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Asset Management
CY2017- CY2022

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SCADA Strategy

CY2017 – CY2022

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1.0	03/06/2014	Mark Beech	Previously approved version
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1.2	18/12/2016	Troy Praag	Review/QA full document
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2.0	19/12/2016	Mark Cooper	Final version – issue for use.

Originated By

Title	Name	Signature	Date
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Executive Summary

Multinet's SCADA Strategy details the management of existing SCADA (Supervisory Control and Data Acquisition) assets and their associated components. It details the lifecycle management of SCADA assets, including the replacement of existing and requirement for new installations to maintain and improve network monitoring and control.

The strategy covers the field based SCADA assets (i.e. peripheral hardware) on Multinet's Gas Distribution network. It does not extend to SCADA software which is covered in Multinet's ICT strategy.

The SCADA strategy aims to achieve a high level of safety and reliability for SCADA assets which in turn provides real-time network performance data and network operation capability. Network performance data is integral to the day-to-day operation of the network and for the development of asset management strategies.

Multinet plans to complete the following ten programs (detailed in Table 0-1) to maintain its alignment with the Network Objectives, as detailed in Section 3.1, and remain compliant with its regulatory obligations under the Gas Safety Case, Gas Distribution System Code, AS 4645 and AS 2885.

Table 0-1 provides the financial summary of the capital expenditure which is expected to be incurred in the calendar year period 2017 to 2022. Table 0-1 includes a breakdown of direct, overheads and real cost escalators for the purpose of reconciliation with that of the overview documentations which support our forthcoming Access Arrangement submission.

Table 0-1: Summary of Capital Expenditure ($'000)

Program Name	CY2017	CY2018	CY2019	CY2020	CY2021	CY2022
Network Control	$228	$601	$568	$488	$488	$439
RTU Fringe Installation/Relocation	-	$16	$32	-	$16	$16
Aged pressure transmitters	$354	-	-	-	-	-
Jordan actuator replacement	$641	-	-	-	-	-
Hazardous area non-compliant sites	-	$177	$177	$167	$167	$167
Kingfisher RTU replacement	-	$209	$209	$209	$209	$209
TRIO Radio Replacement and Streamlining	$182	$541	$340	-	-	-
Data-logger	$186	$186	$186	$186	$186	$165
Gas Detector Installations	$52	$52	$52	$52	$35	$35
Vortex Flowmeter Installation	$22	$22	$22	$22	-	-
Total Direct Expenditure	**$1,664**	**$1,803**	**$1,585**	**$1,123**	**$1,100**	**$1,031**
Overhead	$100	$108	$95	$67	$66	$62
Subtotal	**$1,764**	**$1,911**	**$1,680**	**$1,191**	**$1,166**	**$1,093**
Real cost escalation	-	$11	$8	$8	$12	$13
Total Expenditure	**$1,764**	**$1,922**	**$1,688**	**$1,199**	**$1,178**	**$1,106**

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1. Document Overview

1.1. Objectives

This document articulates Multinet Gas' approach to the management of its existing SCADA (Supervisory Control and Data Acquisition) assets and their associated components.

It has the following objectives:

- Articulate the key areas of focus in relation to asset management, risk, investment, cost and service standard outcomes for the "SCADA" asset group;
- Provide for the effective continuous monitoring, recording and optimal control of the Multinet Gas distribution network; and
- Show alignment of asset management practices with Gas Network Objectives.

The document is for use by:

- Multinet Gas Staff (and it's contractors); and
- Regulators - Economic, Technical and Safety.

1.2. Scope

This strategy applies to Multinet Gas' field based SCADA assets (i.e. peripheral hardware) on Gas Distribution network. It does not extend to SCADA software which is covered in Multinet's ICT strategy.

The strategy applies to the maintenance and replacement of Multinet Gas supervisory, communications equipment and systems. The extent of which includes but not limited to:

- Field instrumentation and sensors for SCADA monitoring and control systems e.g. Pressure transmitters, temperature transmitters, flow transmitters, limit switches and gas detectors;
- Motorised actuators and solenoids for gas pilots and generally anything electrical in nature that may be found in the hazardous area of the site;
- RTU (Remote Terminal Units) and their interface hardware, firmware and applications;
- RTU and communications equipment power supplies (AC-DC), power converters (DC-DC), solar panels, chargers and backup batteries;
- Aerials, antennas, masts, RF feeder cables and lightning arrestors used for SCADA monitoring;
- Communications equipment including modems, radio modems and transceivers, of wireless and wired technologies;
- Communications networks and services explicitly used for SCADA; and
- Cello data-loggers

Multinet aims to maintain existing SCADA, communication assets and systems in effective working order through a combination of preventative maintenance, corrective maintenance, along with replacement of equipment that has reached end of life.

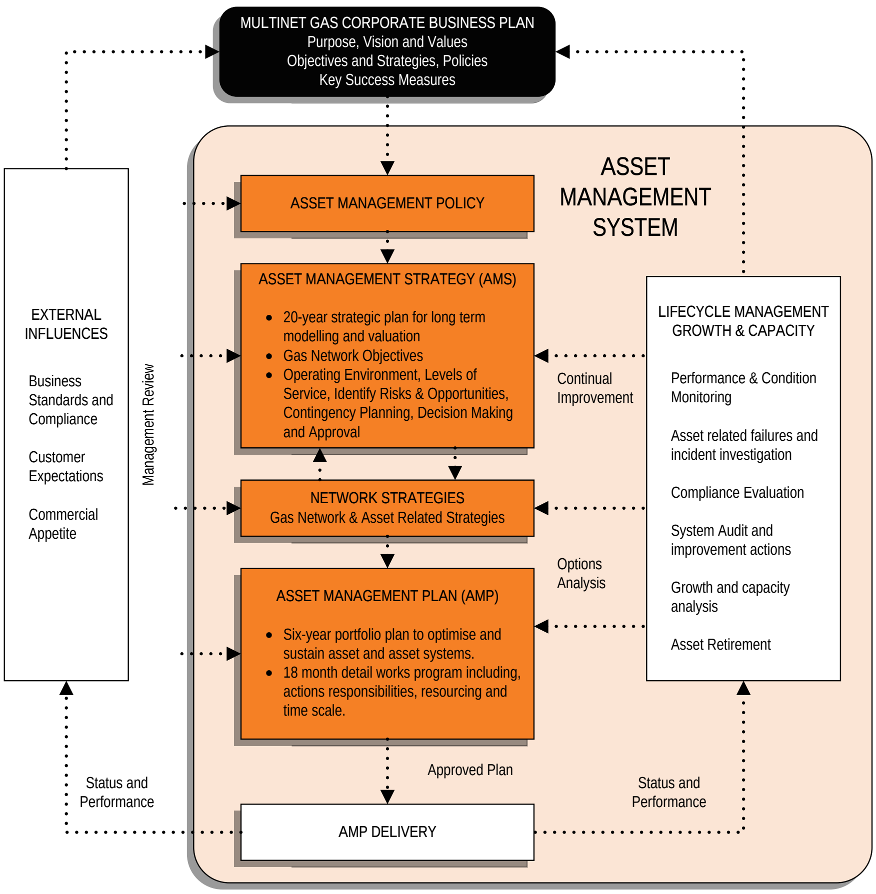
The long term strategy for Multinet Gas is to ensure optimal SCADA monitoring and fringe point control. Smart monitoring and control may include:

- Predictive operation based on weather forecast and actual weather conditions.
- Failsafe setting based on actual load (weather, time of day and season).
- Operation based on historic load rather than instantaneous load.

1.3. Relationship with other Key Asset Management Documents

The SCADA Strategy is one of a number of key asset management related documents developed and published by Multinet Gas in relation to its gas network. As indicated in Figure 1-1 below, detailed asset strategies – including the SCADA Strategy - informs both the Asset Management Strategy (AMS) and Asset Management Plan (AMP) of the programs needed to achieve the long-term objectives of the gas distribution network.

Figure 1-1: Asset Management Framework



1.4. Phasing and Financial Disclosure

All program defined within this strategy are presented in calendar years consistent with the reporting requirements of the Australian Energy Regulator (AER) and where applicable the Gas Distribution System Code (Version 11).

Where required for conversion to financial year (July to June), dollars and volumes can be estimated using a 50:50 expenditure split.

All financial figures quoted within this document - unless otherwise specifically stated - have the following characteristics:

- Real Expenditure / Cost (reference year = 2017);
- Direct Expenditure only (i.e. excludes overheads and finance costs);
- In units of $1,000 (i.e. '000); and
- All years are denoted in Calendar Year format.

Total values shown in tables and referred to in the text of this document may not reconcile due to rounding.

Conversation factors used in the escalation of historic expenditure to real 2017 equivalent expenditure is provided in Table 1-1. Cumulative conversion factors have been provided by the Multinet Gas Regulatory Department.

Table 1-1: CPI Conversion Factors

	2012	2013	2014	2015	2016	2017
CPI Index - $2017	1.09619	1.07465	1.05192	1.02819	1.01296	1.00000

1.5. Data Sources

The following data sources have been drawn upon in development of the SCADA Strategy. Due to legacy data management and lack of internal resources in managing SCADA, it has been predominantly managed by service providers. Detailed historical performance and asset data is inaccurate to a certain extent at this point in time.

- SAP: [ERP tool used for data collection, analysis and maintenance management of MG assets]
- MOSAIC: [Real Time SCADA application for network monitoring]

1.6. References

- Gas Safety Case;
- AS 4645 series - Gas Distribution Networks;
- AS 2885 series – Gas and Liquid Petroleum; and
- Multinet Gas - System Operations Manual.

1.7. Document Review

This document shall be reviewed every two (2) years or earlier if required. The next review is due on or before 31 December 2018.

2. Asset Overview

2.1. Introduction

SCADA (Supervisory Control and Data Acquisition) systems are used by Multinet for the effective and economical monitoring, recording and control of the network. The Australian Energy Regulator (AER) classifies SCADA projects under the term “Telemetry”.

This strategy details Multinet’s management of existing SCADA assets and their associated components. It details the lifecycle management of SCADA assets, including the replacement of existing and requirement for new installations to maintain and improve network monitoring and control.

There are a total of 241 Remote Terminal Units (RTUs) at key Multinet Gas sites that are actively and continuously managed by a SCADA system. Each RTU directly supervises one or more critical assets across the Multinet Gas distribution network; including regulators, meters and fringe sites. Real time data gathered from these field RTUs is represented graphically on SCADA clients in Multinet’s control room where the operators can, at a glance, assess the health of the distribution network.

The use of RTUs and SCADA greatly reduces the operating cost and risks associated with running a distribution network, but for these efficiencies and mitigations to be continuously realised, the RTUs, communications networks and SCADA systems need to be kept in effective working order.

Over time the population of installed RTUs are forecast to increase to provide more detailed coverage of the existing service area. Additionally, the geographical boundaries of Multinet Gas are expected to grow with green field projects and/or acquisitions of a similar make-up. Any new service areas shall, from the commencement of operations, be monitored by RTUs or their equivalent (for example South Gippsland Pipeline).

Table 2-1 shows a brief overview of Multinet’s SCADA communication assets.

Table 2-1: Summary of SCADA Communication Assets

Asset	Volume	
RTUs		241
Networks	HP Network - Solenoid control	5
	HP Network - Variable control	13
	HP No SCADA	1
	MP Monitored	All networks
	LP Monitored	All networks
Base Stations		8
	RTU Radio field sites	181
	RTU GPRS/3G field sites	60

This details information relating to remote or field assets. These can typically be categorised under network control sites, monitor sites, auxiliary equipment, and general SCADA equipment. Depending on the RTU type and the number of inputs and outputs available; an RTU may serve multiple functions or monitor more than one asset.

2.1.1. Network Control sites

SCADA control sites have the ability to regulate and control network pressures in addition to having network monitoring capability. Pressure regulation occurs when the pilot motor applies a positive (or negative) load pressure to the main diaphragm of the regulator which in turn changes the opening position of the main valve of the regulator. The pilot itself has a valve which controls the load pressure applied based on downstream pressure of the regulator.

Control sites typically have additional conditions to monitor which can include (but not limited to):

- Pressure (Inlets, Outlets, differentials);
- Temperatures (Gas, gas heaters);
- Entry conditions (Pit, RTU, battery box);
- Power conditions (Battery, mains, fuses);
- Slamshut status;
- Gas detection;
- Switches;
- Water levels;
- Failsafe modes, statuses and settings; and
- Gas heater conditions.

Control sites also have modes of operation as determined by Group Pressure Control (GPC) monitored and operated in the Network Control Centre (NCC).

2.1.2. Monitored sites

Monitored sites do not have network pressure control capabilities (unlike control sites). They typically monitor fewer inputs including (but not limited to):

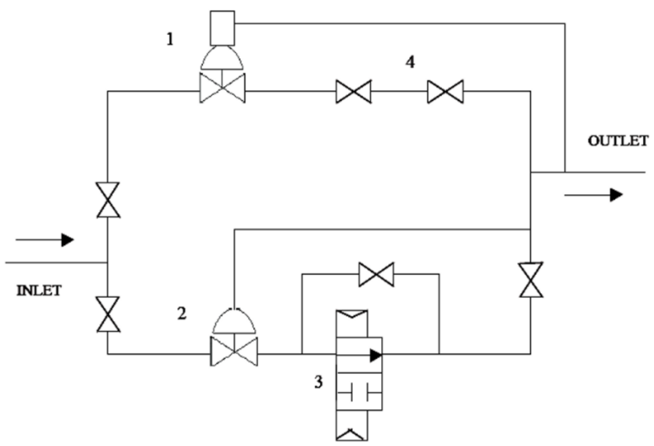
- Power conditions (Mains, battery);
- Entry conditions (Pit, RTU, battery box);
- Pressures;
- Slamshut statuses;
- Temperature (Gas, cabinet, heaters); and
- Gas detectors.

These statuses or conditions are typically set with an alarm which will notify the NCC of any abnormalities.

2.1.3. Auxiliary equipment

The SCADA Control Panel is the interface between the SCADA input from the RTU and the regulator output. It contains the components which control the outlet pressure of the station and the failsafe devices. Figure 2-1 shows a schematic of a typical control panel, with the auxiliary equipment described further below.

Figure 2-1: RTU Control panel



Pilot motor drive (Item 1 above)

The pilot motor drive is operational when a signal is received from the control room via the R.T.U; the pilot motor drive will then raise or lower the pressures by operating the motor for a pre-determined period of time. This motor drive is also calibrated so the pilot cannot exceed a lower or upper pressure limit. The Pilot may be isolated by shutting the valves either side of the device.

Failsafe pilot (Item 2 above)

The Failsafe Pilot is a pre-set pilot regulator which is made active by opening the solenoid valve preceding the device. The Failsafe Pilot is set to a predetermined network safe setting. This gives an indication as to whether the motor pilot is operationally correct or not. The Failsafe Pilot may be isolated by shutting the valves either side of the device.

Solenoid valve (Item 3 above)

The solenoid valve enables the regulator station to be put into the fail-safe mode. When the solenoid is de-energised, the motor driven pilot is commanded to go to Top Limit. The control for the site is then through the Failsafe pilot.

Relief valve (Item 4 above)

The relief valve is used in the case of any leakage through the fail-safe pilot, while not in use. This relief valve is set at 680 kPa to relieve any pressure build up that can be would otherwise cause damage to the solenoid valve.

The Slamshut Panel

Slam shut panels are used on our pressure regulating stations to protect the downstream pipework against over pressurising. This is a basic requirement of Australian Standard AS 4645, and AS 2885. The level of over pressure protection is dependent on the inlet and outlet pressures at the station. The slam shut panels used in Multinet Gas areas have been designed to suit Multinet Gas' own requirements. The panel operates pneumatic actuators on the regulator valves which are immediately upstream of the two runs of two regulators which form part of a city gate or field regulator station. The purpose of the device is to shut down a faulty run of regulators, or in the unlikely event of failure of both regulator runs, to control within safe limits the outlet pressure of a station. In this case the slam shut system would open and close the inlet valve, maintaining an approximate downstream pressure by acting as a 'rough cut' regulator. Figure 2-2 is an example of a slamshut panel.

Figure 2-2: Slamshut Panel

2.1.4. General SCADA Equipment

General SCADA equipment encompasses items that fall under SCADA operations and maintenance but typically play a support role in maintaining SCADA functionality; including (but not limited to):

- Cabinets;
- Batteries and solar panels;
- Junction boxes;
- Antennas; and
- Cable supports.

2.2. Asset Age Profile

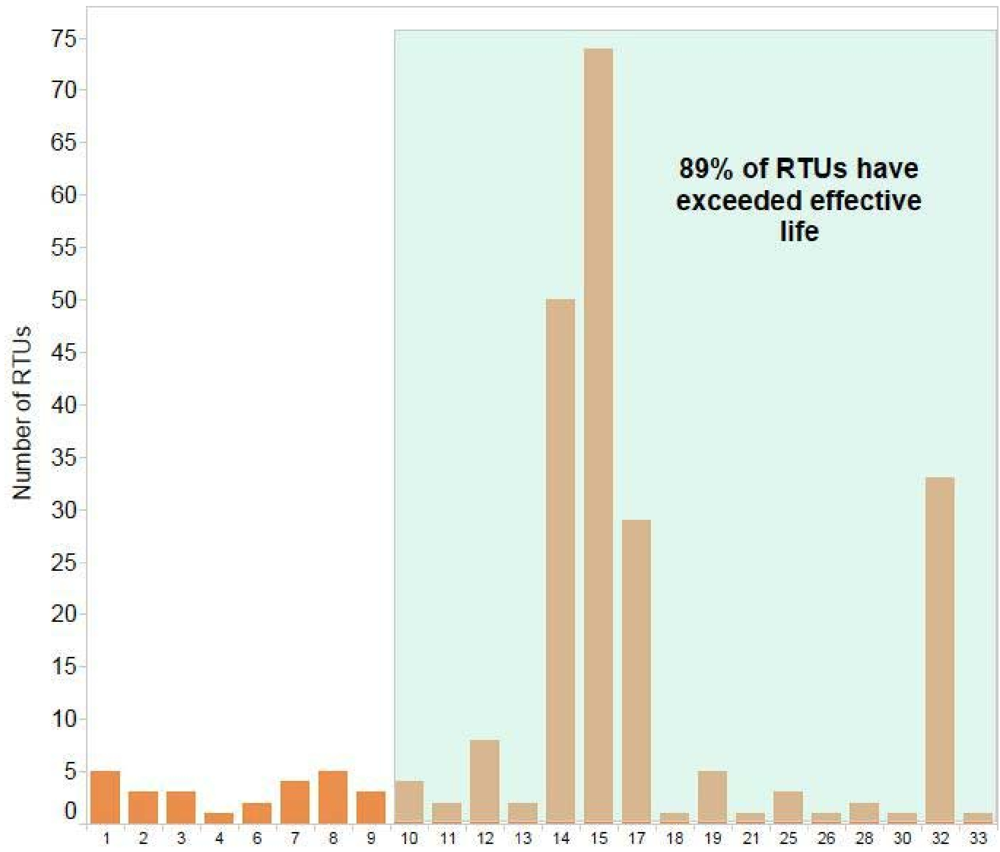
Multinet Gas has history of RTUs and SCADA devices dating back as early as 1983 where the Gas & Fuel initially deployed Email Minitran (and later Microtran 1989) RTUs throughout the distribution network. Although none of these original RTUs themselves remain, much of the instrumentation, cabinets, and fit out are still in service.

In subsequent years several waves of upgrades, expansion and replacement have taken place including:

- **1999**: Replacement of 65 existing Minitran and Microtran RTUs with Kingfisher Telemetry;
- **2001 – 2002**: replacement of 140x low pressure district regulator mechanical time clocks and chart recorders with Kingfisher RTUs as a local PLC and data logger (No Real Time Comms);
- **2003**: Upgrading of 70x non SCADA low pressure district regulator RTUs to real time SCADA (add radio comms); and
- **2004**: Upgrading of 51x non SCADA low pressure district regulator RTUs to real time SCADA (11x radio, 40x GPRS comms).

Various demand driven projects also require additional RTUs (and some removals). Hence some instruments and enclosure fit outs are up to 33 years old and RTUs are typically between 10 to 15 years old. The age profile for RTUs is depicted in Figure 2-3 with the effective life of assets typically being 10 years[1] (hardware components).

Figure 2-3: Effective Life of RTUs



[1] ATO TR 2016/1 effective life of assets Infrastructure Assets Valuation 1997

2.3. Asset Performance

Electronic components rarely display poor performance indicating wear or age. Most failures are end of life failures rendering any attempt at a condition assessment frivolous. However, constant replacement of components due to faults maintains an efficient system.

Radio systems through a combination of the above faults degrade over time reducing the effectiveness and responsiveness of the SCADA system. Faulty systems consume more bandwidth than healthy system and a small number of defective systems can adversely impact as much as 100 SCADA sites.

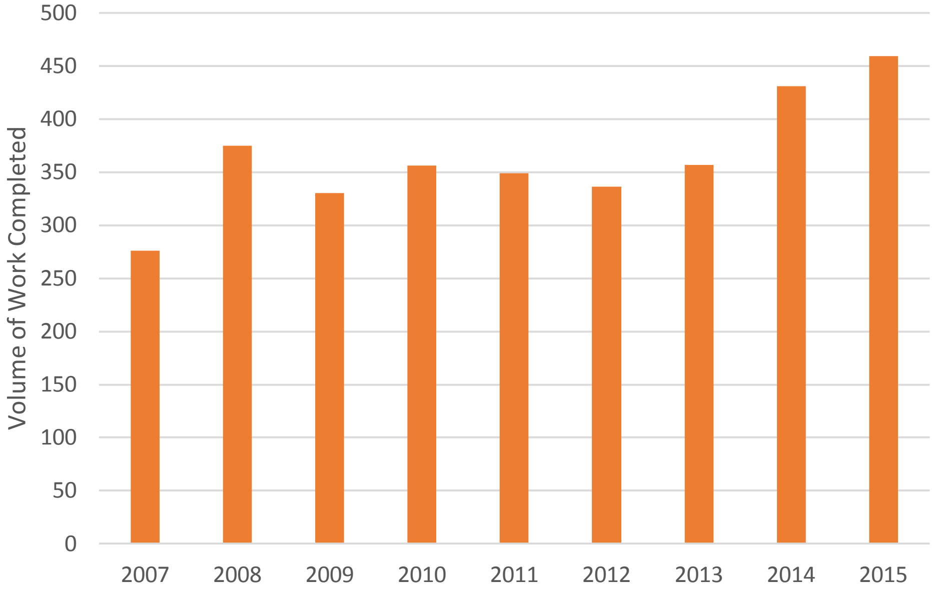
Table 2-2 shows typical failures or hindrances to optimum performance.

Table 2-2: Typical performance issues of SCADA assets

Asset	Performance issues
Trio Radios	• Interference from other Radio Frequency Sources. • Adverse and extreme weather, heat, cold, rain & lightning. • Overgrowth of foliage and interruption of line of sight. Wet trees will attenuate RF signals. • Redevelopment of an area. Buildings and structures can block, reflect or ghost RF signals. • Drift in electronic components over time can cause a radio to transmit off carrier and reduce the reliability of a radio. Drift is often associated with operating temperature extremes. • Antenna alignment and movement: Yagi antennas have large surface areas and can be inadvertently misdirected by wind and vibration causing low RF signal levels. • A single misbehaving radio site can block an entire radio channel with chatter or locked on transmitter. • Ingress of moisture or insects usually destroys radios beyond repair. The warmth of a radio and RF signals often attracts insects and it is not uncommon to find a colony within a failed radio.
RTUs	• Module failure. • Vandalism or third party damage. • Environmental damage.
Field end devices	• Transmitter failure or drift. • Gas detector failure or drift. • Solenoid or limit switch failure. • Actuator failure. • Water ingress.

Figure 2-4 shows the total volume of maintenance and replacement works carried out on SCADA assets over the past nine years. It shows a slow increasing trend in SCADA related field work which is consistent with the aging profile and growth of the SCADA network.

Figure 2-4: Trend of SCADA field work

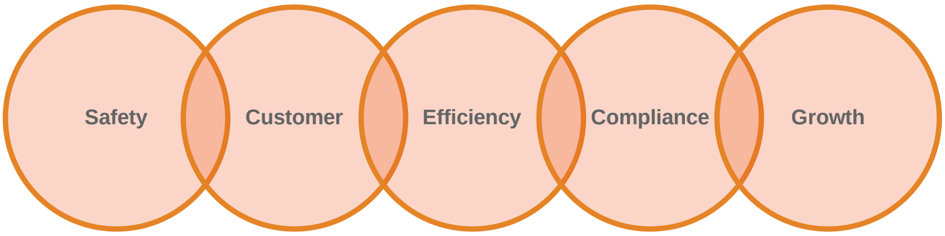


3. Asset Management Drivers

3.1. Network Objectives

Multinet Gas has established five (5) network objectives that govern how the network is operated and maintained. This is reflected mostly in regulatory obligations and in some cases prudent and responsible behaviour, justifiable on economic grounds. Achievement of these objectives ensures the sustainable and reliable operation of the gas distribution network.

Figure 3-1: Gas Network Objectives



The alignment between network objectives and the SCADA strategy is detailed below.

3.1.1. Safety – Achieve Zero Harm, while maintaining current levels of network safety.

This strategy aims to achieve a high level of reliability, personnel safety, and public safety, achieved through inspection, preventive and corrective maintenance, and replacement of SCADA assets. The proactive replacement of aging assets such as radios, data-loggers and RTUs ensures that there is a continuous flow of data and communication to the network control centre, allowing operators to detect and react to faults and emergency situations.

Areas classified as hazardous, such as city gates and pressure regulating stations, require equipment with specific electrical and explosion proof certification. Replacement of equipment such as the Jordan actuators, switches, solenoids and glands ensures that potentially unsafe environments are avoided.

Implementation of equipment like gas detectors and data-loggers ensure any unsafe condition are detected early whereby network control can then enable operators to respond to these faults and emergencies before the risk impacts personnel and the public.

3.1.2. Customer – Effortless Customer Experience

This strategy aims to achieve a high level of customer satisfaction and experience by providing a reliable means of gas supply to the customer. Relocating or installing fringe sites give Multinet a true indication of the lowest pressure point on the network. SCADA control can then effectively and optimally control supply to customers (especially during peak demand hours) avoiding disruptions in gas supply. There is also clear visibility of network performance which is crucial in monitoring customer supply. Data-loggers allow Multinet to cater to customer needs on an individual level if such situations arise.

3.1.3. Efficiency – Sustainable and prudent network investment

This strategy aims to concisely outline the capital expenditure programs for SCADA going forward from 2017 to 2022. Proactive replacement of end of life RTUs will allow for standardised assets which will reduce the need for maintaining obsolete communication technologies and ensure continuous supply and improved reliability. This in conjunction with data-loggers and fringe points will allow for the most optimum and cost efficient capital programs to maintain capacity of the network.

3.1.4. Compliance – Maintain regulatory and technical compliance

This strategy aims to achieve a high level of regulatory and technical compliance by ensuring that all maintenance and replacement activities are carried out to meet the requirements of the following (but not limited to):

- AS/NZ3000;
- AS/NZ2381.1;
- Multinet Gas Safety Case;
- AS 4645;
- AS 2885; and
- Gas Distribution System Code (Version 11).

Some of the Multinet installations may contain components such as Jordan actuators that are not hazardous zone compliant/expired certification and thus require rectification. Multinet's fringe relocations and SCADA control programs are directly in line with the Gas Distribution System Code in maintaining minimum network pressures at all times.

3.1.5. Growth – Seek opportunities for new growth

This strategy aims to cater for future network growth as new customers are added to the network. In particular the installation of vortex flowmeters in key areas of the network allow us to understand the gas consumption of customer at certain sites such as Korumburra, Leongatha and Lilydale.

3.2. Lifecycle Management

Multinet rarely installs new SCADA equipment in the field due to network growth. Newer and modern equipment are typically installed due to the required replacement of old or obsolete technology. Other instances of new equipment installation is the upgrade of existing sites (and their respective equipment) to provide additional capabilities. Multinet primarily focuses on corrective and preventative maintenance in managing SCADA assets with replacement required in the instance of meeting new regulations, emergence of new technologies and obsolescence of old equipment.

3.2.1. Inspection

Routine Inspections are carried out as part of the scheduled preventative maintenance cycle for a given site. Nearly all sites are continuously electronically monitored via the RTU, hence failures should be detected as soon as they occur. In some incidences, pending failures can be detected and rectification undertaken prior to complete failure of the site.

Radio system have integrated diagnostic capabilities and are electronically monitored to ensure that the radio systems and site performance exceeds the minimum operating parameters, such as signal strength, frequency drift & transmit power levels.

Below are inspections that occur as a result of inspections of other assets.

(a) District Regulator Sites with Time Clock Modules & Cello Data Logger

These sites are inspected annually. The inspection covers housing integrity, regulator operation, gas leakage and water ingress in accordance with AS 4645. These sites receive scheduled pressure changes visits coordinated to cater for seasonal demand.

(b) District Regulator Sites with RTU

These sites are inspected annually for housing integrity, regulator operation, gas leakage and water ingress in accordance with AS 4645. These sites currently receive 2 scheduled pressure changes visits coordinated to cater for seasonal demand.

(c) Field Regulator Sites without SCADA Control

These sites are inspected every six months for housing integrity, regulator operation, gas leakage and water ingress in accordance with AS 4645 and AS 2885.3. Slam Shut Panels (where fitted) are checked for correct actuator operation.

(d) City Gate & Field Regulator Sites with SCADA Control

These sites are routinely inspected every six months. Inspections are scheduled to occur between six-monthly operational checks as part of field regulator preventative maintenance.

3.2.2. Preventive Maintenance

Preventive Maintenance is performed on the SCADA facilities during the sites scheduled maintenance. Each site is periodically maintained on a schedule consistent with the importance of that site.

- SCADA control sites are attended twice yearly;
- Fringe monitoring sites are attended twice yearly;
- Monitored sites are attended yearly (including Custody Transfer Meters (CTM) in conjunction with upstream provider);
- District Regulator RTU's are attended every three years.

Routine maintenance includes the following activities:

- Visual inspection;
- Battery load tests;
- Instrumentation calibration checks and recalibration (if outside of nominal tolerance);
- Test and operate solenoids, actuators and limit switches;
- Enclosure maintenance & pest control as required (Insects, vermin etc.);
- Hazardous Area Inspection and clearing of any hazards identified (for example water in the pit);
- Correction of any defects identified;
- Antenna alignment and assessment against EMR regulations;
- The motorised actuators are overhauled every three years, with the motor brushes and gearbox bearings being replaced at this time; and
- Recording and reporting of the maintenance visit.

Routine maintenance of Trio Digital Radios

Trio digital radios are used as the primary carrier for Multinet Gas SCADA communications with the legacy equipment now dating back some 15 years. As these radios continue to age a higher rate of breakdown and frequency drift has been experienced, particularly in the 5+ year old radios. Trio radios are now targeted as part of the routine maintenance cycle where every radio will be rotated, bench tested and realigned over a 5 year cycle. It is anticipated the need for this will be reduced with the replacement program detailed in this strategy.

ACMA Electro Magnetic Radiation ruling

In 2005 the Australian Communications and Media Authority made rulings that directly impact the use of fixed radio telemetry systems where the spectrum licence holder has a duty of care for the public in the vicinity of a transmitter and its antenna. In layman's terms, the interpretation of the legislation dictates that there is an exclusion zone around each and every fixed licensed antenna installation so that the public cannot enter that zone. The service provider and spectrum licence holder for our equipment (Trio) has dictated the size of that zone and it is believed that almost all existing installations fall within the acceptable definition where in essence the antenna is positioned at a height where a normal person cannot enter the exclusion zone unaided.

Additionally, as a new requirement during routine maintenance of any site, the exclusion criteria are to be assessed against the often changing environment. For example, if a new structure is presently adjacent to an existing installation then a directional antenna cannot be directed towards an occupied building within the limits of the exclusion zone.

3.2.3. Corrective Maintenance - Faults and Defects

The sites are visited on an ‘as needs’ basis to perform Corrective Maintenance as soon as a failure has been detected, usually via an alarm at the Control Room. Corrective maintenance is required to be available constantly, however, unless critical in nature, the usual response expectation is attendance by next normal work period.

The SCADA system inherently includes quality of data checks which drives corrective maintenance.

The communications networks used for SCADA include wireless networks and fixed point to point services. Each of these networks and systems are monitored at either a system or site level with diagnostic tools.

Signal levels and radio performance of each RTU site is logged and alarmed if they exceed the nominated thresholds. An underperforming radio can trigger corrective maintenance. Periodic analysis of long term data is performed to identify trends and may trigger additional works at the next scheduled routine maintenance cycle for a site.

The SCADA system routinely reports total communications failure of a site, which usually triggers corrective maintenance on that site.

Critical Host SCADA infrastructure (Servers, Serial Converters, Radio Transmitters etc.) are automatically monitored by application monitoring software (Currently HP Open View, soon to be NAGIOS, and by the Core application MOSAIC itself). Corrective maintenance and support of Master station / Host SCADA is to be carried out constantly and consistently.

3.2.4. Refurbishment

Where equipment requires refurbishment, it is usually undertaken as a project, especially if it involves a family of equipment located across a number of sites. Whenever possible, equipment refurbishment is aligned with the scheduled maintenance visits as a means of increasing efficiency.

(a) Substandard installation

There are a small number of High Pressure SCADA installations that recent inspections have identified that they contravene the Hazardous Zone Regulations for electrical equipment within a gas/air environment. Some remedial work at these sites is required, including relocation of RTU cabinets and antennas. This work is expected to be completed during overhaul works or as part of the program detailed in Section 4.

3.2.5. Replacement

Equipment is considered for replacement when it is no longer fit for service. This can be either due to age, that is, maintenance parts no longer available, or that the operating criteria has changed and the equipment will no longer perform at a satisfactory standard. Capex programs involving replacement are detailed in Section 4.

The funding strategies adopted include:

- Use the communications system to the point just before it reaches end of useful life;
- Least effort expended during the useful life of the communications system;
- Maximum rewards from the communications system while in service;
- Replace or retire obsolete communications systems with new secondary systems in an efficient manner; and
- Actively monitor the condition and analyse the performance of the communication assets over the life cycle.

3.3. Performance Measures

Key performance indicators (KPI) have been developed to directly measure the overall response and condition of the SCADA and communications assets. These KPIs include:

- Percentage availability of SCADA application (Mosaic) which is a measure of the operational up time expressed as a percentage of the period (usually reported monthly); and
- Percentage availability of SCADA communications which is a weighted measure of the availability of all remotely monitored SCADA assets expressed as a percentage of the period (usually reported monthly).

The above KPIs have a direct correlation to the quality and reliability of the SCADA monitoring and control systems and have a flow on effect to other Multinet Gas KPIs.

4. Capital Program - 2017 to 2022

4.1. Overview

Multinet Gas will complete the following programs to maintain its alignment with Network Objectives (refer section 3.1) and remain compliant with its regulatory obligations under the Gas Distribution System Code, AS 4645 and AS 2885.

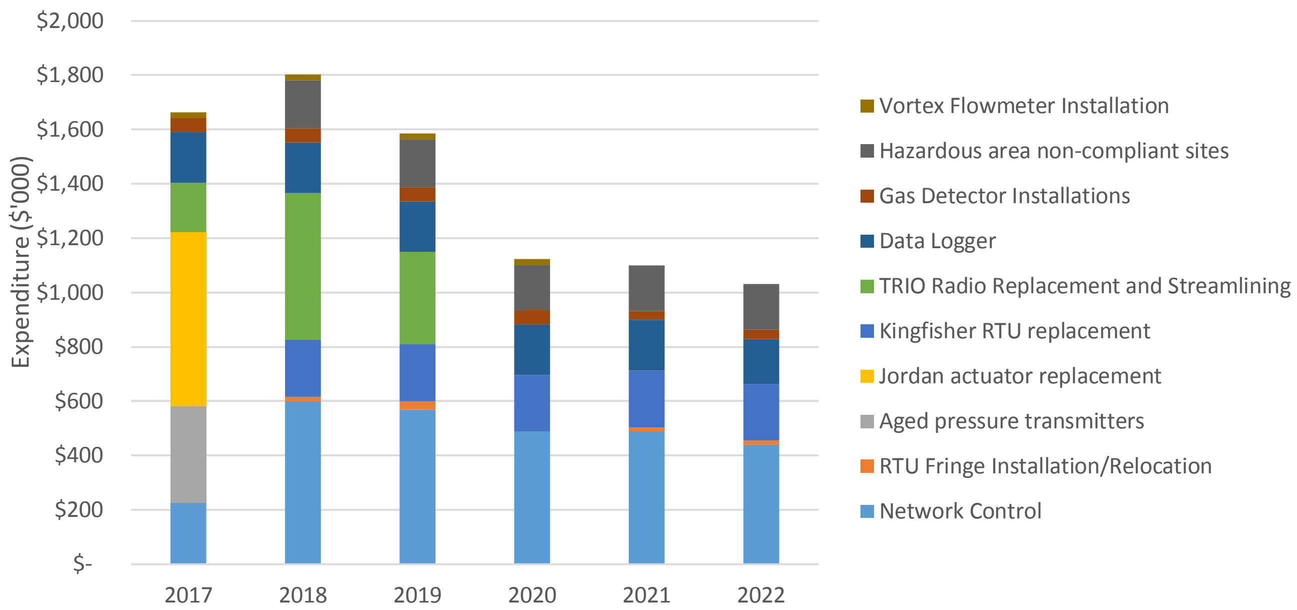
- Network Control (HP, MP, and LP networks);
- RTU (Remote Telemetry Units) Relocation / Installation;
- Jordan Actuator Replacement;
- Aged Pressure Transmitter Replacement;
- Hazardous zone non-compliant site refurbishment;
- Kingfisher RTU Replacement;
- TRIO Radio Replacement & Streamlining;
- Data-Logger Implementation;
- Gas Detector Installation; and
- Vortex Flow meter Installation.

Capex allocation is captured within the AER regulatory accounts 'SCADA' category.

Table 4-1: SCADA Expenditure Summary

Ref	Program	2017	2018	2019	2020	2021	2022
4.2	Network Control						
4.2.3	Variable Network Control - High Pressure	$130	$33	-	-	-	-
4.2.4	Step Control - Medium Pressure (non-monitored)	-	$324	$324	-	-	-
4.2.4	Step Control - Medium Pressure (Monitored)	$98	-	-	$244	$244	$195
4.2.5	Step Control - Low Pressure	-	$244	$244	$244	$244	$244
4.3	RTU (Remote Telemetry Units) Relocation / Installation	-	$16	$32	-	$16	$16
4.4	Jordan Actuator Replacement	$641	-	-	-	-	-
4.5	Aged Pressure Transmitter Replacement	$354	-	-	-	-	-
4.6	Hazardous zone non-compliant site refurbishment	-	$177	$177	$167	$167	$167
4.7	Kingfisher RTU Replacement	-	$209	$209	$209	$209	$209
4.8	TRIO Radio Replacement & Streamlining	$182	$541	$340	-	-	-
4.9	Data-Logger Implementation	$186	$186	$186	$186	$186	$165
4.10	Gas Detector Installation	$52	$52	$52	$52	$35	$35
4.11	Vortex Flow meter Installation	$22	$22	$22	$22	-	-
		$1,664	$1,803	$1,585	$1,123	$1,100	$1,031

Figure 4-1: SCADA Expenditure Summary



4.2. Network Control

4.2.1. Introduction

Multinet has implement SCADA control (of varying types) on many of its high, medium and low pressure networks. Sites classified as "SCADA Control" have monitoring equipment in addition to the capability of controlling pressure remotely. Control can be split into "step" control (i.e. predefined pressure set points) or "variable" control (i.e. continuous pressure set points).

Multinet's program within the forecast period focuses on implementing:

- Variable control of the High Pressure Network (Section 4.2.3);
- Step control on Eastern Medium Pressure Network (Section 4.2.4); and
- Step control on Low Pressure Networks (Section 4.2.5).

4.2.2. Business Drivers and Strategic Alignment

Implementing network control is reflected in Multinet Gas' network objectives through:

- **Safety:** The ability to remotely or automatically control networks to minimise safety risk to public and personnel;
- **Customer:** Reliable and safe supply/control of gas to customers during emergency situations or peak demand;
- **Efficiency:** More sensitive and speedy adjustments to pressure settings during peak and off peak demand. Ability to reduce gas emissions from leaks or regulator venting; and
- **Compliance:** Allows for maintaining of minimum network pressures.

4.2.3. Variable control on High Pressure

All of Multinet's high pressure networks are controlled, with 5 networks on solenoid/step control and 13 networks on variable control. These control systems are utilised on gas regulating stations such as city gates, field regulators, and district regulators to automatically regulate the pressure of gas based on seasonal settings, timed settings, fringe pressures, or emergency situations.

Implementing solenoid/step control typically involves the installation of a new panel with a pilot actuator solenoid, check valves, solenoid valves, needle valves, sense lines, and associated pipework. The upgrading of a solenoid control site to a variable control site typically involves the addition of a pilot actuator motor instead of a solenoid. In both cases of control, configuration needs to be carried out between the NCC, a fringe site, and the regulator site responding to the fringe pressure. The actual physical control itself takes place using the valve in the control unit of the pilot.

The upgrading from a solenoid control to a variable control allows a greater level of variability in controlling output pressures of regulators. This is especially useful during peak demand periods as the more efficient degrees of control:

- Reduces the amount of gas lost via venting of domestic regulators not utilising gas at the time;
- Accommodates maintenance works and emergency situations without fear of lag times;
- Reduced the need for site visits to alter pressure settings (pressure changes are done remotely); and
- Reduces the risk of prolonged exposure to high pressure natural gas and the possible consequences associated with it.

Scope

Three networks / regulators are scheduled to incorporate variable control in the forecast period:

(A) 2017 - Vermont network: 3 supply regulators;

(B) 2017 - Lorimer St regulator upgrade; or

(C) 2018 - Keysborough network: Church St, no SCADA supply regulator.

The sites are driven by capacity requirements, winter testing network performance reports, and the requirement for SCADA control on sites with no communications. A layout of the networks is available in Appendix 5.2.1.

(A) Vermont Network

Vermont HP is a solenoid control network. It consists of four supply regulators, namely:

- P3-002A/C Vermont Outstation;
- P4-288 Ringwood Outstation;
- P4-168 Hedge End Rd; and
- PCAD Cadbury (a dedicated supply to Cadbury-Schweppes and a MP network - not a Vermont HP supply).

Vermont Outstation is undergoing an upgrade to improve its capacity and will become a variable control site in order to supply the Knox SCADA Network. As Knox HP is a variably controlled network, Vermont HP is then required to be upgraded from solenoid control to variable control. The other two regulator stations, Hedge End Rd (P4-168) and Ringwood Outstation (P4-288), are also required to be upgraded for variable control. There are two monitor fringes in Vermont HP (Middleborough Rd and Victoria Ct), that are also required to become SCADA control fringes.

(B) Keysborough Network

The regulator P4-152 in Church Rd currently has no SCADA attached to it. It is a standalone network that is continuously growing and as such will require control implemented in 2018. The 2017 winter testing result will determine whether the regulator is to be incorporated in the existing Keysborough SCADA Network, the Dandenong Industrial SCADA Network or as a standalone network. In all cases, variable control is the most effective choice as all the surrounding networks are currently operating under variable control.

(C) Lorimer Street upgrade

It is recommended to upgrade the P4-154 Lorimer St regulator to a SCADA variable controlled regulator in order to fully utilise Lorimer St supply regulator and reduce the load at Howe Parade (P4-285), as the flow at the Howe Parade Custody Transfer Meter (CTM) is exceeding its meter capacity. The Lorimer St regulator is currently underutilised due to the absence of SCADA control. The regulator currently belongs to the South Melbourne SCADA network which is placed on variable control.

Works Program

A summary of the expenditure for this program is listed in Table 4-2. The program was estimated utilising benchmarked historical expenditure.

Table 4-2: High Pressure Variable Control

Program		2017	2018	2019	2020	2021	2022
Variable Network Control – High Pressure	Units	[redacted]	[redacted]	-	-	-	-
	Program Expenditure	$130	$33				

4.2.4. Control on Eastern Medium Pressure Network

There is currently no SCADA control implemented on Medium Pressure (MP) networks. All the networks are monitored but not all regulators have monitoring capabilities (i.e. only a select group of regulating stations provide monitoring capability). The Eastern MP network is Multinet's largest interconnected MP network comprising of [redacted] regulators of which [redacted] are not SCADA monitored. Due to the density of the eastern suburbs and the amount of low pressure being supported off the Eastern MP network, it is not feasible to abandon or upgrade sections to high pressure in the forecast period. As such, it becomes critical to place this network on control as the advantages are equal to those described in the HP program above, with an addition benefit that control on the network will allows us to reduce the volume of gas leaking from ageing assets still in service on this network.

Scope

The scale of this program is such that it is required to be carried out over the course of 5 years with emphasis on those regulators that:

- do not have any form of SCADA infrastructure,
- are already responding to an established fringe point,
- have most impact on bad pressure fringe areas, and
- regulators most likely to be upgraded to high pressure first in the future.

Refer to Appendix 5.3.2 for list of MP regulators and network layout.

Works Program

A summary of program expenditure is shown in Table 4-3. Note that costs allocated for 2017 are not part of this program and belong to a separate MP network. The program was estimated utilising historical expenditure.

Table 4-3: Medium Pressure Step Control

Program		2017	2018	2019	2020	2021	2022
Step Control – Medium Pressure (Not Monitored)	Units	-	[redacted]	[redacted]	-	-	-
	Exp.	-	$324	$324	-	-	-
Step Control – Medium Pressure (Monitored)	Units	[redacted]	-	-	[redacted]	[redacted]	[redacted]
	Exp.	$98	-	-	$244	$244	$195
	Program Expenditure	$98	$324	$324	$244	$244	$195

4.2.5. Control on Low Pressure Areas

Similar to the Eastern MP network, there are certain low pressure sites that are not expected to be abandoned or replaced within the next 5 to 10 years. Due to the almost total interconnectivity of the low pressure network it is essential for there to be some form of control especially in areas where leak volumes are high.

Scope

Of the 140 low pressure regulators on the network, [redacted] sites are expected to be upgraded to step control within the forecast period (to 2022). The sites will be determined annually for the following year through the winter testing program that aims to model the impact and flow of gas as the mains replacement program on the low pressure network continues. A result of the low pressure replacement program is that there will be smaller manageable pockets of network that can be properly assigned control. Sites will be selected in order of:

- Regulators that have most impact on low pressure fringe areas; and
- Regulators most likely to be upgraded to high pressure first in the future.

Works Program

A summary of program expenditure is shown in Table 4-4. The program was estimated utilising historical expenditure benchmarks.

Table 4-4: Low pressure control

Program		2017	2018	2019	2020	2021	2022
Step Control – Low Pressure	Units	-	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
	Program Expenditure	-	$244	$244	$244	$244	$244

4.3. RTU relocation/installation

4.3.1. Introduction

Fringe sites are typically at the boundaries of connected SCADA networks where the gas pressure is at its lowest. New RTUs are installed or existing RTUs are relocated to represent the true fringe of the network. The fringe RTU communicates the current network pressure to the control centre, which is then utilised within controlled networks to alter supply regulator selling pressures to maintain minimum set pressures at the fringes of the network. On monitored networks, the network control centre is responsible for responding to drops in fringe pressure and manually overriding regulator control settings to maintain network pressure.

Fringe point locations are typically determined as a result of winter testing of which the results are captured in network performance reports. Although the network is currently experiencing low growth, population density can fluctuate across the network, causing new fringes to form. Winter testing is a tool to not only determine the new fringe locations, but also determine any augmentation works required to maintain system pressures.

4.3.2. Scope

There are 5 sites to have RTUs installed as fringe sites as determined by the network performance reports (see Table 4-5). These are forecast locations as of 2016 and can be subject to change through the annual winter testing process. Appendix 5.3 has further details regarding fringe locations.

Table 4-5: List of Fringe Locations

Year	Location
2018	[redacted]
2019	[redacted]
2021	[redacted]
2022	[redacted]

4.3.3. Business Drivers and Strategic Alignment

RTU relocations / installations are reflected in Multinet Gas' network objectives through:

- **Customer:** Fringe sites give us a true indication of the lowest pressure point on the network. SCADA control can then effectively and optimally control supply to customers especially during peak demand hours;
- **Efficiency:** Fringe points will allow for the most optimum and cost efficient capital programs to maintain capacity of the network; and
- **Compliance:** Allows for maintaining of minimum network pressures.

4.3.4. Works Program

A summary of program expenditure is shown in Table 4-6. The program was estimated utilising historical expenditure.

Table 4-6: RTU Relocation/installation Expenditure

Program		2017	2018	2019	2020	2021	2022
RTU installation/relocation	Units	-	[redacted]	[redacted]	-	[redacted]	[redacted]
	Program Expenditure	-	$16	$32	-	$16	$16

4.4. Jordan Actuator Control

4.4.1. Introduction

A number of the Field Regulators are currently being controlled using “Jordan Control” Rotary Actuators. These actuators were installed between the 1980s & 2000s and do not have IEC EX or AUS EX Certification. At the time of installation, the Jordan Control Actuators where only ATEX rated (compliant at the time). Current industry standards as stipulated in AS/NZS 60079.10.1:2009 require equipment to be IEC EX rated or AUS EX rated. As a result, these motors are to be targeted for replacement in order to establish hazardous area compliance.

4.4.2. Scope

Several sites on the network are already being upgraded as part of separate capital works projects, and are therefore excluded from the scope of this project. There are a remaining [redacted] sites across the Multinet network that have been identified as having a Jordan Rotary Actuator (Refer to Appendix 5.4.1). In addition to replacing the Jordan Actuator at each site, some of the sites will also require replacement/updating of other components. The scope of works necessary to facilitate this activity is as follows:

- The existing Jordan control actuator will be removed and replaced with an RMG actuator;
- Auxiliary pipework in the field regulators will be updated to meet MG Standards;
- Solenoids that are non-compliant with MG standards will be replaced where applicable;
- Switches that are non-compliant with MG standards will be replaced where applicable;
- Pressure Transmitter that are non-compliant with MG standards will be replaced where applicable;
- Where RMG actuators are fitted, the SCADA Control Board will be replaced with a Motor Control Boards;
- All sites will have RTU Failsafe code updated to the new standardised Failsafe Diagnostic Code;
- All site specific drawings, and stranded drawings will be updated to reflect changes;
- All out of date SAP information will be updated to reflect current conditions; and
- All site specific Hazardous Area Dossier will be updated to reflect changes.

4.4.3. Business Drivers and Strategic Alignment

Jordan actuator replacements are reflected in Multinet Gas’ network objectives through:

- **Safety:** Replacement of non-compliant equipment in hazardous areas/zones; and
- **Compliance:** Complying with hazardous areas/zone regulations.

4.4.4. Works Program

A summary of program expenditure is shown in Table 4-7. The programs was estimated utilising historical expenditure benchmarks and industry experience.

Table 4-7: Jordan Actuator Replacements Expenditure

Program		2017	2018	2019	2020	2021	2022
Jordan Actuator Replacement	Units	[redacted]	-	-	-	-	-
	Program Expenditure	$641	-	-	-	-	-

4.5. Aged Rosemount transmitters

4.5.1. Introduction

The pressure and temperature transmitters (Rosemount 1144 and 1151) will be replaced using a time based replacement program spanning three years (currently in the last financial year of the program). These transducers are no longer supportable via industry supplied spare parts. These transmitters were installed in 1983/4 with a 15 year life expectancy. There are a [redacted] sites remaining ([redacted] transmitters). These exclude sites that have other replacement programs attached to them such as the Jordan Replacement Program above.

4.5.2. Scope

This program will see Rosemont pressure and temperature transmitters replaced with [redacted] transmitters. Refer to Appendix 5.4.2 for a full list of sites with remaining Rosemount pressure and temperature transmitters.

4.5.3. Business Drivers and Strategic Alignment

The transmitter replacements are reflected in Multinet Gas' network objectives through:

- **Safety:** Replacement of non-compliant equipment in hazardous areas/zones; and
- **Compliance:** Complying with hazardous areas/zone regulations.

4.5.4. Works program

A summary of program expenditure is shown in Table 4-8. The programs was estimated utilising historical expenditure benchmarks and industry experience.

Table 4-8: Transmitter replacement expenditure

Program		2017	2018	2019	2020	2021	2022
Pressure Transmitter Replacement	Units	[redacted]	-	-	-	-	-
	Program Expenditure	$354	-	-	-	-	-

4.6. Hazardous non-compliant Sites/substandard Installations Rectification

There are a small number SCADA installations that recent inspections have identified that they contravene the Hazardous Zone Regulations for electrical equipment within a gas/air environment. Remedial work at these sites is required, including relocation of RTU cabinets and antennas. Some of this work is expected to be rectified in programs above (e.g. Jordan actuator replacement and Rosemount transmitter replacement). Unfortunately, due to the lack of granularity of certain assets within the SCADA data management system, it is unclear to what degree sites are non-compliant. As such an allowance is needed for the estimated refurbishment for [redacted] sites which will include the rectification of:

- Auxiliary pipework in the field regulators will be updated to meet MG Standards;
- Solenoids that are non-compliant with MG standards will be replaced where applicable;

- Switches that are non-compliant with MG standards will be replaced where applicable;
- All sites will have RTU Failsafe code updated to the new standardised Failsafe Diagnostic Code;
- All site specific drawings, and stranded drawings will be updated to reflect changes;
- All out of date SAP information will be updated to reflect current conditions; and
- All site specific Hazardous Area Dossier will be updated to reflect changes.

4.6.1. Business Drivers and Strategic Alignment

Site rectification work is reflected in Multinet Gas' network objectives through:

- **Safety:** Replacement of non-compliant equipment in hazardous areas/zones; and
- **Compliance:** Complying with hazardous areas/zone regulations.

4.6.2. Works Program

A summary of program expenditure is shown in Table 4-9. The programs were estimated utilising historical expenditure and industry experience.

Table 4-9: Non-compliant Equipment/sites Rectification

Program		2017	2018	2019	2020	2021	2022
Hazardous zone non-compliant Installation	Units	-	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
Program Expenditure		-	$177	$177	$167	$167	$167

4.7. Kingfisher RTU Replacement

4.7.1. Introduction

The design life of the Kingfisher PLUS+ (Previously Series II) RTU is 10 years.

The Kingfisher PLUS+ modular RTUs are typically comprised of backplanes and various different modules. Many backplanes existing on the Multinet network are exceeding their design life and have been experiencing multiple issues. "CSE Semaphore[2]" have advised that the Kingfisher Series II PC1 modules have also ceased production and minimal support will be provided. The PC1 module happens to be the most extensively used module on the network.

Current RTU logic on the Kingfisher series II platform is constructed using the traditional rule-based RTU/PLC language known as ladder logic. While ladder logic is still widely used today, it has become part of a set of closely related programming languages (defined by the IEC 61131-3 standards) rather than just a single language available to the programmer. By adopting a modern RTU (and modern application software), future MG RTU installations will give programmers the ability to configure RTUs with much improved efficiency while also making the program easier to read and understand. Many RTU functions which currently need to be manually programmed are completely transparent and embedded in the firmware of modern RTUs.

Given the above, there is an increasing need for the replacement of these RTUs with new and modern RTUs and a standardisation of design going into the field. Currently there a number of different modules existing on the network coupled with inaccurate design drawings and non-standard/inaccurate RTU code.

4.7.2. Scope

Multinet has [redacted] RTUs transmitting data for the efficient and safe operation of the network. Of these, 21 are deemed to be complex sites owing to the multiple data points being communicated (e.g. gas temperature, gas pressure, gas

[2]CSE Semaphore: https://www.servelec-group.com/technologies/

heater temperature etc.). These will be targeted first in a program to replace [redacted] RTUs a year which will effectively replace a majority of the Kingfisher RTUs on the network to 2022 (all replaced by 2023). While this program is rolled out, existing Kingfishers will be maintained and supported by other Kingfishers removed from the field. It is prudent to replace all the RTUs with the proposed cheaper and more modern RTU[3] as keeping the ageing and obsolete Kingfishers on the network is no longer a feasible solution.

Appendix 5.5 contains a list of RTU sites categorised by complex and simple sites.

4.7.3. Business Drivers and Strategic Alignment

The Kingfisher RTU replacement program is reflected in Multinet Gas' network objectives through:

- **Safety:** Proactive replacement of RTUs reduces the risk of aging asset failure ensuring that there is a continuous flow of data and communication to the network control centre, allowing operators to detect and react to faults and emergency situations.
- **Efficiency:** Proactive replacement of end of life RTUs will allow for standardised assets reducing the need for maintaining obsolete communication technologies and ensure continuous supply and improved reliability.

4.7.4. Works Program

A summary of program expenditure is shown in Table 4-10. The program was estimated utilising supplier advice.

Table 4-10: Kingfisher Replacement Program

Program		2017	2018	2019	2020	2021	2022
Kingfisher RTU Replacement	Units	-	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
	Program Expenditure	-	$209	$209	$209	$209	$209

4.8. TRIO Radio Replacement and Streamlining

4.8.1. Introduction

A large number of radios on Multinet's SCADA have surpassed their effective service life of 7 years. Within the current access arrangement period (2013-17), the D series radios were proposed to be upgraded to E series radios. While some of the D series radio were replaced, the E series radios have now also become outdated and requires replacement with a newer, more secure, radio. A review of alternative radio technologies is required to determine whether suitable, cheaper and more progressive options are available for replacement of existing Trio radios. There is an opportunity to look at technology such as "Multipath IP radios" that may be a cheaper and more reliable communications option.

Furthermore, the existing communication channels have been a shared service by both United Energy and Multinet Gas and there are many drivers for the separation of communication infrastructure for the two companies in addition to the replacement program. These drivers are:

- Different field hardware (RTU) devices between gas and electricity sites;
- Different polling regimes and data upload requirements;
- Different response time and availability requirements;
- Previously existing radio channel congestion issues;
- Desire to upgrade speed and security requirements for electricity devices;
- Economies of retaining older and slower radio hardware with remaining;

[3] Siemens as a potential RTU supplier

- Lifespan on less critical gas devices; and
- Approaching end of life for the original 900MHz radio system deployed at 101 Collins St.

4.8.2. Scope

Multinet Gas has engaged “37 South” to conduct an analysis on the separation of communication channels as well as the replacement of the relevant hardware at base stations and field sites. After a detailed desktop analysis, it was determined that due to the reduction in loading on existing radio channels, it is possible to segregate the 8 existing radio channels shared by both United Energy and Multinet Gas into 4 channels specific to Multinet Gas and 4 channels specific to United Energy. The 4 channels specific to Multinet Gas can then be consolidated to 4 specific base stations that will provide the optimum range of communication for the Multinet network. These are:

- Eureka Tower;
- Mt Dandenong;
- Arthurs Seat; and
- Lower Plenty.

While the channels remain the same, each field site consolidated to the remaining few base stations will opportunistically have the existing radio replaced with a newer and modern radio. A trial is currently underway to determine the best technology for this application at the recently acquired Eureka Tower base station and its associated field sites, following which the remaining sites corresponding to the remaining base stations will also have their radios replaced. The 2 radio options available are the “Schneider QR-450” and the “4RF SR+” shown below.

Figure 4-2: TRIO Radios

4.8.3. Business Drivers and Strategic Alignment

The TRIO radio replacement and streamlining program is reflected in Multinet Gas’ network objectives through:

- **Safety:** Proactive replacement of radios reduces the risk of aging asset failure ensuring that there is a continuous flow of data and communication to the network control centre, allowing operators to detect and react to faults and emergency situations;
- **Customer:** Clear and continuous visibility of network performance which is crucial in monitoring customer supply;
- **Efficiency:** Reliable communication of network performance will allow for the most optimum and cost efficient capital programs to maintain capacity of the network; and
- **Compliance**: Essential for monitoring network pressures to ensure we meet minimum network pressures.

Replacing the existing radios will ensure Multinet has have the latest technology to respond to fluctuations on the network that may affect customers as well as giving accurate monitoring conditions of the network during maintenance or emergencies.

4.8.4. Works Program

A summary of program expenditure is shown in Table 4-11. The program was estimated utilising external consultant estimation.

Table 4-11: TRIO Radio Replacement and Streamlining Expenditure

Program	2017	2018	2019	2020	2021	2022
TRIO Radio Replacement & Streaming Program	$182	$541	$340	-	-	-
Program Expenditure	$182	$541	$340	-	-	-

4.9. Data-logger implementation

4.9.1. Introduction

Multinet's fleet of Cello data-loggers has reached their end of life. They have already undergone a field life extension program in January 2015 and are currently still operating on the 2G network, with no compatibility for use with 3G networks or 4G networks.

While it is understood that Vodafone is still utilising their 2G network, given the pace at which telecommunications is rapidly evolving, it is expected that Vodafone will eventually cease operating their 2G network similar to Telstra and Optus. It is also expected that manufacturing of monitoring equipment utilising 2G will be rapidly phased out. As such there are 2 potential points of failure for the current fleet of Cello data-loggers: Asset failure and network obsolescence.

Data-loggers serve multiple purposes on the network. Multinet aims to utilise new data-loggers to conduct monitoring activities such as

- Winter Testing of distribution networks;
- Emergency monitoring of network fringes;
- Individual consumer supply reliability issues;
- Monitoring of pressure regulating stations;
- Monitoring of critical aspects of capital works; and
- Telemetry for cathodic protection units.

Multinet has been using digital data-loggers for the above activities since 2007 with the exception of cathodic protection unit monitoring. This represents a new initiative that Multinet intends to undertake to improve efficiency and network safety.

Telemetry on Cathodic Protection Units (CPUs)

All of Multinet's CPUs and test points are measured on a monthly basis across the whole network. While still an effective method, it poses an element of risk as isolated incidents could occur before or after the time of measurement. As such, Multinet would not be aware of any incidents until the subsequent potential reading the following month. Having remote monitoring of cathodic protection units would solve this issue and in addition, contractors would be protected from the very rare occurrence of electrical faults happening in the area at time of reading. This is due to the fact that a majority of the CPUs and test points are within close proximity of power poles. The data recorded would also allow Multinet to view any unusual spikes in D.C traction systems that could potentially affect our network.

4.9.2. Scope

[redacted] is Multinet's preferred data-logger as it is a compact logger with integrated battery, quad band GPRS/GSM or 3G modem, internal and external antenna options, flexible IO, an integrated submersion sensor and is also required to be intrinsically safe, making it ideal for hazardous areas.

Network Pressure Loggers

On average, Multinet has used [redacted] loggers a year for the past 8 years for winter testing purposes. Multinet intends to continually purchase [redacted] loggers a year for the next 6 years (the forecast period) to service network pressure logging requirements and enable the gradual phasing out of the Cello data-loggers. Multinet intends to structure capital expenditure this way so as to adapt to any newer and modern technologies that may arise and also utilise some data-loggers as permanent fixtures at key sites where necessary. The continuous procurement of these loggers per year will also help facilitate any ad-hoc requirements such as monitoring of critical works or emergency monitoring situations.

Cathodic Protection Data Loggers

Telemetry on cathodic protection units will essentially be a long term solution to operating the cathodic protection network. As such a program will be in place to roll out these data-loggers to all the cathodic protection units in the forecast period prioritised based on network criticality starting from transmission sites, moving to high pressure sites and then medium pressure sites.

4.9.3. Business Drivers and Strategic Alignment

The installation data loggers is reflected in Multinet Gas' network objectives through

- **Safety:** Proactive replacement of data-loggers ensure that there is a continuous flow of data and communication to the network control centre or asset management, allowing operators to detect and react to faults and emergency situations.
- **Customer:** Data-loggers allow us to cater to customer needs on an individual level if such situations arise.
- **Efficiency:** Data-loggers at key sites will allow for the most optimum and cost efficient capital programs to maintain capacity of the distribution and cathodic protection network
- **Compliance:** Essential for monitoring network pressures to ensure we meet minimum network pressures.

4.9.4. Works Program

A summary of program expenditure is shown in Table 4-12. The program was estimated utilising manufacturer estimation for the purchase of data-loggers and site installation.

Table 4-12: Data-Logger Implementation Expenditure

Program		2017	2018	2019	2020	2021	2022
Cathodic Protection Data Loggers	Units	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
	Exp	$102	$102	$102	$102	$102	$81
Network Pressure Loggers	Units	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
	Exp	$84	$84	$84	$84	$84	$84
Program Expenditure		$186	$186	$186	$186	$186	$165

4.10. Gas detector installation

4.10.1. Introduction

Electronic gas detectors can reduce the risk from, and improve response to, gas escapes. They represent an early warning device for potentially explosive atmospheres in pressure reducing stations. The focus has been on the installation of these detectors at sites deemed to be in proximity to population or nearby development. This is especially important in urbanised areas where there is slow encroachment on surrounding land where regulating pits are stationed (e.g. Road widenings, footpaths). The installations will provide automated gas detection that will alarm back to the 24x7 control centre upon any significant build-up of gas.

Over the past 3 years Multinet have been installing gas detectors in various pits across the network and this is a continuation of that program.

4.10.2. Scope

The [redacted] Infra Red Point Gas Detectors are the preferred gas detector for use in regulator pits. They are robust units capable of less than 3 second responses under normal operating conditions, range of 0 to 5 Lower Explosive Limit (LEL) and its high sensitivity allows for low alarm set points.

Figure 4-3: Examples of Gas detectors

A total of 16 sites are to have gas detectors installed with priority given to those in highly dense urban areas. Included in the installation of gas detectors is the:

- Installation and termination of cabling at site pit;
- Correct termination of all new equipment;
- Provision of an updated SIOS;
- Liaison with RTS for updated RTU code/Configuration files;
- Liaison with RTS for Screen Display changes & commissioning;
- Loading of software;
- Full commissioning and end to end testing of the RTU and associated equipment;
- Post installation checking of RTU and settings;
- Update Drawings to suit the Multinet Gas Drafting Standards & Templates;
- Update of the site" Hazardous Area Dossier";
- Update of the SAP Equipment details; and
- Site clean-up.

4.10.3. Business Drivers and Strategic Alignment

The installation of Gas Detectors is reflected in Multinet Gas' network objectives through:

- **Safety:** Gas detectors ensure any unsafe condition are detected early whereby network control can then enable operators to respond to these faults and emergencies before the risk impacts personnel and the public.

4.10.4. Works Program

A summary of program expenditure is shown below. The program was estimated utilising historical expenditure resulting in a per site unit cost of [redacted] (Direct).

Table 4-13: Gas Detector Installation Expenditure

Program		2017	2018	2019	2020	2021	2022
Gas Detector Installation	Units	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
	Program Expenditure	$52	$52	$52	$52	$35	$35

4.11. Vortex flowmeter installation

4.11.1. Introduction

Vortex or wafer cone flowmeters are ideal assets for flow monitoring as they require minimal upstream or downstream pipe runs and can be installed virtually anywhere in a piping system. Also ideal for small line sizes and with no moving parts, no replacement parts or scheduled maintenance, the meter offers a low cost of ownership and long life.

Figure 4-4: Vortex Flowmeter

Flow metering is essential in understanding the network for a number of reasons:

- They allow us to understand the consumption of gas at certain injection points on the network which in return allows us to plan works that will mitigate the risk of supply loss due to below standard pressure on the respective networks.
- We can understand the seasonal behaviour of the network and alter network boundaries to utilise gas from other injection points.
- Flow metering also enables us to accurately determine if a regulating station is close to meeting its capacity allowing us to undergo pre-emptive maintenance works before a regulator failure should occur or in emergency situations.
- Lastly, flow metering also allows Multinet Gas Network Planning to calibrate our distribution models so that we can accurately determine the most cost efficient capital expenditure to maintain the network.

4.11.2. Scope

Four sites are planned to have vortex flowmeters installed namely:

- ***2017 – Vermont Outstation:*** requires a flowmeter due to the fact that it has the station services multiple networks on high pressure and medium pressure, making it crucial to understanding the flow at this station during peak demand hours and emergency situations to ensure the optimum capability of the network;
- ***2018 – Lilydale Citygate:*** understanding input into the distribution network will allow Multinet to better calibrate network models for planning future programs;

- ***2019 – Leongatha Citygate:*** requires a flowmeter to differentiate flows coming off the South Gippsland TP network; and
- ***2020 – Korumburra Citygate:*** requires a flowmeter to differentiate flows coming off the South Gippsland TP network.

4.11.3. Business Drivers and Strategic Alignment

The installation of Vortex Flow meters is reflected in Multinet Gas' network objectives through:

- **Customer:** The flowmeters will allow us to understand consumption profiles of certain regions which will allow us to better cater to any abnormal demand periods;
- **Efficiency:** Measurement of flows will allow for better calibrate network models which in turn will allow for the most optimum and cost efficient capital programs to maintain capacity of the network; and
- **Growth:** Flowmeters will allows us to monitor the growth of customers in the newer regions of the network such as South Gippsland regions. This in turn will allows us to plan how to further develop the expanding network.

4.11.4. Works Program

A summary of the project expenditure is shown in Table 4-14.

Expenditure for this program is based on quotations from experienced distributors, AMS Instrumentation and Calibration Specialists[4]. The following is the average cost of procurement and testing of meters, as Multinet does not have any historical costs with which to benchmark.

Table 4-14: Vortex flowmeter expenditure

Program		2017	2018	2019	2020	2021	2022
Vortex Flow Meter Installation	Units	1	1	1	1	-	-
	Program Expenditure	$22	$22	$22	$22	-	-

[4] http://www.ams-ic.com.au/

5. Appendix

5.1. Glossary & Definitions

Term	Meaning
AER	Australian Energy Regulator
AUS EX	Australian Program for the Certification of Equipment for Explosive Atmospheres
AS/NZ	Australian/New Zealand Standards
CP	Cathodic Protection
CPU	Cathodic Protection Units
ESV	Energy Safe Victoria
Gas Meter	Mechanical device (usually) used to measure the volumetric flow rate of gas that passes the device. The volume of energy that passes through the meter is dependent on both gas pressure and temperature when the volume is measured
GFC	Gas and Fuel Corporation
GPC	Group Pressure Control
GPRS	General Packet Radio Services
GSM	Global System for Mobile Communications
HP	High Pressure (Pressure Range: 140 to 515 kPa)
HP2	High Pressure 2 (Pressure Range: 600 to 1050 kPa)
IEC EX	International Electrotechnical Commission System for certification to Standards Relating to Equipment for Use in Explosive Atmospheres
I&C	Industrial and Commercial connections
IO	Input output
LP	Low Pressure (Pressure Range: Up to 7 kPa)
MG	Multinet Gas
MP	Medium Pressure (Pressure Range: 35 to 210 kPa)
NCC	Network Control Centre
OEM	Original Equipment Manufacturer
RF	Radio Frequency
RTU	Remote Terminal Units

Term	Meaning
SAP	Systems Applications and Products is an Enterprise Resource Planning tool which used at Multinet Gas for recording asset data and maintenance management.
SCADA	Supervisory Control And Data Acquisition
SIOS	SCADA Input Output Schematic
SMS	Safety Management Study
TP	Transmission Pressure (Pressure Range: Above 1050 kPa)

5.2. Network Control

5.2.1. HP Variable control

Figure 5-1: Vermont Network H42

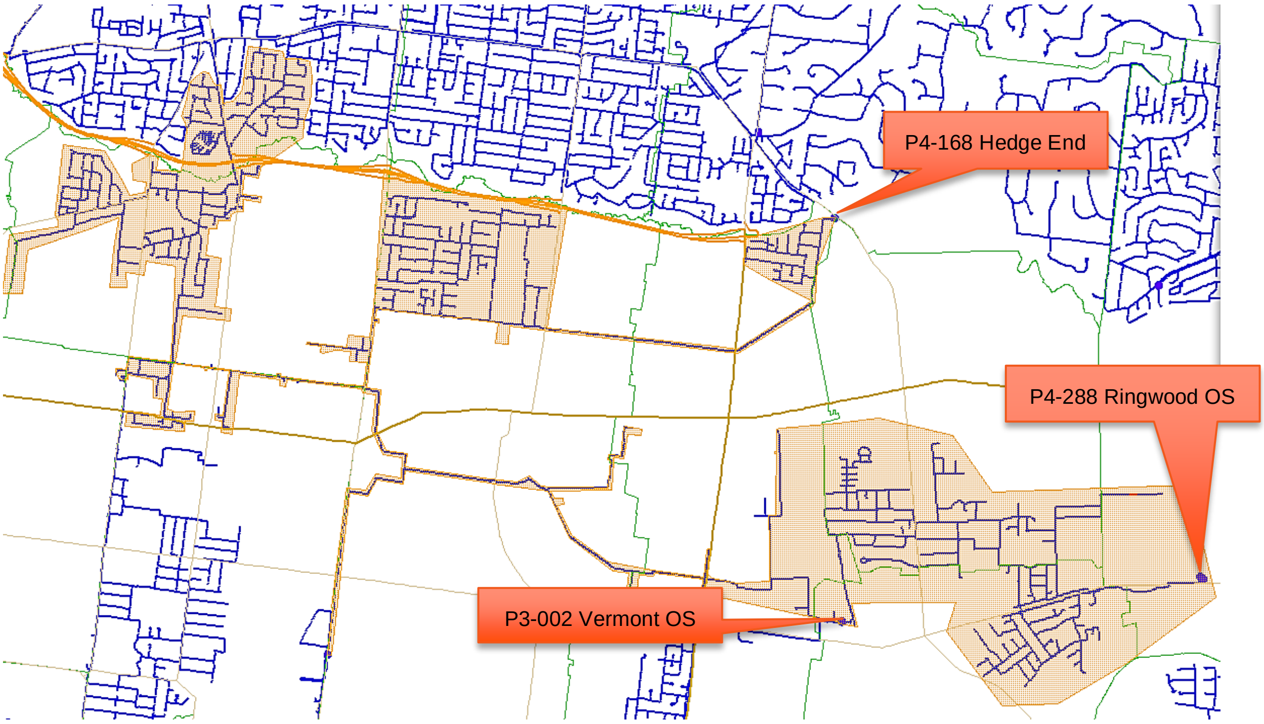


Figure 5-2: Keysborough network H66

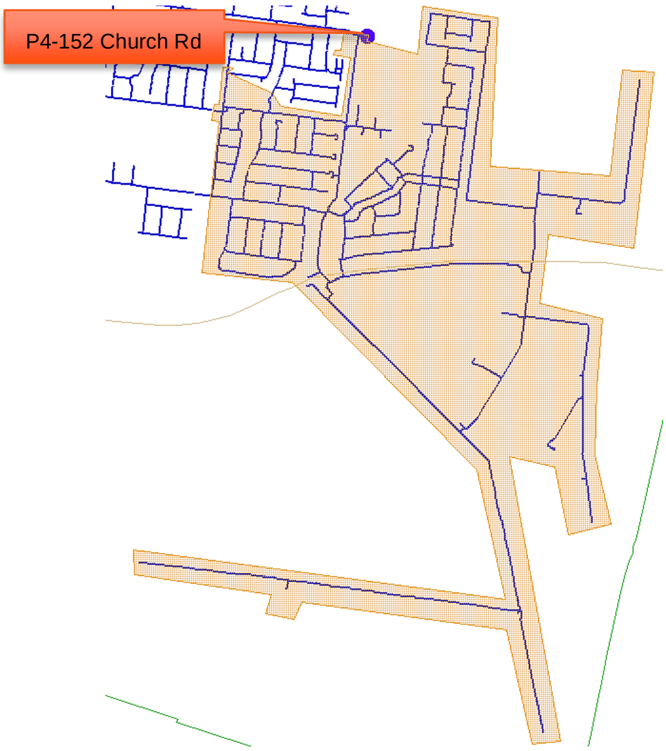
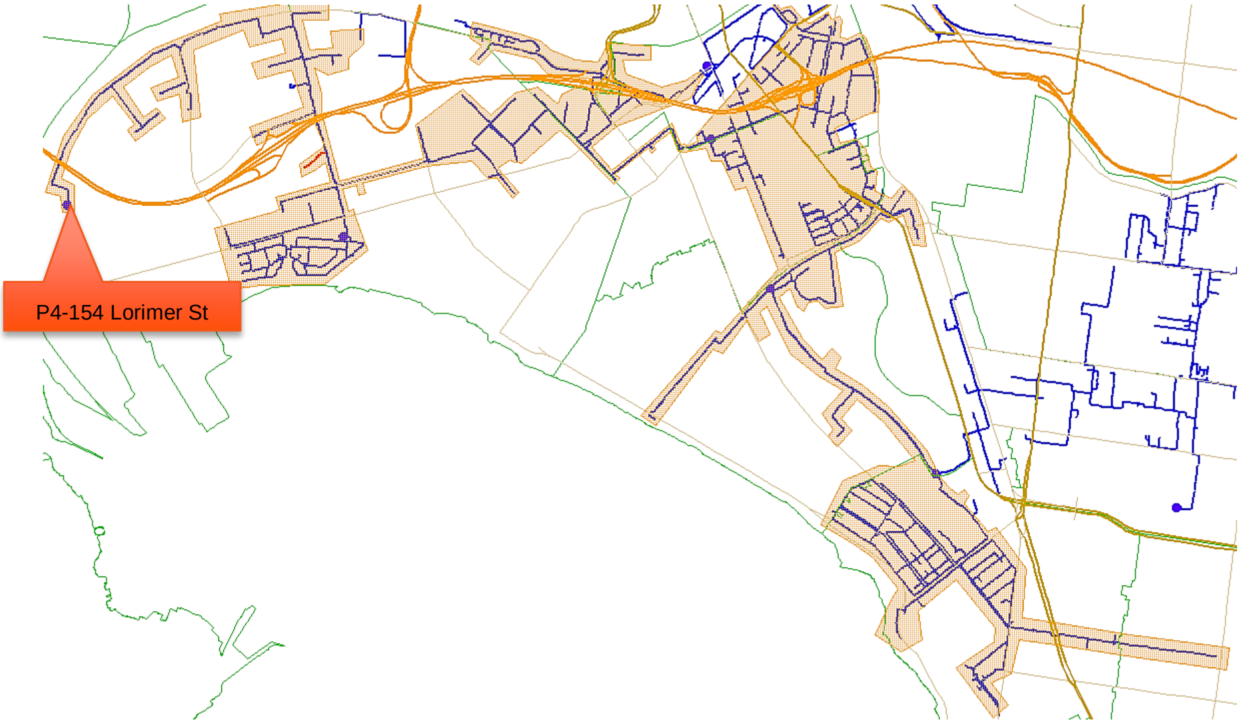


Figure 5-3: South Melbourne H07 Lorimer St Regulator Upgrade



5.2.2. MP Step Control

Figure 5-4: Eastern MP M43 network step control

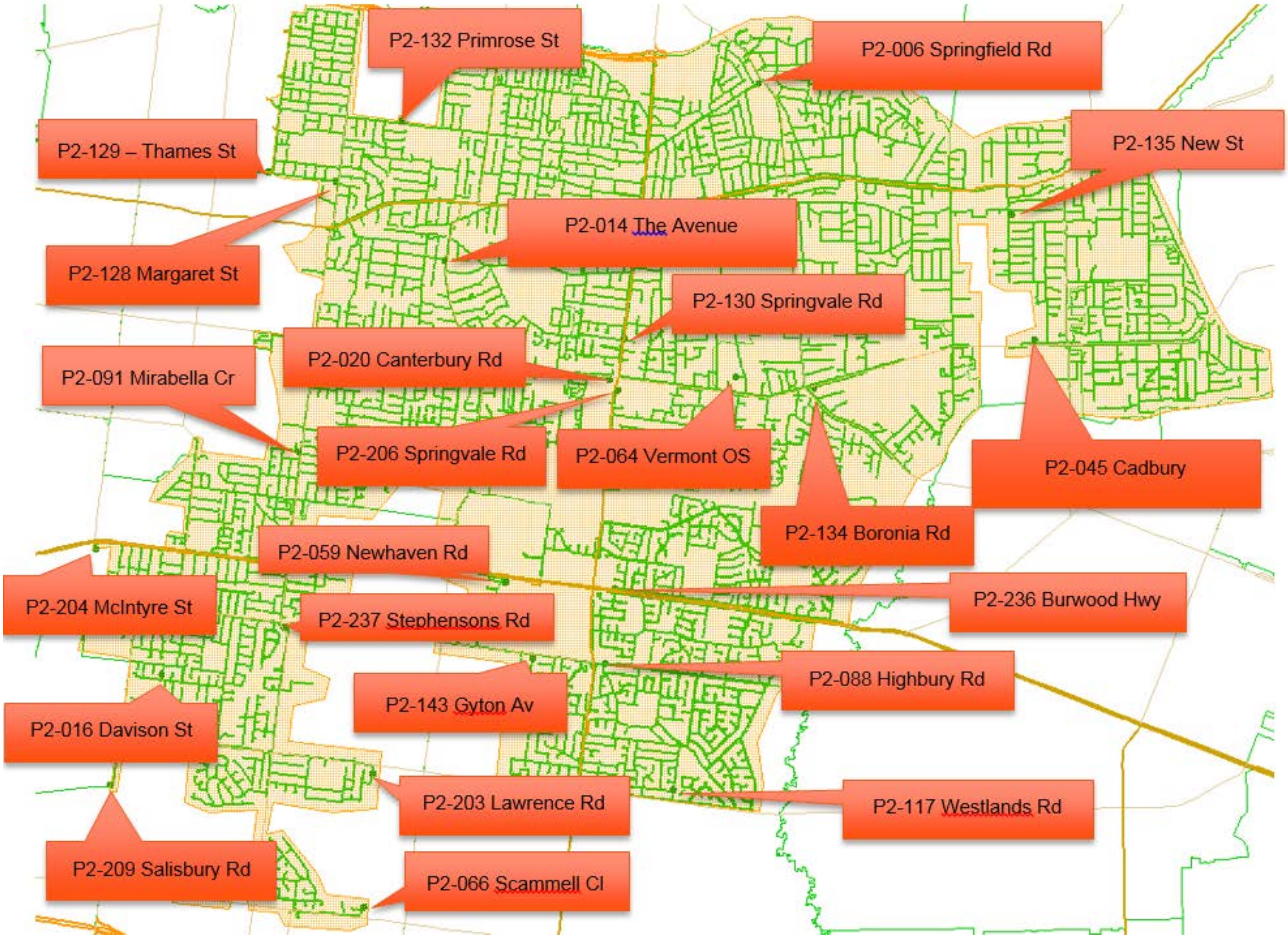


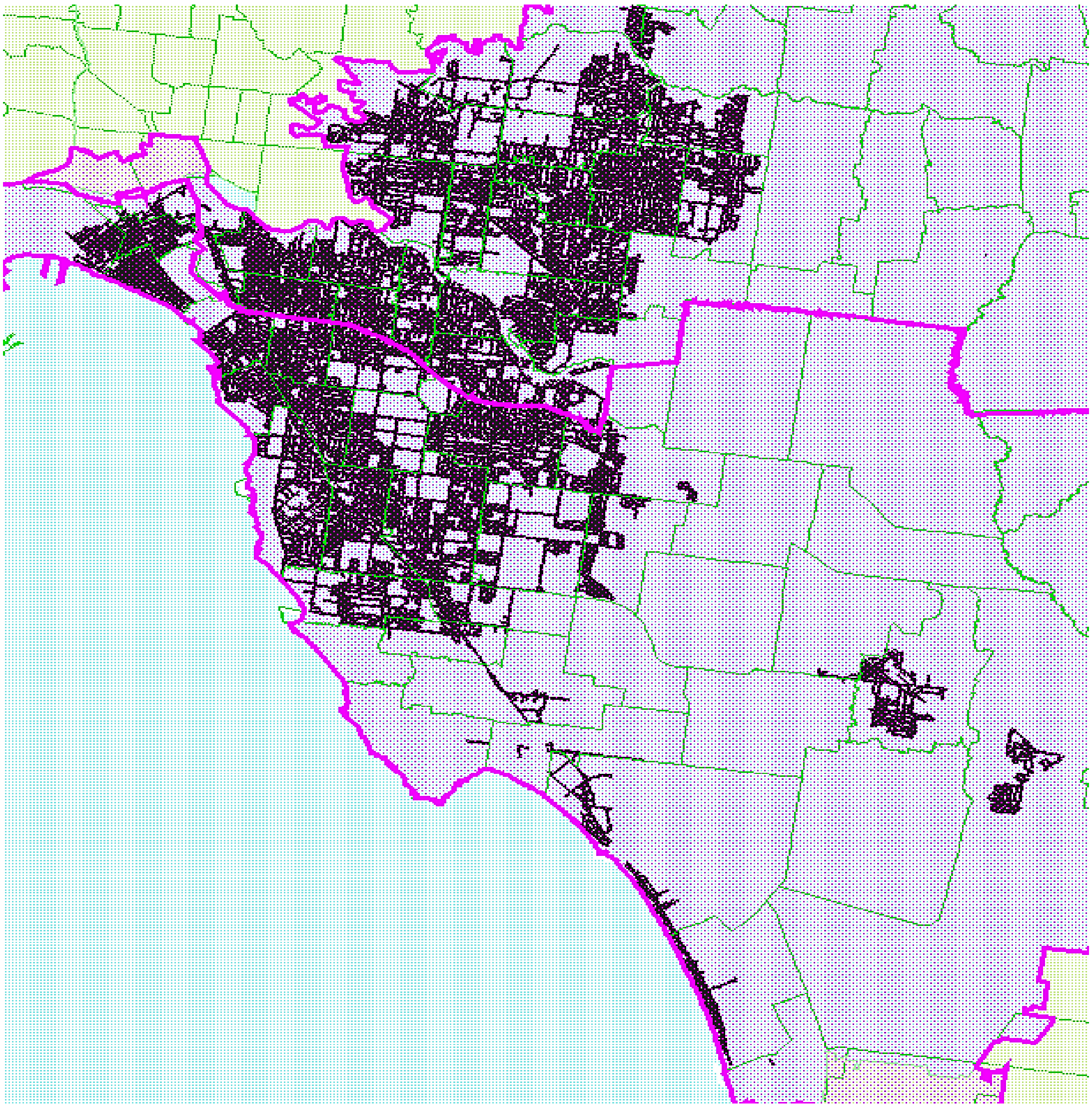
Table 5-1: List of MP Step Control Sites

Year	2018	2019	2020	2021	2022
No SCADA	P2-014 The Avenue	P2-117 Westlands Rd			
	P2-016 Davison St	P2-132 Primrose St			
	P2-020 Canterbury Rd	P2-143 Gyton Ave			
	P2-066 Scammell Cl	P2-203 Lawrence Rd			
	P2-091 Mirabella Cr	P2-206 Springvale Rd			
SCADA monitored			P2-059 Newhaven St	P2-209 Salisbury & Huntingdale	P2-129 Thames St
			P2-006 Springfield Rd	P2-204 McIntyre St	P2-130 Springvale Rd
			P2-236 Burwood Hwy	P2-045 Cadbury	P2-134 Boronia Rd
			P2-237 Stephensons Rd	P2-064 Vermont Centre	P2-135 New St
			P2-088 Highbury Rd	P2-128 Margaret St	

5.2.3. LP Network

The diagram below shows the interconnectivity of the LP network. Due to its size control will be implemented based on annual winter testing analysis and the eventual segregation of the network into manageable pockets.

Figure 5-5: Low Pressure Network

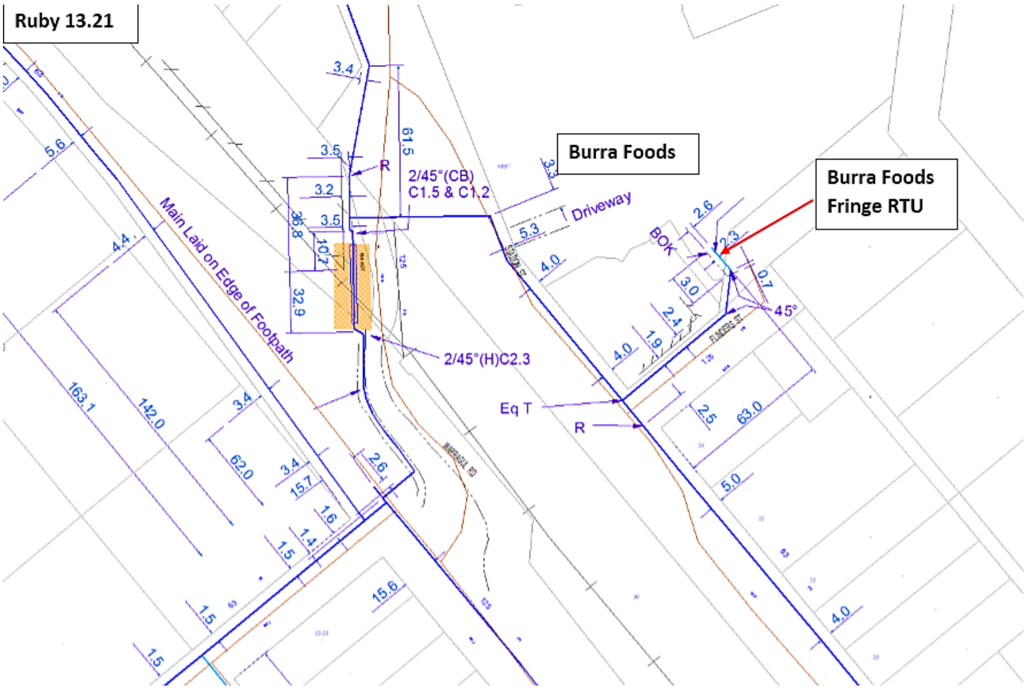


5.3. Fringe relocation/installation

The following sites are to have new fringes installed, or relocated from existing fringes. They may be subject to change following further winter testing for the following year.

2018

Figure 5-6: Burra Foods. Korumburra Fringe detail



2019

Figure 5-7: Inverness Ave, The Basin Fringe detail

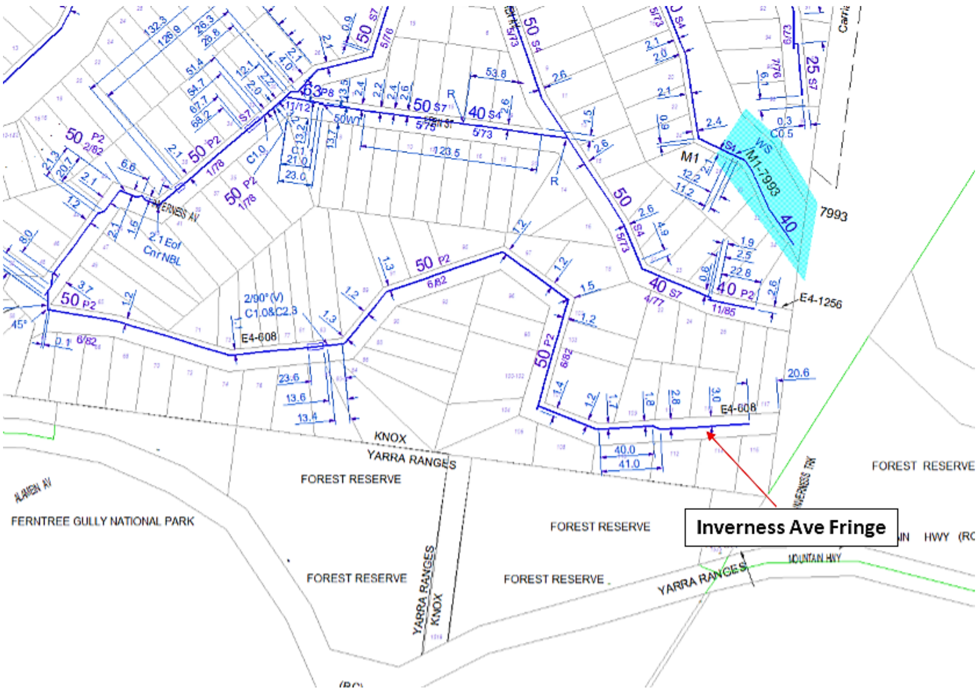
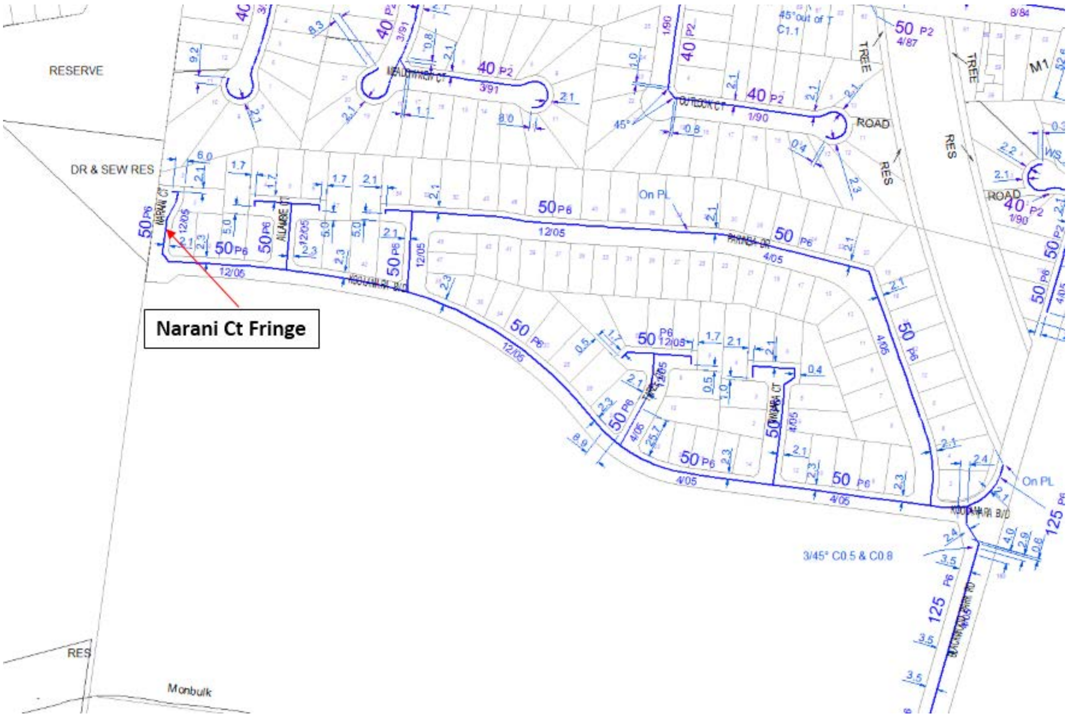
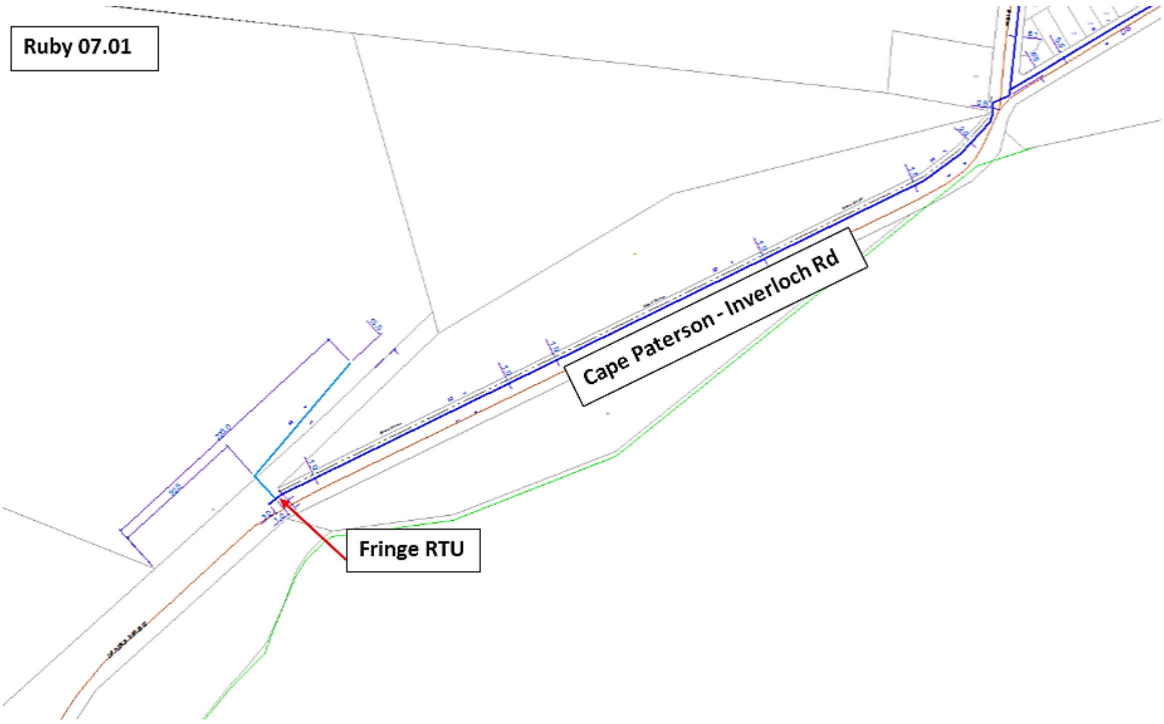


Figure 5-8: Narani Ct, Ferntree Gully Fringe detail



2021

Figure 5-9: Inverloch Fringe detail



2022

Figure 5-10: Donna Buang Rd, Warburton Fringe detail

5.4. Aged, obsolete and non-compliant equipment/sites

5.4.1. Jordan Actuator sites

Table 5-2: Jordan Actuator Sites

Regulator Number	Description	RTU Number
P4-255	Princes Hwy	D9-066
P4-058	Ferntree Gully Rd	D9-026
P4-008	Webb Ave	D9-082
P4-086	Mc Naughtons Rd	D9-056
P4-007	Dandenong DTS	D9-020
P4-092	Edithvale Rd	D9-022
P3-005	Russell St (Springvale)	D9-072
P4-059	Police Rd	D9-065
P3-006	Howard Rd	D9-042
P4-078	Hallam Valley Rd	D9-035
P4-141	Heatherton Rd	D9-037
P4-060	Wellington & Stud Rds	D9-083
P4-250	Blaxland Dve	D9-008
P4-024	Cecil & Market St	D9-012
P4-276	Albert Rd	D9-002
P4-023	Ross Gregory Dve	D9-070
P4-171	Springvale & Cheltenham	D9-074
P4-178	Chandler Rd	D9-014
P4-182	Glenfern Rd	D9-033
P4-161	White St	D9-084
P4-285	Howe Pd	D9-043
P4-256	Azalea Ct	D9-005
P4-044	Fitzsimmons Lane South	D9-027
P4-080	Blackburn Rd	D9-007
P4-046	McGowans Rd	D9-054
P4-048	Loughnan Rd	D9-052
P4-119	Wonga Rd	D9-085
P4-120	Lincoln Rd	D9-050
P4-121	Maroondah Hwy	D9-053
P4-053	Boronia Rd	D9-009
P4-067	High Street Rd	D9-040
P4-234	Reynolds Rd	D9-069

5.4.2. Rosemount sites

Table 5-3: Rosemount Sites

Site number	Description	Rosemount	Volume
D9-076	Sth Melb Outstation - Primary Regs	1151	2
		1144	1
D9-045	Hutton St	1144	1
D9-060	New St and Head St	1144	1
D9-025	Ewart St (700 kPa)	1144	2
D9-004	Aughtie Drive	1151	1
D9-003	Atkinson St	1144	1
		1151	1
D9-041	Highett Depot - Primary Regs	1144	4
D9-068	Regent St	1144	1
D9-080	Vermont Outstation	1144	1
D9-078	Tooronga Outstation	1144	1
D9-046	Jacana St fringe	1151	1
D9-024	Ester Cl fringe	1151	1
D9-036	Harold Rd fringe	1151	1
D9-044	Hunter Rd	1144	1
D9-001	Airds Rd	1151	2
D9-017	Clarendon St	1144	1
D9-031	Gembrook City Gate	1144	2
D9-049	Lilian St	1151	2
D9-048	Kilby Rd	1151	1
D9-064	Plummer St	1151	1
D9-038	Hedge End Rd	1151	1
D9-021	East Boundary Rd	1151	1
D9-075	St Ninians Crt	1151	1
D9-057	Middleborough Rd	1151	1
D9-271	Joy Avenue	1151	1
D9-274	Sir William Fry Reserve	1144	4
D9-275	Nepean Hwy & Highett Rd D/R	1144	4
		Total	**43**

5.5. Kingfisher RTUs

Table 5-4: List of Kingfisher RTU sites by complex and simple

Complex		Simple	
D9-043	Howe Pd	D9-076	Sth Melb Outstation - Primary Regs
D9-020	Dandenong Terminal Station	D9-005	Azalea Ct
D9-025	Ewart St (700 Kpa)	D9-018	Clynden Av
D9-004	Aughtie Drive	D9-027	Fitzsimmons Lane South
D9-041	Highett Depot - Primary Regs	D9-007	Blackburn Rd
D9-014	Chandler Rd	D9-054	Mc Gowans Rd
D9-031	Gembrook City Gate	D9-052	Loughnan Rd
D9-255	Yarra Glen City Gate	D9-085	Wonga Rd
D9-254	Seville East City Gate	D9-050	Lincoln Rd
D9-259	Lang Lang City Gate	D9-053	Maroondah Hwy
D9-264	Korrumburra City Gate	D9-009	Boronia Rd
D9-267	Lang Lang CTM	D9-026	Ferntree Gully Rd
D9-288	Leongatha City Gate	D9-040	High Street Rd
D9-066	Princes Hwy	D9-032	George and Stud
D9-051	Lorimer St	D9-082	Webb Ave
D9-068	Regent St	D9-056	Mc Naughtons Rd
D9-243	BOC CTM M006	D9-022	Edithvale Rd
D9-244	Templestowe CTM RTU	D9-072	Russell St (springvale)
D9-262	Henty Street CTM RTU	D9-065	Police Rd
D9-263	Murrumbeena CTM RTU	D9-045	Hutton St
D9-280	Lilydale City Gate RTU	D9-016	Cheltenham & Corrigan Rds
		D9-042	Howard Rd
		D9-035	Hallam Valley Rd
		D9-037	Heatherton Rd
		D9-083	Wellington & Stud Rds
		D9-008	Blaxland Dve
		D9-063	Pettys Lane
		D9-060	New St and Head St
		D9-059	New St & Bent Ave
		D9-073	Sackville St
		D9-003	Atkinson St
		D9-080	Vermont Outstation
		D9-078	Tooronga Outstation
		D9-028	Floods Rd fringe
		D9-046	Jacana St fringe
		D9-024	Ester Cl fringe
		D9-036	Harold Rd fringe
		D9-013	Century Drive

Complex		Simple	
		D9-030	Garfield Ct fringe
		D9-011	Carlton Rd
		D9-077	Tammany Dve Fringe
		D9-044	Hunter Rd
		D9-001	Airds Rd
		D9-039	Helmich Crt
		D9-012	Cecil & Market St
		D9-017	Clarendon St
		D9-002	Albert Rd
		D9-070	Ross Gregory Dve
		D9-074	Springvale & Cheltenham Rds
		D9-033	Glenfern Rd
		D9-058	Mooroolbark Rd
		D9-069	Reynolds Rd
		D9-049	Lilian St
		D9-048	Kilby Rd
		D9-087	Swan St
		D9-064	Plummer St
		D9-084	White St
		D9-038	Hedge End Rd
		D9-055	Mcilrick St
		D9-021	East Boundary Rd
		D9-061	Burwood /Newhaven Rd
		D9-071	Rowland St
		D9-081	Wannan and Wickham
		D9-075	St Ninians Crt
		D9-057	Middleborough Rd
		D9-023	Elgar Rd
		D9-088	Kinrade St District Regulator RTU
		D9-089	Dandenong & Darling District Reg RTU
		D9-090	Charman & Balcombe District Reg RTU
		D9-091	Stanley St District Regulator RTU
		D9-092	Brindisi St District Regulator RTU
		D9-094	Adrian Ave.
		D9-095	Albion Rd. & Dunlop St.
		D9-096	Arlington St.
		D9-097	Ashburn Gr. & Alamein Rd
		D9-101	Balwyn & Whitehorse Roads
		D9-102	Balwyn Rd. & G. Barnard Reserve
		D9-103	Balwyn Rd. & Stroma Av.
		D9-105	Beauford St.

Complex		Simple	
		D9-107	Benwerrin Drive
		D9-109	Birkby St.
		D9-112	Boondara & Belmore Rds.
		D9-113	Bowen Crescent
		D9-115	Broughton Rd.
		D9-116	Bulleen Road
		D9-119	Caravan Street
		D9-121	Chadstone Rd.
		D9-123	Combarton St.
		D9-125	Cromwell Rd.
		D9-129	Dorking Road
		D9-130	Downing St.
		D9-134	Gardenia Road
		D9-138	Gordon St. & Balwyn Rd.
		D9-139	Graham St.
		D9-140	Greville Street
		D9-144	High & Ayr Streets
		D9-147	Hurstmon Street
		D9-150	Kerferd Street
		D9-153	Kooyong & Dandenong Rds.
		D9-154	Kooyong & Glen Eira Roads
		D9-158	Leonard Street
		D9-161	Lyndoch Av & Orrong Rd.
		D9-163	Malmsbury St
		D9-165	Maylands Avenue
		D9-168	Millicent Avenue
		D9-170	Morton Street
		D9-172	Myrniong Street
		D9-179	Orrong & Toorak Rds.
		D9-180	Osborne Street
		D9-185	Patterson & Fraser St.
		D9-186	Pilita Street
		D9-192	Ripley Grove
		D9-193	Ronald Street
		D9-196	Rostrevor Pde.
		D9-199	Shierlaw Ave.
		D9-201	Spencer & Prospecthill Rd.
		D9-204	Stevensons Road
		D9-205	Summerhill & Ashburton Rd.
		D9-206	Summerhill & Toorak Rds.
		D9-209	The Boulevard

Complex		Simple	
		D9-210	Thompsons Road
		D9-211	Timber Ridge & Marilyn St.
		D9-214	Turner Street
		D9-219	Wellington Street
		D9-223	William & Gourlay Sts.
		D9-225	Willsmere Rd.
		D9-226	Wimmera Street
		D9-228	Wood Street
		D9-230	Yarbat Avenue
		D9-093	Acland St. & The Esplanade
		D9-098	Bagley & New Street
		D9-100	Bakers Rd.
		D9-106	Begg St.
		D9-108	Bignell & Centre Rds.
		D9-110	Bluff & Balcombe Roads
		D9-111	Bluff & Teddington Rd.
		D9-114	Brighton Rd & Carlisle St.
		D9-118	Burrindi Road
		D9-122	Chesterville Rd.
		D9-124	Corrigan & Heatherton Rds.
		D9-126	Dalgetty Road
		D9-128	Dendy St.
		D9-131	Druitt St.
		D9-133	Elizabeth Street
		D9-141	Haydens Road
		D9-143	Heslop Street
		D9-149	James Street
		D9-151	Kirkham Rd/ Dawn Av.
		D9-152	Kirkham Road
		D9-157	Leila & Koornang Rds.
		D9-160	Linacre Road
		D9-166	Mcswain Street
		D9-167	Mena Avenue
		D9-169	Morey Road
		D9-171	Murrumbeena Cres.
		D9-173	Nepean Hw. & Glenhuntly Rd
		D9-174	Nepean Hw. & Park Road
		D9-175	New St. & Cramer Walk
		D9-176	North & Aisling Rds.
		D9-177	North & Kooyong Rds.
		D9-178	Oak Avenue

Complex		Simple	
		D9-181	Park Street
		D9-182	Parkmore & Gardiners Rds.
		D9-183	Parnell St.
		D9-184	Paschal St.
		D9-187	Plantation Ave.
		D9-188	Poath Rd.
		D9-190	Regent & Osborne Sts.
		D9-191	Richard Street
		D9-195	Roseberry Grove
		D9-198	Scarlet Street
		D9-200	Simon Avenue
		D9-202	Springvale Outstations
		D9-207	Sussex Road
		D9-208	Teddington Road
		D9-213	Tucker & Mc Kinnon Rds.
		D9-216	Vickery & Centre Road
		D9-217	Washington Drive
		D9-220	Wheatley Road
		D9-221	White Street
		D9-224	William St.
		D9-227	Windsor Avenue
		D9-231	Yarraman Road
		D9-242	Stkilda & Bent Streets
		D9-248	North Avenue
		D9-249	Springfield Road
		D9-235	Leisha Crt Fringe
		D9-237	Luisa St Fringe
		D9-233	Malcolm Rd Fringe
		D9-236	Karen St
		D9-234	Yering Fringe
		D9-241	Campbell St Fringe
		D9-238	McKinley Ave Monitor
		D9-239	Plummer/Balcolmbe Monitor
		D9-246	Burwood/Springvale Rd Monitor
		D9-247	Victoria Cres Monitor
		D9-253	McIntyre Rd Monitor
		D9-252	Grantley St Monitor
		D9-251	Stephensons Rd Rd Monitor
		D9-256	Ringwood City Gate
		D9-258	Springvale & Wickham Monitor
		D9-261	East Boundary Road MP

Complex		Simple	
		D9-260	New Street MP
		D9-265	Wonthaggi City Gate
		D9-268	Thomas & McKinnon MP
		D9-269	Salisbury & Huntingdale
		D9-270	Margaret Street MP
		D9-271	Joy Avenue
		D9-272	Yarra Glen Fringe - Japponica
		D9-273	Margaret Court Fringe
		D9-279	Canterbury & Boronia
		D9-283	Hammond Road
		D9-281	Huntingdale Road Nth
		D9-282	Huntingdale Road Sth
		D9-291	York Road RTU
		D9-289	Leongatha Fringe (Rifle Range Road)
		D9-290	Magnolia Street Fringe
		D9-284	Anne Court Fringe
		D9-285	Wisteria Lane Fringe
		D9-286	Highview Road Fringe

5.6. TRIO radio replacements and streamlining

The following table details the program going forward with regards to field device radio replacement and migration. Trials are currently underway to implement Eureka tower as a base station with newer radio models. In 2018, consolidation of radio channels to one channel at one repeater station will take place along with replacement of the existing radios. In 2019, consolidation of radio channels to one channel at two repeater stations will take place along with replacement of the existing radios. Overall, only the Ferny Creek and 101 Collins St base stations will be decommissioned and their field devices consolidated to existing stations or 3G/GPRS.

Table 5-5: Program of Field Device Radio Migration and Replacement

Year	**2017**	**2018**			**2019**				
To / *From*	Eureka	MTD D	MTD E	3G	Arthurs D	Arthurs E	Ferny Creek	Lower Plenty	101 Collins
Eureka	15								
MTD D		56							
MTD E		12							
Arthurs D					22				
Arthurs E									
Ferny Creek	2	22		4					
lower Plenty								25	
101 Collins	23								
Total devices	**40**	**90**		**4**	**22**			**25**	

5.7. List of Tables

5.8. List of Figures