Pukekohe and North Franklin Rural Communities Water Supply – Programme of Works

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ABSTRACT

Watercare Services Limited inherited a large number of water and wastewater system assets following the amalgamation of Auckland's former Councils in 2010. This included a large number of regional assets operated by the former Franklin District Council. None of the Franklin area Water Treatment Plants (WTP) were graded to DWSNZ and the water quality produced by these plants attracted a number of water quality complaints, far higher than all other areas in Auckland. Most of the WTPs were producing at, or above the consented watertake limits and the sources were close to their total allocation limits.

Watercare provided a simple solution to the problem, which was to extend Auckland's metropolitan water network through Pukekohe and into the rural communities of Patumahoe, Clarks Beach, Glenbrook Beach and Waiau Beach. The programme of work commenced in early 2011 and was completed at the end of 2014. A key driver for this work was to improve water supply resilience in the area.

The execution of this seemingly simple solution required significant engineering effort through a number of discrete elements that were distributed over a large geographic area. Works included constructing over 30km of watermain from the Waikato No.1 watermain through to Clarks Beach, a new pump station at Drury, and bypass arrangement on the Waikato watermain to provide additional security of supply to the area. A new service reservoir was constructed at Clarks Beach and new Chlorine booster plants were installed at Patumahoe, Clarks Beach and Glenbrook Beach.

There were a number of engineering complexities associated with the programme. These were exacerbated by the limited information on the existing infrastructure and its operation. Much of the legacy infrastructure to where the new pipelines were connected required significant reengineering.

Commissioning each element of the works had its own complex challenges. Strategies were put in place and actioned for each phase of commissioning. No water quality complaints were received as a result of any commissioning activity.

This programme of work is an exceptional example of the success of a single, integrated water company serving the Auckland Region. The communities have an improved, resilient water supply receiving A grade water from the Waikato WTP and will cater for growth over the long term horizon.

This paper outlines the extent of the work packages delivered and discusses the strategies employed to ensure that the final solution was implemented with a seamless transition for the customers.

KEYWORDS

Auckland Council Integration, water planning, watermain construction, commissioning.

1 INTRODUCTION

At integration of Auckland's, water and wastewater assets across the region were amalgamated into Watercare. This included a number of water treatment plants in non-metropolitan areas, many of which were ungraded and had significant issues. Watercare set a target to supply the entire region with "A" grade water by 2020.

Franklin in particular historically received 100-times the number of complaints of other areas in Auckland. It was therefore one of Watercare's highest priorities for significant improvements. Watercare undertook an assessment of the existing assets and then set out to undertake a programme of works to significantly improve water supply to the Franklin area.

2 DEVELOPING A SOLUTION TO RESOLVE LEGACY PROBLEMS

2.1 FRANKLIN ASSETS AT COUNCIL INTEGRATION

Following the local body integration in 2010, Watercare signed a Statement of Intent with Auckland Council to achieve an "A" grade for all non – metropolitan water treatment plants by 2020. A 3 year target was set to 35% of plants to be graded by 2012, 45% of plants to be graded by 2013 and 50% of plants to be graded by 2015.

Of 17 non-metropolitan WTPs transferred to Watercare at council integration, 11 were located in Franklin and all were ungraded. The WTP that were transferred to Watercare had multiple issues compromising drinking water quality and quantity.

70% of all water quality related complaints in the Auckland Region were generated in Pukekohe. As Pukekohe has a population of approximately 20,000 people and the Auckland region has approximately 1.2million residents this was a disproportionate number of complaints (Figure 1). These complaints were primarily related to water quality and aesthetic issues such as taste, odour and colour. Watercare's water quality complaint target is less than 5 per 1000 customers.

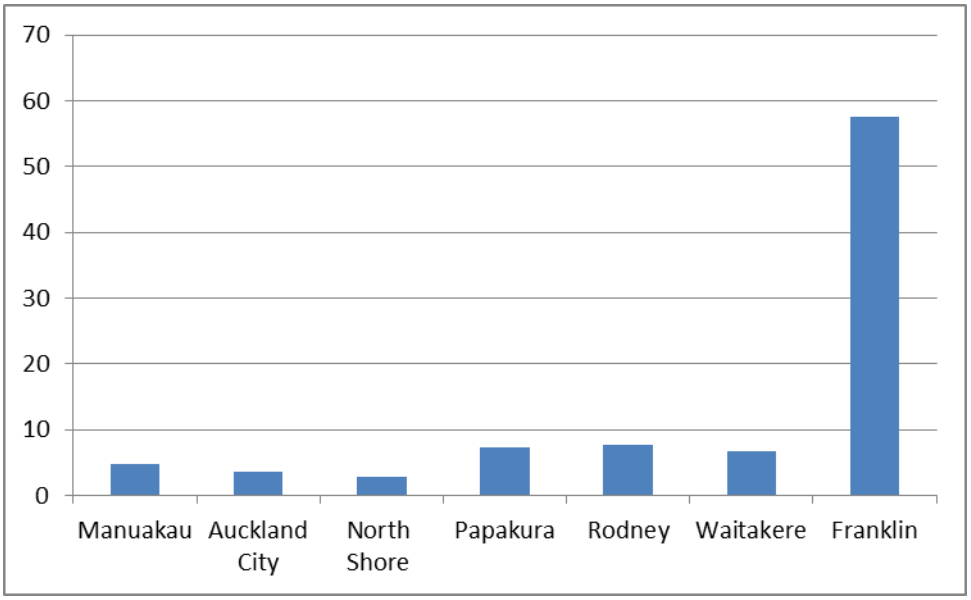

Figure 1: Water Quality Complaints per 1000 properties in the Auckland region

All Franklin area WTPs were fed from bores or springs that had various water quality issues such as elevated levels of iron and manganese causing aesthetic issues in Pukekohe. In addition most of the water take consents were close to expiration, close to capacity and due to the large horticultural industrial water take in this area were unlikely to be increased. At the time of integration, growth in Pukekohe was constrained due to a lack of available water supply.

Pukekohe was serviced by three separate treatment plants: Hickey Springs, Douglas Rd and Buckland Rd WTPs. Hickey Springs WTP was the largest, serving the majority of the town. E.coli was detected at the Douglas Rd WTP in October 2010 and was subsequently taken out of service by reconfiguring the local network. No construction work was required to facilitate this action. Buckland Rd WTP serviced an area of the network that could not be supplied from the Hickey Springs WTP.

Water supplied from the Clarks Beach WTP periodically exceeded Drinking Water Standards New Zealand 2005 (Revised 2008) (DWSNZ) due to the elevated levels of Boron. Water abstracted from the Waiau Beach bore had pH levels of up to 9.1, significantly reducing the effectiveness of the chlorine residual. Glenbrook Beach source water was high in iron and manganese and was aesthetically unsatisfactory. All of these bores were in poor condition and Glenbrook Beach was classed as unsecure following the detection of *E.coli*.

2.2 DEVELOPING A SOLUTION

Watercare Services reviewed the existing Franklin water supply assets and their operation as described above and sought to address the following high level issues:

- An unacceptably high numbers of customer complaints
- The Franklin WTPs were ungraded and required significant operational input to ensure compliance with DWSNZ. Whilst there is no legislative requirement to grade WTP's, Watercare set itself the goal of achieving the same level of service to both metropolitan and non-metropolitan customers
- The existing supplies could not meet the peak demand requirements and had no capacity for expansion due to the over-allocation of the existing ground water sources

Planning options considered to address the issues described above included:

- upgrading the processes and capacity of the existing WTPs to ensure compliance with all statutory requirements
- Developing a new water supply to either supplement or replace the existing supply

Connecting Pukekohe to the metropolitan water supply system was determined to be the most logical, cost effective and robust solution given the proximity of the Waikato watermain to the Pukekohe Township. Following selection of this option, efforts were focused on the sizing and timing of such a connection and ancillary works to make the solution work.

The Waikato watermain is integral with the operation of Waikato WTP and was not designed as a transmission service main. It has two surge tanks along its length at Harrisville Rd and Trig Rd and a balancing tank at Runciman Rd; these assist with transient pressures that run through the watermain when the plants treated water pumps shut down and allow effective control of the treated watermain. At the connection to Redoubt reservoirs there are non-return valves to prevent backfeeding the Waikato watermain when the WTP was not operating and to control the flow of water into the reservoir complex. Moreover, the watermain is controlled from the WTP distributed control system (DCS) rather than Watercare's network control (SCADA) system.

An alternative source of supply to the Waikato watermain was therefore required to provide security of supply when Waikato WTP was out of service. This would be achieved by back feeding the Waikato watermain from Redoubt Reservoir complex. The non-return/control valves located at the Redoubt reservoir complex needed to have bypass facilities installed. A new pump station was required to lift water back up to the level of Runciman tank.

Watercare also reviewed the North Franklin areas of Patumahoe, Clarks Beach, Waiau Beach and Glenbrook Beach. The majority of the water treatment assets could not achieve DWSNZ grading requirements. The capacity for growth in this area was limited due to abstraction limitations imposed by existing consents.

Options were developed to improve water supply system resilience and provide for future growth in North Franklin, including:

- constructing a replacement WTP using the Kaawa aquifer groundwater source
- connecting these networks to the main metropolitan network by extending the Pukekohe watermain to North Franklin

The Kaawa aquifer was considered to have better water quality and yield than the existing sources. However, this solution required 9 km of watermain to be constructed between the source works and the North Franklin Townships. The extension of the Pukekohe watermain through to Glenbrook Beach would also pass through Patumahoe.

Financially the watermain was a more expensive capital solution when compared with constructing a new bore and WTP. However, it was more cost effective when compared on a Net Present Value basis due to a significant reduction in operational and maintenance costs. The watermain solution also provided for growth, which a new local WTP was unlikely to be able to achieve and was therefore the solution that was adopted.

3 IMPLEMENTING THE SOLUTION

A central theme to this programme of work was urgency, which in turn drove the procurement strategy. The programme of work was delivered through a number of individual work packages with a focus on the critical path. This approach resulted in a number of separate design and construction contracts that required significant coordination.

3.1 INTERIM WORKS

It would take several years to construct the infrastructure required to connect the supplies to the metropolitan network. Several interim solutions were developed to improve the North Franklin water supplies in the interim.

A flushing programme was initiated in Pukekohe to clean the local mains. The town was flushed in a structured manner focusing on the areas that typically received the most complaints.

To solve the aesthetic issues with Iron and Manganese in Pukekohe a containerised membrane filtration unit was trialled, built and commissioned within a year. This unit oxidised and precipitated contaminants prior to ultrafiltration. This eliminated the discoloured water and reduced the number of water quality related complaints in Pukekohe to close to zero.

At the remaining plants, Patumahoe, Glenbrook Beach, Clarks Beach and Waiau Beach, the chlorine dosing and the control systems were upgraded and the plants were then able to shut down automatically prior to any breach of the DWSNZ. This allowed the plants to comply with the DWS standards for the next three years without any transgressions.

3.2 WATERMAIN

The Pukekohe watermain is designed to operate under pressure utilising gravity head. The watermain was constructed in three main sections:

- Section 1 - Runciman to Pukekohe
- Section 2 - Pukekohe to Patumahoe, and
- Section 3 - Patumahoe to Clarks Beach

Section 1 was predominantly a 667 mm OD concrete lined steel watermain, which is Watercare's standard transmission watermain material. A number of route options were considered; staying within the road corridors was required for ease of ongoing operation and to ensure that the project met tight time constraints. The final horizontal alignment followed Pukekohe East Road towards the town's limits and then skirted around the towns centre to connect into Totara Reservoir and avoid more heavily trafficked areas. From Totara reservoir, the watermain alignment takes the most direct route to Kitchener reservoir. The vertical alignment of the watermain was generally designed with 1350mm of cover, which is Watercare's standard.

For the most part the watermain was constructed using open trenched construction with shoring at the welding locations only. Ground conditions in Subway Road were particularly poor with a lot of silts and clays, coupled with a very high water table, resulting in a trench that would not stand up. A continuous shoring system was

used in this location. Ground water was managed by constructing “crows nests”, i.e. lining water filled barriers with geotextile cloth to form a permeable retaining tank.

The watermain crosses the North Island Main Trunk (NIMT) Rail line passing under a large embankment. The road in this location has a small, very fragile, road under rail bridge to cross the rail line, which would be adjacent to the watermain once installed. Ground conditions in the area were challenging with the embankment being constructed of fill on alluvial soils comprising silts and clays with variable amounts of woody organic material. Kiwirail had significant concerns about Watercare constructing a watermain under the NIMT because tolerances of the rails with regard to settlement, and in particular differential settlement between rails, are extremely narrow.

Watercare adopted a micro tunnelled option to cross the rail line. The watermain was designed within a carrier pipe so that it could be replaced in the future if necessary and to prevent catastrophic failure of the embankment should the watermain ever fail in this location. A steel casing pipe was used as a carrier pipe and the pipe material was changed to PE from CLS to prevent rusting. The steel carrier pipe had its own cathodic protection system installed. During construction of the Kiwirail section there was ongoing survey of the rails to ensure that settlement did not become problematic.

A total of 6 line valves were incorporated into the design of Section 1. Two of the line valves were located at the two reservoirs, which is a Watercare design standard. The other line valves were spaced approximately 1.6km apart to meet Watercare design standards. The line valves are housed in chambers located off the carriageway to ensure that they can be accessed safely.

Section 2 between Pukekohe and Patumahoe is an 8km, 500OD polyethylene (PE) watermain running from outside Kitchener Reservoirs to Carter Road Reservoirs. The watermain follows the road with the line valves located off the carriageway where possible. Air valves were installed to a Watercare standard design that was amended to accommodate the PE pipe material. Electrofusion saddles were used successfully to mount the air valve stubs.

The watermain was predominantly constructed using directional drilling. The pipe was butt welded into strings and the strings were joined using electrofusion couplers. There were a number of quality issues associated with the electrofusion couplers that delayed completion of this section of watermain.

Section 3 is a networks watermain and is therefore designed to Watercare’s local watermain design standard. This section was also constructed using directional drilling methodology following the road corridor. The pipe diameter was 400OD reducing to 250OD at Clarks Beach.

3.3 RESERVOIRS

One of the key strategies by Watercare was to focus on the delivery at the connection points. This resulted in close to complete replacement of the pipework supplying and being delivered from the reservoirs.

All of the reservoirs would adopt the same basic design philosophy being supplied through PRV solenoid controlled valves. Bypass facilities were also incorporated to allow the reservoirs to be taken out of service. Downstream of the reservoirs new bulk supply points were constructed to Watercare standards.

The connections at Kitchener Reservoir were particularly complex (Figure 2). Seven separate connection shutdowns were required over 4 months, to ensure that water supply to customers was not affected. The site was very constrained and the contractor had to work in difficult conditions during winter to meet Watercare timelines. Kitchener reservoir was the first of the Pukekohe reservoirs put into service because it was at the end of the Pukekohe watermain at the time and would ensure that the entire main would be turned over. It is also the main point of supply and storage for Pukekohe.

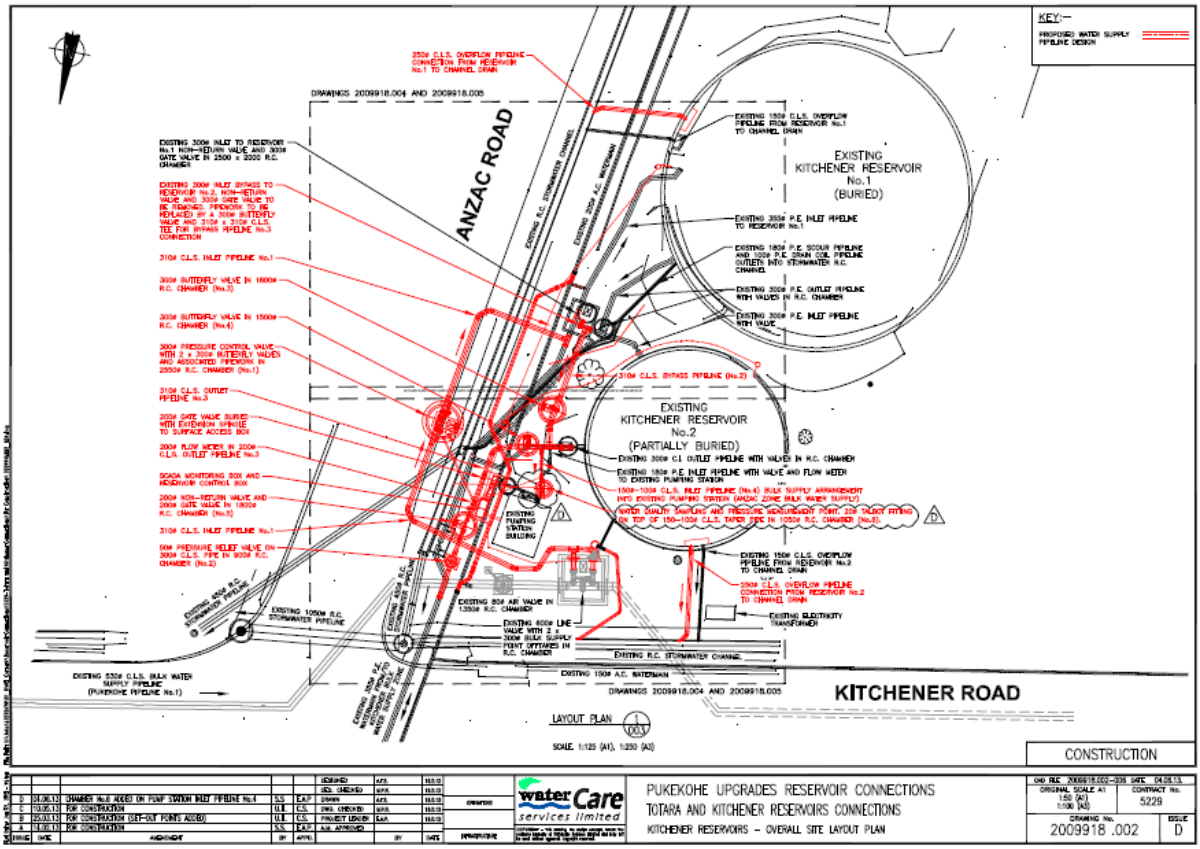

Figure 2: Kitchener Reservoir pipe work layout

Totara reservoir had extensive but relatively straight forward redevelopment with new inlets being created. The existing inlets and outlets were reused as outlets. Most significantly a new overflow was constructed to manage the new worst case flow scenarios.

Prior to this programme of works water would be taken from Patumahoe bore, receive treatment and then supply into the reservoirs that are adjacent to the bore. Water was then pumped from the reservoirs into the local area. Now the works are complete the local area is supplied via a PRV directly from the Pukekohe watermain. Patumahoe reservoir now provides a gravity supply to the downstream communities, improving resilience of the system. However, the reservoir can still supply Patumahoe via the pump station if required.

A new 1100m^3 reservoir and pump station was also constructed at Clarks Beach as part of this programme of works to replace an aged 450m^3 reservoir. Watercare took the opportunity to construct the new reservoir below ground because it was located in a public reserve. This storage coupled with the connection to Patumahoe storage significantly improved the resilience to Clarks Beach and the downstream communities of Waiau and Glenbrook Beach.

3.4 CHLORINE BOOSTER PLANTS

Modelling was undertaken to establish the likely chlorine residual along the watermain. It was determined that boosting would be required at Clarks Beach and Glenbrook Beach and chlorine booster plants were therefore built. The results for Patumahoe were marginal given the theoretical calculations being used. A mobile chlorine plant was therefore developed for this location so that it could be easily removed and utilised elsewhere if it were not required.

3.5 DRURY PUMP STATION & REDOUBT BY-PASS

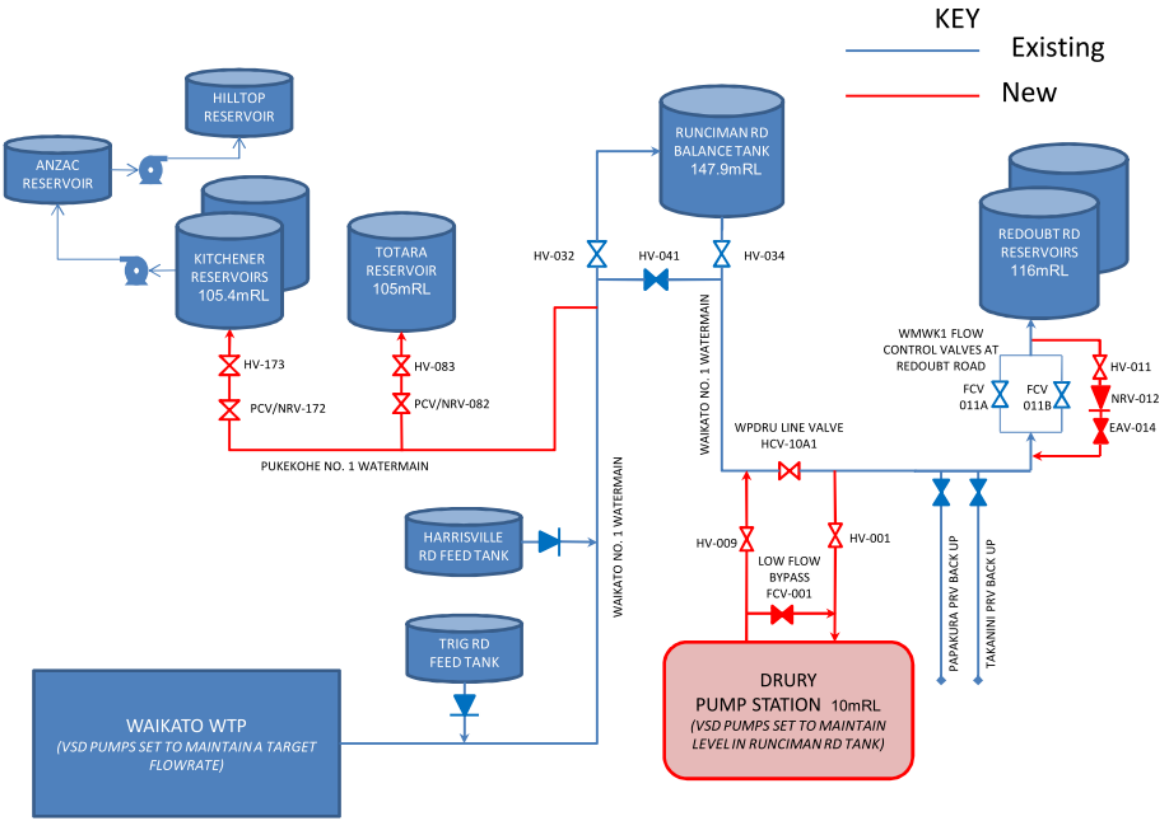

Figure 3: Waikato Waterman Schematic

The Redoubt Road Reservoirs are some 35 meters lower than the Runciman Road Balancing Tank and therefore, to allow water from the Ardmore WTP and the Redoubt Complex to backfeed the Waikato Watermain, a pumped solution was required. A schematic of the system is included in Figure 3.

Drury Pump Station was designed to pump water back from Redoubt Reservoir Complex through to Runciman Tank when Waikato WTP is out of service. The pump station is designed with duty standby pumps controlled on variable speed drives.

Pressure management at the pump station was a key design consideration due to the head differential between Runciman Tank and the pump station being approximately 140m. The pumps were initially proposed with 60kgm^2 flywheels but this was cost prohibitive. An alternative solution was proposed where the pump station would have bypass pipework installed with a check valve to provide surge mitigation. This simple solution has proven to be effective.

The existing dual 600mm Cal-val control valves located at Redoubt Road Reservoirs which control the flow from the Waikato WTP also have non-return functionality. This necessitated the need to build a by-pass around the control valves to allow the water to be back fed to the Drury Pump Station. The by-pass also allows the control valves to be maintained. The connections for the by-pass pipe work were particularly challenging due to the steep slope of the Waikato Pipeline either side of the control valve chamber and the acute angle of the spool pieces for the connection (Figure 4).

Figure 4: Redoubt Bypass Connection

3.6 CONTROL SYSTEM

Two strategies were adopted for control of the new system which served to both de-risk the works and provide a resilient system in the longer term.

The control system selection was the subject of much debate for Drury Pump Station. This was due to the existing assets on the Waikato watermain being connected to the Waikato WTP DCS system. The decision was made to use the SCADA system for control of the pump station but it would need to interface to the DCS nodes at Redoubt Reservoir Complex and Runciman Tank. Following the Hazop analysis it was determined that Control interfaces at Redoubt Reservoirs and Runciman Tank would be duplicated so that a discrete SCADA package could be developed. This allows the two control systems to sit side by side. Operational procedures are used to pass control of the watermain between the WTP and the water transmission network.

When new infrastructure was developed a similar approach was taken in that new control and communications infrastructure was installed on the SCADA system. A number of legacy assets were left in place where the functionality was outside the scope of these works.

4 COMMISSIONING

4.1 PUKEKOHE

Commissioning the Pukekohe network onto the new water supply was a significant risk to the overall success of the project. It was made complex due to the size of the task and the number of various teams involved, including Water Network Operations, Water Transmission Operations, Water Treatment Operations, the main watermain contractor and project staff. The programme was further complicated because there were significant upgrades of the Waikato WTP and Ardmore WTP being undertaken which placed a lot of strain in shutdown opportunities. Note that Watercare procedures do not allow two such significant WTPs to be out of service for planned works at the same time. A detailed commissioning plan was developed that identified the various roles and stakeholders leading up to an including go live.

Drury Pump Station was wet commissioned prior to the Pukekohe Watermain being available. This was important as a major water outage in Pukekohe soon after connection to the metropolitan supply would be seen as major failure. Runciman Balance Tank was used to facilitate the commissioning process. The tank level was dropped by draining it into Redoubt Reservoirs. The pumps were then run filling Runciman Tank.

The key challenge with commissioning the new supply was that significant areas of Pukekohe's local network would be reversed. This was because water was previously supplied from Hickey Springs up through the network to Kitchener and Totara Reservoirs. Once the final connection was made to Kitchener Reservoir and water was supplied from the new Pukekohe Watermain, water would gravitate down through the network. Moreover, once the final connection was made, it would not be possible to go back.

There were a number of strategy and planning meetings held where options of how to transition from the Hickey Spring supply to the metropolitan supply would be undertaken. However, it was decided that a big bang approach should be taken. This is because it was not possible to really know how the network would behave if a gradual transition was adopted as the hydraulic network models for the town were not sufficiently accurate. It was also deemed that the dirty water risk could be most easily managed if a single significant change was to occur.

Leading up to go live, Watercare undertook a communications campaign that included messages in the paper and liaison with the local community board. Importantly, Watercare was careful not to specify dates in its communications through this phase. This was for two reasons; firstly that it provided more flexibility to address any construction or operational issues that could prevent meeting the date and also previous experience indicated that when you advertise a specific date, people complain on that date.

Qualitative analysis was undertaken to assess pH expectation as a result of commissioning the new CLS watermain because the calcium in concrete causes pH rise. The analysis suggested that the pH would start out at approximately 9 decreasing to 8.4 quickly but staying at that level for an extended period. This was deemed unacceptable and therefore transportable CO2 dosing units were designed and commissioned to buffer the pH.

Water quality sampling and analysis over and above standard procedure was undertaken to qualify any anticipated taste and odour differences. Further, the analysis reviewed water of differing pH to ascertain how sensitive the customers would be expected to be to the new supply. The information was invaluable because the results concluded that the new supply would not be significantly different, although it would have a more pronounced chlorine taste.

Flushing was undertaken both through the new Pukekohe Watermain and throughout the local network prior to go live. In particular, flushing was targeted at areas of the network likely to encounter reverse flows and therefore sediment entrainment.

At go live, the last shutdown at Kitchener Reservoirs, involved the Hickey's Spring WTP pumping directly to the network, without the reservoirs to act as a header tank, to allow the final connection to be made. During the final connection the site was further constrained by the presence of the containerised CO2 dosing to correct pH during the early weeks of operation.

Once the connection was made the Operations team shut down Hickey Springs WTP and also kicked off extensive flushing of the local network. The flushing was undertaken to both address any dirty water issues and to get relatively high turnover in the Pukekohe Watermain before the morning peak.

4.2 NORTH FRANKLIN COMMUNITIES: PATUMAHOE, CLARKS BEACH, WAIAU BEACH AND GLENBROOK BEACH

Commissioning of the rural communities was relatively straight forward because the new supply watermains were connecting to pre-existing supply points. Therefore there was limited requirement for reconfiguration of the local networks.

The most significant issue was that there had been insufficient care to prevent soil ingress into the pipes when the watermains were installed. When pre connection flushing was undertaken this was identified through highly turbid water being discharged. A series of $5m^3$ and $10m^3$ tanks were installed temporarily as settling tanks to flush the watermain through.

5 CONCLUSION

The programme of work to connect the North Franklin rural townships was successfully completed in a short time frame with no disruption to customers.

Pukekohe received an Aa grade in latest grading and the other non–metropolitan communities will be regraded the same in the coming grading rounds as a result of this significant programme of work.

Auckland Council has recently announced several Special Housing Areas (SHA's) in the North Franklin area. The SHA's include the Wesley Development, Kingseat Development and Glenbrook Beach development. Significant growth is also occurring at Patumahoe and on the fringes of Pukekohe. Watercare has been able to support these initiatives because the watermains that have been constructed.

ACKNOWLEDGEMENTS

A significant effort was put in from many staff at Watercare and a number of design consultants and contractors. The main consultants undertaking design for the project were SKM (now Jacobs), URS (now Aecom), CH2MBeca, and GHD. Construction teams included HEB Construction, Pipeline and Civil, and Drilltech 1996.

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