MVA transformers to supply a load of around 15MVA. This project will include provision for additional 33kV circuits on the 33kV bus to allow for future load growth. This project is expected to be commissioned in June 2007.

### A8: Henderson Area

| | | |
|---|---|---|
| *Project* | *Reconfigure the 33kV network in the Henderson area* | |
| *Driver* | *Growth* | |
| *Timescale* | *2007* | |
| *Status* | *Committed* | *Estimated capital $1-5 million* |

The presence of a number of tee off and spur line arrangements on the 33kV network in the area has resulted in performance and loading issues. It is proposed to address these issues by reconfiguring the 33kV network at Waikaukau substation and replacing the protection relays. This is an intermediate solution to improve some of the loading constraints and allows time for future 33kV reinforcements to be investigated fully. This project is expected to be commissioned in late 2007.

### A9: Silverdale Area

| | | |
|---|---|---|
| *Project* | *Establish Red Beach zone substation* | |
| *Driver* | *Growth* | |
| *Timescale* | *2007* | |
| *Status* | *Committed* | *Estimated capital >$5 million* |

Demand is expected to grow with the extension of the northern motorway towards Silverdale/Orewa. A new zone substation at Red Beach is under construction. Both Spur Rd and Manly substations are very heavily loaded and require offloading.

Red Beach substation will enable Manly and Spur Rd substations to be offloaded and reinforce supply to the Red Beach area. It also allows capacity to supply the initial stages of the Silverdale North development until a new substation is constructed for this development in about 5-7 years time.

This project was delayed due to issues around the designation over the site and is now expected to be commissioned in September 2007.

### A10: Glen Eden Area

| | | |
|---|---|---|
| *Project* | *Establish Oratia zone substation* | |
| *Driver* | *Growth* | |
| *Timescale* | *2007* | |
| *Status* | *Committed* | *Estimated capital >$5 million* |

Steady load increases on Waikaukau substation has flagged the need for additional network capacity in the region. Waikaukau substation has a single 7.5MVA transformer which is fully loaded. A new substation is to be established at Oratia allowing Waikaukau to be offloaded, providing backstop support to surrounding substations (Henderson Valley and Laingholm) and capacity provision for future load growth. It also makes provision for a new 11kV feeder to supply the area to the west of the substation e.g. Piha. This project is expected to be commissioned in late 2007.

### A11: Albany Basin

| | | |
|---|---|---|
| *Project* | *Extend the 11kV switchboard and install a second 33/11kV transformer at Mckinnon substation* | |
| *Driver* | *Growth* | |
| *Timescale* | *2007* | |
| *Status* | *Committed* | *Estimated capital $1-5 million* |

Development in the Albany Basin requires additional 11kV feeder support from McKinnon substation. Additional switchgear and another 33/11kV transformer are required at Mckinnon substation. The 11kV switchgear has been commissioned and the commissioning of the new transformer should be completed by September 2007.

The area surrounding Mckinnon substation is largely vacant and has potential for significant load growth. Several projects are underway, such as a new Westfield shopping centre, making this reinforcement important to be able to supply the new loads.

### A12: Albany Basin Area

| | | |
|---|---|---|
| *Project* | *Install an additional 33kV cable to McKinnon substation* | |
| *Driver* | *Growth* | |
| *Timescale* | *2007* | |
| *Status* | *Committed* | *Estimated capital $1-5 million* |

As the load on Mckinnon substation continues to grow, reinforcement of the Browns Bay 33kV ring network is required to maintain supply security. Options considered include:

- Installation of a 33kV cable from the Albany grid exit point to McKinnon substation
- Installation of a 33kV cable from the Albany grid exit point to Browns Bay substation

Load flow analysis shows that a higher level of security will result from installing two 33kV cables to Mckinnon substation. As the existing 33kV cable has insufficient capacity for the projected loads due to derating from adjacent cables, this project has been brought forward to 2007. This project is being undertaken concurrently with the project described in A11 above.

### A13: Takapuna Area

| | | |
|---|---|---|
| *Project* | *Install an additional 33kV cable to Takapuna substation* | |
| *Driver* | *Growth* | |
| *Timescale* | *2007* | |
| *Status* | *Committed* | *Estimated capital <$1 million* |

The load on the Takapuna 33kV ring continues to increase. To maintain supply security to the network in this area, 33kV reinforcement is required. The backstopping for this substation is from the Belmont 33kV circuits which are overhead lines. Because of load sharing, the loss of the one of the Belmont circuits causes the Takapuna circuit to overload.

### A14: Glenfield/Birkdale Area

| | | |
|---|---|---|
| *Project* | *33kV cable reinforcement to the Glenfield/Birkdale area* | |
| *Driver* | *Growth* | |
| *Timescale* | *2007* | |
| *Status* | *Committed* | *Estimated capital <$1 million* |

The 33kV network is running out of capacity under contingency conditions. This reinforcement project is required to maintain security of supply to the network. Options investigated include installing an additional 33kV circuit from Wairau or making minor alterations to the existing 33kV network and making provision for additional 11kV backstopping to the area.

### A15: Quay St, Auckland CBD

| | | |
|---|---|---|
| *Project* | *Replace cables in Quay St, Auckland CBD* | |
| *Driver* | *Replacement* | |
| *Timescale* | *2008* | |
| *Status* | *Proposed* | *Estimated capital >$5 million* |

This project is to replace existing 22kV cables installed in Quay St. Provision will also be made for subtransmission cables between Hobson St and Quay St as part of the long term development of the network in the CBD, and to replace the Penrose/Quay 110kV cables that have been identified for retirement.

### A16: St Johns Area

| | | |
|---|---|---|
| *Project* | *Establish St John zone substation* | |
| *Driver* | *Growth* | |
| *Timescale* | *2008* | |
| *Status* | *Committed* | *Estimated capital >$5 million* |

St Johns substation is currently a 33kV switching station. Development of the Mt Wellington Quarry and growth surrounding the Auckland University's Glen Innes campus has confirmed the need for additional network capacity in this area.

The establishment of St Johns zone substation is a cost effective solution which will provide the capacity and security to meet the long term growth.

### A17: Coatesville Area

| | | |
|---|---|---|
| *Project* | *Install 33kV switchgear at Coatesville substation* | |
| *Driver* | *Growth* | |
| *Timescale* | *2008* | |
| *Status* | *Committed* | *Estimated capital $1-5 million* |

The 33kV supply to Coatesville substation is from Albany GXP. Load projections show that the 33kV cable from Albany will overload under certain contingency conditions. To remove this constraint from the network, it is proposed to install new 33kV switchgear at Coatesville substation and re-arrange the 33kV network. This will enhance the security of the 33kV network in this area.

### A18: North Shore Area

| | | |
|---|---|---|
| *Project* | *Install 33kV cable and a 2$^{nd}$ Transformer to Forrest Hill substation* | |
| *Driver* | *Growth* | |
| *Timescale* | *2008* | |
| *Status* | *Committed* | *Estimated capital >$5 million* |

The load at Forrest Hill substation has exceeded the ONAN rating of the transformer and reinforcement is required. The additional capacity at this substation will allow offloading of adjacent substations, in particular Wairau substation which is heavily loaded. It will also provide adequate 11kV backstopping for Milford substation.

The load on the Wairau 33kV supply point is operating at its n-1 capacity. It is possible to reinforce the supply to this substation by constructing a new 110kV circuit from Albany. However, this reinforcement will not be required if the substation is reinforced at 220kV as proposed as part of the Cross Isthmus upgrade in conjunction with Transpower.

The installation of a 33kV cable from Sunset Road to Forest Hill and reconfiguration of the 33kV network will allow load to be transferred from Wairau substation to Albany forestalling upgrades of Wairau in anticipation of the 220kV upgrade

### A19: Warkworth Area

| | | |
|---|---|---|
| *Project* | *Reinforce the Warkworth 33kV circuits* | |
| *Driver* | *Growth* | |
| *Timescale* | *2008* | |
| *Status* | *Proposed* | *Estimated capital $1-5 million* |

Load on the existing two 33kV lines supplying Warkworth are approaching their capacity limit and reinforcement is required.

Options considered include:

- Reinforcing the existing 33kV lines
- Establishing a new 33kV line

The preferred option is to upgrade an existing 11kV line so it can operate at 33kV. This will provide three 33kV lines to reinforce Warkworth and also allow for future substations at Tomarata, Omaha, Sandspit and Warkworth Central.

The Warkworth area continues to grow with several major subdivisions being proposed in various parts of the network. To supply this load growth, additional zone substations will be required. Timing is dependent on when the developments occur. However, because of the time required to implement this project, it needs to proceed as soon as possible.

### A20: New Lynn Area

| | | |
|---|---|---|
| *Project* | *Increase 33kV capacity at Sabulite & New Lynn substations* | |
| *Driver* | *Growth* | |
| *Timescale* | *2008* | |
| *Status* | *Committed* | *Estimated capital >$5 million* |

New Lynn substation is supplied at 33kV from Transpower Hepburn Rd Substation and also from Sabulite substation. Network reinforcement of the New Lynn area is necessary to maintain supply security. Although a number of 11kV options were considered the preferred option is to reinforce the 33kV ring by adding an extra 33kV cable between Hepburn Rd and Sabulite Rd substations and also between Sabulite Rd and New Lynn zone substations.

### A21: Greenhithe Area

| | | |
|---|---|---|
| *Project* | *Establish Greenhithe zone substation* | |
| *Driver* | *Growth* | |
| *Timescale* | *2008* | |
| *Status* | *Committed* | *Estimated capital >$5 million* |

The Greenhithe area is largely rural but this is rapidly changing as new motorways are developed through the area. This area is supplied by long 11kV feeders from remote zone substations which are very heavily loaded and require reinforcement. Extending the 11kV network does not provide sufficient security of supply or an economic solution to the issue. It is proposed to establish a new zone substation on an existing site to supply the load to this developing area.

### A22: Whangaparaoa Area

| | | |
|---|---|---|
| *Project* | *Establish Gulf Harbour zone substation* | |
| *Driver* | *Growth* | |
| *Timescale* | *2008* | |
| *Status* | *Committed* | *Estimated capital >$5 million* |

Demand on the Whangaparaoa Peninsula has been growing steadily and due to its geographic layout, backup supplies are limited. Over recent years, incremental capacity enhancements such as the dual rating of zone substation transformers have been implemented to defer major reinforcement.

Additional 33kV and 11kV capacity is now required to maintain the level of security. A new zone substation is to be established at Gulf Harbour, utilising the 33kV cable recently laid from Manly zone substation to the Gulf Harbour zone substation site.

### A23: Greenhithe/Hobsonville Area

| | | |
|---|---|---|
| *Project* | *Install a 33kV cable between Greenhithe and Hobsonville* | |
| *Driver* | *Growth* | |
| *Timescale* | *2008* | |
| *Status* | *Committed* | *Estimated capital $1-5 million* |

The area between the proposed Greenhithe substation and Hobsonville substation is growing and is expected to develop considerably over the next few years. This is a result of the new motorway construction and land being made available for development. It is planned to install a new 33kV circuit between Greenhithe substation and Hobsonville substation. This circuit will provide a 33kV backstop to the new Greenhithe substation described in A21 above. It will provide interconnection between the Albany and Henderson GXPs and provide more flexibility in supplying the network.

### Projects planned for years 2009-2012

### A24: Auckland CBD

| | | |
|---|---|---|
| *Project* | *Install a 110kV switchboard and a 110/22kV transformer at Hobson Substation* | |
| *Driver* | *Growth* | |
| *Timescale* | *2009* | |
| *Status* | *Proposed* | *Estimated capital >$5 million* |

Additional 22kV capacity is required at Hobson substation by 2008. Freemans Bay substation is now supplied from Hobson and with the pending retirement of the Penrose Quay cables, Quay substation load will also be supplied from this substation. It is proposed to install a third 110/22kV transformer together with a new 110kV switchboard.

Establishing an 110kV switchboard at Hobson mitigates the risk of supply failure at Liverpool.

### A25: Manukau - Flat Bush Area

| | | |
|---|---|---|
| *Project* | *Establishment Flat Bush zone substation* | |
| *Driver* | *Growth* | |
| *Timescale* | *2009* | |
| *Status* | *Proposed* | *Estimated capital >$5 million* |

The emerging Flat Bush township with city centre and high density multi-storey residential has a planned population of 40,000. The demand is conservatively estimated in excess of 30MVA and will require a new zone substation (Flat Bush zone substation).

Several 11kV feeder reinforcement projects have been completed, to free up capacity to meet the short term load requirements. The option of establishing a new zone substation close to the emerging load centre is the preferred long term solution mainly due to the large load that on its own justifies a dedicated zone substation and the placement of the new zone substation as close as possible to the middle of the load centre to optimise 11kV cable requirements.

### A26: Roscommon Manurewa Area

| | | |
|---|---|---|
| *Project* | *Establish Clendon zone substation* | |
| *Driver* | *Growth* | |
| *Timescale* | *2009* | |
| *Status* | *Committed* | *Estimated capital >$5 million* |

Clendon substation is required to offload the heavily loaded Manurewa substation and will also be used to relieve Wiri zone substation.

The designated Vector substation site near the corner of Roscommon and Wordsworth Roads will be used. Clendon substation will consist of two 20MVA transformers and the target commissioning is before winter 2009. Clendon will be supplied at 33kV from Wiri GXP. Large size 33kV cabling will be installed allowing a possible future 33kV Wiri West and Clendon ring network.

Vector is installing ducts for two 33kV feeders to supply Clendon in conjunction with two major roading projects (Cavendish Drive upgrade and SH20 extension). This coordination minimises the construction impact of cabling the 33kV from Wiri GXP through to Clendon.

### A27: Ellerslie Area

| | | |
|---|---|---|
| *Project* | *Establish Ellerslie zone substation* | |
| *Driver* | *Growth* | |
| *Timescale* | *2009* | |
| *Status* | *Proposed* | *Estimated capital >$5 million* |

Commercial development on Ellerslie Racecourse land coupled with general load growth in the Greenlane area, has identified the need for increased network capacity. A new zone substation is proposed for this area. Based on load growth forecasts the alternative option of 11kV network reinforcement from the adjoining substation is not a viable long term solution.

### A28: Hillsborough Area

| | | |
|---|---|---|
| *Project* | *Establish Hillsborough zone substation* | |
| *Driver* | *Growth* | |
| *Timescale* | *2009* | |
| *Status* | *Committed* | *Estimated capital >$5 million* |

Steady load growth in the Hillsborough area over the last eight years has been accommodated by reinforcement projects on the distribution network. These reinforcements redistribute existing network capacity without generating new capacity. The next stage is to either upgrade Onehunga substation and reinforce the 11kV network in the surrounding area or establish a new zone substation at Hillsborough. The Hillsborough zone substation offers the most economic long term option. This substation was to be commissioned by the end of 2008. However, it has been delayed to 2009 due to Transit's SH 20 project.

### A29: Newmarket Area

| | | |
|---|---|---|
| *Project* | *Establish Mahuru substation* | |
| *Driver* | *Growth* | |
| *Timescale* | *2010* | |
| *Status* | *Proposed* | *Estimated capital >$5 million* |

To meet projected growth arising from forthcoming commercial developments in Newmarket, it is necessary to establish a new zone substation.

Expansion of the existing Newmarket zone substation is not an option.

### A30: Hans Area (Mangere Station)

| | | |
|---|---|---|
| *Project* | *Install a 3rd 33/11kV transformer at Hans substation* | |
| *Driver* | *Growth* | |
| *Timescale* | *2010* | |
| *Status* | *Proposed* | *Estimated capital $1- 5 million* |

There are two 33/11kV 20MVA transformers installed at this substation. Additional capacity will be required to supply the Savill Drive industrial subdivision. Options for reinforcement include a third 33/11kV transformer at Hans substation or a new substation closer to the load centre. The option of a 3rd transformer at Hans is the preferred option. Short term relief can be achieved by transferring load onto Mangere East and Bairds zone substations.

### A31: Takanini/Papakura Area

| | | |
|---|---|---|
| *Project* | *Establish Takanini West zone substation* | |
| *Driver* | *Growth* | |
| *Timescale* | *2010* | |
| *Status* | *Proposed* | *Estimated capital >$5 million* |

This new substation is planned in 2010 to offload the heavily loaded Takanini and Manurewa zone substations. The substation will also provide backstopping to Manurewa, Takanini and Papakura 11kV networks and cater for approximately 6MVA of potential new load growth on the Western side of Porchester Road fringing Great South Road and the railway line.

Vector has initiated the process to purchase a suitable site located close to the Fonterra factory in Great South Road, Takanini. Takanini West substation will off-load Takanini, Manurewa and Papakura zone substations.

### A32: Freemans Bay Area

| | | |
|---|---|---|
| *Project* | *Extend the 22kV distribution network to Freemans Bay* | |
| *Driver* | *Growth* | |
| *Timescale* | *2010* | |
| *Status* | *Proposed* | *Estimated capital $1-5 million* |

As part of the 11kV to 22kV upgrade in the Auckland CBD, it is proposed to extend this conversion to the commercial area of Freemans Bay (Tank Farm). The project involves the installation of 22kV cables and switchgear, and transferring load from the 11kV to 22kV network. The 22kV upgrade will increase the network capacity and provides a sound footing for long term growth in this area.

### A33: Mangere South Area

| | | |
|---|---|---|
| *Project* | *Install a 3rd transformer at Mangere substation* | |
| *Driver* | *Growth* | |
| *Timescale* | *2011* | |
| *Status* | *Proposed* | *Estimated capital >$1- 5 million* |

There were three 33/11kV 20MVA transformers installed at this substation. One of these transformers has been relocated to Manukau substation. Substantial Industrial development potential exists to the north of Auckland International Airport. The plan is to reinstate the third transformer by 2011 to supply this new load.

### A34: Auckland CBD

| | | |
|---|---|---|
| *Project* | *Install a 22kV switchboard at Victoria substation* | |
| *Driver* | *Growth* | |
| *Timescale* | *2011* | |
| *Status* | *Proposed* | *Estimated capital $1-5 million* |

A 22kV switchboard is to be established at Victoria substation to enable interconnection of 22kV circuits as part of the rollout of the 22kV network in the Auckland CBD. The switchboard will serve as a marshalling point for the 22kV distribution network in the area. This is part of the overall plan to reticulate the CBD at 22kV.

### A35: Auckland CBD

| | | |
|---|---|---|
| *Project* | *Establish Hobson West substation* | |
| *Driver* | *Growth* | |
| *Timescale* | *2012* | |
| *Status* | *Proposed* | *Estimated capital $1-5 million* |

A 22kV switchboard is to be established at Hobson West substation to enable interconnection of 22kV circuits as part of the rollout of the 22kV network in the Auckland CBD. This is part of the overall plan to reticulate the CBD at 22kV

### A36: Westgate Area

| | | |
|---|---|---|
| *Project* | *Establish Massey North zone substation* | |
| *Driver* | *Growth* | |
| *Timescale* | *2009* | |
| *Status* | *Proposed* | *Estimated capital >$5 million* |

Load growth north of Triangle Rd substation and to the north and east of the Westgate shopping centre has signalled the need for additional capacity in this area. Triangle Rd substation is fully loaded and the site is not large enough to redevelop and continue to supply the area. A new zone substation in the Westgate area allows Triangle Rd substation to be offloaded and will cater for the forecast load growth.

#### A37: Titirangi Area

| | | |
|---|---|---|
| *Project* | *Establish Titirangi zone substation* | |
| *Driver* | *Growth* | |
| *Timescale* | *2009* | |
| *Status* | *Proposed* | *Estimated capital >$5 million* |

The Titirangi area is currently supplied from Laingholm and Atkinson Rd substations. Atkinson Rd substation is very heavily loaded and requires reinforcement. Options included replacing the existing transformers at Atkinson Rd with larger units. However, the benefits of establishing a new substation at Titirangi outweigh the alternative options.

#### A38: Glenvar Area

| | | |
|---|---|---|
| *Project* | *Establish Glenvar zone substation* | |
| *Driver* | *Growth* | |
| *Timescale* | *2009* | |
| *Status* | *Proposed* | *Estimated capital >$5 million* |

The area around Long Bay is being developed into residential subdivisions over the next few years. The existing substation at Torbay does not have enough capacity to supply these new subdivisions. Options included installing additional capacity at Torbay substation. However, this substation is supplied by a spur cable and security of supply would become an issue. The alternative being proposed is to construct a new substation in Glenvar Rd. This new substation will supply part of the new subdivisions, but also reinforce other parts of the network, notably Browns Bay substation and also Spur Rd substation. A 33kV ring will be created as part of this project to provide alternative feeds into the area.

#### A39: Kaukapakapa Area

| | | |
|---|---|---|
| *Project* | *Establish Kaukapakapa zone substation* | |
| *Driver* | *Growth* | |
| *Timescale* | *2009* | |
| *Status* | *Proposed* | *Estimated capital $1-5 million* |

The load on the Helensville 11kV feeder to Kaukapakapa continues to show steady increase and is approaching its full load capacity. The 11kV feeder is very long and has poor reliability. This project is to resolve the loading on this long rural feeder by establishing a new zone substation at Kaukapakapa. The substation will provide capacity to offset the load increases, allow offloading of Helensville substation, partition the 11kV feeder to improve its performance statistics and backstop the adjacent zone substations.

### A40: Swanson Area

| | | |
|---|---|---|
| *Project* | *Establish Waitakere zone substation* | |
| *Driver* | *Growth* | |
| *Timescale* | *2009* | |
| *Status* | *Proposed* | *Estimated capital >$5 million* |

The Swanson area continues to develop and the Swanson zone substation is approaching full capacity. This substation has several very long rural feeders with poor reliability. A new zone substation at Waitakere will offload Swanson substation and allow for ongoing growth in this area. The new substation will allow some of the long 11kV feeders to be shortened, improving network performance.

Once completed, it is planned to extend the 33kV line from this substation to Waimauku, providing sub-transmission security to both substations.

### A41: Ranui Area

| | | |
|---|---|---|
| *Project* | *Establish Ranui zone substation* | |
| *Driver* | *Growth* | |
| *Timescale* | *2009* | |
| *Status* | *Proposed* | *Estimated capital >$5 million* |

The Swanson area continues to develop and the Swanson zone substation is approaching full capacity. In addition the load continues to grow in the Ranui area which is currently supplied from Triangle Rd substation. A new zone substation will shorten up the 11kV feeders offload adjacent substations at Swanson, Triangle Rd, Simpson Rd and Woodford substations.

### A42: Rosedale Rd Area

| | | |
|---|---|---|
| *Project* | *Establish Rosedale zone substation* | |
| *Driver* | *Growth* | |
| *Timescale* | *2010* | |
| *Status* | *Proposed* | *Estimated capital >$5 million* |

Significant development is taking place in new industrial subdivisions located in the Rosedale area. A new zone substation in the vicinity of Old Rosedale Rd is proposed to share the load increase in the Albany basin that would otherwise be fed from Mckinnon substation and enhance the network capacity in the Rosedale area. The new substation also allows a higher level of backstopping to local feeders

Options considered included:

- Installation of a second transformer at East Coast Road substation
- Establishment of a new substation in Rosedale Rd

Analysis has shown that the establishment of a new zone substation in Rosedale Road is the most cost effective long term option.

### A43: Henderson Area

| | | |
|---|---|---|
| *Project* | *Install 2nd transformer at Keeling Rd substation* | |
| *Driver* | *Growth* | |
| *Timescale* | *2010* | |
| *Status* | *Proposed* | *Estimated capital $1-5 million* |

The load on Keeling Rd substation continues to increase with commercial development in the Henderson area. This substation was commissioned in 2003 with one transformer but with provision for a second transformer once the load grew. Henderson Valley substation is still quite heavily loaded and reinforcement from Keeling Rd is the obvious solution.

### A44: Snells Beach Area

| | | |
|---|---|---|
| *Project* | *Establish Sandspit Rd zone substation* | |
| *Driver* | *Growth* | |
| *Timescale* | *2010* | |
| *Status* | *Proposed* | *Estimated capital $1-5 million* |

Snells Beach load continues to grow as land is made available for subdivision. Snells Beach is supplied by a single 33kV line from Warkworth substation (see A19 above). Due to its remoteness, backstopping Snells Beach substation at 11kV is limited. It is proposed to install a substation in the Sandspit area. The two substations will then provide mutual backstopping.

### A45: Waimauku Area

| | | |
|---|---|---|
| *Project* | *Install a 2nd transformer and construct a new 33kV line to Waimauku zone substation* | |
| *Driver* | *Growth* | |
| *Timescale* | *2010* | |
| *Status* | *Proposed* | *Estimated capital $1-5 million* |

The area around Waimauku substation is growing with plans for an additional 6000 people. To enable supply to this population growth, it is planned to install a second transformer at this substation. To maintain security of supply to the substation, it is also planned to construct a new 33kV line from the new Waitakere substation (A40) to Waimauku.

### A46: Warkworth Area

| | | |
|---|---|---|
| *Project* | *Establish a southern 33kV ring in the Warkworth area* | |
| *Driver* | *Growth* | |
| *Timescale* | *2010* | |
| *Status* | *Proposed* | *Estimated capital >$5 million* |

To ensure the security of supply is maintained is this area, it is necessary to establish new substations at Sandspit (A44) and Glenmore Rd (A62). Investigations are currently underway looking at possible 33kV line routes.

### A47: Henderson Area

| | | |
|---|---|---|
| *Project* | *Reinforce 33kV lines and install 2nd transformer at Keeling Road and Woodford substations* | |
| *Driver* | *Growth* | |
| *Timescale* | *2010* | |
| *Status* | *Proposed* | *Estimated capital >$5 million* |

To ensure the security of supply is maintained is this area, it is necessary to reinforce both the Keeling Rd substation and the Woodford substation with second transformers. To improve the network security, a 33kV tie line between the Woodford and Keeling Road substations is proposed as well as an interconnection with Hepburn GXP. Currently these substations are supplied by single circuit 33kV radial lines. The new configuration will create a 33kV ring from Hepburn Rd.

### A48: Highbury Area

| | | |
|---|---|---|
| *Project* | *Install a 2nd transformer at Highbury substation* | |
| *Driver* | *Growth* | |
| *Timescale* | *2012* | |
| *Status* | *Proposed* | *Estimated capital <$1 million* |

Load forecasts for the Highbury area indicate that additional transformer capacity will be required to maintain the security of supply to this area. After looking at various reinforcement options, it has been decided that a second transformer at Highbury is the most cost effective option.

**Projects planned for years 2013-2017**

| No | Project Description | Year | Cost |
|---|---|---|---|
| A49 | Install a 3rd transformer for South Howick substation | 2013 | $1-5m |
| A50 | Reinforce 33kV capacity to St Johns substation | 2014 | >$5m |
| A51 | Reinforce 33kV capacity to Onehunga substation | 2015 | >$5m |
| A52 | Install a 3rd transformer at Otara substation | 2016 | $1-5m |
| A53 | Establish Wiri West zone substation | 2017 | $1-5m |
| A54 | Install a 3rd transformer at Bairds substation | 2017 | $1-5m |
| A55 | Establish Tomarata zone substation | 2011 | $1-5m |
| A56 | Reinforce 33kV capacity to Manly substation | 2011 | >$5m |
| A57 | Reinforce 33kV capacity to Orewa substation | 2012 | >$5m |
| A58 | Establish Wainui zone substation | 2012 | >$5m |
| A59 | Reinforce the 33kV to Northcote substation | 2013 | $1-5m |
| A60 | Install a 2rd transformer at Simpson zone substation | 2013 | $1-5m |
| A61 | Establish Hobsonville East zone substation | 2014 | >$5m |
| A62 | Establish Waiwera zone substation | 2014 | >$5m |
| A63 | Establish Warkworth West (Glenmore Rd) zone substation | 2016 | >$5m |
| A64 | Upgrade Albany zone substation | 2017 | >$5m |

*Table 4.4 Auckland projects planned for years 2013-2017*

# 4.5. WELLINGTON AREA

## 4.5.1. GROWTH IN THE WELLINGTON AREA

The Wellington region 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 contains a number of Government departments.

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

Overall demand growth in the region is expected to be low with most of the growth expected to take place within the Wellington CBD. Residential load is increasing in Churton Park, Woodridge subdivision, Whitby and the Aotea Block, Porirua.

The following maps show the existing and proposed network for the Wellington region.

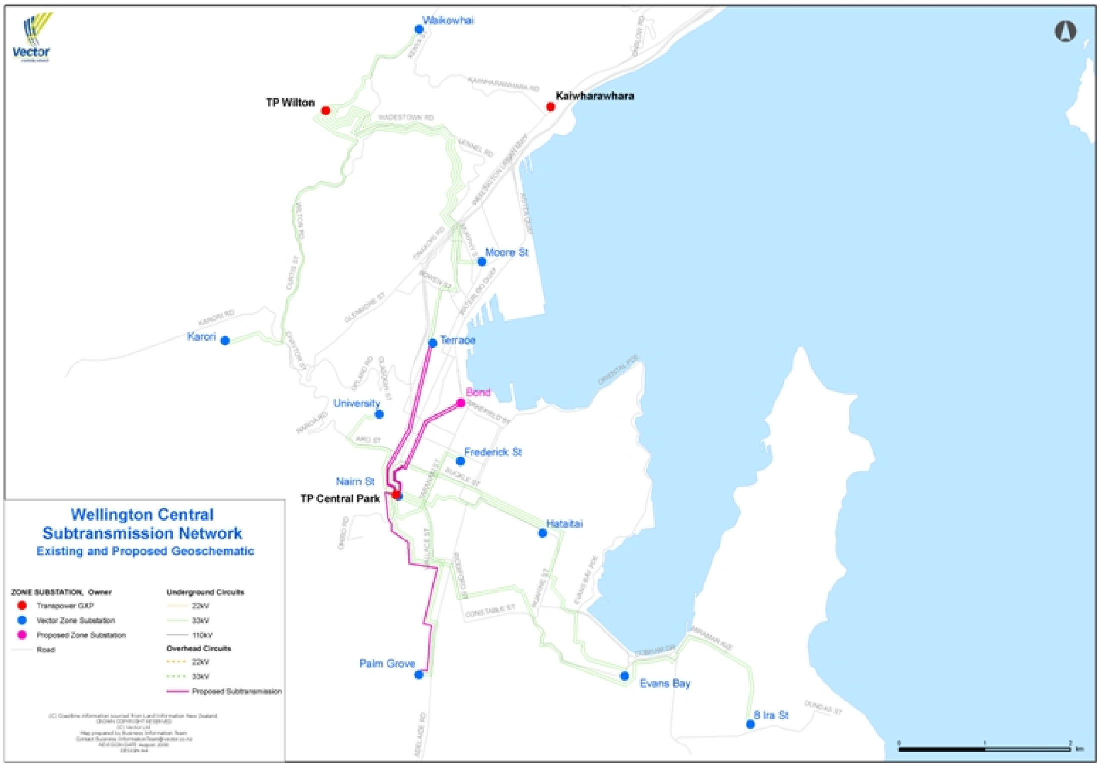



*Figure 4.10 Proposed projects in Wellington City*

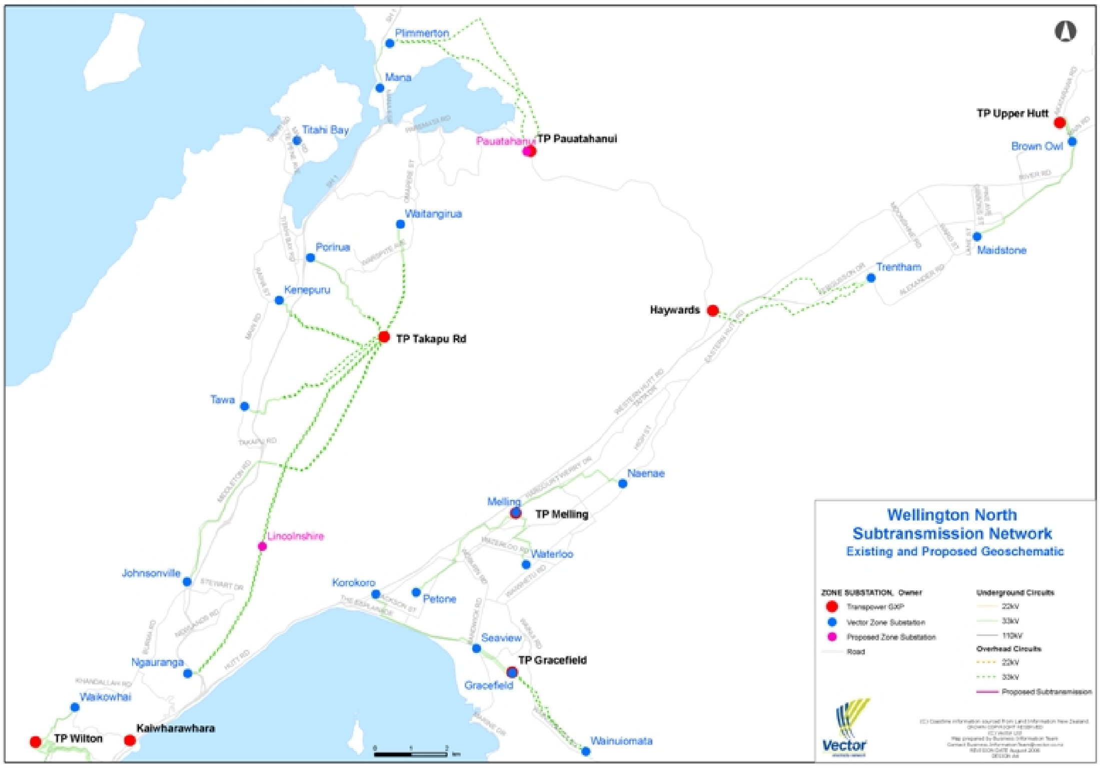



*Figure 4.11 Proposed projects in the Greater Wellington Area*

### 4.5.2. ISSUES AND OPTIONS IN THE WELLINGTON AREA

Projects currently underway or expected to start in the next 12 months

**Projects planned for years 2009-2012**

**W1: Wellington CBD**

| | | |
|---|---|---|
| *Project* | *Frederick Zone Substation (Te Aro) 11kV network reinforcement* | |
| *Driver* | *Growth* | |
| *Timescale* | *2008* | |
| *Status* | *Proposed* | *Estimated capital $1-5 million* |

Due to the load growth of Te Aro, reinforcement of the 11kV network supplying this area is required to maintain security. Two new 11kV feeders will be installed from Nairn St substation and the network configured to transfer 12MVA of Frederick St substation load to Nairn St. This will defer the 33kV upgrade to Frederick St substation and the establishment of Bond zone substation. Non network options were considered, but were not able to provide a satisfactory solution.

**W2: Wellington CBD**

| | | |
|---|---|---|
| *Project* | *Reinforcement of the 33kV capacity to Terrace & Moore Zone substations* | |
| *Driver* | *Growth* | |
| *Timescale* | *2008* | |
| *Status* | *Proposed* | *Estimated capital >$5 million* |

The ratings of existing 33kV cables to Terrace and Moore St substations are less than the zone substation transformer capacity. To gain full capacity from the transformers the two existing 33kV cables to each zone substation will be run in parallel to Moore St, and a pair of new 33kV XLPE cables of rating comparable to the transformer installed between Central Park GXP and The Terrace. This will increase the capacity of both substations and mitigate the consequential risk of simultaneous multiple failures of the aging 33kV gas cables.

**W3: Wellington CBD**

| | | |
|---|---|---|
| *Project* | *Reinforcement of the Terrace and Moore 11kV networks* | |
| *Driver* | *Growth* | |
| *Timescale* | *2009* | |
| *Status* | *Proposed* | *Estimated capital $1-5 million* |

Reinforcement of the 11kV network in the Wellington CBD in line with demand growth forecasts in order to maintain supply security.

**W4: Wellington CBD**

| | | |
|---|---|---|
| *Project* | *Reinforcement of the 33kV capacity to Frederick St substation* | |
| *Driver* | *Growth* | |
| *Timescale* | *2011* | |
| *Status* | *Proposed* | *Estimated capital >$5 million* |

The ratings of the 33kV cables to Frederick St are less than that of the zone substation transformer capacity. The two existing cables will be doubled up to supply one transformer, and a third cable will be laid to supply the other.

**W5: Pauatahanui Area**

| | | |
|---|---|---|
| *Project* | *Establish Pauatahanui zone substation* | |
| *Driver* | *Growth* | |
| *Timescale* | *2012* | |
| *Status* | *Proposed* | *Estimated capital >$5 million* |

Demand growth in the Whitby area has grown in recent years. This is currently supplied from Waitangirua. Future development is anticipated in the areas supplied by Mana, Porirua and Waitangirua substations. A new substation is proposed to improve the subtransmission security of this part of the network and improve 11kV backstop support.

**Projects planned for years 2013-2017**

| No | Project Description | Year | Cost |
|---|---|---|---|
| W6 | 33kV reinforcement to Palm Grove substation | 2013 | $1-5m |
| W7 | 33kV reinforcement to Evans Bay substation | 2014 | $1-5m |
| W8 | Establish Bond Street zone substation | 2014 | >$5m |
| W9 | Establish Lincolnshire zone substation | 2014 | >$5m |

*Table 4.5 Wellington projects planned for years 2013-2017*

## 4.6. CHANGES FROM PREVIOUS PLAN

### 4.6.1. AUCKLAND AREA

***Manukau substation***

The project to install the third transformer at this substation has been completed.

***Remuera substation***

The 11kV feeder reinforcement project at this substation has been completed.

***Ellerslie substation***

The substation identified for the Greenlane area has been renamed Ellerslie for clarity. The project as proposed remains unaltered.

***Wiri West substation***

This substation has been deferred until 2017 due to construction of Clendon zone substation.

***Clendon substation***

This is a new project which will offload Manurewa substation.

***Takanini West substation***

This is a new project which will offload Takanini substation.

***Otara substation***

This is a new project to install a third transformer at this substation.

***22kV Distribution Extension***

The project to extend the 22kV distribution from the Auckland CBD to Freemans Bay has been removed from the plan.

***Bush Rd substation***

The new 33kV bus at Bush Rd has been commissioned.

***Gulf Harbour substation***

The 33kV cable from Manly substation to the proposed Gulf Harbour substation has been completed.

***Forrest Hill substation***

The project to reinforce Forrest Hill substation with a new 33kV supply has been upgraded to include a second 33/11kV transformer and additional 11kV feeders.

***Warkworth Southern 33kV Ring***

This project has been initiated to enable a secure supply to the new substations at Sandspit and Warkworth West.

***Ranui substation***

This is a new project to reinforce between Triangle Rd and Swanson substations. It enables several adjacent substations to be offloaded.

***Wairau 110kV Reinforcement***

Wairau Rd 110kV supply reinforcement project have been removed from the list of active projects pending a review of options for this site. This project is intricately linked with Transpower's 220kV Cross-Isthmus project and reinforcement options need to avoid stranding assets and be compatible with the long term 220kV supply to this site. This project will be re-established once the review is completed

***North Harbour substation***

A new substation has been introduced for North Harbour to supply the expected load growth in the area.

***Changes in timing***

Several projects have either been deferred or brought forward to meet amended load forecasts.

### 4.6.2. WELLINGTON AREA

***University substation***

The project to reinforce the 33kV cable to this substation has been completed.

***Frederick St substation***

This is a new project to reinforce the 33kV supply to Frederick St substation.

***Evans Bay substation***

This is a new project to reinforce this substation.

***Lincolnshire substation***

This is a new project to reinforce the network.

## 4.7. TRANSFORMER REDEPLOYMENT

To ensure optimum utilisation of existing assets, transformers removed from substations are relocated to other substations if performance and condition criteria are met and it is economic to do so. These are evaluated on a project by project basis.

## 4.8. TRANSPOWER SUPPLY POINTS

Transpower supplies the Vector network through 22 grid exit points. Transpower and Vector liaise on works programmes to ensure priority and critical issues are addressed. Reference should be made to Transpower's Annual Planning Report (www.transpower.co.nz) for full details of these and other projects proposed in the Auckland and Wellington regions.

### 4.9.1 ISSUES AND OPTIONS AT THE GRID EXIT POINTS

**Central Park Grid Exit Point**

Transpower's upgrade project completed.

**Hepburn Grid Exit Point**

| | |
|---|---|
| *Driver* | *Security of supply* |
| *Timescale* | *2006* |
| *Status* | *Committed* |

The project to install a third 110/33kV transformer at Hepburn has been completed. The GXP now has 2x120MVA and 1x80MVA 110/33kV transformers.

**Albany Grid Exit Point**

| | |
|---|---|
| *Driver* | *Security of supply* |
| *Timescale* | *2006* |
| *Status* | *Committed* |

The third 120MVA 220/33kV transformer has been commissioned at Albany.

**Penrose Grid Exit Point**

| | |
|---|---|
| *Driver* | *Security of supply* |
| *Timescale* | *> 2007* |
| *Status* | *Proposed* |

There are current concerns over the security of the 220kV supply into Penrose. Options to address this issue are currently being investigated by Transpower.

**Silverdale Grid Exit Point**

| | |
|---|---|
| *Driver* | *Security of supply* |
| *Timescale* | *2007* |
| *Status* | *Committed* |

Silverdale GXP was commissioned in 2003. A single 220/33kV 100MVA transformer was installed. Load flow analysis shows that the 33kV backup capacity will be exceeded in 2007. It is proposed to install a second 220/33kV 120MVA transformer to improve the security of supply. This is due for commissioning in late 2007.

**Haywards Grid Exit point**

| | |
|---|---|
| *Driver* | *Security of supply* |
| *Timescale* | *2008* |
| *Status* | *Proposed* |

The existing single 110/33kV transformer and the single 110/11kV transformer do not meet Vector's security criteria. It is proposed to install a 33/11kV transformer to improve the security of supply to both the 33kV and 11kV buses.

## 4.9. COMMUNICATION NETWORK

Vector's communication network provides a communication path for various applications and operational services such as:

- Protection signalling
- Automation
- SCADA
- Metering and load control
- Remote equipment monitoring and maintenance
- Operational telephony
- Substation security
- Transfer of large amount of power system data available within modern microprocessor based IEDs

The communication network physical layers are mainly based on the copper wire telephony type pilot and optical fibre cables. Third parties communication networks (UHF/VHF, GSM/GPRS, digital microwave, Ethernet/IP) are used to extend the network coverage.

Vector is moving its operational services to an IP based communication network. Digital communication over the pilot cable has been successfully implemented using g.shdsl communication technology.

New substations built are interconnected to the communication network via optical fibres. The existing pilot cables that have reached the end of their technical life are being replaced with optical fibre cables.

## 4.10. CUSTOMER INITIATED NETWORK DEVELOPMENTS

Auckland contains some of the highest residential and commercial growth in New Zealand. Customer initiated projects within Vector can be broken into the following expenditure categories:

- Reticulation of commercial and residential subdivisions accounts for approximately 40% of customer initiated works
- New service connections in areas where reticulation already exists or only requires minor extensions accounts for a further 20% of expenditure

The remainder of the expenditure is divided between:

- Customer substations installed for commercial customer’s with loads unable to be supplied from the low voltage reticulation and major customer developments (such as Highbrook) and upgrades (such as Pacific Steel)
- Cable relocations driven by road widening projects initiated by TLAs and Transit
- Transformer changes where transformer-connected customers require an upgrade or downgrade in capacity to match their load
- Low voltage reinforcements initiated by an increase in customer capacity but necessitating reinforcement of the low voltage network

The demands from the customer led initiatives are included in the load forecasts and influence the timing and priority of capital works in the Vector network.

Forthcoming projects identified but have yet to be fully committed to a formal plan are listed as follows:

- Albany Basin: An ongoing development in the Albany Basin which will eventually comprise of 6000 residents and 15,000 employees
- Flat Bush: Manukau City Council have indicated an extensive residential and commercial development in the Flat Bush area eventually accommodating 40,000 people by 2020
- Newmarket: Ongoing development involving the Westfield Plaza

## 4.11. CAPITAL EXPENDITURE

Figure 3.2 shows the historical effects of extreme events on SAIDI. However Figure 4.12 shows the variability and overall impact of extreme events. Based on the long term average (1994/05 – 2006/07), extreme weather events are the second highest single contributor to SAIDI within Vector, the highest being overhead asset failure. However the unpredictability, represented by the range exceeds that of any other category.

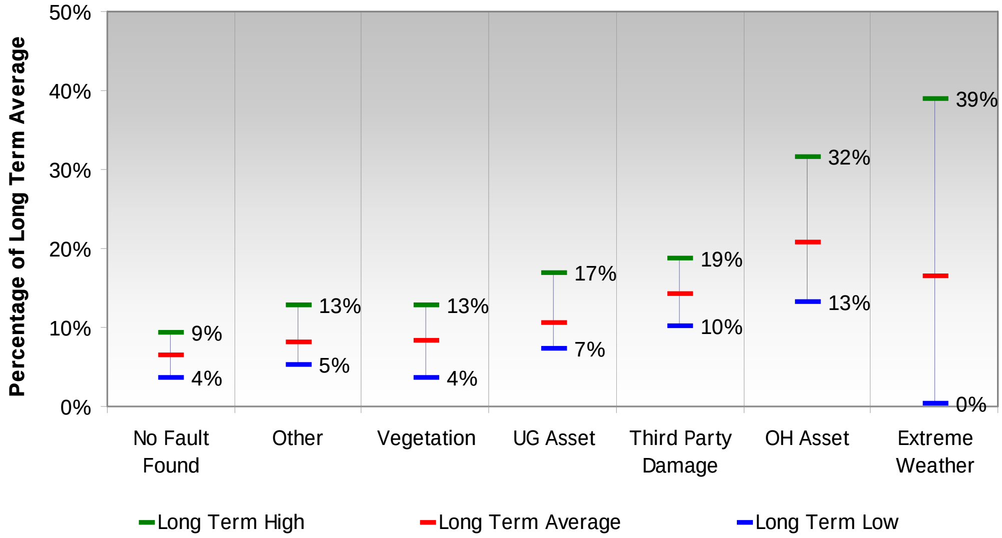



*Figure 4.12 Divergence of SAIDI based on Long Term Average*

The frequency and impact of these extreme events appears to be on the increase from which Vector incurs a significant opex and capex cost.

The capital expenditure profiles shown in Figure 4.13 represents the range of spend trajectories Vector could follow going forwards.

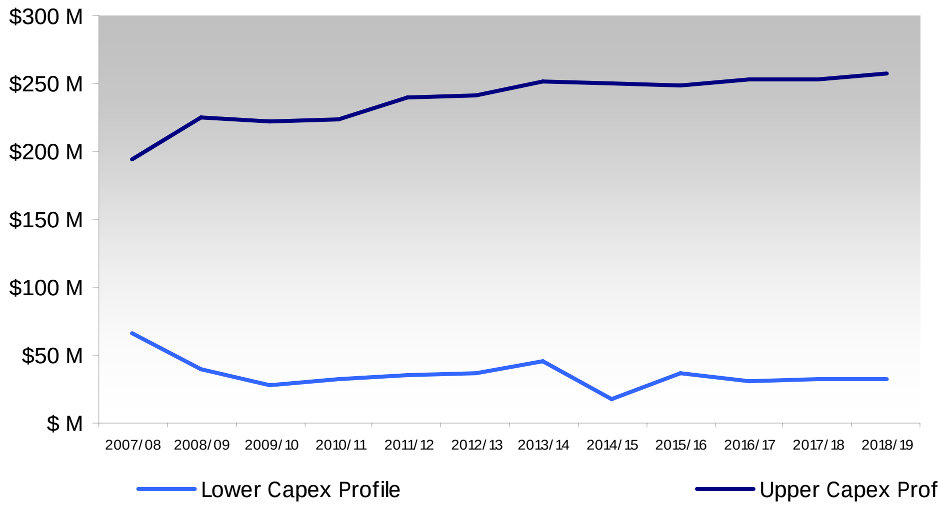



*Figure 4.13 Forecast Capital Expenditure10*

10 Capex expenditure is based on 2006$

As clarity and certainty is gained on the future regulatory requirements for quality of supply, customer satisfaction, the price-quality considerations, rate of return, continuance of supply and other input parameters that impact investment decisions, a more definitive strategy can be communicated.

The lower line represents minimum expenditure that Vector must commit in order to comply with its legal obligations, deal with known HSE issues, and provide sufficient network capacity to just meet peak demands, with no security of supply. It does not include any expenditure on planned asset replacement, network performance improvement, customer growth, security of supply-based projects, or the overhead improvement programme.

The impact of this expenditure profile will be increasing asset failure rates and breaching of Vector's security of supply criteria. This will manifest as a reduction in customer service levels (reduced reliability and extended outages due to lack of back-stopping capability) and sharply increasing operational expenditure on fault response and customer complaints.

The upper line represents a level of expenditure that would enable Vector to provide an optimal asset management strategy, plus provide improved outcomes for quality and customers, namely:

- Compliance with health, safety and environmental statutory requirements
- Optimal replacement of assets that have come to the end of their economic lives
- Prudent provision of capacity for growth and security of supply criteria
- Maintenance of the current levels of service provided by the network
- Investment in automation and asset renewal that will improve our ability to meet current quality targets

Following the lower expenditure trajectory (essentially based on a "run to failure" asset replacement strategy) will cause a relentless and increasingly steep decline in network performance, and make the "wall-of-wire" issue virtually impossible to manage efficiently. If this strategy was adopted generally by lines businesses in New Zealand, within 10 -15 years the demand for resources and equipment would far outstrip availability, leading to rapidly escalating costs (as has recently been seen in Australia) and an inability to complete necessary works.

Vector's preferred strategy for asset renewal would be to manage the "wall of wire" issue by smoothing out the asset renewal in a planned way that enables a managed ramp-up of field resources and equipment supply, thereby enabling delivery on all of our asset management drivers at minimum whole-of-life cost. This is illustrated in Figure 4.14

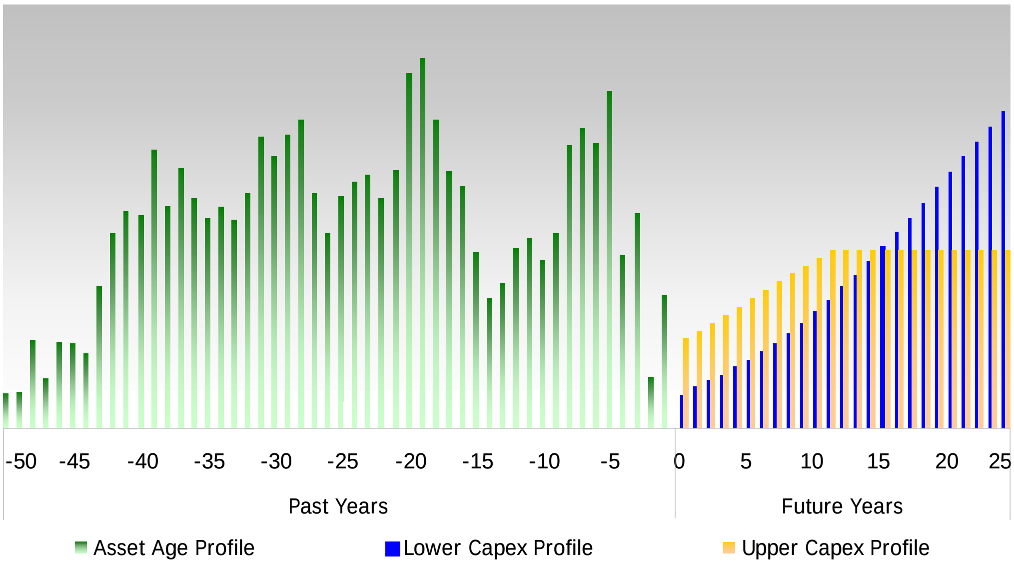



*Figure 4.14 Alternative Asset Renewal Expenditure Profiles*

The preferred overall strategy would be one where the required price-quality considerations, customer segments, service standards and performance are aligned. Further more, we must ensure that the balance of capital and operational expenditure is considered and optimised in terms of the financial management of the company. This requires clarity and certainty on future regulatory requirement.

Table 4.6 and Table 4.7 shows the breakdown of the Capital Expenditure profiles shown in Figure 4.13

| Category | FY0708 | FY0809 | FY0910 | FY1011 | FY1112 | FY1213 | FY1314 | FY1415 | FY1516 | FY1617 |
|---|---|---|---|---|---|---|---|---|---|---|
| Customer Growth | 40 M | 43 M | 42 M | 42 M | 42 M | 42 M | 42 M | 42 M | 42 M | 41 M |
| Network Growth | 70 M | 81 M | 74 M | 79 M | 74 M | 74 M | 74 M | 77 M | 69 M | 70 M |
| Network Integrity | 67 M | 72 M | 81 M | 77 M | 98 M | 100 M | 111 M | 106 M | 112 M | 117 M |
| Compliance | 4 M | 7 M | 3 M | 2 M | 2 M | 2 M | 2 M | 2 M | 2 M | 2 M |
| Overhead Improvement | 12 M | 12 M | 12 M | 12 M | 12 M | 12 M | 12 M | 12 M | 12 M | 12 M |
| Performance | 2 M | 12 M | 11 M | 11 M | 11 M | 11 M | 11 M | 11 M | 11 M | 12 M |
| **Grand Total** | **195 M** | **226 M** | **223 M** | **224 M** | **240 M** | **241 M** | **252 M** | **250 M** | **249 M** | **253 M** |

*Table 4.6 Capital Expenditure by Category- High Profile*

| Category | FY0708 | FY0809 | FY0910 | FY1011 | FY1112 | FY1213 | FY1314 | FY1415 | FY1516 | FY1617 |
|---|---|---|---|---|---|---|---|---|---|---|
| Customer Growth | 7 M | 7 M | 7 M | 7 M | 7 M | 7 M | 7 M | 7 M | 7 M | 7 M |
| Network Growth | 30 M | 10 M | 5 M | 12 M | 16 M | 20 M | 28 M | 2 M | 19 M | 13 M |
| Network Integrity | 25 M | 18 M | 13 M | 12 M | 10 M | 9 M | 9 M | 8 M | 8 M | 9 M |
| Compliance | 3 M | 6 M | 3 M | 2 M | 2 M | 2 M | 2 M | 2 M | 2 M | 2 M |
| Overhead Improvement | 0 M | 0 M | 0 M | 0 M | 0 M | 0 M | 0 M | 0 M | 0 M | 0 M |
| Performance | 0 M | 0 M | 0 M | 0 M | 0 M | 0 M | 0 M | 0 M | 0 M | 0 M |
| **Grand Total** | **66 M** | **40 M** | **27 M** | **33 M** | **35 M** | **37 M** | **46 M** | **18 M** | **36 M** | **30 M** |

*Table 4.7 Capital Expenditure by Category- Low Profile*

# 5. LIFE CYCLE ASSET MANAGEMENT

## 5.1. ASSET MAINTENANCE AND RENEWAL STRATEGY

Vector operates and manages a wide range of assets from 110kV power transformers to 230V service connections. Each asset is managed in terms of risk and criticality with the optimum maintenance, refurbishment and replacement strategies defined.

The foundation of the asset maintenance plan is the customer service targets, based on customer type and service expectations. The resulting maintenance, refurbishment and replacement strategies for each asset ultimately impact on customer service targets, power quality, health and safety implications, reliability management and cost. To complement and improve the outcomes of this analysis, Vector is in the process of adopting a formal Reliability Centred Asset Management (RCAM) methodology for its sub-transmission assets based on a pilot study undertaken by Siemens AG during the 06/07 year.

This section gives an overview to Vector's approach to maintenance, asset refurbishment and replacement.

In general, preventative maintenance consists of the following:

- Routine asset inspections, condition assessments, servicing and testing of assets

- Evaluation of the results in terms of meeting customer service levels, performance expectations and risks

- Repair, refurbishment or replacement of assets when required

Detailed maintenance criteria for each asset are documented in Vector's maintenance instructions and standards together with the Contractors check lists. These include the inspection, testing and condition assessment requirements for each asset, together with decision guides on the appropriate countermeasures.

The maintenance criteria receives constant attention and review to ensure that Vector's practice and policy reflect the optimal needs of individual assets or areas. Assets that are considered to have a greater risk of failure or the consequence of failure is too high have enhanced preventative and condition based maintenance schedules.

As a general philosophy, the timing of any individual asset or area replacement is based on the following condition and performance assessments:

- As the asset approaches the end of its technical life and is no longer suitable for its application, in terms of asset functionality or customer requirements

- When the asset presents an unacceptable risk regarding its function, environment, or to the safety of public or operating and maintenance personnel

- For economic reasons the remaining life maintenance or remedial costs are higher than the expected replacement costs

When the requirement arises for an individual asset or area to undergo replacement, the opportunity is taken to consider an upgrade and/or capacity increase to meet future supply requirements.

## 5.2. OVERHEAD NETWORK

### 5.2.1. ASSET DESCRIPTION

*Overhead Lines*

The overhead system consists of 26km of 110kV line, 440km of 33kV line, 7km of 22kV (link with Counties Network), 4,495km of 11kV line and 7,582km of 400V line. There is still 24 km of 6.6kV in Auckland and this is being progressively uprated to 11kV. Over 158,000 poles support the overhead distribution network, of which 22% are wood and 78% concrete. There are also 119 steel towers on the Auckland network.

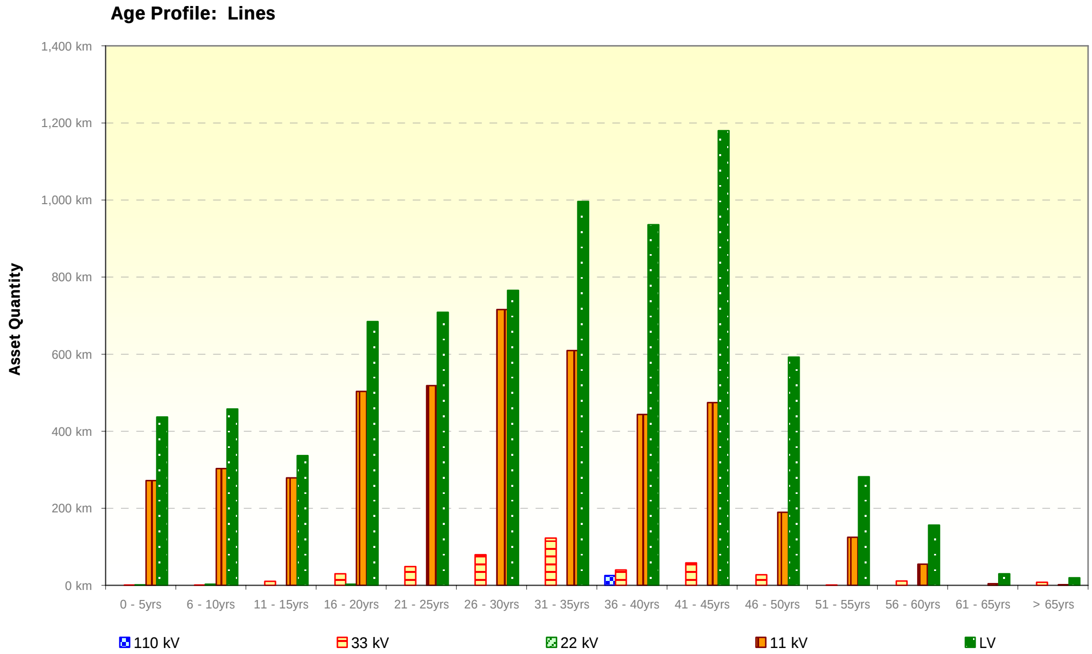



*Figure 5.1* Overhead lines age profile

The poles have an average age of 28 years; however there are a large number of poles older than 40 years of age. The expected life of a wood pole is 40 years and 60 years for concrete. Relatively few new wood poles have been installed since the early 1960's. In the 1980's pole nails were fitted to wood poles on the Auckland network as a means of life extension. This was very successful and some of these poles are still in service today. In general poles in the Wellington network are in poor/good condition, with a significant number of wood poles currently being replaced. Poles on the Auckland network are in fair to good condition.

The circuits supported by the steel towers range in voltage from 110kV to 400V with most having been in service for more than 70 years. A recent inspection of the towers revealed that the majority show severe corrosion of the hot dip galvanised braces and bolts together with ground-line corrosion of some main members. While there have been no unassisted tower failures, structural modelling has shown that their mechanical integrity has been severely compromised with the result that they pose an unacceptable security of supply and safety risk.

Conductors vary across the overhead network, but are predominantly Copper (Cu), All Aluminium Conductor (AAC) and Aluminium Conductor Steel Reinforced (ACSR) conductors. New line reconstruction utilises All Aluminium Alloy Conductor (AAAC). Low Voltage Aerial Bundle Conductor (LVABC) and Covered Conductor Thick (CCT) for 11kV lines are used in areas susceptible to tree damage. There is a small section of High Voltage Aerial Bundle Conductor (HVABC) which was installed 14 years ago. Although the material proved to be effective for improving reliability, it was discontinued because of high installation costs. Conductors in all networks are generally in good condition.

Crossarms are predominantly hardwood (99%), with the remainder being steel. On the Wellington network, they are in a fair condition while those on the Auckland networks are in a fair to poor condition.

Fault passage indicators, both remote and local have been installed at most major tee offs on the overhead lines. All pole mounted fault passage indicators are in poor condition and are being replaced with conductor mounted units.

*Overhead Switches*

There are 1,661 Air Break Switches (ABS) and 136 $SF_6$ fill switches for breaking the overhead network into sections. Most of the ABS's are more than 20 years old and are not cost effective to refurbish. ABS's on all networks are in fair to poor condition. The vast majority of the $SF_6$ switches are less than 5 years old and all are in sound condition.

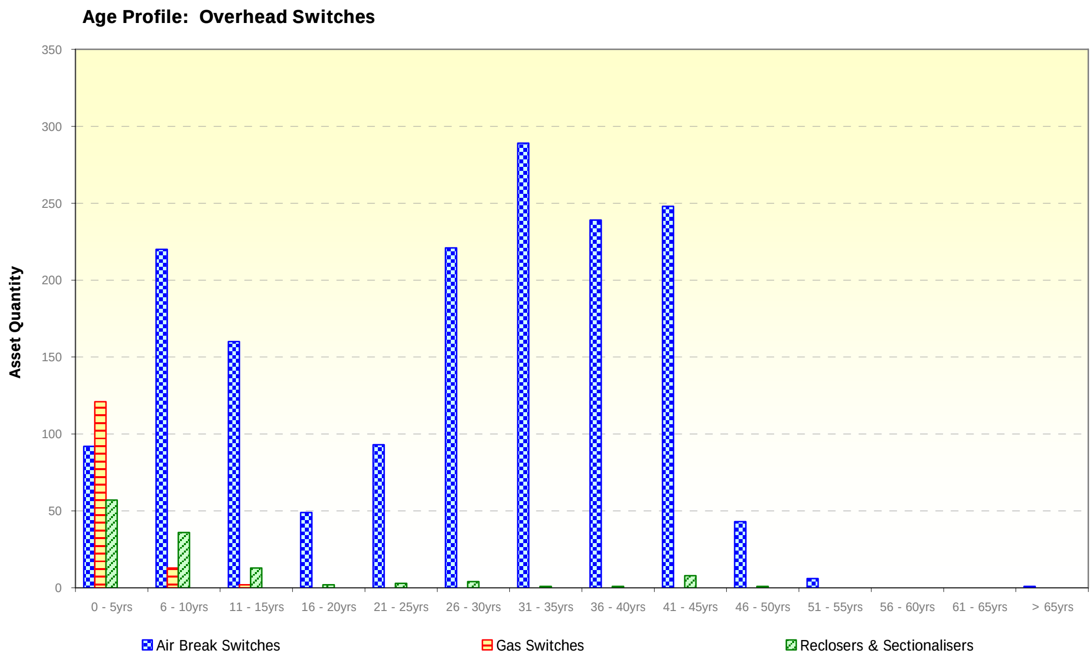



*Figure 5.2* Overhead switches age profile

There are 126 oil filled, $SF_6$ and vacuum reclosers and sectionalisers on the network. The oil filled reclosers are in poor condition and generally found on the Auckland network. All other reclosers are less than 10 years old and in excellent condition.

### 5.2.2. ASSET MAINTENANCE

Maintenance of the overhead network is a mix of reactive (based on faults) and condition monitoring to drive the preventative maintenance programs.

Planned maintenance includes:

- Annual visual line patrol of poles and hardware checking for safety issues and hardware about to fail, including clearance checking to meet the Electrical Code of Practice
- Five yearly condition assessments of wood poles using ultrasonic methods and top load analysis to determine if the serviceability of the poles
- Five yearly detailed visual inspection of all poles, towers and hardware. A top load analysis is carried out on all heavily loaded concrete poles as a serviceability check
- Proactive vegetation management and local council vegetation management agreements in line with the Tree Regulations
- Five yearly measurements of earth sites
- Three yearly ABS visual inspection and manual operation is carried out. A thermovision camera is used to check the contact and connections under load
- Nine yearly visual inspections of $SF_6$ switches, including operation and gas pressure checks
- Five yearly inspection and testing of reclosers and sectionalisers
- Five yearly inspection and testing of fault passage indicators, including battery replacement.

Corona camera inspections have been carried out on some 33kV insulators and several 11kV feeders with unknown faults.

A problem has been identified with some types of 11kV expulsion drop-out (EDO) fuses that are overheating and have the potential to catch fire. This appears to be caused by the different metals used at the pivot point on the fuse holder, causing seizing and preventing the fuse holder from falling. This is being monitored and if warranted a replacement program will be put in place.

One brand of 400V service fuses has been overheating and failing caused by water in the jumper leads migrating into the fuse holder. This type of fuse are no longer used and are replaced when found.

A safety risk has been identified with old connectors and a replacement program has been implemented. A number of sample tests were carried out on low voltage connectors and many were found to be at the end of their life. A programme is now in place to replace all low voltage connectors over the next five years.

### 5.2.3. ASSET RENEWAL AND REFURBISHMENT

There is a mix of replacement strategies due to the diverse range of assets on the overhead network and of differing critically.

*Bulk Asset Replacement*

Areas for a bulk replacement of overhead assets are determined by mapping equipment defects found during asset condition surveys, equipment failures, and reviewing asset age profiles. The number of customer's affected by outages arising from equipment failures assists in prioritising areas. Equipment with less than ten years remaining life is replaced.

*Steel Towers*

A two year program to refurbish the steel towers is half way through. This consists of corrosion abrasive blasting and any severely damaged members replaced. The entire structure is painted providing a low maintenance period of at least 20 years. At the end of this period maintenance will consist of cleaning and repainting.

*Poles*

Poles are tested for their serviceability as set out in HB C(b)1:2006 and AS/NZS 4676:2000. Wood poles are also tested using ultrasound method. Any pole not meeting serviceability requirements are programmed for replacement.

The pole testing program in Wellington has identified 3,000 poles (both wood and concrete) to be replaced. The replacement programme will be completed in 2009.

*Crossarms and Hardware*

Crossarms are identified for replacement from detailed line inspections. Crossarms installed before 1990, were of class 2 and tended to have a life of up to 40 years. Class 3 crossarms installed in the 1990's are found to be in need of replacement after 20 years. Only class 1 or 2 are now installed on the network. Crossarm replacements are a particular focus in the northern part of the Auckland network.

Pin type insulators are no longer used for 33kV and 11kV insulators. All replacements are of the solid core post type as they provide a higher level of reliability in polluted environments and lightning prone areas.

*Conductors*

Conductors are programmed for replacement based on condition assessments and analysis of fault history. Numbers of joints per span or signs of damage are used to determine the need for replacement. 11kV spur lines of 16$mm^2$ copper are being replaced with AAAC conductors and fused where possible.

*Air Break Switches*

Air Break Switches (ABS) are replaced based on condition assessments. All replacements are $SF_6$ switches. Old ABS's are not refurbished.

*Reclosers*

A number of the older oil filled reclosers are now at the end of their technical life and economic life. These are being replaced with vacuum reclosers.

*Programs of work*

Refurbishment and replacement of assets on the overhead network is an ongoing program with budget allocated for each year. Work packages are developed by each of Vector's contracting partners based on results from the condition inspections and network performance.

# 5.3. SUBTRANSMISSION CABLES

## 5.3.1. ASSET DESCRIPTION

The subtransmission network consists of 687km of cables and lines rated at 110kV, 33kV and 22kV as detailed below.

| Cable Type | 110kV | 33kV | 22kV | Total Length (km) |
|---|---|---|---|---|
| Underground PILC | 1 km | 32 km | 78 km | 110 km |
| Underground XLPE | 27 km | 199 km | 32 km | 258 km |
| Underground Fluid Filled | 17 km | 177 km | 24 km | 218 km |
| Underground Gas Pressurised | 20 km | 74 km | 5 km | 100 km |
| Total by Voltage | **65 km** | **483 km** | **139 km** | **687 km** |

*Table 5.1* *Subtransmission cables by lengths and voltage*

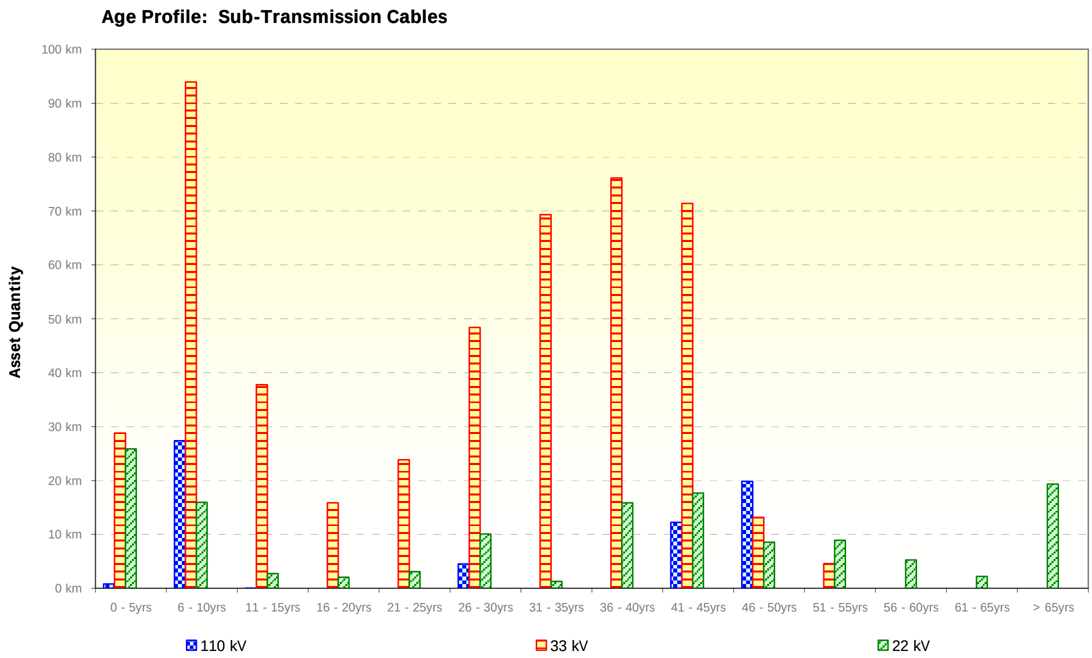



*Figure 5.3* Subtransmission cable age profiles

On average, the subtransmission cables are 28 years old and are generally in good to very good condition.

Several XLPE circuits installed in the 1990s have suffered from joint failures. These circuits are subject to partial discharge testing to gain an early indication of any problems. Some of the older gas filled cables are starting to exhibit signs of ageing with increasing frequencies of gas leakage. They are closely monitored and a number of these cables have been programmed for replacement.

### 5.3.2. ASSET MAINTENANCE

Due to the criticality of these cables to the overall system security and reliability of the network, regular inspection and condition monitoring activities are undertaken. These include;

- Regular route patrols, with enhanced frequency in parts of the CBD, to identify any potential problems on the Auckland network
- Proactive work with external contracting partners to prevent third party damage
- Annual cable termination inspections and thermographics
- All gauges and transducers associated with pressure cables checked at 6 monthly intervals
- Serving tests conducted every 2 years to confirm the integrity of the cables' outer sheaths
- On-line and off-line partial discharge testing undertaken on cables where a previous fault history indicates potential problems

Over and above routine maintenance all fluid filled and pressurised gas cables are continuously monitored via the centralised SCADA system, to provide early warning of falling cable pressure. Associated leaks can be rectified before an electrical failure has the chance to occur.

Maintenance related issues centre predominantly around gas leaks and serving faults. These are repaired as and when they are identified. The fault history is used as an input into the cable retirement decision making process.

### 5.3.3. ASSET RENEWAL AND REFURBISHMENT

Subtransmission cable replacement is determined by a combination of condition and performance assessments relating to the risk of loss in functionality, analysis of failure and defect rates, associated costs of repair, failures and condition tests.

The proposed subtransmission cable replacement program over the next ten years is detailed below. However, the priority of any particular replacement project may change as improved condition information becomes available, performance expectations change or changes to the network design and configuration cause a re-assessment.

Year 2007/08 projects

- Planned upgrading of selected sub transmission joints

Years 2008/09 – 2011/12 projects

- Install Distributed Temperature Sensing (DTS) on the Wellington sub-transmission cables
- Replace both Balmoral, Auckland 22kV solid cables
- Replace one Evans Bay, Wellington 33kV gas cable
- Replace both Sandringham, Auckland 22kV solid cables
- Replace both Parnell, Auckland 22kV solid cables
- Replace both Ponsonby, Auckland 22kV gas/solid cables
- Replace both Chevalier, Auckland 22kV oil/solid cables
- Replace the Palm Grove, Wellington 33kV gas cable

Years 2012/13 – 2016/17 projects

- Replace both Maidstone, Wellington 33kV gas cables
- Replace both Hataitai, Wellington 33kV gas cables
- Replace the Liverpool to Quay, Auckland 22kV gas cable
- Replace both Ira Street, Wellington 33kV gas cables
- Replace the Takanini to Maraetai, Auckland 33kV oil cables
- Replace both Karori, Wellington 33kV gas cables
- Replace both Onehunga, Auckland 33kV solid cables
- Replace both Petone, Wellington 33kV gas cables

## 5.4. DISTRIBUTION CABLES

### 5.4.1. ASSET DESCRIPTION

*Distribution cables*

The underground distribution network is via 5km of 22kV, 4,119km of 11kV, 42km of 6.6kV and 9,568km of 400V cables.

The 6.6kV and the older 11kV cables are PILC or PIAS construction while the more recent 11kV and the 22kV cables are XLPE insulated. The PILC cables are in good condition although some early 1950s cable has been failing. There is a concern that the PIAS cable may be subject to corrosion of the extruded aluminium sheath and while some cable has been replaced over the last few years there is no evidence that this is likely to become a major problem. The XLPE insulated cables are in good condition with the exception of the early natural polyethylene cables which are prone to develop water trees and fail.

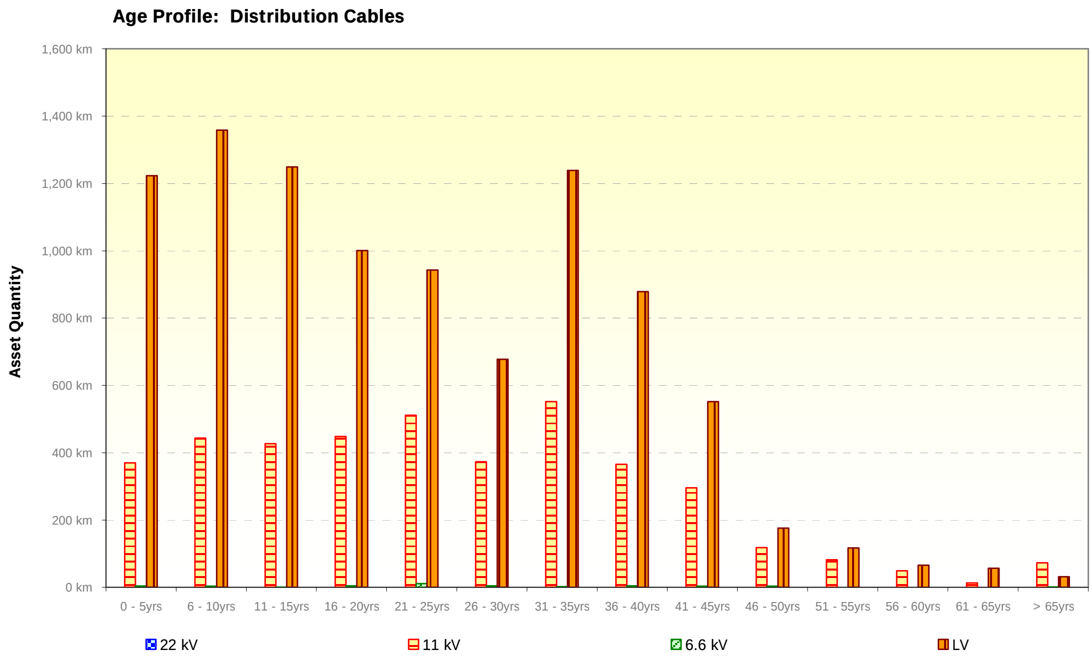



*Figure 5.4* Distribution cables age profile

Old 400V cables are PILC construction while newer cables utilise either PVC or XLPE insulation. In general the PILC and XLPE cables are in good condition. Some of the single core PVC cables have failed and this may become an issue in the future.

*Pillars and pits*

Pillars and pits provide the point for a service cable to connect to Vector's reticulation. They contain the fuses necessary to isolate the service cable from the network.

For loads up to 100 amps an underground pit is installed in preference to the above ground pillar. However there are still situations where the above ground pillars are still necessary. Installation of pits began about 3 years ago and comprehensive inspections to date have not shown up any potential maintenance issues. Pits are manufactured from polyethylene as are most of the newer pillars. Earlier style pillars were constructed of concrete pipe, steel, and aluminium.

Older polyethylene pillars are generally adequate for their purpose although many have suffered knocks and minor vehicle impact. The mild steel pillars are showing signs of age and in many cases the steel portion is suffering from severe corrosion with replacement of individual pillars being a common event.

### 5.4.2. ASSET MAINTENANCE

*Distribution cables*

Maintenance of the underground cable network is limited to visual inspections of cable terminations, undertaken in conjunction with the overhead inspections. The cables are operated to failure and then repaired or sections replaced as necessary.

In the early 1970's, natural polyethylene insulated 11kV cable was installed on the Auckland network. This type of cable has a high fault history and the current policy is to repair the cable when it faults to restore supply, then take steps to replace the cable in a programmed manner.

*Pillars and pits*

Pillars and pits are visually inspected at 3 yearly intervals. The pillar inspection includes a loop impedance test to check the condition of the connections from the fuses to the source.

Where practical, damaged pillars are repaired, otherwise a new pillar or a pit is installed depending upon the circumstances.

### 5.4.3. ASSET RENEWAL AND REFURBISHMENT

*Distribution cables*

Cable replacements are determined based on a combination of fault history and frequency together with tests completed as part of fault repairs. Cable replacements will be targeted on cables exhibiting high fault rates particularly the natural polyethylene insulated 11kV cables.

*Cable terminations*

Cable termination replacement is driven by visual inspection and analysis of fault rates. The exception to this are 11kV cast metal terminations, where analysis of fault rates together with a risk assessment has resulted in a decision to replace them with heatshrink terminations.

*Pillars and pits*

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. Older pillars are being targeted for planned replacement as repair becomes impractical or uneconomic.

Anticipated distribution cable and pillar replacement projects over the next ten years are detailed below.

Year 2007/08 projects

- Continued program replacement of cast iron cable terminations

- Replacement of natural polyethylene 11 kV cables that have faulted during the year
- Second year of a planned program for the replacement of mushroom pillars

Years 2008/09 – 2011/12 projects

- Continued replacement of natural polyethylene cables
- Targeted replacement of cables that have been displaying a high fault rate
- Continued program replacement of cast iron cable terminations
- Complete breadbox and mushroom pillar replacement project
- Replace concrete pipe pillars

Years 2012/13 – 2016/17 projects

- Continued replacement of natural polyethylene cables
- Continue targeted replacement of cables that are showing high fault rates
- Continued program replacement of cast iron cable terminations
- Replace metal pillars that were fitted with mild steel components

## 5.5. SUBTRANSMISSION TRANSFORMERS

### 5.5.1. ASSET DESCRIPTION

Vector owns 254 transformers, including two at Lichfield, which lies outside of Vector's main supply networks. There are 17 transformers with a primary voltage of 110kV, 186 at 33kV and 51 at 22kV ranging in rating from 5MVA to 65MVA. The age profile of the subtransmission transformers is shown below.

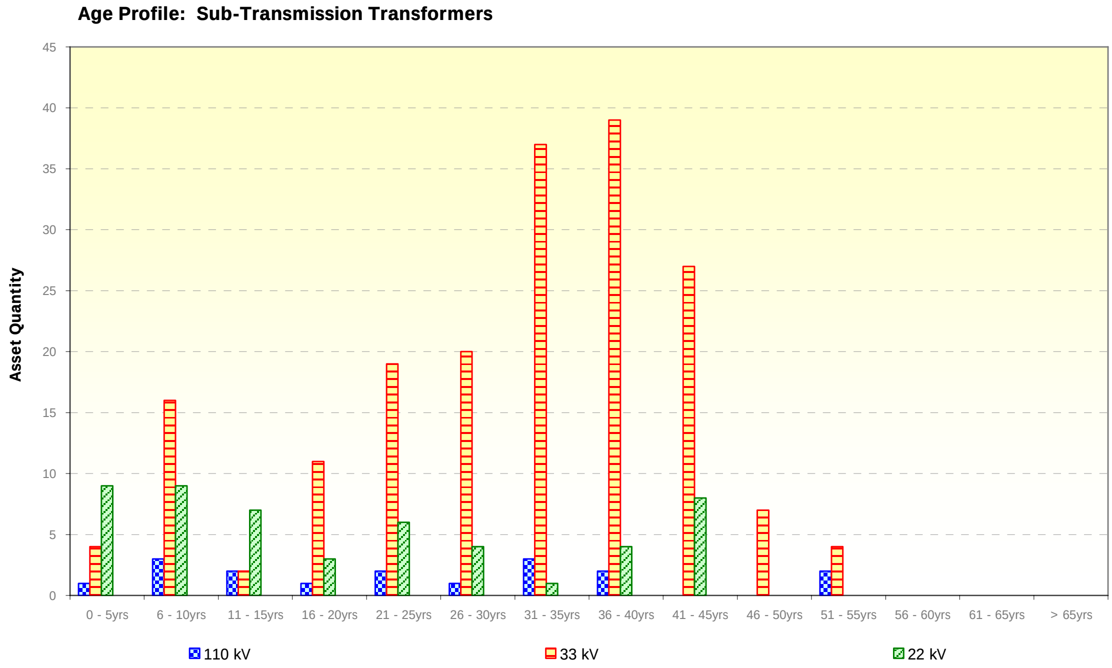



*Figure 5.5* Subtransmission transformers

The transformer population is generally in good condition although there are a small number coming to the end of their technical life requiring more intensive monitoring. The design life of a transformer is 45 years, but subject to prior operating conditions and maintenance, this life may be extended.

### 5.5.2. ASSET MAINTENANCE

Routine inspection and condition monitoring include:

- Annual dissolved gas analysis
- Monthly visual checks for moisture, oil levels and leaks, and fan operation
- Annual Thermal Imaging of terminations and connections
- Annual Tap Changer Activity Signature Analysis (TASA) condition assessment
- As required Transformer Condition Assessment (TCA) condition assessment as an alternative to dissolved gas analysis

The timing for the transformer refurbishment is scheduled based on DGA and condition assessment results. Transformers scheduled for relocation are refurbished as part of the move where their condition and assessed remaining technical life makes this an economic option. To improve the decision accuracy associated with major refurbishment, the PDC method, a non-invasive test to determine the moisture content of the winding insulation is being used.

### 5.5.3. ASSET RENEWAL AND REFURBISHMENT

Transformer asset replacement is based on a combination of non-invasive and invasive condition assessment. Components that have deteriorated beyond acceptable parameters are taken out of service for a detailed inspection, while tests conducted on the oil and winding insulation give an indication of probable life expectancy of the transformer. A decision is made on refurbishment or replacement based on the functionality and performance requirements of the asset.

Year 2007/08 projects

- There are two transformers programmed for major refurbishments being one 110kV transformer from the Wairau substation and one Atkinson Rd substation 33kV transformer
- There are no planned transformer replacements in this period

Years 2008/09 – 2011/12 projects

- Budgetary provision has been made to replace one transformer in 2010/11

Years 2012/13 – 2016/17 projects

- Budgetary provision has been made to replace three transformers during this period

## 5.6. CIRCUIT BREAKERS

### 5.6.1. ASSET DESCRIPTION

There are 2,133 circuit breakers (CBs) on Vector's network. Thirty five 33kV CBs are installed at Transpower Grid Exit Points with the remainder installed at Vector zone substations and at secondary distribution substations on the Wellington network. Vector also owns two 110kV CBs and associated isolators at Lichfield.

Both zone and secondary substations contain CBs in either an indoor switchboard configuration (consisting of multiple CBs connected to a common bus) or individually connected in outdoor switchyards.

The CBs range from new to over 50 years of age. Further, the CB's consist of a mix of technologies which also corresponds to the relative age of the equipment. The oil type circuit breakers are the oldest in the network and constitute 75% of the asset followed by $SF_6$ at 13% and vacuum at 12%.

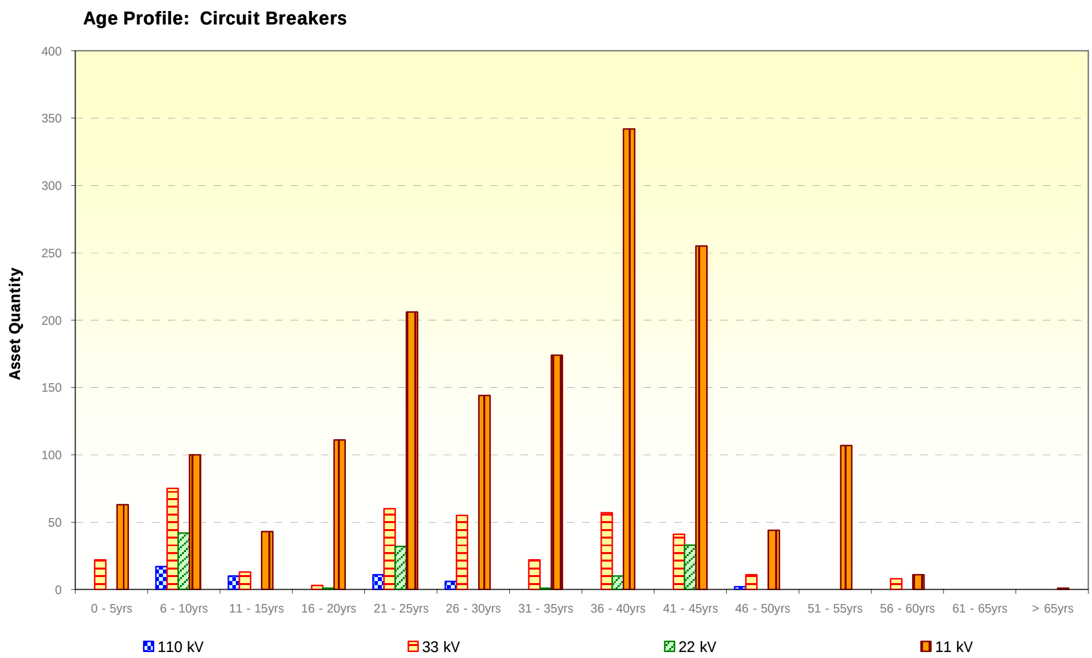



*Figure 5.6* Circuit breaker age profile

The data indicates that the majority of CB's are less than 40 years of age. The bulk of installations occurred in two waves; in the 1965-70 eras and to a lesser extent in the 1980s.

The SF6 and Vacuum CB's are the newest in the networks. They are in very good condition and pose little risk to the network due to modern manufacturing technologies, higher specifications and compliance with the latest international equipment standards.

Certain oil-type CBs are approaching the end of their technical life. Inadequate fault level rating, equipment failures and mal-operation, lack of spare parts, and increased maintenance costs over newer equipment are areas of concern for this aging equipment.

### 5.6.2. ASSET MAINTENANCE

In general, preventative maintenance on Vector's switchgear consists of the following

- All switchgear is visually inspected monthly/quarterly for leaks and general condition depending on history and type (i.e. some circuit breakers require more frequent inspection than others)
- Thermographic examination is undertaken on all switchboards annually
- Kelman profile testing and non-invasive partial discharge location and monitoring is carried out on a two year cycle

- Major maintenance on the switchgear including inspection and testing of circuit breakers on an eight year cycle and testing of protection relays and systems on a two and four year cycle
- Condition assessments (either on a scheduled basis or as a result of routine inspection or equipment fault operation)

Through this process, assets that have been identified for replacement are the Reyrolle Type 'C' CB's (due to age and on-going operational issues), English Electric type OLX switchboards and 33 kV ORT2 CBs. The Motorpol supplied 36PV25 (Crompton & Grieve) circuit-breakers are under review for inclusion on the replacement list. Results have shown very low or no gas pressure in the circuit breaker poles and action is being taken to regas all of these CBs. Their ongoing condition will be closely monitored.

### 5.6.3. ASSET RENEWAL AND REFURBISHMENT

The timing for the replacement of circuit breakers is based on condition, performance, ratings and industry related information but can also be the result of non-electrically related drivers such as site relocation or decommissioning, safety considerations and Building code regulations (e.g. fire protection requirements). A risk matrix has been developed that identifies priority Circuit Breakers for replacement.

Programmed replacements are:

Year 2007/08 projects

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- Complete the 11kV English Electric type OLX switchboard replacement at Triangle Rd substation
- Complete the 11kV Ferguson Palin switchboard replacement at McNab substation
- Complete the 11kV Reyrolle type C7T switchboard replacement at The Terrace substation
- Complete the Reyrolle type C switchboard replacements in secondary substations in Victoria St, Tory St and Adelaide Rd, Wellington
- Replace the 33kV Reyrolle type ORT2 outdoor CBs at Wellsford (CBs P132 & P136) and Warkworth (CBs P106, P280, P130)
- Replace the 11kV English Electric type OLX/South Wales switchboard at Helensville substation

Years 2008/09 – 2011/12 projects

- Continue replacement of Reyrolle Type "C" switchboards

- Continued replacement of the 11kV English Electric type OLX, South Wales and GEC/Brush oil type switchboards. (Browns Bay, Atkinson Road, Balmain, New Lynn, Hauraki, Laingholm and Sabulite Rd to be considered)
- Replacement of 11kV South Wales, AEI and Brush/GEC switchboards. (Maraetai, Westfield, Onehunga, Orakei, Manurewa and Pakuranga substations to be considered)
- Replacement of Zone substation switchgear as identified by condition and risk ratings

Years 2012/13 – 2016/17 projects

- Continued replacement of oil type circuit breakers across the networks based on condition and risk assessment

## 5.7. ZONE SUBSTATION BUILDINGS

### 5.7.1. ASSET DESCRIPTION

There are 130 buildings located at zone substations in the Vector network. These buildings are generally stand alone and house switchgear, protection equipment, ancillary supplies, plus in some instances transformers and ripple injection equipment.

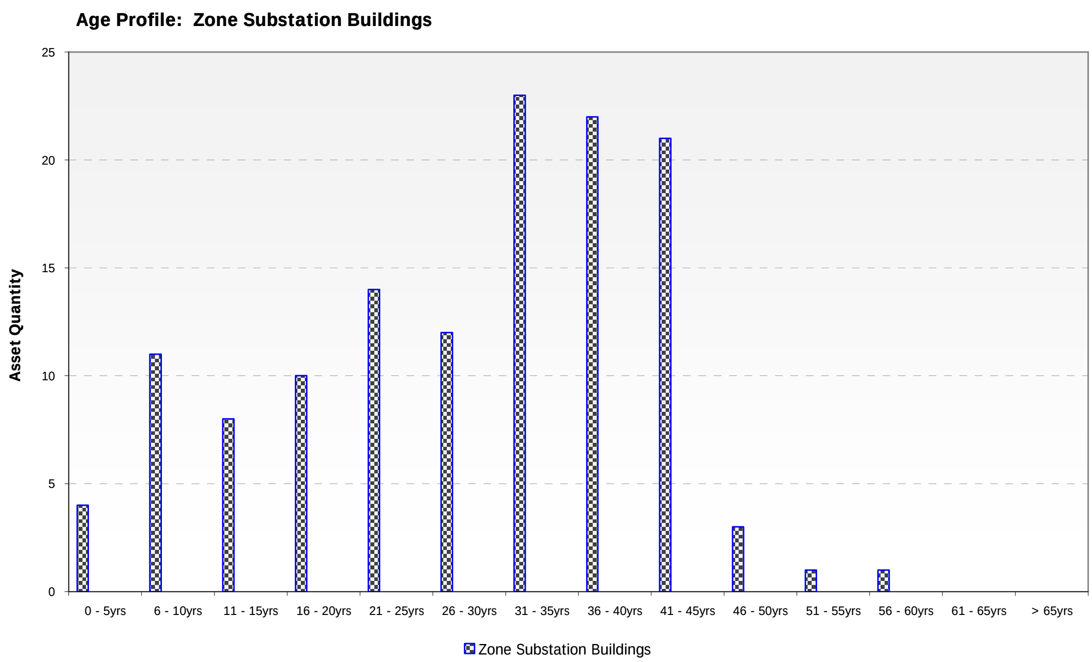


*Figure 5.7 Zone substation building age profile*

The average age of the buildings is 28 years and they are generally in a good condition.

### 5.7.2. ASSET MAINTENANCE

Routine monthly and 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 warrants of fitness inspections are carried out and any defects rectified.

### 5.7.3. ASSET RENEWAL AND REFURBISHMENT

The zone 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.

This work is done as part of an ongoing seven year program.

## 5.8. POWER SYSTEM PROTECTION

### 5.8.1. ASSET DESCRIPTION

Vector operates over 3,300 protection relays of which 72% are electromechanical, 19% solid state and 8% of digital or numerical type.

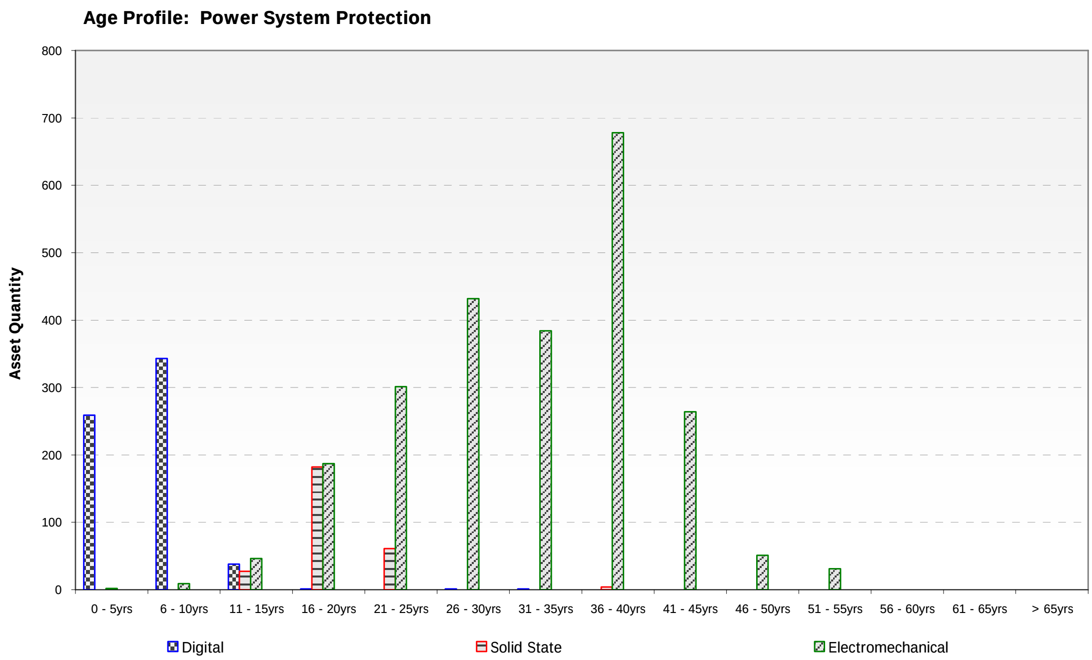


*Figure 5.8* Protection relays age profile

Apart from the Nilstat ITP relays they are generally in good condition.

### 5.8.2. ASSET MAINTENANCE

Electromechanical relays are tested on a four year basis. Solid state relays of the Nilstat ITP type are tested on an annual basis, to monitor the condition prior to replacement.

Numerical relays are equipped with self-diagnostic functions, but international experience has shown that not all protection relay faults can be detected by the self-monitoring functions. Vector has adopted the CIGRE Study Committee B5 (Protection and Automation) recommendations for testing numerical protection relays. The testing schedule is shown in Table 5.2.

| **Test** | **Test Description** | **Interval** |
|---|---|---|
| Function check of the protection (without test equipment) | The function check is to include:<br>Comparison of the quantities "current" and "voltage" with the displays<br>Tripping test by initiating a Trip command<br>Reading-out and analysis of the event memory<br>Check of the protection local and remote fault indications | Two years |
| Protection Test (with test equipment) | The Protection Test is to include:<br>Check of one measuring point of the input quantities "current" and voltage" both for each phase, neutral and for each measuring range by comparison with the display | Four years |

| | | |
|---|---|---|
| | Check of the function of all binary inputs and outputs<br>Interface test consisting of:<br>Reading out and analysis of the indication and fault recording memory using PC interface<br>Reading-out of all setting parameters and comparison with the initially set parameters<br>Check of the protection local and remote fault indications | |
| Parts Replacement | Back-up battery replacement | Ten years |

*Table 5.2 Protection Relay Test Schedule*

### 5.8.3. ASSET RENEWAL AND REPLACEMENT

Replacement programmes are generally based on relay condition and or failure. At the time of replacement the opportunity is taken to upgrade the protection schemes to meet the current standards.

The planned protection relay replacement program over the next ten years is detailed below.

*Year 2007/08 projects*

- Ongoing replacement of Nilstat relays
- Complete the Remuera substation protection and control replacement/upgrade
- Complete the Quay 11kV substation protection and control replacement/upgrade
- Complete the Wiri Substation protection and control replacement/upgrade
- Parnell Substation. Overall cable transformer differential protection replacement of the incoming feeders
- Zone substations supplied from the Hepburn GXP protection and control replacement/upgrade
- Stage 1 of the protection and control replacement/upgrades for zone substations supplied from the Takapu Rd GXP in Wellington

*Years 2008/09 – 2011/12 projects*

Auckland network

- Ongoing replacement of Nilstat relays
- Victoria substation. Protection and control replacement / upgrade
- Hans substation. Protection and control replacement / upgrade
- Papakura substation. Protection and control replacement / upgrade
- Quay 22kV substation. Protection and control replacement / upgrade

- Manukau substation. Protection and control replacement / upgrade
- Zone substation and network supplied from GXP Henderson. Protection and control replacement / upgrade
- Zone substation and network supplied from GXP Wellsford. Protection and control replacement / upgrade

Wellington network

- Zone substation and network supplied from GXP Takapu Rd. Protection and control replacement / upgrade
- Zone substation and network supplied from GXP Haywards. Protection and control replacement / upgrade
- Zone substation and network supplied from GXP Gracefield. Protection and control replacement / upgrade
- Zone substation and network supplied from GXP Wilton. Protection and control replacement / upgrade

*Years 2012/13 – 2016/17 projects*

- Ongoing protection and control replacements / upgrades across all networks as identified by asset condition monitoring

## 5.9. SUBSTATION DC AUXILLIARY SUPPLY

### 5.9.1. ASSET DESCRIPTION

There are 119 DC auxiliary systems, with an average age of 20 years that provide power supply to the substation protection, control, metering, monitoring, automation and communication systems, as well as power circuit breaker tripping and closing mechanisms. These systems are in good condition.

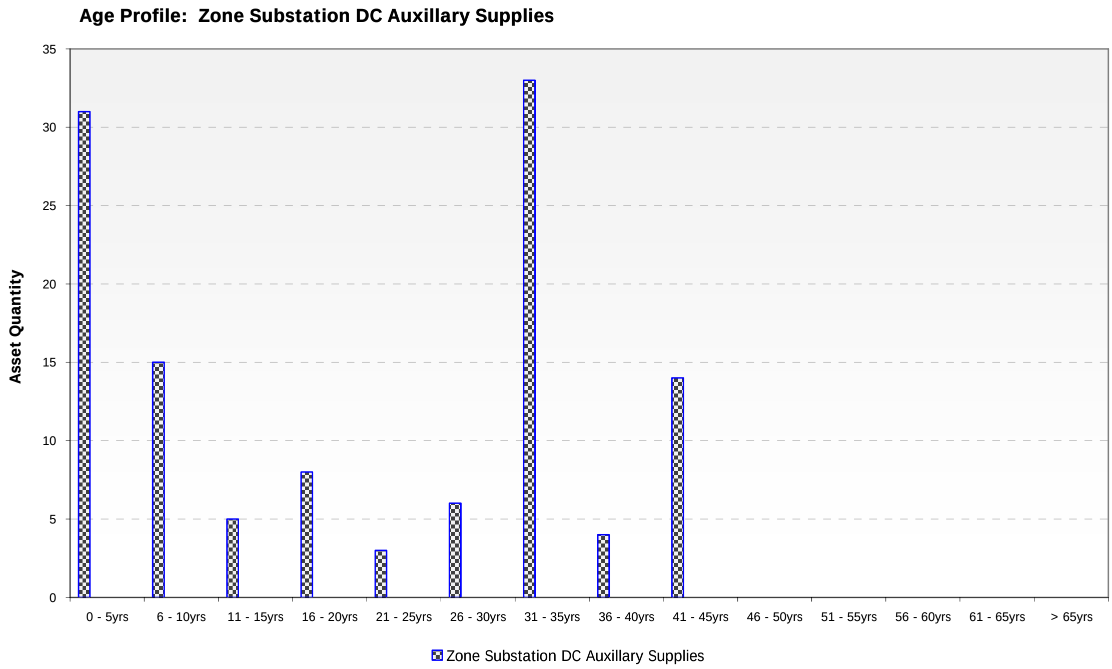


*Figure 5.9* DC auxiliary supplies age profile

Vector's standard DC auxiliary systems comprise of batteries, battery charger, DC/DC converters and battery monitoring system.

The major substations are equipped with a redundant DC auxiliary system.

### 5.9.2. ASSET MAINTENANCE

Maintenance for the VRLA batteries 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).

### 5.9.3. ASSET RENEWAL AND REFURBISHMENT

In all networks batteries are replaced, using VRLA batteries, as they fail or based on condition assessment results.

## 5.10. SCADA

### 5.10.1. ASSET DESCRIPTION

The SCADA system consists of three sub-systems, the main SCADA master-station, the ripple control and metering system, and the remote terminal units (RTUs). The

RTU's are located at grid exit points and zone substations for operational control and network status indication. Due to their age the RTUs are only in a fair condition. Control over the networks is managed via the centralised Control Room situated in Auckland

#### 5.10.2. ASSET MAINTENANCE

The SCADA system offers in-built self-diagnostic capabilities flagging any defects to the Control Room staff. Existing SCADA RTU's do not have full back up and maintenance is based on failure.

A proportion of the RTUs have reached the end of their technical life and are due for replacement.

#### 5.10.3. ASSET RENEWAL AND REFURBISHMENT

Vector has embarked on a planned replacement programme of the RTUs. With ten RTUs replaced annually per region. The SCADA integration strategy enables Vector to deploy standard RTUs (e.g. from Foxboro or Serce) as the replacements across the networks.

### 5.11. ENERGY AND PQ METERS

#### 5.11.1. ASSET DESCRIPTION

Vector's bulk metering systems consists of 35 intelligent web-enabled revenue class energy and power quality meters communicating within the metering central server over an Ethernet based IP routed communication network.

The system provides Vector with essential information to manage GXP charges, quality and reliability of the power delivered to Vector's customers.

It is currently used to:

- Improve operational efficiency by controlling peak demands at the grid exit points, which ultimately reflects in reduced line charges to Vector's customers

- Provide comprehensive power quality and reliability information that will enable the verification of quality of power delivered to our customer's against the published Vector service levels, and faster resolutions of power quality issues

- Increase the power supply stability by initiating instantaneous load shedding during grid under frequency events

These meters have been installed since 1999 are still relatively new and in very good condition.

### 5.11.2. ASSET MAINTENANCE

Planned maintenance is based on a four yearly inspection cycle carried out in conjunction with the protection relays. As these devices are intelligent any malfunction is notified promptly to the master station enabling remedial actions to be undertaken as necessary.

### 5.11.3. ASSET RENEWAL AND REFURBISHMENT

These assets have a technical life of 15 to 20 years. They will be scheduled for replacement based on service history, reliable operation and age.

Year 2007/08 projects

- There are no planned replacements in this period

Years 2008/09 – 2011/12 projects

- There are no planned replacements in this period

Years 2012/13 – 2016/17 projects

- Replacement will be considered from 2014 depending on performance

## 5.12. DC SYSTEM

### 5.12.1. ASSET DESCRIPTION

Vector provides a 550V DC supply to the trolley buses in Wellington. This supply originates from 15 distributed substations, containing 15 converter transformers, 19 mercury arc rectifiers, 2 solid state rectifiers and 53 DC circuit breakers. To provide backup supply, in case of faults, there is approximately 53 km of DC underground cables linking the substations.

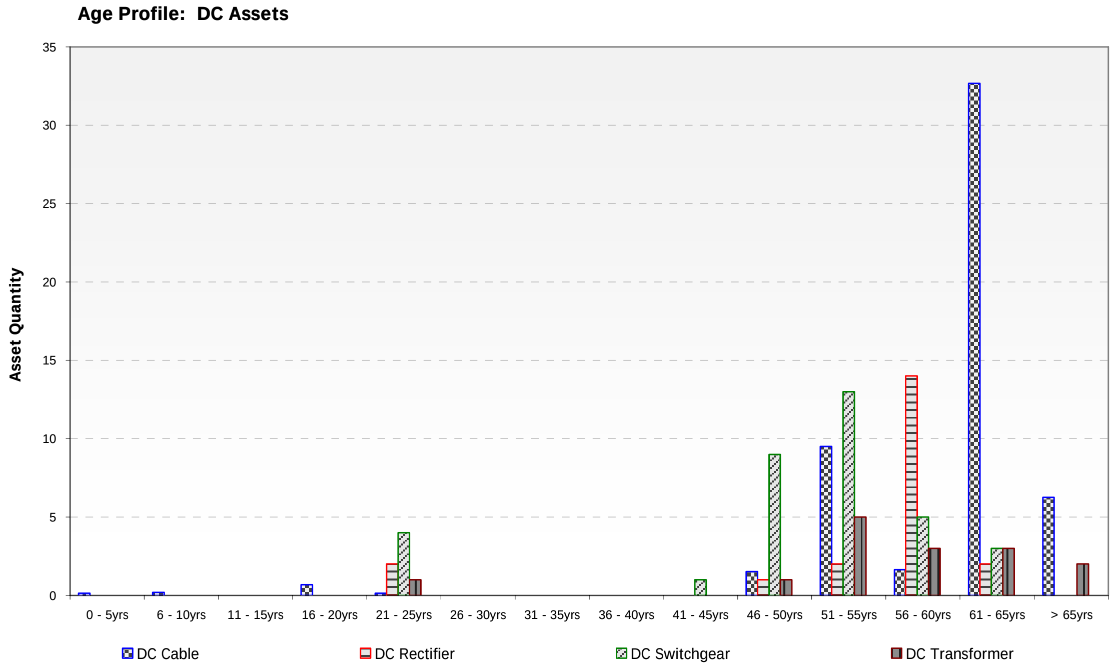


*Figure 5.10* DC equipment age profiles

These assets have an average age of 55 years and have exceeded their technical life and they are in a fair to poor condition. These assets are used to supply a single customer and Vector is currently in negotiations over the ongoing needs of the DC system together with the level of service expected. Such an agreement is necessary to fund the ongoing operation, maintenance, refurbishment and replacement of the assets. Without an agreement, the assets will be decommissioned.

### 5.12.2. ASSET MAINTENANCE

In late 2005 – early 2006 Vector undertook an extensive review of these assets. As a result, an upgrade and maintenance plan has been developed for the next 10 years. The implementation of this plan, however, requires the customer to commit to funding.

Vector has implemented a detailed inspection and condition monitoring program to assess remaining life and identify any potential issues. This includes;

- Thermal imaging on all assets
- Transformer oil dissolved gas analysis
- Ductor tests and trip testing on the DC circuit breakers
- Arc drop tests and tank to cathode voltage tests on the mercury arc rectifiers
- Insulation tests on a sample of underground cable

These tests are undertaken on an annual basis.

The transformer tests all show high levels of contamination of the oil with six of the fifteen having signs of overheating and partial discharge indicating possible thermal faults.

The mercury arc rectifiers test results indicate that the integrity of the vacuum is deteriorating which is an end of life indicator.

If continued service is required there are a number of maintenance and safety concerns that will need to be attended to such as:

- Covering of exposed live components on the DC circuit breakers
- Replacement of the asbestos lining in the circuit breaker arc chutes
- Bunding for any mercury spill containment
- Refurbishment of the replaced transformers to keep for contingencies

### 5.12.3. ASSET RENEWAL AND REFURBISHMENT

The current practice is to allow these assets to run to fail. Repairs are completed if cost effective or the asset is replaced from the spares held.

As noted above, if continued service is required, the asset upgrade and maintenance plan developed by Vector will need to be implemented. This requires customer commitment to funding and would include asset renewal projects consisting of the following.

Year 2007/08 projects

- Replace four converter transformers with new units
- Procure three solid state rectifiers to be kept as spares
- Upgrade the protection on the DC circuit breakers to facilitate faster response to faults

Years 2008/09 – 2011/12 projects

- Replace two converter transformers
- Replace rectifiers as they fail from spares holding

Years 2012/13 – 2016/17 projects

- Asset replacement as required due to faults

# 5.13. DISTRIBUTION TRANSFORMERS

## 5.13.1. ASSET DESCRIPTION

Vector owns and operates approximately 24,747 distribution transformers of which 61% are ground mounted and 39% are pole mounted. Ground mounted transformers are either stand alone, enclosed in metal or fibreglass canopies, open enclosures or fully enclosed within other buildings. The transformers are generally 11kV/415V and rated between 30 and 1,500kVA, although there are a small number rated at 1.5kVA, 5kVA, 7.5kVA and 10kVA. There are also a small number of 6.6kV/415V transformers. With the development of the 22kV distribution network in the Auckland CBD, 22kV/415V transformers are also being used. There are also some 11/6.6kV auto transformers for special applications.

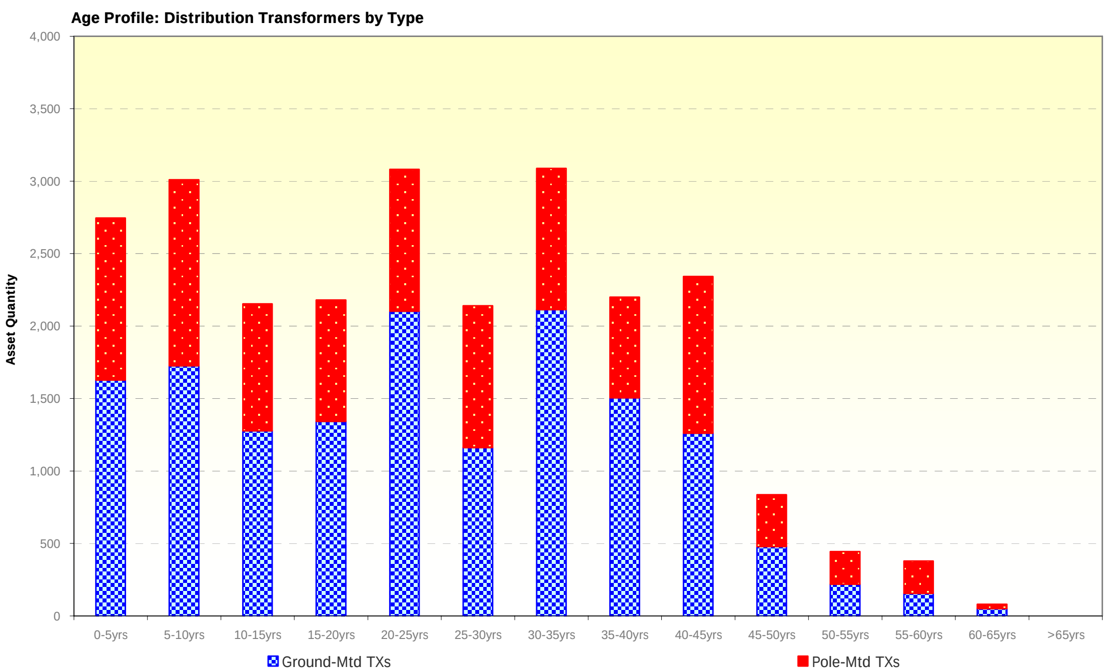


*Figure 5.11 Distribution transformers age profile*

In general asset condition has improved due to recent renewal programmes across all networks. Generally, replacements have been due to rust and minor oil leaks and many of these transformers have been replaced with refurbished transformers.

## 5.13.2. ASSET MAINTENANCE

Transformers are inspected for defects at cyclic intervals as shown in Table 5.3

| DISTRIBUTION SUBSTATION PREVENTATIVE MAINTENANCE | AUCKLAND[11] | WELLINGTON |
|---|---|---|
| Earthing System Inspection & Testing | 5 Yr | 5 Yr |
| Enclosure Inspection | 12 Month/4 Yr | 12 Month |
| Equipment Inspection | 3 Yr/6 Month | 12 Month |
| Remote Function Inspection & Testing | 12 Month/Nil | Nil |
| Switchgear Service | 8 Yr | 8 Yr |
| Transformer Load Reading | 3 Yr/Nil | Nil |

*Table 5.3 Distribution Transformer Test and Inspection Schedule*

Opportunities to align maintenance frequencies across the regions will be taken as appropriate.

Onsite repairs are generally minor i.e. oil top up, replacement of bolts, minor rust treatment and paint repairs. Where it is uneconomical to complete onsite and the asset poses a safety or reliability risk before the next inspection cycle the asset is replaced.

The main cause of transformer failure is mechanical (not electrical) summarised as two subgroups:

- Some transformers installed between 1998 and 2001 have been identified as prematurely rusting. Estimated to be 2% of population
- Ground mounted transformers, approximately 25 years old, have increased risk of non compliance due to excessive rust or oil leaks. Estimated to be 5% of the population

### 5.13.3. ASSET RENEWAL AND REFURBISHMENT

Transformer replacement is determined from condition criteria, accessed during regular inspection. Any transformer failure is investigated as to cause and a cost/benefit decision made to repair, refurbish, replace or scrap the asset.

The refurbishment and replacement of transformers is an ongoing program with budget allocated each year. Work packages are developed by each of Vector's contracting partners based on the results of condition inspections.

[11] Dependent on terms of Maintenance Contract

# 5.14. GROUND MOUNTED DISTRIBUTION SWITCHGEAR

## 5.14.1. ASSET DESCRIPTION

Vector owns and operates over 3,905 ground mounted switchgear, made up of oil, $SF_6$ and resin insulated equipment of varying ages and manufacturers. Generally the switchgear is 11kV but there is a small quantity of 6.6kV units.

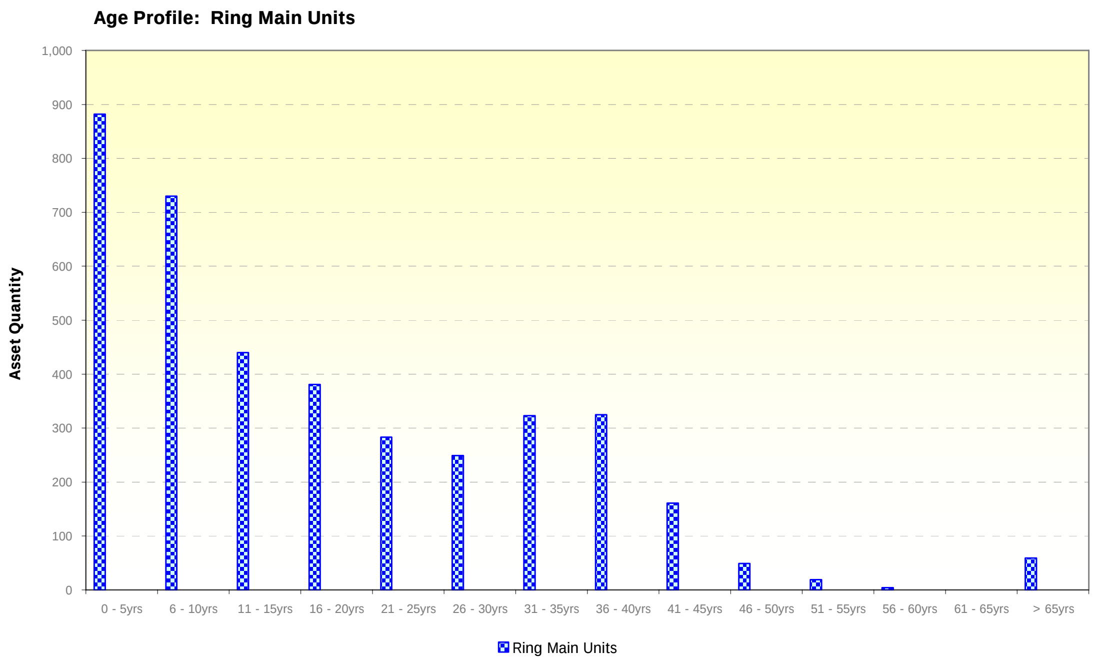


*Figure 5.12 Ground mounted distribution switchgear age profile*

In general, these assets have had recent renewal programmes similar to the distribution transformers. To a lesser degree replacements have been driven by transformer replacement, by either the switchgear being physically attached to a transformer or where there is an opportunity to replace during other work. Other general causes for replacement are vehicle damage, minor oil leaks and corrosion. Replacement switchgear provides benefits of safer and more reliable operation, with less maintenance.

## 5.14.2. ASSET MAINTENANCE

Switchgear is visually inspected every three years with a full service every eight years. The full service includes both electrical testing and mechanical service. Currently the Live Tank Oil Sampling (LTOS) methodology is being evaluated and depending on results this may replace the eight year service. Magnefix switchgear is selectively cleaned every 3 years following visual inspection. Minor defects are generally repaired onsite i.e. oil top up, replacement of bolts, minor rust treatment and paint repairs. Where it is unsafe, uneconomic or impractical to complete repairs onsite asset is replaced.

### 5.14.3. ASSET RENEWAL AND REFURBISHMENT

Switchgear replacement is based on condition and availability of components for repair. Any switchgear failure is investigated as to cause and a cost/benefit decision made to repair, refurbish, replace or scrap the asset.

As part of Vector's continual improvement process the use of oil filled switchgear has been reviewed and other types of switchgear investigated. The result has been a change in specification and implementation of $SF_6$ and vacuum switchgear in selected locations.

Refurbishment and replacement of switchgear is an ongoing program with budget allocated each year. Work packages are developed by each of Vector's contracting partners based on results from the condition inspections.

## 5.15. MOBILE GENERATOR CONNECTION UNITS

### 5.15.1. ASSET DESCRIPTION

Vector has two Mobile Generator Connection Units (MGCU) for use during prolonged power outages. These units are transported to site and coupled to hired generators to restore temporary power. Each MGCU comprises a 2.5MVA 415V/11kV transformer, LV and 11kV switchgear, protection and accessories. Both MGCUs were commissioned in 2005.

### 5.15.2. ASSET MAINTENANCE

Routine inspections and maintenance will be carried out in accordance with the maintenance standards for each type of equipment used. When the MGCU's are not in use they are connected to a LV supply to keep the batteries fully charged.

### 5.15.3. ASSET RENEWAL AND REFURBISHMENT

As the two MGCUs are relatively new there are no plans any refurbishment or asset replacement at this time.

# 5.16. POWER FACTOR CORRECTION PLANT

## 5.16.1. ASSET DESCRIPTION

There are a number of capacitor banks installed across the network to correct power factor and provide voltage support.

In the Auckland network there are currently 25 zone substation 11kV bus connected capacitor banks ranging in size from 3MVAr to 9MVAr. There are also 75 pole mounted 11kV capacitor banks rated at 750 kVAr and 2 ground mounted 33kV bus connected capacitor banks rated at 18MVAr.

The majority of the 11KV capacitor banks were installed during the spring of 1998/99 as a cost effective means to ratify a Transpower VAR Support Agreement.

The condition of the indoor capacitor bank assets in the Auckland network is generally good. All vacuum switches have been replaced with 3 phase contactors.

## 5.16.2. ASSET MAINTENANCE

The Auckland network capacitor banks have an annual service which includes checking the operation of equipment, cooling fan operation and earthing, cleaning primary equipment and filters, and a visual inspection of all components.

Also a four yearly major service is undertaken which covers secondary injection on SPAJ140 and SPAJ160 relays, checking operation of LOGO and RVS unit, IR and Ductor on SF6 CB, IR on vacuum switches, capacitance measurements and primary injection on reactors.

Overhead capacitor banks have a 12 monthly visual inspection and an 8 year major maintenance refurbishment.

## 5.16.3. ASSET RENEWAL AND REFURBISHMENT

Replacement decisions are based on condition, age, location, criticality and performance. Replacement expenditure may be required on the switched overhead units. These switches have a stated mechanical life of 10,000 operations but there is no planned replacement program at this time.

## 5.17. ASSET VALUE

The value of the assets on Vector's network are summarized in Table 5.4. The information is derived from the ODV Report – March 2004.

| Asset Category | Value ($million) |
|---|---:|
| Sub-transmission | $380.3 |
| Zone substations | $216.7 |
| Distribution cables and lines | $468.6 |
| Distribution switchgear | $109.8 |
| Distribution transformers | $148.5 |
| Distribution substations | $69.6 |
| Distribution miscellaneous | $4.0 |
| LV distribution | $370.5 |
| Other assets | $28.5 |
| Service connections | $60.8 |
| DC | $1.0 |
| **Total** | **$1,858.4** |

Source: ODV Report March 2004

*Table 5.4 Asset Value by Category*

The information contained in Table 5.4 is very much out of date with a new valuation due in 2008. Over the intervening years, Vector has experienced rapid input cost increases. Figure 5.13 charts the global increase in the costs over the last three years, in the power utility area. Vector own costs have shown similar dramatic increases over the same period. Table 5.5 shows the price increases for specific network equipment purchased for use on the Vector network for the same period. The costs are reflected back into the capital works but are not necessarily covered by the CPI-X Price Path regulatory thresholds.


*Figure 5.13 Capital Goods Price Inflation – Power Lines Index*

| Item | Price increase since 2004 |
|---|---|
| 20MVA transformers | 66% |
| 10MVA transformers | 82% |
| 11kV 300mm² cable | 20% |
| 400V 185mm² cable | 20% |
| 11kV circuitbreaker | 9% |

*Table 5.5 Equipment Price increases (Jan04 – Dec06)*

## 5.18. BUDGETS

### 5.18.1. FORECAST NETWORK MAINTENANCE EXPENDITURE

The operational expenditure shown in Figure 5.14 represents the range of spend trajectories Vector could plan to follow (lower line), or follow reactively (upper line).

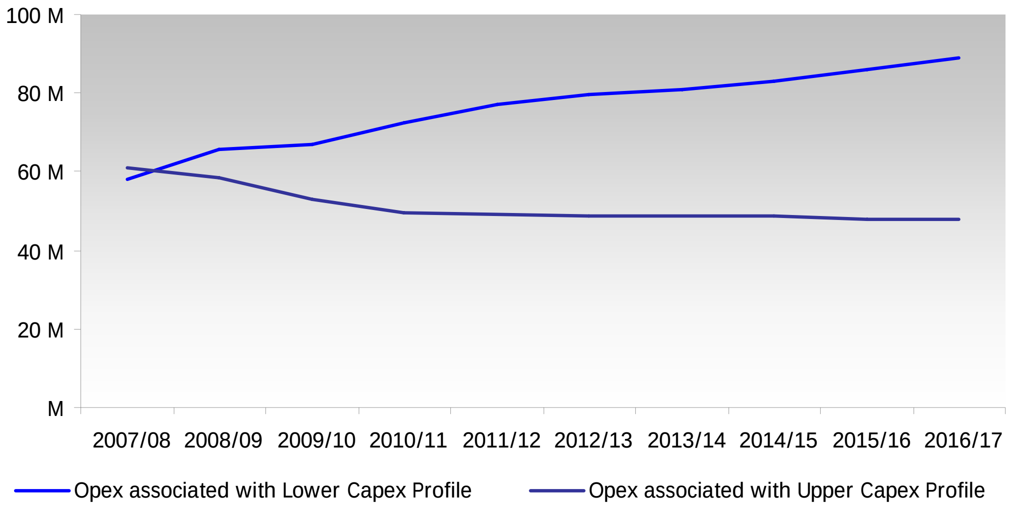


*Figure 5.14 Maintenance Expenditure Profile*[12]

It needs to be read in conjunction with the capital expenditure ranges in Figure 4.13 to understand the connection between the "run to failure" capex expenditure line (lower line in Figure 4.13) and escalating fault expenditure (upper line in Figure 5.14). As we gain clarity on future regulatory requirements for quality of supply, customer satisfaction, rate of return, and other parameters that impact investment decisions, a more definitive strategy can be communicated.

The opex (upper line - Figure 5.14) associated with the lower capex profile (Figure 4.13) represents the minimum expenditure that Vector must commit in order to comply with its legal obligations. It does not include any expenditure on non-legislated preventative maintenance or rectification of identified defects with the exception of those identified as legislated. The profile includes the rapidly escalating fault costs which result from this maintenance strategy and minimum capital expenditure profile.

The opex (lower line - Figure 5.14) associated with the upper capex profile (Figure 4.13) represents a level of expenditure that will enable Vector to manage its network assets in an optimum "whole of life" approach, including enhanced vegetation management, outside of the first-cut provisions, to assist in the management of reliability, minimizing faults and respond to asset replacement in a planned manner.

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[12] Maintenance expenditure is based on 2006$

Table 5.6 shows the breakdown of preventative and provisional maintenance expenditure as a subset of the lower opex profile shown in Figure 5.14 but corresponds to the upper capex expenditure profile in Figure 4.13. The complete opex expenditure, corresponding to the lower opex line in Figure 5.14 is shown in Table 5.7.

Table 5.8 shows the breakdown of preventative and provisional maintenance expenditure corresponding to the upper opex profile shown in Figure 5.14 but aligning to the lower capex expenditure profile in Figure 4.13. The complete opex expenditure, corresponding to the upper opex line in Figure 5.14 is shown in Table 5.9

Table 5.10 shows the asset renewal and refurbishment expenditure associated with the upper capex profile shown in Figure 4.13 while Table 5.11 shows the expenditure associated with the lower capex profile

| Preventative Maintenance | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Asset Type | Asset Category | FY0708 | FY0809 | FY0910 | FY1011 | FY1112 | FY1213 | FY1314 | FY1415 | FY1516 | FY1617 |
| Distribution | Circuit Breakers | $522k | $522k | $522k | $522k | $522k | $522k | $522k | $522k | $522k | $522k |
| | DC System | $5k | $5k | $5k | $5k | $5k | $5k | $5k | $5k | $5k | $5k |
| | Distribution Cable | $930k | $930k | $930k | $930k | $930k | $930k | $930k | $930k | $930k | $930k |
| | Distribution Transformers | $1875k | $1875k | $1875k | $1875k | $1875k | $1875k | $1875k | $1875k | $1875k | $1875k |
| | Ground Mounted Switchgear | $1283k | $1283k | $1283k | $1283k | $1283k | $1283k | $1283k | $1283k | $1283k | $1283k |
| | Overhead Network | $2298k | $2298k | $2298k | $2298k | $2298k | $2298k | $2298k | $2298k | $2298k | $2298k |
| | Power Factor Correction Plant | $11k | $11k | $11k | $11k | $11k | $11k | $11k | $11k | $11k | $11k |
| | Power System Protection | $118k | $118k | $118k | $118k | $118k | $118k | $118k | $118k | $118k | $118k |
| | Substation DC Auxillary Supply | $40k | $40k | $40k | $40k | $40k | $40k | $40k | $40k | $40k | $40k |
| Sub-Transmission | Subtransmission Cable | $352k | $352k | $352k | $352k | $352k | $352k | $352k | $352k | $352k | $352k |
| Zone Substation | Circuit Breaker | $561k | $561k | $561k | $561k | $561k | $561k | $561k | $561k | $561k | $561k |
| | Power Factor Correction Plant | $52k | $52k | $52k | $52k | $52k | $52k | $52k | $52k | $52k | $52k |
| | Power System Protection | $430k | $430k | $430k | $430k | $430k | $430k | $430k | $430k | $430k | $430k |
| | SCADA | $97k | $97k | $97k | $97k | $97k | $97k | $97k | $97k | $97k | $97k |
| | Substation DC Auxillary Supply | $163k | $163k | $163k | $163k | $163k | $163k | $163k | $163k | $163k | $163k |
| | Subtransmission Transformers | $316k | $316k | $316k | $316k | $316k | $316k | $316k | $316k | $316k | $316k |
| | Zone Substation Buildings | $1006k | $1006k | $1006k | $1006k | $1006k | $1006k | $1006k | $1006k | $1006k | $1006k |
| | Preventative Total | **$10059k** | **$10059k** | **$10059k** | **$10059k** | **$10059k** | **$10059k** | **$10059k** | **$10059k** | **$10059k** | **$10059k** |
| Provisional Preventative Maintenance | | | | | | | | | | | |
| Asset Type | Asset Category | FY0708 | FY0809 | FY0910 | FY1011 | FY1112 | FY1213 | FY1314 | FY1415 | FY1516 | FY1617 |
| Distribution | Distribution Cable | $797k | $797k | $797k | $797k | $797k | $797k | $797k | $797k | $797k | $797k |
| | Distribution Transformers | $2308k | $2308k | $2308k | $2308k | $2308k | $2308k | $2308k | $2308k | $2308k | $2308k |
| | Ground Mounted Switchgear | $890k | $890k | $890k | $890k | $890k | $890k | $890k | $890k | $890k | $890k |
| | Overhead Network | $1587k | $1587k | $1587k | $1587k | $1587k | $1587k | $1587k | $1587k | $1587k | $1587k |
| Sub-Transmission | Subtransmission Cable | $2263k | $2263k | $2263k | $2263k | $2263k | $2263k | $2263k | $2263k | $2263k | $2263k |
| Zone Substation | Circuit Breakers | $280k | $280k | $280k | $280k | $280k | $280k | $280k | $280k | $280k | $280k |
| | Energy and PQ Meters | $5k | $5k | $5k | $5k | $5k | $5k | $5k | $5k | $5k | $5k |
| | Overhead Network | $42k | $42k | $42k | $42k | $42k | $42k | $42k | $42k | $42k | $42k |
| | Power Factor Correction Plant | $20k | $20k | $20k | $20k | $20k | $20k | $20k | $20k | $20k | $20k |
| | Power System Protection | $121k | $121k | $121k | $121k | $121k | $121k | $121k | $121k | $121k | $121k |
| | SCADA | $537k | $537k | $537k | $537k | $537k | $537k | $537k | $537k | $537k | $537k |
| | Substation DC Auxillary Supply | $88k | $88k | $88k | $88k | $88k | $88k | $88k | $88k | $88k | $88k |
| | Subtransmission Cable | $15k | $15k | $15k | $15k | $15k | $15k | $15k | $15k | $15k | $15k |
| | Subtransmission Transformers | $568k | $568k | $568k | $568k | $568k | $568k | $568k | $568k | $568k | $568k |
| | Zone Substation Buildings | $705k | $705k | $705k | $705k | $705k | $705k | $705k | $705k | $705k | $705k |
| | Provisional Preventative Total | **$10226k** | **$10226k** | **$10226k** | **$10226k** | **$10226k** | **$10226k** | **$10226k** | **$10226k** | **$10226k** | **$10226k** |

*Table 5.6 Preventative & Provisional Preventative Opex Expenditure Associated with the Upper Capex profile (ref: Figure 4.13) and Lower Opex profile (ref: Figure 5.14)*

| Category | FY0708 | FY0809 | FY0910 | FY1011 | FY1112 | FY1213 | FY1314 | FY1415 | FY1516 | FY1617 |
|---|---|---|---|---|---|---|---|---|---|---|
| Preventive | $10M | $10M | $10M | $10M | $10M | $10M | $10M | $10M | $10M | $10M |
| Provisonal | $10M | $10M | $10M | $10M | $10M | $10M | $10M | $10M | $10M | $10M |
| Vegetation | $11M | $10M | $6M | $3M | $3M | $3M | $3M | $3M | $2M | $2M |
| Remedial | $30M | $28M | $26M | $26M | $25M | $25M | $25M | $25M | $25M | $25M |
| **Grand Total** | **$61M** | **$58M** | **$53M** | **$49M** | **$49M** | **$49M** | **$49M** | **$49M** | **$48M** | **$48M** |

*Table 5.7 Preventative & Provisional Preventative Opex Expenditure Associated with the Upper Capex profile (ref: Figure 4.13) and Lower Opex profile (ref: Figure 5.14)*

| Preventative Maintenance | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Asset Type | Asset Category | FY0708 | FY0809 | FY0910 | FY1011 | FY1112 | FY1213 | FY1314 | FY1415 | FY1516 | FY1617 |
| Distribution | Distribution Cable | $834k | $834k | $834k | $834k | $834k | $834k | $834k | $834k | $834k | $834k |
| | Distribution Transformers | $1687k | $1687k | $1687k | $1687k | $1687k | $1687k | $1687k | $1687k | $1687k | $1687k |
| | Overhead Network | $1708k | $1708k | $1708k | $1708k | $1708k | $1708k | $1708k | $1708k | $1708k | $1708k |
| | Power System Protection | $112k | $112k | $112k | $112k | $112k | $112k | $112k | $112k | $112k | $112k |
| Zone Substation | Power Factor Correction Plant | $10k | $10k | $10k | $10k | $10k | $10k | $10k | $10k | $10k | $10k |
| | Power System Protection | $390k | $390k | $390k | $390k | $390k | $390k | $390k | $390k | $390k | $390k |
| | SCADA | $1k | $1k | $1k | $1k | $1k | $1k | $1k | $1k | $1k | $1k |
| | Zone Substation Buildings | $388k | $388k | $388k | $388k | $388k | $388k | $388k | $388k | $388k | $388k |
| Preventative Total | | **$5131k** | **$5131k** | **$5131k** | **$5131k** | **$5131k** | **$5131k** | **$5131k** | **$5131k** | **$5131k** | **$5131k** |
| Provisional Preventative Maintenance | | | | | | | | | | | |
| Asset Type | Asset Category | FY0708 | FY0809 | FY0910 | FY1011 | FY1112 | FY1213 | FY1314 | FY1415 | FY1516 | FY1617 |
| Distribution | Distribution Cable | $797k | $797k | $797k | $797k | $797k | $797k | $797k | $797k | $797k | $797k |
| | Distribution Transformers | $2308k | $2308k | $2308k | $2308k | $2308k | $2308k | $2308k | $2308k | $2308k | $2308k |
| | Ground Mounted Distribution Switchgear | $890k | $890k | $890k | $890k | $890k | $890k | $890k | $890k | $890k | $890k |
| | Overhead Network | $1411k | $1411k | $1411k | $1411k | $1411k | $1411k | $1411k | $1411k | $1411k | $1411k |
| Sub-Transmission | Subtransmission Cable | $573k | $573k | $573k | $573k | $573k | $573k | $573k | $573k | $573k | $573k |
| Zone Substation | Energy and PQ Meters | $5k | $5k | $5k | $5k | $5k | $5k | $5k | $5k | $5k | $5k |
| | Power System Protection | $76k | $76k | $76k | $76k | $76k | $76k | $76k | $76k | $76k | $76k |
| | Zone Substation Buildings | $650k | $650k | $650k | $650k | $650k | $650k | $650k | $650k | $650k | $650k |
| Provisional Preventative Total | | **$6710k** | **$6710k** | **$6710k** | **$6710k** | **$6710k** | **$6710k** | **$6710k** | **$6710k** | **$6710k** | **$6710k** |

*Table 5.8 Preventative & Provisional Preventative Opex Expenditure Associated with the Lower Capex profile (ref: Figure 4.13) and Upper Opex profile (ref: Figure 5.14)*

| Expenditure Category | FY0708 | FY0809 | FY0910 | FY1011 | FY1112 | FY1213 | FY1314 | FY1415 | FY1516 | FY1617 |
|---|---|---|---|---|---|---|---|---|---|---|
| Preventive | $5M | $5M | $5M | $5M | $5M | $5M | $5M | $5M | $5M | $5M |
| Provisonal | $7M | $7M | $7M | $7M | $7M | $7M | $7M | $7M | $7M | $7M |
| Vegetation | $8M | $7M | $3M | $3M | $3M | $3M | $3M | $3M | $2M | $2M |
| Remedial | $38M | $47M | $52M | $57M | $62M | $65M | $66M | $68M | $72M | $75M |
| **Grand Total** | **$58M** | **$66M** | **$67M** | **$72M** | **$77M** | **$80M** | **$81M** | **$83M** | **$86M** | **$89M** |

*Table 5.9 Preventative & Provisional Preventative Opex Expenditure Associated with the Lower Capex profile (ref: Figure 4.13) and Upper Opex profile (ref: Figure 5.14)*

| Expenditure Category | FY0708 | FY0809 | FY0910 | FY1011 | FY1112 | FY1213 | FY1314 | FY1415 | FY1516 | FY1617 |
|---|---|---|---|---|---|---|---|---|---|---|
| Renewal | $64M | $69M | $79M | $75M | $96M | $98M | $109M | $104M | $110M | $114M |
| Other - Security Upgrades, etc. | $3M | $2M | $2M | $2M | $2M | $2M | $2M | $2M | $2M | $2M |
| **Grand Total** | **$67M** | **$72M** | **$81M** | **$77M** | **$98M** | **$100M** | **$111M** | **$106M** | **$112M** | **$117M** |

*Table 5.10 Renewal Expenditure based on the upper Capex profile (ref: Figure 4.13)*

| Expenditure Category | FY0708 | FY0809 | FY0910 | FY1011 | FY1112 | FY1213 | FY1314 | FY1415 | FY1516 | FY1617 |
|---|---|---|---|---|---|---|---|---|---|---|
| Renewal | $25M | $18M | $13M | $12M | $10M | $9M | $9M | $8M | $8M | $9M |
| Other - Security Upgrades, etc. | $0M | $0M | $0M | $0M | $0M | $0M | $0M | $0M | $0M | $0M |
| **Grand Total** | **$25M** | **$18M** | **$13M** | **$12M** | **$10M** | **$9M** | **$9M** | **$8M** | **$8M** | **$9M** |

*Table 5.11 Renewal Expenditure based on the lower Capex profile (ref: Figure 4.13)*

# 6. RISK MANAGEMENT

Risk management in Vector is an integral part of the asset management process. The consequences and likelihood of failure or non-performance, current controls to manage this, and required actions to make risks acceptable are all understood and evaluated as part of the asset management function.

Risks associated with the assets or operations of the network are evaluated, prioritised and dealt with as part of the asset maintenance, refurbishment and replacement programmes, and work practices. The acceptable level of risk will differ depending upon the level of risk our customers and the communities in which we work are willing to accept and the circumstances and the environment in which the risk will occur. This analysis ranges from high frequency but low impact events, such as tree interference, through to low probability events with high impact such as the total loss of a zone substation for an extended period.

Risk associated with assets are managed in Vector by a combination of:

- Reducing the probability of the failure, through the capital and maintenance work programme and enhanced working practices

- Reducing the impact of failure, through contingency and emergency plan development and insurance

The capital and maintenance asset risk management strategies are outlined in the Asset Maintenance and Development sections. Vector's contingency and emergency planning is based around procedures for restoring power in the event of a fault occurring on the network, and are detailed in Section 6.5.

## 6.1. RISK ACCOUNTABILITY AND AUTHORITY

### 6.1.1. VECTOR BOARD RISK AND ASSURANCE COMMITTEE

The Board oversees risk management for the Vector Group as a key part of its corporate governance responsibilities.

It has a specific committee designated to review risk and assurance across the Group, the Board Risk and Assurance Committee (BRAC). Key aspects of this role include endorsing the risk context under which Vector operates, and overseeing the Internal Audit and Insurance Programmes.

The BRAC meets regularly to review the Group's risk context, the Group's most serious risks, and key controls which includes the Internal Audit and Insurance programmes.

Specific risk issues are raised with the Board on an ongoing basis within the normal management reporting functions to the Board. These include Electricity Business related asset management and security of supply issues including capital expenditure approvals.

### 6.1.2. EXECUTIVE RISK COMMITTEE

The Executive Risk Management and Assurance Committee (ERMAC), which reports through to the BRAC, oversees and monitors the implementation of appropriate and consistent risk management across Vector by:

- Developing and maintaining for the Board's review and approval, a risk management policy consistent with the company's objectives

- Overseeing and monitoring the implementation of risk management processes to ensure compliance with the risk management policy

The ERMAC meets on a six weekly basis. It reviews the key risks facing the group including the most significant risks in the Electricity Business.

A key to the delivery of assurance for Vector is the Internal Audit programme managed at a corporate level, although directly reporting through to the BRAC.

The aim of the audit is to consider:

- The extent to which Vector is applying its risk management and, control and assurance structures, accountabilities, processes and reporting mechanisms in support of its risk management and corporate governance policies

- Opportunities for improving Vector's established risk management and corporate Governance policies, structures, accountabilities, processes and reporting mechanisms in support of the company's business goals

### 6.1.3. ELECTRICITY BUSINESS MANAGEMENT TEAM RISK MANAGEMENT STRUCTURE

The Electricity Business management team, made up of the unit's CEO and Direct Reports, meet monthly to oversee the operation of risks management and assurance within the Electricity Business. Strategic and operational risk categories are reviewed. High level risks are reported in the strategy register while more detailed operational risks are captured in a second register.

The role of the Electricity Business management team is to:

- Develop and maintain a systematic approach to risk management and assurance
- Monitor risks and their management regularly - this includes the effectiveness of Controls and progress of Treatments
- Develop a systematic assurance programme for the unit
- Report to the ERMAC twice annually and Board as required, but at least annually

During monthly risk meetings, new risks are reviewed and risks within a specific section of the Electricity Business are given specific focus. Those areas with risks assigned to them include, but are not limited to, Engineering (Network Planning and Asset Management Strategy), Service Delivery (Asset Maintenance) and Capital Delivery functions. Risks are managed through analysis, treatments and controls.

## 6.2. RISK MANAGEMENT PROCESS

The Vector risk management process is based on the risk management standard AS/NZ4360.

The criticality of risk is determined on the basis of "likelihood" and "consequences" of the event associated with the risk occurring. The combination of these two is used to prioritise the level of controls to manage the risk

The most significant risks have visibility through to the ERMAC and to the BRAC.

The risk management process adopted by Vector is shown in Figure 6.1.

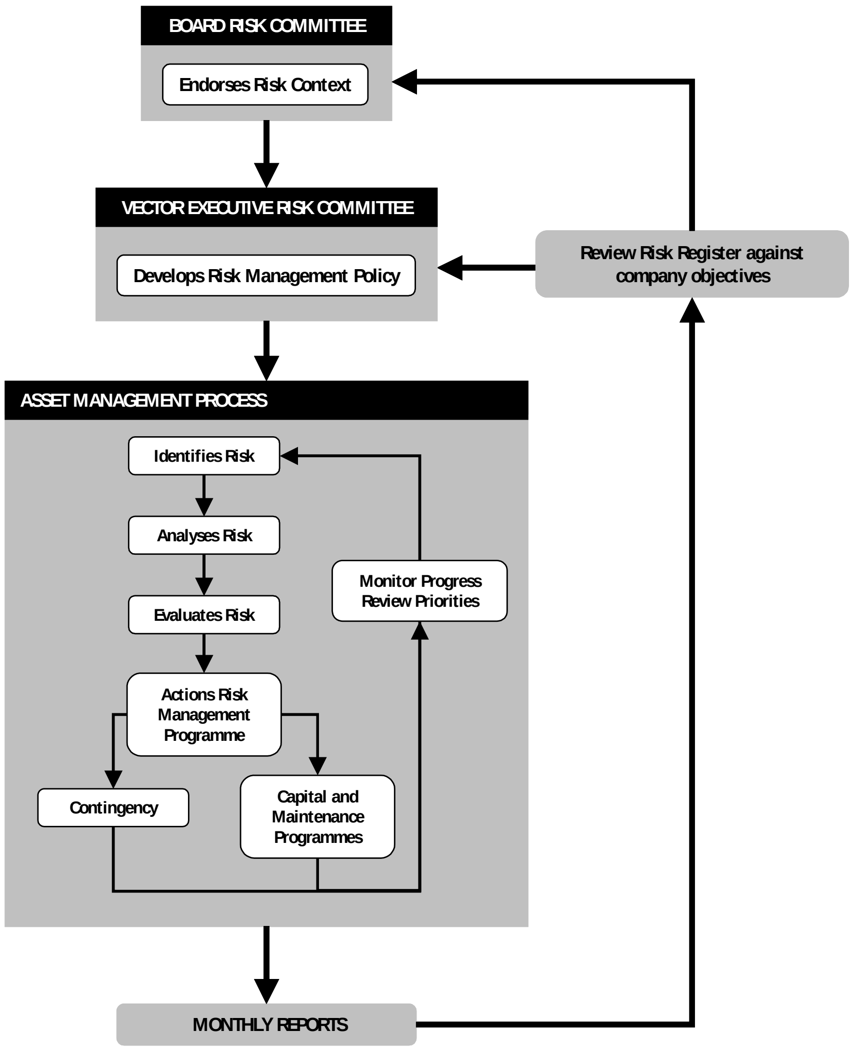


*Figure 6.1 Vector's Risk Management Process (Based on AS/NZ4360)*

Vector's risk management policy is defined to ensure that:

- All risks to the business are identified, understood and works prioritised to mitigate the effects are in place

- Practices that could cause injury, environment or reputation damage, or financial loss are understood, documented and managed

## 6.3. RISK IDENTIFICATION AND ANALYSIS

The risks are evaluated against the risk matrix shown in Figure 6.2

**Risk Assessment**

| | Minor | Moderate | Serious | Major | Catastrophic |
|---|---|---|---|---|---|
| **Frequent** | H | H | VH | E | E |
| **Likely** | M | H | VH | VH | E |
| **Possible** | L | M | H | VH | VH |
| **Unlikely** | L | M | M | H | VH |
| **Rare** | L | L | L | M | H |

**Risk Assessment Using Consequence And Likelihood**

L = Low

M = Moderate

H = High

VH = Very High

E = Extreme

Red = Board Attention

Orange = Executive Attention

Green = Management Attention

*Figure 6.2 Vector's Risk Prioritisation Matrix*

Risks which have *Catastrophic* or *Major* risk consequences include risks which could lead to loss of life, significant sustained loss of reputation, or financial loss of a magnitude sufficient to impact negatively on the company.

## 6.4. RISK MANAGEMENT PROGRAMME

The Electricity Business maintains an operational risk register, which is formally updated on a monthly basis for presentation to the Business Unit's Leadership team.

The Internal Audit programme is an important process to establish assurance around controls and the programme is overseen by the BRAC.

The Electricity Business's Asset Management Plans and practices are reviewed periodically by an expert third party as part of this assurance programme. In 2005 and 2006 the practices were reviewed by an independent expert consultant. The practices were reviewed in 2007 by Siemens AG (Germany) who endorsed the plans and were positive about the asset management practices the company deployed from an international perspective.

### 6.4.1. OPERATIONAL RISK MANAGEMENT PROCESS

The asset/operational risks can relate to a single asset, a process or a whole class of assets. Operational risks generally arise from security of supply, asset and process failure, disaster recovery, network quality and delivery, or personnel issues. Controls are applied by way of

- Asset monitoring
- Asset performance modeling and planning
- Fault response plans
- Maintenance plans
- Third party / public safety management plans
- Engagement of experienced contractors
- Quality and performance assessment of field work

Controls are supported by treatment processes where actions are taken to remove or mitigate the risk.

## 6.5. CONTINGENCY PLANS

### 6.5.1. SWITCHING

The majority of distribution feeders are designed to allow reconfiguration by network switching to provide power from an alternative source following a fault. Distribution switching may be carried out remotely via SCADA, at selected sites, on both the Wellington and Auckland networks.

Following a power supply outage, the control room staff reconfigure the network to restore power to as many customers as possible until the fault can be rectified. This is achieved, either by remote switch operation from the control room, or by manual field switching.

To hasten the restoration of supply, the Control Room has prepared contingency switching plans for major outages such as complete loss of a zone substation.

There are 224 contingency plans for the Auckland region and 68 for Wellington. Generally these relate events that have a "very high" or "extreme" classification within the risk matrix (see Figure 6.2) which corresponds with the loss of a zone substation or subtransmission feeder. Figure 6.3 and Figure 6.4 are examples of the types of information used in the contingency plans.

## ZONE SUBSTATION CONTINGENCIES

### Mt Albert SUBSTATION

No Of Transformers: 1

Transformer Size: 12

Sub Peak MVA: 10

No Of Feeders: 4

No Of Customers: 3000

**SURROUNDING SUBSTATION LOADS AFTER CONTINGENCY**

| Surrounding Sub | Normal Peak MVA | Capacity | | LOAD TRANSFERRED | | | | PEAK AFTER CONTINGENCY | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Winter | Summer | n-1 | n-2 | n-3 | n-4 | n-1 | n-2 | n-3 |
| CHEV | 16 | 32 | 29 | 4 | 0 | 0 | 0 | 20 | | |
| ROSE | 23 | 43 | 37 | 2 | 0 | 0 | 0 | 25 | | |
| AVON | 24 | 40 | 40 | 1 | 0 | 0 | 0 | 25 | | |
| SAND | 18 | 40 | 39 | 3 | 0 | 0 | 0 | 21 | | |

*Figure 6.3 Example of Zone Substation contingency*

## VECTOR CONTINGENCY SWITCHING

REGION **Auckland**
Zone Substation: **Mt Albert**

Ref Number: **A 377** Date: **13/03/2002** Revision No: 4 Revision 26/05/2006

Contingency: **N-1 Mt Albert**

Scenario: T1 requires complete off loading

| Time | Operation | Switch Type | Number | Location or Label |
|---|---|---|---|---|
| | **CLOSE** | **CB** | **11** | **Andy Miller via Auto Tr and local @ CHEV** |
| | **OPEN** | **CB** | **19** | **Carrington Rd @ MALB** |
| | | | | **CB 19 (200 A) onto CB 11 CHEV (n/op) 0A = Total 200A** |
| | **CLOSE** | **LINE SW** | **5085** | **UNITEC Gate 1, Carrinton Rd** |
| | **OPEN** | **CB** | **16** | **Wilcott St @ MALB** |
| | | | | **100A to CB4 ROSE (225 A) = Total 325 A** |
| | **CLOSE** | **LINE SW** | **6082** | **Mercury Motors, New North Rd** |
| | **OPEN** | **CB** | **17** | **Allendale Rd @ MALB** |
| | | | | **70 A to CB6 AVON (150 A) = 220 A** |
| | **CLOSE** | **LINE SW** | **5149** | **@ Supermarket, 4 Kitenui Ave** |
| | **OPEN** | **CB** | **20** | **Fowler Ave @ MALB** |
| | | | | **175 A to CB8 SAND 8 (170 A) = 340 A** |

Remarks:

**Re-done, September 2002**
**Updated 26/5/06**

| | | | |
|---|---|---|---|
| Switching Orginated By | R Downey | Date | 11/09/2002 |
| Checked by System Control | B Ashton | Date | 26/05/2006 |

| Revision No: | Revision: | Revised | Revision | Checked By: |
|---|---|---|---|---|
| 4 | Updated | B Ashton | 26/05/2006 | |

*Figure 6.4 Example of switching plan to offload Zone Substation*

### 6.5.2. EMERGENCY PLANS

The Electricity Business has developed a number of plans to cover emergency situations. These plans are reviewed and updated regularly to ensure currency. Examples of the plans are:

- Crisis Management Plan
- Major Incident Plan
- Storm Response Plan
- Priority Notification Procedures
- Total Loss of a Zone Substation Plan
- Loss of Transpower Grid Exit Plan (Transpower Plan)
- Call Centre Continuance Plan
- Control Room Disaster Recovery Plan

In addition there are 11 contingency plans detailing special arrangements for major customers such as Pacific Steel, Fonterra and Auckland Airport.

## 6.6. HEALTH AND SAFETY

### 6.6.1. HEALTH AND SAFETY POLICY

At Vector, safety is a value, not merely a priority.

Vector’s policy is to:

- Provide a safe and healthy work place for all our people, contractors and visitors
- Ensure health and safety considerations are part of all business decisions
- Monitor and continuously improve our health and safety performance
- Communicate with our people, contractors, customers, and stakeholders on H&S matters
- Operate in a manner that minimises health and safety hazards
- Encourage safe and healthy lifestyles, both at work and at home

We aim to achieve this by:

- Meeting all relevant legislation, standards and codes of practice for the management of health and safety
- Identify, assess and control workplace hazards
- Accurately report, record and learn from all incidents and near misses
- Establish health and safety goals at all levels within the Company, and regularly monitor and review the effectiveness of our Health and Safety Management System
- Consult, support and encourage participation from our people on issues that have the potential to affect their health and safety

- Promote our leaders', employees' and contractors' understanding of their health and safety responsibilities relevant to their roles
- Provide information and advice on the safe and responsible use of our products and services
- Suspend activities if safety would be compromised
- Take all practicable steps to ensure our contractors work in line with this policy

### 6.6.2. HEALTH AND SAFETY PRINCIPLES AND PRACTICES

All Vector employees and contractors working for Vector are responsible for ensuring their own and other's safety by adhering to safe work practices, making appropriate use of plant and equipment (including protective clothing and equipment) and promptly reporting incidents, near misses and hazards.

Our goal is zero lost time injuries.

Vectors key Health and Safety principles are:

- Everyone is responsible for safety
- We look out for each other
- Safety will be planned into our work
- All injuries are preventable
- Management is accountable for preventing injuries
- Employees must be trained to work safely

Vector's Safe Work Practices manual define the essentials necessary to maintain an injury free environment. These practices reflect the basic approach necessary for Vector and our contracting partners to identify and eliminate accident causes.

All contracting partners working for the company are required, as a minimum, to comply with these Safe Work Practices whilst carrying out any work on the network. Contracting partners are also required to report all employee accidents/incidents and near misses to Vector together with their investigations and intended corrective actions.

As part of our focus to continually improve health and safety, we have instituted Safe Teams and a Safety Leadership Team as a task force to encourage all staff, both Vector and contracting partners staff, to voice their opinion on safety standards, raise concerns and suggest improvements.

We have undertaken a number of audits of our health and safety systems and processes using internationally recognised Health and Safety practitioners over the last eight years as part of our continuous improvement programme.

Our progress on health and safety over the last 12 months is shown in Figure 6.5.

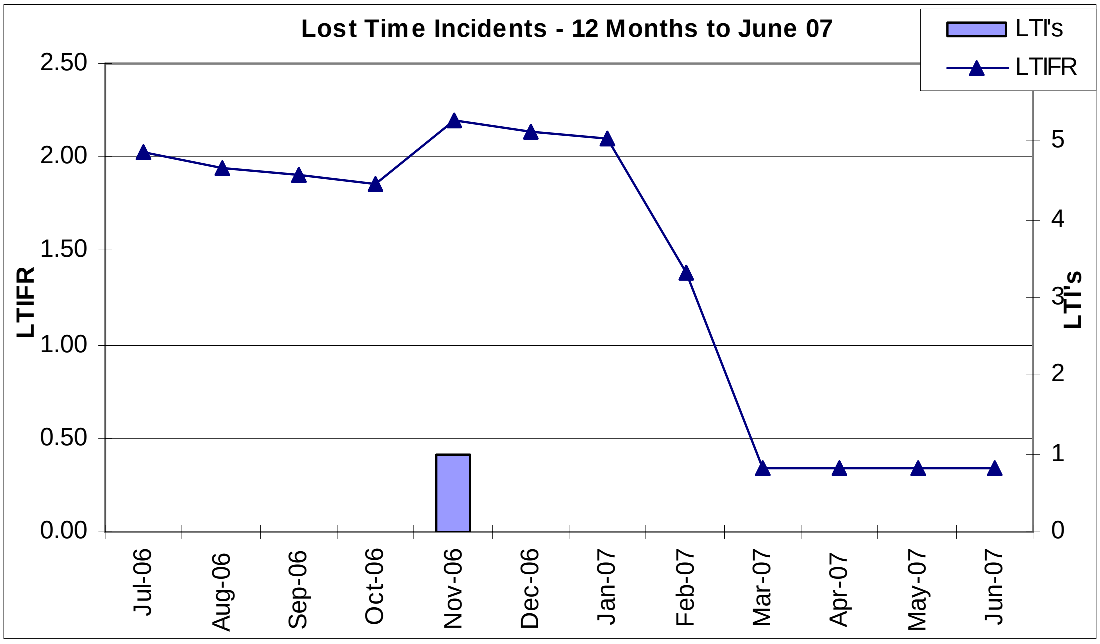


*Figure 6.5 Network Safety Performance*

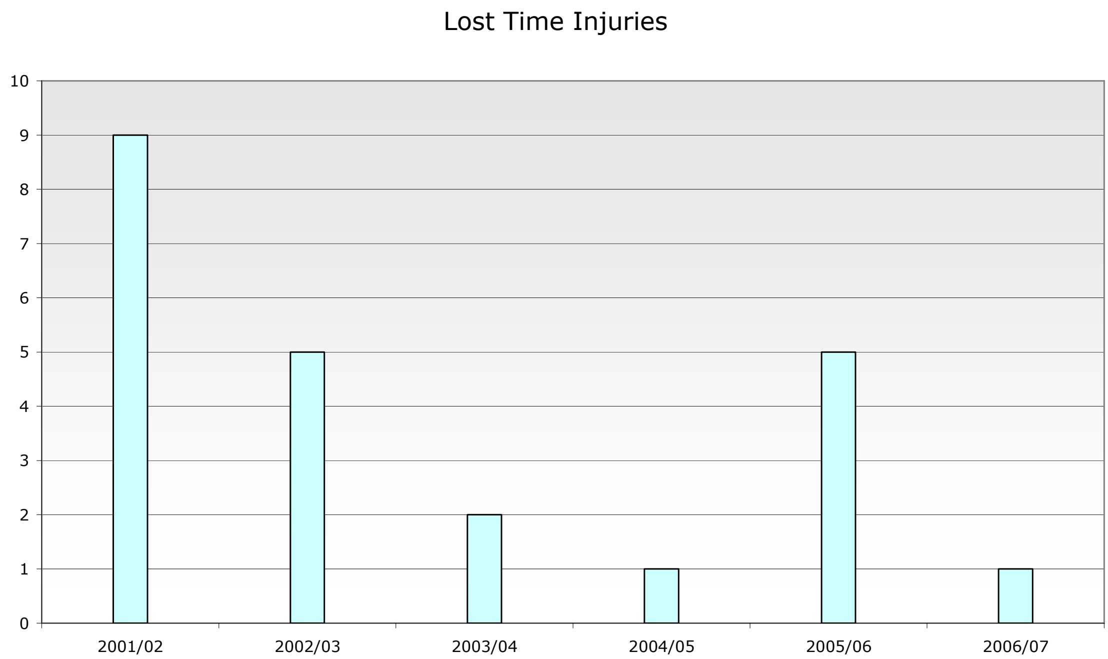


*Figure 6.6 Lost Time Injuries Chart*

Figure 6.6 shows the Lost Time statistics for the last six years reflecting an encouraging downward trend.

The Electricity Business monitors electricity related public safety and staff/contractor safety incidents. On a monthly basis these incidents are reviewed to ensure lessons are captured and where appropriate captured in our own safety programmes.

With respect to overall community safety, the Electricity Business offers a cable location and residential isolation services.

A public safety awareness communications programme on electricity has been undertaken, an example of which is the “Stay Safe” schools programme, which was successfully rolled out in 2005. Sixty seven schools have been visited and 14,400 children have been through the programme, designed to raise children’s awareness of the hazards of electricity.

### 6.6.3. ENVIRONMENTAL PRACTICES

Vector also puts significant emphasis on environmental management. Pattle Delamore Partners Ltd, were engaged to audit our environmental processes and compliance along with those of our contracting partners. Being the first of such audits, information gathered has enabled further significant improvement in this area.

Much work has been done by Vector in raising the awareness of the field staff on environmental issues. We work closely with, and have a good relationship with the ARC. We have done a formal audit of our Environmental Systems which included auditing our contracting partners. Action plans were developed and we are now able to report that all actions have been completed. We are also working on the Vector Environmental Management System to make that more robust.

# 7. EVALUATION OF PERFORMANCE

## 7.1. PROGRESS AGAINST PLANS

### 7.1.1. CAPITAL PROJECTS IN THE VECTOR NETWORK

The 2006/07 capex budget was $170.2 million, against which projects to the value of $161.0 million were delivered.

The variances are due to

- Uncertainties surrounding the "Notice of Intention to Declare Control" issued by the Commerce Commission on 9 August 2006
- Reprioritisation of projects during the year
- Delays in projects due to unexpectedly long lead times on the delivery of key overseas sourced equipment
- Unforeseen consent issues creating delays
- Delays due to construction resource constraints

## 7.2. PERFORMANCE AGAINST TARGETS

Vector has in place detailed performance targets that are defined and linked to ensure that we are striving for and achieving the company goals in an optimum and efficient way.

Physical performance in Vector is tracked through the following key measures:

- Reliability
- Standard Service Levels
- Safety and Environmental
- Customer Satisfaction

These key measures:

- Are directly applicable to the core business
- Support the aims of the business strategy
- Enable Vector to track and easily communicate performance
- Enable direct comparison with other companies for the purposes of benchmarking

The ongoing results of these measures are communicated on a monthly basis to all Vector employees and contracting partners. Accountability for the performance targets is a function of all employees. Our contracting partners are incentivised through the contract incentive structure to achieve their targets and Vector employees have the performance measures embedded in the performance related pay scheme.

### 7.2.1. RELIABILITY

The reliability targets and actual measures for the combined network for 2006/07 are shown in Table 7.1

| Overall Performance | | |
|---|---|---|
| Measure | Actual | Target |
| SAIDI | 115.6 | 85.5 |
| SAIFI | 1.42 | 1.31 |
| Excluding Extreme Weather | | |
| Measure | Actual | Target |
| SAIDI | 83.8 | 85.5 |
| SAIFI | 1.15 | 1.31 |

*Table 7.1 Reliability Statistics (exclusive of Transpower outages)*

The Electricity Business is required to demonstrate that its SAIDI and SAIFI reliability measures for the assessment year do not exceed the five year average to 31 March 2003. Due to impact of extreme weather events throughout the 06/07 assessment year, Vector exceeded both reliability targets.

Excluding the impact of extreme weather events from the 06/07 reliability figures, both measures finished below target. In explanation to the Commission, set out in

Table 7.2 shows the extreme weather periods considered by Vector to be outside its reasonable control. This table excludes outages arising from Transpower's network.

| Start Date/Time | End Date/Time | Hours | Faults | SAIDI | SAIFI |
|---|---|---|---|---|---|
| **Auckland Network** | | | | | |
| 11/06/2006 18:00 | 13/06/2006 14:00 | 44 | 75 | 14.3 | 0.09 |
| 8/11/2006 21:00 | 10/11/2006 20:00 | 47 | 81 | 9.7 | 0.08 |
| 12/03/2007 23:00 | 15/03/2007 18:00 | 67 | 63 | 5.5 | 0.06 |
| 28/03/2007 7:00 | 30/03/2007 13:00 | 54 | 50 | 2.6 | 0.03 |
| **Wellington Network** | | | | | |
| 11/06/2006 2:00 | 12/06/2006 23:00 | 45 | 7 | 0.4 | 0.01 |
| 18/06/2006 16:00 | 19/06/2006 18:00 | 26 | 5 | 0.1 | 0.00 |
| 3/10/2006 15:00 | 5/10/2006 14:00 | 47 | 7 | 0.3 | 0.00 |
| 23/10/2006 16:00 | 25/10/2006 14:00 | 46 | 7 | 0.1 | 0.00 |
| 13/11/2006 17:00 | 15/11/2006 17:00 | 48 | 12 | 0.4 | 0.01 |
| 14/03/2007 8:00 | 15/03/2007 16:00 | 32 | 9 | 0.1 | 0.01 |

*Table 7.2 Extreme Weather Periods by Network Area*

In order to define "extreme weather periods", Vector employs a methodology which combines meteorological data (peak average wind speed, >50kph), with excessive HV fault frequency (8-times or greater than the daily average), to identify extreme event hours.

Proactive reliability initiatives will continue to target the worst performing feeders and network areas, aiming to bring performance back in line with customer service expectations.

These initiatives focus on minimising the time customers are without electricity and also target a reduction in the number of interruptions customers' experience. Customer consultation has identified frequency of interruption as a high priority item for reliability improvement.

All initiatives are evaluated using a cost/benefit framework that compares delivered network performance against standard service level performance targets.

Key initiatives to improve performance include a continuation of the existing program to:

- Segment feeders with circuit breakers so that fewer customers are affected in the event of a fault
- Fit Control Centre operated remote control to these circuit breakers to minimise restoration delays following a network fault

- Install fault passage indicators to assist in localising the fault location and initiate quicker network restoration
- Improved vegetation management

### 7.2.2. STANDARD SERVICE LEVELS

The standard service level targets and achieved results for the Vector networks for 2006/07 are shown in Table 7.3. Transpower related events are not included in these figures.

| Measure | Actual | Target |
|---|---|---|
| Frequency | 90,689 | 90,000 |
| Duration | 71,644 | 70,000 |

*Table 7.3 Service Level Breaches*

The targets set for 2006/07 and future years will continue to be aligned with customer expectations coupled with the trade-off between price and quality.

### 7.2.3. SAFETY

Vector, in conjunction with its contracting partners has identified four key areas that led to five lost time injuries last year (July 2005 – June 2006). These can be summarised as

- Behaviour – engaging in unsafe behaviours while working on the network
- Engineering – network equipment installation practices and procedures are not rigorous enough
- Tools – ensuring tools used for installing equipment are suitable for use without compromising the safety afforded by PPE equipment
- Policy – ensuring health and safety policies are observed

Considerable work has gone into understanding the behaviour trait that lead to the unsafe practices. While there is a focus on all four areas, one of the key initiatives will be to train front line supervisors to identify the trait that result in "risky" behaviours. Training programs under development will ensure that contracting partners' staff displaying these behaviours are appropriately managed.

For the corresponding period between July 2006 and June 2007, the number of lost time injuries reduced to one.

### 7.2.4. CUSTOMER SATISFACTION

Vector continues to monitor customer satisfaction as a key performance indicator both for Vector staff and our contracting partners across the Wellington and Auckland electricity networks. Previously, the focus has been on the quality of fault service delivered to customers. This year the assessment will be expanded to include customer feedback on capital and customer projects, the tree trimming programme and Vector relationship with the larger customer and Retailer areas. The Customer Satisfaction score for this year was 83.2% against a target of 83%.


*Figure 7.1 Customer Satisfaction Scores*

Vector still continues with two different business models for customer interaction, based on contractual agreements with Energy Retailers. On the central and south Auckland networks customer's contact Vector directly for fault and general enquiries around pricing and service. On the north Auckland and Wellington networks the customer interaction in these instances is managed via the customer's Energy Retailer. However customers contact Vector directly across all networks with tree enquiries, mapping requests and any connection requests around network assets.

## 7.3. PLANNED IMPROVEMENTS FOR PERFORMANCE

Vector has a number of initiatives planned for 2007/08:

- The requirement for asset replacement expenditure is increasing, driven by the build and condition profiles of the installed asset base. Vector needs to ensure that assets are accurately assessed and appropriately prioritised for replacement

- In 1997 Vector moved away from an in-house model to an outsourced business model for all field activities. This model was appropriate at the time and achieved significant efficiency and performance improvements. Since then significant changes have occurred in the industry, operating environment and to Vector itself. As such the current operating model is under review to identify the most effective model going forward

- International demand for distribution network equipment and materials is increasing beyond manufacturers' installed production capacity, placing pressure on our ability to source critical equipment within reasonable lead times. New procurement strategies are being implemented to mitigate this risk

- Accurate data is fundamental to Vector's operations. A review of the processes has identified a number of areas for improvement. This includes interfaces and obligations on our contracting partners to supply timely and accurate asset data, functionality of IT systems used to hold asset information and data integrity

- The price/quality regulatory regime requires Vector to focus on how to meet demanding performance targets within a severely constrained cost framework. Areas receiving particular attention are around the standardization of equipment and practices, and refining processes to streamline the delivery of capital and maintenance works programmes