TIMARU WASTEWATER PONDS AND WETLANDS – BALANCING THE COSTS AND BENEFITS

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ABSTRACT

Timaru District Council has recently completed the Timaru Domestic Wastewater Treatment Plant upgrading project. This project had a capital cost of $19.1M, and is the final stage of the district-wide $60.7M Wastewater Management Strategy.

The Strategy provides for the separation of industrial and domestic wastewater and the construction of new domestic wastewater treatment ponds and wetlands near the existing milliscreen plant at Washdyke. These ponds and wetlands treat the separated domestic flows, including treated wastewater piped from the towns of Geraldine, Pleasant Point and Temuka. High strength industrial wastewater (trade waste) continues to be fine screened (0.75mm) at the milliscreen plant, before combining with the treated domestic flows for discharge to the marine outfall.

The treatment upgrade completed in December 2014, provides an appropriate balance between community financial and environmental aspirations. It focusses on the community's overall requirement to reduce the public health risks associated with the human component of the wastewater.

This paper describes the process undertaken to achieve an overall consensus on the Wastewater Strategy, the key issues for stakeholders, the consenting aspects of the treatment ponds/wetlands and the outfall, as well as the design and construction challenges and their resolution. The performance of the new ponds and wetlands is also discussed.

KEYWORDS

Timaru, wastewater strategy, treatment ponds, wetlands, marine outfall

1 INTRODUCTION

The Timaru District in South Canterbury comprises four main urban areas including the city of Timaru and the inland towns of Geraldine, Pleasant Point and Temuka. Each area has a piped sewer network serving a population of approximately 40,000 persons. In addition, the district has two significant industrial areas connected to the Timaru sewer network. These areas, located in the Port and at Washdyke (north of Timaru), support mainly food processing and related industries. The locations of the main urban areas are shown in Figure 1a.

Since 1987, Timaru's domestic and industrial wastewater had been treated at a 0.75mm milliscreening facility located at Aorangi Road, Washdyke with wastewater then discharged to the ocean via an outfall, located approximately 2 km to the north. Wastewater generated in Geraldine, Pleasant Point and Temuka was treated locally in oxidation ponds and discharged to the Opihi River and two of its tributaries.

Changing community expectations regarding environmental performance and emerging regulatory requirements prompted Council to begin a review, in 1997, of district-wide wastewater management practices. The Timaru District Wastewater Management Strategy was adopted in 2000 and the final stage of work (the upgraded Timaru Wastewater Treatment Plant), commissioned in early 2015 – refer to Figure 1b.

This paper describes the process undertaken by Council to achieve an overall consensus on the Strategy, the key issues for stakeholders, the environmental "context" of the upgraded WWTP and outfall, as well as design and construction challenges and their resolution. The operational risks and performance of the new treatment ponds and wetlands are also discussed.

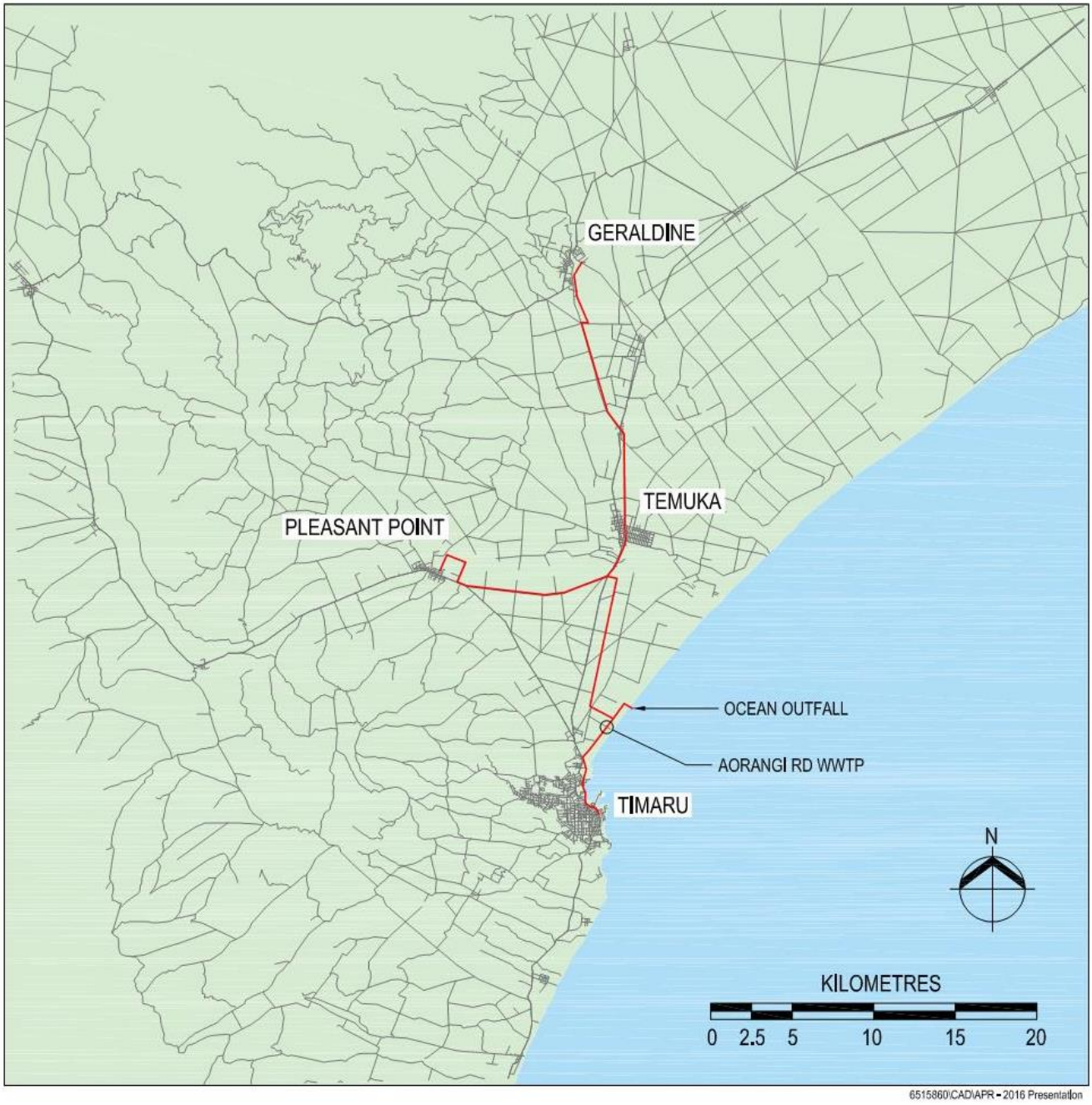

Figure 1a: Timaru District Wastewater Scheme

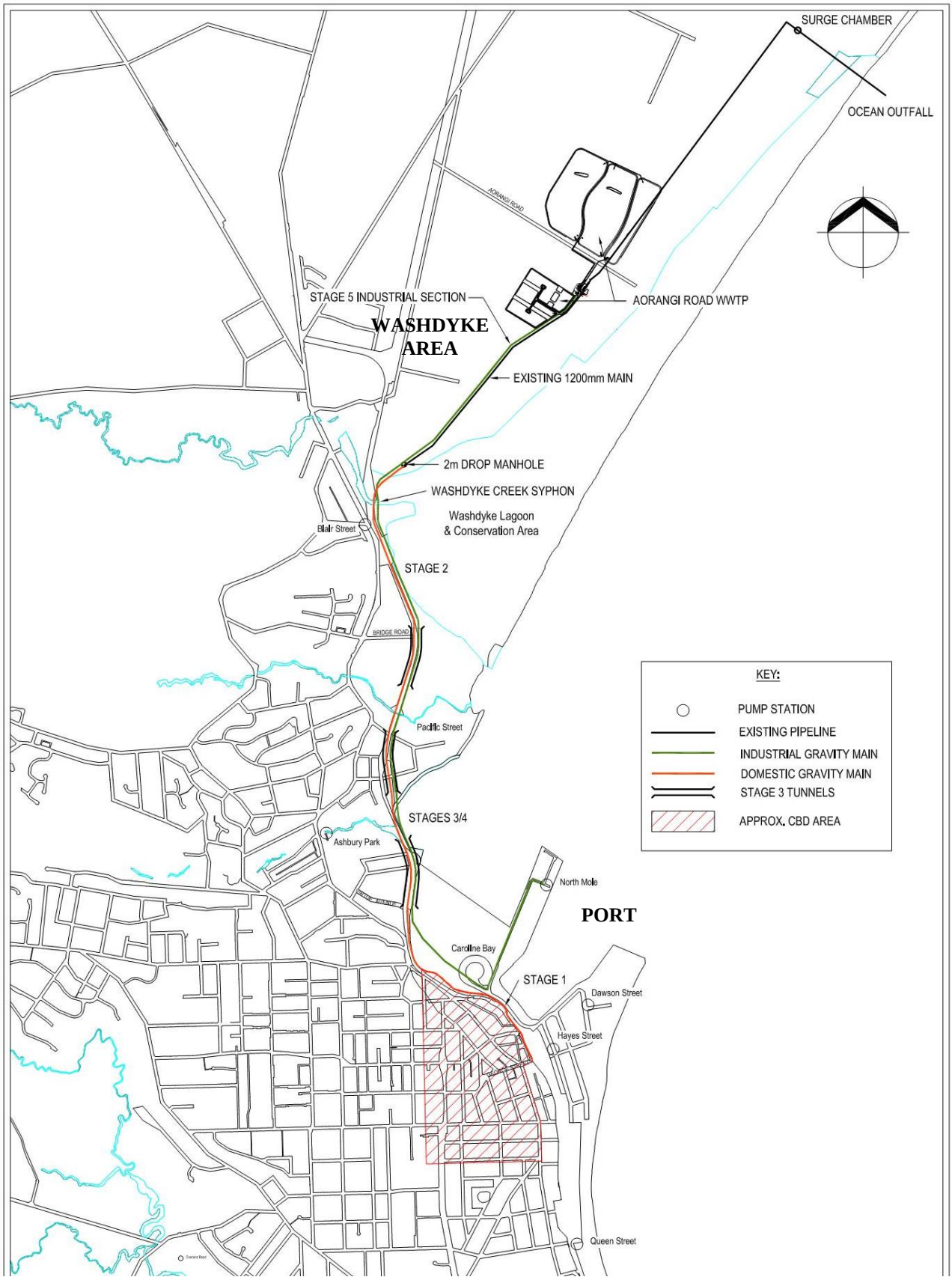

Figure 1b: Domestic and industrial wastewater trunk mains in Timaru and Washdyke

2 DEVELOPMENT OF THE WASTEWATER MANAGEMENT STRATEGY

2.1 IMPETUS FOR STRATEGY

Council initiated a review in 1996 of the district's wastewater treatment and disposal practices. This review was prompted by the emerging regulatory environment that included two new plans: the Opihi River Regional Plan and the Canterbury Regional Coastal Environment Plan, as well as the proposed National Coastal Policy Statement.

The Opihi River Plan prohibited the discharge of human wastewater into the river (directly or indirectly), after 31 December 2003. This would therefore apply to the Pleasant Point and Temuka oxidation pond discharges and would likely also apply to the Geraldine oxidation pond discharge.

The Coastal Plan provided for new water classifications and quality standards to help protect Canterbury's coastal waters and their associated uses.

The Coastal Policy Statement would exclude the discharge of human wastewater to the ocean, unless it had first passed through or over land (including treatment wetlands). The proposed Canterbury Coastal Plan and National Policy Statement would therefore apply to the future discharge of wastewater through the Timaru ocean outfall.

2.2 WASTEWATER WORKING PARTY

As a response, Council set up the Wastewater Working Party with an independent facilitator (Gay Pavelka), to advise on a district-wide Strategy to upgrade the existing wastewater system, such that the requirements of the two Plans were met. Council supported a community-based approach, noting that the Strategy needed to be robust and viable and should recognise the unique nature of the Timaru District's wastewater. Compliance with proposed environmental standards was a non-negotiable requirement.

The Working Party, which was supported by Council's engineering and asset management staff, together with consultants Beca, Pattle Delamore and Mitchell Partnerships, was widely representative of the District's stakeholders. These included:

- Tangata Whenua
- Timaru District Council Assets Unit
- Community Boards
- Federated Farmers
- Chamber of Commerce
- Industrial Dischargers
- Royal Forest and Bird Society
- Central South Island Fish & Game Council
- National Council of Women
- Crown Public Health

Invited observers represented:

- Environment Canterbury
- Department of Conservation/Aoraki Conservation Board
- Timaru District Council Planning Unit

The consultation objectives were wide ranging and specifically covered the following issues:

- To include Runanga in the decision-making process in accordance with the roles prescribed in the RMA.
- To ensure that the community's spectrum of views was included in fairly-held discussion about wastewater issues and options.

- To ensure all the wastewater issues that affect the community were identified and understood, sound information was available and a range of options were evaluated objectively.

- That the desired outcome was a consensus recommendation to the Council from the range of interests in the Community.

Wastewater disposal options were a key issue for the Working Party and a comprehensive assessment was carried out. The closest possible land application area to the Timaru WWTP was the Levels Plains, on higher ground between 1 and 12 km to the west of the WWTP. Land disposal areas, within reasonable distances of the inland towns' WWTPs, were also identified. However, soils and climatic constraints, high conveyance and land acquisition costs, and competition from other landuses, meant land application from either Timaru or the inland towns, was unlikely to be sustainable from an environmental or economic perspective. The industrial component of the wastewater was considered to be unsuitable for land application.

2.3 ROLE OF RUNANGA AND WIDER COMMUNITY

Te Runanga O Arowhenua chose to join the Working Party in addition to holding several consultation hui. Separate meetings also took place between Council representatives and the Runanga on a number of occasions. A Summary of Understanding was reached between Council and the Runanga in October 1999 to confirm how land disposal could remain a future option for disposing of treated wastewater (given that an ocean outfall was seen by the Working Party as the best practicable option). This understanding included a 5 yearly review of land treatment options after treatment upgrading was completed.

Council also maintained an 0800 number, published a number of articles in the "Timaru Herald", "High Country Herald" and "Temuka Leader", and sent regular newsletters to residents near the proposed Aorangi Road site and along the inland towns' pipeline route. To facilitate further feedback, thirty thousand pamphlets with a questionnaire were delivered to all households in the Timaru District – with 1041 questionnaires returned by September 1999. Results indicated around 80% support for the proposed wastewater management option.

Several meetings were held with residents living near to the Timaru WWTP and this process continued through the subsequent consenting process.

2.4 INDUSTRIAL AND DOMESTIC FLOWS AND LOADS

The pie charts in Figure 2 show that the Timaru urban wastewater stream is unique in that it has a 40:60 volume ratio between domestic and commercial/industrial wastewater, but an approximate 10:90 strength ratio.

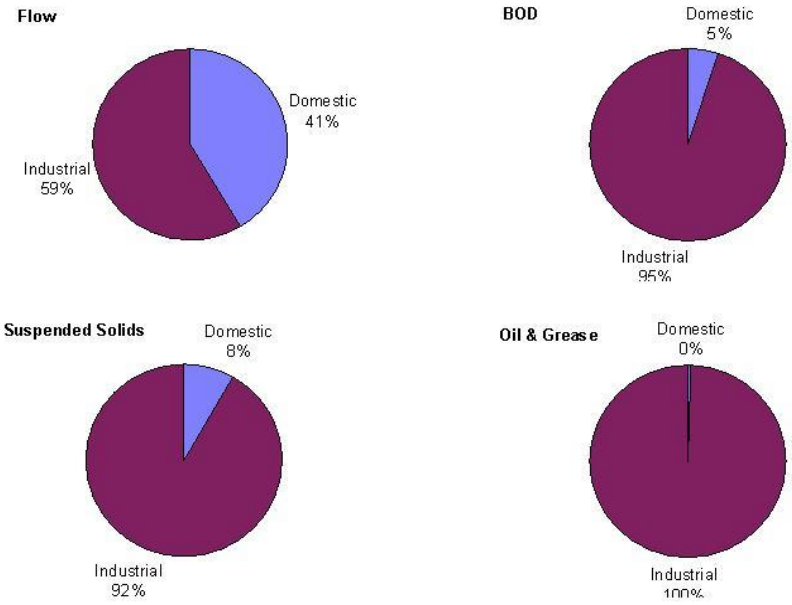

Figure 2: Comparison of domestic/industrial flows and mass loads

The main contributing industries connected to the Timaru urban sewer network are:

- Meat Processing
- Fish Processing
- Vegetable Processing
- Brewing
- Pelts Processing
- Wool Scouring
- Rendering

Most of these industries are located in the Washdyke and Port areas. The three inland towns have typical domestic wastewater characteristics with all urban areas experiencing the addition of significant amounts of rainwater into the sewers, during and after rain events.

Combined treatment options were assessed by the Working Party based on the current and projected industrial flows and loads, projected population increases, ocean disposal requirements, operational feasibility and the costs to ratepayers.

It became clear from this assessment, that treating the combined industrial and domestic wastewater in one centralised facility, would not be financially sustainable.

2.5 SEPARATION AND TREATMENT OF WASTEWATER STREAMS

With this in mind, the Working Party was able to support a strategy that separated the industrial and domestic wastewater streams and focussed on the improved treatment of the domestic flows to improve microbiological wastewater quality before discharge. The geographical location of the Port and Washdyke industrial areas offered the opportunity to separate trade waste and domestic flows, apply different treatment processes to each and then combine for discharge through the existing outfall. The inland towns' flows could also be conveyed to the Timaru WWTP for further treatment in the domestic stream treatment process (refer to Figures 1b and 5).

An oxidation pond-based system was identified early in the development of the Strategy as providing the best value for money to treat the separated domestic flows, given the low operational and maintenance costs. Council purchased a small farm to the north of Aorangi Road which was suitable for the ponds and when combined with the land already owned south of Aorangi Road, provided the opportunity to add wetland polishing, before combining with the milliscreened industrial flows and discharging to the outfall.

Options to treat the separated industrial flows at Aorangi Road in anaerobic lagoons (or equivalent tank-based system) and possible UV disinfection, were also identified. The need to further treat industrial flows would be determined by the commitment of industry to further treat trade wastes onsite, as well as future outfall consenting requirements. Space was allocated for the future centralised treatment of industrial wastewater if/when required.

2.6 ADOPTION OF WASTEWATER STRATEGY

Other New Zealand Local Authorities, with similar industrial flow and load characteristics to Timaru (such as Hastings, Napier and Gisborne), have more recently adopted and implemented separation of domestic and industrial streams, thus permitting the application of different treatment processes to economically achieve acceptable discharge standards. However, in 1999, when the Timaru District Wastewater Strategy was adopted by Council, separation was an innovative approach.

The Strategy focuses on delivering what the community identified as the priorities in respect of wastewater treatment and disposal in the district. It provides for the cost-effective and sustainable management of the districts' wastewater, offering an overall improvement in the environmental performance of the WWTP and a reduction in the health risks associated with the outfall discharge.

The Strategy recommended by the Working Party and subsequently adopted by Council included:

- Upgrading of the inland towns' wastewater treatment plants (oxidation ponds).
- Conveyance of the inland towns' treated wastewater to the Timaru ocean outfall (initially direct to the outfall, but ultimately via the new treatment ponds and wetlands at Aorangi Road).
- Separation of the Timaru Port and Washdyke industrial wastewater streams.
- Construction of new oxidation ponds, maturation ponds, wetlands to treat the Timaru and inland towns' domestic flows.
- Treatment of the Port and Washdyke industrial flows in anaerobic ponds (or an equivalent tank-based system) and possible UV disinfection (or equivalent). *This aspect was subsequently not required in order to achieve compliance with consent discharge limits.*
- Continued discharge of all the Timaru and inland towns' wastewater to the ocean via the existing outfall.

The separation of the domestic and industrial wastewater streams is shown in Figure 4.

Implementation of the above tasks has formed the work programme to eliminate discharges of wastewater to rivers, separate domestic and industrial flows and upgrade the overall Timaru sewerage system (including treating all domestic flows at Aorangi Road). With an overall expenditure of $60.7 million, the work was broken down into multiple construction projects to spread funding requirements and risk.

Beca undertook a review of wastewater flows and loads to the Milliscreen in June 2004. This review indicated that there had been substantial increases in both flows and loads, mainly from industrial sources at the Port and Washdyke. The review confirmed the strategy of separating the industrial and domestic flows, and identified technically feasible treatment options that would achieve the wastewater quality standards likely to be required for continued discharge through the outfall. The review included initial cost estimates for the treatment options, which were then updated in 2008.

2.7 COMMITMENT FROM INDUSTRY TO REDUCE FLOWS AND LOADS

Centralised treatment of industrial wastewater at Aorangi Road would result in a significant increase in trade waste charges that were unlikely to be sustainable. As such, key components of the Strategy are for industrial dischargers to treat their own wastewater on site and the need for site-specific trade waste discharge agreements with all major trade waste dischargers.

Better Technical Options Ltd (BTO) was engaged by Council to assess the relative contribution from each industry source and, based on discussions with these dischargers, make recommendations on opportunities for onsite reductions in flows and load. The assessment showed that five industries contributed approximately 85% of the BOD load and that all the industries were willing to cooperate with Council to avoid the full costs of a centralised treatment facility. Industry acknowledged the need to have certainty in regard to future trade waste charges.

Through a model developed by BTO and Council, trade waste discharge limits were set for each of flow, BOD, suspended solids and fats/oils/grease. For some dischargers, it is possible to allow some components to exceed the TDC discharge consent limit and the individualised agreement process has won favour with all affected dischargers. The trade waste model is also used to determine the level of trade waste fees.

The commitment of industry to an ongoing programme to improve trade waste quality is a key component of the Strategy. To this end, Council continues to hold liaison meetings with the major industrial discharger groups to discuss implications of industrial wastewater treatment proposals and the trade waste charging framework. Discussions with individual industries are also on-going regarding the specific details of each industrial discharge including potential growth and on-site treatment options.

2.8 COMPLETION OF WORK PROGRAMME

Council completed the 15 year programme of work required to implement the Strategy in December 2014. The final stage was the successful commissioning of the upgraded Timaru domestic WWTP at Aorangi Road, which had an overall capital cost of $19.1M (refer to Table 6). The adoption of the Strategy and subsequent completion of the works, underpins Council's long-term vision to provide key wastewater infrastructure in a sustainable manner, while recognising the environmental, social and economic aspirations of the community.

3 WWTP AND OUTFALL CONSENTING

3.1 CONSENTS PROCUREMENT PROGRAMME

Work commenced in 2000 on the preparation of consent applications required to implement the Strategy. Obtaining long-term consents with appropriate conditions was a key objective for Council.

Consents were obtained firstly for the upgraded inland towns' WWTPs and conveyance pipeline to the coast, which was required under the programme requirements of the Opihi River Regional Plan. The consequent discharge of treated wastewater from the inland towns then became authorised under the existing Timaru WWTP outfall consent, until its expiry in December 2010.

Consent applications were then prepared for the construction and operation of the proposed upgraded Timaru WWTP. The consent applications used a 'black box" approach to allow flexibility around the future development of either pond or tank-based treatment processes. The applications drew nine submissions.

These consents, as well as an expanded designation over the site, were granted in November 2007, for a period of 35 years (with no appeals).

The outfall consent expired in December 2010. Consent applications were lodged in 2009, following a further comprehensive consultation process. Consents were granted in November 2010 for a period of 35 years. One objection was submitted by the Department of Conservation with nine submissions in support, primarily from industrial trade waste dischargers. There were no appeals to the decision.

3.2 KEY CONSENTING ISSUES

3.2.1 TREATMENT PONDS

Council continued to consult with the Working Party, as well as neighbours and other stakeholders, through the WWTP consenting process. The primary concerns of residents related to surface flooding (due to the siting of the ponds close to a floodway from the nearby Opihi River), future erosion of the coastline reducing the capacity of the floodway, potential for odour nuisance, loss of amenity and the reduced value of neighbouring properties.

Some properties near the WWTP and along Aorangi Road were able to be purchased by Council. However, the key mitigation was the comprehensive set of consent conditions that Council proposed for both the construction and operation consents, as well as the designation. These related mainly to a commitment to maintain the beach position (and therefore the stopbank and floodway) through renourishment (if required), minimising the potential for odour nuisance from the upgraded WWTP through the provision of adequate mechanical aeration on the primary ponds, appropriate operations and maintenance procedures and an ongoing performance monitoring programme.

At the same time, the expanded WWTP site was designated in the Timaru District Plan including provision for a 150m odour buffer around the wider site. This designated buffer extends in part over private property (pasture land to the north) and meets the Ministry of Works (1974), recommended separation distance from treatment ponds to isolated dwellings. Allowable activities within the designation included the discharge of dust during construction, which proved useful during excavation of the ponds over the summer period.

The creation of large ponds and wetlands in the coastal environment north of Timaru was viewed as a positive ecological outcome. These ponds include an island for roosting, as well as a significant shallow shoreline (particularly within the planted wetlands), which provide important bird habitat. The presence of these ponds also provides an important opportunity to showcase sustainable "green" wastewater treatment systems to the community.

3.2.2 OUTFALL

The coastal environment, into which the outfall discharges, is relatively inaccessible, with a high energy wave environment. The water clarity is frequently discoloured by adjacent river flows as well as re-suspension of sediments in the active nearshore environment.

While the environment in the vicinity of the outfall did not appear to be conducive to frequent public use, a key issue for Council was establishing what recreation did occur along the shoreline. The water classification in the Canterbury Coastal Plan, of the waters around the outfall, is for the protection of aquatic ecosystems, rather than contact recreation, but some stakeholders had indicated that there were a number of coastal and recreational values along the shoreline that should be maintained or enhanced.

To this end, a Beach User Survey was carried out by the Field Connection to establish public awareness of the area and the use of this, and other beaches within the Timaru area. The survey showed relatively infrequent visitation to the outfall area with the primary recreational activity being beach walking. Fishing from the shore also occurred where access was easiest (particularly at the Opihi River mouth approximately 8km north of the outfall).

A number of other technical studies were also carried out, including outfall performance modelling, ecological and water quality studies and a Quantitative Microbial Risk Assessment. The latter study, carried out by NIWA, used both rotavirus and oocysts of *Cryptosporidium parvum* as "model" pathogens – the former associated with risks from human sewage and the latter for risks associated with both human sewage and meat industry wastewaters. The risk model assessed the effects of the upgraded WWTP wastewater scenario.

The risk assessment showed that for normal virus concentrations, the risks of viral infection to recreational water users are low. For extreme virus concentrations (as might occur in an epidemic within the local population), the risks were elevated. However, the relatively low public use, lack of contact recreation and the pond- based treatment process will mitigate any significant health risks. The risks to those fishing at the mouth of the Opihi River and around Washdyke Lagoon (3.5km to the south of the outfall), were assessed as less than minor.

The pre-upgrade wastewater plume, on occasions, was visible from the shoreline. The Coastal Plan required that for ecosystems protection, the visual clarity of the receiving water should not be changed by more than 50 percent. This is considered reasonable in the context of the location, the poor background clarity and the lack of high vantage points to view the discharge. The assessment of the effects of the upgraded wastewater showed that with the significant reduction in solids concentrations in the domestic flows, as well as the progressive reduction in solids, fats, oils , grease and colour from industry, the 50 percent change in clarity requirement could be met within a mixing zone of 350m either side of the outfall. This mixing zone was considered to be appropriate in the context of the receiving environment.

The AEE was able to establish that acceptable environmental standards would be achieved after reasonable mixing (at the mixing zone described above), by upgrading the domestic treatment component, mixing with inland towns' wastewaters and continuing (subject to industry onsite treatment), to screen industrial flows through the 0.75mm aperture milliscreens.

3.2.3 CONSENTS CONDITIONS

Consent conditions for both the WWTP construction and operation, as well as continued discharge through the existing outfall, were generally agreed with key stakeholders as well as the relevant consent authorities.

An objection by the Department of Conservation related to the duration of the outfall consent and a solution was reached by negotiation. Council agreed to a consent condition requiring a major review of the effectiveness of the treatment and disposal strategy after 12 years of operation.

A comprehensive set of monitoring conditions were agreed for both the WWTP and outfall consents. A key outfall consent condition related to the use of the wastewater trigger value exceedance concept, as described in Table 13.2 of the New Zealand Water Environment Research (NZWERF), 2002 Municipal Wastewater Monitoring Guidelines. These guidelines provide for a permissible number of sample exceedances, over a compliance period, based on the discharger's risk. This risk is based on the assumption that at some time in the future, the discharge will breach the consent limit, by way of measured samples, when in fact the true continuous wastewater concentration is below the percentile limit. Permissable exceedances were included for both 50 and 90 percentile wastewater trigger limits, with a remedial programme required, when the allowable trigger values are exceeded by more than the allowable number in a 12 month period.

Extensive environmental monitoring was not required, due to the remote, inaccessible nature of the outfall (no nearby boat ramps). However, low frequency monitoring of the benthic environment (5 yearly) and annual visual inspections of the outfall structure are required. Monthly monitoring of shoreline water quality for faecal indicator organisms to the north and south of the outfall, together with regular beach inspection for the presence of any outfall 'material" are also required.

4 CONSENT REQUIREMENTS

4.1 LAND-BASED ACTIVITIES

In December 2007, TDC was granted a Designation (equivalent to a land use consent), as well as a number of resource consents from Environment Canterbury that authorise the upgrade of the WWTP. The Designation allows the construction, operation and maintenance of the upgraded treatment plant, including a 150m odour buffer.

4.2 DISCHARGE THROUGH OCEAN OUTFALL

4.2.1 OVERVIEW

In November 2010, TDC was granted a consent authorising the continued discharge of treated effluent to the ocean (CRC101831), and a consent to erect and construct, and to occupy and use, the coastal marine area for a pipeline outfall structure (CRC101832). CRC101831 sets quality requirements for the domestic effluent, prior to recombination with the milliscreened industrial flows, as well as the final combined domestic/industrial effluent discharged to the outfall.

Appropriate effluent trigger limits for the key wastewater parameters of total suspended solids (TSS), biochemical oxygen demand (BOD) and fats, oils and grease (FOG) were the subject of considerable debate prior to, and at the hearing. The concentration of these parameters is strongly influenced by industry inputs and will not be significantly reduced after the upgrading of the Domestic Treatment Plant.

"Trigger" limits, rather than "not to exceed" standards were considered appropriate as it was recognised that breaching a "trigger" would not necessarily mean that an adverse environmental effect had also occurred. Exceeding a trigger requires Council to carry out additional monitoring and an investigation to determine the reason, and the likely consequence of the exceedance, as well as determine any practical measures that can be implemented to reduce the concentration of the contaminant and prevent a recurrence.

4.2.2 DOMESTIC EFFLUENT TRIGGER LIMITS

Condition 22(a) of CRC101831 sets out the trigger limits for the Domestic Treatment Plant effluent as follows:

The results of sampling of treated effluent sampled in accordance with Condition 21 shall be compared with the following trigger values as the median for the sampling period 1 November to 30 April. A trigger value for

Enterococci will only apply if the treatment of separated domestic flows is by "in-tank" processes rather than in a pond-based system.

Containment	Reported As	Trigger Values	Allowable No. of Exceedances[1, 2]
Faecal coliforms	Organisms per 100 millilitres	5,000	9
Escherichia coli	Organisms per 100 millilitres	5,000	9
Enterococci	Organisms per 100 millilitres	5,000	9

1. From Table 13.2 of NZWERF (2002)
2. Based on 13 samples taken fortnightly between 1 November and 30 April in the following year

4.2.3 COMBINED INDUSTRIAL AND DOMESTIC WASTEWATER TREATMENT PLANT EFFLUENT TRIGGER LIMITS

Condition 23 of CRC101831 sets out the trigger limits for the combined Industrial and Domestic Treatment Plant effluent as follows:

The effluent quality discharged to the ocean shall be calculated on a 24 hour flow-weighted average (on day of sampling) of both the Industrial and Domestic Wastewater Treatment Plants' effluent results sampled in accordance with Condition 21. The combined results shall be compared with the following trigger values.

Containment	Reported As	Trigger Values[1]			Allowable No. of Exceedances[2]
pH	No. units	5-9			Not applicable
Carbonaceous Biochemical Oxygen Demand	Grams per cubic metre	Median	1,300		8
		90%ile	1,600		3
Total Suspended Solids	Grams per cubic metre	Median	1,200		8
		90%ile	1,400		3
Total Fats Oils and Grease	Grams per cubic metre	Median	420		8
		90%ile	1,000		3
Ammoniacal Nitrogen	Grams per cubic metre	Median	42[4]		8
		90%ile	55[4]		3
Metals/ Metalloids[3]	Grams per cubic metre	90%ile	Cd	0.33[4]	3
			Cr(iii)	1.644[4]	
			Cr(vi)	0.264[4]	
			Pb	0.264[4]	
			Ni	4.2[4]	
			Zn	0.9[4]	
			Hg	0.024[4]	
Semi Volatile Organic Compounds (SVOCs)	Grams per cubic metre	90%ile	1,2,4 – trichlorobenzene	4.8[4]	3
			Phenol	24[4]	

1. These trigger values are based on a calendar 12 month dataset.
2. From Table 13.2 of NZWERF, (2002).
3. Metals/metalloids and SVOCs sampling programme as per Note 1 in Condition 21.
4. Back-calculated from 95%ile level of species protection trigger values in Table 3.4.1 of ANZECC (2000) times a dilution factor of 60:1.

5 DOMESTIC WWTP UPGRADING

5.1 PRE-2014 TREATMENT PROCESS

The pre -2014 treatment processes at the Aorangi Road site are illustrated in Figure 3:

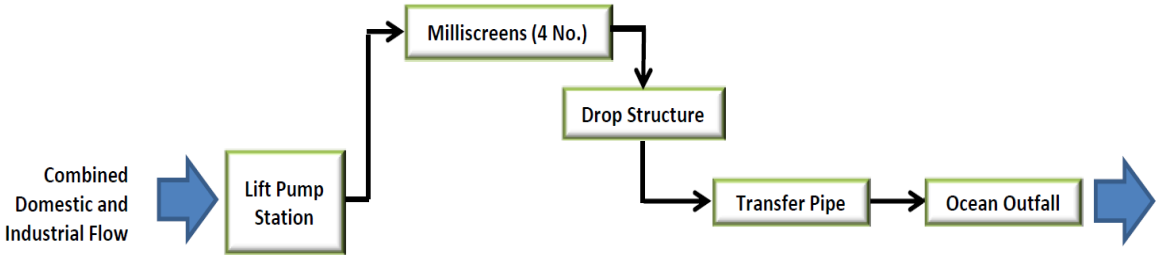

Figure 3: pre-2014 treatment processes at Aorangi Road

5.2 UPGRADING STRATEGY

5.2.1 OVERVIEW

As described in Section 2, the significant industrial discharge loads are located in the Port and Washdyke areas. It was decided to install a separate trunk sewer for industrial wastewater through the Washdyke Industrial Zone and extend it to the Port which is near the centre of Timaru – refer to Figure 1b.

With the significant industrial loads separated, the domestic WWTP services a population of 26,000, plus minor commercial and industrial loads.

5.2.2 DESIGN FLOWS

Because the domestic flow was mixed with industrial flows, the domestic flow had to be estimated at the time of design in 2011. The 2006 census urban population was 26,000 in Timaru, which would suggest a flow of 9,100 m³ per day, based on typical unit flow guidelines. Measurement of the flows during the Christmas-New Year period, when industries would be expected to have minimal contribution, found an average daily flow of 11,000 m³/d. This is somewhat above the average New Zealand value of 350 l/p.d, but within the range of the 1995 study. After assessing the information from different catchments, an average daily flow of 12,000 m³ per day for domestic flow was adopted.

After considering the nature of the Timaru sewer network, typical values for wet weather peak flow factors were adopted. The Lift Pump Station and screen channels at the inlet of the domestic plant are sized on the calculated capacity of the incoming sewer, which is greater than the maximum flow predicted by applying a peaking factor to the average flow.

The treated wastewater from the inland towns' (Temuka, Pleasant Point, Geraldine) treatment ponds is diverted into the maturation pond (Pond 2). Typical flows from the inland towns' pipeline are about 40 l/s, with the pipeline able to convey a peak flow of 84 l/s.

Key domestic design flows are shown in Table 1, with industrial flows in Table 2.

Table 1: Design Domestic Flow Rates

Parameter	Flowrate
Annual Average Daily Flow	140 l/s (12,000 m³/d)
Peak Flow (based on domestic sewer capacity)	1,450 l/s
95 %ile Average Daily Flow	320 l/s
Flow from Inland Towns	Peak = 84 l/s Average = 40 l/s

Table 2: Industrial Flow Rates

Parameter	
Annual Average Daily Flow	100 l/s (8,640 m^3/d)
Average Daily Flow (Peak Processing Period)	197 l/s (17,000 m^3/d)
Peak Flow (assumed)	500 l/s
Capacity of industrial sewer	1350 l/s

The ocean outfall is currently limited to a hydraulic capacity of 1,400 l/s, when flowing under gravity. The capacity of the outfall could be increased in future to approximately 2,200 l/s by installing a pump station at the outfall surge chamber.

5.3 DOMESTIC TREATMENT PROCESS TRAIN

5.3.1 OVERVIEW

An oxidation-pond based system was identified early in the Strategy as providing the best value for money given the low operational, maintenance and energy costs. Council had purchased a small farm north of Aorangi Road, which was suitable for locating large ponds, and was able to acquire additional adjoining land.

The upgrading of the domestic treatment (as shown in Figure 4) comprises:

- Inlet lift station
- Inlet screen on a mound (3mm gap step screens)
- Two primary ponds in parallel with four x 4kW brush aerators on each pond (Ponds 1A and 1B)
- One maturation pond (Pond 2)
- Three wetland ponds in-series with shallow planted zones around the perimeter and between ponds
- Peak flow pump station to lift Pond 2 or wetlands wastewater into the outfall pipeline at higher flows rates (normal flows are conveyed by gravity to the outfall)

The aerial layout plan shown in Figure 5 shows the pond configuration which utilises the natural gradient of the site. Space has been reserved near the industrial stream milliscreening facility for possible future industrial stream treatment units (should these be required), such as membrane-covered anaerobic lagoons and aerobic lagoons.

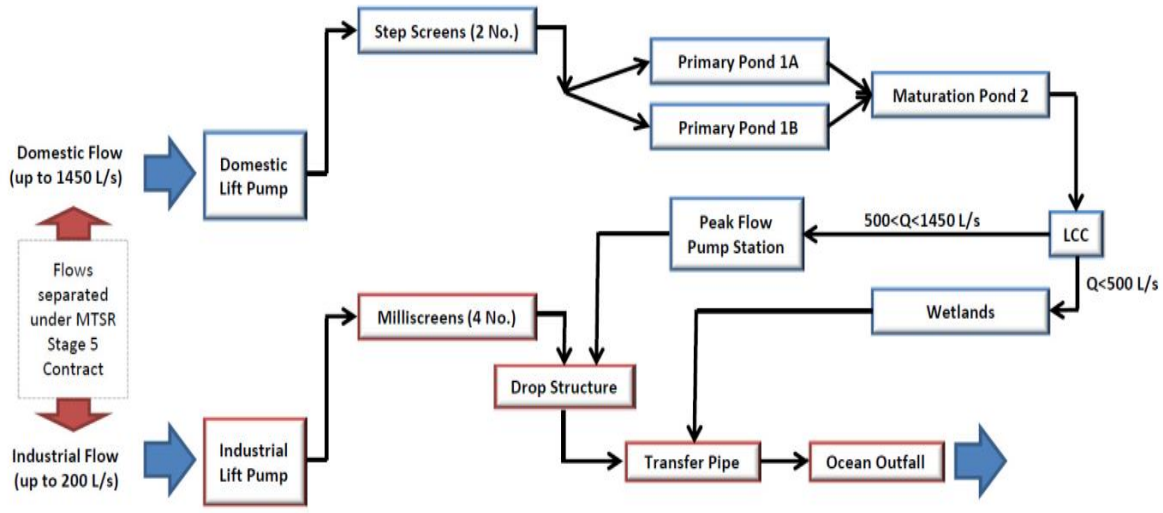

Figure 4: Post upgrade treatment processes at Aorangi Road

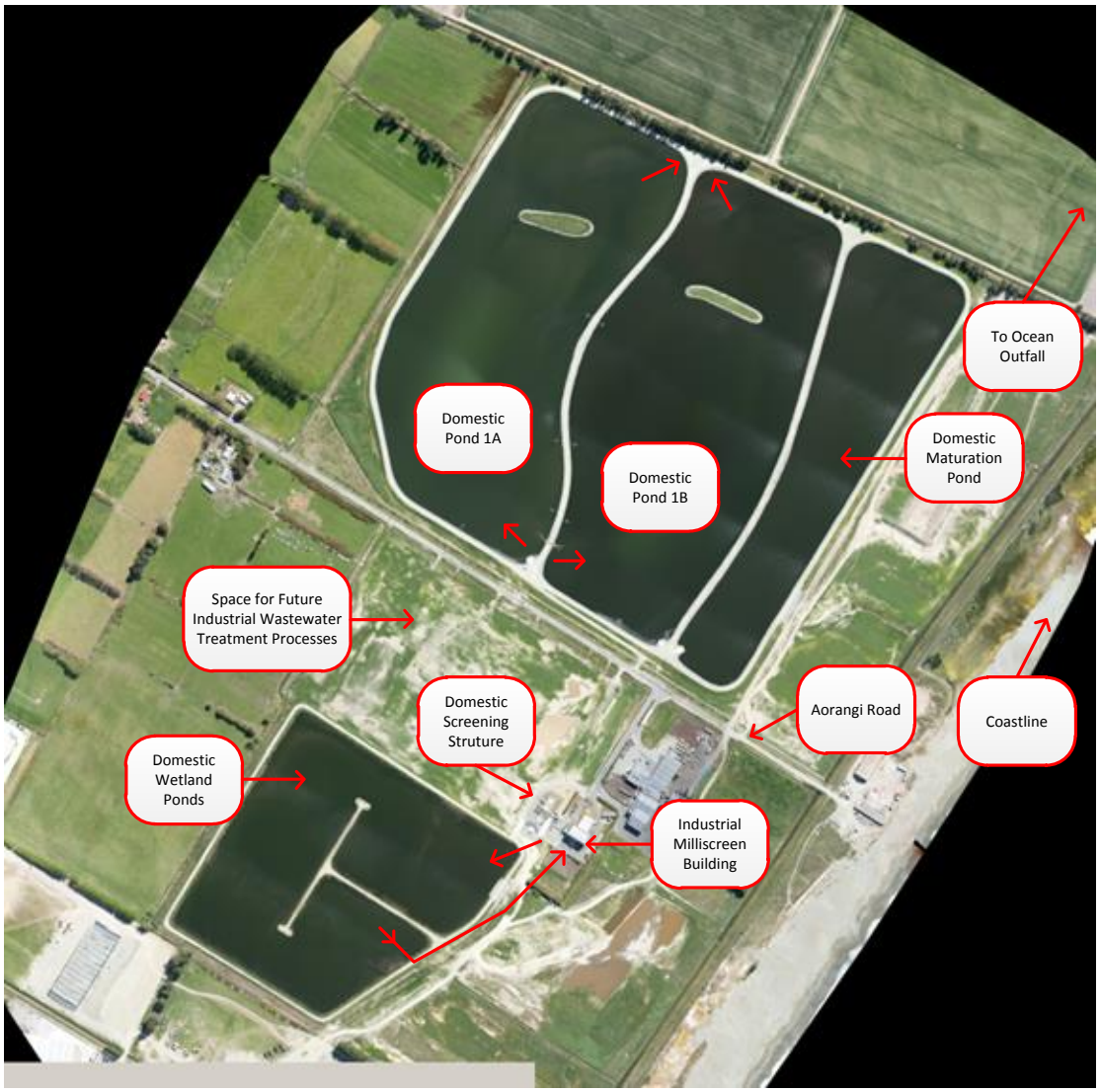

Figure 5: Aerial plan of the ponds and wetlands layout

5.3.2 DESIGN LOADS

A per capita BOD of 85 g per day was selected as the design basis for the Timaru domestic wastewater treatment plant. This value makes allowance for some industrial or commercial wastewater loads within the domestic city catchment.

On the basis of a population of 26,000 people, the design mass load is 2,200 kg BOD per day.

The oxidation pond and wetland pond areas and volumes are summarised in Tables 3 to 5.

Table 3: Primary Oxidation Pond Design Details

Description	Primary Pond 1A	Primary Pond 1B	Total
Surface Area at Normal Operating Levels (ha)	13.5	13.2	26.7
Water Depth Range (m)	1.2 – 2.0	1.6 – 2.0	
Average Water Depth (m)	1.6	1.7	1.65
Hydraulic Residence Time at average flow of 12,000 m^3/d (days)	36.7	36.7	-
BOD_5 load kg/d	1100	1100	2,200 (a)
BOD_5 Loading Rate (kg/ha.day)	82.4	82.4	-

Note (a) Allowable load without aeration. With all aerators operating, allowable load increases to 3,300kg BOD/d or 39,000 pe.

The base of each pond varies as a result of the natural fall of the land prior to building the ponds. The deepest portion of the primary ponds is on the eastern sides which provides additional sludge storage.

There are four 4 kW brush aerators on each primary pond. The purpose of the aerators is to assist in establishing a desirable circulation pattern in the ponds and to provide some mixing in the pond during calm periods. Mixing brings algae to the surface for a dose of sunlight so that oxygen is produced by photosynthesis.

The current predicted BOD loading rate of about 83 kg/ha/d could be handled by the primary ponds without aeration during winter, which is the normal design procedure. If the BOD load did increase due to population growth, or trade waste loads in the domestic catchment, the mechanical aerators could handle an extra 13,000 population equivalent or 1,100 kg BOD/d. In any event, aeration makes pond operation more reliable, less susceptible to adverse climatic conditions, and prevents odour emissions (refer to Archer, 2015).

Table 4: Maturation Pond Design Details

Description	Maturation Pond 2
Surface Area at Normal Operating Level (ha)	8.2
Water Depth Range (m)	2.25 – 2.65
Average Depth (m)	2.44
Volume at Normal Operating Level (m^3)	200,000
Hydraulic Residence Time at average flow of 12,000 m^3/d (days)	16
BOD_5 load kg/d (assuming 75% reduction in primary ponds)	550
BOD_5 loading rate (kg/ha.day)	67

Flow from the maturation pond passes through the wetland pond system to provide additional removal of organic material and especially pathogens.

Wetlands with open water areas are recommended by the USEPA (2000), because they provide additional tertiary treatment (from sunlight exposure) and for their aesthetic appeal to the general public. The wetlands are surface flow wetlands, which resemble the appearance of natural wetlands, by having a shelf around the perimeter of the ponds close to water level which is planted to provide habitat for desirable wildlife.

The wetlands comprise a series of three ponds with a water depth of approximately 1 m separated by shallower (300 mm deep) planted zones. The flow rate to the wetlands is limited to 500 l/s. At higher flows (which occur during periods of wet weather), all flow is diverted from the outlet of the Maturation Pond 2 and sent to the ocean outfall via the Peak Flow Pump Station.

The wetland design criteria are set out in Table 5.

Table 5: Wetland Ponds Design Details (3 ponds in-series)

Description	Total
Surface Area at Normal Operating Level (Ha)	9.2
Volume at Normal Operating Level (m3)	70,000
Hydraulic Residence Time at Average Flow (Days)	5.83

5.3.3 ODOUR MANAGEMENT

The domestic wet well and screen structure are enclosed and odour is extracted to the existing biofilter with a new fan and ducting system. Odour from the domestic screenings is contained within covered skips, or by discharging the screenings directly to a plastic bag.

The primary ponds each have 4 x 4kW brush aerators which can be operated to increase DO concentrations and prevent the release of odours during periods of overloading or biomass upset.

5.3.4 WILDLIFE MANAGEMENT

The pond and wetland areas attract birds and other wildlife, and indeed the wetland pond design specifically provides a perimeter area for the establishment of desirable wildlife. However, it is acknowledged that some wildlife are considered pests, and may interfere with operation of the plant. Fish and Game NZ no longer manages the geese as a hunting resource and a permit is no longer required to shoot them. Federated Farmers had lobbied for the change from game bird to 'pest', so that farmers can control geese numbers. Thus, Council is able to control geese numbers themselves.

The construction of the ponds incorporates such design features as boat access ramps at both south and north ends of the ponds, primarily for maintenance access, but also to assist with controlled culling of Canada Geese, and other nuisance wildfowl, as part of a Wildlife Management Plan. Islands were formed in Ponds 1A and 1B to provide bird roosting areas. These islands also reduce the waves generated by the long fetch to the south where strong winds come from.

5.4 CONSTRUCTION ISSUES

The capital cost of the ponds was minimized by using silty material available on the site. The amount of silt that was recovered depended on the groundwater level at the time and also choice of equipment to recover the silt, e.g. scrapers do not recover as much silt as an excavator/truck combination. The summer construction periods were affected by significant rainfall events which extended the contract period. Some silt had to be imported from quarries in the area when the above factors reduced the amount that could be 'won' from the site.

5.5 PERFORMANCE OF DOMESTIC WWTP

The main objective of the domestic treatment plant is to reduce disease transmission risk from humans to other humans. The indicator organism wastewater monitoring results shown in Figure 6, demonstrate that the disease transmission risk is being substantially reduced by the ponds and wetlands in series. Median values are:

E.Coli = 90 organisms/100ml
Enterococci = 63 organisms/100ml
Faecal Coliforms = 120 organisms/100ml

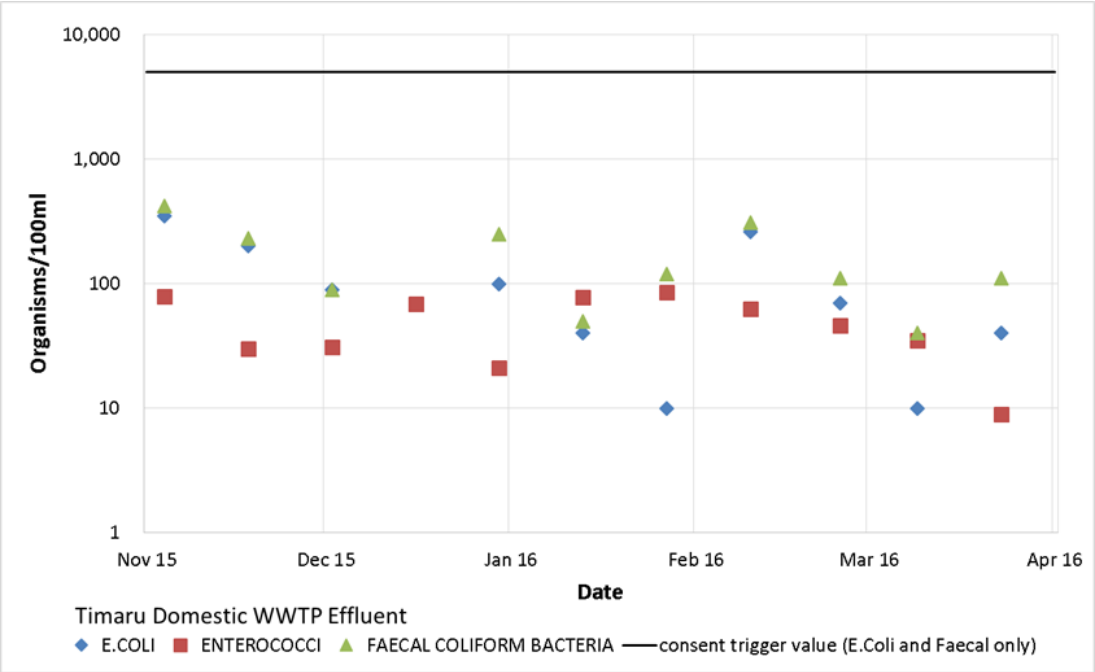

Figure 6: Indicator bacteria concentrations after domestic pond and wetland treatment

6 PROJECT COSTS

The breakdown of the overall project cost is shown in Table 6. It can be seen that conveyance costs account for about 65% of the total. Most of the new conveyance cost was needed to replace the badly corroded main trunk sewer (concrete). All new piping is polyethylene including access chambers.

Table 6:Overall project costs

	Work	Year	Cost
1	Concept/Investigations/Consenting	1997-2001	$0.5M
2	Inland Towns Oxidation Ponds Upgrade	2002	$0.4M
3	Inland Towns Pipeline	2002-2003	$4.5M
4	Land Acquisition	2004-2007	$1.8M
5	New Trunk Sewer Central Timaru to Aorangi Road		
	Stage 1: Central Timaru to Virtue Avenue	2003-2004	$4.3M
	Stage 2: Washdyke Lagoon Perimeter	2005-2006	$4.1M
	Stage 3: Tunnelling	2007-2009	$15.4M
	Stage 4: Connecting Stage 1t o the tunnels and the tunnels to Stage 2	2008-2009	$2.3M
	Stage 5: Washdyke to Aorangi Road	2012-2013	$5.7M
6	Wastewater Treatment Upgrade including Planting of Wetlands	2012-2014	$19.1M
7	Various Interconnecting Pipelines and Laterals	2009-2014	$2.4M
8	Wastewater Component Model Build and Dischargers Negotiation	2010-2014	$0.2M
	Total	**1997-2014**	**$60.7M**

7 CONCLUSIONS

In the 1980s, Timaru District Council had invested significant capital in the Aorangi Road milliscreening plant, a section of sewer east of Washdyke, a new ocean outfall and three oxidation ponds to serve the inland towns of Geraldine, Pleasant Point and Temuka. The district-wide Wastewater Strategy adopted in 1999 sought to maximise the use of these assets, while meeting community, environmental and statutory requirements.

The procurement of 35 year consents in 2010 for the continued use of the existing Timaru Milliscreen Plant for industrial flows, the construction and operation of the new domestic WWTP and the ongoing operation of the ocean outfall, has provided a sustainable solution for Timaru District. The commitment of industry to improve onsite treatment and the development of individual trade waste agreements has provided certainty to all parties regarding the ongoing costs of treatment. This has, in turn, provided employment and social benefits to the community.

By focussing on the community's preference for a reduction in public health risks, Council has been able to focus on the development of treatment ponds and wetlands which treat the domestic wastewater effectively, with relative ease of operation and low operational costs. With the use of land-based, natural treatment systems, Council is effectively capturing "green energy", thus reducing costs to the community, while reducing reliance on electricity.

The new ponds and wetlands are environmentally compatible within the coastal environment north of Timaru, providing additional valuable bird habitat, as well as an opportunity for showcasing natural wastewater treatment processes to the community.

The inclusion of the inland towns' treated wastewater with the Timaru domestic flows provides substantial dilution for the milliscreened industrial flows, before discharge to the outfall. This is a key component for ongoing compliance with consent conditions. From monitoring results to date, the domestic ponds/wetlands are performing as expected and the wastewater quality is comfortably meeting consent requirements.

The Strategy and its implementation has resulted in an affordable outcome for the community. The Uniform Annual Charge per property peaks at $374 (incl. GST) per annum. This is very low by New Zealand standards. Council has also been able to keep trade waste charges to industry to $0.66/$m^3$ fixed charge and $0.11/$m^3$ variable charge (both incl. of GST), which again is very low by New Zealand standards.

ACKNOWLEDGEMENTS

The authors acknowledge the assistance provided by Ashley Harper (Group Manager District Services, TDC) and the following CH2M Beca staff; Rob Crosbie, Iain Partington, Steve Christensen and Simon Drew. All had significant inputs to the design and construction phases.

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Archer HE, (2000): Can Performance of Waste Stabilisation Ponds Be Improved? Water NZ Conference September 2015

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Figure 7: Domestic Inlet Screening Structure