COLLABORATIVE EXPERIENCES IN EFFECTIVE WATER NETWORK IMPROVEMENTS

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ABSTRACT

The expectations of water utilities to provide consistently high and resilient levels of service to customers and transparency to both internal and external stakeholders are increasing.

As water and wastewater provider to more than 1.4 million rural and metropolitan residents within Auckland (New Zealand's largest city), Watercare's mission is to provide reliable, safe and efficient water and wastewater services, and our vision is to be trusted by our communities for exception performance every day.

This paper provides a summary of two recent Watercare water network projects, and demonstrates successful outcomes through a collaborative working relationship between operations and planning staff. Issue identification by operations staff, followed by comprehensive and collaborative investigation and modelling of scenarios covering service levels, operational performance and resilience can inform a plan of works that will achieve a successful outcome, with minimal impact to customers.

Case study 1 covers the commissioning of a new 900L/s bulk water booster pump station which, through increased pipeline velocity, had the potential to cause discoloured water to over 60,000 people and highlighted a significant network resilience issue through reliance on a single bulk pipeline. The subsequent re-zoning of a range of distribution networks in the nearby Lincoln and Swanson water supply zones (WSZs) supplying 20,000 customers was achieved using existing underutilised pipelines, allowing the future creation of additional zones, which could reduce pressure and provide more efficient and resilient network management.

Case study 2 covers supply security improvements to the Albany area which supplies 30,000 people and a major commercial area. When a burst occurred in 2015, an unknown bulk cross-connection made the supply problematic to isolate and required a CCTV inspection to identify the location. Subsequent modelling supported the successful installation of multiple pressure reducing valves (PRVs), valves and network strengthening so each supply can now be separately isolated without impacting customers.

Today's industry professionals have access to increasingly capable and highly mobile tools and analytic capability and the adoption of these tools can provide powerful real-time insight and collaboration opportunities. Watercare is actively developing a consolidated approach to capturing, transforming, storing, reviewing, and utilising data to provide benefits to our staff and regional partners - particularly as it relates to planning the creation of new assets to meet Auckland's growth.

Case study 3 outlines the identification of excessive and variable water pressures in the Takapuna and Northcote WSZs. Models were used to support the installation of seven PRVs and resulted in a reduction in breaks and disruption which could have affected up to 50,000 people.

This case study also demonstrates how enhanced digital technology can make it easier and more accurate to identify, analyse and quantify issues in the network, assist with more informed decisions, and make it easier to communicate impacts to internal teams and external stakeholders. As Watercare navigates the nexus of people, process, and developing technology, we will also gain better insight

into system performance, changes and the influencing factors relating to demand profiles. This will allow us to develop more targeted non-revenue water reduction and network efficiency programmes.

KEYWORDS

water network, modelling, level of service, resilience, operations, planning, customers, collaboration

PRESENTER PROFILE

Mike is a Senior Water Network Planner and Hydraulic modeller with over 14 years' experience in various roles and companies in New Zealand and the UK.

Zoran is a Senior Operations Engineer who has worked on projects to improve customer service levels in Auckland for over 20 years, including setting up many district metered areas and pressure management zones.

Brendon is currently Principal Planner - Water Networks, and also assists as a Strategic Business Adviser to the Digital Development team. Brendon has more than 20 years' experience in water networks and engineering in the Auckland region.

1 INTRODUCTION

1.1 BACKGROUND

Maintaining expected levels of service to customers is the role of a well-managed water utility, and responding to faults and customer complaints is what operations staff in these utilities do well. However, maintaining consistently high levels of network performance takes more than thorough operational monitoring. Working with planners to model scenarios for operational changes or network reconfiguration can provide valuable insights into how the system will react and inform a plan of works that can achieve a successful outcome with minimal impact to customers.

As water and wastewater provider to more than 1.4 million rural and metropolitan residents within Auckland (New Zealand's largest city), Watercare's mission is to provide reliable, safe and efficient water and wastewater services, and our vision is to be trusted by our communities for exception performance every day.

An important focus of Watercare's approach is to create efficiency and business value through an ongoing and collaborative working relationship between operations and planning staff. This approach requires proactive collaboration, and a mature appreciation of the nexus of people, process, and developing technology.

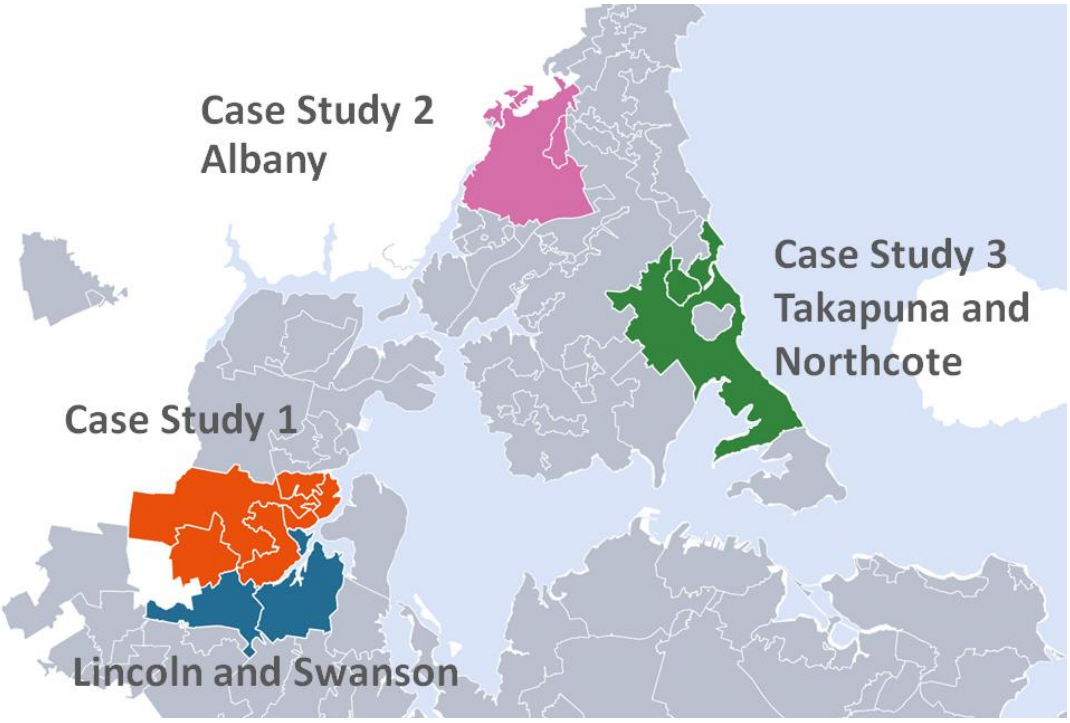

Figure 1 – Case Study Locations

1.2 OUTCOMES AND MEASURES OF SUCCESS

Watercare is a minimum-cost service provider, so defining the intended outcomes of any operational and project objective must include current and future economic and funding environments.

For the purpose of the featured projects, outcomes were generally defined as:

- Maintaining customer trust / public reputation
- Improved network resilience to growth areas
- Reduced disruption (levels of service improved / maintained)
- Demonstrable value in capital spend
- Improved stakeholder transparency
- Support for communities and business
- Improved operational efficiency

The three featured case studies provided distinct successes as outlined in Table 1 below.

Table 1 – Summary of Case Study Success Measures

Case study	Measures of success
1. Triangle Road Pump Station (PS) Commissioning	• Provide water supply zone (WSZ) backup; reduce dependency on single bulk pipeline • Fully utilize adjacent WSZ reservoir capacity and pipelines • Mitigate water quality issues / complaints during a managed commissioning of the PS • Avoid negative effects including media coverage and customer business disruption • Proactively manage customer expectations
2. Albany WSZ Resilience	• Provide supply security to a large zone and significant commercial centre • Avoid future liability issues from supply disruption • Provide WSZ redundancy
3. Takapuna / Northcote WSZ Resilience and Pressure Management	• Reduce network faults and ongoing cost of repair • Improve levels of service by reducing pressure fluctuations and reduce disruptions • Reduce levels of leakage / NRW • Reduce demand through pressure management

1.3 METHOD

The issues outlined in this study were identified by operations staff, who performed analysis work to develop initial integration / network upgrade options based on their knowledge of the network and local areas to help develop practical solutions.

Option scenarios were presented to Planning staff who worked in conjunction with the operations, using network hydraulic models to develop the optimal solutions that could be implemented without impact to customers. For each of the solutions, the planning team was able to predict how the network would operate with the proposed changes, provided insight into works required to a maintain levels of service, including identifying areas of flow reversal or velocity increase that could lead to discoloration.

This analysis then facilitated impact assessments of the planned solutions using corporate network and customer data, and considering ongoing operational reconfiguration, to enable stakeholder management planning.

The modelling allowed us to determine the required capacity of new assets such as pipelines and PRVs, while enabling predicted growth in the zones.

2 CASE STUDY 1 – TRIANGLE ROAD PS COMMISSIONING

2.1 ISSUE IDENTIFICATION

The North Harbour No. 1 bulk watermain (NH1) has reached capacity during summer months and needed to be strengthened to maintain the supply and water pressure as the northern North Shore and Rodney areas grow.

The Triangle Rd Booster PS was built on the NH1 to boost pressure and flows to provide for the next decade of growth, at which time a duplicate North Harbour No.2 (NH2) water main and proposed additional storage will be in operation.

However, staff were aware that commissioning the PS would increase velocity in the NH1, which had a high risk of supplying discoloured water to over 60,000 people, primarily within two large zones supplied directly from the watermain – Lincoln and Swanson.

There are also large, underutilized pipelines in the adjacent Massey Zone with low demand and poor turnover which have historically caused water quality problems.

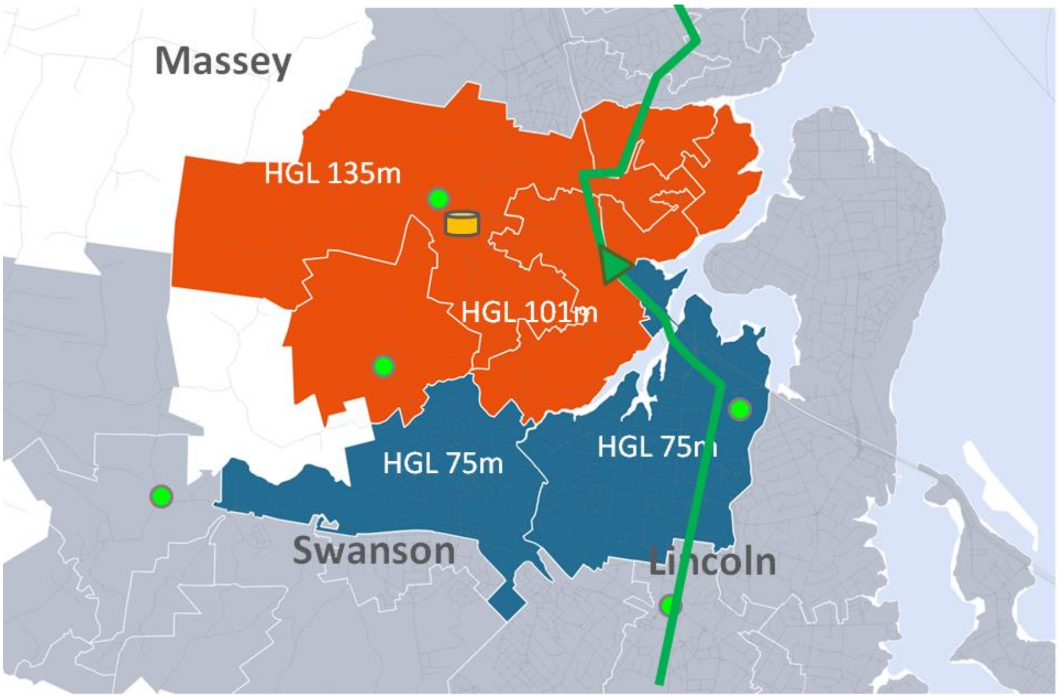

Figure 2 – Massey, Lincoln and Swanson WSZs showing the bulk main and supply points

2.2 ANALYSIS

While the Lincoln and Swanson zones are predominantly residential, they include large industrial customers and a regional hospital and there was no alternate supply. Massey Reservoir, in the neighbouring zone, was underutilised, and was generally run at 50% capacity to ensure regular turnover. During the feasibility assessment, we identified that the pipelines between Massey reservoir and the boundary Lincoln-Swanson Zone had additional bulk capacity.

Following an impact analysis, a communications & stakeholder engagement plan was developed by a wider internal team, and the agreed key mitigation was to provide total backup for the WSZ so commissioning could take place during the night, allowing any discoloured water to be stored in bulk reservoirs to settle.

A number of key network integration / upgrade opportunities were subsequently identified and verified by operations and planning staff.

2.3 MODELLING AND FIELD VERIFICATION

A collaborative planning study was conducted in-house using hydraulic modelling, and staff were able to confirm how the network would operate under proposed scenarios covering both current and future operational performance. This allowed us to mitigate any impact on levels of service and to quantify the change in flows in all pipelines where discolouration could be a risk. The study identified new connections, pressure reducing valves and meters which would be sized based on predicated future flows and identified the need for further network improvements to enable the solution.

2.4 SOLUTION IMPLEMENTATION

To prepare for the commissioning event, a number of stakeholder initiatives were implemented, including:

- Notifications to Council, Auckland Regional Public Health Service, Local Boards
- Proactive engagement with residents and affected businesses
- Initiatives targeted to specific needs – i.e. dialysis patients, laundromats
- Media releases and internal customer-facing resources

The physical network interventions were completed at a cost of $0.5M and included:

- Additional PRVs, air valves and supply pipelines at/near the adjacent WSZ boundary
- Additional SCADA and data logger facilitation
- Reservoir cleaning
- CCTV inspection of sections of critical supply pipelines
- Installation of valves and fire hydrants to facilitate network flushing
- Commissioning and testing of new PRVs to cover expected flow ranges
- 24-hour trial of supply reconfiguration

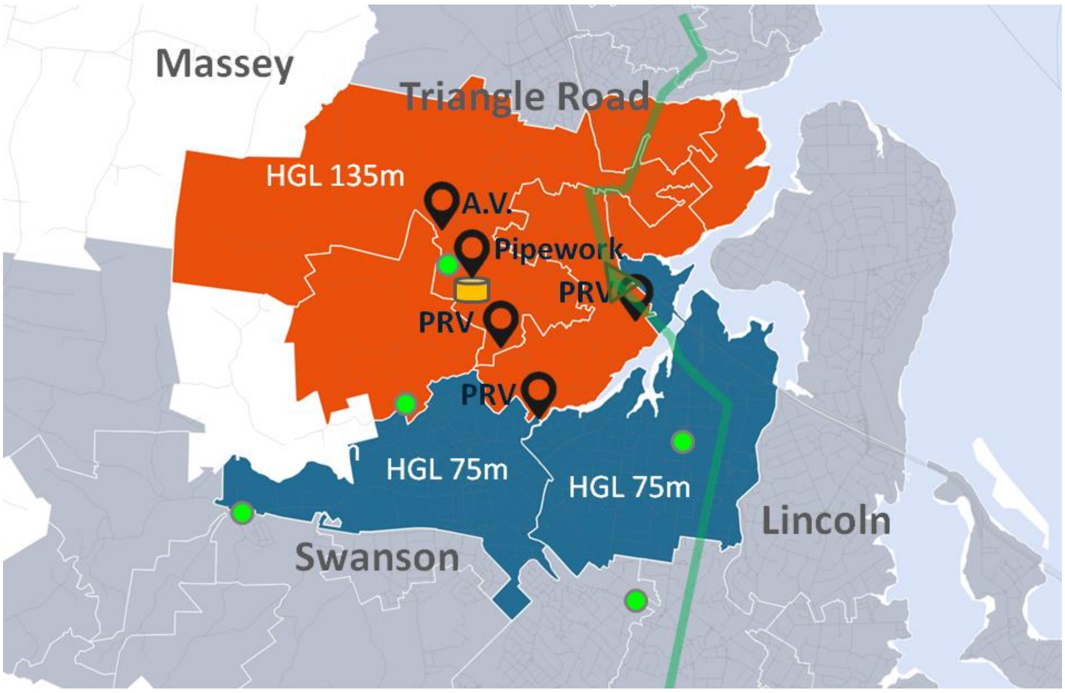

Figure 3 – Final Implemented Solution, Massey, Lincoln and Swanson WSZs

2.5 BENEFIT REALISATION

During a 24-hour trial shut, two large bulk meters with a typical daily throughput of 5,135 m3 were completely isolated. While the system responded well with no pressure related issues, increased local velocity resulted in 22 water quality complaints but these were promptly resolved by crews on standby to flush the network.

Following the success of trials and subsequent modelled confirmation, the planned PS commissioning was undertaken. The stakeholder management plan included proactive stakeholder and media engagement to ensure that customers checked the colour of their water before use.

While the bulk system registered 100NTU, all discoloured water was isolated from the distribution network and customers and this, combined with comprehensive network flushing, did not result in any water quality complaints.

The featured WSZs are now more resilient and flexible, the new operational arrangements allow the potential to better utilize the neighbouring reservoir capacity and provides for future sub-zones and pressure managed zones to reduce leakage and faults within the area.

3 CASE STUDY 2 – ALBANY WSZ

3.1 ISSUE IDENTIFICATION

In 2015, a major water incident occurred in Albany and disrupted supply to around 3,500 properties - half of the Albany WSZ - and the nearby Westfield Mall for almost 24 hours.

Figure 4 – Water Main Burst in Albany, 2015(Source: Stuff)

The incident was caused by a break in a 300mm local trunk main, however, attempts to isolate this main were prevented due to an unknown cross-connection between this main and the adjacent bulk main. The cross connection meant that both mains had to be isolated for repair, taking a large number of customers out of service as there was no back-up supply to the zone.

A project was therefore initiated to reinforce the security of supply to this WSZ and avoid future liability issues from supply disruption.

3.2 ANALYSIS

While the Albany WSZ is predominantly residential, it included a large number of commercial customers with no alternate supply.

Initially, a number of new / reconfigured connections to adjacent zones were required so that the bulk main could be isolated to locate the cross-connection. This involved modelling to confirm the validity and sizing of PRVs which would supply the Albany WSZ by adjacent zones with various HGL.

3.3 MODELLING AND FIELD VERIFICATION

A range of scenarios were collaboratively discussed with operations and modelled by planning staff to ensure that equipment capacity would ensure resilience, future levels of service and fire-flow, and to confirm the scope of further required work.

Once the re-configured supply through the PRVs and zone connections had been commissioned, it allowed the bulk main to be taken out of service. The 300mm bulk main was isolated and a short section was cut to allow an internal CCTV inspection to locate the offending cross-connection.

3.3.1 PROJECT IMPLEMENTATION

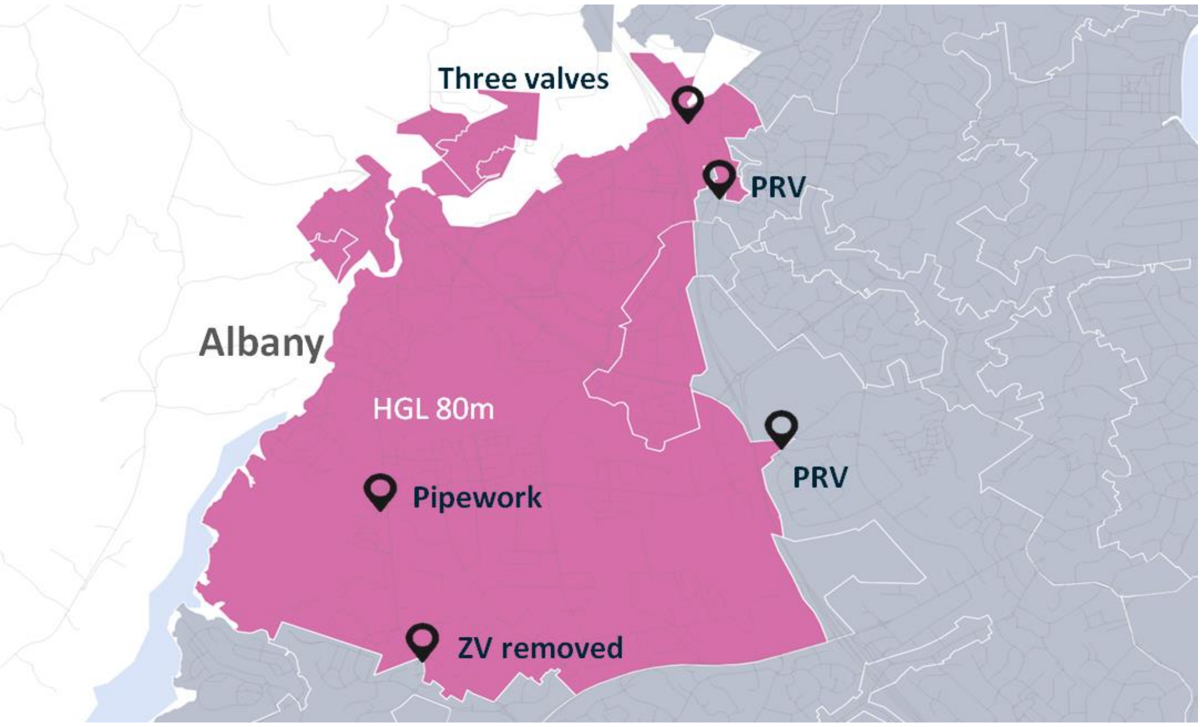

Figure 5 – Final Implemented Solution, Albany WSZ, supplying approximately 30,000 residents

The physical network interventions were completed at a cost of $0.2M and included:

- Opportunistic construction of a 50m long section 300mm pipeline during road widening
- Installation of two PRV's – in one case, utilizing an abandoned local pump station chamber
- Installation of new 300mm valve and hydrant on the identified cross-connection to allow it to be closed in the future.

Figure 6 – Valve and hydrant installation on 300mm bulk main, Albany WSZ

3.3.2 BENEFIT REALISATION

The planned WSZ improvements were completed and facilitated further zone-wide shutdowns without impact or customer complaint. The planned shut for the 300mm valve and hydrant installation, including charging and flushing the system, was completed inside 11 hours.

The Albany WSZ is now more resilient and can facilitate alternate supply to residential and commercial customers, and the bulk transmission pipeline can now be taken out of service for future maintenance.

4 APPLICATION OF NEW TECHNOLOGY – TAKAPUNA AND NORTHCOTE PRESSURE MANAGEMENT

While these two case studies provided measurable benefits in system resilience, improved collaborative internal processes, and improved stakeholder engagement, they were largely achieved using traditional data analysis tools.

Watercare is actively developing a consolidated approach to capturing, transforming, storing, reviewing, and utilising data to provide benefits to our staff and regional partners - particularly as it relates to planning the creation of new assets to meet Auckland’s growth. The following case study provides early insight into the application of these tools.

4.1 ISSUE IDENTIFICATION

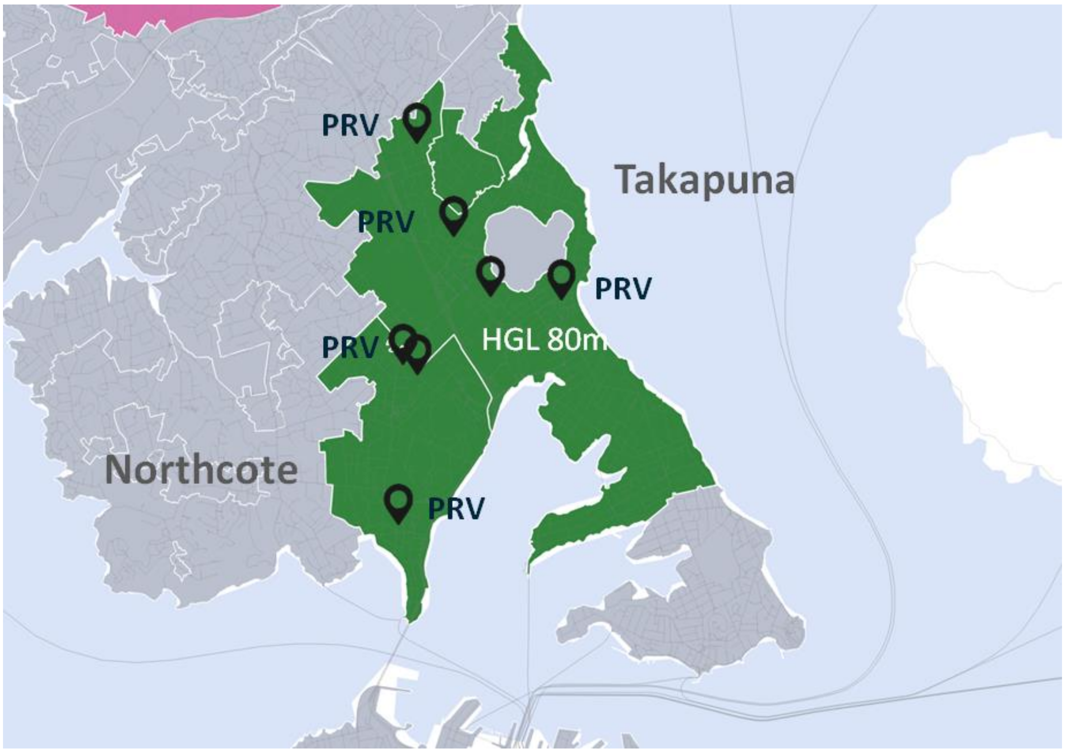

Figure 7 – Takapuna and Northcote WSZs on Auckland's North Shore, supplying a population of 50,000

The Takapuna WSZ covers part of Auckland's North Shore and supplies approximately 13,500 properties through five connections to the bulk network. The neighboring Northcote WSZ supplies approximately 4,500 properties and is supplied through two connections to the bulk network.

These two zones have historically had high consumption per capita, a large number of water main breaks and high levels of leakage. Both WSZs were subjected to high pressure as well as frequent pressure fluctuations as they were supplied directly from the bulk system with no active pressure control.

Improvements to the capacity of bulk transmission network in this region are planned over a 5-year period, however, a short-term proactive pressure management programme was proposed for these WSZs to reduce both faults and customer demand.

4.1.1 ANALYSIS

Measurement of pressures at key points in the two zones allowed operations and planning staff to determine that parts of the zone regularly experienced high pressures and large pressure fluctuations. Analysis using the hydraulic model helped to determine that the pressure fluctuations were caused by the supply from the bulk transmission system, rather than through dynamic head losses within the zone.

The model confirmed that large parts of the networks were experiencing high pressures and this correlated well with the areas of high burst frequency.

4.2 SOLUTION IMPLEMENTATION

The physical network interventions were completed at a cost of $0.3M and included the installation of PRVs at seven supply points in the Takapuna and Northcote WSZs. HGL was reduced from 96m to a target of 80m and this eliminated pressure fluctuations caused during the filling of adjacent transmission reservoirs.

Planning staff were able to confirm that the proposed reduction in pressure would not compromise the level of service to customers and maintain the required fire-flow into the zone. They advised on the correct PRV settings to maintain a supply balance and allow for growth in the zone.

4.3 PROJECT IMPLEMENTATION AND INTERIM BENEFITS

The installation of the PRVs at seven supply points and network improvements were completed by network maintenance contractors. Pressures were lowered remotely at night to minimize the impact on customers. Sixteen data loggers installed at the most critical points across the two WSZs confirmed that pressure across the WSZs were reduced successfully and pressure fluctuations during transmission reservoir filling was minimized.

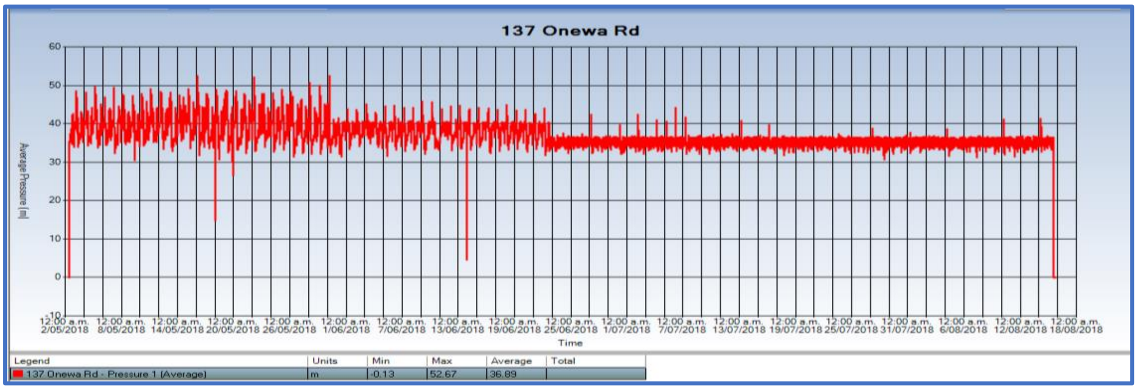

Figure 8 – Pressure Reduction in Northcote WSZ

Water main breaks in both WSZs have reduced by 46%, the number of customer water complaints have reduced by 31% while reported water leaks have reduced by 25%. This has resulted in reduced disruption, and potentially extended the useful life of network and private assets.

4.4 GEOSPATIAL DEMAND QUERY

In parallel, Watercare has been enhancing digital capability to facilitate easy access to network performance insights. A new system performance app returns up-to-date information on metered consumption and supply within discrete water supply zones, and has provided insights into the effect of the pressure management on the Takapuna and Northcote WSZs.

Figure 9 below shows how the supply and consumption in the Northcote and Takapuna WSZs compared to the total Auckland metropolitan region. Early results suggest that while supply and consumption have increased in these WSZs, they have done so at a lower rate than the total regional profile. The linear average is slightly more noticeable in supply, indicating that the pressure reduction – in addition to reducing faults and disruption - may be assisting to manage non-revenue water in the WSZs.

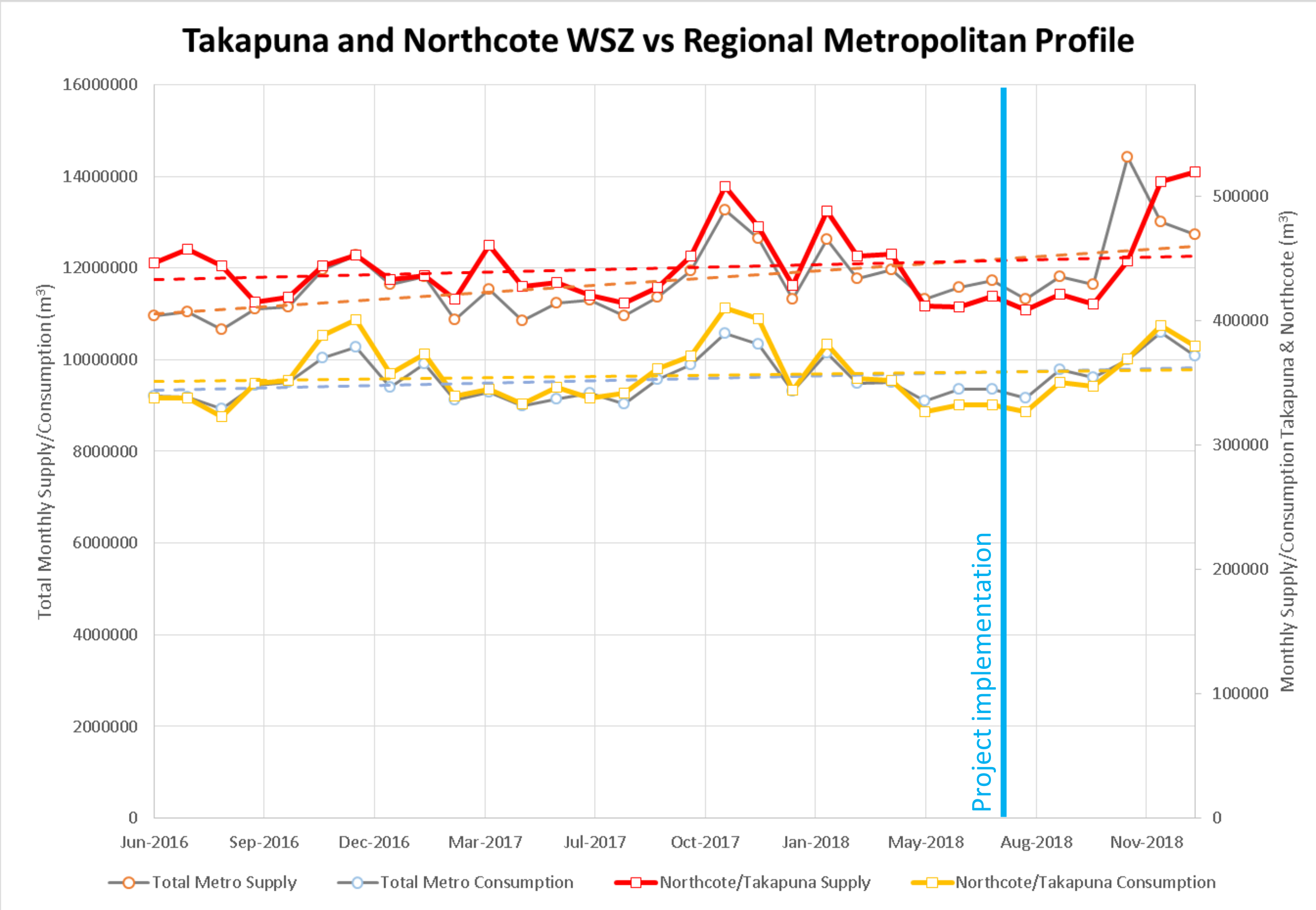

Figure 9 – Supply vs. metered consumption in Takapuna and Northcote compared to the Metropolitan region

As Watercare's system performance software is developed it will allow us to gain better insights into how demand profiles are changing, and the influencing factors. This in turn will allow us to develop more targeted non-revenue water reduction and network efficiency programmes.

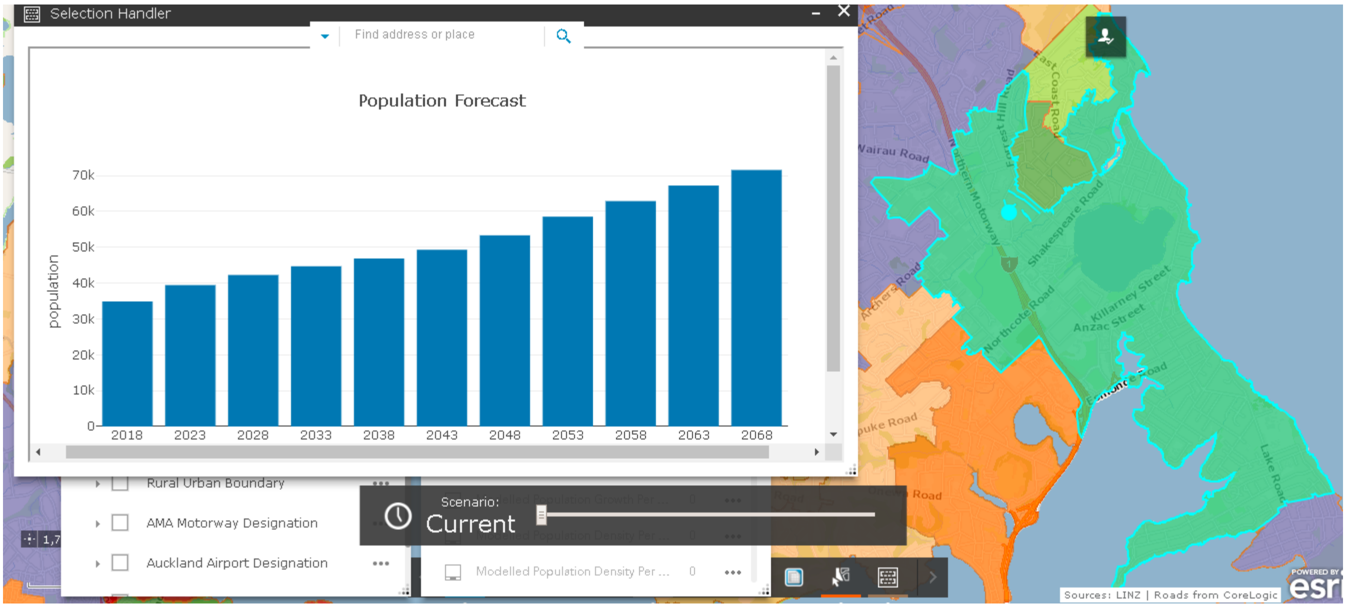

Figure 10 – Current development of Watercare's System Performance App returning population data

5 FUTURE APPLICATIONS

Watercare is actively developing a consolidated approach to utilising data to deliver insights. One portion of this toolset is the system performance app which will give planners, operators and field crews easy access to information on network performance. This will include access to predicted model results and real time data, so data on pressures, flow, water age, consumption and leakage along with break and fault information can all be easily viewed coincidentally.

Our "Next Generation GIS" programme is currently establishing a connected geometric model of the water and wastewater distribution networks using corporate GIS data and will allow boundary and valve isolation tracing through a web browser. The geometric model has been built to align with the geometry and schemas of our hydraulic models and will provide webhosted model access so all Watercare staff can easily track network performance, and assess the impact of network changes without specialist software.

6 CONCLUSION

In conclusion, Watercare's experience suggests that proactive, collaborative working between the operations and planning staff can lead to the successful delivery of future-proof solutions which provide system resilience and increase community trust by minimizing supply disruption.

Understanding the impacts of proposed solution scenarios can also help develop optimal outcomes and also build in mitigations for identified implementation issues.

Utilisation of emerging digital technologies can make it easier and more accurate to identify, analyse and quantify issues in the network, enable more informed decisions, and make it easier to communicate impacts to internal teams and external stakeholders.

The featured case studies have delivered efficient, low capital solutions with a focus on value, and we are confident that as Watercare navigates the nexus of people, process, and developing technology, we will also gain better insight into system performance, demand profile changes and potential influences. This will allow us to develop more targeted non-revenue water reduction, network efficiency and targeted capital programmes.