TAURANGA CITY INTEGRATED WATER MANAGEMENT STUDY

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ABSTRACT

While water is plentiful in New Zealand, drinking quality water is becoming a valuable commodity requiring careful management if it is to be available for future generations. Tauranga's population is forecast to double by 2051, placing increased pressure on the way the Council manages existing infrastructure and levels of service. As a result, drinking water demand management has become an increasingly important tool for Local Government.

Tauranga City Council partnered with GHD to investigate an Integrated Water Management (IWM) approach to developing demand management strategies. Analysis indicates that significant reductions (14 %– 41%) can be made to domestic drinking water demand through implementation of water saving devices (WSD), rainwater tanks (RWST) and greywater reuse. An IWM approach also enabled investigation of the impacts of demand reduction on wastewater discharge and stormwater runoff.

Simplified economic cost benefit analysis indicates installation expenditure is one of the challenges to implementation of WSD, RWST, which needs to be addressed. For the time being, Council will focus on education and incentives through its WaterLine program and improving system losses through pressure reduction and leakage management, while undertaking further assessment of options. Detailed investigation is also required to quantify environmental, social and cultural impacts of water demand management, and to develop truly sustainable water management.

KEYWORDS

Integrated Water Management, Demand Reduction, Water Saving Devices, Rainwater Harvesting, Greywater Reuse, Water Consumption, IWM

1 INTRODUCTION

1.1 DEMAND MANAGEMENT IN COUNCIL WATER SUPPLIES

In New Zealand there is an increasing demand for freshwater, driven by a growing population requiring water for electricity, drinking water supply, and industrial processes, as well as more intensive land use and the subsequent need for irrigation and stock feeding. This is demonstrated by the number of consents and volume of water abstracted, with a number of river systems and groundwater sources rapidly reaching full allocation status for abstractive use. Between 1999 and 2006 total water allocated for abstraction increased by 50%, which can largely be explained by an increased in irrigated land (NZBCSD 2008).

There are also competing needs for freshwater from an environmental, social and cultural standpoint. Healthy, freshwater ecosystems are the backbone of our natural environment, form part of our cultural identity and provide recreational opportunities as well as attracting tourism, which has a high economic value.

As a result of these competing needs and increased demand on water supplies and infrastructure, there is a growing recognition of the benefits of implementing demand management strategies for Council water supplies. Tauranga City Council (TCC) are among many local authorities in New Zealand who have undertaken demand management practices in order to secure water supplies for future generations, meanwhile bringing a number of environmental, social, cultural and economic benefits.

1.2 DRIVERS AND CHALLENGES

One of the key drivers for demand management in TCC is population growth. The population growth rate of Tauranga between 1996 and 2006 was 24.9% bringing the population to 103,477. The population is expected to double between 2006 and 2051, placing considerable pressure on the water supply infrastructure to meet the increased demand.

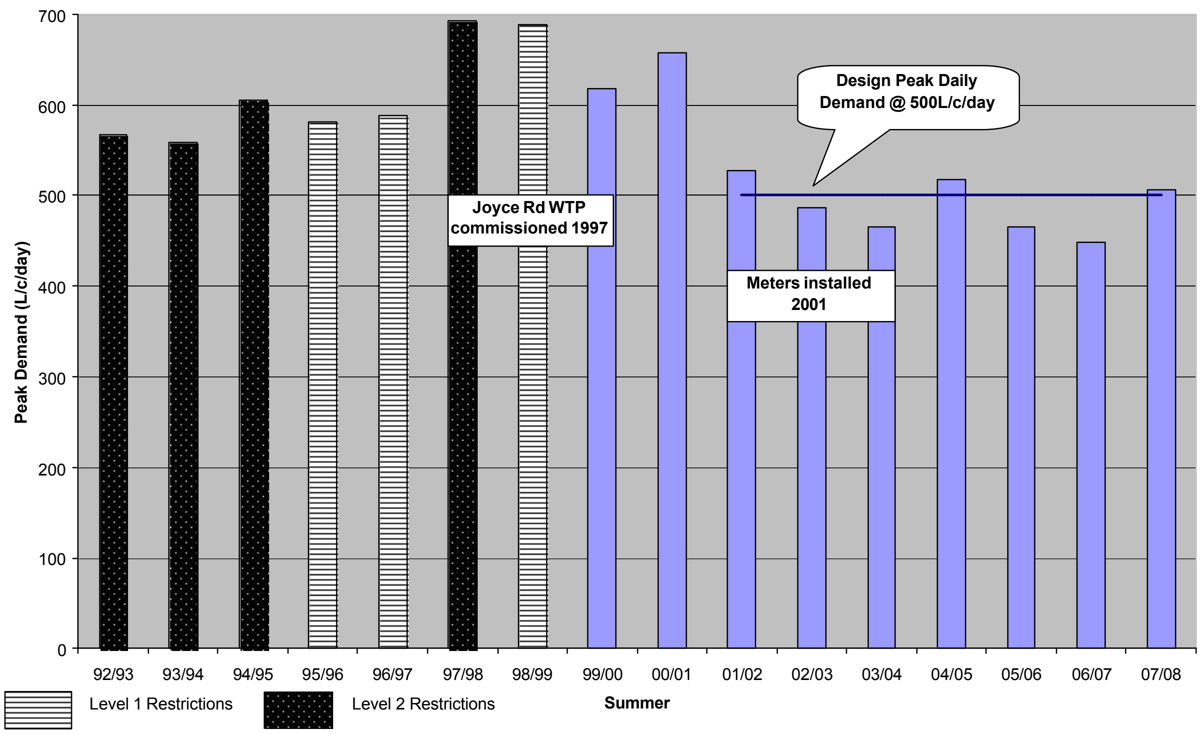
The total production capacity of existing treatment facilities is currently 69,000m3/day, which could be expanded to 90,000m3/day to fully utilise the existing resource allocation. TCC's water supply planning horizon is 2051 and its projected water demand at that time is 109,200m3/d. The resource consent for abstraction is anticipated to expire around 2046 and the projected water demand at that time is 104,283m3/d.

Either additional water sources and treatment capacity, or a reduction in peak demand, will be required to meet this projected demand. Work is underway to secure a consent for abstraction and treatment from an additional water source, as well as investigation into demand management strategies.

The large investment required for developing new infrastructure has led to the consideration of a number of demand management practices over recent years, with the most significant benefit gained through the adoption of universal metering and volumetric charging in 2002 (Figure 1). This reduced the average per capita consumption by 25% and per capita peak use by 30%. This was coupled with customer education initiatives including the WaterLine customer advisory service, which focuses on water conservation and leak repairs, a schools education programme and public talks and events. For a capital cost of less than $10 million TCC were able to delay an estimated capital expenditure of $70million on infrastructure for more than 10 years. There was also additional benefit through the reduction in wastewater flows.

Whilst water metering was an effective tool for some time, the current challenge for TCC is to apply further demand management practices to delay investment in a new treatment facility.

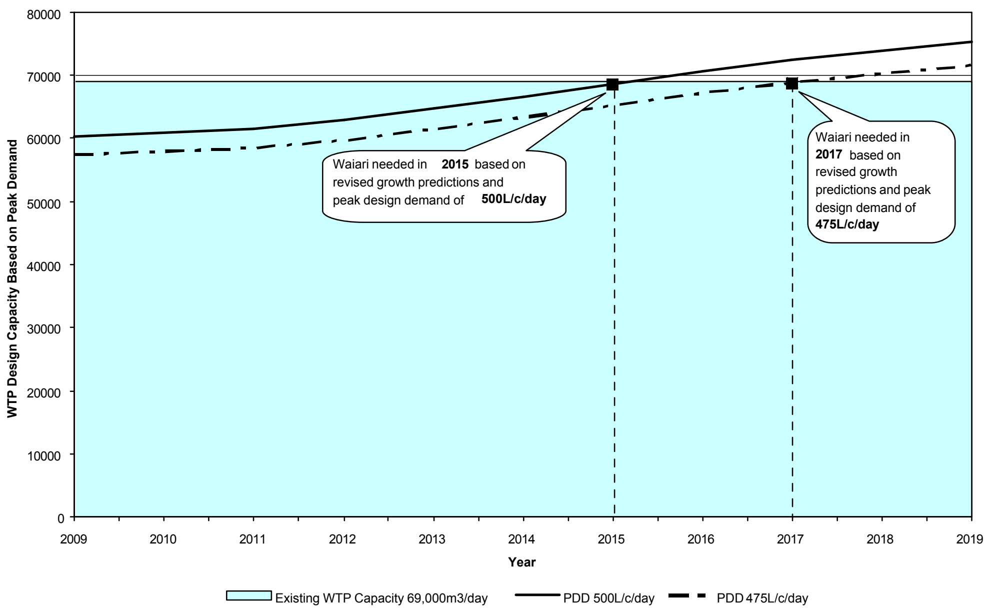
Figure 1: Reduction in peak demand through the installation of water meters.



1.3 TARGET SETTING

Without demand management measures the proposed Waiari Water Treatment Plant will be required in 2015. Following a review, new targets were set to reduce overall peak consumption by 5%, from 500 l/capita/day to 475 l/capita/day, and to reduce the infrastructure leakage index (ILI) to less than 1.5. These measures are expected to delay the construction of the treatment plant by two years to 2017. Reduction of infrastructure leakage has been set as another target.

Figure 2: Delay of Waiari Treatment Plant Scheme



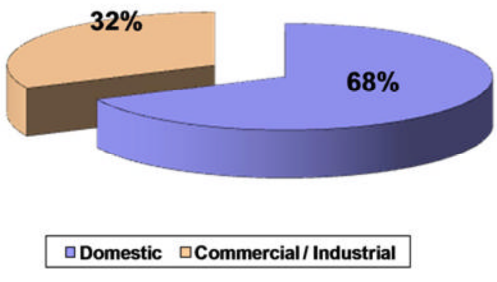
1.4 PRINCIPLES OF INTEGRATED WATER MANAGEMENT

Integrated Water Management (IWM) provides a sustainable approach to decision-making, design, implementation and management of water, wastewater and stormwater services. IWM considers all aspects of sustainability including economic, environmental, cultural and social issues. The philosophy behind the implementation of IWM is to;

- Reduce water demand, wastewater discharge and stormwater runoff,
- Find alternative sources of water,
- Utilise water of a quality suitable for purpose and
- Maximise the use of existing infrastructure to delay implementation of new infrastructure.

TCC and GHD partnered to investigate how IWM could aid decision making, especially in the area of drinking water demand management. The study focused on residential demand reduction, which accounts for around 68% of TCC's total water consumption, as shown in Figure 3. This paper presents the challenges TCC have faced in meeting increased demand, and the approaches taken as a result the IWM study.

Figure 3: Tauranga Drinking Water Consumption



2 DEMAND MANAGEMENT OPTIONS

Options for demand management can be broadly split into two areas. The **supply side;** defined as infrastructure managed by the water provider i.e. water treatment plants, pipes, valves, reservoirs, and the **demand side**, defined as beyond the customer meter i.e. on-section. While the IWM study focuses purely on the demand side options, TCC are currently undertaking a large programme of work to reduce losses through pressure management and leakage detection and repair.

A desktop study indicated a number of demand management options that were potentially suitable for implementation in Tauranga. Table 1 describes these options and the reason for their selection or rejection for this investigation.

Table 1: Drinking Water Demand Management Options

Demand Management Option	**Selected for Investigation**	**Reason for Selection/Rejection**
Water Tariff Structures	No	Potentially simple way to reduce demand, but was considered outside of scope of this study
Appliances with low water consumptions (e.g. washing machines and dishwashers)	No	Local Council has little opportunity to influence implementation. Maybe investigated later as part of a future building sustainability rating scheme or incentivising though Water Efficiency Labelling Scheme regulations.
Water Saving Devices (WSD), such as low flow showerheads and taps	Yes	Ease of installation and incentivising products.
Dual Flush Toilets	Yes	Has become a standard feature of modern houses with high water saving potential
Rainwater Storage Tanks	Yes	Alternative water supply that is becoming more common on new developments. Has high water saving potential and multiple uses (outdoor and indoor)
Water flow reducers at property connection	No	Difficulties in implementation. Requires further consideration
Reuse of greywater (water from basins, shower, bath and laundry)	Yes	Effectiveness of reducing water demand and relative simplicity of installation
Reuse of blackwater (water from toilets and kitchen sinks)	No	Requires high level of treatment due to pathogens and organics. Requires further consideration
Onsite wastewater disposal	No	Not considered due to space limitations and public health considerations in an urbanised area such as Tauranga
Behavioural Change	No	Potential to change peoples' water use habits through education was considered outside of the scope of this study, and is already a key component of TCC's operations.

GHD and TCC developed eight drinking water demand reduction options that could be initiated in domestic households. The selected options are presented as follows:

- Option 1 – The existing residential allotment (current case – baseline for comparison)
- Option 2 – Water Saving Devices (WSD) (low flow taps and showerheads) and dual flush (D/F) toilets
- Option 3 – WSD fixtures and greywater recycling for D/F toilet
- Option 4 – Standard fixtures and standard toilet with a rainwater storage tank (RWST) for outdoor use
- Option 5 – WSD fixtures, D/F toilet flushing and RWST for outdoor use
- Option 6 – Standard Fixtures and RWST for outdoor use and standard toilet flushing
- Option 7 – WSD fixtures and RWST for outdoor use and D/F toilet flushing
- Option 8 – WSD fixtures, RWST for outdoor use, and greywater recycling for D/F toilet flushing.

The components of each option are presented graphically in Figure 4.

Figure 4: Options Selected for Study

	Fixtures		Toilet			RWST		
						Toilet		Outdoor
	Standard	WSD	Standard	WSD	Greywater Recycling	Standard	WSD	
Option 1	✓		✓					
Option 2		✓		✓				
Option 3		✓		✓	✓			
Option 4	✓		✓					✓
Option 5		✓		✓				✓
Option 6	✓					✓		✓
Option 7		✓					✓	✓
Option 8		✓		✓	✓			✓

3 TAURANGA CITY IWM MODEL

3.1 GHD IWM TOOLKIT

GHD's IWM toolkit was developed to permit modelling of the impacts that IWM strategies have on drinking water demand, wastewater discharge and stormwater runoff. The IWM Toolkit allows a daily water balance to be performed on all 'three waters' simultaneously. Inputs are highly customisable, including use of localised rainfall, evaporation, soil soakage, rainfall runoff, complex water demand patterns and pipe network losses/leaks. Multiple options can be run simultaneously from a single residence through to a citywide scale. The IWW Toolkit has been used successfully on projects such as the Pimpama Coomera Waterfuture Master Plan (2004) and East Perth Redevelopment Authority - Riverside Integrated Urban Water Management Strategy (2006).

3.2 PRELIMINARY ANALYSIS

3.2.1 POPULATION PROJECTIONS

Population growth projections for Tauranga will influence the expected water demand, wastewater discharge and stormwater runoff over the next 50 years. The 2006 Census and revised TCC SmartGrowth figures were utilised to develop current and future population growth and dwelling occupation rates (revised population figures account for the current economic downturn).

3.2.2 DRINKING WATER CONSUMPTION

Current drinking water consumption was determined using TCC water treatment plant records and metered billing accounts. An average consumption of 493.15 L/dwelling/day or 194.92 L/capita/day was calculated as presented in Table 2.

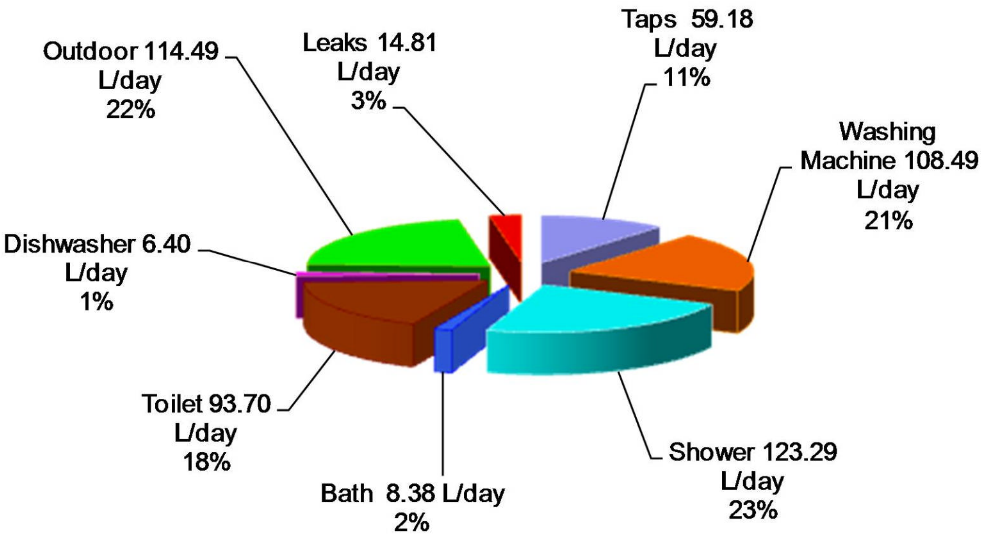
Table 2: 2008 Drinking Water Consumption

Source of demand	**Metered Consumption**	**Existing Connections**	**Cumulative Water Consumption**	**Metered Average Daily Consumption**	**Dwelling Occupancy Rate**	**Average Consumption**
	m^3/connection/ year	No.	m3/year	L/dwelling/day	No.	L/capita/day
Domestic	180	42,920	7,725,600	493.15	2.53	194.92
Commercial	1,032	3,531	3,643,992	N/A	N/A	N/A

It was assumed, due to Tauranga's recent growth in residential housing, that a portion of the existing dwellings would already have implemented demand reduction devices such as WSD fixtures, rainwater tanks and D/F toilets. It was not possible to calculate the proportion of homes that have such devices as part of this study however, based on metered consumption, the majority do not. The metered figure of 493.15 L/dwelling/day is therefore referred to in this study as a dwelling having "standard" fixtures (mix of both non-water saving and water saving devices). All demand reduction calculations presented in this report are compared to this standard situation. Leaks/losses within the network were factored into the water balance based on calculated TCC loss rates.

The typical Tauranga residential drinking water balance was primarily based on the findings of the BRANZ Ltd Auckland and Kapiti Coast water use studies (Heinrich, M – BRANZ), as well as Metrowater and Waitakere water use information. Consumption figures were compared and verified by first principles using typical flow rates and usage patterns. The adopted drinking water demand balance is presented in Figure 5.

Figure 5: Typical Tauranga Dwelling Water Balance (2008)



The drinking water demand balance was further developed to make allowances for seasonal variations, specifically the volume of water used for outdoor activities such as garden watering. The average increase/decrease in outdoor use was based on the information and usage patterns presented in the previously described BRANZ studies, that being approximately 22% higher than average demand in summer and 10% lower than average demand in winter.

It was surmised that outdoor water use is dependant on preceding weather conditions and therefore highly variable. A simplified approach was adopted in the study where garden watering events were controlled by an equation that considered the current season and preceding rainfall depths and duration. Expected future domestic consumption was based on the adopted population growth projections, and it was assumed that industrial, agricultural and commercial demand increased at the same rate as domestic growth.

3.2.3 WATER SAVING DEVICES (WSD)

The Ministry of Consumer Affairs and Ministry for the Environment are currently preparing a Water Efficiency Labelling Scheme (WELS), which is due to be implemented by the end of 2009. The scheme will rely in part on AS/NZS 6400 on which the Australian WELS is based. The scheme rates fixtures on their water consumption characteristics. The typical consumption values provided for regular and WSD fixtures under this scheme have been adopted in the modelling process and are presented in Table 3.

Table 3: WELS Fixture Consumption Data

Fixture	Regular Fixture Consumption	Typical WS Fixture Consumption	Potential Water Use Reduction
Taps	Up to 18 L/min	3 - 4 L/min	6 L/person/day
Shower	12 L/min	8 L/min	9 L/person/day
Toilets	12 L/flush	3 or 6 L/flush for D/F toilet	19 L/person/day

3.2.4 TAURANGA RAINFALL

A review of TCC's rainfall gauges indicated that the Bethlehem Station provided the longest continuous data set (2000 – 2008) that most closely matched the NIWA average of 1198 mm/yr for the Tauranga area. An eight-year period of rainfall was utilised to ensure that the effect of short-term seasonal variances, such as unusually wet or dry years, was minimised.

3.2.5 RAINWATER STORAGE TANKS (RWST)

RWST sizes of 2, 3, 4, 6, 8, 10 & 15 m^3 were selected for our analysis. Tanks larger than 15 m^3 were considered impractical for use within an urban environment due to allotment space constraints. It was assumed that only 50% of a house roof could be practicably connected to a rainwater tank due to roof shape, property topography and downpipe location. Allowances were made for losses due to material wetting, gutter blockage and first flush diverters

3.2.6 WASTEWATER AND STORMWATER DISCHARGE

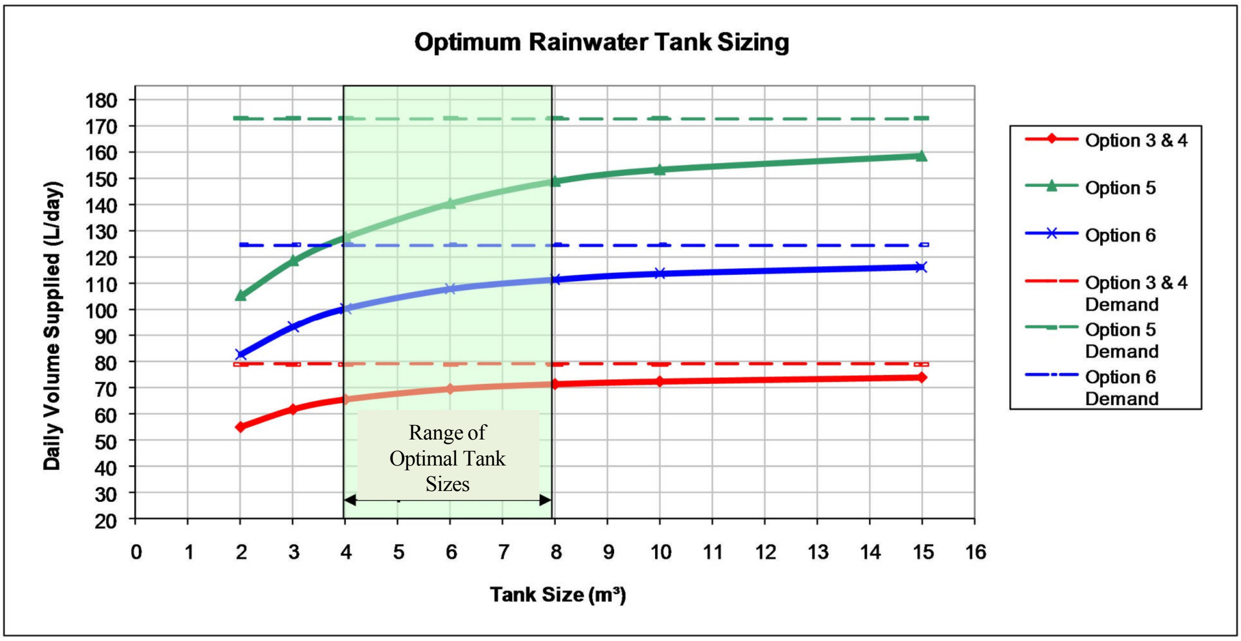
Residential wastewater volumes were determined from TCC wastewater treatment plant records and typical domestic wastewater loads. A typical residential allotment was developed for stormwater runoff generation calculations based on information provided by TCC's planning and rates departments and using typical soil permeability figures.

4 RESULTS OF IWM ANALYSIS

4.1 OPTIMUM RWST SIZING

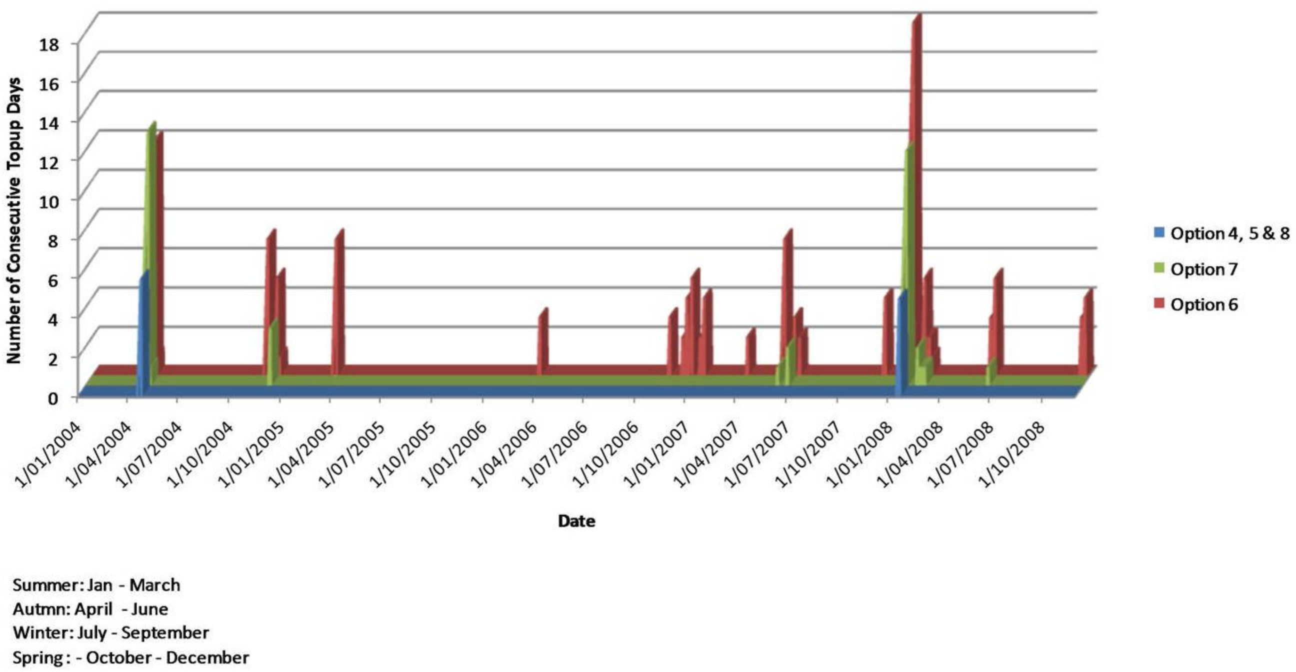
RWSTs are proposed in a number of the investigated options (Options 4 – 8). Analysis of all of the selected tank sizes (2 – 15 m³) indicates that the optimum tank size is in the range of 4 – 8m3, as shown in Figure 6. A 6m³ tank was adopted for analysis purposes. None of the RWSTs investigated achieved 100% supply of domestic demand, which would require unpractically large tanks to achieve.

Figure 6: Optimum Rainwater Tank Sizing



The reliability of a 6 m³ tank was assessed by analysing each of the demand reduction options over a period of approximately five years of rainfall (2004 – 2008). The number of consecutive days top-up is compared to seasonal period in Figure 7.

Figure 7: 6m³ Rainwater Tank Top-up Requirements



Option 6, which has the greatest demand, will require the greatest number of top-up events (18 times in the four year period analysed). Top-up would be from the drinking water network, which would be required for around 13% – 20% of RWST demand. Top-up events are generally required in the first four months of the year (Summer – Autumn). This is not unexpected as this is generally the driest period of the year for Tauranga and, correspondingly, the highest outdoor water demand period. Small RWSTs can therefore not be relied on alone to reduce peak water demand.

4.2 WATER CONSUMPTION

The daily household drinking water demand for each of the selected options is presented volumetrically in Table 4. All RWST options are assumed to have a tank capacity of 6 m³.

Table 4: Household Drinking Water Demand

Fixture	**Drinking Water Demand – (L/dwelling/day)**							
	Option 1	**Option 2**	**Option 3**	**Option 4**	**Option 5**	**Option 6**	**Option 7**	**Option 8**
Taps	59.18	44.38	44.38	59.18	44.38	59.18	44.38	44.38
Washing	108.4	108.49	108.49	108.49	108.49	108.49	108.49	108.49
Shower	123.29	101.24	101.24	123.29	101.24	123.29	101.24	101.24
Bath	8.38	8.38	8.38	8.38	8.38	8.38	8.38	8.38
Toilet	93.70	45.56	0.00	93.70	45.56	0.00	0.00	0.00
Dishwasher	6.40	6.40	6.40	6.40	6.40	6.40	6.40	6.40
Leaks	14.81	14.81	14.81	14.81	14.81	14.81	14.81	14.81
Subtotal	414.25	329.27	283.71	414.25	329.27	320.55	283.71	283.71
Outdoor*	78.90	78.90	78.90	9.30	9.30	32.28	16.53	9.30
Total	**493.15**	**408.17**	**362.61**	**423.55**	**338.57**	**352.83**	**300.24**	**293.01**

Options 2 to 8 reduce drinking water demand by 70 – 200 L/dwelling/day, which equates to savings of 14% – 41% as shown in Table 5.

Table 5: Household Demand Savings

Fixture	Drinking Water Demand Reductions – (%)							
	Option 1	**Option 2**	**Option 3**	**Option 4**	**Option 5**	**Option 6**	**Option 7**	**Option 8**
Taps	0%	25%	25%	0%	25%	0%	25%	25%
Washing	0%	0%	0%	0%	0%	0%	0%	0%
Shower	0%	18%	18%	0%	18%	0%	18%	18%
Bath	0%	0%	0%	0%	0%	0%	0%	0%
Toilet	0%	51%	100%	0%	51%	100%	100%	100%
Dishwasher	0%	0%	0%	0%	0%	0%	0%	0%
Leaks	0%	0%	0%	0%	0%	0%	0%	0%
Subtotal	**0%**	**21%**	**32%**	**0%**	**21%**	**23%**	**32%**	**32%**
Outdoor	0%	0%	0%	88%	88%	59%	79%	88%
Total	**0%**	**17%**	**26%**	**14%**	**31%**	**28%**	**39%**	**41%**

Options have been ranked from least to greatest demand reduction in Table 6. Option 8 provides the greatest demand reduction, whilst Option 4 provides the least reduction when compared to the current demand situation described by Option 1 (baseline option).

Table 6: Ranking of Options

Option	**Ranking**	**Domestic Consumption (L/dwelling/day)**	**% Reduction**
Option 8	1	293.01	41%
Option 7	2	300.24	39%
Option 5	3	338.57	31%
Option 6	4	352.83	28%
Option 3	5	362.61	26%
Option 2	6	408.17	17%
Option 4	7	423.55	14%
Option 1	8	493.15	0%

4.3 DEMAND REDUCTION IMPLEMENTATION RATE

Water demand is directly proportional to the number of dwellings that apply demand reduction initiatives. This is termed the implementation rate and has been assessed in Table 7. The greater the implementation rate the higher the demand savings achieved.

Table 7: Potential Water Demand Reduction Based on Implementation Rate

Implementation Rate	Option 1	Option 2	Option 3	Option 4	Option 5	Option 6	Option 7	Option 8
0%	0%	0%	0%	0%	0%	0%	0%	0%
10%	0%	2%	3%	1%	3%	3%	4%	4%
20%	0%	3%	5%	3%	6%	6%	8%	8%
30%	0%	5%	8%	4%	9%	9%	12%	12%
40%	0%	7%	11%	6%	13%	11%	16%	16%
50%	0%	9%	13%	7%	16%	14%	20%	20%
100%	0%	17%	26%	14%	31%	28%	39%	41%

It is difficult to ascertain likely implementation rates for existing dwellings, as it is highly dependant on the incentives provided to homeowners to retrofit demand reduction initiatives. It has been assumed for this study that the maximum likely implementation rate in existing developments would be in the order of 10%. At this rate, savings in existing developments would range from 1% for Option 4 through to 4% for Options 7 & 8. The success of water reduction in existing dwellings will be highly dependant on the incentive/rebate schemes provided to homeowners to retrofit their existing dwellings with demand reduction initiatives.

Implementation of water saving initiatives in future developments was considered more straightforward as it was assumed it could potentially be encouraged/enforced through building consent requirements, amongst other means. It is therefore assumed for the study that 100% implementation could be gained in future developments, equating to savings of 14% - 41% for Option 4 through to Option 8 respectively.

Table 8 provides the estimated demand reduction, assuming 10% of existing and 100% of future developments implement the proposed demand reduction initiatives.

Table 8: Potential Water Demand Reduction based on an Implementation Rate of 10% in Existing and 100% in Future Developments

Year	Option 1	Option 2	Option 3	Option 4	Option 5	Option 6	Option 7	Option 8
2006	0%	2%	3%	1%	3%	3%	4%	4%
2016	0%	5%	7%	4%	9%	8%	11%	11%
2026	0%	7%	11%	6%	13%	11%	16%	16%
2036	0%	8%	13%	7%	15%	14%	19%	19%
2046	0%	9%	14%	8%	17%	15%	21%	22%
2051	0%	10%	15%	8%	17%	16%	22%	23%

Demand reduction will increase more rapidly as the number of future developments constructed increases. Under this premise, drinking water demand would be reduced by 8% - 23% by the year 2051 depending on the selected option.

There are also significant savings to be made in the prevention of leaks, which account for around 15% of Tauranga's water demand. TCC has targeted reduction of leakage as one of its immediate goals.

4.4 STORMWATER RUNOFF REDUCTION

The volume of rainwater stored in a 6m³ RWST will generally only be a portion of the overall storage capacity. The actual volume available on any given day may range from 0 – 6m³ depending on previous rainfall events and daily water use. Analysis of eight years of rainfall and daily water use (option dependant) indicates that a 6m³ rainwater tank will on average have the capacities presented in Table 9. This available capacity provides an Onsite Storage Detention (OSD) volume that can be utilised to slow peak flows and reduce runoff volumes. Decreasing peak volumes and flows can reduce negative impacts on downstream waterways and potentially reduce stormwater infrastructure requirements

Table 9: Average Capacity in a 6 m³ RWST available for Onsite Stormwater Detention

	Option 4	Option 5	Option 6	Option 7	Option 8
Spare Capacity (m³)	1.3	1.3	2.528	1.853	1.3

TCC's stormwater network is generally designed to convey the 10% Annual Exceedence Probability (10% AEP) event wholly within the pipe system. The 10% AEP event was therefore utilised for stormwater hydrograph routing for a critical storm duration of 10 minutes. Analysis for the undeveloped, developed (current) and developed with RWST cases was performed to determine the effect this OSD capacity has on peak stormwater runoff (Table 10).

Table 10: Peak 10% AEP Stormwater Runoff

	Options 1 - 3		**Options 4 - 8**	
	m³/s	**Increase in Runoff**	**m³/s**	**Increase in Runoff**
Pre-development runoff	0.12	0%	0.12	0%
Post-development runoff	0.18	50%	0.18	50%
Post-development with RWST	N/A	N/A	0.14	17%

Options 1 – 3 do not include a RWST and therefore do not impact stormwater runoff. Analysis indicates that inclusion of a RWST (Options 4 – 8) will reduce post development runoff by around 0.04 m³/s in the 10% AEP.

Analysis also indicates that it is feasible to reduce the post development 10% AEP discharge volumes from an increase of 40% down to 17% through the installation of a 6 m³ RWST as shown in Table 11.

Table 11: Typical Discharge Volumes for 10% AEP Event

	Options 1,2 & 3		**Options 4, 5 & 8**		**Option 6 - 7**	
	m³/s	Increase in Runoff Volume	m³/s	Increase in Runoff Volume	m³/s	Increase in Runoff Volume
Pre-development runoff	6.3	0%	6.3	0%	6.3	0%
Post-development runoff	8.8	4.0%	8.8	40%	8.8	40%
Post-development with RWST	N/A	N/A	7.5	19%	7.2	14%

Analysis indicates that RWST may have minimal impact on events larger than the 10% AEP as peak discharge will typically occur later during these storm events once the RWST is already full. There will be no impact on stormwater runoff flows or volumes for any event if the RWST is full prior to a storm event. RWST can therefore not be relied upon alone to reduce stormwater infrastructure requirements. Permanent detention/attenuation storage may be required where infrastructure capacity is limited.

4.5 WASTEWATER REDUCTION

The potential reductions in wastewater discharge presented in Table 12 are based on the assumption that 10% of existing and 100% of future developments will implement the selected water demand reduction initiatives.

Table 12: Potential Wastewater Discharge Reduction (%)

Year	Option 1	Option 2	Option 3	Option 4	Option 5	Option 6	Option 7	Option 8
2006	0%	2%	3%	0%	2%	0%	2%	3%
2016	0%	6%	9%	0%	6%	0%	6%	9%
2026	0%	8%	13%	0%	8%	0%	8%	13%
2036	0%	10%	16%	0%	10%	0%	10%	16%
2046	0%	11%	17%	0%	11%	0%	11%	17%
2051	0%	12%	18%	0%	12%	0%	12%	18%

Wastewater discharge reduction is dependent on decreased water consumption, not on where the water is sourced. Hence, installation of rainwater tanks has no impact on wastewater discharge (e.g. Options 4 & 6) unless coupled with WSD fixtures. The effects of inflow/infiltration have not been considered in the calculations provided but are another area of IWM that can significantly impact the efficiency of wastewater and stormwater services.

5 DISCUSSION OF IWM ANALYSIS

5.1 DRINKING WATER DEMAND REDUCTION

IWM analysis indicates that there can be significant reductions in drinking water demand, up to 41% depending on the reduction option initiated and the implementation rate of the option.

Peak demand reductions have been calculated from average demand results by multiplying average daily figures (including residential and commercial/industrial) by a peak demand factor and comparing against the current peak production capacity of 69,000 m^3/day (the peaking factor was calculated from TCC's daily treatment plant records). The peak daily demand for each of the selected options is presented in Table 13.

Table 13: Peak Daily Drinking Water Demand for Option Implementation of 10% in Existing and 100% in Future Developments (m³/day)

	Option 1	**Option 2**	**Option 3**	**Option 4**	**Option 5**	**Option 6**	**Option 7**	**Option 8**
Year	(m^3/day)	(m^3/day)	(m^3/day)	(m^3/day)	(m^3/day)	(m^3/day)	(m^3/day)	(m^3/day)
2006	51,389	50,504	50,029	50,664	49,778	49,927	49,379	49,304
2011	57,676	55,707	54,652	56,063	54,095	54,425	53,206	53,039
2016	**64,176**	61,087	59,431	61,646	58,557	59,076	57,164	56,901
2021	**70,572**	**66,381**	64,134	**67,140**	62,948	63,652	61,058	60,701
2026	76,944	**71,655**	**68,819**	**72,612**	**67,322**	**68,210**	64,937	64,487
2031	82,849	76,542	**73,161**	77,683	**71,376**	**72,435**	**68,532**	**67,995**
2036	88,719	81,400	77,477	82,725	75,406	76,634	**72,105**	**71,483**
2041	94,087	85,844	81,424	87,336	79,092	80,476	75,374	74,673
2046	99,025	89,930	85,055	91,576	82,482	84,008	78,380	77,606
2051	103,848	93,922	88,601	95,718	85,793	87,459	81,316	80,472

Existing treatment plants are expected to have sufficient capacity until the year 2019 (69 000 m^3/day - Option 1), at which point the proposed Waiari Treatment Plant will be required at an estimated cost of $60 Million. The discrepancy between the Waiari Treatment Plant construction dates described in Table 13 and Figure 2 are due to differences in assumed peak daily demand. Nevertheless, the analysis indicates that the implementation of demand reduction initiatives could potentially delay construction of the Waiari Treatment Plant by some 13 years (from 2019 to 2032 in Table 13).

Table 14 describes the approximate period in which each of the selected options will achieve TCC's current demand reduction goal of 475 L/capita/day.

Table 14: Time to Achieve TCC Goal of 475 L/capita/day Assuming Implementation rate of 10% in Existing and 100% in Future Developments (L/capita/day)

Year	**SmartGrowth Population**	**Option 1**	**Option 2**	**Option 3**	**Option 4**	**Option 5**	**Option 6**	**Option 7**	**Option 8**
2006	103,566	496	488	483	489	481	482	477	476
2011	116,236	496	479	470	482	**465**	**468**	**458**	**456**
2016	129,336	496	**472**	**460**	477	453	457	442	440
2021	142,226	496	467	451	**472**	443	448	429	427
2026	155,067	496	462	444	468	434	440	419	416

Option 1 (current case) will never achieve this goal, whilst Option 8 will achieve this in a matter of a few years from installation. Table 14 assumes that these options are implemented from today at a rate of 10% in existing and 100% in future development.

Careful consideration must be given to the options that include a RWST as their reliability may not be sufficient during dry weather or high demand periods.

5.2 POTENTIAL WASTEWATER DISCHARGE REDUCTION

Although existing wastewater treatment plant capacity was not investigated as part of this study, the results in Section 4.5 indicate that demand reduction initiatives will reduce wastewater discharge where the volume of water used is reduced. Utilising alternative water sources does not impact wastewater discharge volume unless combined with other demand reduction initiatives.

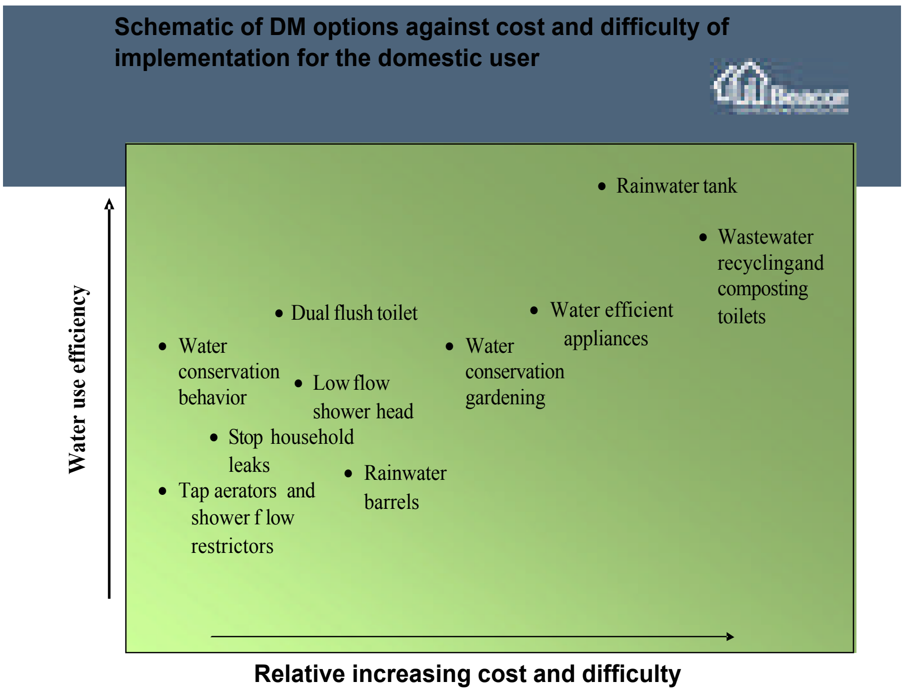
5.3 POTENTIAL STORMWATER RUNOFF REDUCTION

Limited modelling of a design storm event indicated that the installation of RWSTs has the potential to reduce stormwater runoff. Analysis indicates negligible reduction will be experienced where tanks are full prior to storm events. It is reasonable to expect tanks to fill during extended periods of wet weather with low outdoor water use, such as during the winter season. RWSTs can therefore not be relied upon alone to provide permanent reduction of stormwater runoff. Dedicated OSD will be required where it is important to restore pre-development stormwater runoff rates.

6 GENERAL DISCUSSION

Through the use of the IWM model, TCC has been able to quantify which demand management options give the greatest benefits in terms of volumetric reduction in water use. As well as the volumetric gains, the ease and cost to implement have influenced the approach taken. This is illustrated in Figure 8. For example, wastewater recycling has significant potential to reduce demand, but is difficult and costly to implement due to high capital costs and maintenance considerations. Furthermore, standards would need developing and, if large-scale benefits are to be achieved, regulation would be required through a District Plan Change Review. Tap aerators and flow restrictors on the other hand are cheap to install and have little administration issues, but have less potential in reducing overall demand.

Figure 8: Cost/ Difficulty vs Efficiency - Demand Side Options (Source: Beacon Pathway 2008)



Below is an outline of each option and the considerations which have shaped TCC's approach to meeting demand management targets. These are described below and summarised in table 17.

6.1 USE OF WATER EFFICIENT DEVICES

Modelling results show that for an average Tauranga dwelling, if water efficient devices are used (low flow shower head, dual flush toilet/gismo and low flow taps) this could reduce household drinking water demand by 17%. If this is implemented in 10% of homes (around 4,500) across the city this could achieve a 2% reduction in demand. Use of water efficient devices will also lead to a reduction in wastewater flows. However, the actual implementation rate that can be achieved is dependent on a number of factors which are discussed below.

The benefits that can be achieved through retrofitting water saving devices is dependent on the plumbing system a household has, such as high or low pressure. For example, there is little value in installing flow restrictors and aerators on low-pressure systems. The effectiveness of such devices citywide will be partly dependent on the plumbing design of housing stock.

To achieve a reduction in demand through the use of such devices, the main option for implementation is though customer education and incentives. Enforcing the use of devices such as flow restrictors falls under national legislation (The Building Act) and therefore local Councils have little direct influence.

A basic cost/benefit analysis has been undertaken which shows the likely payback period for an average customer (Table 15). This is an important consideration, which will influence customer choice and the uptake rate across the city. For example, the high benefit/low cost of retrofitting a toilet weight to a single flush toilet is likely to generate a greater uptake rate.

Therefore the approach TCC will take to maximise customer use of such devices will be through strengthened education and incentive programs and providing ongoing customer support/guidance through the Waterline program for the retrofitting of water saving devices. There is little evidence available to quantify the potential effectiveness of such educational programmes to achieve a demand reduction, however, monitoring performance once initiatives are underway will go some way to achieving this.

Table 15: Cost Benefit Analysis – Low Flow Devices

Device	***Cost to TCC (excl GST)***	***Std Fixture***	***With Device***	***% saving ave daily use***	***Saving l/h/d***	***Saving p/a average water bill***	***Straight line payback***	***Retrofit - Considerations***
Gismo/Toilet Weight or Dual Flush Toilet	$1	12 litre flush	3/6 litre flush	51	48.14	$ 22.84	2/3 weeks	No benefit if existing toilet is dual flush. Gismo/weight benefit relies on flush control by individual. Therefore the actual may not be achieved.
Low Flow Showerhead	20	12 l/s	8 l/s	18	22.05	$ 10.46	2 years	Only of benefit on high pressure system
Tap - Flow Restrictors (2)	$15	up to 18 l/s	low as 4 l/s	25	14.79	$ 7.02	2 years	Only of benefit on high pressure system. Doesn't reduce volumetric needs

(1) Savings are based on average water use of 493 l/d/d. (2) Based on kitchen sink aerator, flow restrictor on bathroom hand basin taps (x2). Volume requirement may reduce benefit.

6.2 USE OF RAINWATER TANKS

Use of the IWM model has shown that for an average Tauranga dwelling, if a rain tank is installed for the purpose of outdoor use it could reduce household drinking water demand by 14%. If this is implemented in 10% of homes (around 4,500) across the city this could achieve a 1% reduction in demand.

Greater benefit is shown if the rain tank is used for both outdoor use and flushing of a standard single flush toilet. In this instance, the reduction in household drinking water demand could be as much as 28%. If this is implemented in 10% of homes across the city this could achieve a 3% reduction in demand. Integrated modelling has also shown potential benefits for stormwater by slowing peak flows and reducing runoff volumes.

There is clearly a large potential for rainwater tanks to reduce average and peak demands. However, in terms of difficulty and cost to implement (Figure 8), this is a more complex option, and is reflected in TCC's current approach. This is further discussed below.

The options for implementing the use of rain tanks vary depending on whether they are retrofitted in existing homes or installed on new builds. For retrofitting, the main options are to educate customers on the benefits of installation and provide incentive programmes (e.g. rebate schemes). However, due to the relatively high cost of installation and low cost of water, there is a long payback period, which may be a barrier to uptake. For example, modelling has shown that an average property with a 6 m^3 rain tank used for outdoor use and toilet flushing in Tauranga, could save $65 p/a in water charges. This gives a simple straight-line payback of approximately 46 years. This is for a rain tank costing approximately $3000 (tank, pump, fixtures and fitting) and does not include maintenance costs, pump replacement costs or any cost involved in obtaining a building consent.

The most effective method to ensure installation of rain tanks on new builds is regulation. This would require enforcement through a District Plan Change which could be a lengthy process and is also subject to appeal. This approach is currently being taken by Kapiti Coast District Council, and TCC are keen to learn how this is implemented and the benefits gained.

Another consideration for the installation of rain tanks is to how to ensure standards for fitting are met (e.g. backflow prevention, labelling, plumbing) and ongoing maintenance is carried out. For this reason TCC are currently developing installation and maintenance guidelines for domestic rain tanks which will be available to customers in late 2009.

There is also the consideration of rain tank reliability due to water patterns and seasonal water use, which has been discussed further in Section 4.1.

It is recognised that TCC's research to date has not included all the holistic benefits and costs associated with rain tank installation options, such as the environmental, cultural, social, and financial implications (revenue versus operational costs), as well as stormwater reduction. This is an area for future research.

Although rain tanks offer significant potential for demand reduction, due to the cost of implementation TCC are, in the short term, concentrating on a non-regulatory approach for rain tanks, such as education, awareness and promotion. Furthermore, they will explore possible incentives for retrofitting in conjunction with other 'quick win' demand management options.

6.3 GREYWATER RE-USE

Modelling has shown greywater recycling to have a high potential for reducing peak and average demand. Also, unlike rain tanks, it is not reliant on weather patterns or seasonal water use. Again, the spectrum of options for implementation range from education through to regulation. For TCC this is an area for future investigation, particularly the health considerations, soil suitability, design requirements and appropriate methods of implementation. The first step is the development of use and installation guidelines for Tauranga. In the short term TCC will focus on other lower cost demand reduction options to achieve the demand management targets.

6.4 REDUCING OUTDOOR USAGE

Research has shown outdoor usage to be a large proportion of water used during the summer months (Figure 5). Outdoor usage covers garden irrigation, car washing and recreation needs. The increased use of water for outdoor purposes generally coincides with periods of peak demand, making outdoor usage a key area of focus if peak demand reduction is to be achieved. Rain tanks do have some benefit in this area, although their seasonal availability does not make them 100% reliable. TCC are currently reviewing their water restrictions policy to look at how changes could reduce peak demand. Education is another focus area, especially during the summer months. TCC are working to strengthen education initiatives around water conservation gardening to include workshops, linking with other organisations and businesses, and improving the information available to customers on the Council's website, literature and media.

6.5 REDUCING HOUSEHOLD LEAKS

Leakages on internal pipework, dripping taps and the like can lead to large-scale wastage of water. TCC address this though an ongoing education programme and a free leak detection and small repairs service through WaterLine. This is further described in section 6.7.

To further facilitate this, Automatic Meter Reading (AMR) is currently being piloted in TCC, which, amongst other things, will assist TCC in early identification of leaks. This will enable TCC to provide more information to customers regarding leaks and further advice through the WaterLine program.

6.6 TARIFF STRUCTURE CHANGE

Changes in tariff structure and the use of "economic instruments" are highly effective in reducing demand and, compared to other options, relatively simple and cost effective to implement. This has been demonstrated through the implementation of universal water metering at TCC and from experience of other Councils. With the advantage of having universal metering, further options for TCC include seasonal and/or volumetric tariffing and wastewater charging. These options could provide the demand reductions required in order to delay large investment in infrastructure and will be investigated further prior to seeking approval from elected members.

6.7 EDUCATION

Education is a key component of TCC's demand management programme, and pre-dates other initiatives such as universal water metering. Education, awareness raising and promotion are the cornerstone for delivery of any the water demand management options discussed in this report. Education and promotion is primarily delivered through TCC's WaterLine programme with support from TCC's corporate communications team. The WaterLine programme includes an Advisory Service that provides home visits telephone hotline advice on fixing leaks and water conservation options. Other education initiatives include; a schools educational programme, public displays and talks, source to sea DVD, targeted advertising and information packs. A future focus for WaterLine is delivering the "three waters" messages, bringing with it an integrated approach and public understanding to water management, with further funding being sought for an additional FTE to support the Demand Management Strategy.

Table 16 provides a summary of future focus for TCC's demand side management.

Table 16: Summary of future focus of TCC Demand-Side Management in order of hierarchy.

Options	Short term approach/strategy
Changes in Tariff Structure	Investigate options and implications to review with elected members
Education, incentives, awareness programmes	A continuation and strengthening of the WaterLine Programme
Reducing household leaks	Continue to address through WaterLine Programme Continue to research through AMR pilot
Water conservation gardening/ reduction in irrigation	Water restriction policy being reviewed. Promote water conservation gardening – WaterLine
Water efficient devices e.g. low flow shower heads, taps, cistern weights	Increased/bigger promotion through WaterLine programme and communications team Consider incentives – bigger drive
Use of rainwater tank	Develop guidelines/standards for installation Education and promotion Continue research/understand how TCC could implement Incentives/regulation
Greywater re-use	Area for future research

7 CONCLUSIONS AND RECOMMENDATIONS

The decision to undertake an Integrated Water Management study of Tauranga has enabled TCC to review the effect of potential drinking water demand reduction strategies on water supply, wastewater discharge and stormwater runoff. This has lead to a revised TCC strategy for demand management, focusing on where the biggest gains are while recognising the limitations around implementation.

Whilst many of the above initiatives will contribute to general reduction of water demand, this will indirectly reduce the peak demand as well. Research indicates that some options will carry heavier weight in terms of peak demand management (e.g. tariff structuring and rain tanks), and that payback periods and the price of water are some of the main barriers to private uptake of water saving devices.

There is recognition that the study did not fully explore all of the economic, environmental, cultural and social benefits of the demand management options, which would allow a full cost/benefit analysis, and is an area for future research. However, the use of IWM has been an important first step at quantifying the benefits of implementing demand management options.

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