greater WELLINGTON
REGIONAL COUNCIL

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Household rainwater capture in metropolitan Wellington

1. Purpose

To inform the committee of the results obtained from modelling the use of rainwater for household toilet flushing and outdoor water supply in metropolitan Wellington.

2. Significance of the decision

The matters for decision in this report **do not** trigger the significance policy of the Council or otherwise trigger section 76(3)(b) of the Local Government Act 2002.

3. Background

Harrison Grierson Consultants Ltd was commissioned by Greater Wellington to model the performance of a household rainwater tank system capturing rainwater from a house roof for toilet flushing and outdoor water use.

The modelling was carried out using two tank sizes (5,000 litres and 10,000 litres), on three combinations of roof size (100m^2, 150m^2, 200m^2), and three household occupancy rates (two, three and four occupants). Daily rainfall data for Upper Hutt, Lower Hutt, Porirua and Wellington cities were used for both an average rainfall year and a dry year. Generally there are only minor variations in rainfall between the cities.

The 36 individual results obtained for each city identify the annual volume of rainwater used by each combination of household and the annual volume of municipal water supply needed to top-up the rainwater tank to a minimum level to ensure adequate water for toilet flushing. A simple cost-benefit analysis was carried out on the results to determine the potential savings, costs and payback from installation of the tanks.

The timing and volume of top-up required is of specific interest to Greater Wellington in planning for capacity to provide the additional water supply when needed. Since the greatest demand for top-up was expected to occur over the summer period, Wellington City's three driest summers (1st January to 31st March) over the last 100 years were also modelled.

Final reports have been received from the consultant separately covering the modelling results for each of the four cities of metropolitan Wellington, and a report on the analysis of Wellington City's three driest summers.

4. Modelling

The model performed a daily calculation of the volume of water in the tank for each combination of tank size, roof size, occupancy rate and average rainfall or dry year data. The net change in tank volume comprised the rainwater captured from the roof plus any top-up from the municipal supply, minus the rainwater used by the household. Municipal water was supplied to the tank when needed to maintain a minimum level of 10% full.

It was assumed the entire roof area was utilised for rainwater capture and the first 1mm of each rainfall event was discarded to allow for first flush diversion. The model calculated the annual total volume of rainwater captured and used, and municipal top-up water supplied to maintain the minimum level.

Rainwater draw-off for toilet flushing and outdoor use was based on the results of the *Auckland Water Use Study* carried out by BRANZ in 2008 (*Project EC1356*). This publication identified that rainwater use varied from 24.5% of the estimated average domestic daily demand during autumn/winter, and increased to 34.5% during spring/summer due to increased outdoor water use. The domestic daily demand was varied in line with average monthly consumption.

5. Results obtained

5.1 Rainfall capture

The modelling results show some minor anomalies between the normal and dry years for some cities, most likely due to the rainfall pattern of the specific years used. A small variation in rainfall capture volume was reported between the four cities; however the following observations are made on the basis of average water use:

- A 5,000 litre rainwater tank can provide between approximately 65% and 100% of a household's needs for toilet flushing and outdoor use for up to four occupants in all but the driest years.
  - the percentage of water required that is provided by the rainwater captured decreases as the roof capture area reduces, occupancy increases, and between average and dry years.
  - two-occupant households would require no top-up, or only a small top-up, from the municipal supply in an average year and slightly more in a dry year (top-up volume increasing with smaller roof capture area).

- three-occupant households would require a small top-up from the municipal supply in an average year and a large top-up in a dry year (substantial top-up with small roof capture area).
- four-occupant households would require a very large top-up from the municipal supply with all roof collection areas in a dry year, and a large top-up with the small roof capture area in an average year.

- A 10,000 litre rainwater tank captures a larger amount of rainwater than a 5,000 litre tank, particularly in a dry year. The increase in rainwater captured is greater at higher occupancy rates and with smaller roof capture areas. However the difference in rainwater captured between the two tanks in many cases was not substantial.

- A 10,000 litre tank would meet most needs for toilet flushing and outdoor use in an average and a dry year for a two-occupant household. Top-up is still required for three and four-occupant households but a smaller amount than for a 5,000 litre tank.

5.2 Cost Benefit Analysis

The consultant reports provide a simple cost-benefit analysis for both sizes of rainwater tank. A cost of $7,500 plus GST was assumed for a 5,000 litre tank installation and $10,000 for a 10,000 litre tank installation, based on a previous quotation received. A water meter and manifold would also be required to gain the saving in metered water charges, if not already fitted. Operating and maintenance costs are minor and were ignored.

The value of the rainwater collected was calculated in terms of the potential saving to the householder in metered water charges at the current rate for each city. Annual savings varied between cities and with occupancy rate and roof collection area. The minimum saving was approximately $52 for a two-occupant house in Porirua and the maximum saving was $174 for a four-occupant house in Wellington.

The simple cost-benefit analysis was carried out over a period of five years. It was considered that a householder making an investment in a rainwater tank would expect to see payback in five years to make the investment worthwhile. The analysis was carried out using the average saving in metered water charges for both tank sizes, with and without the cost of a water meter and manifold. GST, and interest costs for a debt funded installation, were also excluded.

The table below shows the approximate payback calculated for the two sizes of tank with both the average and the maximum saving in metered water charges that would be achieved for each city. The table shows that, even in the best case scenario at maximum savings, payback for a rainwater tank installation is unlikely to occur within the lifetime of the system. This makes a rainwater tank installation very uneconomic from a purely cost benefit perspective. A substantial reduction in the cost of the installation and/or metered water charges would be needed to change this outcome.

The analysis also identified that the interest charges for a debt-funded installation would be well in excess of the maximum savings that would be achieved in metered water charges.

	5,000 litre rainwater tank		10,000 litre rainwater tank	
	Payback at Average Savings	Payback at Maximum Savings	Payback at Average Savings	Payback at Maximum Savings
Wellington	61 years	43 years	78 years	56 years
Upper Hutt	48 years	37 years	92 years	68 years
Lower Hutt	51 years	37 years	96 years	67 years
Porirua	70 years	53 years	130 years	96 years

Table 1: Payback period for rainwater tank systems

The cost and savings in each of the 4 cities was calculated assuming that 25% of households installed a rainwater tank system for toilet flushing and outdoor use. This is seen as an upper limit of what may be achievable over at least 10 years with regulations for new houses and financial encouragement for existing houses.

A summary of the results is shown in the table below.

	5,000 litre rainwater tank		10,000 litre rainwater tank	
	Average Total Cost (25% Houses)	Average Total Savings over 5 years	Average Total Cost (25% Houses)	Average Total Savings over 5 years
Wellington	$132 million	$10.5 million	$175 million	$11 million
Upper Hutt	$27 million	$1.8 million	$36 million	$1.9 million
Lower Hutt	$72 million	$4.6 million	$96 million	$4.9 million
Porirua	$30 million	$1.4 million	$39 million	$1.5 million
Total	$261 million	$18.3 million	$346 million	$19.3 million

Table 3: Average total cost for installation in 25% of households

5.3 Driest summers

The summer period (1st January to 31st March) of 1939, 1982 and 2001 was identified as Wellington City's three driest summers of the last 100 years. The rainfall data for these three years was modelled for a two-occupant house with a 5,000 litre tank capturing water from a 100m^2 roof.

The results identified that only 47% to 62% of the household's water requirement for toilet flushing and outdoor use over the summer period would be provided by the rainwater collected. An average of 6,400 litres top-up would be required (35 litres/person/day over summer). For the driest of the 3 years, the top-up required was greater than the rainwater collected.

In comparison, rainwater in the 'normal' dry year provided 92% of the household's needs, requiring a top-up of only 3,600 litres over the year. On the surface this result looks favourable; however a review of the daily data revealed that top-up was generally not needed outside the December to April period. Practically all the top-up needed over the year would occur during the summer period, when water supply demand is at its peak.

5.4 Comparison with bulk water supply

The volume of water substituted by the installation of rainwater tanks was approximately 25,000 litres per person in an average year. The four cities have a population of approximately 390,000 (Statistics NZ 2010 figures). With 136,445 households in the four cities this equates to an occupancy rate of 2.85 per household. An average of 71,250 litres of rainwater per household would be collected. For 25% of households, estimated as the upper limit of what could be achieved, the total volume of rainwater collected is estimated at 2,430 million litres in an average year and less in a dry year. This would be obtained at an estimated cost of between $261 million and $346 million.

The Whakatikei dam by comparison would provide usable storage of 5,900 million litres at a capital cost of $142 million including treatment plant and network upgrades to provide the additional flow. A third lake at Kaitoke is expected to provide usable storage of 4,500 million litres at an estimated capital cost around $80 million to $90 million.

The average rainwater collected in the driest summers by a 2-occupant house with a 5,000 litre tank was 7,500 litres. Assuming this is representative of 25% of houses with a rainwater tank, the total rainwater collected would be only 260 million litres. Either the Whakatikei dam or third lake would be needed to provide the 205 million litres of top-up water for these rainwater tanks.

6. Comment

The three areas of house roof modelled cover a good range of single and two storey house sizes; however the model assumes the entire roof will be available for rainwater capture. This may not always be practical or cost effective, particularly with retro-fitted installations. Less effective results and increased top-up would be required for smaller roof capture area.

The cost of installing a rainwater tank system will vary depending on specific house and site circumstances. In some cases the tank installation and connection to stormwater drainage pipes and toilets will be relatively straightforward and less costly; in others it will be more complex, more intrusive and more expensive.

The modelling results confirm that a rainwater tank has the potential to provide a high proportion of a household's requirement for toilet flushing and outdoor water use. If the tank was large enough it could be self-sufficient, but larger tanks are more expensive to install and likely to create more on-site difficulties.

A 5,000 or 10,000 litre tank for the situations modelled was shown to be clearly not cost-effective. The savings from reduced meter charges would be insufficient to cover the interest charges of the installation and the simple payback would exceed the expected life of the installation.

In general, a 10,000 litre tank performed better in meeting a household's needs for toilet flushing and outdoor use than a 5,000 litre tank. But the difference was often not significantly more to justify the additional cost of the 10,000 litre tank and the site difficulties from its larger size. The roof capture area appears to be as important as the size of the rainwater tank.

The metropolitan water supply would need to have the capacity to supply the top-up water to maintain a minimum level for toilet flushing, which will mainly occur over summer at times of peak demand. Since control of the system is lost, planning of metropolitan water supply systems to be able to supply the full household requirement for toilet flushing and outdoor use is prudent. On that basis, household rainwater tank systems still connected to the metropolitan water supply are unlikely to reduce the need for the development of the water supply system.

The metropolitan Wellington water supply system would provide similar quantities of water at drinking water quality for substantially cheaper cost than a rainwater tank installation.

The consultant's reports comment on the use of rainwater tanks for alternative purposes, including stormwater retention and emergency water supply. These uses are generally mutually exclusive unless special systems are used. The use of a rainwater tank for household emergency water supply would appear to be an obvious benefit to households in all cities.

7. Conclusions

Whilst a high percentage of a household's water needs for toilet flushing and outdoor use are possible with a rainwater tank system, it is not cost-effective as an alternative to the metropolitan Wellington water supply system.

A 10,000 litre rainwater tank would be inadequate in an average year for many households to avoid the need to top-up the tank from the municipal water supply, to maintain a minimum level. This reliance on the municipal water supply would occur mainly during the summer period at times of peak water demand, and increase during dry summers.

The installation of household rainwater tanks would not reduce the need for development of the metropolitan water supply system to meet peak demand in a dry summer from a growing population.

The use of a rainwater tank for emergency water supply would provide a level of independence and security for a household in an emergency. The volume of a rainwater tank dedicated to emergency supply could be less than 5,000 litres and stand alone from the municipal water supply. This would reduce the cost and complexity of the installation. More investigation into the use of household rainwater tanks for emergency purposes would be beneficial.

8. Communication

A media statement is not considered necessary at this time.

9. Recommendations

That the Committee:

1. ***Receives** the report.*

2. ***Notes** the content of the report.*

3. ***Notes** that further investigation is to be carried out into the use of rainwater tanks for emergency storage and reported back to the Committee.*

4. ***Agrees** that the consultant's reports will be made available to the Water Supply Managers of our four city council customers and Capacity Infrastructure Services for information and feedback.*

Report prepared by:	Report approved by:
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