2004
ASSET MANAGEMENT PLAN

ASSET MANAGEMENT SUMMARY

This summary is provided to meet the mandatory disclosure requirements of Regulation 24 of the Commerce Commission Electricity Information Disclosure Requirements 2004.

THE VECTOR NETWORK

The Vector network supplies more than one third of New Zealand's electricity peak demand. The distribution business involves the operation and maintenance of a regional supply network that covers greater Auckland and greater Wellington – an area of approximately 5,200km^2. Vector has 644,000 customers.

NETWORK SUMMARY

Peak Demand	1,944MW
Area Covered	5,200m^2
Customer Connections	644,000
Supply Points from Transpower	22
Zone Substations	121
Distribution Substations	23,000
Subtransmission Cables	637km
Subtransmission Lines	476km
HV Distribution Cables	3,911km
HV Distribution Lines	4,525km

PURPOSE OF THE ASSET MANAGEMENT PLAN

The purpose of the Asset Management Plan (AMP) is to describe how Vector will manage the assets and investment in its network in order to achieve the performance targets and strategic goals it has set.

Vector's AMP is provided to enable customers and other interested parties to identify Vector's performance targets, areas of business focus, forecast levels of maintenance expenditure and capital investment planned to manage its asset base. The plan also identifies our 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 the appropriate balance between the needs and expectations of our customers, and the cost of providing the network service – this incorporates the risk and consequences of asset failure.

Vector's asset management approach is to:

- Ensure that the required standard service levels are met, including reliability of supply to customers
- Provide a safe environment for operating personnel and the general public
- Proactively manage environmental issues
- Manage the assets to achieve the required functionality, performance and value of assets to enable the continuation of a viable network business

This AMP gives an overview to Vector's approach to maintenance, development, asset renewal and replacement. This may change over time as Vector seeks to continually advance work in this area, including as a result of further familiarisation with the Commerce Commission's regulatory regime.

DATE AND PLANNING PERIOD

The AMP has been developed as part of the Information Disclosure for 2004 and covers a period of ten years from 1 June 2004 until 31 May 2014.

The plan is a view going forward and 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 as we gain better information on our customer expectations, asset capabilities and condition.

ASSET MANAGEMENT SYSTEMS AND INFORMATION

Central to Vector's goals of providing superior customer service are information systems. Our systems combine the three components of customer management, network management and financial management into one network management strategy.

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.

In addition to system development, Vector has invested heavily in staff training and has staff members involved in international technical working groups such as CIGRE and ESAA to ensure we actively participate in industry initiatives and advancements.

An initiative was launched in September 2003 to identify issues and factors that need to be addressed in order to enhance Vector's core business. The Core Business Enhancement Programme (CBEP) and its supporting programme management software (iTools) became fully operational in February 2004. Six project concepts will be managed as formal cross-functional projects in the CBEP, including:

- Knowledge and information management
- Business model
- Customer information
- Fixed asset accounting
- Network investment decision framework
- Contract management

NETWORK AND ASSET DESCRIPTION

Vector's network can be viewed as three networks:

1. 110kV transmission network, which connects from the Transpower network to Vector bulk supply substations and also provides additional security for the Transpower transmission system.

2. 33kV and 22kV subtransmission network, which connects between the Transpower grid exit points and Vector zone substations, each of which serves a particular geographic area with similar asset and customer characteristics.

3. 11kV and 6.6kV, and 400/230V distribution network linking our customers to our 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 about understanding what our customers value and meeting these requirements cost-effectively.

Vector has a number of standard service levels against which we assess and measure our performance. The standards give Vector a basis for measuring performance and for determining the extent of asset maintenance, repair, refurbishment and acquisition. The standards also assist in establishing more defined customer expectations and therefore customer value. These service standards vary between the network areas reflecting differences in both network design and security standards in addition to customer expectations. As part of our integration process and reflecting the outcomes of the current regulatory environment, we will be looking to identify the potential to align or change these service standards.

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 service providers, our suppliers and the public we serve."*

Our safety target for 2004/05 remains:

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

ASSET DEVELOPMENT AND MAINTENANCE PLANS

Ensuring the network meets the future demands of customer requirements, load growth, statutory requirements, environmental and safety issues, requires Vector to continually improve its asset management.

Our approach is to first optimise the use of existing assets where possible through automation, load management or other non-asset development solutions to defer major capital expenditure, so long as our reliability objectives are met and maintained.

Ensuring that asset maintenance, refurbishment and replacement programmes are value-based is also critical to Vector. Asset maintenance can be a significant proportion of the total lifecycle costs and Vector's approach is one of value-based maintenance to achieve the required reliability standards.

Asset maintenance plans are developed taking into account the variety of customer, environmental, operational performance and condition factors. 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 opportunities where value can be gained through programmes of replacement rather than incurring ongoing remedial and preventative maintenance costs.

To enhance and simplify this process, Vector has lifted to another level, the tools and approaches it takes to analysing network information. The objective has been to allow key trends and areas needing focus to be quickly and accurately identified. This information is available to Vector and its service providers to assist in the decision making approach.

Our new standards represent the first steps down a new path in network asset management. Our continued focus on improved asset condition and network performance information will improve our decision making process. This in turn will enhance the ability for customers to evaluate their service requirements in terms of cost and performance – enabling a choice to either take their own measures to achieve the performance they require, or contract Vector to do so.

RISK ASSESSMENT

Risk is 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

Management of risk is undertaken by the risk committees, which direct the identification, analysis, prioritisation and treatment of risks across the business.

Vector has a suite of contingency plans in place developed under the framework of risk reduction, readiness, response and recovery. Plans are in place to cope with storms, total loss of supply of a zone substation, Transpower grid exit point, the Control Room and Call Centre.

EVALUATION OF PERFORMANCE

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

- Reliability
- Safety
- Customer satisfaction
- Environmental impact

All employees and service providers are accountable for achieving the performance targets. Our service providers are incentivised through a contract bonus structure to achieve their targets whilst Vector employees have the performance measures embedded in their performance related pay scheme.

TABLE OF CONTENTS

1. INTRODUCTION 1
1.1. Vector Asset Management Overview 1
1.2. Network Summary 5
1.3. Asset Management Philosophy 6
1.4. Asset Management Process 7
1.4.1. Influencers 7
1.4.2. Asset Management Drivers 9
1.5. Relationship with Business Processes 9
1.5.1. Plan Implementation 10
1.6. Planning Period 10
1.7. Responsibilities and Accountabilities for Asset Management 11
1.8. Asset Management Information Systems 11
1.8.1. Overview 11
1.8.2. GIS System 12
1.8.3. SCADA/DMS (Supervisory Control and Data Acquisition/Distribution Management System) 14
1.8.4. Network Analysis Tools 15
1.8.5. The Next 12 Months 15

2. NETWORK ASSETS 17
2.1. Network Overview 17
2.2. Transmission and Subtransmission Network 18
2.3. Transmission and Subtransmission Design 19
2.4. Distribution Network 20
2.5. Distribution Design 20
2.6. Protection 21
2.7. Communication Network 21
2.8. Metering 22
2.9. Load Control System 22
2.10. Improvements to Network Design 23

3. SERVICE STANDARDS 24
3.1. Reliability 25
3.2. Network Management 28
3.3. System Design Security 30
3.3.1. Auckland Network Security 30
3.3.2. Auckland Network Transmission, Subtransmission and Distribution Reliability 32
3.3.3. Northern and Wellington Network Security 33
3.3.4. Northern and Wellington Transmission, Subtransmission and Distribution Reliability 33
3.3.5. All Network Areas 34
3.4. Power Quality 34

4. NETWORK DEVELOPMENT 36
4.1. Forecast Growth 37
4.2. Network Investment 38
4.2.1. Network Constraint Management 39
4.2.2. Non-Traditional Investment Solutions 40
4.2.3. Distributed Generation 41
4.2.4. Third Party Service Provision 41
4.3. Asset Development 42
4.4. Auckland Customer Area 43
4.4.1. Growth in the Auckland Area 43
4.4.2. Issues and Options in the Auckland Area 43
4.5. Northern Customer Area 50
4.5.1. Growth in the Northern Area 50
4.5.2. Issues and Options in the Northern Area 50
4.6. Wellington Customer Area 58
4.6.1. Growth in the Wellington Area 58
4.6.2. Issues and Options in the Wellington Area 58
4.7. Transformer Redeployment 59
4.8. Transpower Supply Points 60
4.8.1. Issues and Options at the Grid Exit Points 60
4.9. Customer Initiated Network Developments 61
4.10. Network Performance Projects 62
4.11. Expenditure Forecast 62

5. ASSET MAINTENANCE 64
5.1. Asset Maintenance Strategy 64
5.1.1. Fault Analysis 67
5.2. Asset Process 68
5.3. Asset Maintenance by Asset Type 69
5.4. Transmission and Subtransmission Cables and Lines 70
5.4.1. Asset Description 70
5.4.2. Asset Performance and Condition 70
5.4.3. Asset Maintenance 71
5.4.4. Asset Issues and Risks 71
5.4.5. Asset Replacement 71
5.5. Transmission and Subtransmission Transformers 72
5.5.1. Asset Description 72
5.5.2. Asset Performance and Condition 73
5.5.3. Maintenance 73
5.5.4. Asset Issues and Risks 73
5.5.5. Asset Replacement 73
5.6. Transmission and Subtransmission Switchgear 74
5.6.1. Asset Description 74
5.6.2. Asset Performance and Condition 74
5.6.3. Maintenance 75

5.6.4. Asset Issues and Risks ... 75
5.6.5. Asset Replacement ... 75
5.7. Zone Substation Buildings ... 75
5.7.1. Asset Description ... 75
5.7.2. Asset Performance and Condition ... 75
5.7.3. Asset Maintenance ... 76
5.7.4. Asset Issues and Risks ... 76
5.8. Protection and Control: Relays ... 76
5.8.1. Asset Description ... 76
5.8.2. ASset Performance and Condition ... 76
5.8.3. Maintenance ... 77
5.8.4. Asset Issues and Risks ... 77
5.8.5. Asset Replacement ... 77
5.9. Protection and Control: DC Auxilliary Supply ... 77
5.9.1. Asset Description ... 77
5.9.2. Asset Performance and Condition ... 78
5.9.3. Maintenance ... 78
5.9.4. Asset Issues and Risks ... 78
5.9.5. Asset Replacement ... 78
5.10. Communications and Control: SCADA ... 78
5.10.1. Asset Description ... 78
5.10.2. Asset Performance and Condition ... 79
5.10.3. Maintenance ... 79
5.10.4. Asset Issues and Risks ... 79
5.10.5. Asset Replacement ... 79
5.11. Metering Systems ... 79
5.12. 11kV and 400V Overhead Network ... 80
5.12.1. Asset Description ... 80
5.12.2. Asset Condition and Performance ... 80
5.12.3. Maintenance ... 82
5.12.4. Asset Issues and Risks ... 82
5.12.5. Asset Replacement ... 82
5.13. 11kV and 400V Underground Distribution Network ... 83
5.13.1. Asset Description ... 83
5.13.2. Asset Condition ... 83
5.13.3. Maintenance ... 84
5.13.4. Asset Issues and Risks ... 84
5.13.5. Asset Replacement ... 84
5.14. Distribution Transformers ... 85
5.14.1. Asset Description ... 85
5.14.2. Asset Condition ... 86
5.14.3. Maintenance ... 86
5.14.4. Asset Issues and Risks ... 86
5.14.5. Asset Replacement ... 86
5.15. Distribution Switchgear ... 87
5.15.1. Asset Description ... 87

5.15.2. Asset Condition ... 87
5.15.3. Maintenance ... 87
5.15.4. Asset Replacement ... 87
5.16. Distribution Substations ... 88
5.16.1. Asset Description ... 88
5.16.2. Asset Condition ... 88
5.16.3. Asset Issues and Risks ... 88
5.16.4. Asset Replacement ... 89
5.17. Forecast Maintenance Expenditure ... 89

6. RISK MANAGEMENT ... 90
6.1. Risk Accountability and Authority ... 91
6.1.1. Vector Board ... 91
6.1.2. Executive Risk Management Committee ... 91
6.1.3. Executive Team (General Management) ... 92
6.1.4. All Employees ... 92
6.2. Risk Management Process ... 92
6.3. Risk Identification and Analysis ... 94
6.4. Risk Management Programme ... 94
6.5. Contingency Plans ... 95
6.5.1. Switching ... 95
6.5.2. Critical Spares ... 95
6.5.3. Disaster Analysis ... 95
6.5.4. Civil Defence and Emergency Management Act ... 96
6.5.5. Health and Safety ... 96

7. EVALUATION OF PERFORMANCE ... 99
7.1. Progress Against Plans ... 99
7.1.1. Capital Projects in the Vector Network ... 99
7.2. Performance Against Targets ... 100
7.2.1. Reliability ... 100
7.2.2. Safety ... 101
7.2.3. Customer Satisfaction ... 101
7.3. Planned Improvements for Performance ... 102

LIST OF FIGURES

Figure 1.1 The Vector Network 4
Figure 1.2 Asset Management Philosophy 7
Figure 1.3 Vector's Asset Management Process 8
Figure 1.4 Asset Management Structure Chart 11
Figure 1.5 HV SAIDI Analysis Tool 13
Figure 1.6 HV Fault Analysis Tool 14
Figure 2.1 Schematic of Vector's Network 18
Figure 3.1 SAIDI Actuals (including Transpower outages) 27
Figure 3.2 SAIFI Actuals (including Transpower outages) 27
Figure 3.3 CAIDI Actuals (including Transpower outages) 28
Figure 3.4 Example of a Voltage Sag report 35
Figure 4.1 Forecast Maximum Demand across the Network 37
Figure 5.1 GIS Analysis Data - SAIFI 67
Figure 5.2 Asset Decision Process 69
Figure 5.3 Subtransmission Transformers Age Profile 72
Figure 5.4 Subtransmission Circuit Breakers Age Profile 74
Figure 5.5 Distribution Transformers Age Profile 85
Figure 6.1 Vector's Risk Management Process (Based on AS/NZ4360) 93
Figure 6.2 Vector's Risk Prioritisation Matrix 94
Figure 6.3 Network Safety Performance (Northern, Wellington and Service Providers) 97
Figure 6.4 Network Safety Performance (Vector and Service Providers) 98
Figure 7.1 Customer Satisfaction Score 102

LIST OF TABLES

Table 3.1 Results for SAIDI, SAIFI, CAIDI 26
Table 3.2 Standard Service Levels: Reliability and Power Quality 29
Table 3.3 Standard Service Levels: Northern and Wellington Networks 30
Table 3.4 Transmission and Subtransmission Security 32
Table 3.5 Distribution Security 32
Table 3.6 Security of Supply Criteria 33
Table 4.1 Forecast Capital Expenditure Budget ($ million) 63
Table 5.1 Transmission and Subtransmission Cable Lengths and Voltages 70
Table 5.2 Forecast Maintenance Expenditure ($ thousand) 89
Table 7.1 Reliability Statistics (inclusive of Transpower outages) 100

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
CAIDI	Customer Average Interruption Duration Index
CBD	Central Business District (of Auckland)
CIGRE	Conference Internationale des Grands Reseaux Electriques (International Council for Large Electric Systems)
CCT	Covered Conductor Thick
Cu	Copper
DC	Direct Current
DGA	Dissolved Gas Analysis
DMS	Distribution Management System
DTS	Distributed Temperature Sensing
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
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
OSH	Occupational Safety and Health
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	Sulphurhexafluoride
SREI	Safety Rules Electricity Industry
TASA	Tap Changer Activity Signature Analysis
TLS	Transformer Load Simulator
TMS	Transformer Management System
V	Volt
VRLA	Valve Regulated Lead Acid battery
VT	Voltage Transformer
XPLE	Cross Linked Polyethylene Cable
ZAIDI	Zonal Average Interruption Duration Index

1. INTRODUCTION

1.1. VECTOR ASSET MANAGEMENT OVERVIEW

With around 644,000 electricity customers in the Auckland and Wellington regions, Vector continues to maintain a customer focused approach to effective asset management. Now, more than ever, customers are demanding greater performance, security and innovation to assist them in growth and development. A key challenge for Vector is to continue to understand these needs and push industry boundaries to translate them into solutions that benefit customers and lead the industry forward.

At the time of producing this AMP, the Commerce Commission had recently reset its thresholds to apply from 1 April 2004. The Commission had also already assessed lines businesses against its initial price path threshold (as at 6 September 2003 (which Vector complied with)) and, at the time of writing, was about to assess lines businesses against the initial price and quality thresholds (as at 31 March 2004).

While the thresholds are now operational (during the last AMP process, the thresholds were being developed), the investigation and control parts of the regulatory regime are yet to be fully developed by the Commission. As such, it is still a time of familiarisation with the regulatory regime for lines businesses, as well as other stakeholders. In developing the AMP, Vector has been mindful of the requirements of the regulatory regime and what they mean for asset management. Vector also has additional work underway internally to further understand the ramifications of the regulatory regime for asset management. For example, Vector is currently examining the optimal specification of its investment models, including how to explicitly encapsulate in those models a range of trade-offs relevant to the Commission's regulatory regime (eg, between price (cost) and quality, between capital expenditure and maintenance).

This AMP gives an overview to Vector's approach to maintenance, development, asset renewal and replacement. This may change over time as Vector seeks to continually advance work in this area, including as a result of further familiarisation with the Commerce Commission's regulatory regime.

Vector engages consumers, consumer groups and retailers, as part of Vector's standard business processes and commitment to offering quality customer service, to provide input and feedback on the proposed AMP.

Vector strives to provide an appropriate level of quality (defined in terms of four aspects: safety, customer satisfaction, reliability and power quality), at any given price level. To do this, Vector has developed and implemented industry leading business systems and practices such as:

- Ensuring a company wide focus on quality by linking staff bonuses to team and company performance on quality, as well as publishing an internal newsletter (*On Target)*, which focuses on Vector's performance with respect to quality and the ways in which this performance can be improved
- 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 (Duke Energy) to audit Vector's practices; ensuring a company wide focus on safety through assessing staff and service provider performance with respect to specific Key Performance Indicators (KPIs) related to safety
- Using network modelling in order to simulate the workings of Vector's network in entirety, starting from Transpower grid exit points down to distribution transformers; and using the model to perform scenario analysis for changes in quality. The outputs of such analysis are used as an input into asset management planning decisions, as well as to present options to large consumers
- Implementing systems that effectively report and manage the impact of power quality on Vector's customers; an ongoing programme to install power quality measuring equipment; an electronic mail system that automatically sends large customers a power quality report in real-time; and a web-based reporting system that makes both real-time and historical power quality information available to customers
- A dedicated 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 quality performance, which enhances Vector's ability to better plan and manage its network

The objective of the AMP is to describe how Vector will manage the assets and investment in its network in order to achieve the performance targets and strategic goals it has set across its networks.

Vector is made up of three network areas – Northern, Auckland and Wellington, as shown in Figure 1.1, each of which have differing asset configuration, management and service characteristics. Vector's three networks currently operate under two different contractual models. At the time of publication, the Auckland network operates under a conveyance agreement which means it has a direct relationship with each of its 290,000 customers in the Auckland, Manukau and Papakura area. The Northern and Wellington networks are currently run under an interposed agreement which means the company has a direct contract with retailers, which buy lines services and in turn manage the end customer relationship.

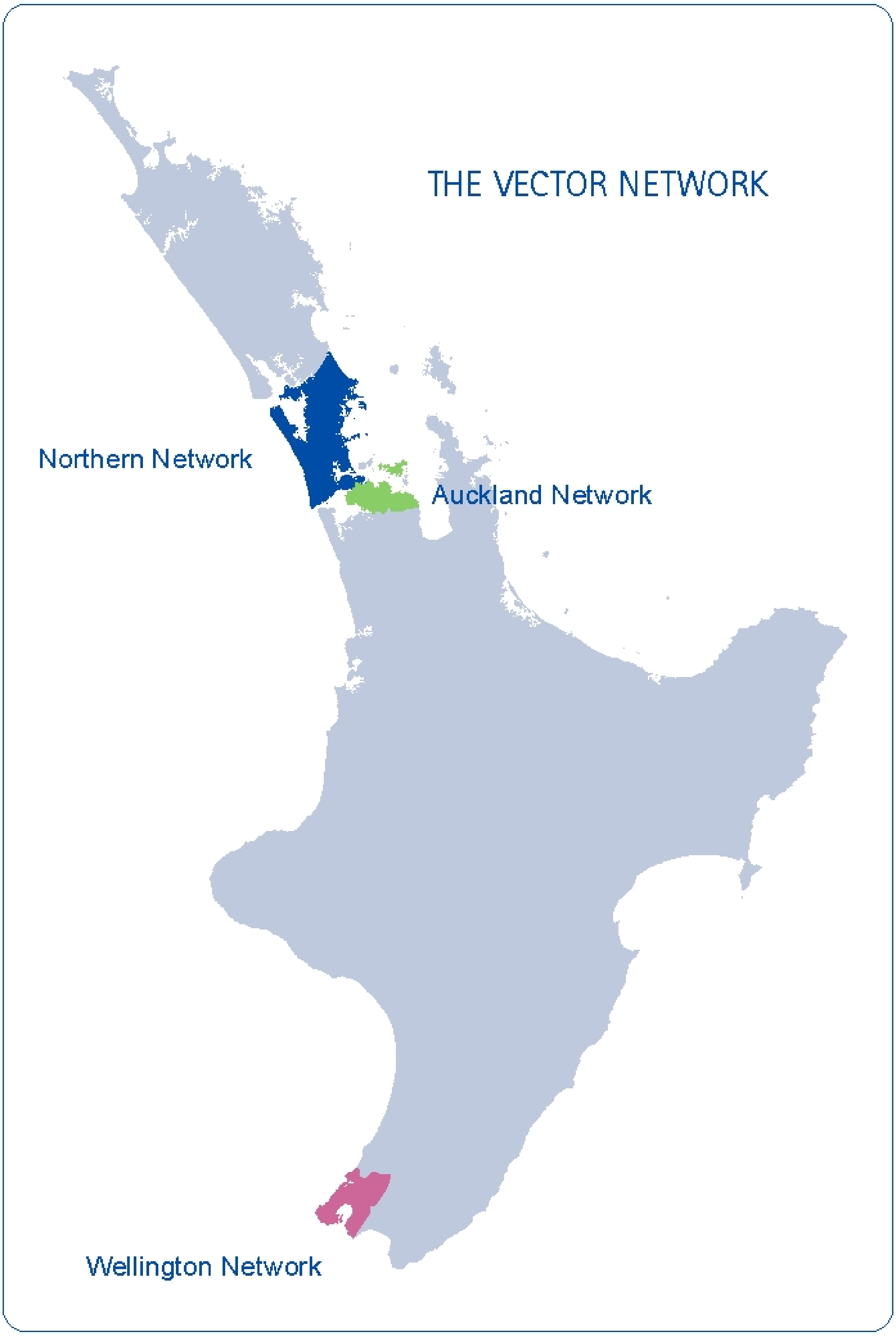

Figure 1.1 The Vector Network

The continued focus for asset management at Vector is one based on greater utilisation of the existing assets achieved through higher performance. This is achieved through understanding customer drivers, enhanced value-based maintenance strategies, better real-time use of capacity, timely system upgrades and utilisation of advanced condition monitoring techniques and technology. Each investment we make is considered specific to the characteristics of the network areas which the investment serves and, underlying this, what levels of service our customers expect. This requires a sophisticated analysis of technologies, trends in future demands, customer service requirements, asset condition, operational performance and future costs.

To support this objective Vector has turned the way information is managed on its head and developed a system that combines the three components of customer management, network management and financial management into one network management strategy. This integrated system provides a common platform for supporting and improving asset management planning, day to day network operations and customer service provision. The system which delivers flexibility, integration of information sources, simplicity and speed for optimal decision making has had huge benefits for network performance, field operations and customer satisfaction.

The asset planning process prioritises the programmes for maintenance and development to balance customer service and operational efficiency. Implicit in the asset planning process is an understanding and evaluation of the risks to operation and the consequences of failure. Also critical is the collection of information from which performance can be monitored and improvement targets set.

The AMP is the foundation document for the management of Vector's assets. From this document, customers and other interested parties will be able to identify Vector's performance targets, areas of business focus, forecast levels of maintenance expenditure and capital investment, and their rationale. The plan also identifies our approach to the management of network risks and our approach to contingency planning.

1.2. NETWORK SUMMARY

The Vector network supplies more than one third of New Zealand's electricity peak demand. The distribution business involves the operation and maintenance of a regional supply network that covers greater Auckland and greater Wellington - an area of approximately 5,200km^2. Vector has 644,000 customers.

Peak Demand	1,944MW
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HV Distribution Lines	4,525km

1.3. ASSET MANAGEMENT PHILOSOPHY

Vector's approach is designed to ensure a balance between the needs and expectations of our customers, business objectives, regulatory framework and the cost of maintenance and replacement. This is balanced against the risk and consequences of asset failure.

Vector's approach to asset management is to:

- Ensure that the required standard service levels are met, including reliability of supply to customers
- Provide a safe environment for operating personnel and the general public
- Proactively manage environmental issues
- Manage the assets to achieve the required functionality, performance and value of assets to enable the continuation of a viable network business

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

Vector has a comprehensive set of environmental guidelines and response procedures for managing equipment installations and work carried out by contractors. Input from Regional Councils ensures that these guidelines are appropriate and minimise any adverse environmental impacts from works.

Trees interfering with lines still remain a problem across the network. Vector has significantly increased spend in vegetation management this year in response to reliability concerns and also in response to the new tree regulations.

In line with Vector's approach to a customer driven level of service provision, the asset management plans are continually developed from analysis of customer requirements, an assessment of the condition of the asset, the risk and consequences of asset failure and analysis of least cost solutions, as shown in Figure 1.2.

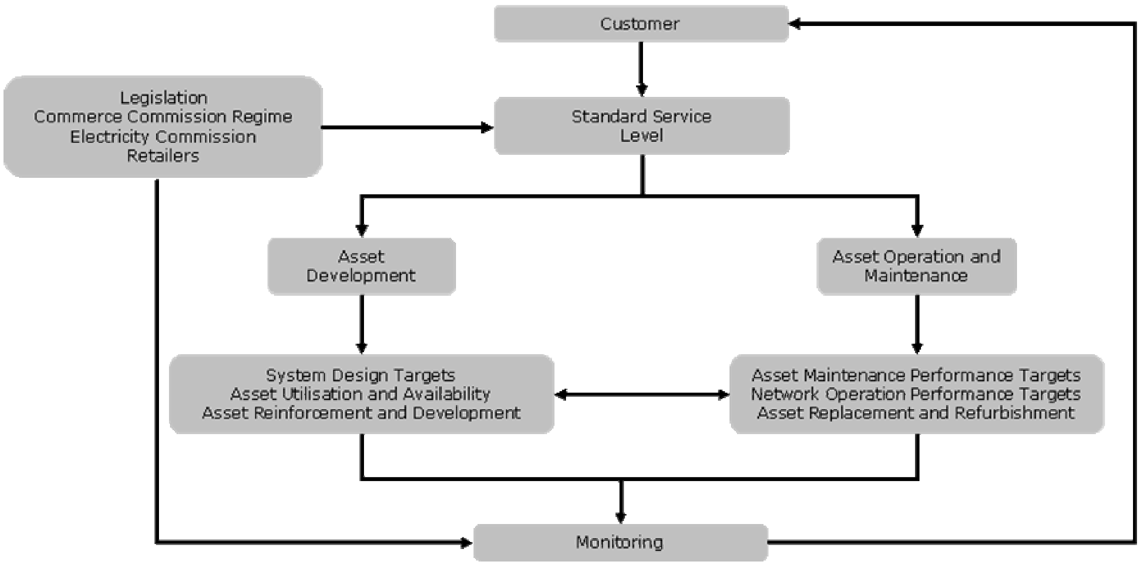

Figure 1.2 Asset Management Philosophy

1.4. ASSET MANAGEMENT PROCESS

Vector's asset management process is shown in Figure 1.3.

1.4.1. INFLUENCERS

- ***Shareholders***
  Vector is owned by the Auckland Energy Consumer Trust. The Trust is responsible for appointing the Board of Directors and agreeing the Statement of Corporate Intent.

- ***Customers***
  Vector manages the network to meet the needs of its customers and works with the energy retailers within the Northern and Wellington 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
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 Bill 2003

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

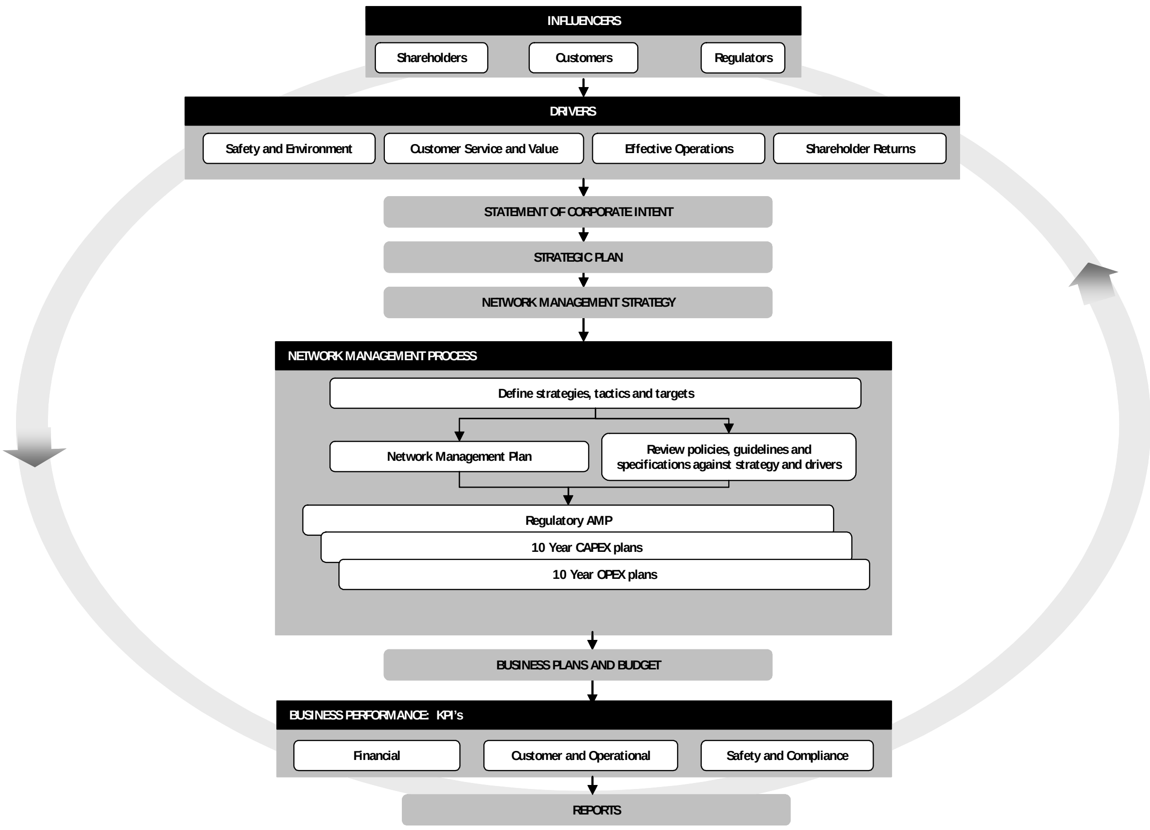

Figure 1.3 Vector's Asset Management Process

1.4.2. ASSET MANAGEMENT DRIVERS

- ***Customer Service and Value***
  Vector's objective is to deliver improved customer value by matching the performance of both its assets and service providers 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, service providers 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 and comply with all legal environmental requirements.

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

1.5. RELATIONSHIP WITH BUSINESS PROCESSES

The AMP is directly influenced by a number of other policy documents and processes:

- ***Statement of Corporate Intent***
  This document defines the Directors' intentions and objectives for Vector for the financial year and is prepared in conjunction with the shareholders. This encompasses business activities and objectives, values, and performance targets.

- ***Strategic and Business Plans***
  Vector has developed a strategic intent and a set of supporting organisational values. Its strategic intent has two thrusts, namely to enhance its core business and to pursue significant growth opportunities in selected market spaces. It has documented a 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 service providers.

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 service delivery.

- ***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 June 2004 until 31 May 2014. The plan is a view going forward. 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

The responsibilities for asset management are outlined in Figure 1.4.

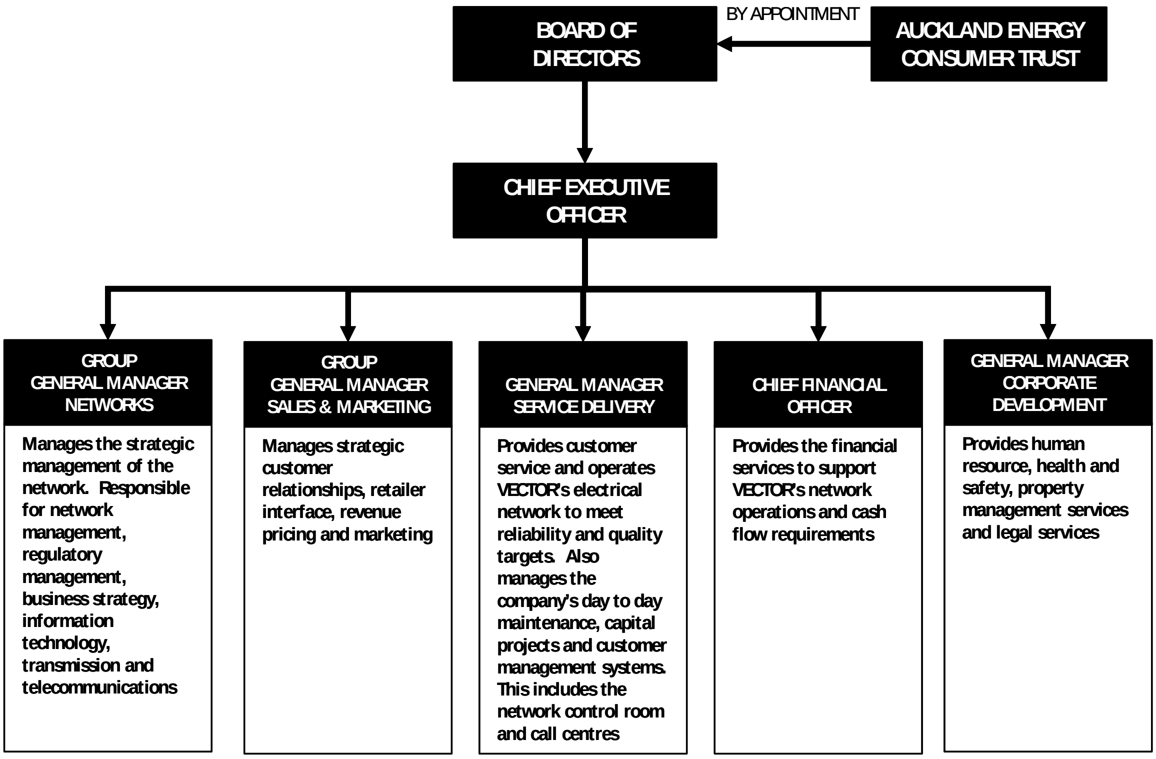

Figure 1.4 Asset Management Structure Chart

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 GIS remains the central focus for asset information collected within Vector and information flows between the GIS and other corporate systems. Our service providers 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 is a key feature of Vector's information system strategy.

1.8.2. GIS SYSTEM

The GIS system is the cornerstone of Vector's asset management information systems. The system is used for the following business applications:

- Performance monitoring 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 register

The following developments to the system have been completed over the past 12 months.

Extension of the System to Support Requirements for SCADA/DMS in the Auckland Region

The GIS system provides the foundation data for the SCADA/DMS system. To allow this, the accuracy, range and type of data recorded in the GIS has been expanded significantly over the past 12 months.

A key area has been the establishment of an integrated schematic view of the HV and Subtransmission network.

Analysis Tools

Vector has lifted to another level, the tools and approaches it takes to analysing network information. The objective has been to allow key trends and areas needing focus to be quickly and accurately identified. This information is available to Vector and its service providers to assist in the decision making approach.

Examples of the types of output are shown in Figures 1.5 and 1.6.

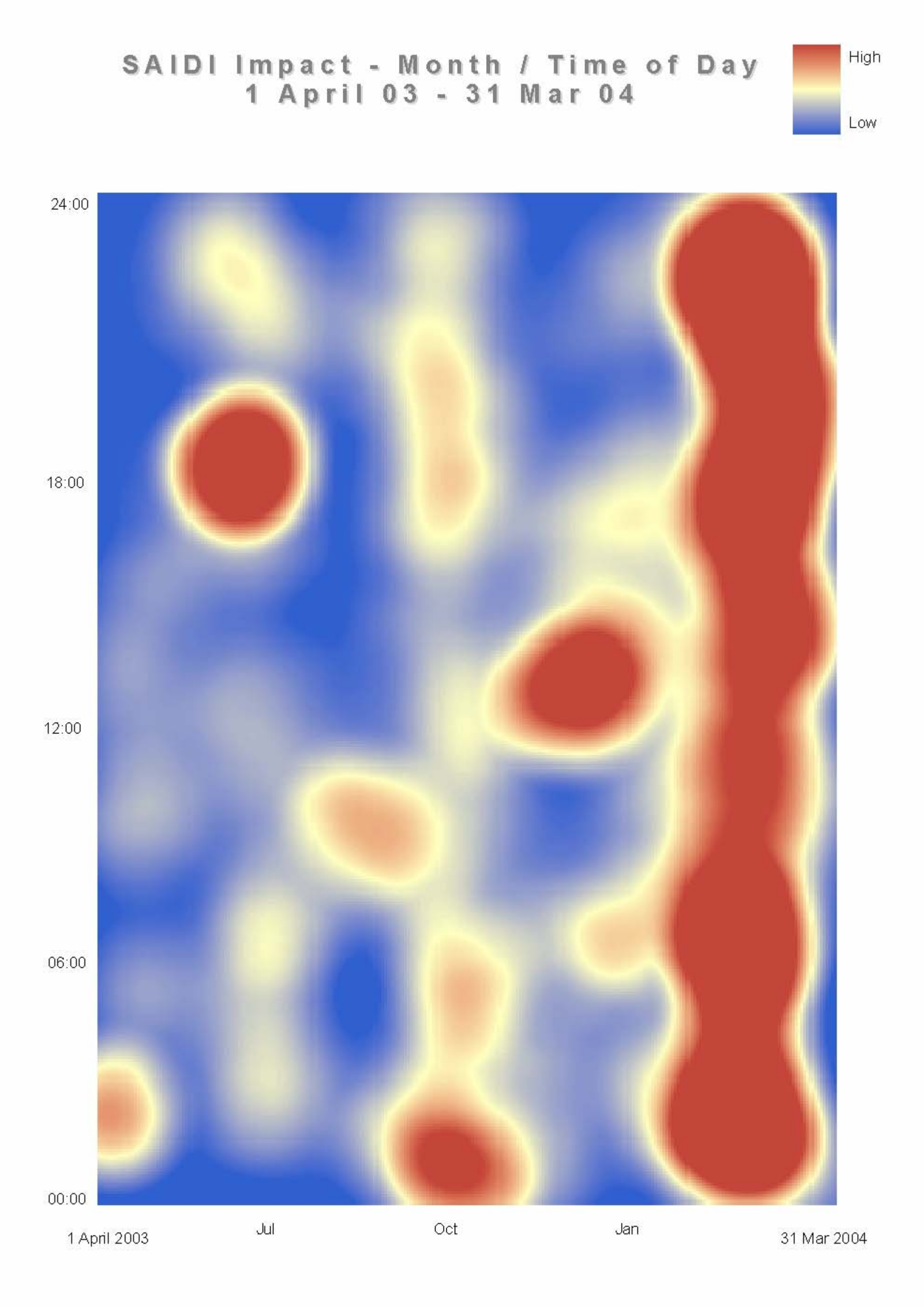

Figure 1.5 HV SAIDI Analysis Tool

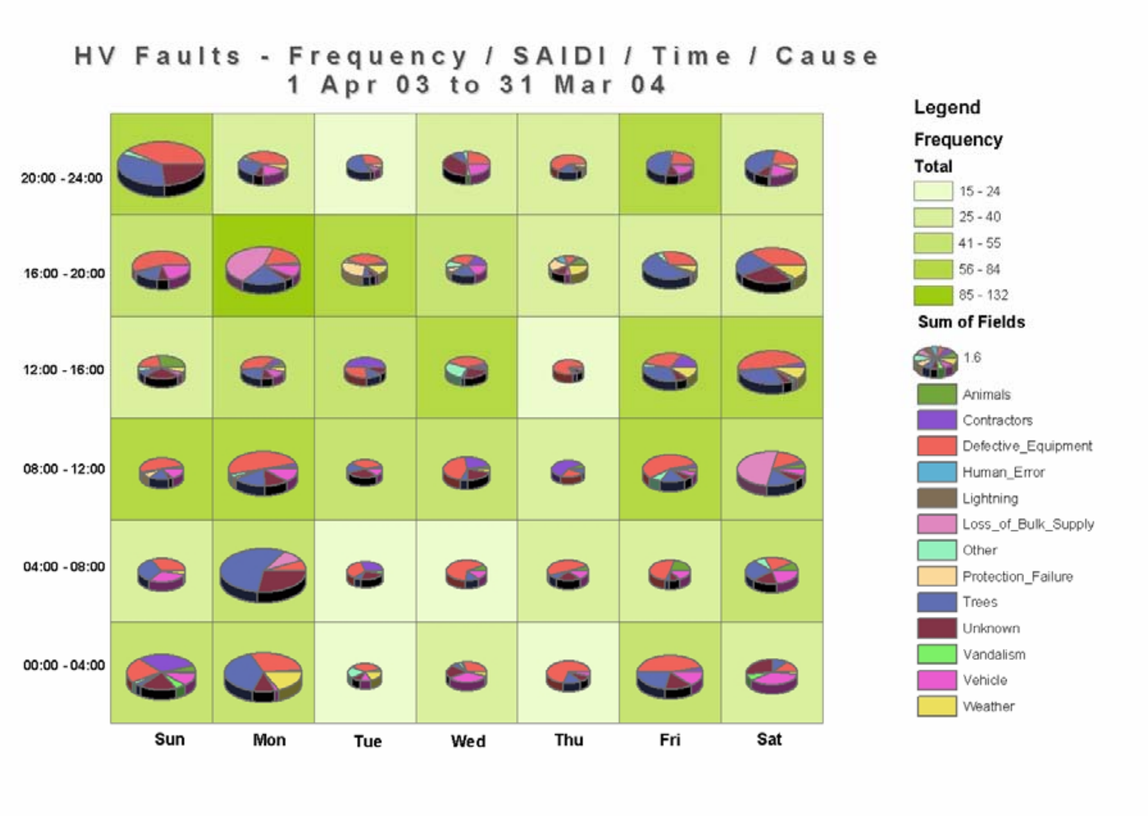

Figure 1.6 HV Fault Analysis Tool

Network Analysis Integration

The establishment of a network schematic view in the GIS provided opportunity to develop a method for creating data files (both graphics and attribute data) for direct use by Vector's network modelling software. This integration provides major reductions to the effort involved in undertaking electrical analysis projects.

Field Data Collection and Verification

A GIS based field application has been developed and implemented to allow recording of inspections, tests and defects as part of Vector's preventative maintenance programmes.

In addition the system also allows errors in the GIS data, noticed during field inspections, to be corrected in the field, thereby efficiently improving data quality.

1.8.3. SCADA/DMS (SUPERVISORY CONTROL AND DATA ACQUISITION/DISTRIBUTION MANAGEMENT SYSTEM)

The project to implement a new "real-time" network management system has continued during 2003/04.

Following comprehensive evaluation of systems available, a solution from *Telegyr Systems* (SCADA), *CES International* (DMS) and *Siemens NZ* was selected, as our SCADA/DMS system.

The solution provides base SCADA functionality, integrated with advanced distribution management system (DMS) functions including outage management, switching management, real-time load flow analysis and dynamic asset rating.

The system is integrated, both with Vector's GIS system (for network data) and with its Customer Management System (for customer call taking and for provision of information on outages to customers).

The system provides Vector with advanced tools, that improve customer service (through more accurate and up to date information on faults), reduce restoration times, improve asset utilisation and reduce the potential for human error.

1.8.4. NETWORK ANALYSIS TOOLS

DIgSILENT Powerfactory

Vector uses a specialised software package, DIgSILENT Powerfactory, for all power system related modelling and analysis.

The complete subtransmission and high voltage distribution network is modelled for all three regions, from the Transpower grid exit points to the low voltage terminals of Vector's distribution transformers.

These network models are being used for investment decisions and enhancement to customer service based on load flow, short circuit, network reliability assessment, protection device coordination, motor starting, network loss assessment, open point optimisation and power quality analysis.

CYMCAP

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

1.8.5. THE NEXT 12 MONTHS

The following are the principal planned developments of Vector's network information systems:

- Further development and application of information analysis tools
- Selection and refinement of field information tools
- Investigate the upgrade of GIS (Smallworld) to leverage new functionality
- Move the land base from DCDB to CRS/Terralink
- Implement a GIS/SAP asset register

2. NETWORK ASSETS

2.1. NETWORK OVERVIEW

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

The network can be considered as three networks – transmission, subtransmission and distribution. The 110kV transmission network connects the Transpower network to the Vector bulk supply substations for Vector supply, but also supports security on the Transpower transmission system. The subtransmission network connects the Transpower network at the grid exit points to zone substations, at 33kV or 22kV. Each substation serves a particular geographic area, with known asset and customer characteristics. At the substations the voltages are further stepped down to 11kV or 6.6kV. The distribution network then carries the electricity to distribution transformers, or for some commercial customers, directly to their premises. At the distribution transformers electricity is stepped down to 400/230V for final delivery to customers.

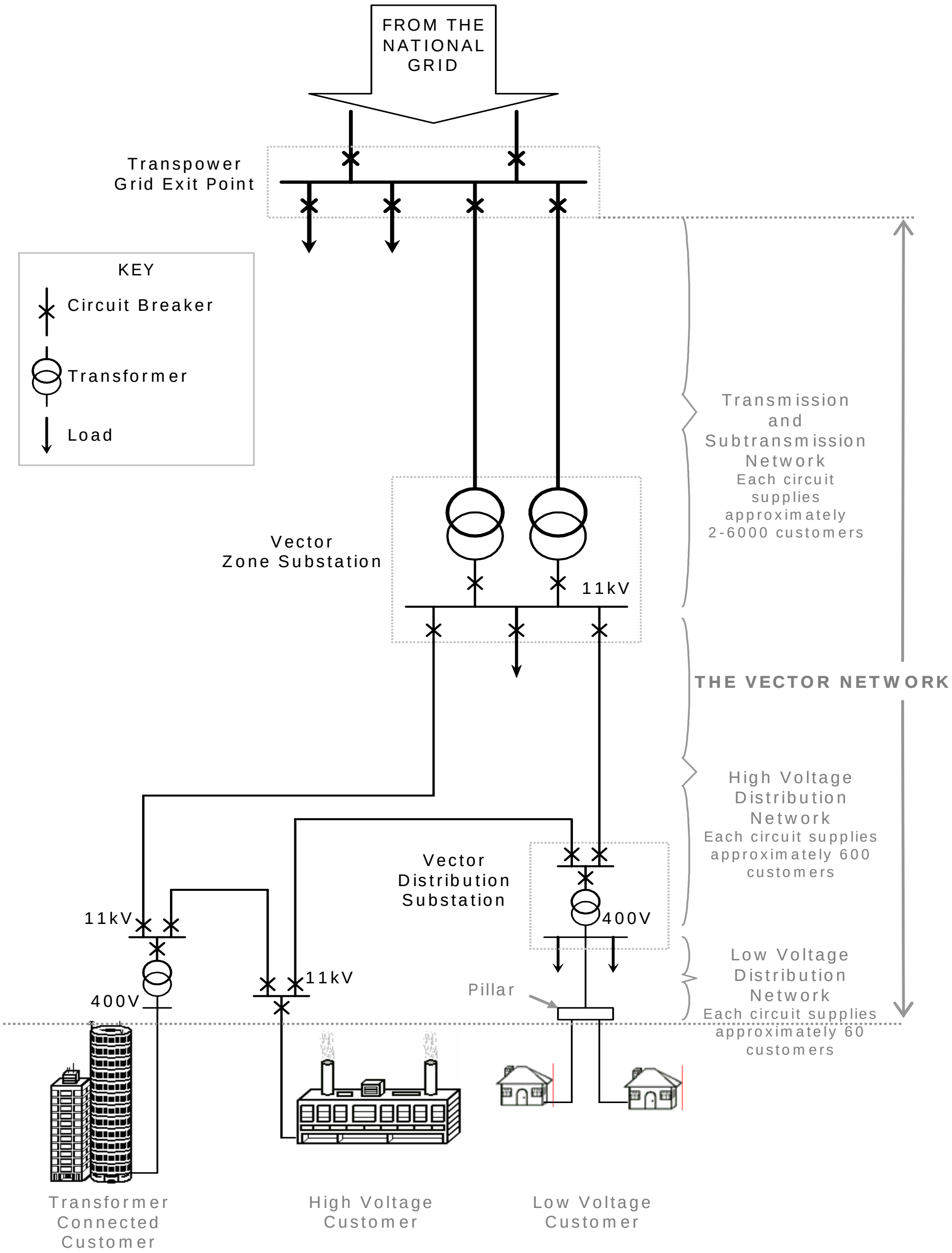

Figure 2.1 Schematic of Vector's Network

2.2. TRANSMISSION AND SUBTRANSMISSION NETWORK

The higher voltage transmission and subtransmission network is designed to transfer large amounts of electricity efficiently, and also provides additional security to the Transpower cross isthmus network. The network transfers electricity from Transpower's network via 22 grid exit points, to 121 zone substations. A zone substation typically supplies between 2,000 to 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. The zone substations are all remotely controlled via the SCADA system, which allows remote operation to be carried out from the Control Room and returns load and equipment operation information.

2.3. TRANSMISSION AND SUBTRANSMISSION DESIGN

The transmission network has been developed essentially as a radial network.

The subtransmission networks in Auckland and Wellington have been designed as radial feeders, with two or three transformers at each zone substation. There are no ties between zone substations at subtransmission level (other than in the CBD). The subtransmission network in the Northern region is a combination of radial feeders and meshed networks.

The future development of the subtransmission system will be driven by the reliability and design standards and customer service levels, and may include single transformer stations, and more interconnections at subtransmission voltage.

Auckland Network

Generally the load on a zone substation should not exceed 30MVA in the Auckland network, in order to keep the number and size of 11kV feeders within practical bounds. In some cases where the load is relatively concentrated, the design maximum load can rise to 50MVA (eg, in the CBD, where land for new zone substations is expensive and difficult to obtain, or in heavily industrial areas).

If there is to be no loss of supply for a single subtransmission circuit fault, the allowable load on the station is limited to the sum of the short-term ratings of the remaining healthy circuits. Vector's design philosophy permits the station load to be increased beyond this limit by accepting a small probability that in the event of a fault, load will have to be shed immediately while load transfers are carried out, with the proviso that all supply is restored within three hours. For the subtransmission security targets see Section 3.

Wellington Network

In the case of Wellington, each zone substation was designed to an n-1 security standard. Because of the closed ring formation of the 11kV distribution network, the amount of interconnection between different zones is very limited. The size of transformers in Wellington varies between 10MVA to 30MVA depending on the load density of the area the zone substation supplies. The design for zone substations in the Hutt and Porirua areas are similar to that for Wellington, ie, to maintain a single contingency security. The radial (interconnected) nature of the distribution network however provides additional backup supply under multiple contingency situations. It should also be noted that due to fault level constraints, the transformers at 12 of the Wellington network zone substations can not be operated in parallel.

Northern Network

The subtransmission network in the Northern Region is configured in a mesh formation. Security of the network is dependent on the power flow in the network under different contingency conditions. The transformers at six of the Northern network substations can not be operated in parallel due to fault level constraints.

2.4. DISTRIBUTION NETWORK

The function of the distribution network is to deliver electricity from the zone substations to customers. It includes a system of cables and overhead lines operating mainly at 11kV, with some 6.6kV, which distribute electricity from the zone substations to distribution substations. Typically 600 customers are supplied at the high voltage distribution level. At the distribution substations the electricity is then stepped down to 400V and delivered to customers either directly, or through a reticulation network of overhead lines and cables. Approximately 30 to 150 customers are supplied from each distribution substation, via the low voltage distribution network. For larger loads, electricity can also be delivered at 6.6kV, 11kV or (for very large loads) 33kV. Four main categories of customer connection are available and the final network connection type is determined through consultation with the customer. The connection types are:

- Single phase low voltage
- Three phase low voltage
- Transformer connection
- High voltage connection

A number of customers are fed by dedicated substations, and take supply at 33kV or 11kV.

2.5. DISTRIBUTION DESIGN

The distribution system in Auckland, Northern and the Hutt areas consists of interconnected radial circuits originating from zone substations. The design is based on the concept of availability of feeder backstopping capacity, according to the security standards. A distribution feeder fault may result in an outage, but in urban substations supply should largely be able to be restored within two to three hours by switching operations on the distribution network. This system provides a very reliable means of electricity supply. In the case of Wellington, the backbone 11kV network is constructed in the form of closed rings fitted with unit protection. In this type of network, no supply loss will be experienced by customers under single contingency situations. From the backbone closed ring networks, radial feeders have also been developed to supply the marginal demand. These radial feeders are interconnected to allow backup under emergency conditions.

The distribution circuits are controlled by automatic circuit breakers at the zone substations. Switches are installed at strategic locations on the circuits to provide operational flexibility. A key focus is on automation of these switches in the network where applicable to improve service levels. For the distribution security targets see Section 3.

There are a number of large customers in the Auckland network connected to the network at high voltage. The ownership of the substations serving these customers 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. Similar arrangements exist in the Wellington and Northern areas. All customers in the Wellington CBD are supplied at low voltage.

2.6. PROTECTION

Vector's network is protected from the Transpower grid exit points to the customers supply point by protection relays and fuses.

The main role of protection relays is to detect network faults by monitoring various parameters (current, voltage, etc) and to initiate opening of relevant circuit breakers should an abnormal situation be observed. This minimises damage to the equipment, hazards to people and loss of supply to customers.

All new and refurbished substations are equipped with multifunctional Intelligent Electronic Devices (IED's). Each IED combines protection, control, metering and monitoring functions within a single hardware platform communicating with the substation computers over an optical fibre LAN using industry standard protocols.

2.7. COMMUNICATION NETWORK

Vector's inter substation communications network consists of optical fibres and copper wire telephone type pilot cables, GSM/GPRS and UHF/VHF radio. GSM/GPRS network and UHF/VHF radio are used to provide communication to field installed devices.

The operational communications network consists of different architectures and technologies. Vector is progressively migrating its operational services to an Ethernet and IP technology based communication network.

2.8. 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 of type ION7600 and ION7500. The meters communicate to the metering central software over an Ethernet based IP routed communication network.

A number of the meters installed at zone substations are of ION7700 type. These meters communicate to the central computer over the GSM communication network. The system provides Vector with essential information to control the cost, quality and reliability of the power delivered to Vector's customers, and is currently used to:

- Improve operational efficiency by controlling peak demands at the bulk supply 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 the quality of power delivered to our customers against the published Vector service levels, and faster resolutions of power quality issues
- Increase the power system stability by initiating instantaneous load shedding during under frequency events.

In order to reduce the metering installation and maintenance cost at the supply points, Vector, in collaboration with the national grid operator Transpower, has initiated and is funding a trial project for sharing metering data from ION® intelligent revenue and power quality meters being installed at the new Silverdale substation.

2.9. LOAD CONTROL SYSTEM

Vector's load control system consists of a number of audio frequency (475Hz and 1050Hz) ripple control plants, pilot wire and DC bias systems, as well as a small number of CylcoControl plants. These assets together with our metering system give us the ability to:

- Control residential hot water cylinders (load shedding)
- Control street lighting
- Meter switch for tariff control

2.10. IMPROVEMENTS TO NETWORK DESIGN

The current network architecture is continuously reviewed to ensure an architecture that is structured around meeting the customers needs while achieving technical excellence (the customers needs are reflected by Vector's service level standards and feedback from customers) at an economically sustainable level.

The approach is to develop an optimised network architecture based on customer needs, cost, reliability and network losses. Network simulation software is one tool that will be used to select the optimum solution. Performance parameters will be established to measure the success of any project and we will continuously strive to improve our performance through feedback and optimisation.

Technological developments and innovation in areas such as distribution network automation (eg, remote switching, intelligent metering) and distributed generation technology will be considered in the process.

Data (eg, fault, customer, power quality and load data) collected by Networks, Service Delivery and Sales and Marketing will be used for analysis, to determine trends and to perform investigations with the ultimate goal of identifying areas for improvement.

In addition to technical performance, the network architecture will address issues such as amenity value and health and safety requirements.

3. SERVICE STANDARDS

Service for Vector is about understanding what our customers value and then meeting these requirements cost-effectively where appropriate. It encompasses providing our customers with a safe, reliable supply of electricity, providing customer specific solutions, being accessible to customers, and providing accurate timely information.

Our customer research has shown that different groups have different needs and tolerances of power fluctuations in terms of length and time of day. All research indicates that reliability in terms of fault frequency and duration of outages is important to customers, but with different levels of criticality.

An important consideration in considering improvements to Vector's network is the Commerce Commission's regulatory regime for electricity lines businesses. In addition to thresholds set for price and quality levels, lines businesses are also required to engage with consumers to better understand price-quality trade-offs. While the thresholds are not direct regulatory control, they have a controlling effect. Investment decisions, therefore, clearly need to be considered in the context of compliance (or otherwise) with the thresholds. The Commission has indicated that there may be valid reasons for breaching a threshold, so long as there is a sound explanation for such behaviour and it is shown, in effect, to be in the long-term interest of consumers. Vector will consider its investments within this context, including making judgements about whether an explanation (ex post) would likely be accepted by the Commission, if the restrictions of the thresholds themselves constrained Vector's ability to introduce appropriate improvements to the network.

For a number of commercial and industrial customers, feedback has indicated that power quality is, in many cases, as critical as outages. Power quality is the provision of supply within acceptable parameters such as voltage, frequency and waveform distortion. In the Vector networks we have a number of customers sensitive to voltage fluctuations, many of whom run continuous process operations with high costs associated with a disturbance or loss of supply. Customer requirements and willingness to pay for varying service levels will ultimately drive performance.

Vector has maintained a number of standard service levels against which we assess and measure our performance. The standards give Vector a basis for measuring performance and for determining the extent of asset maintenance, repair, refurbishment and acquisition. The standards also assist in establishing more defined customer expectations and therefore customer value. These service standards vary between the network areas reflecting differences in both network design and security standards in addition to customer expectations. As part of our integration process and reflecting the outcomes of the current regulatory environment, we will be looking to identify the potential to align or change these service standards.

Network performance at Vector is managed at three levels:

1. Reliability targets set at network level in the Northern and Wellington networks and in the Auckland network for individual zones to align with our standard service levels by customer type, SAIFI and CAIDI (which in turn, give SAIDI).

2. The ability to handle extreme contingencies with the minimum impact to the customer, through risk mitigation. This is managed through our formal risk management process as in the “loss of substation” and similar scenarios.

3. Power quality and customer responsiveness.

3.1. RELIABILITY

Reliability reflects what the customer sees, as it is a measure of how often the power is off and for how long. Reliability is primarily a function of the original design and specification, equipment selection, maintenance practices and the operating regime. Reliability is generally measured by the industry standard measures of SAIDI, SAIFI and CAIDI.

$$\text{SAIDI} = \frac{\text{Sum of (Number of Interrupted Customers} \times \text{Interruption Duration)}}{\text{Total Number of Connected Customers}}$$

$$\text{SAIFI} = \frac{\text{Sum of (Number of Interrupted Customers)}}{\text{Total Number of Connected Customers}}$$

$$\text{CAIDI} = \frac{\text{Sum of (Number of Interrupted Customers} \times \text{Interruption Duration)}}{\text{Sum of (Number of Interrupted Customers)}}$$

The measures of SAIDI, SAIFI and CAIDI are used as they provide a consistent measure of performance across the network that can be compared on a year by year basis. Vector's reliability performance targets are disclosed in accordance with the Electricity Information Disclosure Requirements 2004. The results and targets for 2003 and targets for 2004 are shown in Table 3.1.

Measure	2003 Target	2003 Actual	2004 Target
SAIDI	80	109.6	80
SAIFI	1.3	1.58	1.3
CAIDI	61.5	69.9	61.5

Table 3.1 Results for SAIDI, SAIFI, CAIDI

The following figures show SAIDI, SAIFI and CAIDI for the combined Northern, Auckland and Wellington networks.

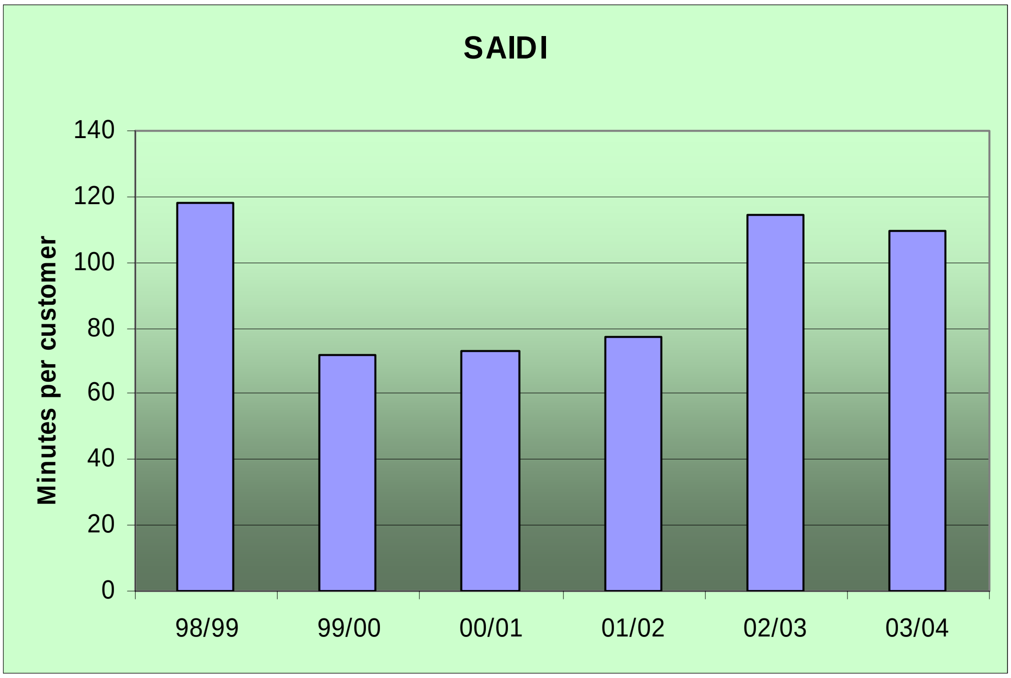

Figure 3.1 SAIDI Actuals (including Transpower outages)

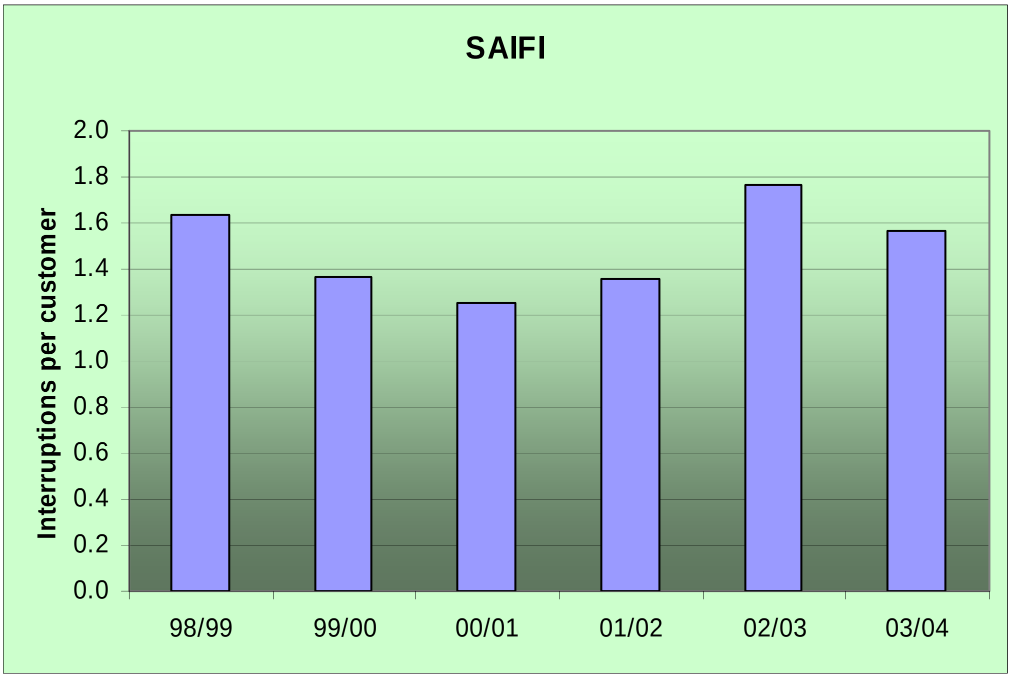

Figure 3.2 SAIFI Actuals (including Transpower outages)

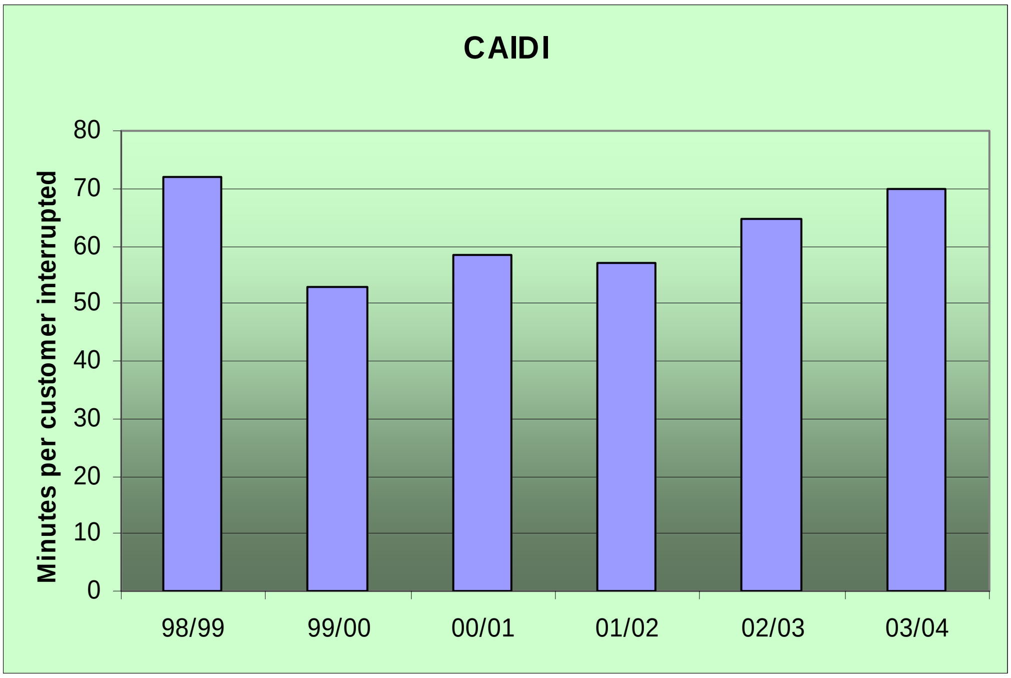

Figure 3.3 CAIDI Actuals (including Transpower outages)

Although we are not yet reaching the key reliability targets we have set for our networks, we are seeing the benefits of targeted asset management practices.

Whilst weather has had a significant impact, there are a number of areas we will focus attention on in the coming year to improve this position. These include planned maintenance practices in the Northern and Wellington network areas and vegetation management practices in all network areas.

Our focus on reducing the human error component of the reliability results has had very good results. Initiatives included working with our service providers to improve switching practices – we will continue to maintain focus on this area.

3.2. NETWORK MANAGEMENT

Auckland Network

Within the Auckland network, the risk of an outage occurring for customers in a given area is calculated and assessed against the baseline level of service for that customer type. This ensures that effort is directed to proactively highlight poorly performing areas and specific corrective actions taken to enhance reliability.

To align the reliability targets with our customers requirements and expectations which vary across the network, we have implemented specific outcome targets for different zones. These standard service levels, shown in Table 3.2, give our customers a reasonable expectation of what level of service they will receive from Vector, dependant upon what region they live in. Customers will be able to contract for higher levels of reliability and quality where required.

		Reliability		Quality
Customer Group	**Service Area**	**Potential Number of Faults Per Year**	**Maximum Restoration Time Per Fault (hours)**	**Potential Number of Events Per Year Where Voltage Sags to Less Than 80% of Nominal Value**
Large Commercial	Commercial	Up to 3	Up to 2	Up to 20
	Industrial	" 4	" 2	" 20
	Residential	" 4	" 2.5	" 30
	Rural	" 14	" 3	" 40
Small Commercial	Central*	Up to 4	Up to 2.5	Up to 30
	Rural	" 14	" 3	" 40
Residential	Central*	Up to 4	Up to 2.5	
	Rural	" 14	" 3	

**For customer groups by zone substation, Central relates to everything but Rural*

Table 3.2 Standard Service Levels: Reliability and Power Quality

For network management purposes, within the Auckland network, reliability targets and standard service levels are translated into SAIDI, SAIFI and CAIDI targets for our service providers.

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. The solutions could range from restructuring of the fault crew response, automation, or installation of fault passage indicators, to assist efficient fault location.

We have developed sophisticated analysis techniques to enhance our understanding of fault patterns, based on time of day, area, and assets to enable focus to be placed in areas which are causing problems.

Service providers are incentivised under the performance nature of the contract to manage the operation and maintenance of the network to achieve the network reliability targets and customer service standards. The annual maintenance plans are developed as a result of the review and analysis of SAIFI and CAIDI performance, and the optimum management plan to achieve the standard service level for that network is established.

Northern and Wellington Networks

The standard service levels for our customers in the Northern and Wellington networks are shown in Table 3.3. These standard service levels give our customers a reasonable expectation of what level of service they will receive from Vector, dependant upon what type of area they live in.

Customer Group	Average Fault Restoration Time (hrs)
Urban	3
Rural	6

Table 3.3 Standard Service Levels: Northern and Wellington Networks

In the Northern and Wellington networks, the reliability targets for service providers are currently at network level and the service providers are incentivised under the performance nature of the contract to manage the operation and maintenance of the network to achieve the reliability targets.

It is our intention to replicate the approach used in the Auckland network, but first we are still in the process of collecting and analysing the data available for those networks to understand their performance and capabilities to enable us to set appropriate reliability targets.

3.3. SYSTEM DESIGN SECURITY

We are continuing the process of reviewing the system design security criteria with a view to development of common criteria based on the strategic long-term vision of the business for all three regions of Vector. In the interim, Vector will continue to manage the assets of the networks based on the existing criteria.

3.3.1. AUCKLAND NETWORK SECURITY

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

- Customer needs, which vary by market segment and are reflected by service level standards, are trending towards higher reliability and improved power quality
- Take customer needs, currently, into consideration

- Capacity and network reinforcements are investments and Vector strives for least cost solutions (optimum asset utilisation) and the deferring of capital expenditure
- Investment strategies and service offerings provide improved value to customers and improved return to shareholders
- Risk management strategies are aligned with the planning philosophy
- Continuously strive for innovation and optimisation in network design and introducing leading edge technology like sophisticated scheduling and remote switching technology to improve utilisation

In support of these principles, Vector moved away from a deterministic planning approach to a probabilistic approach, which recognises that our product has variable reliability and quality and that the customers needs and business strategy should drive investment in the network.

Reliability based planning is the foundation of this approach. It is a probabilistic evaluation of the networks ability to meet customer needs. It assesses the probability of failing to supply customers load by applying long-term industry averages cross checked with actual Vector statistics for failure rates and repair times for all network elements (cables, lines and transformers) in a stochastic model. The outputs of the model are then used to assess the reliability of the network and to compare the relative reliability of different options.

The success of reliability based planning depends on the data and the model used. This means overlaying the industry long-term averages with Vector data.

The short-term goals are to apply this model for:

- Comparing the network reliability with customer specified reliability requirements and costs
- Overlaying recorded service level standards indices with predicted values and identify areas to focus on to get the maximum improvement
- Refining service level standards to determine service levels that are consistent with the network
- Improving asset utilisation and determine the optimum capital expenditure and network reinforcement window
- Demonstrating the relative improvement in reliability for different planning options

The long-term goals include requirements such as including the impact of ageing assets and the total cost of reliability.

The ability to predict the reliability of the network with confidence, combined with alternative technical solutions, advances in information management, communication and distributed generation are providing the framework within which planning can meet customer expectations while improving the return to shareholders.

The reliability implied by the current service level standards will apply until the output of the reliability based planning modelling provides more customer and network specific service levels.

3.3.2. AUCKLAND NETWORK TRANSMISSION, SUBTRANSMISSION AND DISTRIBUTION RELIABILITY

Type of Zone Substation Load	Acceptable Probability of Loss of Supply in a Year Due to Subtransmission Events
CBD or predominantly industrial	0.5%
Mixed commercial/industrial and residential	2%
Predominantly residential	5%

Table 3.4 Transmission and Subtransmission Security

No customer will be without supply for longer than three hours following any single subtransmission fault.

Type of Feeder Load	Acceptable Probability of Loss of Supply in a Year Due to a Backstopping Shortfall
CBD or predominantly industrial	0%
Mixed commercial/industrial and residential	2%
Predominantly residential	5%
Overhead spur up to 1MVA	100% (no backstop)
Underground spur up to 300kVA	100% (no backstop)

Table 3.5 Distribution Security

No customer will be without supply for longer than three hours following any single feeder fault (except for customers on spurs, where in some circumstances the repair time may exceed three hours).

The variation between areas is for two reasons:

1. The reliability requirements of CBD, industrial and commercial customers are higher than residential.

2. The load profiles in different areas 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, but commercial and industrial areas have much longer peaks.

This approach will lead to more consistent levels of reliability and security across the network.

3.3.3. NORTHERN AND WELLINGTON NETWORK SECURITY

The historical approach adopted for the Northern and Wellington regions applies deterministic criteria as an initial screening process on security, to identify areas where more detailed analysis is required, using probabilistic methods.

3.3.4. NORTHERN AND WELLINGTON TRANSMISSION, SUBTRANSMISSION AND DISTRIBUTION RELIABILITY

Group Peak Demand (GPD) MVA	Type of Substation Load	Minimum Demand to be Met 1st (Tx/cct) Outage	 2nd (Tx/cct) Outage
Up to 1.0	Overhead spurs (LV or HV) Lightly loaded feeders	100% GPD in repair time, target 3 hrs urban, 6 hrs rural	Repair time (refer definitions)
Up to 0.8	Underground spurs (LV or HV) Lightly loaded feeders	100% GPD in repair time, target 3 hrs urban, 6 hrs rural	Repair time (refer definitions)
Up to 12	Urban feeders Urban zone substations	100% GPD within 3 hrs	100% GPD in repair time
Up to 12	Rural feeders Rural zone substations Rural grid connection points	50% GPD within 6 hrs, 100% GPD in repair time	
12-60	Urban zone substations	100% GPD immediately	50% GPD within 3 hrs, 100% within repair time
12-40	Remote grid connection points Rural zone substations	75% GPD within 6 hrs, remaining load in repair time	100% GPD in repair time
60-200	Zone substations supplying high density load areas	100% GPD immediately	100% GPD within 2 hrs
40-300	Normal grid connection points	100% immediately	50% GPD within 3 hrs, 100% within repair time

Table 3.6 Security of Supply Criteria

A network security model has been developed to identify the various conditions and areas where loss of a network component could result in loss of supply to consumers. Fault statistics based on long-term industry averages are used to identify the probability of equipment failure. Based on the expected demand and the capacity of back up supplies, the model calculates the demand not met due to the loss of a network component. Using this information, together with load duration characteristics and the average time required to restore supply, an estimate of the energy not served due to the fault is assessed. In this way, the model analyses costs of non-supply due to failure of network components such as transformers, busbars and subtransmission circuits and compares them with the cost to remove the risks. This provides guidelines regarding reinforcement expenditures.

The security standards for the three regions of Vector are based on the historical standards that existed prior to the merger with UnitedNetworks. These standards are currently being reviewed and will be brought into alignment where there are differences.

3.3.5. ALL NETWORK AREAS

For all network areas the reliability and security standards represent the first steps down a new path in network asset management. With a true customer focus, we will establish baseline or customer specified reliability standards for each feeder. This will drive capital investment decisions, maintenance and fault repair practices, long-term spares holding policy and emergency response plans. Our continued focus on improved asset condition and network performance information will improve the decision making process. We will be able to provide customers with reliability options and associated costs, allowing them to choose whether they will take their own measures to achieve the reliability they want, or contract Vector to do so.

3.4. POWER QUALITY

Vector recognises the importance of power quality to our customers.

The Vector networks are designed to a quality level that most modern equipment can effectively operate with. However, as technology advances, new electronic equipment is becoming increasingly sensitive to power disturbances. Also, some specific businesses, such as those in manufacturing and service industries, have a higher reliance on disturbance free power.

Vector continually strives to reduce power disturbances that affect our customers. However, all electricity networks are subject to unplanned disturbances and it is impossible to guarantee a perfect power supply free of voltage sags, surges or harmonic distortions. A sag is a momentary decrease in voltage below the normal tolerance, typically lasting less than some milli-seconds. They are often the result of faults or incidents occurring elsewhere, including disturbances originating from neighbouring commercial premises or even your own equipment, the effect of which ripples through parts of our network.

The following strategies have been implemented to effectively report and manage the impact of power quality on customers and Vector's network.

- An ongoing programme to install power quality measuring equipment at grid exit points, zone substations and customer sites
- An electronic mail system that automatically sends a power quality report in real-time to customers informing them that their plant could have experienced a power quality disturbance
- A web-based reporting system that makes both real-time and historical power quality information available to customers. Figure 3.4 illustrates a typical report that is available on the intranet for customers to access
- The application of modelling software and tools to predict the impact of power quality disturbance on customers
- The application of mobile power quality instruments to investigate power quality related complaints

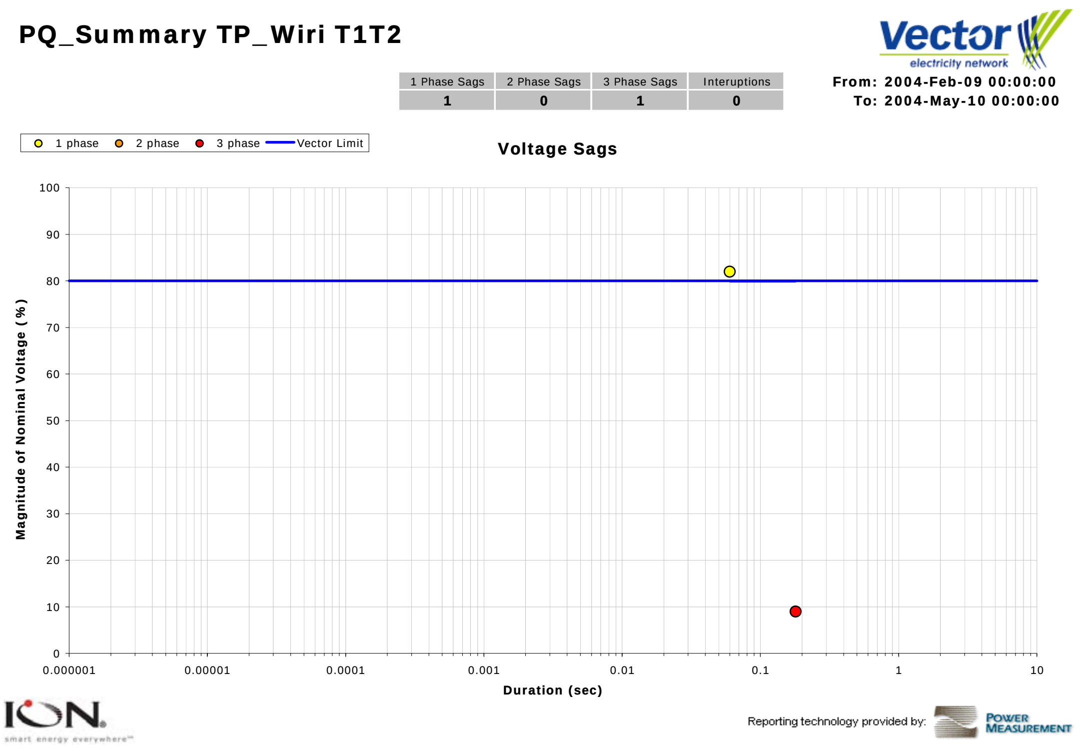

Figure 3.4 Example of a Voltage Sag Report

4. ■ NETWORK DEVELOPMENT

The network must efficiently meet the future needs in terms of customer requirements, load growth, statutory requirements, environmental and safety issues. As part of the strategic planning process, it is critical to ensure that any investment is cost-effective over the planning period and phased in at the optimum time. Risks, costs and benefits are reviewed and revised as new load growth and asset capacity, utilisation and capability information becomes available.

Our approach is to first optimise the use of existing assets where possible through automation, load management or other non-asset development solutions, and thereby defer major capital expenditure, provided that our reliability objectives are not compromised. Capital expenditure is mainly driven by growth and new connections, but compliance with regulations and safety issues, and replacement of aging assets contribute significantly to the capital spend.

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

4.1. FORECAST GROWTH

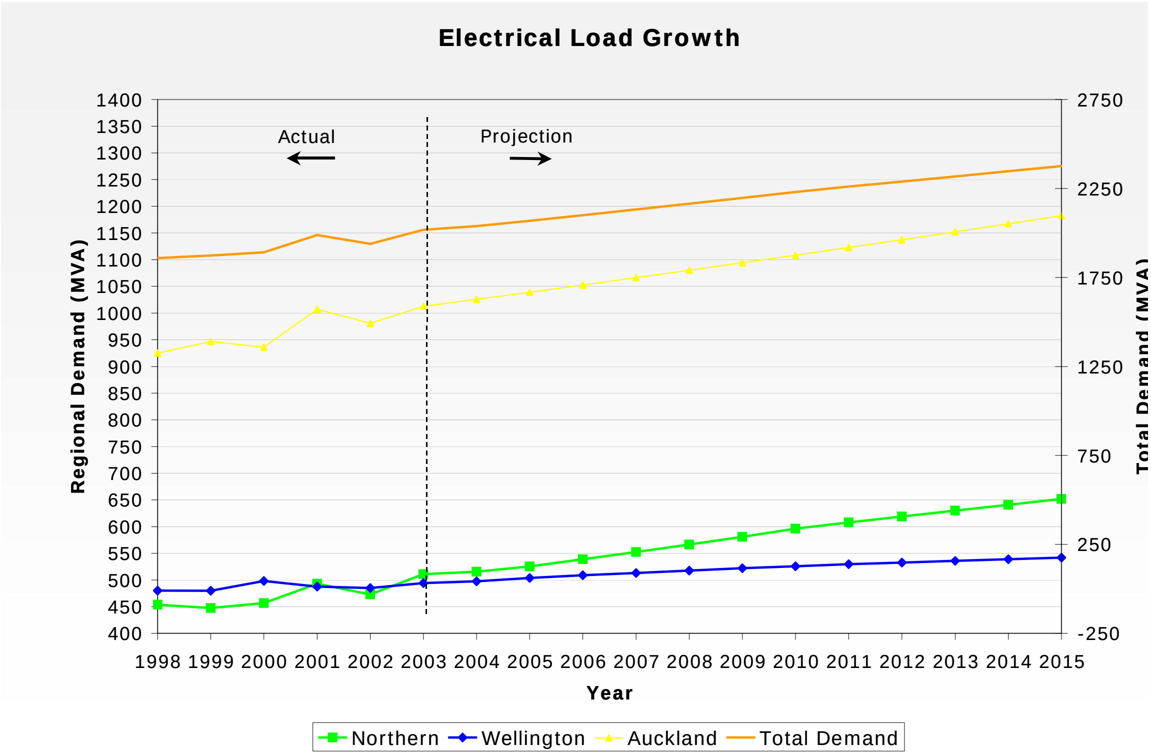

Figure 4.1 Forecast Maximum Demand across the Network

The long-term forecast for Vector's total network shows an average growth rate of 1.4% per annum. Figure 4.1 shows the forecast demand growth across the network. Vector forecasts peak demand at a zonal level based on data from the SCADA system at zone substations and 11/6.6kV feeders. The forecast is for a "normal" climate year, therefore the actual demand is adjusted for any climate extremes experienced. Peak demand is then forecast for the next 15 years. An underlying basic growth factor specific to the particular zone substation is applied, reflecting the expected impact of economic growth, population growth, available land for development, district plan changes etc. Individual commercial developments are accounted for where known. The forecasts are then adjusted to include block load transfers between zone substations, which are planned as a capital expenditure deferral strategy, but also deliver improved asset utilisation as well.

Short-term maximum demand in Vector's network is mainly influenced by climate, particularly the severity of winter. Medium-term demand is mainly driven by population growth with specific area growth being governed and regulated by regional council development and district plans, and also area specific commercial developments.

The load on Vector's network is primarily an urban load, consisting of:

- Residential load
- Small commercial loads, such as dairies and single shops or small blocks of shops
- Large commercial loads, including shopping malls and light industrial factories
- Large industrial loads, ranging from large factories to steel mills

Peak demands do not occur simultaneously. Advantage is taken of the diversity of load profiles when designing the network. Residential loads tend to peak in the evening, with a peak lasting two to three hours from 17:00 hours. Commercial loads tend to peak during the day with a peak lasting five or six hours. Peak demands are seasonal and area specific, with some areas peaking in winter and others in summer. The underlying trend for peak demands is moving towards a summer peak, particularly in commercial areas, and the network will have to be designed and operated to ensure performance is maintained under changing customer usage patterns.

The challenge for Vector is to manage the maturing network at an economic level. Reinforcement and development projects are reviewed and planned for when the forecast loads exceed the system design security criteria outlined in Section 3.

4.2. NETWORK INVESTMENT

Vector invests in its network for the following reasons:

1. To provide additional capacity for growth.
2. To replace assets which have come to the end of their economic lives.
3. To ensure the assets comply with health, safety and environmental statutory requirement.
4. To maintain and improve where necessary the service provided by the network.

Vector's approach to network investment is to seek the best value investments. This is done by considering a wide range of traditional and non-traditional solutions for each investment.

As part of the network investment decision framework project, a work stream has been developing a framework that encourages the use of new solutions to minimise the long-term investment expenditure in the electricity and gas networks while maintaining the service and risk level. 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

A decision tree has been developed that helps a network planner to consider all the issues involved with the use of generation as an alternative to building network infrastructure for backstopping or capacity constraints. Similar decision trees will be developed for other network alternatives e.g. use of capacitors for voltage improvement. Ideally, these decision trees will be linked in a knowledge management system, which will allow new technology information to be easily disseminated to decision makers and incorporated into the decision trees.

As part of the work on ensuring that the company invests optimally when faced with network constraints, Vector has been sponsoring a research project undertaken by an Engineering Postgraduate student at Auckland University. The project has developed a Reliability Model that determines the network backstopping capability for the worst-case fault on any particular feeder, and then suggests either an alternative switching configuration if possible, or the least-cost capacity augmentation of feeder segments for backstopping. This model could also be used for modelling alternative solutions such as the impact of distributed generation on backstopping capability.

Most alternative solutions, such as automation and load management, provide incremental increases in capacity from existing assets 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.

Vector has a process of evaluating and, where appropriate, implementing alternatives to traditional investment in network assets. Each investment is considered specific to the characteristics of the network area in which the investment serves. This requires a sophisticated analysis of technologies, trends in future demands, customer service requirements and associated costs.

4.2.1. NETWORK CONSTRAINT MANAGEMENT

As load grows throughout the network the capacity of existing assets will be soaked up. Eventually constraints will emerge where the load on the existing assets is such that Vector's service levels are compromised. Prior to this point Vector looks to invest to relieve the constraint.

Constraints are local to the specific area served by the constrained assets. Constraints are also time dependent – they occur only when existing capacity is exhausted and are relieved as soon as further capacity is provided through investment. Constraints can occur at any point in the network, in the transmission network, the subtransmission network or the distribution network. Generally, the lower down the network the smaller the area of customers affected and the smaller the level of investment to relieve the constraint.

Investment to relieve constraints is carried out in the same manner as other Vector network investments. A range of alternative solutions is considered. To ensure that as wide a range of solutions as possible is considered, Vector looks to signal constraints to potential solution providers.

A particularly cost-effective means of relieving constraints is via load management. Constraints can be relieved by:

- Reconfiguring the network to reduce the load in the constrained area
- Encouraging customers to shed load at peak times
- Local generation

In addition to the major proposed projects outlined in the AMP, Vector makes a number of smaller, but sizeable investments throughout its network each year. Vector is investigating other ways of signalling the need for these investments to encourage third party solutions eg, embedded generation.

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-side response

- Embedded generation (both new generation and use of existing generation – eg, CBD building 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
- Demand Exchange; evolving market mechanism developed to enable load to be traded

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 and fuel cells.

There is approximately 105MW of installed generation in the Vector foot print including biogas plants at Greenmount (5MW), Whitford (2MW), Rosedale (4MW), Redvale (3MW) and Silverstream (2.7MW). In addition to the physically embedded plants, Vector has one notionally embedded power plant at Southdown (120MW). A number of customers also generate power from their own solar panels.

The technical requirements for generator connection to the Vector distribution network are specified in a public document. Vector has also published a guide for customers who wish to install embedded generation with a capacity less than 5kW. Generation projects with a capacity greater than 5kW are dealt with by Vector's technical specialists due to the unique characteristics generation has on the distribution network.

Vector employs distributed generation as a non-traditional investment solution that is considered and applied where appropriate. A current initiative is to actively purchase on the Vector Demand-side Exchange (www.demandexchange.co.nz) back up diesel generation and non-essential interruptible load for load management during peak load times on the Vector network. It is also envisaged that the exchange will help provide the tools necessary in utilising the demand-side for investment deferral.

Vector is a co-sponsor of the Centre for Advanced Engineering study "A New Zealand Study on Distributed Generation". The study is evaluating the impact of distributed generation on transmission and distribution networks in New Zealand.

4.2.4. 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 in
- 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 breech 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 service providers are linked directly to the provision of the service
- 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:

- Encourage the number of possible solutions and participants
- Set prices through competitive process
- Ensure timeframes are short (to enable other solutions to emerge over time)

4.3. ASSET DEVELOPMENT

A number of localised areas within the Vector network have been identified as approaching the point where Vector's supply reliability criteria can not be maintained. Each issue and constraint is reviewed to determine the optimum operational and economic approach to addressing the problem and maintaining customer service by considering the following options:

- Increased asset utilisation, through advanced automation, dynamic ratings etc
- Load management (including demand-side management)
- Level of acceptable risk
- Asset performance improvement
- Customer requirements and customer based solutions
- Capital investment

This results in a revised asset development programme in terms of the:

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

It is expected that by improving the utilisation of assets, Vector will be able to stage investments and defer or reduce overall capital expenditure. Detailed investigation of the options will occur before any new project is committed. Significant projects are summarised in this section, with their approximate cost range (ie, < $1 million, between $1 and $3 million, and > $3 million). "Committed" status indicates that the project has an approved budget.

4.4. AUCKLAND CUSTOMER AREA

4.4.1. GROWTH IN THE AUCKLAND AREA

This area covers Auckland City, Manukau City and parts of Papakura District.

Demand growth is not consistent throughout the Auckland area, with some areas experiencing rapid growth due to new developments and others experiencing low or negative levels of growth as areas become fully developed or existing commerce and industry move away.

Residential demand is expected to increase in central Auckland with the development of new apartments and refurbishment of offices into apartments, which will continue at a high rate for the next few years. Residential growth in the Manukau City and Takanini/Alfriston areas are also high because of a high number of planned subdivisions. Residential growth elsewhere 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 to be focused in the Avondale area and around East Tamaki, with large retail development in Mt Wellington. Industrial and commercial load growth is also expected to continue in the Wiri and Manukau areas, and in the vicinity of Auckland airport.

4.4.2. ISSUES AND OPTIONS IN THE AUCKLAND AREA

A1: Manukau Area

Project	*Reinforcement at Manukau*	
Driver	*Growth*	
Timescale	*2005*	
Status	*Proposed*	*Estimated capital >$1 million*

Manukau will require reinforcement or changes to the current operating regime by 2005 if the forecast load growth is realised. Options under review include:

- Installation at Manukau of additional 11kV switchgear and a third 33/11kV transformer
- Increased asset utilisation
- Load management, asset performance analysis and risk evaluation

Interim low cost measures to increase transformer ratings (eg, installation of fans and extra radiators), or automated load transfer facilities will be considered as options, which may provide a worthwhile deferral of the reinforcement expenditure.

A2: Freemans Bay Area

Project	*22kV cable replacement*	
Driver	*Replacement*	
Timescale	*2005*	
Status	*Proposed*	*Estimated capital $1-3 million*

The uprating of Freemans Bay zone substation from 6.6 to 11kV was completed in February 2002. This overcomes the supply problems within the area. However, the 22kV cables supplying Freemans Bay are 36 year old gas pressure cables. Vector has recently replaced cables of similar age and technology. The performance of these cables is being closely monitored and we will initiate replacement when condition monitoring confirms actual performance is unacceptable.

Options for the replacement work include:

- New cables from existing supply point (Kingsland)
- New cables from Hobson supply point
- Investigation of constraints caused by 6.6/11kV break line

A3: Quay Substation

Project	*22kV distribution*	
Driver	*Growth*	
Timescale	*2005*	
Status	*Proposed*	*Estimated capital <$1 million*

A 22kV backbone distribution network will be established in 2005 to supply the new load (Arena, etc) as well as connecting load transferred from the existing 11kV network. This will avoid the need for a third 22/11kV transformer. Extension of the 22kV switchboard will be investigated to enable future stages of the 22kV network development.

Part of the 11kV switchgear (panels 1-9) at Quay is scheduled for replacement in the next 10 to 15 years due to the age of the equipment. This will be reviewed in light of the development of the 22kV distribution network in the CBD.

A4: Hobson/Quay Interconnector

Project	*22kV cable replacement*	
Driver	*Replacement*	
Timescale	*2005*	
Status	*Proposed*	*Estimated capital $1-3 million*

There are currently four 22kV cables between Hobson and Quay substations. These cables act as a backstop to the main 110kV supply to Quay substation. However, the Quay 110kV gas pressure cables are expected to be retired from service within the next five years. The exact timing depends on the condition of the cables but may also be affected by construction of the new eastern arterial road. When these cables are no longer in service, the 22kV cables connecting Hobson and Quay will become the primary supply to Quay, and will need to be replaced to provide the required security.

A5: Ellerslie, Penrose Area

Project	*McNab 11kV switchboard replacement*	
Driver	*Replacement*	
Timescale	*2005*	
Status	*Proposed*	*Estimated capital $1-3 million*

The 11kV switchgear at McNab substation is 52 years old and is nearing the end of its technical life. Condition monitoring using partial discharge testing has shown that the equipment remains in satisfactory condition for continued operation. However, the protection relays on the switchgear have reached the end of their useful life and require replacement as they no longer provide minimum accepted performance. The options to address this issue are to replace the switchgear including the relays or to only replace the protection relays. Load forecasts indicate replacement of the switchboard will be required in 2005 for reasons of equipment rating.

A6: Ponsonby Area

Project	*Replace 22kV cables*	
Driver	*Replacement*	
Timescale	*2006*	
Status	*Proposed*	*Estimated capital $1-3 million*

One of the cables supplying Ponsonby substation is a gas pressure cable which is 39 years old. We are closely monitoring the performance and reliability of all remaining gas cables on our network and we will initiate replacement when condition monitoring confirms actual performance is unacceptable. The other two cables supplying Ponsonby are 55 years old and nearing the end of their technical lives. This project is independent of the 6.6kV uprating project although they could be done at the same time.

A7: Hobson Substation

Project	*New 110kV switchgear and transformer*	
Driver	*Growth*	
Timescale	*2006*	
Status	*Proposed*	*Estimated capital >$3 million*

Additional 22kV capacity is required at Hobson by 2006. It is proposed to install a 110/22kV transformer to provide the additional capacity. Installation of this transformer will require the installation of an 110kV switchboard at Hobson. The additional 22kV capacity will also provide a source of supply to Quay substation upon retirement of the Penrose-Quay 110kV cables.

As part of the CBD long-term development plan, two 22kV cables will be installed to Liverpool substation in 2005 to form a 22kV distribution backbone network. These feeders will be used to connect new customers as well as accommodating load transferred from heavily loaded parts of the 11kV network. Major reinforcements on the 11kV distribution network will be frozen. Eventually, the 22/11kV transformers and the 11kV network at Hobson will be phased out.

A8: Penrose Area

Project	*McNab 33kV cable replacement*	
Driver	*Replacement*	
Timescale	*2007*	
Status	*Proposed*	*Estimated capital >$1 million*

The cables are solid PILC cables and their performance is being monitored. Load forecasts indicate replacement of the cables will be required in 2005 for reasons of equipment rating.

A9: Ponsonby and Chevalier Area

Project	*Uprating Ponsonby and Chevalier substations to 11kV*	
Driver	*Growth*	
Timescale	*2007*	
Status	*Proposed*	*Estimated capital $1-3 million*

As outlined in last year's AMP, Ponsonby and Chevalier are the last remaining substations operating at 6.6kV. It is becoming progressively more difficult to maintain security of supply to customers supplied from these substations as the load grows. The uprating will require new transformers for Chevalier, unless suitable surplus transformers become available from elsewhere on the network. Indications are that uprating will need to occur within the next five years. Uprating to 11kV is the most cost-effective option for increasing the rating of the distribution network. The existing Ponsonby transformers were replaced in 2001 with dual ratio units so these will not require replacing as part of the upgrade.

A10: Chevalier Area

Project	*Replace 22kV cables*	
Driver	*Replacement*	
Timescale	*2007*	
Status	*Proposed*	*Estimated capital >$3 million*

One of the cables supplying Chevalier substation is a fluid filled cable which is 23 years old. The other two cables are 72 years old and nearing the end of their technical lives. This project is independent of the 6.6kV uprating project although they could be done at the same time.

A11: Kingsland Area

Project	*Replace Kingsland 22kV switchgear*	
Driver	*Performance*	
Timescale	*2008*	
Status	*Proposed*	*Estimated capital $1-3 million*

This switchgear is 38 years old and nearing the end of its technical life. Condition monitoring using partial discharge testing has shown that the equipment remains in satisfactory condition for continued operation. Regular testing will continue and as soon as the results indicate that the condition is such that performance will deteriorate beyond minimum acceptable levels, the switchgear will be replaced. The options to address this issue are limited to replacement of the switchgear.

A12: Hobson West Substation

Project	*New zone substation*	
Driver	*Growth*	
Timescale	*2009*	
Status	*Proposed*	*Estimated capital >$1 million*

Land for Hobson West substation has been purchased. The part of the land not required by Vector for the substation has been sold to a developer who is constructing apartments. A cable tunnel has been built. With the plan to phase in 22kV distribution and freezing the development of the 11kV network in the CBD, establishment of Hobson West substation as a 22/11kV zone substation is no longer required. Instead, the substation site will be used to accommodate a 22kV switchboard which will serve as a marshalling point for the 22kV distribution network to the south east part of the CBD.

A13: Maraetai Area

Project	*11kV switchgear replacement*	
Driver	*Replacement*	
Timescale	*2009*	
Status	*Proposed*	*Estimated capital <$1 million*

The 11kV switchgear at Maraetai substation is 46 years old and nearing the end of its technical life. Condition monitoring using partial discharge testing has shown that the equipment remains in satisfactory condition for continued operation. Regular testing will continue and as soon as the results indicate that the condition is such that performance will deteriorate beyond minimum acceptable levels, the switchgear will be replaced. The options to address this issue are limited to replacement of the switchgear.

A14: Takanini Area

Project	*Substation reinforcement*	
Driver	*Growth*	
Timescale	*2009*	
Status	*Proposed*	*Estimated capital <$1 million*

There is strong growth in the Takanini area with a prediction of around 3000 houses per annum to be built over the next few years. This will require reinforcement of the capacity at Takanini substation to maintain adequate security of supply.

Options for the reinforcement include:

- New cables from existing supply point (Takanini)
- New 33/11kV transformers
- Additional 33/11kV transformers
- Combination of the above

A15: Liverpool Substation

Project	*New 110/22kV transformers*	
Driver	*Replacement*	
Timescale	*2009*	
Status	*Proposed*	*Estimated capital <$1.5 million*

Liverpool substation has three 110/22kV transformers, two of which are 28 years old, and the third is five years old. One of the older transformers has undergone a mid-life refurbishment and the second is scheduled for refurbishment in 2005. The condition of the two older transformers will be monitored, and when they reach the end of their technical life they will be replaced. This is expected to be within the next 10 years.

A16: Onehunga / Te Papapa Area

Project	*Onehunga substation uprating to 33kV*	
Driver	*Growth*	
Timescale	*2011*	
Status	*Proposed*	*Estimated capital >$3 million*

The Onehunga substation is 41 years old and reaching its design capacity. The substation is currently supplied at 22kV and allowance has been made at Transpower Penrose to uprate the substation to 33kV. A short-term solution of using automated load transfer was implemented in 2001. This will defer uprating to 33kV until the load increases above the new design limit or condition monitoring indicates that equipment at the substation needs replacement. Interim solutions have been investigated such as ties between Onehunga and Te Papapa in 2004 with uprating to 33kV in 2011.

A17: Sandringham Area

Project	*Replace 22kV cables*	
Driver	*Replacement*	
Timescale	*2011*	
Status	*Proposed*	*Estimated capital >$3 million*

The cables supplying the Sandringham 22kV switchboard and Balmoral substation are approaching the end of their economic life. Four of the cables are 62 years old and one is 26 years old. Two of the 62 year old cables have inadequate fault rating. It is planned to replace these cables when necessary with three new 33kV rated cables to Sandringham and two 33kV rated cables to Balmoral. Several options were considered and replacement of the existing cables, operating initially at 22kV with eventual uprating to 33kV was considered the best option. It is expected that the new cables will be required within the next 10 years.

A18: Parnell Substation

Project	*22kV cable replacement*	
Driver	*Replacement*	
Timescale	*2011*	
Status	*Proposed*	*Estimated capital $1-3 million*

The 22kV cables supplying Parnell substation are 77 years old and nearing the end of their technical life. These are solid PILC cables, and their performance is being monitored. They will be programmed for replacement when their performance deteriorates to an unacceptable level.

A19: Liverpool/Quay Interconnector

Project	*22kV cable replacement*	
Driver	*Replacement*	
Timescale	*2012*	
Status	*Proposed*	*Estimated capital >$3 million*

The existing gas pressure cable is 37 years old. Vector has recently replaced cables of similar age and technology. The performance of this cable is being closely monitored and it is expected that it will be require replacement within the next 10 years.

4.5. NORTHERN CUSTOMER AREA

4.5.1. GROWTH IN THE NORTHERN AREA

This area covers the North Shore City, Waitakere City, and Rodney District and includes residential (both rural and suburban), commercial and industrial developments. Most of the commercial and industrial developments are centred around the Albany Basin, Takapuna, Glenfield, Henderson and Te Atatu areas. Areas north of the Whangaparaoa Peninsula and west of Henderson are predominantly rural residential.

Overall the load growth in the region is relatively high at around 2% per annum. The highest load growth in this region is expected to occur around the Albany Basin with the development of industrial and retail businesses. With the opening of the new motorway from North Shore to Orewa (which is planned to be extended to Puhoi), it is expected that significant residential developments will take place in areas north of Silverdale. Demand in established areas is expected to remain relatively static.

4.5.2. ISSUES AND OPTIONS IN THE NORTHERN AREA

N1: Northern Area

Project	*Uprate various 33kV circuits*	
Driver	*Growth*	
Timescale	*2005-2011*	
Status	*Proposed*	*Estimated capital >$3 million*

Due to load growth in the area, the existing conductor on several 33kV circuits is constraining capacity. Replacement with a larger conductor provides an economic way to defer major capital expenditure. The affected circuits are:

- Albany-Coatesville
- Helensville-Silverdale
- Hepburn-Henderson Valley
- Wairau-Birkdale
- Albany-James Street
- Wairau-James Street
- Wellsford-Warkworth
- Hepburn-New Lynn
- Henderson-Riverhead

N2: Albany Basin Area

Project	*Establish a 33kV bus at Bush Road substation*	
Driver	*Growth*	
Timescale	*2005*	
Status	*Proposed*	*Estimated capital >$3 million*

The two transformers at Bush Road are fed from the Albany grid exit point via a radial circuit and a tee off from the Albany-Sunset Road circuit. Security will be enhanced by installing a new 33kV feeder from Albany to Bush Road substation and on to Sunset Road substation. The installation of a 33kV switchboard will allow better utilisation of the feeder capacity and improve operational flexibility of the network.

N3: Warkworth Area

Project	*Install ex-Orewa transformers at Warkworth*	
Driver	*Growth*	
Timescale	*2005*	
Status	*Proposed*	*Estimated capital <$1 million*

The project to replace the transformers at Orewa zone substation will result in two spare transformers. Capacity constraints exist at Warkworth substation and it is proposed to install these transformers to alleviate this problem.

N4: Waimauku Area

Project	*Install second transformer at Waimauku zone substation*	
Driver	*Growth*	
Timescale	*2005*	
Status	*Proposed*	*Estimated capital <$1 million*

The load in this area continues to grow. A large load (1.5MVA) is currently being installed close to this substation. Reinforcement is required to maintain the security of supply to customers.

N5: Orewa Area

Project	*New transformers at Orewa substation*	
Driver	*Regulatory*	
Timescale	*2005*	
Status	*Committed*	*Estimated capital $1-3 million*

The existing transformers at Orewa exceed the noise requirements for the area and are being replaced with new low noise transformers. The existing transformers will be used elsewhere on the network where noise will not be an issue.

N6: Henderson Area

Project	*Reconfigure the Henderson area 33kV network*	
Driver	*Growth*	
Timescale	*2005*	
Status	*Proposed*	*Estimated capital <$1 million*

The presence of a number of tee off and spur line arrangements on the 33kV network in the area has resulted in performance issues. It is proposed to address these issues by reconfiguring the network.

N7: Silverdale Area

Project	*Establish new Red Beach zone substation*	
Driver	*Growth*	
Timescale	*2005*	
Status	*Proposed*	*Estimated capital $1-3 million*

With the extension of the Northern motorway towards the Silverdale/Orewa area, demand is expected to grow steadily. Forecasts indicate that additional 33/11kV capacity will be required in the next few years. Options investigated include the establishment of a new zone substation in the Red Beach area or the establishment of a new zone substation at the Transpower Silverdale grid exit point site.

The Red Beach substation will enable Manly substation to be offloaded and will defer the construction of the Gulf Harbour substation.

N8: Coatesville Area

Project	*Install second transformer and associated 33kV reinforcement at Coatesville zone substation*	
Driver	*Growth*	
Timescale	*2006*	
Status	*Proposed*	*Estimated capital $1-3 million*

The load on Coatesville substation continues to grow and the transformer is loaded to around 90% during peak times. This project will provide sufficient capacity for a number of years.

N9: Glen Eden Area

Project	*Install second transformer at Waikaukau zone substation*	
Driver	*Growth*	
Timescale	*2007*	
Status	*Proposed*	*Estimated capital <$1 million*

The load on Waikaukau substation continues to increase. The load will be monitored each year to determine the exact timing of this reinforcement.

N10: North Shore Area

Project	*33kV cable to Forest Hill substation*	
Driver	*Growth*	
Timescale	*2008*	
Status	*Proposed*	*Estimated capital $1-3 million*

The installation of a 33kV cable from Sunset Road to Forest Hill and reconfiguration of the 33kV network. This will enable the 110kV reinforcement at Wairau Road to be deferred for a number of years. This project will need to be reviewed when more definite information regarding the cross isthmus project becomes available.

N11: New Lynn Area

Project	*Reinforce 33kV capacity at New Lynn substation*	
Driver	*Growth*	
Timescale	*2008*	
Status	*Proposed*	*Estimated capital $1-3 million*

As the demand around the New Lynn area increases, reinforcement is required to enhance the security of supply. Various options have been considered including the installation of additional 11kV ties between Sabulite Road and New Lynn and between Sabulite Road and McLeod Road to enable load transfer from the 33kV group, or reinforcement of the 33kV ring by adding a new 33kV cable. The 11kV option was discarded as it involved complicated switching operations in addition to not providing a long-term solution. A 33kV cable will be installed between Sabulite and New Lynn zone substations.

N12: Swanson Area

Project	*Install second transformer at Swanson zone substation*	
Driver	*Growth*	
Timescale	*2009*	
Status	*Proposed*	*Estimated capital <$1 million*

The load on Swanson substation continues to increase. The load will be monitored each year to determine the exact timing of this reinforcement.

N13: Henderson Area

Project	*Keeling Road substation to Woodford substation 33kV tie*	
Driver	*Growth*	
Timescale	*2009*	
Status	*Proposed*	*Estimated capital $1-3 million*

Due to load growth around the Henderson Valley area, a 33kV tie line between the Woodford and Keeling Road substations, which are currently supplied by single 33kV radial circuits, will be required to maintain sufficient security of supply.

N14: North Shore Area

Project	*Highbury substation second transformer*	
Driver	*Growth*	
Timescale	*2009*	
Status	*Proposed*	*Estimated capital <$1 million*

There is steady load growth in the Highbury/Northcote area. The establishment of Takapuna zone substation in 2001 enabled both Hillcrest and Northcote zone substations to be offloaded as an interim measure. However, additional 11kV capacity will be required towards the end of the planning period. Options include installation of a second transformer at Northcote, Highbury or Balmain substations. The Highbury option is currently preferred as additional capacity located there can be used to backup the other two zone substations.

N15: Albany Basin Area

Project	*33kV cable to McKinnon substation*	
Driver	*Growth*	
Timescale	*2010*	
Status	*Proposed*	*Estimated capital $1-3 million*

Following reinforcement and changes to the operating regime, reinforcement of the Browns Bay 33kV ring network is required to maintain security of supply. Options 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 a 33kV cable to McKinnon substation.

N16: East Coast Bays

Project	*Install second transformer at Forest Hill zone substation*	
Driver	*Growth*	
Timescale	*2010*	
Status	*Proposed*	*Estimated capital <$1 million*

The load on Forrest Hill substation continues to increase. The load will be monitored each year to determine the exact timing of this reinforcement.

N17: Albany Basin Area

Project	*McKinnon substation and transformer*	
Driver	*Growth*	
Timescale	*2010*	
Status	*Proposed*	*Estimated capital $1-3 million*

As the demand around the Albany Basin industrial area increases, reinforcement of the 11kV capacity will be required to maintain the security of supply in the area. As the area is predominately commercial/industrial, demand management is not a viable option. It is proposed to install a second transformer at McKinnon substation, with related 33kV network reinforcement.

N18: Northcote Area

Project	*Reinforce 33kV supply to Northcote zone substation*	
Driver	*Growth*	
Timescale	*2011*	
Status	*Proposed*	*Estimated capital >$3 million*

The load on Northcote substation continues to increase. The load will be monitored each year to determine the exact timing of this reinforcement.

N19: Albany Basin Area

Project	*Rosedale Road new zone substation*	
Driver	*Growth*	
Timescale	*2011*	
Status	*Proposed*	*Estimated capital $1-3 million*

As the demand in the Albany Basin/Browns Bay area increases, reinforcement of the 11kV capacity will be required to maintain the security of supply in the area. Options include:

- Installation of a second transformer at East Coast Road substation
- Establishment of a new substation near P79 along East Coast Road

Economic analysis has shown that the establishment of a new zone substation in Rosedale Road is the preferred option.

N20: Greenhithe Area

Project	*Establish Greenhithe substation*	
Driver	*Growth*	
Timescale	*2012*	
Status	*Proposed*	*Estimated capital >$3 million*

As the demand in the Greenhithe area increases through residential development, there will be a need to increase the 11kV capacity to maintain the security of supply in the area. As this area is already supplied by long 11kV feeders from remote zone substations, 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.

N21: Whangaparaoa Area

Project	*33kV cable to Manly substation*	
Driver	*Growth*	
Timescale	*2012*	
Status	*Proposed*	*Estimated capital >$3 million*

As demand in the Whangaparaoa Peninsula continues to grow, reinforcement will be required to maintain security of supply. Due to the geographic location of the area, backup from the 11kV network is limited. Options under consideration include the uprating of the existing submarine cables or installation of a new 33kV circuit. The 33kV circuit would provide a long-term solution, but is dependant upon the construction of the toll bridge. We will continue to assess these options in line with Transit's plans.

N22: North Shore Area

Project	*Fourth 110kV circuit to Wairau Road substation*	
Driver	*Growth*	
Timescale	*2012*	
Status	*Proposed*	*Estimated capital >$3 million*

In recent years, a series of small capital projects has been initiated to maintain the security of supply in the area. In the next five to 10 years, demand will grow to an extent that further reinforcement is required. Options for reinforcement include installing a fourth 110kV feeder to Wairau Road substation, or installing 220/33kV transformers at Wairau Road, supplied from the proposed 220kV cross isthmus cables. This project will be reviewed when more definite information regarding the cross isthmus project becomes available. In the meantime, planning will be based on the fourth 110kV transformer feeder option.

N23: Whangaparaoa Area

Project	*Establish Gulf Harbour substation*	
Driver	*Growth*	
Timescale	*2013*	
Status	*Proposed*	*Estimated capital >$3 million*

Demand on the Whangaparaoa Peninsula has been growing steadily and due to the 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. The stage has now been reached where additional 33kV and 11kV capacity is required to maintain the level of security. A new zone substation will be established at Gulf Harbour, which includes the installation of a 33kV cable from Manly zone substation to the Gulf Harbour zone substation site.

N24: Henderson Area

Project	*Install second transformer at Woodford zone substation*	
Driver	*Growth*	
Timescale	*2014*	
Status	*Proposed*	*Estimated capital <$1 million*

The load on Forest Hill substation continues to increase. The load will be monitored each year to determine the exact timing of this reinforcement.

4.6. WELLINGTON CUSTOMER AREA

4.6.1. GROWTH IN THE WELLINGTON AREA

The Wellington area 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. The Wellington CBD is by far the most significant business and retail centre in the region. There are also business and retail centres scattered around the area at Lower Hutt, Porirua, Upper Hutt, Seaview, Gracefield, Petone and Johnsonville. Small industries and warehouse developments centre along the Lower Hutt, Ngauranga Gorge, Petone, and Naenae areas.

Overall demand growth in the region is expected to be low with most of the growth expected to take place around the Wellington CBD area.

4.6.2. ISSUES AND OPTIONS IN THE WELLINGTON AREA

W1: Wellington CBD/CBD Fringe

Project	*Reinforcement of the 33kV capacity to zone substations*	
Driver	*Growth*	
Timescale	*2004-2012*	
Status	*Proposed*	*Estimated capital $13 million*

Revaluation of the ratings of 33kV cables has confirmed that in some areas the cable ratings are significantly less than previously thought. To mitigate this problem a new circuit will be installed to each zone substation, and the two existing cables to each zone substation will be run in parallel. This will enable better utilisation of the existing transformer capacity and provide more backup capacity to adjacent substations under contingencies. The affected zone substations are:

- University
- Frederick Street
- Palm Grove

W2: Hutt Valley

Project	*Rearrange connection between Haywards and Trentham busbars*	
Driver	*Growth*	
Timescale	*2005*	
Status	*Proposed*	*Estimated capital <$1 million*

There is a backup capacity shortfall of about 3MVA upon loss of the single transformer at Haywards 11kV grid exit point. At Trentham the two 33kV circuits and transformers are very under utilised. The proposal is to reconnect the 33kV Haywards-Trentham circuit to form an 11kV interconnector between the Haywards and Trentham 11kV boards. It is expected this will provide sufficient backup capacity to both substations, and also improve the utilisation at Trentham.

W3: Hutt Valley

Project	*Replace Melling ripple injection plants*	
Driver	*Performance*	
Timescale	*2005*	
Status	*Proposed*	*Estimated capital <$1 million*

The existing rotary injection units are 45 years old, situated on the flood plain and have insufficient signal strengths in certain areas. A new static plant will be installed within the Transpower substation.

W4: Wellington CBD

Project	*Establish Bond Street substation*	
Driver	*Growth*	
Timescale	*2012*	
Status	*Proposed*	*Estimated capital > $3 million*

As the demand in the Wellington CBD and the fringe areas grows, reinforcement will be required to maintain the capacity and security of supply in the area. A site has already been reserved in the area for a new zone substation.

4.7. TRANSFORMER REDEPLOYMENT

To ensure optimum utilisation of existing assets, transformers are relocated when released if performance and condition criteria are met. The Hobson and Onehunga projects will release the following transformers:

- Hobson transformers 2x 22/11kV units to be relocated to Chevalier
- Existing Chevalier 22/6.6kV units to be scrapped
- Onehunga 22/11kV transformers to be scrapped

Other transformers to be relocated include:

- Mangere Central 33/11kV transformer to be relocated to Manukau
- Spare 110/22kV transformers to be relocated to Liverpool

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.

4.8.1. ISSUES AND OPTIONS AT THE GRID EXIT POINTS

Central Park Grid Exit Point

Driver	*Growth and security of supply*
Timescale	*2005*
Status	*Committed*

The age and condition of the existing 110/11kV transformers has prompted the need for replacement. Due to space limitation on the site, reinforcement of the 33kV capacity needs to be considered at the same time. A long-term solution involving installation of a third 110/33kV transformer and replacement of the 110/11kV transformer with 33/11kV units has been agreed with Transpower. Work is currently progressing on this project.

Hepburn Grid Exit Point

Driver	*Security of supply*
Timescale	*2007*
Status	*Proposed*

The existing transformer capacity at Hepburn is insufficient to meet the Transpower reliability standard although there is sufficient back up capacity from within the 33kV and 11kV networks for the next few years. A proposal to install a third 110/33kV 50MVA transformer at Hepburn is being considered.

Penrose Grid Exit Point

Driver	*Security of supply*
Timescale	*> 2006*
Status	*Discussion*

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

4.9. CUSTOMER INITIATED NETWORK DEVELOPMENTS

Customer initiated capital expenditure is driven primarily through the growth of the city, and with North Shore and South Auckland areas being some of the fastest growing areas in New Zealand, Vector experiences a significant level of the following growth related activities:

- New subdivisions account for around 40% of customer activity, including reticulation and streetlighting for commercial and residential developments
- New service connections in areas where reticulation already exists or only requires moderate extension account for a further 20% of expenditure
- Customer substations are installed for commercial customers with loads unable to be supplied from the low voltage reticulation

The remainder of the expenditure is divided between:

- Cable relocations; mainly driven by council road widening projects
- Capacity changes; where transformer connected customers require an upgrade or downgrade in capacity
- Low voltage reinforcements; where a change in customer capacity requires an upsizing 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.

4.10. NETWORK PERFORMANCE PROJECTS

Fibre Optic Cable Extensions

Driver	*Growth*
Timescale	*Ongoing*
Status	*As required*

The fibre optic cables are used for operational communication, network control and protection signalling. It is proposed to extend Vector's fibre optic network backbone to connect all Transpower points of supply in Vector's area. Any new zone substation built will be connected to the Transpower point of supply via fibre optic cable. To minimise costs, use is also made of fibres installed by others across the network.

4.11. EXPENDITURE FORECAST

The capital expenditure plan that corresponds to the asset replacement, refurbishment and development projects is given in Table 4.1. These forecasts are based on known and current solutions only. Extensive analysis of alternate approaches, including load management, increased asset utilisation through advanced technology etc is expected to enable the forecast expenditure to be reduced.

Network projects include:

- Compliance projects where the main drivers are regulatory, environmental, health and safety etc
- Growth projects where the main drivers relate to growth in demand
- Performance projects where the main driver is replacement of assets in order to improve network reliability and/or reduce maintenance costs
- Replacement projects where the main driver is replacement of assets that are at the end of their useful life, or where the whole of life maintenance and remedial costs are higher than the replacement costs. Risk analysis is another key driver in this category

Category	04/05	05/06	06/07	07/08	08/09	09/10	10/11	11/12	12/13	13/14
Network	70	72	55	52	40	40	40	65	70	40
OIP	19	10	10	10	10	10	10	10	10	10
Customer	38	36	34	34	34	34	34	34	36	38
Total	127	118	99	96	84	84	84	109	116	88

Table 4.1 Forecast Capital Expenditure Budget ($ million)

5. ASSET MAINTENANCE

5.1. ASSET MAINTENANCE 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 and the optimum maintenance strategies defined.

Ensuring that the asset maintenance, refurbishment and replacement programmes are value-based is the critical driver in Vector's asset management policy. Asset maintenance can be a significant proportion of the total lifecycle cost and Vector's approach is one of value-based maintenance.

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

The current foundation for the asset maintenance plan is the customer service targets, which are based on customer type and service expectations in the Auckland network and network and zonal reliability targets in the Northern and Wellington networks. The decisions on maintenance for each asset are based on their impact on the reliability targets, fault frequency, duration of outages, power quality, health and safety implications, reliability management and cost. Asset maintenance, refurbishment and replacement on the Vector network are designed to maintain the functionality of the asset and the operating capability of the network to meet these requirements.

The asset management practices, maintenance regimes and initiatives trialled in recent years are very similar between the three network areas for the subtransmission assets. Because of this, the subtransmission asset sections are written for Vector as a whole.

There are however significant differences in the initiatives trialled between the three networks in the overhead and underground distribution assets. This reflects differing asset bases and differing risk and priority analysis. This difference in approach has provided Vector with a large data set of asset failure modes, risks and success statistics for initiatives. We will use this information to evaluate:

- The likelihood of similar risks in other network areas
- The benefits of implementing similar strategies in other network areas to achieve improvements in reliability or safety

The effectiveness of these initiatives will be monitored to determine success rates and any secondary risk exposures before deciding on further expansion or implementation strategies.

Because of the differences in approach, the improvements for reliability and safety for the distribution assets are split into the Auckland, Northern and Wellington networks. Asset maintenance and replacement practices are very similar and are not broken down at the network area level.

In general, in all network areas, preventative maintenance on Vector's network 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, risks etc
- Repair, refurbishment or replacement of assets when required

Asset maintenance criteria are documented in the service providers and Vector's maintenance instructions and standards. These include the inspection, testing and condition assessment requirements for each asset. The maintenance instructions also include the actions to be taken based on the results of the tests and condition assessments.

The development of the asset maintenance plans takes into account the variety of customer, environmental, operational performance and condition factors. Generic maintenance actions are developed for each asset type, but can be applied differently based on asset performance requirements and criticality. Together with our service providers, we regularly review the maintenance requirements for individual assets or areas, supported by information updates and refine and optimise the maintenance plans. Assets that are at a greater risk of a certain type of failure or have high utilisation or high risks associated with failure can have enhanced preventative and condition based maintenance schedules. Similarly, areas with known asset problems or fault causes can have enhanced maintenance or monitoring programmes implemented.

As a general rule, the timing for any replacement is based on condition and performance assessments made as the asset:

- Approaches the end of its useful life and is no longer suitable for its application, in terms of asset functionality or customer requirements
- When the asset presents an unacceptable risk for performance or to the operating and maintenance personnel
- For economic reasons if the whole of life maintenance or remedial costs are higher than the expected replacement costs or monitoring dictates the risk is unacceptable

From the detailed inspections and condition assessments, it has been determined that the condition of certain assets means that replacement or refurbishment is necessary to maintain the functionality of the asset. In line with our approach to value-based maintenance, asset refurbishment or replacement programmes are applied to address known condition or performance issues for certain groups of assets in a particular area or environment and/or monitoring is stepped up. This further refines our existing replacement strategy and will enable full analysis of the economic and life cycle benefits of individual assets against groups of asset replacement programmes.

The underlying objective is to identify opportunities to achieve, where appropriate, overall value through programmes of replacement rather than incurring remedial and ongoing preventative maintenance costs. It is recognised that asset types have a finite life and for some asset types there may be a point where fault rates or performance degradation start increasing at such a rate that ongoing maintenance is uneconomic.

One of the major factors considered is whether an asset's condition is regularly monitored through inspection or testing, versus assets where it is not possible or practical to inspect. The relative cost of inspection when compared to the replacement cost is also a consideration. Where the cost of inspection is low, or there are low volumes of assets and the cost of replacement is high, replacement on an individual asset basis is most likely to be the approved method. For assets where condition inspection is not possible, or the costs of inspection are prohibitive, replacement will be driven by age or by fault rate analysis, and are more likely to be comprehensive than specific.

5.1.1. FAULT ANALYSIS

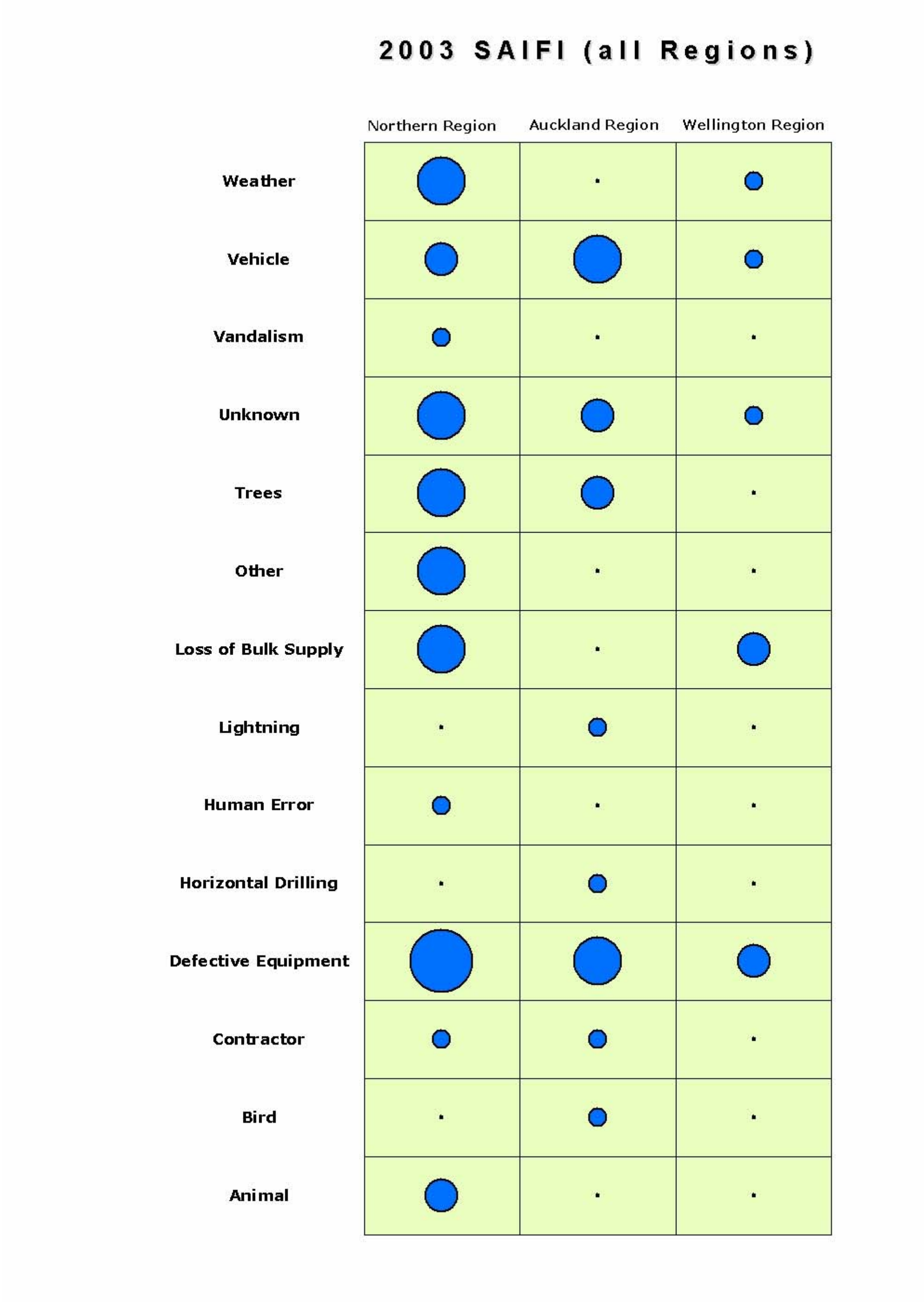

Figure 5.1 GIS Analysis Data - SAIFI

Analysis of faults, their impact in terms of frequency and duration, their costs and impact on customer service targets is a fundamental part of our asset maintenance strategy.

Figure 5.1 shows the HV SAIFI profiles by fault type for 2003 for each network. Reducing SAIFI will be a challenge and require focussed asset management to ensure customer service and reliability targets are maintained.

Vector is committed to reducing the planned outage component of SAIDI and SAIFI and has made a significant commitment in the Northern and Wellington networks to provide generation capability and additional teams to work on the network live.

Trees still remain a problem across the network. Vector has significantly increased spend in vegetation management this year in response to reliability concerns and also in response to the new tree regulations. We will continue to optimise the spend on vegetation management through targeted cutting plans, but in some areas where cutting is not an option, small scale undergrounding or reconductoring with ABC/CCT will be considered. To reduce the defective equipment component of SAIFI across the networks, asset replacement will be targeted.

To ensure asset management is value-based, all proposed repair, refurbishment and replacement work is assessed to ensure that the rationale fits with one or more of the following drivers:

- Safety and environmental issues
- To bring performance in line with customer or performance targets
- Work will result in a cost saving
- Customer wants and is willing to pay for improved performance

No work proceeds without value analysis to determine the most cost-effective solution to achieve the required level of performance.

When the requirement arises for an asset to be replaced, the opportunity is taken to consider the justification for both an upgrade and/or capacity increase to meet future supply requirements and replacement with modern technology to ensure minimum asset lifecycle costs. Vector is continually reviewing equipment for use on the network in terms of whole of life costs, which include reliability, initial costs and ongoing maintenance and operational costs.

5.2. ASSET PROCESS

For any asset replacement or refurbishment decision the process outlined in Figure 5.2 is followed to ensure consistency and comparability of options across the network areas and across the range of project types Vector manages.

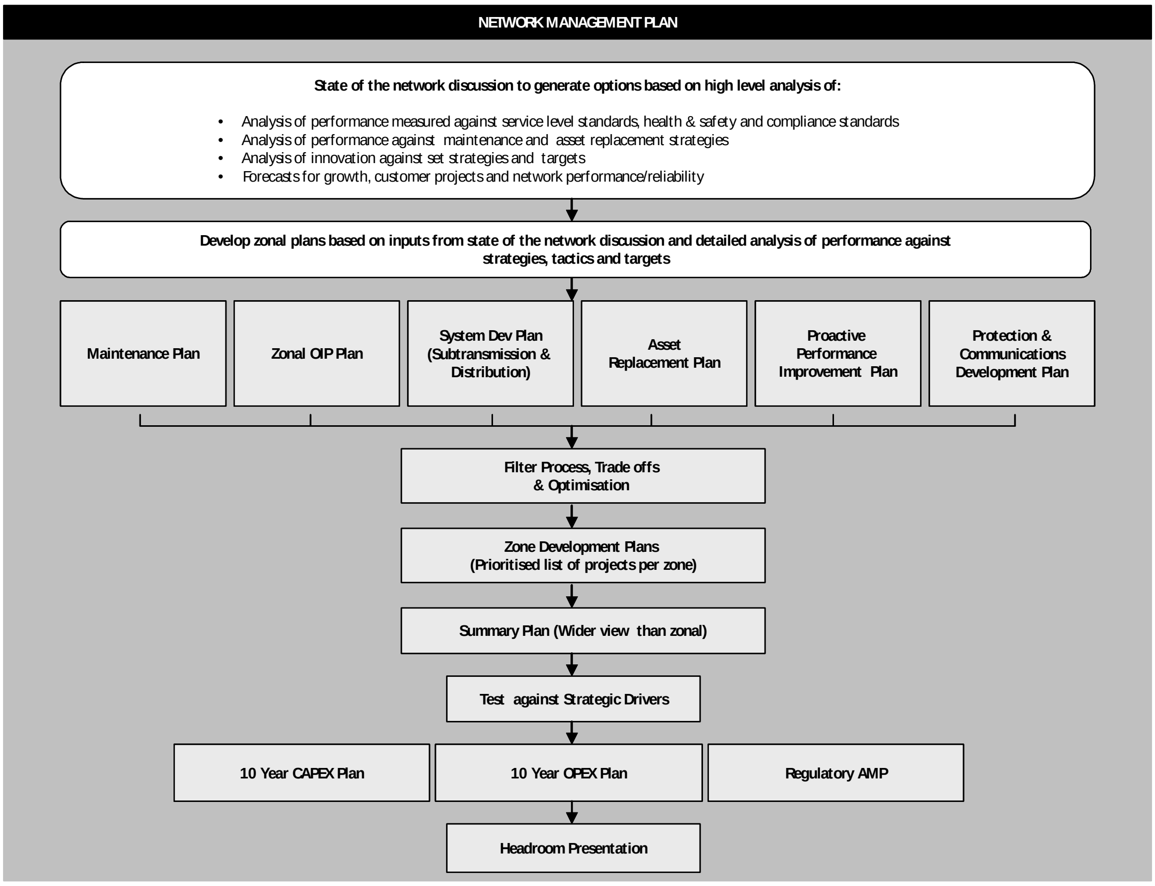

Figure 5.2 Asset Decision Process

5.3. ASSET MAINTENANCE BY ASSET TYPE

In this section the following terms are used:

Asset description
A brief description of the asset.

Asset performance and condition
Design capacity and current utilisation. Age profiles and condition based test investigations. Improvements for reliability and safety made in 2003/04.

Asset maintenance
Brief description of the generic planned maintenance activities.

Asset issues and risks
Indication of asset specific risks, their impacts, current controls and planned actions.

Asset replacement
Major work that does not increase the capacity of the asset, but maintains the capacity and functionality of the asset at its lowest whole of life cost.

5.4. TRANSMISSION AND SUBTRANSMISSION CABLES AND LINES

5.4.1. ASSET DESCRIPTION

The subtransmission network consists of 1,113km of cables and lines rated at 110kV, 33kV and 22kV as detailed in Table 5.1.

Cable Type	110kV	33kV	22kV	Total Length (km)
Overhead	28	445	3	476
Underground PILC	0	33	68	101
Underground XLPE	27	173	10	211
Underground Fluid Filled	26	175	19	220
Underground Gas Pressurised	20	74	12	106
Total by Voltage	101	900	112	1,113

Table 5.1 Transmission and Subtransmission Cable Lengths and Voltages

5.4.2. ASSET PERFORMANCE AND CONDITION

Improvements for Reliability

Joint Testing
X-ray investigation of joints is now a standard test procedure to assess the internal condition of joints following detection of leaks.

Cable Ratings
Cable ratings to calculate long-term cyclic and short-term emergency loadings for all subtransmission cables, based on identified hot spots, have now been completed for all networks. These ratings are used as the basis for determining future network reinforcement options. The ratings also provide more accurate limits for network operations, and provide information to support consideration of short-term off load options in emergency situations, which improves asset utilisation. Research to improve the accuracy of the models continues. This includes comparing actual measured cable temperatures with calculated values, and improved condition testing procedures for measurement of soil thermal resistivity.

To facilitate this, Distributed Temperature Sensing (DTS) has been installed to enable continuous temperature monitoring and enables the exact location of hot spots. DTS is a relatively new technology and Vector is working with CIGRE to develop standards for the DTS equipment and cable rating techniques. The new standards are expected to be published by the end of 2004.

All new subtransmission cables have optical fibres within or attached to them, to enable future connection to DTS monitoring.

Partial Discharge Tests

We are planning to conduct trials this year to investigate the use of on-line partial discharge location and monitoring on our cables. The tests will show fault locations enabling repairs to be actioned efficiently and also assist in determining the ability of the cable to handle increased loading, potentially deferring capital investment. Although this trial was programmed for last year, there are a limited number of suppliers who can provide this service and to ensure the trial is accurate, we need to have a number of suppliers available at the same time. If the trials are successful, the test will become part of the base maintenance on our cables.

Corona camera

We have implemented trials with the corona camera this year to investigate its potential as a condition monitoring technique for the subtransmission and 11kV lines. A number of substransmission lines in the Northern network have been flown and the camera identified a number of problem insulators that would not have been picked up through existing maintenance techniques.

5.4.3. ASSET MAINTENANCE

- Regular route patrols, with enhanced frequency in parts of the CBD, to identify any potential problems in the Auckland network
- Proactive work with external service providers to prevent third party damage
- Annual cable termination inspections and thermographics
- Serving tests

5.4.4. ASSET ISSUES AND RISKS

No new issues or risks have been identified for the subtransmission cable and line assets this year.

5.4.5. ASSET REPLACEMENT

Cables

The various cables have varying design lives, but the main criteria for transmission and subtransmission cable replacement are an assessment of the risk of loss of functionality, analysis of failure rates and costs and condition tests. Condition and performance are used as the main guideline for replacement. The fluid filled and gas cable pressures are continuously monitored via the SCADA system, with alarms to give early warnings of falling pressure.

5.5. TRANSMISSION AND SUBTRANSMISSION TRANSFORMERS

5.5.1. ASSET DESCRIPTION

Vector owns 244 transformers, two of which are at Lichfield, which lie outside of Vector's main supply networks. The subtransmission transformers range in rating from 5MVA to 65MVA. The age profile of the subtransmission transformers is shown in Figure 5.3.

The ODV design life of a transformer is 45 years, but if the transformer is not subject to abnormal operating conditions and is well maintained, the design life can be extended.

Figure 5.3 Subtransmission Transformers Age Profile

5.5.2. ASSET PERFORMANCE AND CONDITION

<u>Improvements for Reliability</u>

Tap Changer Condition

Following successful trials of the Tap Changer Activity Signature Analysis (TASA) condition assessment method, all future maintenance requirements for tap changers will be determined by this test. In the Auckland network this has been implemented as part of ongoing preventative maintenance and this will be replicated in the Northern and Wellington networks.

5.5.3. MAINTENANCE

Routine condition monitoring of transformer components is carried out using non-invasive methods. Each transformer is subject to monthly visual checks for moisture, oil levels and leaks, and fan operation.

On an annual basis, in the Auckland network DGA and TASA tests for transformer and tap changers are carried out, along with alarm tests, Buchholz relay tests and thermal imaging of terminations and connections. A similar process is followed in the Northern and Wellington networks, with TASA tests for tap changers being introduced in 2004.

The timing for the transformer refurbishment is scheduled based on DGA and other condition assessment results. Transformers scheduled for movement to another site are refurbished as part of the move where their condition and assessed remaining useful life makes this an economic option. We are continuing with trials using the TJH2b Transformer Condition Assessment (TCA) programme for complete analysis of transformer oil. If the trials are proven successful it will be introduced as an alternative to the standard DGA tests within the preventative maintenance routine. To improve the timing associated with major refurbishment, we are currently reviewing the PDC method. This is a non-invasive test to determine the moisture content of the winding insulation.

5.5.4. ASSET ISSUES AND RISKS

No new issues or risks have been identified for the transformer assets.

5.5.5. ASSET REPLACEMENT

Transformer replacement is based on condition. Transformers or components that have deteriorated beyond acceptable parameters are taken out of service for a detailed inspection of moisture levels, the core and windings. The investigation gives an indication of life expectancy of the transformer and a decision is made on refurbishment or replacement based on the functionality and performance requirements of the asset.

5.6. TRANSMISSION AND SUBTRANSMISSION SWITCHGEAR

5.6.1. ASSET DESCRIPTION

Vector owns and operates 1,788 subtransmission circuit breakers, rated at 110kV, 33kV, 22kV, 11kV and 6.6kV. The circuit breakers are oil, vacuum, SF_6 and Gas Insulated Switchgear (GIS). Figure 5.4 shows the age profile of circuit breakers.

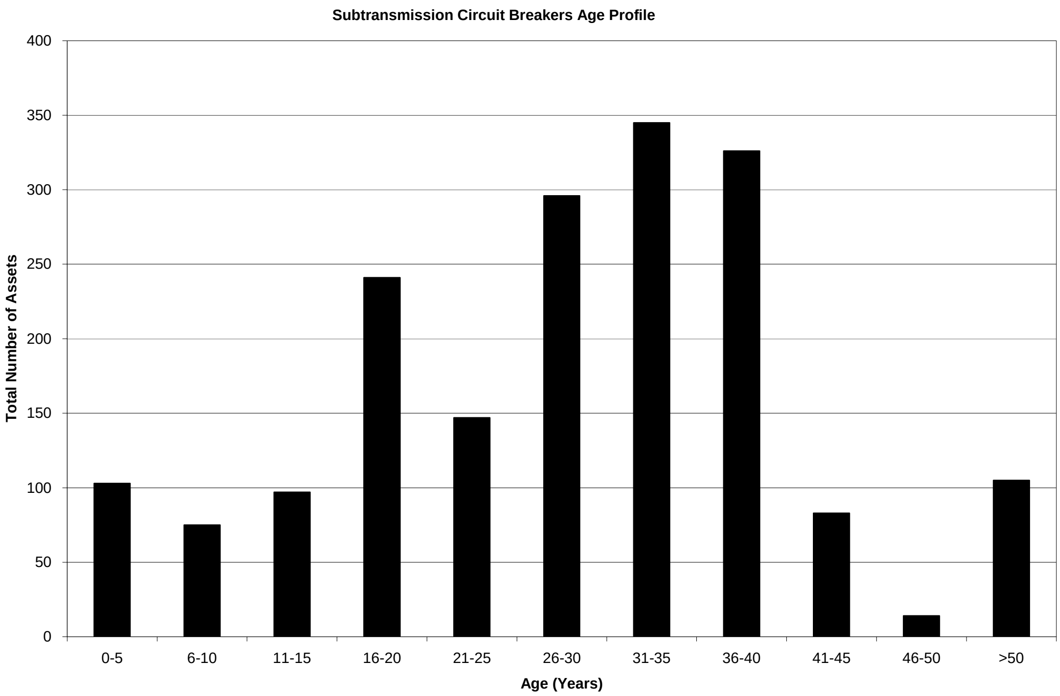

Figure 5.4 Subtransmission Circuit Breakers Age Profile

5.6.2. ASSET PERFORMANCE AND CONDITION

The condition of the circuit breakers is generally good with no new condition problems identified through maintenance or operation.

5.6.3. MAINTENANCE

- All switchgear is visually inspected regularly for leaks and general condition
- 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 yearly cycle
- Major maintenance on the switchgear including inspection and performance testing of the circuit breakers on an eight year cycle and testing of the protection relays and systems on a two and four year cycle

5.6.4. ASSET ISSUES AND RISKS

No new issues or risks have been identified for the switchgear assets.

5.6.5. ASSET REPLACEMENT

Circuit breaker replacement is based on condition.

5.7. ZONE SUBSTATION BUILDINGS

5.7.1. ASSET DESCRIPTION

There are 121 zone substations in the Vector network.

5.7.2. ASSET PERFORMANCE AND CONDITION

The buildings and grounds are in functional condition. Any minor issues are dealt with as routine repairs.

Improvements for Reliability and Safety

Zone Substation Revitalisation

Following the identification of asbestos in some zone substation ceilings within the Auckland network an asbestos removal programme was adopted in accordance with the OSH guidelines for the management and removal of asbestos. All high and medium risk sites have been completed, and low risk sites are now scheduled to be completed by 2004/05. There have been some delays in this programmed work due to the lack of availability of specialised resources.

Earthing System, Seismic Upgrades and Oil Bundling

Work on earthing system and seismic upgrades are now complete in the Auckland network and on target to be completed by 2009/10 in the Northern and Wellington networks.

Oil containment programmes continue in all networks and are scheduled to be completed by 2006/07

Fire Protection

All zone substations have been surveyed in line with Vector's policy on fire detection and suppression. Any works resulting from this survey are scheduled to be completed by 2004/05.

5.7.3. ASSET MAINTENANCE

All zone substations and grounds and ripple injection spaces are maintained with regard to access security, condition and safety. The routine inspections include the building and other assets such as lighting, fire systems, fans, heaters and safety equipment.

5.7.4. ASSET ISSUES AND RISKS

No new issues or risks have been identified for the zone substation assets.

5.8. PROTECTION AND CONTROL: RELAYS

5.8.1. ASSET DESCRIPTION

Vector operates over 5,200 relays. 88% of the relays are electromechanical, 6% solid state and 6% numerical.

5.8.2. ASSET PERFORMANCE AND CONDITION

The condition of the relays is good, with the exception of one particular model of solid state relay (Nilstat ITP) in the Auckland network.

Improvements for Reliability

Digital Relays

To provide an enhanced protection signalling distance and directional over current scheme, a number of electromechanical relays were replaced last year in the Northern and Wellington networks.

5.8.3. MAINTENANCE

Electromechanical relays are tested on a four year basis.

Solid state relays of the Nilstat ITP type are tested 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; therefore Vector has adopted the recommendations on testing numerical protection relays from the CIGRE Study Committee 34 Power System Protection and Local Control.

5.8.4. ASSET ISSUES AND RISKS

No new issues or risks for the relay assets have been identified for the relay asset group.

5.8.5. ASSET REPLACEMENT

Individual replacement of relays is based on as failed and asset replacement programmes are based on condition.

5.9. PROTECTION AND CONTROL: DC AUXILLIARY SUPPLY

5.9.1. ASSET DESCRIPTION

Each zone substation is equipped with DC auxiliary systems to provide the power supply for protection, metering, communication and control devices, including the circuit breakers closing and tripping circuits. The major substations are equipped with a redundant DC system.

Vector has battery banks at all zone substations and some HV customer substations to provide tripping and closing supply to the circuit breakers. Batteries also provide standby power supplies for the relays, SCADA, metering and communication equipment.

5.9.2. ASSET PERFORMANCE AND CONDITION

Improvements for Reliability and Safety

All batteries have now been replaced with Valve Regulated Lead Acid (VRLA) batteries in the Auckland network. The VRLA batteries are industry standard, remove the environmental risks associated with the NICAD and are a more cost-effective option.

5.9.3. 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).

5.9.4. ASSET ISSUES AND RISKS

No new issues or risks have been identified.

5.9.5. ASSET REPLACEMENT

In all networks batteries are replaced when failed or based on condition assessment results with VRLA batteries.

5.10. COMMUNICATIONS AND CONTROL: SCADA

5.10.1. ASSET DESCRIPTION

The existing SCADA system consists of three sub-systems, the main SCADA system, the ripple control RTU's at the grid exit points and the grid exit point metering system. Control systems for all network areas are now based in Auckland.

5.10.2. ASSET PERFORMANCE AND CONDITION

Improvements for Reliability and Safety

The protection system and corresponding communication links on the Northern network have been replaced with a 31km high bandwidth fibre optic backbone which enables the Control Centre to be linked to all zone substations. This replacement is delivering improved availability and reliability and is a key step in moving towards intelligent monitoring and control.

5.10.3. MAINTENANCE

The main SCADA system is self-diagnostic in terms of failure being immediately apparent in the Control Room. The existing SCADA RTU's do not have full back up and maintenance is based on failure.

5.10.4. ASSET ISSUES AND RISKS

No new issues or risks have been identified for the SCADA system.

5.10.5. ASSET REPLACEMENT

Communication and control assets are replaced as part of the overall system development to ensure compatibility.

5.11. METERING SYSTEMS

Vector's bulk metering systems consists of a number of 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 control cost, 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 customers 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

5.12. 11KV AND 400V OVERHEAD NETWORK

5.12.1. ASSET DESCRIPTION

The overhead system consists of over 4,500km of 11kV line and over 5,300km of 400V line. Over 155,000 poles support the overhead distribution network, of which 22% are wooden and 78% concrete. Conductors vary across the overhead network, but are predominantly Cu and AAC. AAAC has been trialed and is considered for use on any major line construction. ABC and CCT are used in areas susceptible to tree damage, where the trees can not be cut or removed due to resource consent and council restrictions.

5.12.2. ASSET CONDITION AND PERFORMANCE

Improvements for Reliability: Auckland Network

Small Scale Overhead Improvements
In a number of sites, poles and overhead lines have been replaced with underground cables to improve reliability in areas where there was frequent and repeated damage to the overhead network by vehicle impacts. Car versus pole incidents continue to be one of the leading fault causes in the Auckland network. Considerable analytical effort has gone into identifying trouble spots, and we are working closely with the Land Transport and Safety Authority and the Councils to identify and implement the most cost-effective mitigation measures. In some cases these involve traffic engineering solutions.

HV Connectors Replacement
The programme to replace HV feeder connectors with fault rated connectors has already proven to be successful, with a significant drop in secondary faults through jumper burn-offs. The replacement programme will continue through 2004/05.

Overhead Switches
On the Auckland network, existing air break switches (ABS) which meet the criteria for replacement are being replaced with fully enclosed gas insulated (SF_6) switches which have minimal maintenance requirements, extended life, enhanced reliability and safer operation.

Ultrasonic Pole Testing
Vector has continued with ultrasonic testing of wooden poles. The ultrasonic methodology gives an accurate, consistent assessment of pole condition that is not influenced by the operator's opinion. The condition of the pole can be easily determined and decisions made on appropriate maintenance and replacement

activities. Ultrasonic testing and subsequent serviceability indices analysis is now part of the standard preventative maintenance work. All wooden poles supporting transformers of 100kVA or greater were tested in 2002/03, and to date approximately 45% of the wood pole population has been assessed using this method. The remainder will be completed by 2005. By the end of 2005 it is expected that the remaining life of all wood poles will be reasonably predictable. Ultrasonic pole testing has been introduced and is underway in the Northern and Wellington networks.

Transformer Neutral Connectors

A programme to replace all transformer neutral connectors was completed in 2001/02. A subsequent programme to replace all main line neutral connectors was completed in April 2004. A study to determine if there is a need to replace all service main neutral connectors was completed in 2003 and based on this investigation, Vector plan to initiate a replacement programme in 2004/05. This programme was initiated to avoid the risk of customers being affected by return currents via house earths.

Automatic Reclosers

To improve response times we are looking at automating reclosers in a number of key locations.

Improvements for Reliability: Northern and Wellington Networks

Conductor Sleeving

A number of overhead 11kV spans which were identified as experiencing conductor clashing have been fitted with sleeves. The sleeves are designed to prevent transient occurrences from resulting in a feeder tripping.

Automatic Reclosers

A programme has been initiated to replace reclosers to assist with the discrimination of overhead faults and the minimisation of affected customers. The latest technology vacuum type reclosers provide an enhanced level of measurement, protection and reliability and will continue to be installed where appropriate to improve service.

Fault Passage Indicators

To improve reliability a programme has been initiated to install additional fault passage indicators (FPI's) in areas of the network where fault location is difficult and time consuming. To date additional FPI's have been installed at 40 locations giving us the capability to detect phase to phase and phase to earth faults, leading to faster restoration and more effective fault analysis.

Corona Camera

The corona camera has also been trialled in feeders where we are experiencing reliability problems, to proactively detect insulator and connector failure. To date a number of rural lines have been flown and we have had significant success in detecting potential fault spots for proactive replacement.

5.12.3. MAINTENANCE

- Annual visual line patrol of poles and hardware, including clearance checking to meet the Electrical Code of Practice
- Five yearly condition assessment of wooden poles using ultrasonic methodology
- Five yearly detailed inspection of all poles and hardware
- Proactive vegetation management and local council vegetation management agreements
- Three yearly inspection of earthing connections
- Five yearly measurement of earth sites
- Three yearly ABS inspection and operation

5.12.4. ASSET ISSUES AND RISKS

No new asset issues or risks have been identified for this asset group.

5.12.5. ASSET REPLACEMENT

Poles

With the introduction of ultrasonic testing with the Auckland network, Vector has developed pole replacement criteria which exceeds the requirements of SREI, Appendix G. Any poles that when assessed have a remaining strength of less than 50% of original strength are subject to an engineering analysis to determine their serviceability index as defined in HbC(b)1-1999 and AS/NZ4676 (2000). Poles with an unacceptable serviceability index are tagged for replacement, and poles with a marginal serviceability index are scheduled for re-test. This approach will be replicated within the Northern and Wellington networks.

It is Vector's policy to view areas with high volumes of yellow tag poles as candidate areas for wider scale asset replacement.

Investigations to determine the strengths of termination poles in the Auckland network commenced in 2004.

Cross Arms and Hardware

Cross arms are visually inspected and replaced as required.

Pole cross arms and hardware are replaced to meet the current equipment standards when a pole is replaced, and as individual items when condition indicates this is the best option.

Lines

The lines are inspected on an annual basis and replacement is based on condition assessments and analysis of fault history. Some localised re-conductoring is planned in 2004/05 to replace the existing line with CCT or ABC in areas where tree damage is frequent and there are restrictions on tree cutting. A continuing focus for 2004/05 will be on re-tensioning conductors in low clearance spans.

Air Break Switches (ABS)

ABS are replaced based on a set of performance criteria. ABS will be replaced with SF_6 switches when required.

5.13. 11KV AND 400V UNDERGROUND DISTRIBUTION NETWORK

5.13.1. ASSET DESCRIPTION

The underground distribution network consists of over 3,900km of HV cable and over 6,100km of LV cable. HV cable types are predominantly PILC, with XPLE now standard for new cables. LV cables are predominantly PILC and PVC insulated cables.

5.13.2. ASSET CONDITION

Improvements for Safety: Auckland Network

Pillar Internal Inspections

Loose connections in the line or neutral within pillars have the potential to cause shocks and power outages. To mitigate this risk Vector is continuing a programme of internal pillar inspections, which includes checking connections, looking for heat damage, earth loop impedance tests and security. The earth loop impedance test also assists with checking the condition of connections between the customers point of supply and the distribution substation. We plan to replicate this maintenance procedure in the Northern and Wellington networks in 2005/06, but as an initial stage we are implementing a visual inspection of all pillar assets in 2004 to check for safety issues.

Service Fuses

To remove the risk of connection failure which could lead to possible damage to the customers property, the programme to replace wall mounted service fuses was initiated in 2001/02. All premises have now been visited and approximately 1,000 sites require replacement. The delays are due to customers not agreeing to access and we are working hard with these customers to reach agreement.

5.13.3. MAINTENANCE

- Maintenance for both 11kV and 400V cables is reactive, based on faults
- Two yearly visual inspection of pillars, plus pillar internal checks and loop impedance testing (in the Auckland network)

5.13.4. ASSET ISSUES AND RISKS

No new asset issues or risks have been identified for this asset group.

5.13.5. ASSET REPLACEMENT

Cable Terminations

The inspection programme for cable terminations is limited to a visual check for compound leaks. Acoustics and thermographics have been trialed as an alternative condition assessment methodology, but results remain insufficiently reliable to be useful. Replacement is therefore driven by the visual inspections and analysis of fault rates. The impact of the replacement work within all networks is being carefully monitored to assess the benefits of asset replacement compared to run to failure for this asset group.

Cables

Cable replacement is based on a combination of fault rate analysis and the tests performed following fault repairs. It is proposed to progressively replace the relatively small amount of remaining 11kV aluminium sheath cable in the Auckland network over the next five years due to corrosion of the sheath leading to reliability problems. The majority of this cable type has already been replaced and this proposed work will complete the asset replacement.

Fault Passage Indicators

Individual asset replacement is based on failure.

Pillars

Pillars are replaced based on fault, normally through foreign interference. Each damaged pillar is assessed to determine the risk of future potential damage by vehicles due to location. If the risk is high the pillar is replaced with a pit.

5.14. DISTRIBUTION TRANSFORMERS

5.14.1. ASSET DESCRIPTION

Vector owns and operates over 23,000 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 rated between 30 and 1,000kVA, although there are a small number rated at 1.5kVA, 5kVA, 7.5kVA and 10kVA. Figure 5.6 shows the age profile of the distribution transformer assets.

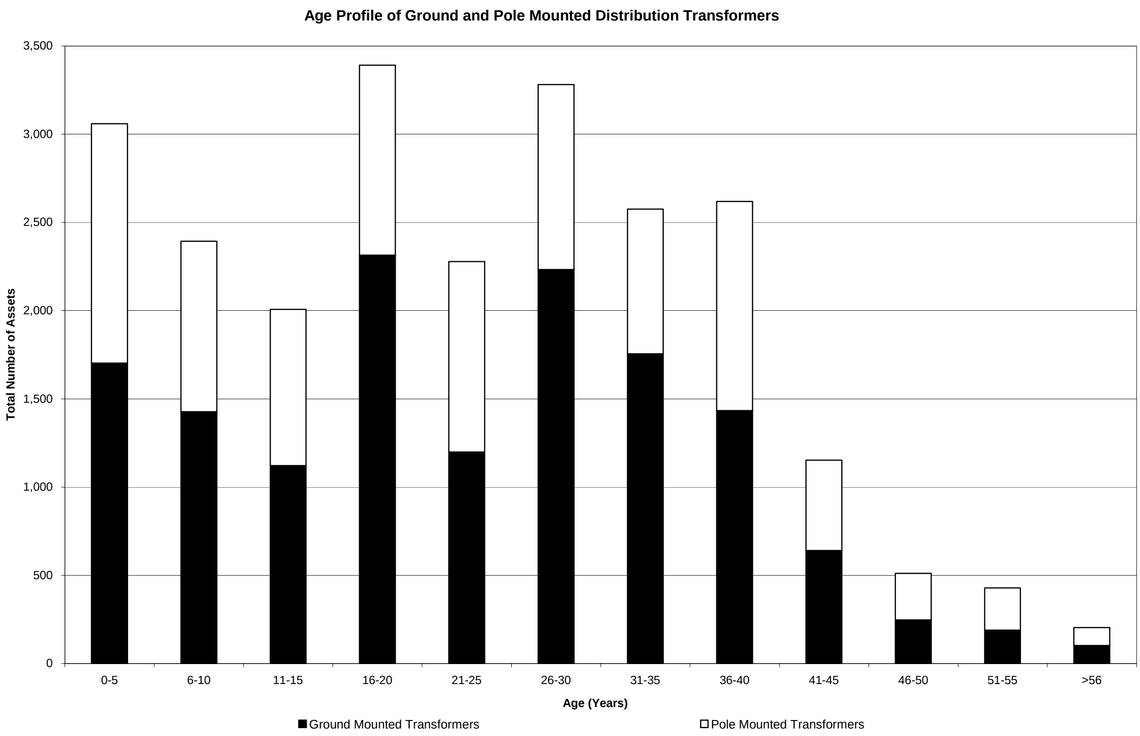

Figure 5.5 Distribution Transformers Age Profile

5.14.2. ASSET CONDITION

The condition of the transformer asset in the Auckland network is generally good. However, inspections of recent transformer installations has identified that a number of the transformers manufactured between January 1998 and December 2001 are exhibiting signs of premature rusting. Discussions are continuing with the transformer manufacturers to identify and eliminate the causes for the rusting, quantify the number of transformers affected and carry out remedial work.

The condition of the transformer asset in the Northern and Wellington networks is generally worse than that in the Auckland network.

5.14.3. MAINTENANCE

- Visual transformer inspection on a three year cycle
- Load records on a three year cycle
- Earthing resistance tests on a three year cycle, including MEN resistance, individual bank resistance and step and touch potential

5.14.4. ASSET ISSUES AND RISKS

Transformers in the Northern and Wellington networks where extensive rusting could result in safety or environmental issues are being identified and replaced.

5.14.5. ASSET REPLACEMENT

Transformers are replaced if they do not meet specified criteria or on an as failed basis. Transformers that are identified during inspections as requiring replacement due to age or condition will be replaced. All failed transformers are returned to the Siemens' facility or Vector's facility management contractor for investigation of failure and a decision is made on the cost benefits of repair, refurbishment, replacement or scrapping of the asset. As part of Vector's continual improvement process the use of other types of transformers and cooling and insulating mediums is being investigated. Use of equipment without oil would eliminate damage to the environment caused by oil spills and leaks.

5.15. DISTRIBUTION SWITCHGEAR

5.15.1. ASSET DESCRIPTION

Ground mounted switchgear is a mix of oil, SF_6 and resin insulated equipment and is of varying ages and manufacturers.

5.15.2. ASSET CONDITION

The condition of the switchgear asset is generally good.

Rusting and failure of busbar band joints on Long and Crawford and ABB SD switchgear in open enclosure distribution substations on all networks is an issue. Inspections of this switchgear will be prioritised in the Northern and Wellington networks and busbar band joints replaced as required. A different design and construction method for the busbar band joints for SD switchgear is currently being investigated and tested.

Premature rusting of panels on ABB SD switchgear due to incorrect installation and build up of material on the switchgear is being investigated to determine the magnitude of the issue and remedial options will be investigated.

Improvements for Safety

Fault levels at substations in the Wellington network where Magnefix switchgear is installed are being calculated and related to the fault rating of the switchgear. Replacement options will be investigated and implemented as required.

Inspection of Frank Wilde switch units on all networks to identify discharge and ventilation issues will be carried out and remedial work carried out as required.

5.15.3. MAINTENANCE

- Visual inspection on a three year cycle
- Full service on an eight year cycle

5.15.4. ASSET REPLACEMENT

Switchgear replacement is based on condition and availability of components for repair. Any failed switchgear units are returned to the Vector facility management contractor for investigation of failure and a decision is made on the cost benefits of repair, refurbishment, replacement or scrapping of the asset. A similar process will be instigated for the Northern and Wellington networks.

As part of Vector's continual improvement process the use of oil filled switchgear was reviewed and other types of switchgear investigated. Use of equipment without oil will eliminate damage to the environment caused by oil spills and leaks.

As a result of this review one manufacturer's SF_6 distribution switchgear has been installed on the Papatoetoe and Rosebank Overhead Improvement Projects. It is intended to install, assess and monitor other manufacturers SF_6 switchgear on other Overhead Improvement Projects. Ultimately the purchase and installation of oil filled distribution switchgear on all networks will cease.

5.16. DISTRIBUTION SUBSTATIONS

5.16.1. ASSET DESCRIPTION

Vector owns and operates over 23,000 distribution substations. The substations are maintained with regard to security, condition and safety.

5.16.2. ASSET CONDITION

Distribution substations and enclosures are visually inspected and maintained annually. Checks and maintenance include access, security, signage, graffiti removal, vegetation management, cleaning and weatherproofing. The condition of the substations and enclosures is generally good. The types of defects found and maintenance required are consistent across the networks and relatively minor in nature with the main issues being vegetation, access problems, and security of the substation. The exception is some transformers in the Wellington network where the transformer is an integral part of the enclosure and there are rust and oil leak issues. Designs of alternative substations and an accelerated replacement programme for these substations are being investigated.

5.16.3. ASSET ISSUES AND RISKS

No new asset risks or issues have been identified.

5.16.4. ASSET REPLACEMENT

Distribution substation enclosure and equipment replacement is on an as failed basis.

5.17. FORECAST MAINTENANCE EXPENDITURE

Table 5.5 shows forecast operational maintenance expenditure over the planning period.

	04/05	05/06	06/07	07/08	08/09	09/10	10/11	11/12	12/13	13/14
Maintenance Expenditure	39,233	37,214	35,189	33,751	28,690	28,690	28,690	28,690	28,690	28,690

Table 5.2 Forecast Maintenance Expenditure ($ thousand)

6. RISK MANAGEMENT

Asset risk in Vector is an integral part of the asset management process. Asset risks, the consequences of failure, current controls to manage this, and required actions to make risks acceptable are all understood and evaluated as part of the asset function and performance analysis. Any risks associated with the assets or operation of the network are evaluated, prioritised and dealt with as part of the asset maintenance, refurbishment and replacement programmes. The acceptable level of risk will differ depending upon the level of risk our customers are willing to accept and the circumstances and the environment in which the risk will occur. As part of the risk analysis, very low probability events with high impact are analysed, such as total loss of a zone substation. From this analysis contingency plans are developed. Risk is 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

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

The Board endorses the risk context under which Vector operates. A Board Risk Committee meets regularly, at least quarterly, reviewing the risk register and risk methodologies in terms of their corporate governance responsibilities.

6.1.2. EXECUTIVE RISK MANAGEMENT COMMITTEE

The Executive Risk Management Committee who report through to the Board Risk Committee oversees and monitors the implementation of appropriate and consistent risk management in each business unit, and across the company as a whole, by:

- Developing and maintaining, for the Board's review and approval, a risk management policy for Vector consistent with the company's objectives
- Overseeing and monitoring the implementation of risk management across Vector to ensure that it is in compliance with the risk management policy

In terms of implementation, the Executive Risk Management Committee on a monthly basis;

- Assesses all new risks identified, confirms the priority and actions determined by each functional unit in terms of managing these risks
- Reviews priority and actions for entries on the active register
- Monitors progress on actions assigned against entries in the register
- Reviews new high priority entries and progress on resolution of existing high priority entries

One of the requirements of the Charter of the Executive Risk Management Committee is:

> *"Secure a comprehensive third party audit of the application of risk management at Vector at least every two years, and a third party audit of key elements at least annually."*

The aim of the audit is to consider:

- The extent to which Vector is applying its risk management structures, accountabilities, processes and reporting mechanisms in support of its risk management policy

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

The most recent audit was carried out by Marsh Limited and confirmed that risk was being managed at Vector in accordance with accepted standards. The audit report also recommended several improvement opportunities which are currently being implemented.

6.1.3. EXECUTIVE TEAM (GENERAL MANAGEMENT)

The General Management team are responsible for the management of risk within their functional area or as otherwise assigned. Each functional area within Vector has a risk register on which risks, solutions and accountabilities are listed and reported. Networks and Service Delivery, which cover the network management and operational management functions of the networks, have unique registers reviewed consistently by the staff from those areas.

6.1.4. ALL EMPLOYEES

All staff and service providers are responsible for reporting any identified risks that come to their notice. Individuals may then also have responsibility for managing an individual risk, a risk control or be responsible in delivering a specific risk treatment.

6.2. RISK MANAGEMENT PROCESS

The risk management process for Vector focuses on those risks which are classified to be catastrophic or major type (which internally are called "strategic risks") and which are regularly reported through to the Board. This process includes understanding of the consequences of failure from these events, valuing the impact of the event and defining response plans. Other risks that do not have the same impact are nevertheless monitored and reviewed by the Executive Risk Committee although not receiving direct Board oversight.

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

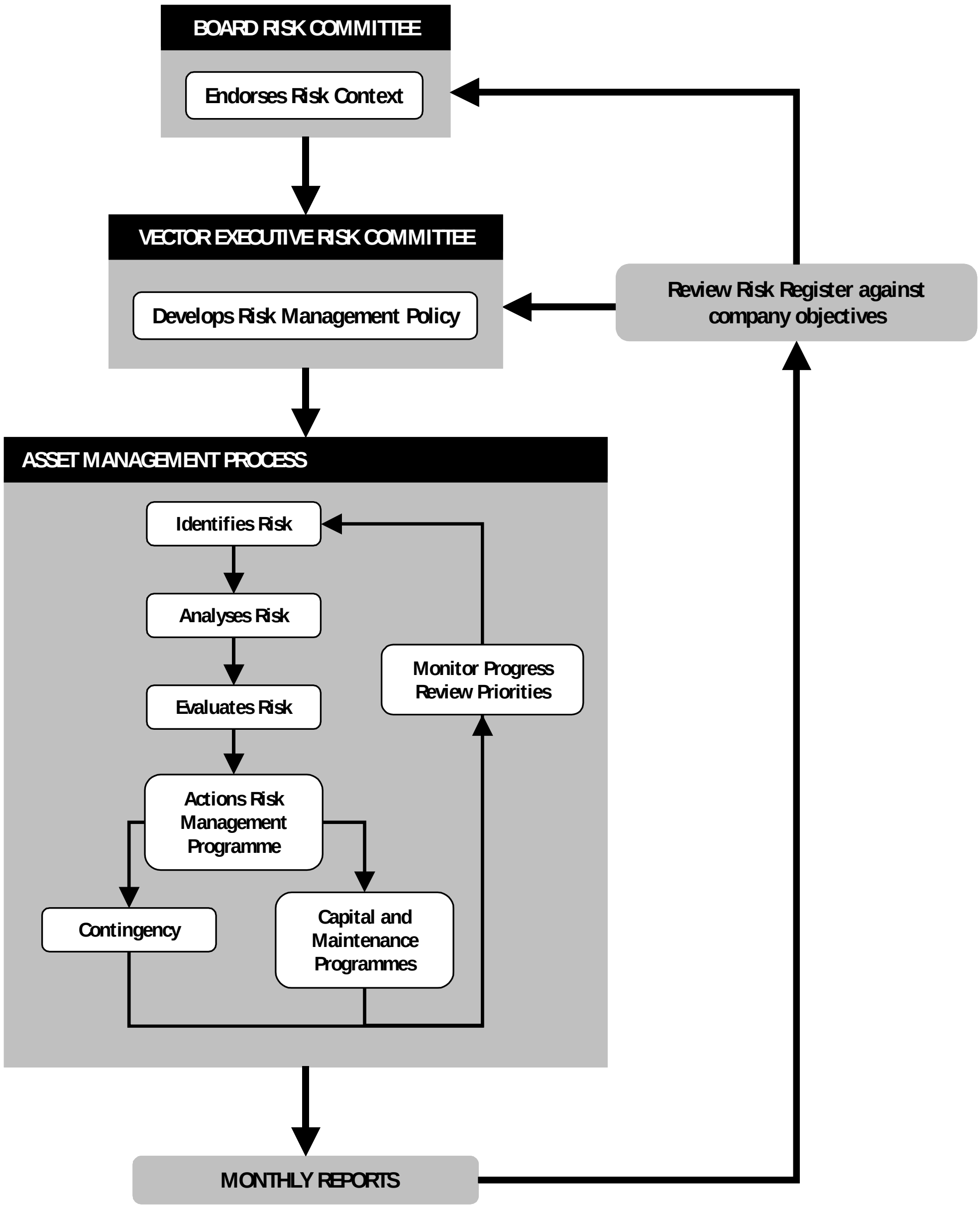

Figure 6.1 Vector's Risk Management Process (Based on AS/NZ4360)

Vector's risk management policy is defined to ensure that:

- All risks to the business are identified and understood and works prioritised to mitigate risk with a catastrophic and major risk register being maintained and tracked at Board level
- Practices that could cause disruption to service and operations, injury to people or the environment, or significant financial loss are understood, documented and mitigated
- The business is protected by suitable insurance polices, or contingency plans, wherever necessary

6.3. RISK IDENTIFICATION AND ANALYSIS

All risks are assigned a risk level based on the consequence and likelihood of the risk. Vector chooses to focus first on consequence and then review likelihood rather than initially looking at the level risks as a combination of these two factors.

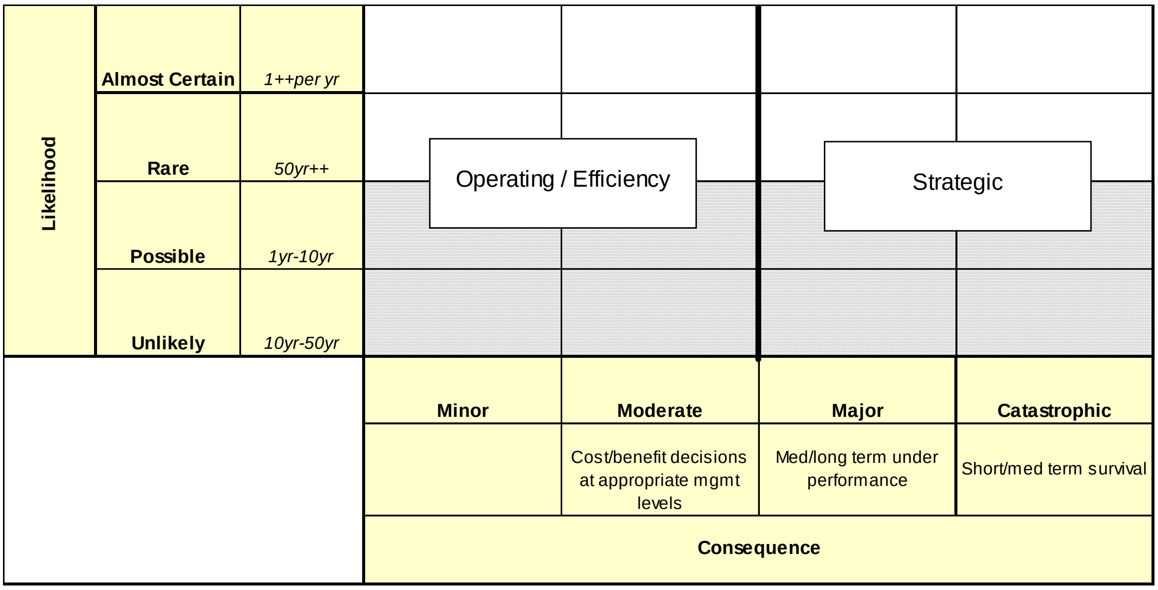

Figure 6.2 Vector's Risk Prioritisation Matrix

Catastrophic and major risk includes loss of life, extended loss of supply, or financial loss of a magnitude sufficient to impact on the company.

6.4. RISK MANAGEMENT PROGRAMME

Vector maintains a risk register, which is formally updated on a monthly basis for presentation to the Executive Risk Management Committee, and quarterly to the Board Risk Committee. The risk register to the Board documents all catastrophic and major risks while the Executive Risk Management Committee review the company's total register and then focuses on one departmental register each month in detail.

6.5. CONTINGENCY PLANS

6.5.1. SWITCHING

For all major feeders, the network is designed to allow reconfiguration by switching so that power can be fed through an alternative path if there is a failure or a need to shift load. In the Wellington CBD, some distribution switching can be carried out remotely via SCADA. A small number of distribution switches in the Northern and Auckland networks can also be operated by SCADA.

In the event of failure of a minor feeder, Control Room operators undertake network analysis and instruct field crews to undertake manual switching to restore power to as many customers as possible (while the fault is repaired), especially to critical customers.

The Control Room has prepared contingency switching plans for major outages such as complete loss of a zone substation. At present these plans are for the Auckland network only but are being extended to Northern and Wellington networks during 2004.

6.5.2. CRITICAL SPARES

A stock of spares is maintained for critical components of the network so that fault repair is not hindered by the lack of availability of required parts. Whenever construction of a new part of the network is undertaken, an evaluation is made of the spares that will be retained to support repair of any key equipment installed.

6.5.3. DISASTER ANALYSIS

Plans are developed, as part of the overall management of the network, which consider the actions that would be taken in the event of a major failure of part of the network. Such plans consider switching options and the rapid construction of temporary lines.

If there is specific concern regarding a risk to the network, detailed contingency plans are developed, which include detailed design of the required temporary lines and the securing of materials required to allow immediate construction.

6.5.4. CIVIL DEFENCE AND EMERGENCY MANAGEMENT ACT

Vector is required under the Civil Defence and Emergency Management Act 2002 (CDEM) to be "able to function to the fullest possible extent, event though this may be at a reduced level, during and after an emergency" and also to have plans for functioning during and after an emergency.

A business continuity plan for Vector has been developed and is current being finalised. Vector is also a member of the Auckland Engineering Lifelines Group (AELG) and through this membership keeps abreast of development in the CDEM area to ensure it is fully prepared for an emergency.

Vector has in place emergency response plans for major events and a Civil Defence and Emergency Management plan that sits above these plans for use in the event of a declared civil defence emergency.

6.5.5. HEALTH AND SAFETY

At Vector safety is a value, not merely a priority. The Vector safety culture described below is being adopted in the broader organisation following the acquisition of UnitedNetworks.

Vector's policy is to:

> *"Create and maintain a safe and injury free work environment for our employees, our service providers, our suppliers and the public we serve."*

To support the Vector safety policy a set of Safety Guiding Principles have been adopted by the company and our service providers. They reflect the principles of other world class companies, and define the ultimate responsibility of management to lead and implement the safety process, while at the same time recognising each individual's responsibility to work safely.

- 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 define the essentials necessary to maintain an injury free environment. These practices reflect the basic approach necessary for Vector and our service providers to identify and eliminate accident causes.

All service providers working for the company are required, as a minimum, to comply with these Safe Work Practices whilst carrying out any work on the network. Service providers are also required to report all employee accidents/incidents and near misses to Vector together with their relevant investigations and intended corrective actions. The service providers are incentivised through the contract bonus structure to achieve the Vector safety targets.

As part of our focus to continually improve health and safety, we have employee safe teams and a Safety Leadership Team – a task force which encourages all staff to voice their opinion on company safety standards, raise concerns and suggest improvements.

In conjunction with Duke Energy we have undertaken a number of audits of our health and safety systems and processes. The latest audit classed us overall as good, and that we had made significant progress in a number of areas. There is no scope to relax and we will be looking for further significant improvements in health and safety.

Our progress on health and safety is shown in Figures 6.3 and 6.4.

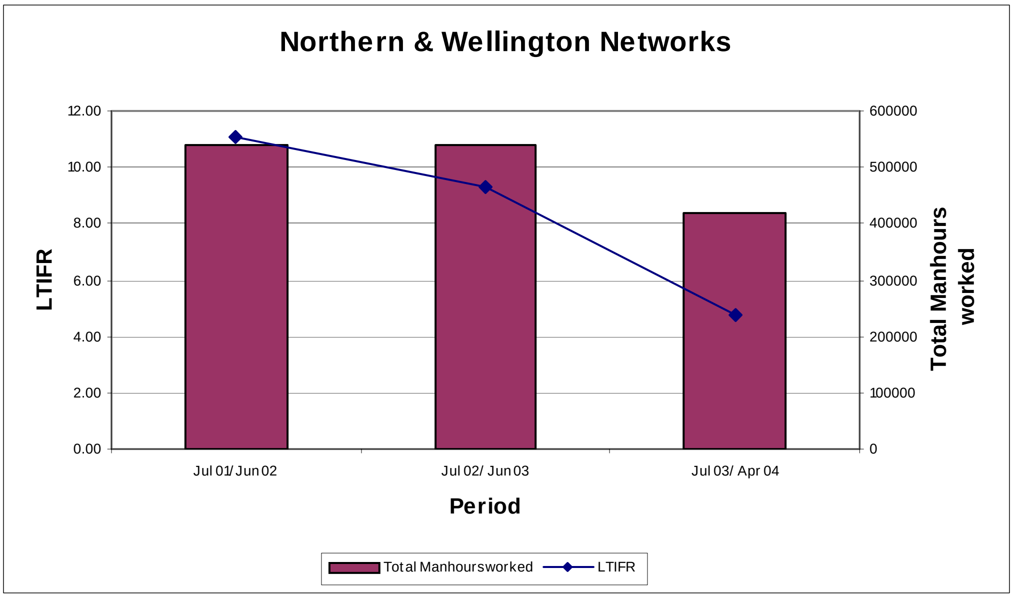

Figure 6.3 Network Safety Performance (Northern, Wellington and Service Providers)

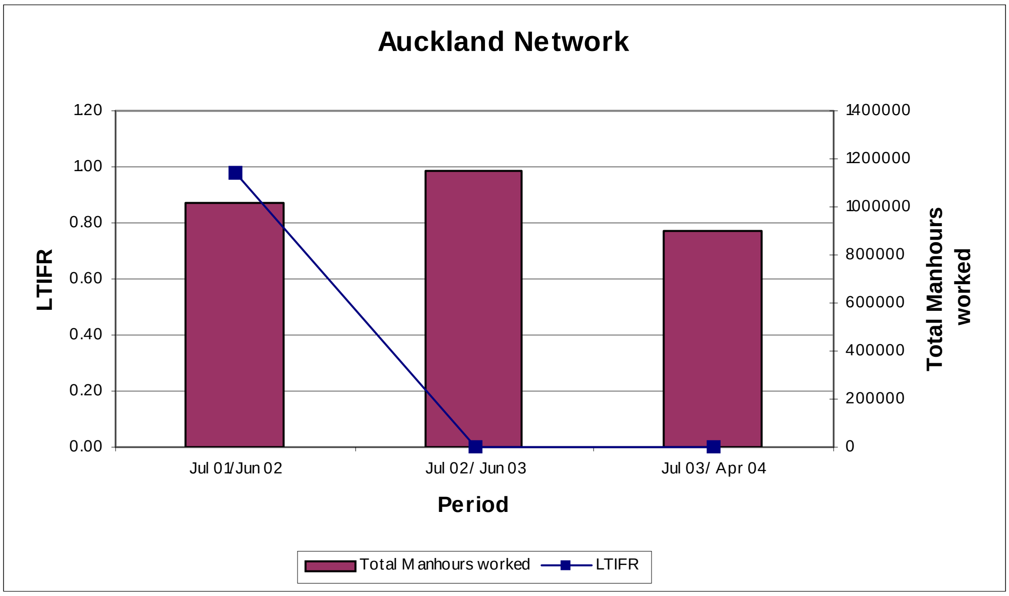

Figure 6.4 Network Safety Performance (Vector and Service Providers)

Our ongoing safety target is simply:

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

7. ■ EVALUATION OF PERFORMANCE

7.1. PROGRESS AGAINST PLANS

7.1.1. CAPITAL PROJECTS IN THE VECTOR NETWORK

The 2003/04 capex plan included a total of $44.8 million for new capital projects expected to be approved in the 2003/04 year. The total value of new network capital projects actually approved (excluding customer initiated projects) was $30.1 million. The significant variances were due to:

- Deferment of asset replacement projects based on enhanced or new condition information indicating that assets were achieving the required functionality at low or acceptable risk
- Removal of projects when detailed analysis proved the expected performance improvements and/or cost savings would not be realised.
- Timing issues
- Longer than anticipated time getting to understand the condition of the assets in Northern and Wellington regions
- The deferral of a number of replacement related projects due to changing third party circumstances
- The deferral of information system projects following the purchase of UnitedNetworks by Vector

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:

- Reliability
- Safety
- Customer satisfaction

These measures:

- Are directly applicable to the core business
- Support the aims of the strategic business
- 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 service providers. Accountability for the performance targets is a function of all employees. The service providers are incentivised through the contract bonus structure to achieve their targets and Vector direct employees have the physical performance measure embedded in the performance related pay scheme.

7.2.1. RELIABILITY

The time weighted reliability targets and actuals for the combined network for 2003/04 are shown in Table 7.1.

Measure	2003 Target	2003 Actual
SAIDI	80	109.6
SAIFI	1.3	1.58
CAIDI	61.5	69.9

Table 7.1 Reliability Statistics (inclusive of Transpower outages)

The targets set for 2003/04 were stretch targets designed to push the assets and service providers who are incentivised to achieve the reliability targets. Whilst we did not achieve the SAIDI target we set ourselves, we were on track until the three storms in February 2004 added 25.8 SAIDI minutes. Transpower outages added another 4.6 SAIDI minutes. Good progress is being made in reducing the fault numbers in areas we have direct control over. We continue to work proactively with Transpower to improve customer focus and reduce the outages due to Transpower faults.

We are proactively targeting the worst performing feeders, identifying the problem areas and initiating works to bring performance in line with our customer service levels.

Our service providers within the Auckland network are constantly reviewing the way they work in the field to minimise the impact of CAIDI. Where possible power is restored first and permanent repairs are progressed later, including the use of live line techniques to avoid further disruption to service. This approach to planned maintenance has been rolled out in the Northern and Wellington networks.

7.2.2. SAFETY

Vector sets safety targets around lost time injury frequency per million man hours worked. These statistics include all lost time injuries sustained by their employees and employees of their service providers whilst working on the network.

The target set for the year ending June 2004 was:

- Achieve a further 1 million man hours lost time injury free on the Auckland network
- Achieve a 50% reduction in the LTIFR for Northern and Wellington networks

Performance at 31 March 2004 year end was:

- Zero lost time injuries during the period at Auckland
- Five lost time injuries Northern and Wellington
- A resultant lost time injury frequency of 0.0 for Auckland and 9.9 for Northern and Wellington

7.2.3. CUSTOMER SATISFACTION

Vector continues to monitor customer satisfaction as a key performance indicator both for Vector staff and for our contracting business partners. For the year 2003/2004 this has continued to relate purely to the Auckland network though we have commenced surveying our other networks (both electricity and gas) but require some baseline data before we can include these in any targets.

The target for 2003/04 remained at 81/100 as per the previous year. Though we were aware that the integration of the two businesses and also the consolidation of the Auckland contracts from three parties down to two could have the potential to impact on customer satisfaction, we wished to maintain the high standards set for previous years. Unfortunately the score at March 2004 was not quite at this target though results to date show that we are on track to achieve above target for the end of our financial year June 2004.

Figure 7.1 Customer Satisfaction Score

Vector is currently assessing how, going forward, we will interact with our customers, but regardless of the outcome of this decision, customer satisfaction will remain a core key performance indicator for internal staff and business partners. Targets for 2004/05 will include all networks.

7.3. PLANNED IMPROVEMENTS FOR PERFORMANCE

To improve performance and to ensure resources are targeted most appropriately, Vector has a number of planned improvements for 2004/05:

- Continued development of tools to enable Vector and the service providers to spot trends and improvement opportunities quickly and efficiently
- Continued implementation of smarter equipment in the field to enable more efficient fault finding and a focus on innovative field practices to substantially reduce outage times