WAIĀRI : PLANNING THE WATER SUPPLY FOR A GROWING CITY

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ABSTRACT

Tauranga is one of New Zealand's fastest growing cities, with a 14 percent increase in population between the 2001 census and the 2006 census, though that number has slowed to 11% between the 2006 Census and the 2013 Census. This sudden population growth has made Tauranga New Zealand's 5th largest city with a current urban population of 137,900 (June 2017).

This paper outlines the Tauranga City Council's (TCC) journey to supply and optimise the provision of water for a growing city which has culminated in a need to develop and implement a third water supply scheme.

TCC first identified the Waiāri Stream as the next potential water source for Tauranga City as early as 1995. In 1999, TCC started investigating the Waiāri Stream to service the projected growth of the city's population, particularly in the eastern parts of Papamoa in earnest.

TCC appointed CH2M Beca Ltd as its delivery partner to provide engineering services for the consenting, design and construction of the intake and water treatment plant (WTP). Land acquisition, the designation of the site, a water take consent for 60Ml/day and other consents were obtained in 2010.

Water demand management measures implemented by TCC through the introduction of universal metering and the global financial crisis led to lower water demands across the city. This led to the project being put on hold in 2012. The project was resurrected in 2016 with the first of three contracts being awarded to procure the construction of the WTP in January 2018. The intended commissioning date is now 2021.

This paper outlines the history of the planning approach used on the project. Studies such as demand, capacity and outage assessments, resilience assessments and decision tools that were used to assist TCC with consenting, decision making and the implementation of the project to achieve the Councils "just in time infrastructure" philosophy are described.

KEYWORDS

Water, planning, water treatment,

PRESENTER PROFILE

Peter Bahrs

Peter is the Team Leader Water Services for Tauranga City Council. He has over 30 years of experience in the water industry both locally and abroad and has held a variety of roles with focus in the water operations field.

He has a wealth of experience including operational management of water infrastructure, the management of laboratories and quality systems; health and safety; asset management; capital and asset renewal, as well as successfully managing the O&M services contracts for water services.

He holds a Bachelor of Science in Agriculture with Honours in Water Utilization

Peter is an active member of Water NZ's Water Services Managers Group.

Chris Olivier

Chris holds a unique insight into the Waiāri Water Supply Scheme having worked for the Tauranga City Council during the early years of concept development and consenting and is now a Senior Associate in Beca Ltd. undertaking the role of Design Manager for the Waiāri Water Treatment Plant delivery.

He has over 35 years' experience in the water industry, the last 18 years in NZ. His experience includes infrastructure planning, project management, asset management services, procurement and contract management. He has worked in local authority, water utility operator and in private practice.

He hold a B.Sc. Eng. (Civil) degree obtained from the University of Natal in South Africa.

1 INTRODUCTION

Tauranga city is situated on the eastern sea board of New Zealand. It is surrounded by rural areas and intense horticulture/agriculture interspersed with small settlements and semi-urban development areas. The urban area is administered by Tauranga City Council (TCC) and the surrounding rural areas by the Western Bay of Plenty District Council (WBoPDC).

Tauranga is one of New Zealand's fastest growing cities and has been so since the 1960s. It experienced a 14 percent increase in population between the 2001 census and the 2006 census, though that number has slowed to 11% between the 2006 Census and the 2013 Census. This population growth has made Tauranga New Zealand's 5th largest city with a current urban population of 137,900 (June 2017).

This population and economic growth has led to an increasing demand on water supply. Based on demand projections undertaken in the mid-1990s, it was originally predicted that by 2005, the capacity of the existing two treatment plants would be exceeded and a new water source would be required.

Based on these projections TCC embarked on a strategy to manage demand and increase its supply capacity.

Its demand management strategy was through education, universal metering and volumetric charging for water while a new water source for the growing city was investigated. The Waiāri Stream was preferred based primarily on potential yield, water quality and its proximity to be able to service the eastern growth areas of the city.

In 2007 TCC appointed CH2M Beca Ltd (CH2M Beca) as its delivery partner to provide engineering services for the consenting, design and construction of the intake and WTP.

As a result of its geographic situation Tauranga needs to draw its water supply from outside the Tauranga district. TCC and WBoPDC undertook several joint water supply studies and, in 2004, both councils signed a Memorandum of Understanding (MOU) to jointly develop the water supply resource and systems of the Western Bay of Plenty in an integrated and sustainable manner.

Although the current Waiāri Water Supply Scheme that TCC is undertaking includes the development of the water source, abstraction facilities, water treatment plant and the 21 kilometres of water pipeline to convey the treated water to the supply network, this paper will focus on the water source development and water treatment plant (WTP).

2 CURRENT SUPPLY STRUCTURE

2.1 WATER SOURCES

Tauranga’s current water supply sources from the Waiorohi and Tautau Stream were first developed in 1957 and 1958 respectively. The WTPs have undergone various modifications and upgrades since then, with the Joyce Road WTP (Tautau Stream) undergoing a major upgrade in 1997 to a continuous microfiltration plant, followed by the Oropi WTP (Waiorohi Stream) in 2003.

Both WTPs have received an "A" grading from the Ministry of Health. The Oropi WTP has a capacity of 33,000m^3/day, upgradable to 54,000m^3/day. The Joyce Road WTP is nearly fully developed up to the limit of its water take permit at a capacity of 34,000m^3/day.

An aerial schematic of the existing WTPs and reservoirs, growth areas and reticulation constraints is shown in Figure 1.

Figure 1 Existing Water Infrastructure

2.2 WATER NETWORK STRUCTURE

The current network structure is such that under normal operation the Oropi WTP supplies water to the Tauranga West and Tauranga Central zones while the Joyce WTP supplies the Tauranga South-Eastern and Coastal Strip zones (Mount Maunganui to Papamoa). Refer to Figure 2 below.

There are some constraints in this existing network structure. For example, the Oropi reservoir levels are at a lower elevation than the Joyce reservoirs. There is however a pumped connection from Oropi to the Joyce supply zone when the need arises. In addition there are some existing capacity constraints with the Joyce supply to the coastal strip which have on occasions required abnormal system operation to maintain supply to this area.

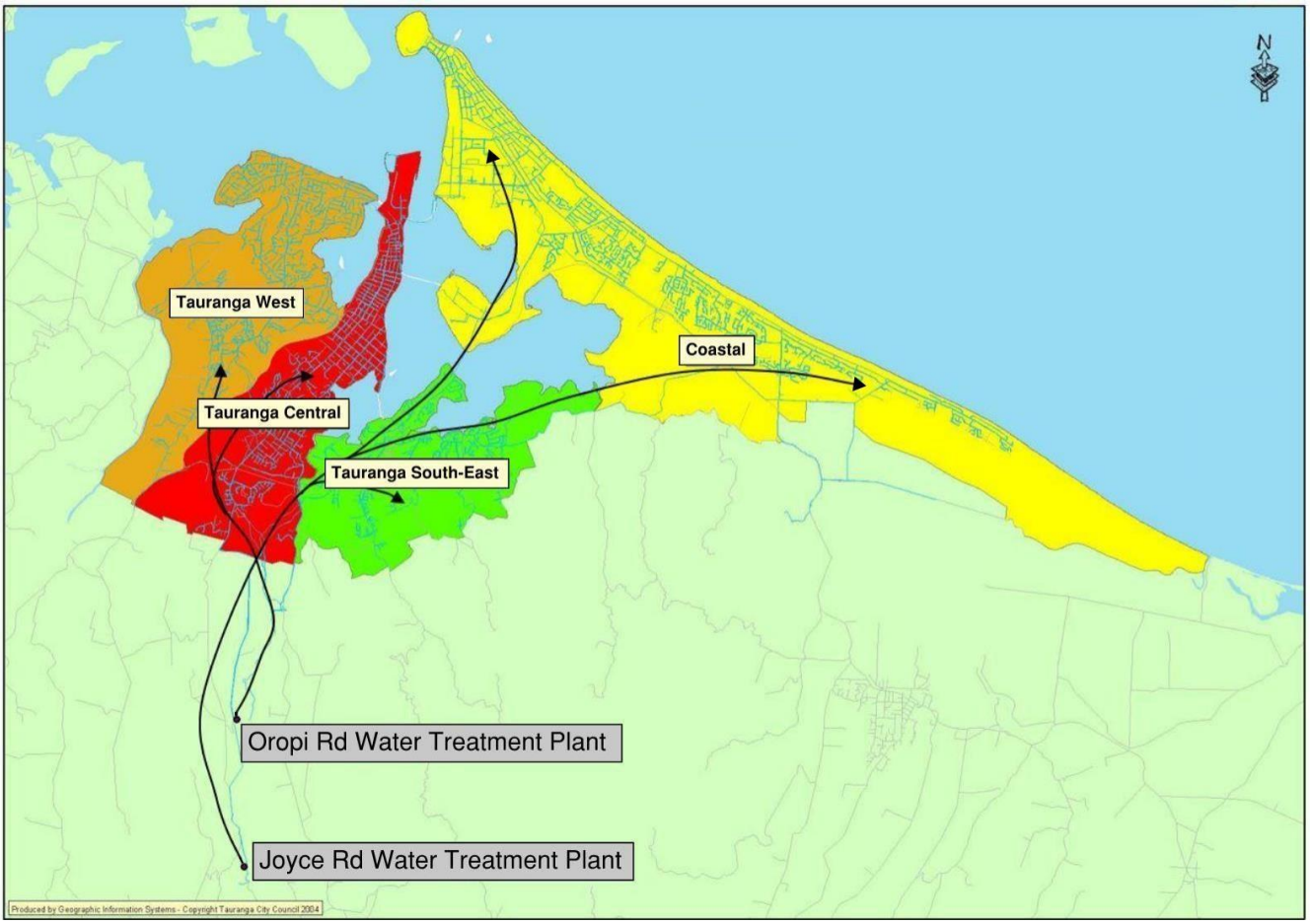

Figure 2 Current Water Supply Network Structure

3 DEMAND MANAGEMENT

As part of the strategy to meet predicted water demand TCC implemented a two pronged action plan: to manage demand and to develop infrastructure to meet demand in excess of capacity. The outcomes of TCC's demand management initiatives are summarised below.

3.1 UNIVERSAL WATER METERING

TCC implemented universal water metering, volumetric charging for water and a consumer education programme in 2002. Peak demand immediately reduced by approximately 30%, with average demand reducing by about 25%. Figure 3 shows the impact of water metering on the peak and average water consumption per person per day.

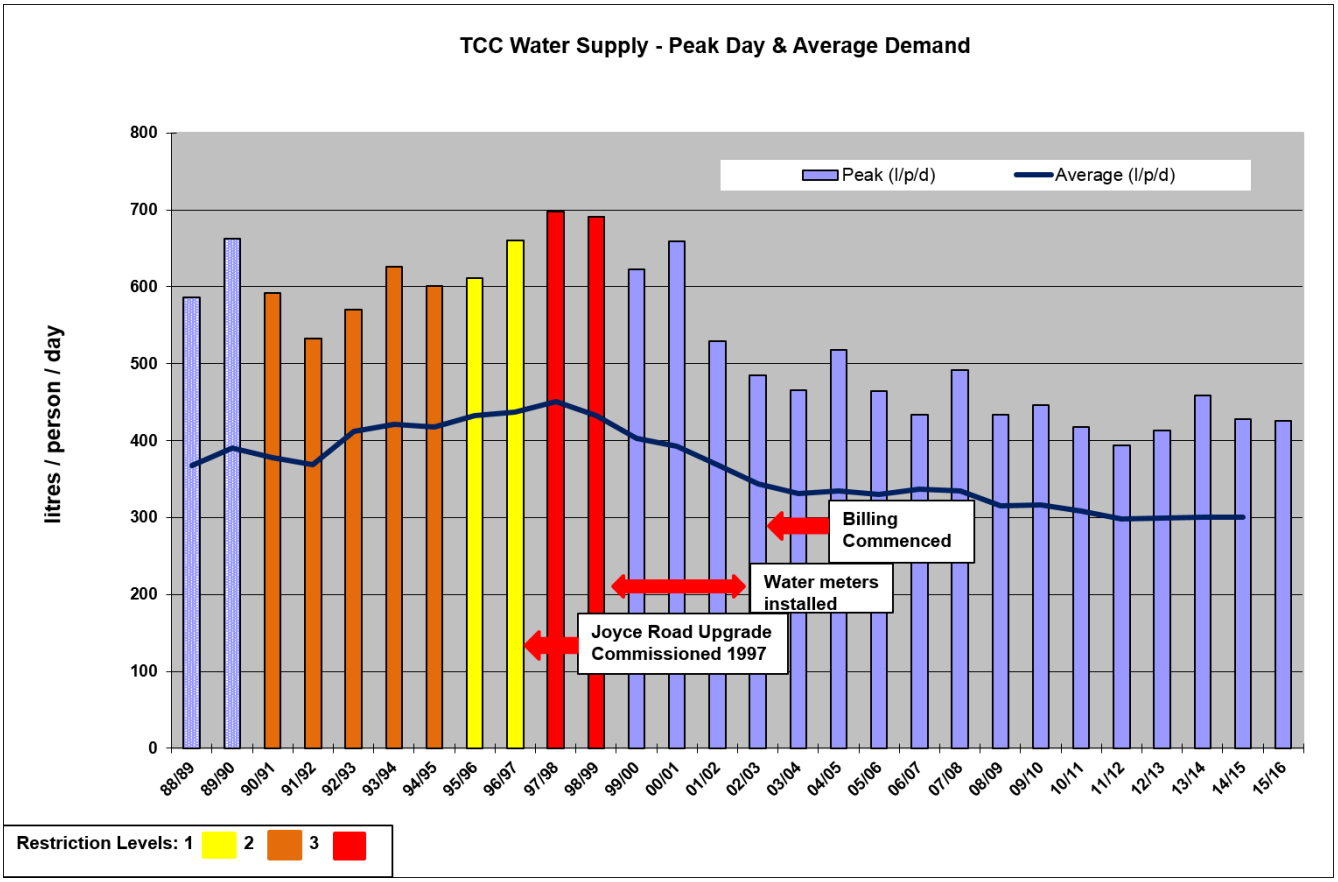

Figure 3 Peak and Average Day Consumption

The primary benefit of the change in water use behaviour as a result of volumetric charging for water has been the significant delay in the development of the third water source. On the basis of these successes the revised estimates for the need of the new source were revised from 2005 to 2015. Further deferrals (to 2021) were also achieved and these are described later in this paper.

The need for increasing supply is driven primarily by peak demand. In Tauranga and in particular the Coastal Strip, that peak demand is mainly weather related.

Figure 4 shows the bulk water demand pre and post the implementation of volumetric charging. This figure shows the overall reduction in bulk water demand resulting from the consumption reduction, despite the growth in population between 2000 and 2008.

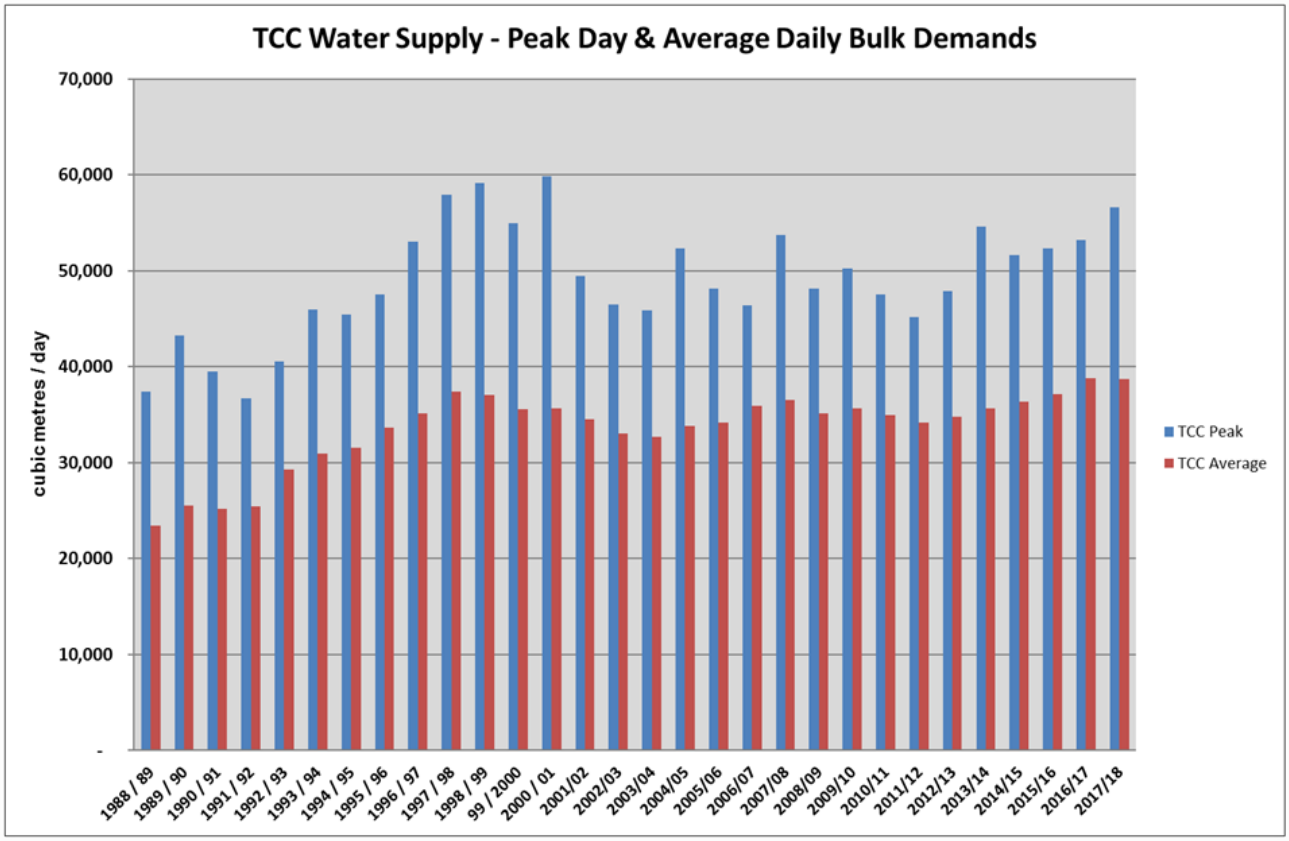

Figure 4 Peak and Average Bulk Water Demand

3.2 GLOBAL FINANCIAL CRISIS

Besides the effects of normal population and economic development growth, water demand decreased during global financial crisis that occurred in 2007/2008. This can be seen by the small dip in bulk demand shown in Figure 4 from 2007/08 through to 2011/12. As a result of this and in line with its policy of "just in time infrastructure", TCC decided not to proceed with the construction of the Waiāri Water Supply Scheme until such time as the development and growth demands signalled the need.

4 CONSENTING AND PLANNING

Given anticipated long lead times and extensive consultation, TCC started the land acquisition and consent preparation activities well in advance of the predicted demand delivery deadline.

Land acquisition and consenting for water treatment and supply purposes were completed by 2010.

CH2M Beca (2008) undertook a review of the previous work performed by to identify the Waiāri Stream as the third water source for the City. That review confirmed, through a quadruple bottom line assessment (QBLA) which took into account social, cultural, economic and environmental well beings that the Waiāri Stream was the preferred option for the next water supply scheme for the City.

As part of the joint development TCC and WBoPDC agreed to jointly apply for a water abstraction consent from the Waiāri Stream.

4.1 CONSENTS

In order to secure the Waiāri water source, TCC obtained the following key consents:

Table 1 Key Consents

CONSENT	KEY POINTS	LAPSE DATE	EXPIRY
Site Designation	In WBoPDC District Plan		Lasts the life of the District Plan
Water Take from the Waiāri Stream	60,000m^3/day (joint consent with WBoPDC)	2020	2044
Undertake Works in a Stream	Subject to strict construction periods	2020	2021
Earthworks Consent	Has to be completed within 3 years of commencement	2020	2021

The consent application was subject to extensive consultation and the application went to the Environment Court for a decision prior to it finally being granted in 2010.

4.2 PROPOSED PLAN CHANGE 9

Ian Jowett (2008) assessed the instream minimum flow requirement for the Waiāri Stream for the water take consent application using the method in the Bay of Plenty Regional Council (BoPRC) Proposed Water and Land Plan (version 9.9.2) which allowed for assessment of effects of flow levels on various environmental factors.

The consents for the Oropi (54,400 m^3/day) and Joyce (37,300 m^3/day) water takes are due for renewal in 2026. Ian Jowett (2008) carried out an assessment to estimate the minimum flow requirements within the Waiorohi and Tautau Streams using these same methods. The assessment concluded that there is a potential that the total allocation from the two plants could be reduced by over 30 ML/day when there consents are renewed.

This development has added considerable uncertainty over the potential allocation available to TCC after 2026.

4.3 KAITIAKI ADVISORY GROUP

The water take permit conditions required the establishment of a Waiāri Kaitiaki Advisory Group (KAG). Its purpose is to provide advice to TCC and WBoPDC, as the joint consent holders, in relation to monitoring results and environmental and cultural effects. The KAG comprises four TCC elected members (includes Chairperson), two WBoPDC elected members, four iwi/hapu representatives and a representative from BoPRC.

5 DEMAND, GROWTH AND TIMING

In 2015, subsequent to the recovery from the global financial crisis, water demand projections started to show a significant increase. Previous assessments undertaken to determine the appropriate timing for the implementation of the Waiāri Water Supply Scheme had been reasonably simplistic comparing demand growth (population x peak consumption) vs. available treatment capacity. While this approach was reasonable for long term planning it was considered that a more detailed approach needed to be followed when committing significant capital spend on the project.

5.1 DEMAND FORECAST AND THE SUPPLY-DEMAND BALANCE

CH2M Beca (2016) undertook a demand forecast and investigated the uncertainties in the supply-demand balance to assess when the capacity of the existing WTPs may be exceeded. It was agreed that the forecast would be based on the 'advanced' demand forecast framework (Reed & Reed, 2014) category, given the risk to the supply-demand balance and the data available as a result of universal metering. The benefit of undertaking this level of supply-demand balance is that it will provide a more accurate assessment of when the new water source needs to come on line.

A number of different drivers that affected TCC's investment decision are summarised below:

- Population growth across the city leading to increased demand, which will exceed the capacity of the existing WTPs;

- Non-uniform growth (areas such as Papamoa and Pyes Pa / Tauriko are growing faster than the city as a whole). Local demand is now close to exceeding the capacity of the Joyce WTP that serves this area and the bulk transmission infrastructure to enable peak demand to be met.

- Inclusion of an appropriate allowance for the production risks at the two existing WTPs (outage)

A demand forecast was developed based on the different components of demand (population, consumption, peak factors, non-revenue water etc.). This showed peak day demand was expected to grow from 55 ML/d currently to 62 ML/d in 2021 and over 80 ML/d by 2050.

An assessment of the overall water available for use was carried out by taking into account physical and regulatory constraints to the water supply, together with an allowance for outage. The modelled outage results ranged between 3.2 ML/d (5th percentile) and 7.8 ML/d (95th percentile) with .a mean outage value of 5.3 ML/d that was adopted for the peak month. The available water for supply was therefore calculated as 61.7 ML/d. This excluded risks such as membrane fouling, which can be significant, reducing the capacity of the WTP by 15 ML/d or approximately 50%.

A comparison of the forecast peak day demand for water and the available supply is shown as Figure 5. This suggests that the peak day demand would reach the water available for use in the 2020-21 financial year. Therefore, TCC needed to invest in additional water supply infrastructure prior to 2021.

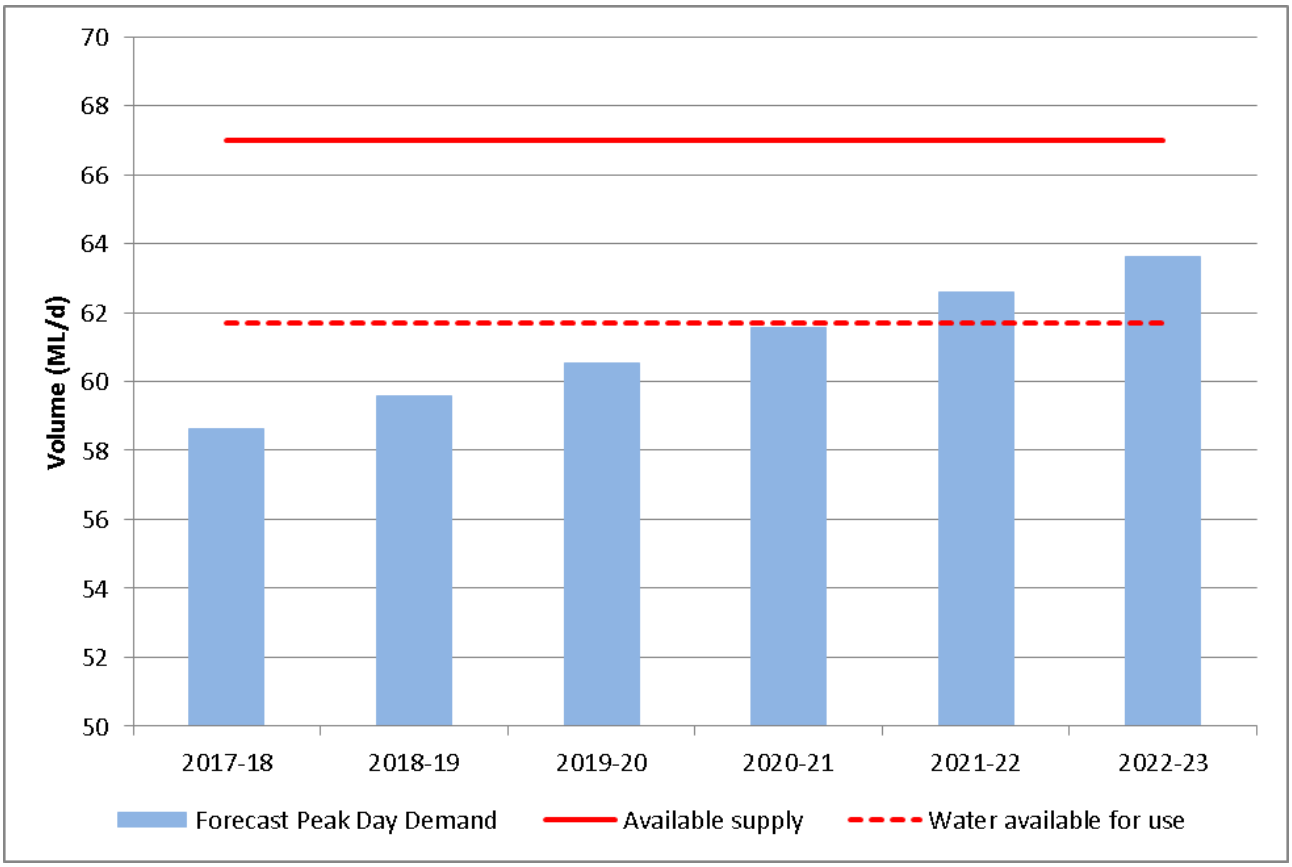

Figure 5 Forecast peak day demand and water available for use

5.2 WAIĀRI WATER SUPPLY - WATER SOURCE STRATEGY REVIEW

Given the lapsed time between the original water source strategy development and the recommended date for implementation, together with the risks and uncertainties described in this paper it was decided that the Water Source Strategy should be reviewed again with the latest available data, risks and drivers. The purpose of this review was to enable TCC to make an informed decision, based on the most current conditions, on whether to proceed with the proposed Waiāri Water Supply Scheme in its 2008 form, or follow an alternative strategy.

CH2M Beca (2017) undertook this review of the strategy taking into account changes since 2008 of:

- Revised population forecasts
- Updated supply and demand forecasts
- Revised cost estimates
- Risks to existing consents

The review was again undertaken using a QBLA approach while a risk assessment of the project uncertainties was also added. Future uncertainties included:

- Increased demand

- The consent for the proposed Waiāri WTP will lapse in 2021
- The existing resource consents at the Oropi and Joyce WTPs may be reduced in 2026 (subject to the new Regional Plan change which is currently under notification

The original options and sequencing were reconsidered plus some new sub-options were added. Although not the lowest net present value cost, based on the findings of the review TCC decided to implement the strategy of developing the Waiāri Stream source.

The network supply structure resulting from the confirmation of this water source strategy is depicted in Figure 6

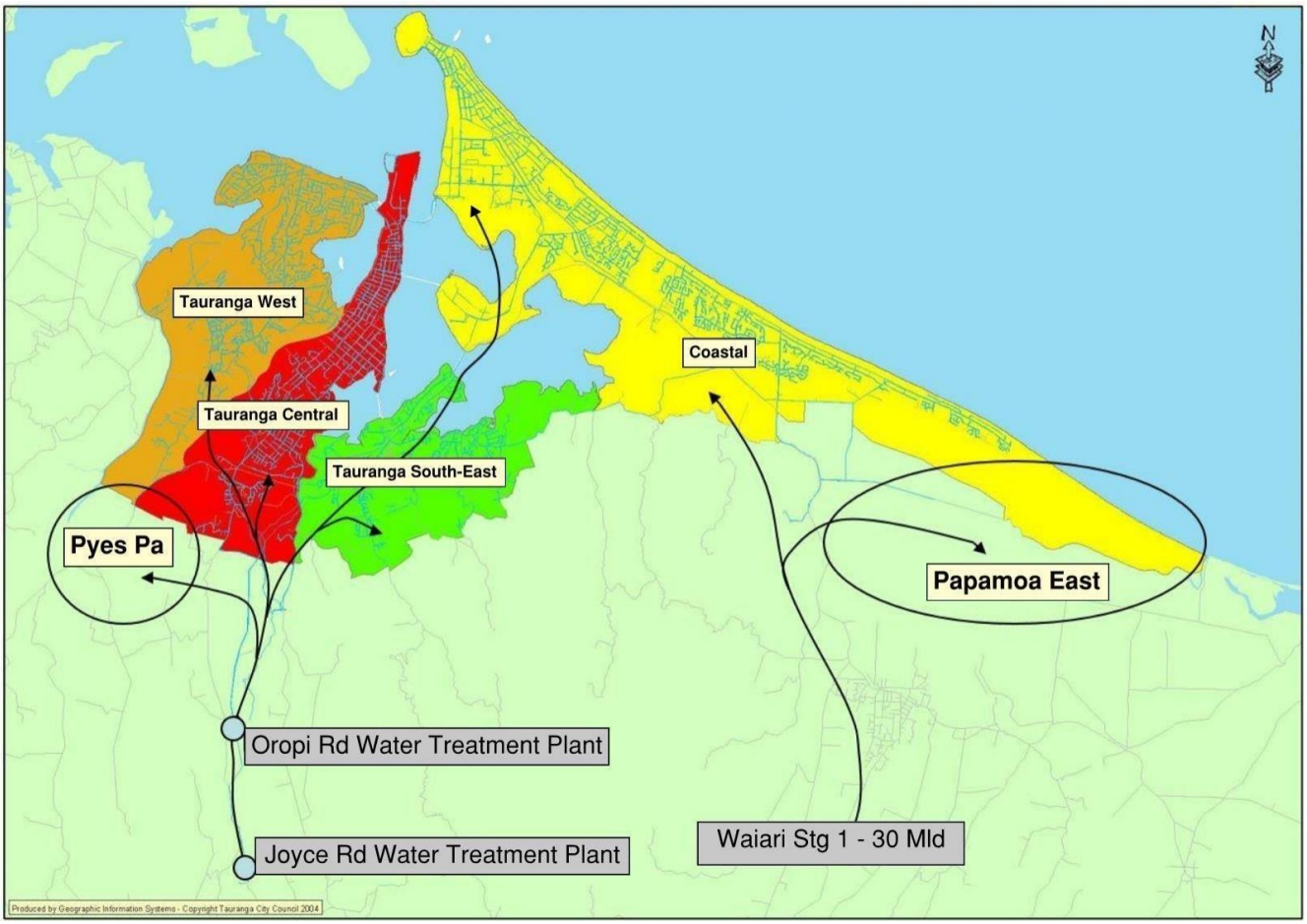

Figure 6 Water Supply Network with the Waiāri WTP

5.3 PROJECT PHASING

Once TCC had committed to the Waiāri Water Supply Scheme as the preferred option to meet the city's water demand, detailed planning for the delivery of the project was commenced.

During the planning and concept design phases completed in 2008, it was proposed that the Stage One of the Waiāri Water Supply Scheme would have a capacity of up to 30 ML/d with future upgrades in two increments of 15 ML/d to a final capacity of 60 ML/d. CH2M Beca (2017) undertook a review of the works and identifies project staging options

to determine a construction approach that provides the best value to TCC in terms of cost, operability, expandability and minimised risk.

The benefit and objectives of undertaking this review were to:

- Minimise the total NPV cost and defer capital expenditure where possible
- Reduce risks to level of service interruptions, including during capacity upgrades
- Allow for advances in water treatment process technologies in the medium to long term

This assessment considered headroom uncertainties from future population growth, potential reductions to the Tautau water take consent, network resilience and the ability to shut down critical treatment or reticulation infrastructure for extended periods to complete major upgrades or network maintenance.

The assessment concluded that the initial treated water production capacity of the Waiāri WTP should be 15ML/d plus an allowance for outage, to allow for uncertainty in water demand predictions over the first 10 years of operation. It was further decided that the first stage of the Waiāri WTP would provide for all major civil and mechanical works to allow plant upgrades up to 30 ML/d to be completed within a period of one year if required. This is to allow for simple expansion of the WTP if there is higher than anticipated water demand from the Waiāri Water Supply Scheme (e.g. reduction in the Tautau water take consent).

6 PROJECT IMPLEMENTATION

The Waiāri Water Supply Scheme is now in its implementation/detail design phase with the contract for the construction of the intake access and river intake works having been awarded and the tender for the micro filtration membranes having closed.

The components of the WTP section of the scheme are shown in Figure 7 and consist of:

- Access to the water intake site on the Waiāri Stream
- A water intake and raw water pump station lifting the water the 80m up to the WTP
- Twin raw water pipelines
- Micro filtration WTP
- Residuals management (sludge treatment) facilities
- Treated water reservoir

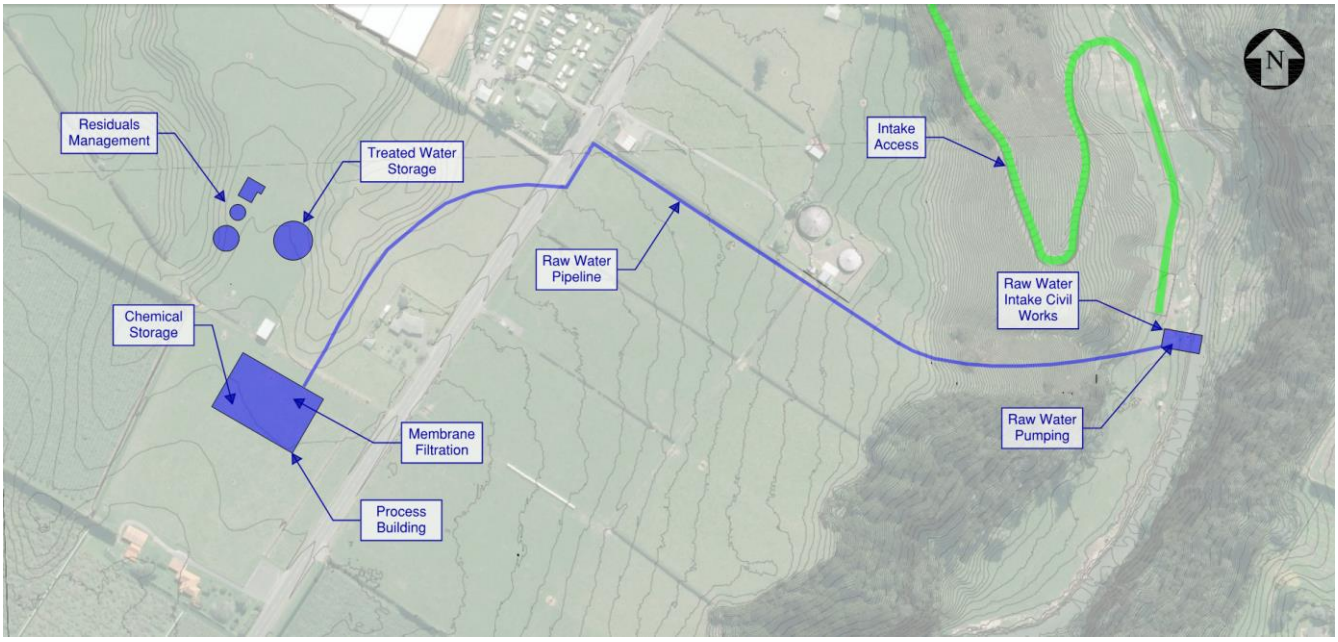

Figure 7 Waiāri WTP and Intake Schematic

During the implementation phase further assessments and concept reviews have been undertaken with the intent of refining and improving the concepts that were developed for the planning and consenting phases.

Additional studies are described below.

6.1 PROCUREMENT PLANNING

Procurement plans were produced for the whole Waiāri Water Supply Scheme. The preferred option bundled work packages into fewer and larger contracts resulting in a more competitive response from experienced contractors.

These plans proposed the procurement of the scheme be split into four construction contract for its delivery.

- A single design/ tender/ build contract for the access, intake and raw water pipelines
- A design/build contract for the micro-filtration membranes
- A single design/ tender/ build contract for the construction of the WTP, sludge handling facilities and the treated water reservoir.
- A single contract for the 21km of treated water pipelines.

6.2 RESIDUALS MANAGEMENT REVIEW

The consented concept for the WTP was for a "zero discharge" of liquid wastes to the environment residuals management process. Various other options were investigated including an option to pipe the backwash wastes to the WBoPDC's Te Puke waste water treatment plant.

The benefit of undertaking this options review was to make available the necessary information and data on which TCC could more confidently base its decisions. Ultimately, on the balance of cost and risk it was decided to retain the consented "zero discharge" concept.

6.3 INTAKE CONCEPT

In conjunction with the decision to reconsider the grit removal process design described below a review of the consented intake and stream works structures was undertake. A Tee Screen type intake was considered to provide a more efficient intake option and reduced the footprint of works in and adjacent to the stream.

The benefits of undertaking this concept design review was increased pump station resilience and efficiency; reduced footprint; improved screen operability; noise reduction and less flood impacts on surrounding areas. These benefits were gained without increasing the capital cost.

6.4 WATER TREATMENT PROCESS REVIEW

The concept process design was reviewed with an increased focus on robustness of operation and resilience. On this basis it was decided that grit removal would not initially be undertaken at the intake site (although provision for retro-fitting cyclone grit separators was allowed for) and that flocculation and Lamella clarification would be added.

The benefits resulting from the decision to include clarification are; a greater range of raw water quality can be processed through the plant and additional protection to the membrane filters is provided.

7 CONCLUSIONS

The planning of the water supply for a rapidly growing city is a long term process. Activities such as consultation, consenting, land acquisition and final procurement are all time consuming activities over which implementing agencies may have varying degrees of control. The realities of the RMA and stakeholder interests make acquiring the rights to abstract and supply water more challenging and the need to provide sufficient time to achieve this is essential.

Although the core objectives and needs might remain constant, factors influencing detailed decision making will vary over the life of the planning period. To successfully plan and deliver for the water needs of a city requires adaptability and flexibility to address the changing environment and factors that will be faced.

For the Waiāri Water Supply Scheme to deliver on its objectives as being the next water source for the Tauranga community the implementation team have had to remain agile while pioneering and negotiating the journey from its original inception through to implementation.

REFERENCES

- CH2M Beca 2008 Waiāri Water Supply – Water Source Strategy Review, CH2M Beca 2008

- Ian Jowett 2008, Effect of water abstraction on the Waiari Stream, Ian Jowett Consulting, May 2008

- Ian Jowett 2008 Water Allocation Requirements for Water Supplies on the Waiorohi and Tautau Streams, Ian Jowett Consulting, November 2008

- CH2M Beca 2016, Demand Forecast and the Supply-Demand Balance, CH2M Beca 2016

- Reed C. and Reed J., 2014, Demand forecast framework for New Zealand

- CH2M Beca 2017, Waiāri Water Supply - Water Source Strategy Review 2017, CH2M Beca 2017

- CH2M Beca 2017, Waiāri Water Supply Scheme - Project Phasing Assessment Report, Ch2M Beca 2017