AUCKLAND CITY COUNCIL – ISTHMUS DISTRICT PLAN REVIEW 2007/08
EUM/METROWATER 3-WATERS DISCUSSION PAPERS

1. PAPER TITLE:	**WATER RE-USE & RECYCLING (STORMWATER & GREYWATER)**
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2. PAPER ISSUE STATUS: DRAFT FOR REVIEW

Issue No	Date	Contributors	Reviewer	Summary of main changes
1	18/03/08	M Menzies	-	Incomplete preliminary draft to R Mills
2	14/04/08	M Menzies	R Mills	Substantially complete draft version of paper
3	09/05/08	M Menzies	I Mayhew	Stronger focus on District Plan implications
4	12/05/08	M Menzies	R Mills	Minor edits/additions + addition of detention tanks (Section 9.4)
5	21/05/08	M Menzies	I Mayhew	Minor edits/additions
6	24/06/08	R Mills		Minor edits to align with other stormwater papers
7	7/07/08	G Ockelston		Edits/additions
8	15/07/08	R Mills		Edit increased impervious area to align with Quantity paper

3. KEYWORDS:

water	stormwater	greywater	re-use	rain tanks
costs	non-potable	sustainability	public health	economics
'third pipe'	wastewater	charges	regulatory	

4. SCOPE OF PAPER (SUMMARY)

- Addresses water re-use/recycling issues and options – including existing and prospective new programmes in the context of prospective initiatives under the Isthmus District Plan review - covering:
  - Rain tanks
  - Greywater recycling
  - Third pipe supply system
- Key issues covered include:
  - Technical facets
  - Sustainability
  - Public health risks
  - Costs/economics

NOTE: It should be noted that there is some overlap between this Paper and the companion paper entitled "Stormwater Quantity". In particular, the latter paper addresses options to control adverse effects of impervious area and rain tanks (as covered herein) are capable of meeting this requirement. Correspondingly, on this topic, both Papers should be read in parallel.

5. RECOMMENDATIONS FOR CONSIDERATION FOR DISTRICT PLAN:

EXPLANATORY NOTE

The studies – and in particular the recommendations - take due note of the 'drivers' for stormwater re-use both at the regional level (ie as developed by Watercare in its 'Three Waters' Strategy – Ref. 7) and at the Auckland City/Metrowater level (ie accounting for 'Drainage Strategic Review' – Ref. 8). Arising from this, it is noted that there are no strong regional or City-level drivers for re-use per se (eg at City-level, the driver is more one of the stormwater attenuation function of rain tanks), for the following reasons:

- The economics of re-use are unattractive as compared to other options for the supply of water
- There is no strong imperative to apply re-use to avoid developing a new bulk water source[1] (ie new bulk water sources are available and are programmed for implementation – refer Ref. 7)

1) Stormwater Harvesting – General: Encourage on sustainability grounds where it is both safe and justifiable on cost grounds (including provision of information)
2) Rain Tanks:
   a) Continue existing programmes (ie Res 8 and Development Contribution Rebate)
   b) Introduce a revised detention tank policy (refer Section 9.4)
   c) Prospective New Measures (refer Sections 9.6 & 9.7 – note the further research needed):
      i. Permit greater site impervious area coverage if a rain tank is provided to Council design standards (refer to papers on Stormwater Quantity and Quality)
      ii. Encourage rain tanks on new developments
   d) All rain tanks with a stormwater discharge attenuation function (ie as well as re-use) to be subject to a compulsory maintenance and inspection regime
3) Greywater Recycling: Prohibit, due to public health risks
4) Third Pipe Supply System: Consider applications on a case-by-case basis

6. OUTSTANDING MATTERS:

#	ITEM	Comment on Work Pending to Address this	Refer Section
1	Rain Tanks: Continuation of Metrowater policy on applicable charging regime	Refer to Metrowater	9.6
2	Third Pipe Supply: Research the issue of the ability of the City to compel householders to install dual plumbing and connect to a third pipe system where such is reticulated to the property boundary	Refer Bob Lamason, ACE	11.6

Note: This is a summary page(s) for quick reference

CONTENTS (Sections 7 – on)

ABBREVIATIONS:

[1] Compare with Australia, where water shortages mean that this is an imperative in some situations

AEP	Annual exceedance probability (eg 2% AEP is equivalent to the 1:50 year event)
MoH	Ministry of Health
OSM	On-site stormwater management

7. SCOPE AND ISSUES

This paper addresses issues surrounding stormwater re-use (or "stormwater harvesting") and water recycling for domestic supply (non-potable uses), evaluating:

- Existing Auckland City Council re-use programmes and the lessons from these
- Other prospective re-use/recycling programmes (eg greywater recycling)
- Issues with stormwater re-use, eg:
  - Sustainability
  - Public health
  - Economics
- Opportunities for facilitating greater re-use through the incorporation of provisions in the update to the Isthmus District Plan, covering:
  - On-site re-use (eg using rain tanks)
  - Reticulated non-potable supply

8. BACKGROUND AND PRIOR WORK

Re-use and/or recycling involves capturing urban water that would otherwise be discharged to waste and re-using it as a non-potable water source. Various modes of capture and re-use are possible, eg:

- Stormwater Re-Use/Harvesting: Capturing the rain falling on a roof and storing it in a tank (ie applies to an individual lot)
- "Third Pipe" Supply: Using water from the likes of a stormwater pond, quarry, etc, and, after treatment, reticulating it to households via a "third pipe" system
- Greywater Recycling: Treating domestic greywater (water from showers, washing machines, etc) and re-using it as a non-potable water source typically for garden watering

There are several "drivers" for this type of re-use, viz:

- Conservation/Sustainability: Rather than discharge stormwater or greywater to waste, it applies the more sustainable practice of re-using the water before discharging it
- Stormwater Discharge Attenuation: Where stormwater is captured (eg in tanks), the peak discharge to the public stormwater system is attenuated – and in turn <u>may</u> assist in reducing downstream flooding and/or stream erosion
- Saving on Mains Water Usage: It reduces the demand on the mains potable water system, in turn:
  - saving on the householders mains water usage and charges[2]
  - potentially delaying the need for implementing additional bulk water sources to cater for growth
- Reduced Wastewater Discharge: Similarly to the above, this applies in the case of greywater recycling

There are no specific regulatory requirements for water conservation and use minimisation. The regional water industry members (e.g. Metrowater, Watercare Services Ltd etc) do however have

[2] Subject to Metrowater's water charging regimes – refer Sections 9.3.6 and 12.2

a self-imposed target[3] for regional gross per capita reduction of 5% from 2004 - 2024 and to provide water conservation information to customers. Private greywater and stormwater re-use options would contribute to this target.

The Proposed Auckland Regional Plan Air, Land and Water (Ref. 9) does not expressly provide for water conservation and re-use. However, applications to take water for municipal supply are required to be accompanied by a demand management plan and a network efficiency and water conservation management plan. The Plan also recognises the concept of low impact urban design, of which rain/stormwater harvesting is an element.

In Auckland City, there are existing re-use programmes, for example (refer Sections 9.2, 10.2 and 11.2 and List of References in Section 13 for fuller details):

- On-Site Stormwater Management (OSM) Programme: This applies in areas of the City zoned "Res 8" and provides for OSM devices to store/attenuate stormwater runoff - whereas the prime focus is on stormwater discharge attenuation, where rainwater tanks are used, there is a related re-use component (note that the OSM Manual – Ref. 1 – also provides for other types of devices which have no re-use component, eg raingardens)
- Development Contribution Rebate Programme for Rainwater Tanks (Stormwater) – Ref. 2: Applies across the City where new dwellings qualify for a rebate on their Development Contribution if they install a rainwater tank
- Discharge Attenuation Tanks in Areas with Under-Capacity Public Stormwater Systems: Rainwater tanks are also a prospective solution in cases where stormwater discharge attenuation is required before development can proceed (eg due to capacity constraints in the public stormwater system, especially in combined sewer areas)
- Case-by-case developments eg Stonefields "Third Pipe"[4] System: As part of the redevelopment of the former Mt Wellington Quarry for residential use, all stormwater is fed to a detention pond – from here a plant abstracts and treats the water for feeding to a separate non-potable "third pipe" reticulation system

There are also other prospective re-use programmes, including adaptations, eg:

- Expansion to the coverage of the aforementioned programmes
- Greywater recycling: This involves the installation of a collection-treatment-distribution system to recycle wastewater from the likes of showers, basins, baths, washing machines[5] - it has been researched previously for prospective application on Waiheke Island - refer Appendix A for fuller details)

Examples of issues arising from these types of programmes, to be addressed in Sections 9 – 11, include:

- Sustainability of re-use as a practice
- Public health risks with non potable water
- The economics of re-use systems
- Other, eg:

[3] Metrowater draft SCI July 2008-2011
[4] "Third pipe" denotes piped non-potable stormwater supply
[5] Compare with blackwater which is from toilets (note that kitchen sink water is often categorised as greywater, but wastes washed down the sink mean that it is not suitable for greywater recycling)

– the ability to encourage the usage of re-use systems (noting that the uptake on rain tanks to date is quite low)
– it is uncertain if householders can be compelled to connect to a “third pipe” type system (note: further legal research is currently in process on this issue)

9.0 RAIN TANKS

9.1 Introduction

A rainwater tank is installed to intercept rain that falls on a roof. From the tank, water is piped back into a dwelling to feed non-potable fixtures (eg toilets – refer Section 9.3.2 for fuller details). In the City, tanks are typically of the “dual-use” type, serving both peak flow attenuation and re-use functions. In its re-use mode, the tank is directly comparable to water supply systems in use in rural areas where there is no mains water reticulation.

The “dual-use” type rain tank layout is shown in Figure 1, with the tank having two zones, viz:

- Lower part (“permanent storage” or “rainwater space”):
  – dedicated to storing water for re-use
  – to ensure continuity of supply in dry periods, it includes a mains connection for “topping-up” the storage
- Upper part (“temporary storage” or “air space”):
  – dedicated to retaining runoff in short duration, high intensity storm events
  – has an orifice outlet at the bottom (ie this defines the interface between the temporary and permanent storage zones); this serves to “throttle” the flow to the desired stormwater discharge rate
  – has an overflow at the top of the tank, connected to the City’s stormwater system

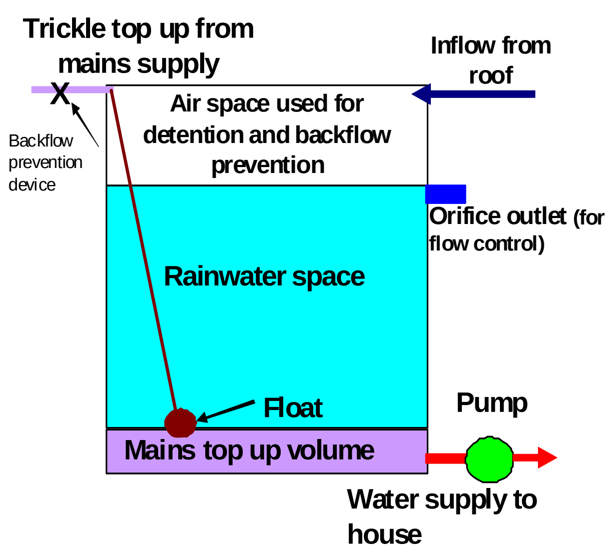

Figure 1: Dual-Use Rainwater Tank - Elevation

In the following sub-sections, attention is given as to how the Isthmus District Plan update might address the usage of rain tanks, in turn covering issues arising, eg:

- Applicability of tanks and their costs/benefits
- Incentives
- Controls
- Generic re-use issues flagged in Section 8 (eg sustainability, public health, economics, etc)
- Prospective changes to programmes under which tanks can be implemented (ie to be addressed in the District Plan update)

9.2 Status Quo Situation

Section 8 has outlined the existing City programmes for rain tanks. The uptake to date is as follows (note that the figures given are very approximate because ACE's databases do not record this information in a readily retrievable form):

- On-Site Stormwater Management (OSM) Programme (introduced in 2003): approximately 80 tanks installed (note, however, that only a small part of the City is zoned Res 8)
- Discharge Attenuation Tanks in Areas with Under-Capacity Public Stormwater Systems: approximately 40 tanks with a re-use component installed since 2003
- Development Contribution Rebate Programme for Rainwater Tanks (Stormwater) [introduced in 2006]: no tanks installed
- Tanks Installed Outside the Foregoing Programmes (eg by householders with an interest in water conservation/re-use): not known, but thought to be less than 10

These numbers should be interpreted in the context of the 'drivers' for the installation of tanks. The first two are associated with regulatory requirements – ie the requirement to install a tank to enable increased areas of impervious service or to compensate for stormwater network capacity issues in areas of combined stormwater/wastewater networks. The last two are purely voluntary. In this context, the drivers are essentially limited to the programmes noted above, with no independent impetus to date from either Watercare or Metrowater. In summary, the uptake to date is seen to be very low. The main reasons include:

- The relative newness of the two main programmes (and in turn the potentially poor level of public knowledge that such programmes exist?)
- In the case of the OSM Programme, the fact that a developer can choose OSM devices other than rain tanks – it should be noted that none of these other devices includes a re-use component
- The unfavourable economics of tanks (ie costs typically exceed benefits – refer Section 9.3.6)[6]
- The limited rebate available in the case of multi-unit dwellings where the Development Contribution Rebate is claimed (ie applies to one storey only)

[6] In the case of tanks in Res 8 areas, the economics are more favourable if account is taken of the ability to increase the density of development over the case where impervious area coverage is limited to 60% (ie on a given site, a developer can get more dwelling units, the profit from which will generally be well in excess of the cost of the rain tank installation)

- The preponderance of inner-city apartment developments in recent years – these are not as amenable to re-use from the viewpoints of limited roof area, little or no lawn/gardens space, etc
- Space and aesthetic issues with the siting and visibility of tanks (albeit noting that, as time goes on, type and size options are increasing)

Separately, the City has traditionally permitted 'detention tanks', for stormwater discharge attenuation. In essence detention tanks are the same as a rain tank, but with no re-use component – and such tanks are typically buried. Whereas Section 9.3 addresses rain tanks, Section 9.4 explores a proposed new policy for detention tanks, bringing requirements more closely into line with the requirements for rain tanks.

9.3 Research & Precedents

9.3.1 Effectiveness of Tanks at Discharge Control in Extreme Storm Events

Rain tanks are normally designed as dual-use devices, exercising both a stormwater peak discharge attenuation function and a re-use/harvesting function. In respect to the attenuation function, the tank is typically required to limit the peak outflow to a pre-determined figure (eg to match the peak discharge equivalent to that from the same site with 60% impervious area cover, in a 10% AEP storm).

In order for tanks to be fully effective in their attenuation capacity (including during flood events), they should be capable of attenuating to the pre-determined level in the 2% AEP storm event (ie the 1:50 year event), thereby matching the flood protection standard set in the Building Act. If tanks are designed to meet only the 10% AEP standard, then the additional overland flow in the 2% AEP event could increase the flood risk. In this context, it is noted that the capacity of guttering/downpipes, sized according to the Building Code E1/AS1[7], means that flows above a 10% AEP will overflow and not reach the tank, albeit that E1/AS1 may incorporate a degree of over-design. This issue could be addressed through one of the following approaches:

- Require over-sized guttering as compared to provisions in Building Code, to contain up to the 2% AEP event
- Accept that tanks will not be fully effective in storms larger than the 10% AEP event

Against the foregoing, practical considerations indicate that attenuation up to the level of the 10% AEP event is probably adequate. The rationale for this judgement is that in events larger than 10% AEP, the following factors come into play:

- Gutters will fill and overflow, leading to overland flow across the lot – and some attenuation will occur as this overland flow traverses the lot
- The pervious area will most likely be fully saturated, meaning that there will be little distinction in hydrological terms between the runoff behaviour of the pervious and impervious areas

9.3.2 Sustainability

[7] Refer http://www.dbh.govt.nz/UserFiles/File/Publications/Building/Compliance-documents/clause-e1.pdf (Sections 5.1.3 and Appendix A)

Stormwater re-use, as is achieved by rain tanks, is considered to be a sustainable method of water management including:

- The re-use of a resource that would otherwise run to waste (ie matches the drive for wiser use of finite resources), with the additional benefit of reducing the adverse effects of stormwater on watercourses and other receiving environments
- It reduces the demands on the mains supply and provides added protection against loss/reduction of supply in a drought[8]
- The ability of people to tangibly contribute to an initiative that meets both 'sustainability' and 'wiser use of finite resources' themes
- Provides for more resilient communities in emergency situations

9.3.3 Public Health

The use of water from rain tanks poses a potential public health risk, arising from the danger of people ingesting non-potable water and getting a gastro-intestinal illness. While tank water supplies are widely used in areas with no public reticulation (for example island communities such as large parts of Waiheke and Great Barrier) the level of activity and pollutants in dense urban areas is greater.

Thus, it is important to limit uses of rain tank water in urban areas to uses where this risk is very low; correspondingly Auckland City Councils standards (Ref. 1) limit use to the following – in turn these uses typically account for about 50% of the total household demand:

- Toilet flushing
- Outdoor watering
- Cold water supply to clothes washing machine

The aforementioned uses are based on a risk analysis by Dr David Ogilvie commissioned by Auckland City Council in July 2002 (Ref. 4). It is noted that Dr Ogilvie's report advised that the cold water feed to the shower could also be non-potable, but Metrowater requested that this be deleted.

Tanks are plumbed to the fixtures listed above, meaning that a dwelling needs to have dual plumbing. For a new dwelling the extra cost over single-system plumbing is of the order of $1,200. Section 9.3.3 addresses the dual plumbing issue for existing dwellings. In accordance with accordance with AS 2700 (colour code P23), the tank supply is fed via lilac coloured pipework, designed to distinguish it from the potable system pipework – this is an important public health safeguard, designed to avoid a plumber connecting to the wrong system when doing alterations/extensions

Noteworthy is the fact that NZ has no official standard covering rain tanks and measures to combat public health risks.

[8] There is potential confusion about the ability of a tank to reduce the demand on the mains system in a drought. Certainly, in a dry spell a tank will likely empty, requiring mains water to be used instead. However, tanks do have a benefit in a drought, because in the 3 year drought that is the critical event for Watercare's storage dams, any water that can be supplied from tanks over this period will reduce the demand on the dams

9.3.4 Issues with Tank Siting

Various practical issues arise with the siting of tanks, including space constraints and visual impacts.

a) Space:
The space issue can be a major constraint, especially on smaller lots where space is at a premium. The typical solution is to select a higher tank that occupies a lesser footprint. On single storey dwelling, such a tank will often need to be partially buried because the top of the tank must be below the lowest point of the spouting for the water to flow to the tank by gravity. Conventional lightweight plastic tanks, or standard concrete tanks, are not designed to be buried. Concrete tanks can experience structural cracking in such situations, and depending on the seasonal groundwater table can allow leakage out, or more seriously the ingress of groundwater – if the later is contaminated, it will affect the level of public health risk, even though the tank water is not intended for potable use.

Tanks designed to be fully buried are significantly more costly than conventional lightweight tanks, by 30% - 50%. A further issue is the high cost, or indeed the impracticality, of partially/fully burying tanks where rock is close to the surface and poses a problem to break-up and dig out[9].

b) Visual Impact:
On the visual impact issue, options to minimise the problem include:

- Screening by the likes of trellis or vegetation
- Partial/full burying of the tank (refer above for comment on the practicality of this issue)
- Applying alternative tank designs (eg:
  - tankage incorporated in fence panels
  - bladder-type tanks located in crawl space under a dwelling

9.3.5 Feasibility of Dual Plumbing Existing Dwellings

Rain tanks are normally considered for new developments. However, it is worthwhile exploring the feasibility of installing dual plumbing in existing dwellings. In essence, new plumbing would be required from the tank feeding the outlets listed in Section 9.3.2 (ie toilets, outdoor taps and cold water feed to clothes washing machine). This would be in the lilac coloured pipe noted in Section 9.3.3, designed to distinguish it from the potable system pipework. Whereas installing this plumbing pipework is not an undue problem for the main pipes (eg under the floor in a dwelling with crawl space and timber floor, or in the roof space for a slab-on-ground dwelling), replacing the pipework up/down the walls with lilac-coloured pipe would be a costly exercise (ie due to the need to remove sections of wallboard).

9.3.6 Economics

[9] For example, this was an issue at the Stonefields development in the former Mt Wellington Quarry – together with the space constraint issue, tanks were rejected in favour of a reticulated "third pipe" supply system

Estimated capital and operating costs for rainwater tanks are set out in the City's On-Site Stormwater Management Manual (Ref. 1). The Manual was mainly concerned with multi-unit developments in Residential 8 zones, where a single tank could supply multiple dwelling units. However, looking at the more representative case of a new single family dwelling with 4 occupants, the typical costs for a tank-based system incorporating dual plumbing and designed to meet 50% of the average annual domestic water demand, are as follows:

- All-up capital cost: $5,500 (including dual plumbing)
- Annual operating/maintenance cost: $200

<u>At present</u> users can look forward to appreciable savings on their mains water and wastewater charges, and the corresponding wastewater charge. This arises from Metrowater's <u>current</u> policy not to change its mains water pricing policy for those with rainwater tanks, and to allow them to also receive the benefit of the reduced wastewater charge (ie arising from the fact that the wastewater volume charge is 75% of the metered mains water consumption – and rainwater tanks will reduce the metered water consumption). However, it should be recognised that there are no guarantees that Metrowater will continue this policy (refer also Section 12.2). Indeed, substantial uptake of rain tanks, with consequential water savings, would almost inevitably lead to a review of how wastewater flows are charged.

Table 1 illustrates the likely <u>annual</u> water and wastewater savings for the tank case cited above; also given is the comparative cost.

Table 1 – Illustrative Example
Rainwater Tank Costs and Savings on Metrowater Charges (including GST)

ITEM	**Basis**	**Cost or Saving**
Costs	Capital: amortise $5,500 at say 12.5% pa	$688
	O&M: say	$200
	Total annual	**$888**
Annual Savings	Assume 50% of the estimated annual water use of 340 m3 is supplied by the tank:	
	- water charge saving: 120 m3 @ $1.405/m3	$226
	- wastewater charge saving: 90 m3 @ $3.36/m3	$405
	Total	**$631**
	Excess of annual cost over savings	**$257**

The figures in Table 1 show that, based on the assumptions applied, the savings do not quite match the costs, making the installation of a rainwater tank an uneconomic proposition on water supply grounds alone (ie ignoring the stormwater runoff attenuation benefit). However, as/when Metrowater's tariff increases by 40%, break-even would be reached.

Accounting for the case where the tank qualifies for the $1,000 subsidy under the City's rebate programme (ie as described in Section 8), the annual cost reduces by $125 and the excess of cost over benefit reduces to $132.

The economics of rain tanks as a supply source for the Auckland Metropolitan area have been also assessed by Watercare as part of its 'Three Waters Strategy' studies (Ref. 7).

This work shows that, in comparison to the option of developing a new bulk water source, rain tanks are many times costlier. For example, compared with implementing capacity increments on the Waikato bulk water source, the Three Waters studies found the cost of rain tanks to be about six times as much[10]. This demonstrates that rain tanks are not an economic proposition in delaying investments in new bulk water sources.

9.3.7 Operation/Maintenance & Compliance Monitoring

Like all 'at-source' stormwater devices, in order to perform satisfactorily on an ongoing basis, tanks require the application of a sound operation and maintenance (O&M) regime. Requirements are not onerous (eg refer checklist in Appendix B), but if these are not done on a regular basis, the tank will in due course fail to satisfactorily perform its functions, and possibly pose a public health risk.

In developing the OSM Manual (Ref. 1), the City explored a range of prospective methods for achieving satisfactory O&M of tanks and other OSM devices. Note, however, that this was addressed in the context of ensuring that the device would be maintained in a satisfactory state of repair to meet its stormwater discharge attenuation function. The adopted O&M regime is a "warrant of fitness" (WOF) system under which owners with tanks that have a discharge attenuation function are required to have their tank inspected by a qualified contractor every two years and, from this, submit to the Council a certificate demonstrating O&M compliance. The Council (ACE) is to have all tanks on a database (under development, but not yet operational) which will record and/or action the following:

- Issue WOF reminders to owners as the due-date nears
- File submitted WOF's on the database
- Follow-up on overdue WOF's
- Carry out random inspections to check O&M compliance

Although not explicitly required for tanks installed outside the OSM/Res 8 programme, it will be appropriate to implement a common O&M standard for all new rain tanks with a discharge attenuation function. However, where tanks are for re-use only, a voluntary regime will be appropriate.

The following issues arise in relation to this O&M compliance obligation:

- Implementation and operation of the aforementioned database has a cost to ACE – the annual cost will depend on the number of tanks constructed, but might be of the order of $10 - $20 per tank
- Given the relatively few tanks to date (refer Section 9.2), ACE has not yet implemented the aforementioned O&M compliance inspection programme – the annual cost of inspecting a sample of say 2.5% of the tanks each year, <u>averaged over all the tanks in place</u>, is estimated at $5 per tank

It should be noted that, at present, no annual fee is in place as a cost-recovery mechanism for the tank O&M database and compliance systems.

[10] Note, however, that this analysis is not applicable to the perspective of a homeowner in Auckland City, where <u>retail</u> water prices apply, and there is currently a wastewater saving to the homeowner from having a rain tank installed (ie as explained earlier in Section 9.3.6)

The foregoing aside, it is recognised that some tanks are likely to 'slip through the net' and not receive adequate maintenance. This should, however, be picked up when a dwelling is sold, with the WOF show on the LIM as needing to be rectified (note that in Auckland, on average, dwellings are sold about every 7 years).

9.3.8 Summary

Summing up, the following points can be made:

- Ignoring the stormwater attenuation benefit, the economics of tanks are not especially attractive (ie costs slightly exceed benefits at current Metrowater tariff levels)
- The economics are highly dependent on the wastewater charges saving (ie accounts for 65% of the savings), so any change to Metrowater's policy on this would have a major impact on the economics
- In cases where a tank is dictated by Council, due to downstream network capacity constraints, the add-on cost to incorporate re-use is modest and close to an economic proposition on the water tariff savings alone (ie ignoring the reduction in the wastewater charge

9.4 Detention Tanks

The City has traditionally permitted 'detention tanks', for stormwater discharge attenuation. These detention tanks are required for the following situations:

- Where new development occurs in combined sewer areas – this includes combined areas where stormwater discharges may be via a kerb outlet
- Where development occurs in Residential 8 areas and site coverage is above 60% (refer OSM Manual – Ref. 1)
- Where reduced flow rates are required for soakage system infiltration rates

Detention tanks are not required on residential developments on sites less than 1,000m2 in area where there may be a downstream stormwater capacity issue, because the Stormwater capital programme is aimed at solving residential habitable floor flooding over time. The increase in potential downstream flooding in the 2% AEP event due to an increase in impervious area from small scale residential development is considered to be minor.

A revised policy for detention tanks is required to bring them into line with parallel rain tank policies and also match the provisions in the Drainage strategic Review (Ref. 8 – 2006).

The revised requirements for detention tanks are proposed to be as follows:

- General:
  - All detention tanks must be built above ground[11]

[11] The reason for this is that below ground tanks are more problematic to maintain and inspect. All tanks shall be designed to the requirements of Councils OSM manual.

- All tanks to incorporate a re-use component (ie sized as set out in the OSM Manual) – noting, however, that for alterations and additions above 15m2 in combined areas, re-use options may be waived if the additions do not contain bathroom or laundry facilities.
- All tanks must meet the consent requirements, including for operations and maintenance obligations of the OSM Manual

- Exceptions
  - For alterations and additions to existing residential buildings that add up to 15m2[12] of impervious area, and still comply with site coverage requirements no detention tanks are required
  - In combined areas that are programmed to be separated within 3 years from the date of any application made for a building consent(as determined by Metrowater), then in lieu of providing a detention system, the applicant may pay to Council the cost of the detention system and avoid the need to install it

9.5 Options

Options for the implementation of rain tanks in the Isthmus are set out in Table 2, addressing both existing and prospective new programmes. Options could be implemented on the basis of a justified regulatory regime, via incentives or through encouragement.

Table 2 – List of Prospective Tank-Based Re-Use Options

OPTION	ACTION REQUIRED TO IMPLEMENT			CATEGORY
	None (ie Existing)	District Plan-Related	Via Other Initiative	
(1) Retain Existing Programmes (refer Sections 8 & 9.2 for details)				
a) No change	Yes	No		Regulatory/ incentives
b) With increased publicity		No	Yes	Encouragement
(2) Introduce New Programmes:				
a) Education		No	Yes	Encouragement
b) Allow greater site impervious area coverage if a rain tank is provided(refer papers on stormwater quantity)		Yes		Regulatory
c) Encourage rain tanks on new developments		Yes		Encouragement
(3) Revised Detention Tank Policy		Yes		Regulatory
(4) Reuse of stormwater injected to groundwater aquifer		Yes		Encouragement

Discussion on these options is given in Section 9.6.

9.6 Discussion

[12] 10m2 is used in the D&C standards, however this may be less than a bedroom extension

The present rain tank programme is primarily driven through the regulatory basis of avoiding the effects of increased imperviousness in Residential 8 zones. Re-use is incorporated as a secondary benefit of providing rain tanks for discharge attenuation. The regime is effectively an elective programme, as the default position from a regulatory viewpoint is to reduce the site impervious area coverage to an extent that OSM controls are not required. However, this may change should greater development intensities be sort through the new District Plan.

The rebate from Development Contributions for Stormwater provides a nominal incentive aiming to recognise the conservation benefits of Stormwater re-use. Again the rebate is optional on the part of the developer, as they retain the choice to pay the full contribution and are not then required to have a rain tank.

Comment on the other options is Table 2 is as follows:

2(b): Allow greater site impervious area coverage if a rain tank is provided:

This concept has merit, both in cases where impervious area limits are set to be exceeded by a proposed development and where limits have been exceeded (eg by impervious area 'creep') and the City seeks a method to mitigate that exceedance[13]. It should be noted that this concept is already applied, as a discretionary activity, where development applications exceed the site impervious area coverage.

This option is discussed in the stormwater quantity paper for use in areas where there maybe particularly sensitive receiving environments and for mitigating effects of increased impervious coverage in soakage areas.

2(c): Encourage rain tanks on new developments

In carrying out the Drainage Strategic Review in 2006 (Ref. 8) consideration was given to incorporating OSM type rain tanks on a City-wide basis to address stormwater capacity issues (note: the matrix of options considered is attached in Appendix C).

The Review considered a range of objective, including:

- Protecting residential floors from 2% AEP flood
- Avoiding the likelihood of damage or nuisance to other property
- Minimising costs both public and private and on rates
- Enabling growth through the use of Development Contributions funding capital works
- Ensuring methods were simple and easily understood
- Provided for water savings

The analysis undertaken as part of the Review showed that City-wide implementation of rain tanks for flood reduction would not achieve the outcomes required. The significant

[13] Refer also companion paper "Stormwater Strategy" which deals with impervious area controls in more detail – coverage is, however, also provided herein because tanks (with a re-use component) are a method of mitigating stormwater discharges from impervious areas

issues arising were that flow attenuation by rain tanks by themselves could not solve existing flood problems particularly, for the following reasons:

- The devices could not effectively be designed to cater for the 2% AEP event (refer Section 9.3.1)
- Rain tanks are in potential conflict with providing for development contribution funding
- Rain tanks have a high compliance cost associated with ensuring an appropriate maintenance regime was in place to ensure the continued operation of the devices (refer Section 9.3.7)

Further, as explained in Section 9.3.6, rain tanks do not represent an economic proposition in delaying investments in new bulk water sources. Further, the potential for tanks to achieve a conservation and/or demand management function is considered to be negligible, at least over the next two decades.

Having discounted the option of City-wide OSM type devises, there may, however, be merit in encouraging developments to incorporate rain tanks (the merits of that option require further consideration by EUM and City Planning). The basis of the policy arising from the Review is that rain tanks should not be mandatory due to the poor economics and limited city-wide flood benefits. However, from a water conservation perspective, the City should be seen to encourage wise use of resources for those developments keen to take up the opportunity. It could well be that, with potential increase in the price of water over time, the option becomes more attractive.

A further point is that on site storage of rainwater improves the resilience of communities in emergencies.

<u>3: Revised detention tank policy</u> – refer Section 9.4

Turning to the issue of providing additional incentives for implementing tanks, note needs to be taken of the failure to date to have any uptake on the incentive under the Development Contribution Rebate Programme for Rainwater Tanks (Stormwater). Prospective reasons for this could be that the incentive is not sufficient, and/or that the programme is not well enough publicised. Prior to any decision to say increase the level of the incentive, increased emphasis should be placed on publicity. Then in say 2 years it would be worthwhile to undertake an analysis to evaluate the programme and identify any modifications warranted.

9.7 Outstanding Matters/Additional Research

The following matters warrant further consideration:

a) Confirming Metrowater's position in respect to continuation of the present financial savings regime for rain tanks (ie water and wastewater)[14]
b) Exploring further the pros/cons of the following options:
    i. allowing greater site impervious area coverage if a rain tank is provided
    ii. encouraging rain tanks on new developments meeting certain criteria

[14] Not a District Plan matter

9.8 Interim Conclusions *[District Plan Implications]*

From Sections 9.6 and 9.7, the following interim conclusions can be made:

1) Retain the present rain tank programmes
2) Introduce a revised detention tank policy
3) Investigate further the following ideas, and in turn how these could/should be covered in the District Plan update:
   a) Allowing greater site impervious area coverage if a rain tank is provided
   b) Encouraging rain tanks on new developments meeting certain criteria

10.0 GREYWATER RECYCLING

10.1 Introduction

"Greywater" is wastewater discharged from domestic showers, basins, baths and washing machines. Greywater recycling involves the installation of a collection-treatment-distribution system to recycle and re-use this greywater. The following types of domestic greywater recycling systems are used:

- Diversion-Only Systems: These are the simplest and easiest to install but because they are not filtered or treated at all they may pose greater hazards, both to health risks and blockage of garden watering systems. Usually operated as a gravity flow greywater system, they collect household water and flow it directly onto the garden.
- Diversion and Filtration Systems: These systems strain the household water, filtering hair or other particles. The greywater is then less likely to block garden watering systems. The filter does need cleaning or replacing at times, and they will cost more to install than diversion-only systems, but are less likely to cause annoying problems with garden pipes so may be worth considering.
- Diversion and Treatment Systems: The best quality, and least hazardous, greywater is produced by a diversion and treatment system. These use various different methods, such as sand filters or aeration, to treat the water and cut down germs and solid particles. This water can be used in more direct irrigation systems and also for flushing toilets. Installing one of these systems is much more expensive, and there are ongoing expenses and maintenance.

The main "drivers" of the greywater recycling, to be accounted for in developing any greywater initiative, include:

- Water conservation (ie reduces the demands on the mains supply)
- Wastewater reduction (ie reduces the amount of wastewater being discharged)[15]
- Sustainability (ie matches the drive for wiser use of finite resources)
- The "feel good" factor

There are, however, a range of issues with implementing such systems, including (* denotes that there are attendant public health issues arising) :

- The ability to treat the greywater 24/7 to an adequate standard*

[15] Where the greywater feeds to a septic tank system, the volume of water going into soakage fields is reduced – and in turn reduces the potential for pollution of water bodies from this source

- The uses to which the recycled greywater can safely be put*
- The quantum of the reduction of demand on the mains water supply system
- Due to the plumbing requirements, the difficulty of retrofitting a greywater system to an existing dwelling, as compared to installation in a new dwelling

The greywater issue was most recently researched on behalf of Auckland City Council by consultant WRCG Ltd and documented in a paper to EUM dated 1 February 2007 (Ref. 5). The application considered at that time was for Waiheke Island where water supply is from rain tanks. During dry periods, supplementary water may need to be purchased from a tanker operator, at an appreciable cost. Correspondingly, greywater recycling was looked at to see if it might be a cost-effective supplementary supply alternative. Whereas the application being addressed in this paper is to the Isthmus, the basic principles of greywater treatment, recycling and re-use are as for the Waiheke Island situation.

Appendix A, which draws heavily on the Ref. 5 material, documents the findings from research into the issues associated with the prospective introduction of recycling (note that, because greywater recycling is not recommended for the Isthmus, it is not seen as warranted to put this detail in the main text). The documentation in Section 10.2 – 10.5 draws on the Appendix A findings – in summary, these are as follows:

- Greywater recycling poses high levels of public health risk (ie mainly due to the level of operation/maintenance inputs on the treatment system and the potential for substandard levels of treatment); in turn MoH is opposed to greywater recycling on public health grounds
- The poor economics of greywater recycling in applications on the Isthmus (ie costs are nearly double that of the benefits from reduced Metrowater potable water use/charges and wastewater charges) – this finding is confirmed from comparable Australian experience
- While these issues may be able to be addressed, the risks and cost benefit do not justify consideration of grey water recycling in an urban area such as Auckland where water shortages are not acute and the likely tangible benefits of grey water recycling are unlikely to be significant.

10.2 Options

Table 3 lists the generic approaches available to implement a greywater recycling programme, noting that no consideration is given at this stage to the type or scale of such a system (refer Section 10.1 and Table A1 – Appendix A). Options are listed from low level (ie the easiest one to do) to high level, including the option of a prospective large-scale scheme, notionally implemented by Watercare. Against each option, the respective pros and cons are listed.

Table 3 – Inventory of Prospective Generic Greywater Recycling Options

OPTION	PROS	CONS
1 No greywater recycling	– Is the least-cost option (ie reflecting the fact that greywater recycling is not cost-effective)	Does not address the sustainability attributes of re-using a scarce resource

	– Obviates the prospective public health risks with greywater recycling	
2 Low-level voluntary greywater recycling	Easy to implement	Uptake likely to be low Potential health risks
3 Active encouragement of greywater recycling	Addresses the sustainability attributes of re-using a scarce resource	Not justified due to: – Poor economics – Unacceptable level of public health risk
4 Compulsory greywater recycling on new dwellings	Good precedent for sustainability	Not justified due to: – Poor economics – Unacceptable level of public health risk
5 Large-scale greywater recycling (eg by Watercare)	Would overcome public health risk concerns with other options	Costs prohibitive (ie cheaper to use more mains water)

Further discussion on the options is set out in Section 10.3. Option 5 (large-scale greywater recycling) is not analysed further, because it lies outside the scope of the District Plan's provisions.

10.3 Discussion

In developing any greywater recycling programme, consideration would need to be given to the following aspects:

- Public health: Recycling poses serious public health risks (eg cross-contamination, accidental use of greywater for potable purposes)
- Cost implications to the Council: The costs of promoting the programme would need to be kept to a modest level, to avoid the costs outweighing the benefits (ie this argues for a relatively simple programme)
- Benefits: Are the benefits of implementing greywater recycling tangible and worth the problems?
- Political factors need to be addressed, eg:
  - the appropriate level of leadership to be shown by the Council (and in turn the form of the programme)
  - willingness to be prescriptive

Addressing these issues in the context of the options listed in Table 3, the research cited in Appendix A illustrates that there are serious public health concerns with <u>any</u> type of greywater recycling programme. Further, as shown in Table A2 (Appendix A), in the Isthmus, the cost of mains water is such that greywater recycling is not an economic proposition.

In conclusion, Option 1 "No greywater recycling" (Table 3) is considered to represent the most appropriate course of action for application to the Isthmus.

10.4 Outstanding Matters/Additional Research

None

10.5 Interim Conclusions *[District Plan Implications]*

Taken in combination, the following factors demonstrate that there are no good grounds for facilitating the implementation of greywater recycling systems on the Isthmus:

- The previous generally negative experience of such systems on Waiheke Island and elsewhere in NZ
- The strong reservations held to such systems on public health grounds, based mainly on the inability to enforce adequate operation/maintenance of the systems in perpetuity – and, in turn, the concerns held by MoH and ARC
- The lack of a sound cost/benefit case for implementing such systems on the Isthmus

Correspondingly, looking at the options in respect to different modes/levels of implementation, the following conclusions can be drawn:

- Regulatory: No case can be made for this level of action (ie no drivers, coupled with health compliance concerns)
- Incentives: As for 'regulatory'
- Encouragement: The drawbacks (especially the public heath issues) outweigh the prospective benefits

11.0 'THIRD PIPE' SUPPLY

11.1 Introduction

The background to a 'third pipe'[16] type supply was given in Section 8. In essence, this involves re-using stormwater (eg from a stormwater pond or groundwater) and, after treatment, reticulating it to households via a non-potable 'third pipe' system. In this Section, attention is devoted to how the Isthmus District Plan review might tackle third pipe supply systems, in turn addressing issues arising, eg:

- Incentives
- Controls

Further issues include the likes of the following - note the comparable coverage of these issues in Section 9.3:

- Sustainability
- Public health
- Economics

11.2 Status Quo Situation

[16] "Third pipe" denotes piped non-potable stormwater supply

The only public third pipe system in Auckland is at Stonefields where, as part of the redevelopment of the former Mt Wellington Quarry for residential use, all stormwater is to be re-used. Stormwater that is fed to a detention pond will be and treated and fed to a "third pipe" reticulation system serving the subdivision. The system is presently under construction and is due to be commissioned in mid-2008[17].

The Stonefields third pipe system came about through negotiation with the developer, Landco, over a requirement in the City's On-Site Stormwater Management Manual that dwellings in Res 8 zones must incorporate stormwater attenuation devices. Landco rejected the option of achieving this through the installation of rain tanks on each dwelling, arguing that it was impractical on small sites. Instead, the "third pipe" plan was developed as another means of gaining the City's sign-off.

Third pipe supply water is metered separately and fed via separate plumbing pipework to toilets, outside taps, etc (refer Section 11.3.3 for fuller details).

11.3 Research & Precedents

11.3.1 Sustainability

The sustainability issues with a third pipe supply are closely similar to those with rain tanks, as set out in Section 9.3.2. In summary, the sustainability attributes include:

- Use of a water resource that would otherwise be discharged
- Added protection against loss/reduction of supply in a drought
- It takes pressure off the public/mains supply

11.3.2 Water Source and Treatment

The water source for a third pipe type supply is typically a stormwater pond, or possibly groundwater aquifer. Any such pond needs to have sizeable storage capacity to cope with demand variability and droughts – although provision is typically made to charge the reticulation with potable mains water when the stormwater-based supply has insufficient water.

Albeit for non-potable use, full-scale treatment is typically provided involving dosing with alum, filtration and chlorination. This essentially matches the technology used in potable systems, but without the additional steps/safeguards required on potable systems to meet the NZ Drinking Water Standards 2005 (DWSNZ). In practice, such treatment is likely to yield water that would meet DWSNZ for something like 99% of the time.

11.3.3 Public Health

The public health issues with a third pipe supply are closely similar to those with rain tanks, as set out in Section 9.3.3. On the Stonefields supply, sign-off from Auckland Regional Public Health permitted toilet flushing, garden watering, irrigation, washing

[17] Another example of a quarry-based supply, albeit for a potable supply system, was the Three Kings Quarry supply proposed in the late 1990's, but eventually abandoned

paths and walls, filling of ornamental ponds, construction and industrial/commercial washdowns. Specific exclusions to the use of this water were for drinking, cooking or other kitchen purposes, personal washing / bathing, evaporative coolers, recreation involving water contact (ie playing under sprinklers), cold laundry tap uses (accounting for the possibility of food preparation using this fixture) and filling swimming pools.

There is some debate as to the relative quality, and in turn the public health risk of a third pipe supply (eg like Stonefields) versus that from rain tanks (refer Section 9.3). In practice, the restriction on uses serves to keep the public health risk very low. In terms of water quality, the main differences arise from the fact that stormwater used in a third pipe supply has flown over land, picking up contaminants en route. The bulk of the contaminants are, however, removed, or reduced to safe levels, by treatment. In contrast, tanks collect roof runoff, but no treatment is applied.

11.3.4 Economics

In theory, given that the components are essentially the same, the economics of such a scheme should be comparable to those for a potable water supply scheme. However, the lack of scale economies means that the unit cost of water from third pipe schemes is typically considerably higher.

As well as the scale factor, the economics depend on many things, including:

- Whether the third pipe system is public or privately operated
- The ability to compel householders to implement dual plumbing and connect (ie this affects the economies of scale)
- Where applicable, the feasibility of dual plumbing existing dwellings (refer Section 9.3.5 for coverage on this topic)
- The tariff structure compared to potable water charging regime (including the wastewater charging regime)

The Stonefields system provides an opportunity to examine actual costs. The following applies to the Stage 1 system, set to meet a peak demand of 900 m3/day:

Capital cost: (treatment & distribution components only)	\$6.2 million
Annual O&M cost:	
- bulk system	\$150,000
- metering, etc	\$50,000
Equivalent total annual cost	\$975,000 (assumes capital amortised at 12.5% pa)
Annual supply	263,000 m3
<u>Unit cost</u>	<u>\$3.71/m3</u>

Clearly, this cost is well in excess of the current Metrowater tariff for potable water (\$1.405), making it uneconomic[18]. Were the tariff for third pipe water to be set above that for potable water, there would be no incentive to install dual plumbing in the house to use the third pipe supply. Metrowater has yet to set the tariff for third pipe supply,

[18] Note, however, that the bulk of the costs are being met by the developer (Landco) – correspondingly, the figures presented do not represent Metrowater's cost regime

but it is likely to have to be at least 20% lower than that for mains water to be an attractive financial proposition to homeowners.

It should be noted that the issue of ability of Auckland City Council to compel householders to install dual plumbing and connect to a third pipe system is not resolved at this time (pers comm., Bob Lamason, ACE). Given certain fixed costs, connection rates under 100% will increase the unit cost of water.

11.4 Options and Discussion

Given their high unit costs compared to Metrowater's mains water tariff, third pipe systems will not be justified on cost grounds alone. Correspondingly, no discussion on options is warranted.

11.6 Outstanding Matters/Additional Research

Although no new third pipe systems are envisaged., it will nevertheless be useful to research the issue of the ability of Auckland City Council to compel householders to install dual plumbing and connect to a third pipe system, where one exists.

11.7 Interim Conclusions *[District Plan Implications]*

From Sections 11.5 and 11.6, the following interim conclusions can be made:

1) Given their high unit costs, proposals for any new third pipe type system should <u>not</u> be facilitated under the Isthmus District Plan, but rather treated on a case-by-case basis as/when such a proposal arises.
2) The connection enforcement issue explained in Section 11.6 should be considered to see if any legal mechanism is available under District Plan provisions.

12.0 OVERALL COMMENTARY

12.1 General

Sections 9 – 11 (and in the case of greywater recycling, Appendix A) have addressed in detail the water re-use possibilities that may warrant coverage in the District Plan update. Table 4 presents a matrix showing how the options rank against various criteria.

Table 4 – Ranking of Re-Use Options

CRITERIA	**RANK FOR OPTION** (1 = highest, 5 = lowest)			Note
	Rain Tanks	**Greywater Recycling**	**Third Pipe Supply**	
Sustainability	1	2	2	A
Public health risk	3	5	3	B
Cost	3*	5	5	C
Ability to implement	1	4	3	D
Overall Rank	**First**	**Last**	**Second**	

<u>Footnotes</u>:

A: All have the effect of reducing mains water demand (and ultimately with it delaying the need for new water supply headworks); rain tanks score higher due to the lesser use of resources to implement and operate
B: Rankings reflect the fact that although water is not for human consumption there will always be risk of accidental ingestion, so the ranking is on a water quality basis
C: All are relatively high cost (ie unit cost exceeds mains water cost) – of the options, rain tanks are the least costly
D: Accounts for implementation precedents, etc
* Assumes current Metrowater provision on wastewater charge effects (refer Sections 9.3.6 & 12.2)

From Table 4, the following observations can be made:

- Rain tanks score highest, reflecting the fact that they have no major drawbacks, are the most cost-effective of the options and are already in use in the City
- The other options (ie greywater recycling and third pipe supply) are penalised by their high costs
- Greywater recycling should be ruled out on individual dwellings, due to the public health risks that arise if/when O&M is not done diligently

From the foregoing, the recommended District Plan provisions for the three re-use/recycling options should be broadly as set out in summary in Table 5.

Table 5 – Suggested District Plan Provisions for Water Re-Use

Re-Use Option	Suggested Provision
General	Re-use should be encouraged on sustainability grounds where it is both safe and justifiable on cost grounds
Rain Tanks	– Encourage with continuation of existing programmes and two prospective new ones – refer Section 9.5 for details. – Where rain tanks are required as part of a regulatory requirement (eg in Res 8 areas) then there is a compulsory maintenance and inspection regime which has ongoing costs both for the private owner and Council as the regulatory agency (Note that the basis for the current rain tank programme is primarily one of stormwater discharge attenuation to mitigate the effects of increased impervious area and water re-use is considered to be a secondary benefit)
Greywater Recycling	Prohibit, due to the attendant public health risks
Third Pipe Supply	Consider applications on a case-by-case basis

12.2 Effect on Re-Use on Metrowater's Revenue

Were re-use installations to proliferate, they would reduce the mains water demand and with it Metrowater's revenue. Whereas greywater recycling[19] and third pipe supply reduce both the water use and wastewater discharge by the same amount, rain tanks result in a saving on wastewater charges because usage is charged at 75% of the metered potable water use volume. Rain tanks reduce the water use, but the wastewater discharge is the same as if there were no tank, so the consumer receives a windfall benefit.

[19] Assumes all recycled water is re-used rather than discharged to the sewer

Metrowater recognises this and, as set out in Section 9.3.6, reserves the right to meter tank usage and charge for the wastewater equivalent to the tank usage.

In simplistic terms, if re-use was to be ultimately applied in say 5% of residential properties in the Isthmus and the re-usage proportion ran at an average of 25%, Metrowater's revenue might drop by about 0.5% - 0.75%%[20]. This is considered minimal (eg compare with the typical annual water demand growth of 1.0 – 1.5% pa[21]) and so should not constrain District Plan initiatives.

13.0 REFERENCES (ANNOTATED)

No	Author	Title	Date	COMMENT
1	Auckland City Council	On-Site Stormwater Management Manual	2003	Includes coverage of: • Rain tank option • Metrowater resolution on charging
2	Auckland City Council	Manual for Development Contribution Rebate Programme for Rainwater Tanks (Stormwater)	2006	Set out programme details, including tank sizing basis, etc
3	Auckland City Council (internal)	Paper to Works Committee: "Rainwater Tanks"	Nov 2005	Includes: • Details on what other Auckland TAs are doing • Economics of tanks under Auckland City's rules
4	Dr David Ogilvie	Auckland City On-Site Stormwater Management Manual – Rainwater Tanks: Public Health Issues – Risk Analysis	2002	Looked at which household uses could safely be drawn from rain tank supply
5	WRCG Ltd	Waiheke Island Greywater Re-use Initiative Issues Paper	Feb 2007	Reports on research into the viability of introducing a greywater recycling programme on Waiheke Island – many of the factors covered also apply to the Isthmus
6	MWH Ltd (for Watercare Services Ltd)	Rainwater Tank Investigation	Feb 2007	Looked at where each of the Auckland TLA's are at, including economics, and assesses future prospects for greater proliferation of tanks (note: this reference is quite lightweight on technical aspects)
7	Watercare Services Ltd	Three Waters Draft Strategic Plan - Discussion Version	June 2007	Addresses strategic options for stormwater, but is quite superficial in its coverage
8	Auckland City Council	Drainage Strategic Review	2006	Included evaluation of options to resolve flooding and cater for growth – as part this, rain tanks were addressed
9	Auckland Regional Council	Auckland Regional Plan Air, Land and Water (Proposed)	2004	Set out policies that may affect the introduction of re-use programmes by TLAs

[20] ie 1.25% less water/wastewater is billed, but the $71.80 standing annual charge is unchanged; the percentage reduces to the figure listed when non-residential usage is accounted for (ie assumed to remain unchanged)
[21] Assumed to match population growth in Auckland City

APPENDIX A:

GREYWATER RECYCLING

A1 Status Quo Situation

A1.1 Informal Systems

At present, as far as is known, most greywater recycling in the Auckland Isthmus is done on an informal basis (ie representing the "diversion-only system" referred to in Section 10.1). In such cases, the householder typically captures water discharging from the selected fixture (eg shower, basin, bath or washing machine) in a bucket or drum. The water is then typically used for just garden or lawn watering. Such recycling is generally only done in summer drought situations (eg when there are hosing restrictions) and then only by people who are best described as "enthusiasts", given the degree of manual labour involved with buckets, etc.

Whereas there are potential public health risks were any of this untreated greywater to be ingested, the risks are quite low if the water is applied directly to the garden or lawn. This aside, it would be unwise for the City to promote such recycling because of the inability to control the uses and the attendant public health risks.

A1.2 Prior Experience with Formal Systems on Waiheke Island

The history of greywater recycling systems on Waiheke can be summarised as follows[22]:

- There was a "push" for greywater re-use about 12 years ago, resulting in a range of commercial systems being installed in domestic applications (estimated number approximately 45)
- Many used the greywater system as a means of reducing the problems with overloaded septic tank soakage fields (ie although others were intended to overcome water shortages)
- Most systems operated satisfactorily for about the first 5 years when the systems were properly maintained and the owner who had the system installed still resided at the property
- Thereafter, problems became increasingly frequent (these are cited in detail, with monitoring results, in the ESR research – refer Section A2.7), covering the likes of:
  - poor or nil maintenance
  - over or under-dosing with chlorine
  - some have been disconnected

A2 Research & Precedents

A2.1 Introduction

The focus of the work reported on in this paper is on addressing findings from research covering:

- MoH's views

[22] as sourced from Auckland City's consenting officers

- ARC's perspective (including consenting)
- Commercial greywater treatment systems, including costs and benefits
- Experience from elsewhere in NZ and overseas

From this, issues affecting the viability of a greywater recycling programme have been reviewed.

A2.2 Public Health - General

Caution must be exercised with the re-use of greywater to ensure that the potential to transmit disease is minimised. This is achieved by:

- Minimising human contact with untreated greywater (ie sub-surface utilisation)
- Placing barriers between the greywater and people (and their pet animals) to minimise exposure to greywater by containing greywater in vessels or tanks as it is utilised
- Disinfection to an even higher standard for utilisation in toilet and urinal flushing or laundry use
- Signposting the land application system to advise that greywater is being re-used and that contact must be avoided
- Using a dedicated land application system not used for recreation (eg childrens play area, BBQ area, etc
- Preventing surface ponding or surface run-off of greywater and confining greywater within the disposal area
- Not irrigating greywater during periods of wet weather
- Distinguishing plumbing which contains recycled greywater and to prevent cross connection to the potable water supply
- Maintaining a connection to the sewer so as to enable isolation of the land application system
- Installing a backflow prevention device on the potable water supply when greywater is used for toilet flushing
- Not irrigating raw or treated greywater on edible plants which are consumed raw

Table A1 sets out appropriate uses of greywater according to the level of treatment.

Table A1 - Appropriate Uses of Greywater According to Level of Treatment

Type of Treatment	**APPROPRIATE USE FOR CASE:**	
	Single Domestic Premises	**Multi-Dwelling or Commercial Premises**
Temporary Diversion Systems:		
Untreated (with or without screening or coarse filtration)	Garden irrigation: – manual surface – sub-surface	Garden irrigation: – sub-soil
Permanent Treatment Systems:		
Primary treatment	Garden irrigation: – sub-soil	Garden irrigation: – sub-soil

Secondary treatment (20/30 standard) (≤5000L/day)	Garden irrigation: – sub-surface – sub-soil	Garden irrigation: – sub-soil
Secondary treatment and disinfection (20/30/10 standard) (≤5000L/day)	Garden irrigation: – surface – sub-surface – sub-soil In-house use: – toilet flushing – washing machine	Garden irrigation: – surface (drip only) – sub-surface – sub-soil
Treatment and disinfection (Class A standard, as per EPA publication 1015) (>5000L/day)	*Not applicable*	Garden irrigation: any method) In-house use: – toilet/urinal flushing – washing machine

Source: EPA, Victoria (http://www.health.vic.gov.au/environment/downloads/greywater_usage.pdf)

A2.3 MOH's Perspective

It is noteworthy that in Section 128 of the LGA, 2002, there is a requirement as part of preparing Water and Sanitary Services Assessments for Council's to *"consider, in making the assessment….the full range of options and their environmental and public health impacts, including …. greywater and stormwater re-use or recycling"*. Whereas this appears to promote greywater recycling, in practice MoH have serious reservations about the use of greywater recycling in domestic applications. The following excerpts from letters from MoH to APRHS dated 27 June 2005 and to ARC (undated) summarise MoH's position:

- *Ministry of Health does not support re-use of wastewater within a residential property because in NZ the risks are not justified by the need. No matter what performance parameters are specified, the high failure rate of many primary on-site treatment systems discharging into poor soils means that inevitably householders will come into contact with poorly treated or untreated effluent. Public health is best protected by separating people from possible contact with sewage effluent.*
- *MoH advises against the use of recycled water domestically with dual supplies. This is because of the risks of cross connection with potable water supplies*
- *[The A/NZ Standard 1547] Committee has already concluded that 1547 will not be expanded to cover re-use of greywater as this is outside the scope of the Standard and some of the jurisdictions involved would not support 1547 if greywater was added. Until such requirements for managing on-site systems are regulated in New Zealand nationally, the Ministry of Health considers the risks of re-using wastewater (where the water quality will usually be poor) is not worth the risks involved.*
- *Notwithstanding the above advice from the Ministry of Health, if a regulatory authority does decide to grant consent to re-use wastewater (including greywater), then the requirements of TP 58 are the minimum that should be required.*
- *The Ministry of Health cannot supply legal advice to public health services who are advised to obtain their own. The responsibilities of the designated officers under the Health 1956 and the Water Supplies Protection Regulations 1961 apply. There is also the question of the liability of a council that allows dual systems if contamination occurs.*

In part, MoH has based the foregoing on research it commissioned by ESR which in turn looked at the performance of operational greywater systems in New Zealand, including several on Waiheke Island. Further information from this ESR report is given in Section A2.7.

A2.4 ARC's Perspective

Section 5.5.20 of ARC's Air Land and Water Plan (Proposed) empowers the provisions of ARC's TP58 "On-Site wastewater Systems". In turn, in Section 7.7, TP58 addresses re-use of treated wastewater effluent generally, with Section 7.7.6 and 7.8.1 covering greywater re-use specifically. Excerpts from this cover:

- *A re-use system should only be considered for households where water supply is restricted and other water demand reducing methods (such as appropriate flow reducing fixtures, water efficient appliances, subsurface garden irrigation of treated effluent, etc, and finally possibly also composting toilets) are insufficient*
- *Greywater has been confirmed to have very high faecal coliform bacteria concentrations …. these contaminants need to be removed from the greywater to ….. lessen any potential for cumulative adverse effect on both receiving soils and/or threat to public health*
- *[Greywater for re-use] will still need to be treated sufficiently to achieve the equivalent of advanced secondary treatment quality followed by chlorination. The sizing of the greywater treatment system must be in accordance with the guidelines for standard domestic wastewater treatment systems provided in [TP58]*

In turn, the policy in Section 5.4.22 of the ALWP is to *"Promote the re-use of treated sewage and sewage solids where it can be demonstrated that the extent and nature of the wastewater and solids will not pose a threat to the environment or to human health*".

A2.5 Consenting

ARC TP58 sets out the following consenting provisions for greywater re-use (noting however that the ALW Plan which empowers TP58 is under appeal and not yet operative):

- *ARC: Treated effluent re-use is a discretionary activity23, requiring a discharge consent*
- *APRHS: All systems require written approval*
- *Auckland City: The re-use system and plumbing require a building consent, in turn meeting the relevant Building Standards*

A2.6 Commercial Greywater Treatment Systems

Filtration and/or treatment plants serve as the core of a greywater recycling system. There are various commercial greywater treatment systems in use in New Zealand. Details on two such systems are set out below:

(a) ECOplus System:

Pertinent details of the "ECOplus" system are as follows - refer Figure A1 (refer also website at: http://www.wastewater-recycling.co.nz/system/):

[23] This is as reported in section 7.7.3 of TP58, but cannot be found in Section 5.5 of the ALWP

- Greywater is collected in a holding tank - when full, the excess water bypasses the tank and flows into the gully trap in the normal manner (but can be diverted to water the lawn and/or garden)
- An aeration device and a flow filter separate the majority of soaps and lint from the water before it enters the holding tank
- The mode of treatment is not disclosed, nor are the operation/maintenance requirements
- The water in the end holding tank is then piped to the toilet system by a 12 volt electric pump which turns on when the toilet is flushed.

The cost of the basic model is $2,500, excluding installation. The reduction in water use and wastewater discharge is claimed to be of the order of 20% – 30%.

Figure A1: EcoPlus Device

(b) WaterSmart:

The "WaterSmart" system is illustrated in Figure A2, with further details available on WaterSmart's website at: http://www.watersmart.co.nz/household-waste-water.html). In essence, the WaterSmart system takes the form of an oversized gully trap that incorporates a pump to deliver water to the lawn and/or garden via an underground irrigation network. Unlike the ECOplus unit, the greywater is filtered rather than chemically treated. The user can decide where to direct the greywater, namely to irrigate the garden, or to go down the sewer. The price of a WaterSmart unit, excluding installation but including the irrigation componentry, is of the order of $2,000 - $3,000 - the variation reflects the size of the plot to be irrigated.

The unit is most effective in areas with permeable soils (eg sandy loams or volcanic soils) where the lawn/garden can be irrigated year-round. Otherwise in firmer soils, the unit would need to be switched to feed the sewer over winter, thus negating its benefits. There may be issues with the potential to pollute groundwater with this type of system.

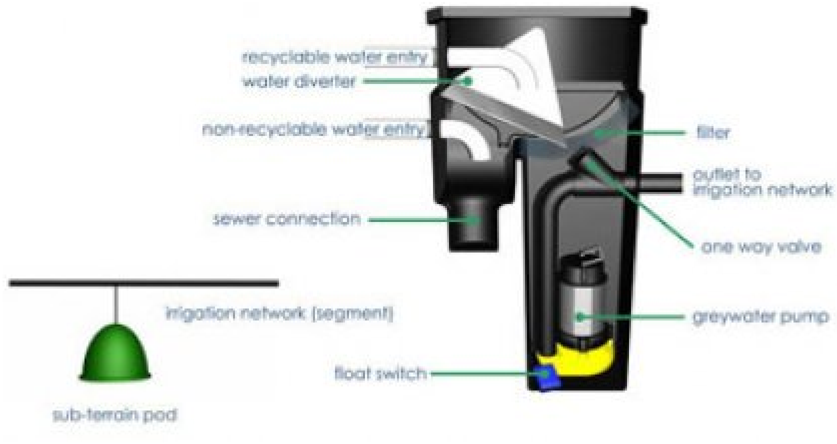

Figure A2: WaterSmart Unit

(c) Implementation Issues:

In relation to implementation of ECOplus in the Auckland region, or indeed potentially any other such system, the following case study notes illustrate that ARC's role in consenting such a system is not clear; refer ARC's letter to ECOplus/Sorensen dated 25 May 2006 which makes the following points:

- *"…gaining ARC approval for the use of the ECOplus greywater recycling systems as a component of a permitted activity for on-site wastewater treatment and disposal"* (ie the reference to permitted activity conflicts with the provision cited in Section 2.2 above that greywater treatment/re-use is a discretionary activity)
- *"I concur with you that ARC must limit its consideration to any additional contaminants that the system may add to the waste stream"*
- *"Greywater use through your specific system should not influence whether the system meets ARC's Permitted Activity criteria or not"*

Further, it is noted that the City's Waiheke Building Consent Officer advised that, given ARC's approval, despite the reservations cited in Section A1.2, he saw no opportunity under the Building Consent provisions to decline the consent for the ECOplus or another comparable system.

(d) Costs and Benefits:

A very approximate estimate of the costs and benefits of either of the above systems installed in a 4 person dwelling in Auckland City's Isthmus area is set out in Table A2. Benefits accrue from savings from both the reduced mains water usage and wastewater charges. No account is taken of externalities such as the environmental costs/benefits, eg:

- The reduction in mains water demand and the beneficial effect on the resource from which that water is sourced
- The ability to continue garden watering with a greywater recycling system when there are hosing restrictions
- The environmental impact of discharging partially treated greywater to groundwater (ie when the discharge rate exceeds the evapotranspiration rate from the surface soils and vegetation)

The table shows that the costs outweigh the benefits by an appreciable amount, indicating that, based on the assumptions applied, greywater recycling is not an economic proposition.

Table A2
Indicative Costs and Benefits of Prospective Greywater Systems in Isthmus

Category	Item	Cost/Other
BASE DATA	Capital cost of unit (installed)	$3,000
	Annual water usage: 4 persons @ 220 l/h/d	320 m3
	Reduction in mains water usage (25%)	80 m3
	Reduction in wastewater discharge (75% of water usage)	60 m3
ANNUAL COSTS	Interest on capital cost @ 12.5% pa*	$375
	Operation & maintenance	$200
	Total	**$575**
ANNUAL BENEFITS (at current Metrowater rates)	Water charge savings: 80 m3 @ $1.405	$113
	Wastewater charge savings: 80 m3 @ $3.36	$202
	Total	**$315**
	EXCESS OF COST OVER BENEFIT	**$260 pa**

* Including depreciation

A2.7 NZ Precedents

The findings from a survey of greywater treatment and re-use systems throughout NZ by ESR for MoH as reported in a paper to the 2006 NZWWA Conference by Leonard and Kikkert are set out below (fuller details on this are given in an ESR by Margaret Leonard dated 4 July 2005):

None of the greywater treatment systems in our survey of 31 greywater systems provided a treatment system that could remove microbial indicators. Sludges from greywater tanks were more highly concentrated sources of microbial indicators, and potentially pathogens, and present a greater risk to those maintaining the systems. Only half those surveyed had a good working knowledge of their systems and kept them well maintained. The lack of maintenance and the low level of treatment used in New Zealand means that on-site greywater systems present a high risk to public health. The environmental effects on soils, groundwater and streams from runoff from saturated soils also need to be considered when these systems are installed.

Overseas, the risk of pathogens in greywater is recognised, and a high level of treatment is required, especially where there is potential for human contact. The level of treatment required does not occur in New Zealand and it would be likely to make greywater re-use or recycling a very expensive option for the homeowner. It is recommended that greywater re-use not be used as an option for managing areas where on-site sewage disposal is problematic, or for reducing section sizes in subdivisions. It is not efficacious to use on-site greywater recycling to solve these problems owing to the high cost to individuals, low level of treatment provided, poor maintenance of on-site systems and consequently, the risk to public health and the environment.

A2.8 Australian Experience

There is considerable impetus and experience for greywater recycling in Australia. The impetus has come from the extended drought that Australia has experienced and greywater offers the potential for overcoming constraints on the availability from the public mains supply. Prior to the upsurge in greywater recycling, regulations were not especially stringent, but as the public health risks have been looked at more closely, regulations have become quite onerous. The main concern is that householders, unless dedicated to wastewater re-use practices, will not necessarily maintain their wastewater management systems unless there is a system of audit. Councils must therefore institute an on-site wastewater management strategy which initially considers the impacts of greywater re-use in their areas before allowing greywater re-use and secondly, rigidly enforces an operating licence by a system of regular audit.

As an example, for schemes with a capacity of greater than 5 m3/day, the State rules in Victoria are set out in the EPA's "Guidelines for Environmental Management: Dual Pipe Water Recycling Schemes" (Publication 1015), in turn requiring the preparation of a site-specific "Recycled Water Quality Management Plan".

A case study which illustrates the issues with greywater recycling is the 245 unit Inkerman Dux Delux development in St Kilda, Melbourne (refer http://www.naiad.net.au/?q=node/41&destination=node%2F41). The $90 million project, initiated in 1996, is a joint venture between the City of Port Phillip and Inkerman Developments P/L. Capital costs were funded by Inkerman Developments, with a grant from the Commonwealth Government's Living Cities, Urban Stormwater Initiative 2000/2001 of $267,214 and an innovation grant from South East Water Ltd of $125,000. The one-off capital cost of the system is $2,000 per apartment and the operating costs are estimated to be $40 - $60 per apartment per year. The water recycling system was designed, approvals negotiated and built by Integrated Eco-Villages P/L. South East Water manage the system under a six years maintenance and monitoring agreement with the body corporate. The project won the United Nations Association of Australia-World Environment Day Award (Local Government Category) for the water sensitive urban design elements of the development.

The main components of the greywater recycling system comprise (technical details are given at http://www.wsud.org/downloads/Info%20Exchange%20&%20Lit/WSUD_04_Conf_Papers/WS040076.PDF):

- Domestic greywater is collected from bathroom basins, baths and showers - laundry effluent is excluded because of possible high phosphorus levels
- After the removal of gross solids in a baffled tank, treated in an aerobic membrane bioreactor - the bioreactor works like an extended aeration plant, but uses microfiltration instead of settling to clarify effluent from the aeration tank - nitrification occurring in the reactor requires pH stabilisation with caustic soda
- The treated greywater is stored in a 45 m3 underground tank, from where it is, after UV disinfection, distributed for two uses:
  - sub-surface garden irrigation across the total development area - irrigation is controlled to release water to dry areas through slow release dripper piping by 12 solenoids triggered by a computer connected to moisture sensors
  - toilet flushing using dual flush toilets throughout the development (to ensure a reliable water supply for toilet flushing, the system is backed up by the potable water supply)

- A sophisticated monitoring system controls the correct performance of all process units and, if it detects a problem, alerts operators by sending Text messages to their mobile phones

As the project was constructed, the rules governing greywater treatment systems were made more stringent. Further, the fact that the system has no discharge meant that the treatment system was not directly covered by the normal standards. Ultimately, South East Water took on the operation and maintenance of the system. Compliances proved problematic, including the need for certification of the UV disinfection unit, and for many months the treated greywater was discharged to the public sewer, pending the approvals.

The following benefits are claimed:

- Reduction of potable water requirements of the project by about 40% in summer and 20% in winter
- Reduced sewer loadings going to Port Phillip Bay via one of the metropolitan sewage treatment plants
- Natural fertilisation of gardens from nutrients in the treated waste water and prevention of manufactured or imported natural fertiliser applications which are a known nutrient pollution source

No hard data is available on the costs of the recycled greywater and in any event any cost would be affected by the subsidies that the project attracted and its pioneering nature. This said, unit costs are thought to be at least 5 times the cost of mains water.

As a further example of the cost issue, Adelaide examined a large-scale greywater recycling scheme and estimated the costs at $5 – 6/m3. This compares with residential charges for mains water of $0.50/m3 for the first 125 m3 pa and $1.25/m3 for usage above that.

APPENDIX B:

INSPECTION & MAINTENANCE CHECKLIST – RAIN TANKS

FREQUENCY				ACTION
After Storm	**Quarterly**	**Annually**	**2-Yearly ***	
√	√	√	√	**Spouting & downpipes:** check for problems such as debris /blockages and leaks & rectify
√	√	√	√	**First-flush diverter device:** check for blockages; empty debris/sediment
	√	√	√	**Tank water quality**: check for clarity and odour
	√	√	√	**Tank inlet/outlet pipework, & orifice:** perform visual check for problems such as debris/blockages/leaks & rectify
		√	√	**Tank structure**: check for leaks & rectify
		√	√	**Pump & electrical system**: check & carry out any necessary maintenance
			√	**First-flush device:** test for correct functioning; repair/replace where faulty or badly worn
			√	**Tank water quality:** collect water sample (before emptying tank, as below) and test
			√	**Tank cleaning :** empty the tank & clean out any sediment accumulations and growths
			√	**Plumbing:** examine plumbing fixtures connected to the supply line from the tank to the dwelling to check for leaks & rectify any faults

* It is recommended that the 2-yearly service should be undertaken by a qualified maintenance contractor

APPENDIX C:

DRAINAGE STRATEGIC REVIEW – OPTIONS MATRIX

Stormwater Strategy

Outcomes Flooding	Reason	Options: On Site Stormwater Management (OSM)	Restrict Development until public infrastructure in place	New Public Infrastructure with funding as per Scenario 2 (current funding)	New Public Infrastructure with funding as per Scenario 4a	New Public Infrastructure with funding as per Scenario 4b	New Public Infrastructure with funding as per Scenario 4a & OSM's	New Public Infrastructure with funding as per Scenario 4b & OSM's	New Public Infrastructure with funding as per Scenario 4b & Development Restrictions
Protect residential habitable floors from 1 in 50 year event	Building Code performance requirement for new buildings and a self imposed target by Council to improve existing evel of service	Does not achieve outcome as OSM only maintain status quo for the 1 in 10 year event and does not deal with the 1 in 50 year event	Does not in itself solve flooding	Achieves outcome	Achieves outcome	Achieves outcome	Achieves outcome	Achieves outcome	Achieves outcome
Avoids the likelihood of damage or nuisance to other property with continued gorwth	Building Code Clause E1.3.1 Do not create nuisance "stormwater to be disposed of in a way that avoids the likelihood of damage or nuisance to other property"	May achieve outcome, but with some considerable risks. Risks relate to reliance on maintenance of system by private owners. High, almost certain risk that this will not be done. Can be mitigated to some degree by enforced warrant of fitness regime but risk is judged to remain significant. Exaples of poor private mtce are Soakage systems,illegeal connections, Waiheke wastewater bylaw	Achieves outcome	Achieves outcome over time 21 years to resolve flooding	Achieves outcome more quickly. 12 years to resolve flooding	Achieves outcome over time. 17 years to resolve flooding	Achieves outcome	Achieves outcome	Achieves outcome
Risk to Council of liability from damage arising from permitting development which causes nuisance		Council liability limted to a degree, however if provate maintenace not carried out then risk of liability remaining	Achieves outcome	Increased risk in interim until flood outcome achieved	Increased risk in interim until flood outcome achieved (less than Scenario 2)	Higher Increased risk to Council than scenario 4 as dvelopment effects not mitigated for long time	Council liability limted	Council liability limted	
Public Cost		Cost of administration of database, active follow up and enforcemnt and certifcation regime Est $05m pa	Limits Economic Development and growth. Severe impacts on Community	Yes - as per capital spend Scenario 2	Yes - as per capital spend Scenario 4	Yes - as per capital spend Scenario 4b	Yes - as per capital spend Scenario 4 plus admin costs $05mpa Opex	Yes - as per capital spend Scenario 4 plus admin costs $05mpa Opex	Limits Economic Development and growth. Severe impacts on Community
Private Cost		Private cost to owners to implement and maintain system. Est $4-$5k per unit. This equals $9.3m pa for 2300 units per year	Private cost of lost opportunity	Nil	Nil	Nil	High	High	Private cost of lost opportunity
Funding Ability via Development Contributions		Directly conflicts with the objectives of having a development contribution able to fund the building of public infrastructure to adress the effects of growth i.e. difficult to justify a DC when the 1 in 10 yr effects of development have been catered for. Note it is not consdiered practical to provide OSM to cater for the 1 in 50 year event. However if desired to limit potential Council liability then it would need to be implemented based on the timing issue of development having to wait for public infrastructure before being allowed to progress. Alteratively to waiting developers could choose OSM which can be decomiisioned when infrastrucure upgraded.	Compatible with Development Contributions but hard to sell if asking for money on one hand and restricting development on the other	less risk to challenge of Development Contributions Quantum	less risk to challenge of Development Contributions Quantum	less risk to challenge of Development Contributions Quantum	Directly conflicts with the objectives of having a development contribution able to fund the building of public infrastructure to adress the effects of growth i.e. difficult to justify a DC when the 1 in 10 yr effects of development have been catered for. Note it is not consdiered practical to provide OSM to cater for the 1 in 50 year event. However if desired to limit potential Council liability then it would need to be implemented based on the timing issue of development having to wait for public infrastructure before being allowed to progress. Alteratively to waiting developers could choose OSM which can be decomiisioned when infrastrucure upgraded.	Directly conflicts with the objectives of having a development contribution able to fund the building of public infrastructure to adress the effects of growth i.e. difficult to justify a DC when the 1 in 10 yr effects of development have been catered for. Note it is not consdiered practical to provide OSM to cater for the 1 in 50 year event. However if desired to limit potential Council liability then it would need to be implemented based on the timing issue of development having to wait for public infrastructure before being allowed to progress. Alteratively to waiting developers could choose OSM which can be decomiisioned when infrastrucure upgraded.	Compatible with Development Contributions but hard to sell if asking for money on one hand and restricting development on the other
Method is simple, understanadable and acceptable		No		Yes	Yes	Yes	No	No	No
Effect on Rates		0.15%	limits growth- affects rates assumptions	Nil	1.40%	0.1%	1.55%	0.25%	limits growth
Water Use Savings		Yes up to 40% water savings	No	No	No	some but not compulsory	Yes up to 40% water savings	Yes up to 40% water savings	No
Subsidy for OSM via rebate from DC		na	na	less ability as current DC $1350 per HUE	less ability as current DC $1350 per HUE	Rebate from DC's of $1000 for OSM which has water reuse option	compulsory so no rebate	compulsory so no rebate	na
						Recommended			

Colour Indicates

- Does not achieve outcome
- Achieves outcome
- Risk associated
- Less risk associated