WASTEWATER - TO DRINK OR DISCHARGE, LESSONS FROM TAURANGA.

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ABSTRACT

Tauranga City is planning a $106 million, 14.5 kilometre wastewater interceptor to transfer wastewater from growth areas to the south and central of Tauranga City across town to an existing wastewater treatment plant. This interceptor sewer is known as the Southern Pipeline Project (SPP)

An external peer review of the SPP considered that a satellite Southern Wastewater Treatment plant (SWWTP) designed to produce near drinking quality water, which would discharge to a small inland stream, should be further evaluated.

The expected benefit of the SWWTP compared with the SPP was that a treatment plant could be staged over a number of years and would reduce risks associated with unplanned growth, avoid high upfront costs, avoid construction disruption from a pipeline and provide an opportunity for reuse of reclaimed water.

The SWWTP would have an ultimate capacity of 12,000 m^3/day ADF and to achieve the desired output quality would use a BNR/MBR/RO treatment process.

The SWWTP option was evaluated and detailed cost estimates were prepared, including holistic costing of all potentially affected facilities to 2051, so that an equal comparison could be made with the SPP. If adopted the SWWTP would have been the first of its type in NZ.

KEYWORDS

Wastewater, reverse osmosis, reuse, reclaimed water, decentralised treatment, satellite treatment plant, whole of life costing, cost benefit analysis.

1 INTRODUCTION

Tauranga City is the third fastest growing city in New Zealand and with that comes demands on the existing sewerage infrastructure. As growth generally occurs at the extremities of the existing reticulation, there is typically little or no spare capacity within the existing reticulation to cater for these new growth areas. The more recent growth area for Tauranga is in the southern catchments being the Tauriko and Pyes Pa areas.

These growth areas are on the opposite side of town to the existing wastewater treatment plants and ocean disposal. The city has two wastewater treatment plants (WWTP), one near the city centre at Chapel Street on the Te Papa peninsula and the other on the coastal strip at Te Maunga.

Of the two existing treatment plants, the closest plant to the developed areas is Chapel Street WWTP. This is a mature plant, confined by development, and situated near the centre of downtown Tauranga. The treated effluent from Chapel Street WWTP is pumped to the newer Te Maunga WWTP where both flows are combined to discharge via the Papamoa Ocean Outfall. The Te Maunga WWTP is a 13 year old plant on an isolated site with room for expansion. As Chapel Street WWTP has limited capacity for expansion, the role of the Southern Pipeline Project (SPP) is to direct the growth related untreated wastewater flow to Te Maunga.

Whilst an optimised interceptor sewer route can readily be determined, alternatives needed to be explored for a number of reasons being:-

1. At $106 million, the cost of the14.5 kilometre interceptor (including two major pump stations) was significant and there was strong pressure from various parties, including the developers who would ultimately fund part of the project, to find a lower cost solution.

2. The SPP would be the most expensive project undertaken by the Council and would have a significant effect on Council's cash flow and debt levels. This was affecting the opportunity to fund other non-wastewater related projects.

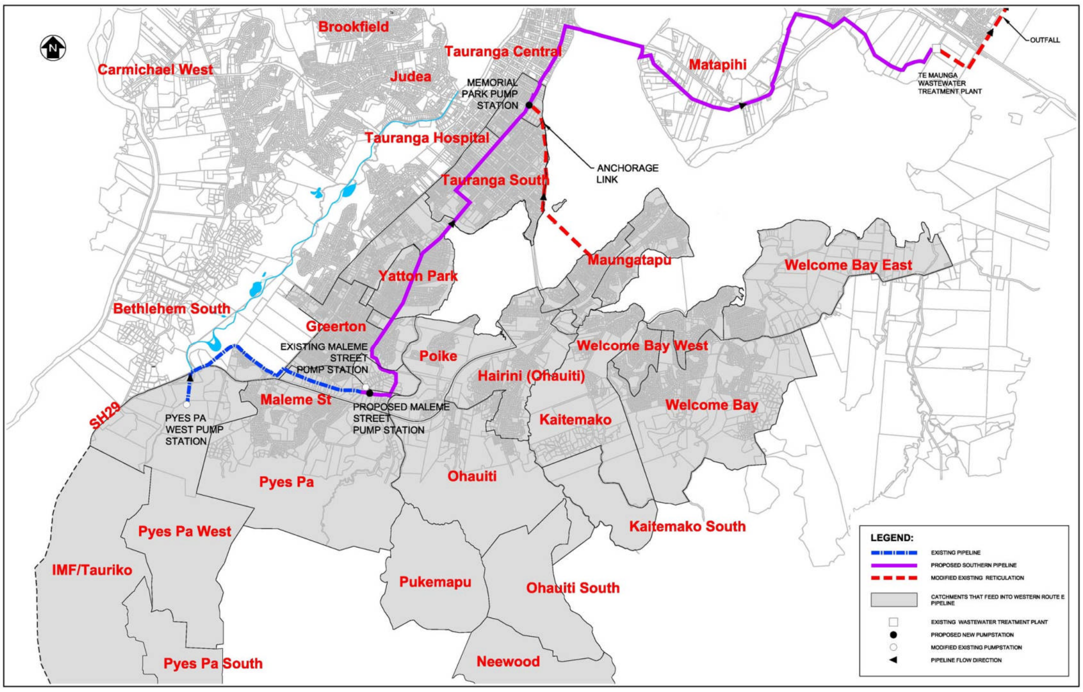
3. The SPP involves a 1 kilometre long harbour crossing through the Coastal Marine Area (CMA). Alternative options needed to be thoroughly explored.

4. The interceptor sewer was seen by some as "old technology" that did not embrace sustainable or green treatment and disposal options.

5. Council had committed in the Regional Growth Strategy (SmartGrowth) to include stretch targets to reduce wastes. Reuse of reclaimed water from a decentralised WWTP would go towards meeting this objective.

Figure 1 shows the extent of the City under consideration and the principal area(s) to be serviced by the SPP.

Figure 1 Catchment area(s) to be serviced by the SPP (shaded grey).



The purpose of this paper is to set out some of the issues that the authors encountered in the study and to summarise some of the more significant aspects that are not always transparent when considering centralised verses decentralised and reclaimed water options.

2 EVOLUTION OF WASTEWATER ASSETS

Virtually all New Zealand towns and cities follow a pattern of population growth expanding outwards from the city centre via a series of green field developments. This is due to the value of the bare land needed to develop affordable subdivisions. Each of these green field subdivisions creates a need for community facilities including wastewater management.

There comes a point where the existing trunk sewer network is unable to service outlying green field developments and either new major interceptor sewers are required, or alternatively wastewater treatment plants installed where receiving environments can sustainably manage wastewater disposal.

Typically a number of smaller wastewater treatment plants cannot achieve the same efficiencies of treatment that a single treatment plant can provide. Multiple treatment sites require multiple areas of land, multiple discharge consents and provide fragmented operation. Therefore there is a tendency to maximise the use of existing facilities.

However there are increasing expectations from within communities to develop sustainable solutions and this in turn raises challenges to conventional interceptor sewer systems verses new opportunities including provision of satellite treatment plants and to reuse the wastewater within the local community. Tauranga City's situation is similar to other developing cities in needing to address these issues.

3 SOUTHERN INTERCEPTOR SEWER PIPELINE (SPP) OVERVIEW

Tauranga has two wastewater treatment plant sites. Chapel Street site is a very "mature plant and site" with a confined footprint near the city centre. The second more modern Te Maunga site has substantial surrounding land area for development and a large buffer distance to the nearest housing. Both plants discharge treated wastewater via wetlands to the Papamoa Ocean Outfall which is near the Te Maunga WWTP.

TCC previously undertook a region wide study on the best use of the region's wastewater treatment plants under the *Smartgrowth* programme. This programme identified Te Maunga as the City's preferred wastewater treatment facility with the Papamoa Ocean Outfall as the preferred long term disposal option.

In considering options for growth management and as part of the SPP an extensive study comprising a GIS based constraints mapping, field investigation, hydraulic modelling and quadruple bottom line assessment (QBLA) was undertaken of possible interceptor sewer route options to link the southern catchments with Te Maunga.

A city-wide trunk sewer MOUSE model was developed which was used to identify constraints within the existing sewerage system. Increments of 10 years through to 2051 were modelled to determine the most appropriate route for the Southern Pipeline.

The model demonstrated that some Southern Pipeline route options permitted areas of the central city to be linked to the Southern Pipeline with minimal additional cost thereby eliminating other wider network constraints predicted to occur around 2021. The modelling also demonstrated the benefits of having a wastewater pump station "hub" at Memorial Park, as being the best solution for the 50 year development horizon, while providing opportunities for cross-links and overall operational flexibility beyond the 50 year horizon.

Using predictive modelling tools in this way is estimated to have saved the City at least $20M in future network upgrades.

The preferred route was determined to be from the southern catchments, through the city, crossing the harbour near the existing railbridge and then through the Matapihi peninsula to Te Maunga. Figure 5 shows a schematic of the route.

While a preferred interceptor route, with a high level of future city benefit had been identified, the cost of this development was significant and there was a strong community view that a lower Whole of Life (WOL) cost option could exist and that only "old technology" was being considered.

The project team were asked to determine whether a de-centralised, satellite treatment plant with a reclaimed water use was a viable option for the southern catchments.

4 COMMUNITY REACTION AND FEEDBACK

To gauge the community interest in the use of reclaimed water, the community was invited to respond to a questionnaire based on whether they would use reclaimed water (for selected purposes such as irrigation and toilet flushing) and how much they were willing to pay for it.

In addition the top twenty water consumption industries were identified and were asked whether they would consider using reclaimed water. It was quickly noted that many of the top water users were either food processing plants or community facilities like hospitals, hotels/motels or swimming pools, none of whom were likely to accept reclaimed water due to potential risks to their operations.

The survey findings were positive towards the use of reclaimed water. Of the 197 responses, 72% were in favour of using it in their home or business. 82% of respondents stated they would expect to pay less for the reclaimed water than drinking water and only 4% said they would pay more. Of the businesses surveyed 52% stated they would have a use for it, 14 % possibly and 34 % stating they would not use reclaimed water.

Overall there was a strong positive response in favour of water reclamation although the majority of respondents expected the cost of reclaimed water to be less.

Cost estimates showed that the production costs for reclaimed water are higher than the existing costs to produce "conventional" potable water and reclaimed water was limited in where it could be used. Currently Tauranga is not constrained in terms of long term availability of raw water sources. Therefore the community expectations for reclaimed water to be a lower cost product than conventionally produced potable water would require reclaimed water to be subsidised in some way. The form or method of subsidy was not examined during this evaluation.

5 SOUTHERN WWTP CONFIGURATION - OPPORTUNITIES AND ISSUES

Wastewater can be treated to any standard, if there are no financial constraints.

Tauranga's current wastewater system discharges through an ocean outfall off the beach at Papamoa. This was selected because of the community desire to cleanup the harbour and not have any wastewater, treated or otherwise, discharging into the streams that lead to the harbour nor discharge directly into the harbour.

It was important that the desired SWWTP site was located in proximity to the community to be serviced and that the site selection was sufficiently robust such that costings were reliable.

The location of the SWWTP was selected based on the following criteria:-

1. Proximity to community to supply wastewater and to be served with reclaimed water.
2. Moderately flat ground not subject to inundation.
3. Good access to power and road networks.
4. Close proximity to treated wastewater disposal and PWWF disposal location.
5. Ability to dispose of reject water. This will be discussed in the next section.

Four sites were considered and the preferred site and proposed plant location and footprint selected is shown in Figure 2. The site is adjacent to State Highway 29 and within 1 kilometre of the major southern residential areas.

Figure 2: Southern WWTP Scheme – Site Plan

NO.	DESCRIPTION	APPROX. AREA
1	INFLUENT BALANCE/ PWWF STORAGE	25 x 15m
2	SCREENING BUILDING	20 x 15m
3	GRIT REMOVAL BUILDING	INCLUDED IN 2
4.1	MBR REACTORS	2 No. 40 x 30m
4.2	BLOWER BUILDING	INCLUDED IN 4.4
4.3	CHEMICAL STORAGE AND DOSING	30 x 10m
4.4	MEMBRANE ANCILLARY SKID	30 x 15m
4.5	UV DISINFECTION	10 x 10m
4.7	WAS/REJECT STORAGE AND PS	10 x 10m
5.1	INTERMEDIATE BALANCE AND RO FEED PS	25 x 15m
5.2	RO UNITS AND ANCILLARIES	20 x 15m
5.3	UV DISINFECTION AND CHLORINE CONTACT TANK	20 x 10m
5.4	RE-USE WATER STORAGE (2 HRS)	20 x 20m
6	CONTROL, MCC AND WELFARE BUILDING	20 x 10m

LEGEND:

100m ODOUR BUFFER ZONE

EXTENT OF ARCHAEOLOGICAL SITE

STAGE 1

STRUCTURE INSTALLED AT STAGE 1
MECH/ELEC INSTALLED AT STAGE 2

STAGE 2/3

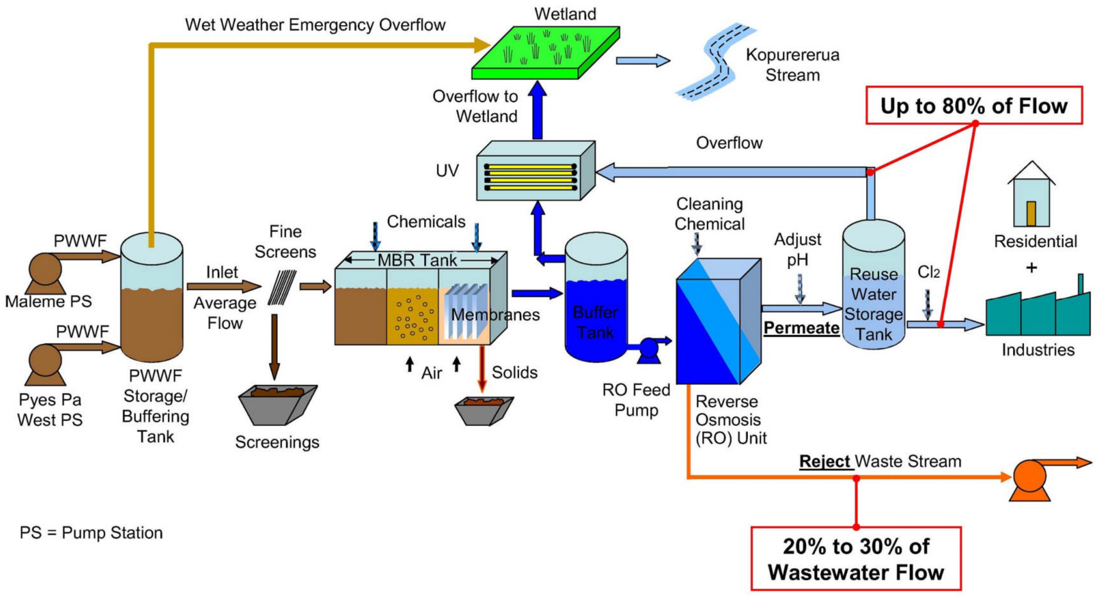
NOTE: 100 YEAR FLOOD LEVEL = EL 4.9m

The proposed SWWTP would require discharge to a relatively small stream (Kopurererua Stream- otherwise known as K-stream) with the treatment discharges in 2051 estimated to be 30% of the stream's average flow. K-Stream can be seen in the top left hand corner of figure 2. The associated effects of pathogens and nutrients on the stream, and the down-stream harbour, were of public and cultural concern. To reduce these risks the peer review panel suggested the installation of a BNR (Biological Nutrient Reduction) plant with an MBR/RO/UV (Membrane Bioreactor/Reverse Osmosis/Ultraviolet Disinfection) treatment system based on recent design trends in Australia. At the time of this study there was only one fully operational BNR/MBR/RO plants internationally (in the USA).

A schematic of the proposed facility is given in figure 3. Key features were:-

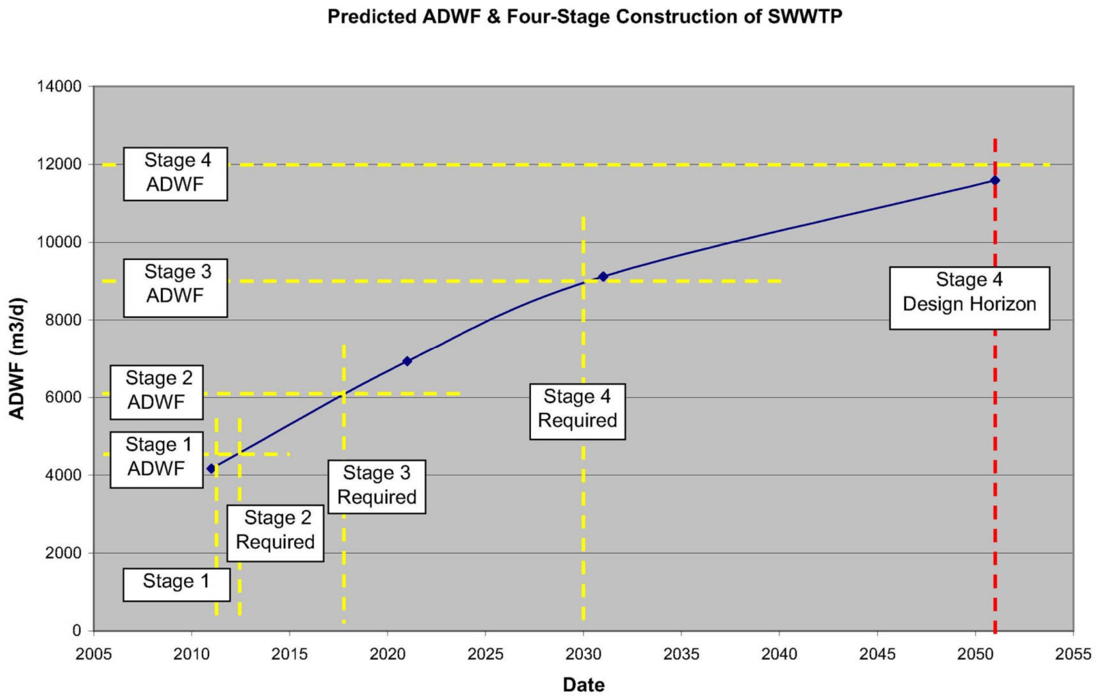
- Influent PWWF balancing facility / tanks.
- Inlet works – fine screens (3 mm expected to minimise membrane damage and blinding) and grit removal.
- Chemical addition to reduce total nitrogen and phosphorus concentrations in effluent.
- Biological WWTP reactors with MBR (using microfiltration).
- Reverse Osmosis for tertiary treatment.
- Inter-process overflow and storage facilities.
- Disinfection (both UV and Chlorine) for differing standards of effluent.
- Chemical dosing for membrane cleaning and pH correction.
- Disposal via wetland and localised outfall into K-stream.

Figure 3: Schematic of Proposed SWWTP.



The plant would be sized for an ultimate ADWF of 12,000 m^3 per day, which is 28 % of the city's future needs and would be established in 4 stages of 4500, 6000, 9000 and 12000 m^3 per day, staged as shown in figure 4.

Figure 4: Predicted ADWF & Four-Stage Construction of SWWTP.



The MBR/RO plant provided some new opportunities and challenges. The major opportunities were:-

1. The level of treatment was of such a high standard that obtaining resource consents involving a discharge into a relatively small stream and receiving harbour environment were considered achievable.

2. There was the ability to reticulate near potable water to the adjoining community, thereby minimising the volume discharged to the stream and also reducing the overall potable water use in that community by around 35%.

3. The overall treatment plant footprint was less than a conventional tertiary WWTP.

4. A WWTP was easier to stage which was perceived to have more potential to reduce cashflow than the SPP, where there was a high capital cost "up-front".

5. Staging could potentially open the opportunity for incorporating future technologies more readily than an interceptor sewer.

Key issues and challenges that became apparent during the investigation are presented here as a check list for others who may find themselves with similar challenges.

1. **Percentage of Treatable Flow -** The MBR process could be arranged to handle most of the diurnal peaks but not the required PWWF volumes. Therefore without

significant (and relatively expensive) untreated wastewater storage some wet weather overflow to the wetlands was inevitable. Consideration was given to using the wetlands as a storage facility, but this increased the overall site operational complexity and potentially the overall site footprint as additional storage was required.

2. **Flow Balancing and Attenuation -** The RO process was limited to managing average flow only. Therefore all diurnal peak flows (outside the MBR's buffering capability) either had to be buffered after passing through the MBR, by providing inter-stage storage/buffering, or bypass the RO thereby resulting in lower standard effluent discharging to the wetland and K-Stream.

3. **Reject Water Quality -** The RO process removes most of the dissolved salts but minimal dissolved gases (such as carbon dioxide). Also investigations and research by the team identified that removal rates for differing salts and gases varied quite considerably. In particular RO removal rates for nutrients varies from 95% to 98% meaning that the total annual nitrogen load to K-stream would still be around 500 to 3000 tonnes per annum, depending on process efficiencies. Since chemical dosing is used, including anti-biofouling chemicals, and since the SWWTP was an inland plant (it was about 12 kms from the coast) discharging to freshwater, it became clear that an extensive assessment of a wide range of chemicals would be required should the plant progress to a full environmental assessment stage. This is less of an issue for a plant with an ocean outfall disposal option in close proximity.

4. **Reject Water Disposal -** The RO process created a unique wastewater stream ("Reject Water") of 25% to 35% of the total flow comprising primarily of salts. In several cases in Australia, the amount of the RO take off stream for reuse is only a small percentage of the total flow (around 10%). In these circumstances the Reject Water can be re-cycled to the head of the plant and diluted with the incoming sewage to reduce reject volumes.

   This Reject Water could not be discharged to the adjoining stream and due to local deep groundwater bores, ground injection was not feasible. The Reject Water therefore needed to be piped through the existing reticulation to one of the existing treatment facilities. Despite dilution by sewage flows from other parts of the city, the operators of the existing facilities and their process advisors had serious concerns that this Reject Water stream would adversely affect the existing treatment processes and biosolids digestion.

5. **Potable or not? -** Throughout this paper, the discharge from the MBR/RO process has been described as near potable water. Our experience in Tauranga found two major reasons why it is only "near potable". The first is that it is treated wastewater and there is always a risk of a treatment process failure or reduction in performance, so the reclaimed water will not be to the standard intended. Chloramine or chlorine addition is needed to reduce the rate of biofouling of the membranes. THMs (trihalomethanes) are well rejected by RO membranes but around 50% of the NDMAs (N-Nitrosodimethylamine) passes through the membrane. Health limits for this trace constituent are 10 ppt (ng/L). Therefore there will be some NDMA present in the RO permeate. This is only a problem if the permeate (either as reticulated reclaimed water or in a downstream river draw-off) is used for potable water. To remove this trace contaminant would require a further chemical/physical treatment step which would add to the cost.

6. **Re-use Water Usage -** Because of the above trace constituents, the reclaimed water use also needs careful consideration as, despite the very high level of treatment and

disinfection, it could not be used where there was a chance it could be consumed. This constraint meant that reclaimed water use excluded hot water supplies, kitchens, hand basins, and laundry tubs. This primarily left toilets, outside taps, garden watering and some industrial uses as a possible points of reuse.

In addition any reticulation of the reclaimed water would need to be done in such a way that there was no chance of a cross connection with the potable water supply. To achieve this would require a separate reticulation system, both in the street and within the property and the installation of backflow prevention on any potable water supply within the same property.

7. **Biosolids** – The biosolids produced from the SWWTP would contain a number of process chemicals as well as biosolids and there was serious concern expressed by TCC's treatment consultants over the treatability of this waste within the existing TCC digesters at Chapel Street WWTP. Therefore separate handling and treatment of the biosolids was required once volumes increased significantly.

8. **Reticulation of Reclaimed Water -** The cost of the reticulation of the reclaimed water was significant. After the costs became known, the reticulation of reclaimed water to residences and local light industry was not actively pursued. However if there was a large single point use for reclaimed water (such as a power station), this may significantly change the economics for this option.

In conclusion, whist the technology exists to produce near drinking water quality reclaimed water, there are a number of significant waste streams and treatment plant product management processes that need to be carefully evaluated to assess their overall environmental effects.

6 THE HOLISTIC APPROACH

Due to the extent of potential effects of a satellite SWWTP on the overall Tauranga infrastructure network, the peer reviewers recommended a holistic approach be used when evaluating the options.

The holistic comparison between the Southern Pipeline Interceptor sewer option and the SWWTP option, involved assessing the entire Tauranga wastewater network through to the point of disposal, all planned trunkmain upgrades, biosolids treatment and disposal, outfall upgrades and all treatment plant upgrades to 2051. During the evaluation process the holistic approach was divided into two distinct areas.

The first aspect to consider was the desire to find a lower cost option by thinking outside the square. The SWWTP also offered the opportunity to change the "business-as-usual" way of disposing of treated wastewater by allowing for the reuse of reclaimed wastewater.

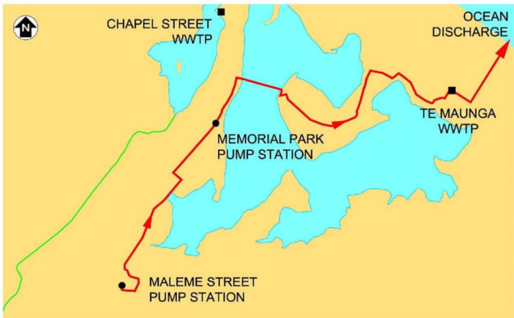
The second aspect was in comparing the funding for the different options. While Council had a cost to build an interceptor sewer and a separate cost to build a SWWTP, these costs did not allow for a like for like comparison to be undertaken.

In summary, two options were evaluated using the holistic approach, the first being the Southern Pipeline Interceptor Project (SPP), and the alternative being for the Southern catchments to be served by a de-centralised satellite treatment plant capable of treating to a near drinking water standard.

Figures 5 and 6 show the two options that were developed for direct WOL cost comparison and their key features.

Figure 5: Southern Pipeline Scheme

SOUTHERN PIPELINE SCHEME



KEY FEATURES:

2 x Wastewater Treatment Plants

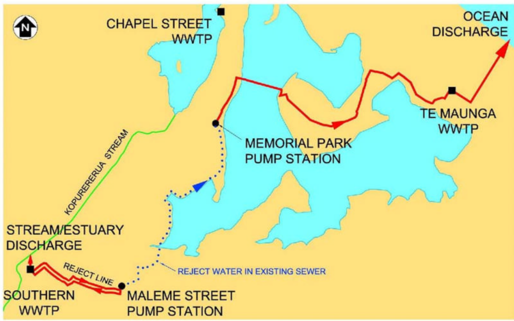
1 x Discharge Point (Ocean)

2 x New Pump Stations (Maleme St. and Memorial Park)

1 x Upgraded Pump Station (Otumanga)

Figure 6: Southern WWTP Scheme

SOUTHERN WWTP SCHEME



KEY FEATURES:

3 x Wastewater Treatment Plants

2 x Discharge Points (Ocean and Stream/Estuary)

2 x New Pump Stations (Maleme St. and Memorial Park)

2 x Upgraded Pump Stations (Otumanga and Pyes Pa West)

Whilst the cost of a pipeline or a treatment plant could be relatively easily estimated in isolation, a much wider cost comparison of all affected parts of the overall wastewater system was required to allow for holistic cost comparisons.

To complicate the comparison further, each option had different influences on the existing reticulation and treatment plants. As these were being influenced by other planned areas for growth, all major upgrades to the Tauranga wastewater network had to be considered.

The study found that whilst a treatment plant could be constructed to service the southern catchments, it didn't entirely eliminate the need for the SPP project. However the ability to defer planned upgrades of the existing treatment plants, as the new treatment plant was progressively commissioned, changed cash flow planning.

The total costs using the holistic approach were substantially higher that the initial capital estimates for both options because of expanding the costing scope to encompass all wastewater infrastructure upgrades. This was the first time the long term cost implications of an integrated city wide wastewater infrastructure had been considered in Tauranga. Base unit costs were developed by a number of consultants followed by allowances for non-construction costs (such as consenting, legal, project management, compensation, and land acquisition), preliminary and general, margin and design/supervision costs, which were then added separately to obtain uniformity for the costings comparison. A contingency amount for unforeseen circumstances for each area of work was added. Operational costs were similarly developed for each area of construction. A risk analysis using @RISK™ Monte-Carlo analysis was undertaken with an 85%ile value taken for budgeting purposes.

A NPV (Nett present value) and WOL (Whole of Life) cost analysis was undertaken to compare options as well as a sensitivity analysis on capital cost deferral in order to determine whether deferrals of particular components could result in a lower overall cost. The entire cost development process was peer reviewed. A substantial level of detail went into preparing the costing analysis and therefore only a summary of the results has been given in this paper.

Figures 7 and 8 give a graphical summary of the capital cost expenditure for both schemes distinguishing the areas in which infrastructure costs would be incurred.

Figure 7: SPP Annual Capex

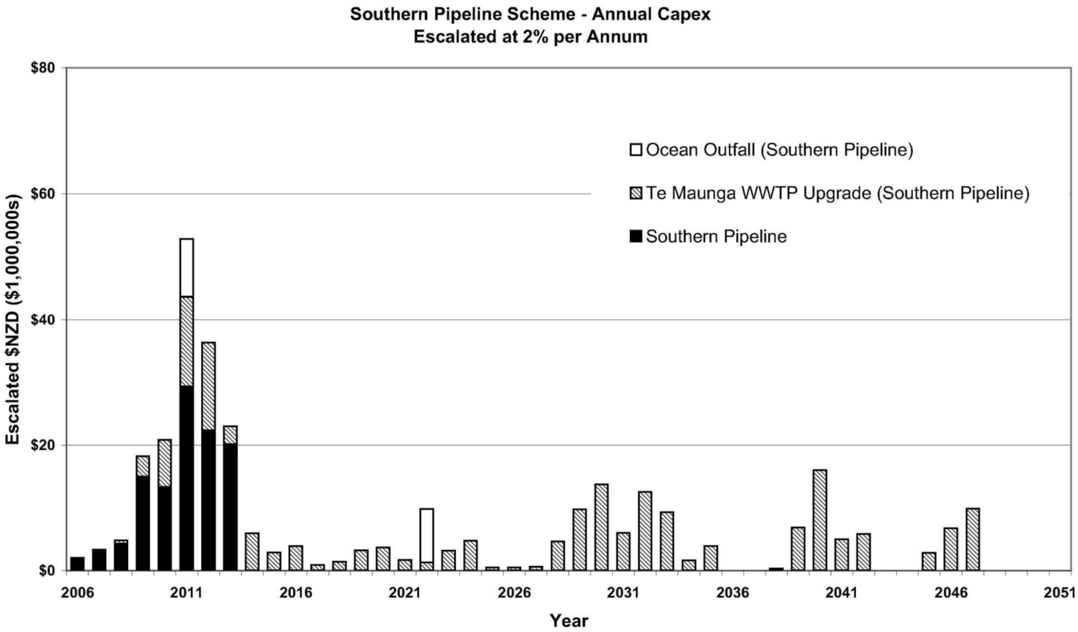
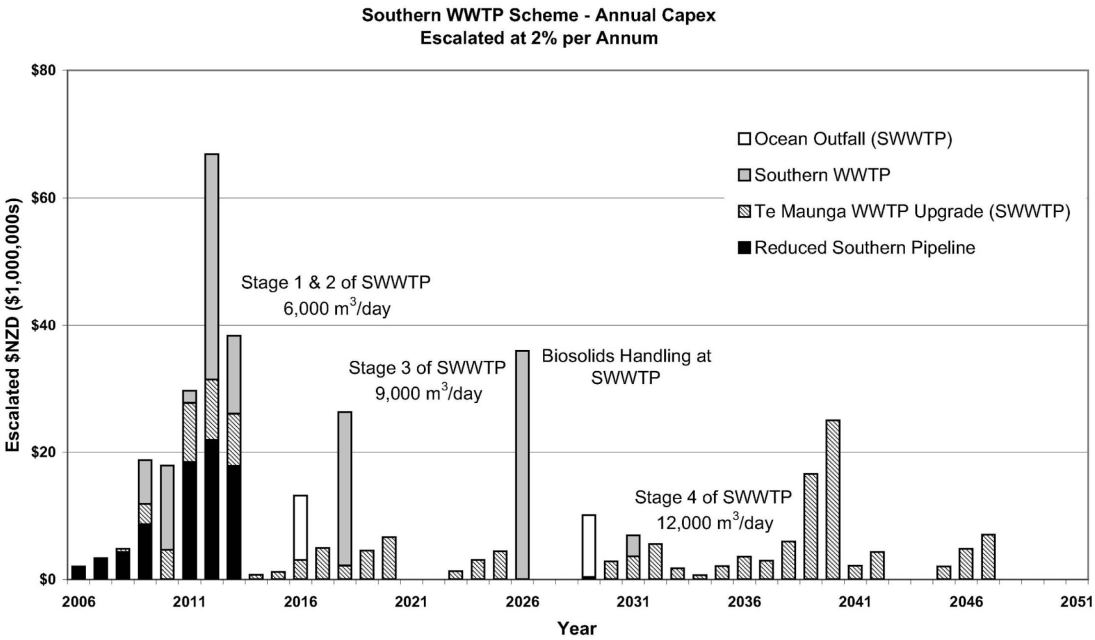


Figure 8: Southern WWTP Annual Capex.



It can be seen that, despite the staging option the initial capital cost for the SWWTP remained more than the SPP and therefore there was no cost benefit by staging. This was partly due to the need for both systems to pickup existing catchments and partly due to the need for a "Reject Water" pipeline to be constructed to the nearest existing reticulation, for the SWWTP. It was assumed that the initial biosolids production from the SWWTP would be pumped with the Reject Water for the first 13 to 14 years but thereafter a biosolids handing plant would be required at the SWWTP.

In summary the NPVs for the schemes were $306 M and $239 M respectively as the deferral of capital cost on the SPP provided a better long term financial position. Figure 9 shows that the WOL cost for the SWWTP was higher than for the SPP due to the higher operational costs for the SWWTP .

Figure 9: NPV and WOL costing comparisons for the schemes projected life

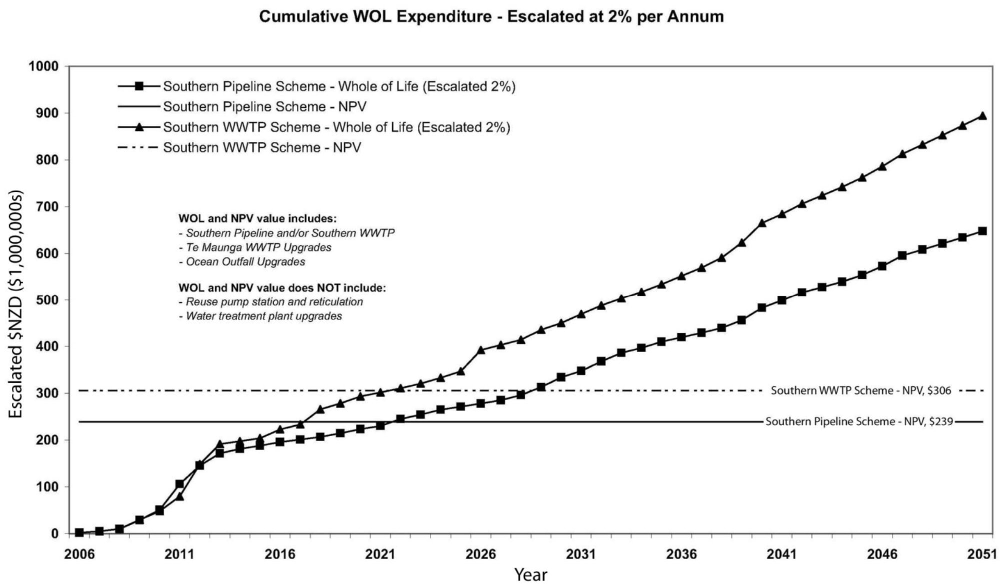
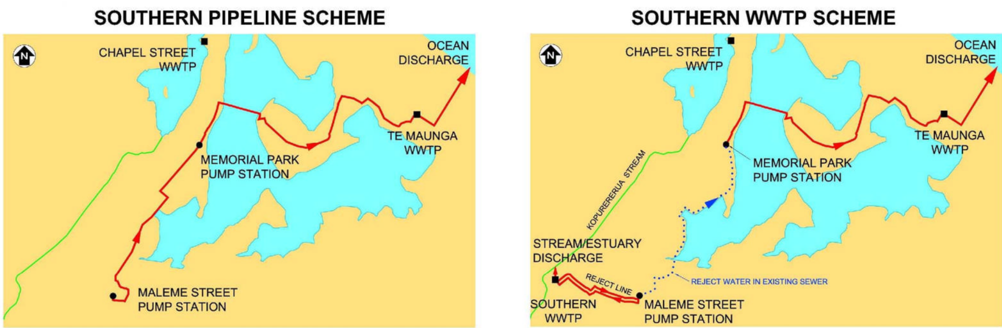


Figure 10 gives a breakdown of the capital cost per unit item considered for comparison.

Figure 10: Scheme Cost Comparison

SCHEME COST COMPARISON



Southern Pipeline Scheme

• Planning, Consenting & other Non-Construction Costs	$ 10.0m
• Maleme St. Pump Station & Storage	$ 13.4m
• Maleme St. to Memorial Park Pipeline	$ 20.1m
• Anchorage Siphon	$ 1.1m
• Memorial Park Pump Station & Storage	$ 11.8m
• Memorial Park to Te Maunga WWTP Pipeline	$ 49.0m
• Te Maunga WWTP Upgrades	$133.8m
• Ocean Outfall Upgrades	$ 15.4m
• **Total Overall Scheme Cost**	**$255m**

Southern WWTP Scheme

• Planning, Consenting & other Non-Construction Costs	$ 15.0m
• Southern WWTP	$ 85.7m
• Southern WWTP Ancillaries	$ 10.2m
• Maleme St. Pump Station & Storage	$ 11.2m
• Anchorage Siphon	$ 1.1m
• Memorial Park Pump Station & Storage	$ 8.9m
• Memorial Park to Te Maunga WWTP Pipeline	$ 45.9m
• Te Maunga WWTP Upgrades	$108.3m
• Ocean Outfall Upgrades	$ 15.4m
• **Total Overall Scheme Cost**	**$302m**

A reticulated reclaimed water scheme (trunk mains and pumping only) for a subdivision immediately adjacent to the SWWTP was also separately priced at $14.8 M capital cost to supply a peak flow of 137 L/s and average of 28 L/s for a population equivalent of 11,100 people including the industrial area. As stated previously, it had been assumed that reclaimed water would only be used for toilet flushing and external taps (irrigation). Industrial use was based on 7.5 m^3/day/hectare at ADWF. This gave a capital cost of around $3,500 per residential lot (excluding GST), based purely on up-front capital cost. The additional costs for dual piping, connections, backflow preventers and metering even for a “greenfield” site would substantially increase building costs and were not included in the above estimate.

The difference between the two options using the holistic costing approach was sufficient for Tauranga City Council to ratify its decision to proceed with the SPP option.

7 SUMMARY OF FINDINGS AND LESSONS LEARNED

The Southern Pipeline Project is a major investment for the Tauranga City Council and involved the investigation of a considerable number of options and alternatives.

The scale of the project generated strong community pressure to investigate, in considerable detail, “state-of-the-art” de-centralised wastewater treatment and use of reclaimed water, based on a holistic whole-of-city wastewater strategy.

Since the proposed decentralised plant was over 12 kms from the ocean, disposal of unused reclaimed water would need to be via a local freshwater stream to the Tauranga Harbour. Since the effluent quality would need to be exceptionally high to meet environmental and cultural criteria expected for a stream and harbour discharge, an advanced BNR/MBR/RO wastewater treatment facility was investigated.

A full city-wide cost analysis was undertaken for the two options; being a decentralised WWTP (SWWTP) and an interceptor sewer to an upgraded existing WWTP at Te Maunga and ocean outfall disposal at Papamoa (SPP).

Key lessons learnt were:-

1. Simplistic comparisons can distort options. In this situation holistic costs were needed to provide balanced comparisons.

2. The use of a city-wide network model to develop options, identify constraints and optimise upgrades can provide substantial savings to overall infrastructure development costs.

3. Despite early consideration of options at a high level, community pressure to re-visit “new” technologies can result in project delays and considerable additional investigative costs.

4. While new technologies can offer new opportunities, people often fail to investigate any weaknesses associated with these technologies, or those promoting new technologies fail to provide the total picture.

5. With wastewater there is still a difference between ideology and the technology capable of economically delivering the desired outcomes.

6. Challenges associated with an RO reclaimed wastewater plant treatment are not always obvious. In particular early consideration needs to be given to:-

    - Reverse osmosis systems do not take out all the minerals and chemicals. There can be a very wide range of percentage removal rates achievable by

RO. A detailed analysis of each chemical and element of environmental importance is needed. In particular removal rates for nitrates are lower than some other salts.

- Disposal and treatment of reject water, which contains a concentration of the captured salts, can be problematic if an ocean outfall or existing saline groundwater disposal route is not readily available.

- A detailed assessment of the chemicals used in the MBR and RO treatment trains to enhance nutrient and chemical capture by the membranes and for cleaning and biofouling control of the membranes is needed to ensure that reclaim options are not negated.

- The by-products produced by the above chemical interactions from the treatment trains and percentage passing through the MBR and then RO systems and their effect or long term fate within the biosolids stream and in the environment need to be well researched and understood.

- Ongoing maintenance costs and membrane replacement can be significant and therefore a WOL costing is considered essential if considering such a scheme.

7. While the de-centralised WWTP allowed for staging and deferred capital expenditure, the need for higher wastewater effluent standards and issues associated with disposal of chemical sludge, and for RO Reject Water management substantially increased costs, compared with a 14.5 kilometre interceptor sewer pipeline and two new major pump stations.

8. There was a high community acceptance of the use of reclaimed water although the expectation was that the cost to the consumer would be less than current potable supply.

9. Throughout the study there were ongoing concerns regarding the reliability of the quality of effluent and in particular control of reclaimed water if made available to residential customers (particularly if it was cheaper than potable water). This area would have required intensive work prior to the scheme proceeding to the next stage.

10. It was concluded that a large single point user of reclaimed water was preferable and ideally any RO plant should be located such that Reject Water could be discharge into an existing salient environment.

11. When considering major infrastructure developments, it is essential to consider a city wide "holistic" review.

The study concluded that an interceptor sewer option was more cost effective than a decentralised WWTP producing near drinking quality water.

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1. SmartGrowth Strategy and Implementation Plan 2006 (updated) for the strategic approach to growth for the Western Bay of Plenty sub-region, (Tauranga City Council, Western Bay of Plenty District Council and Environment Bay of Plenty Regional Council, et al., 2006)

2. Report 83 – Comparison Assessment Southern Pipeline Scheme and the Southern Wastewater Treatment Plant Scheme prepared for Tauranga City Council (URS New Zealand Limited et al., 2008).

NOMENCLATURE

ADWF	-	Average dry weather flow
BNR	-	Biological Nutrient Reduction
Lps	-	Litres per second
MBR	-	Membrane Bioreactor
NDMA	-	N-Nitrosodimethylamine
NPV	-	Net Present Value
PS	-	Pump Station
PWWF	-	Peak wet weather flow
QBLA	-	Quadruple Bottom Line Assessment
RO	-	Reverse Osmosis
SPP	-	Southern Pipeline Project
SWWTP	-	Southern Wastewater Treatment Plant
TCC	-	Tauranga City Council
THM	-	Trihalomethane
WOL	-	Whole of Life Cost