What is our problem with water reuse: How other countries do it?

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INTRODUCTION

The concept of water reuse is familiar to large parts of the world and means many things depending on where and how it is used. The concept of water reuse in New Zealand is typically narrowly used, often referring to the application back to land as primarily a means of discharging wastewater. The current New Zealand approach differs to many parts of the world where the need to manage water and nutrients has necessitated a more diligent means of handling treated wastewater.

Western Europe and parts of North America have strongly driven the need to manage nutrients in wastewater, while water short areas of the world, including the Middle East, Mediterranean, and parts of North America have driven the need to manage the hydraulic component of wastewater reuse. The third main driver for water reuse is to assist with maintaining existing infrastructure in growing and developing communities, especially in central America, parts of Europe and Asia.

New Zealand has until recently not had, or possibly not acknowledged, the need to manage infrastructure, nutrients and/or water resources to the same extent as else where in the world. This paper looks at why this might be and considers a selection of examples that will provide an insight into possible reuse options that could be applied here in New Zealand.

WHAT IS REUSE?

It is important that reuse is defined so there is a common understanding. Most wastewater texts will refer to reuse, with slightly different interpretations provided. The key concept in common is that treated wastewater is used for one or more beneficial purposes. The definitions can also apply to drainage and rainwater. Wastewater reuse is an important practice in a number of countries, especially for agriculture, with about 20% of the world population's food being produced through this practice (UNEP, 2005). Potential uses for treated wastewater are shown below in Figure 1.

Below is a summary, largely sourced from UNEP (2005), defining reuse water and possible uses.

Gray water reuse

Definition of greywater

Greywater is defined as untreated household wastewater that has not come in contact with toilet waste and includes wastewater from bathtubs, showers, washbasins, clothes washing machines and laundry tubs, but does not include wastewater from kitchen sinks or dishwashers or laundry water from washing of materials soiled with human excreta, such as nappies. Figure 2 below identifies the sources of wastewater.

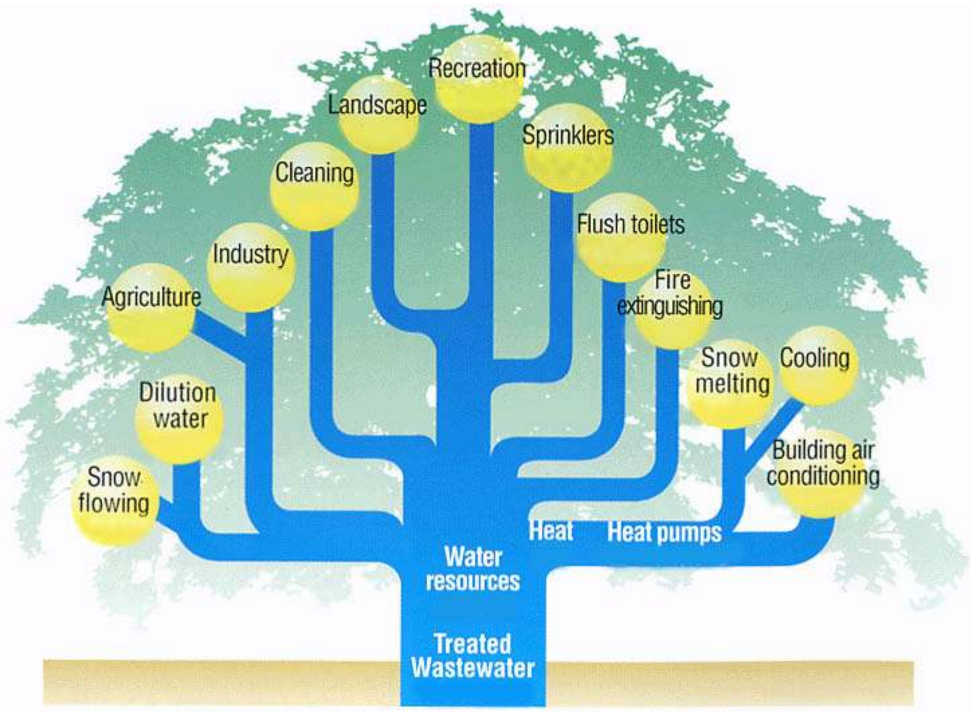

Fig. 1. Tree of water resources recycling (Source: MLIT, 2001).

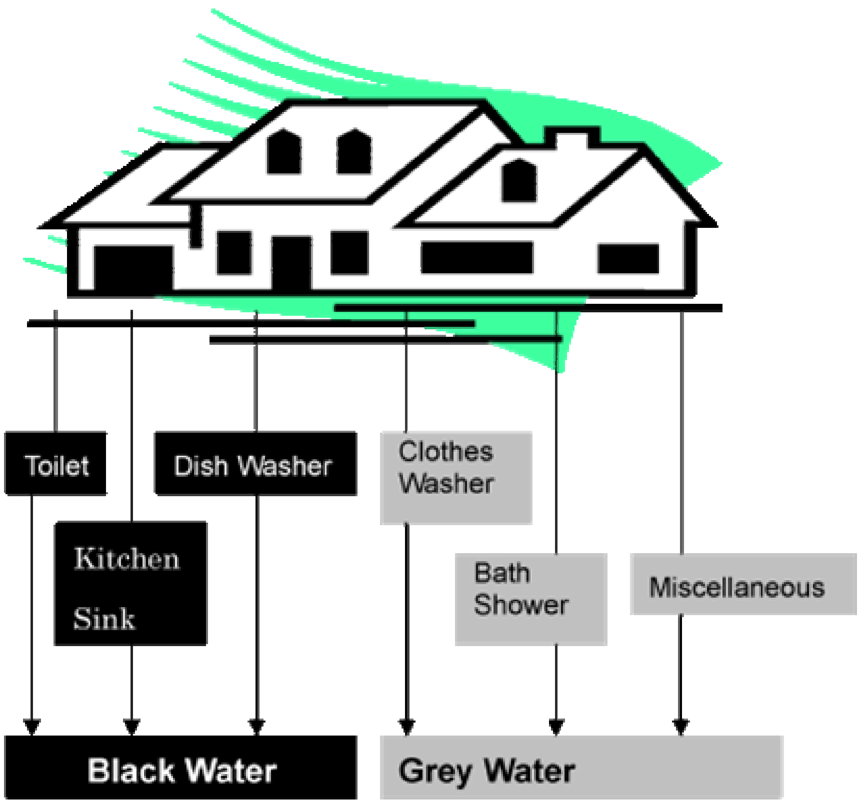

Fig. 2. Sources of household wastewater.

Outline of greywater reuse

In conventional sewer systems, grey water cannot be reused as it is discharged into sewer system along with black water. In some on-site sanitation areas, grey water can be utilised, thereby reducing fresh water consumption, if it is separated from black water.

Greywater is generally reused without pre-treatment for agricultural or landscape irrigation at a household or small community scale. It is best to design a greywater system that prevents human contact and the potential for environmental contamination. Untreated greywater reuse should be avoided for irrigation of root crop and edible parts of food crop. It is also needed to prevent ground water contamination.

Reuse of effluent from wastewater treatment plants

Outline of effluent reuse

Reuse of effluent from wastewater treatment plants is possible for a wide range of land uses, from agricultural to potable urban supplies, as shown in Figure 3 below. Wastewater treatment plant effluent is typically of a secondary effluent quality and can be recycled with or without treatment to meet specific quality requirement.

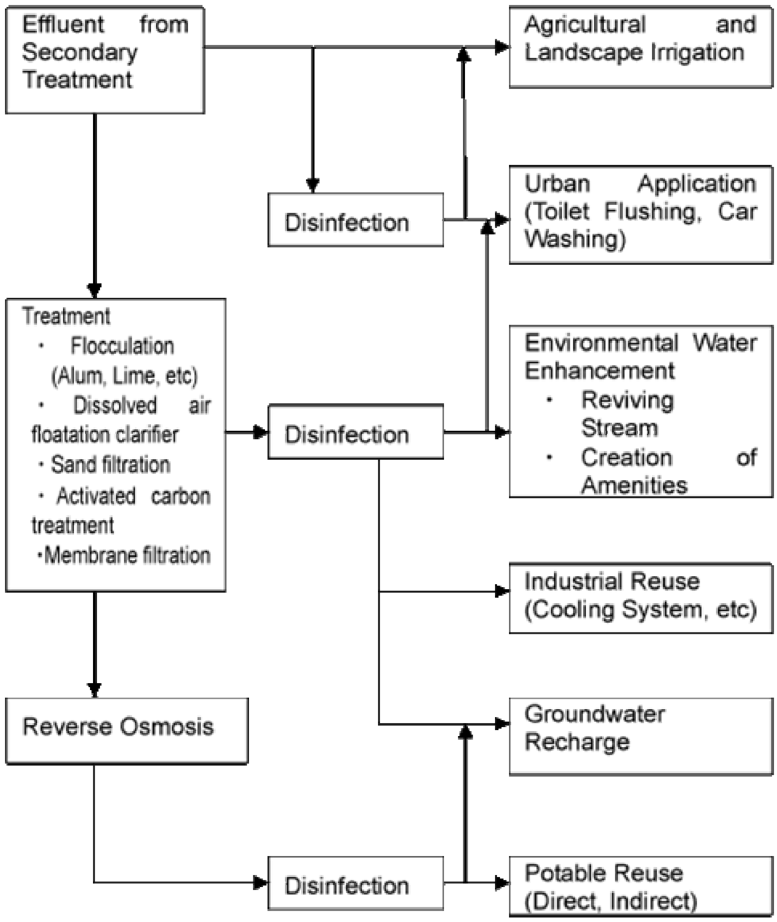

Figure 3. Outline of secondary effluent reuse.

Effluent reuse for agricultural and landscape irrigation

Agricultural irrigation is crucial for improving the quality and quantity of production. Worldwide, agriculture is the largest user of water; the sector has accounted for 67% of total freshwater withdrawal in the world in 2000 (UNEP, 2005). There is strong international motivation for more efficient use of agricultural water through wastewater reuse to provide for sustainable water management.

Main benefits of effluent reuse for agricultural and landscape irrigation include the following:

- Effective allocation of freshwater resources;
- Reduced dependency on synthetic fertilisers; and
- Reduction of nutrient loads to receiving water bodies.

Effluent reuse for agriculture should be practiced with good management to reduce negative human health impacts that could be caused by uncontrolled use. This requires the reuse intended effluent to be treated adequately and monitored to ensure that it is suitable for the intended use. Effluent reuse for agriculture needs to be planned with attention to target crops and existing water delivery methods. Excess nutrients may cause overgrowth, delayed maturity, poor quality of crops and palatability issues if grazed.

Effluent reuse for urban applications

Within communities, recycling of effluent will contribute to limiting raw water consumption and reducing the impacts on the environment when discharged. Most water used in urban activities does not need to be of a potable drinking water quality. In most cases, secondary treated domestic wastewater followed by sand filtration treatment and/or disinfection is suitable for non-portable purposes, including toilet flushing, car washing, garden watering, amenity irrigation, fire-fighting and snow melting in cool climates. An example of urban reuse is shown in Figure 4 below.

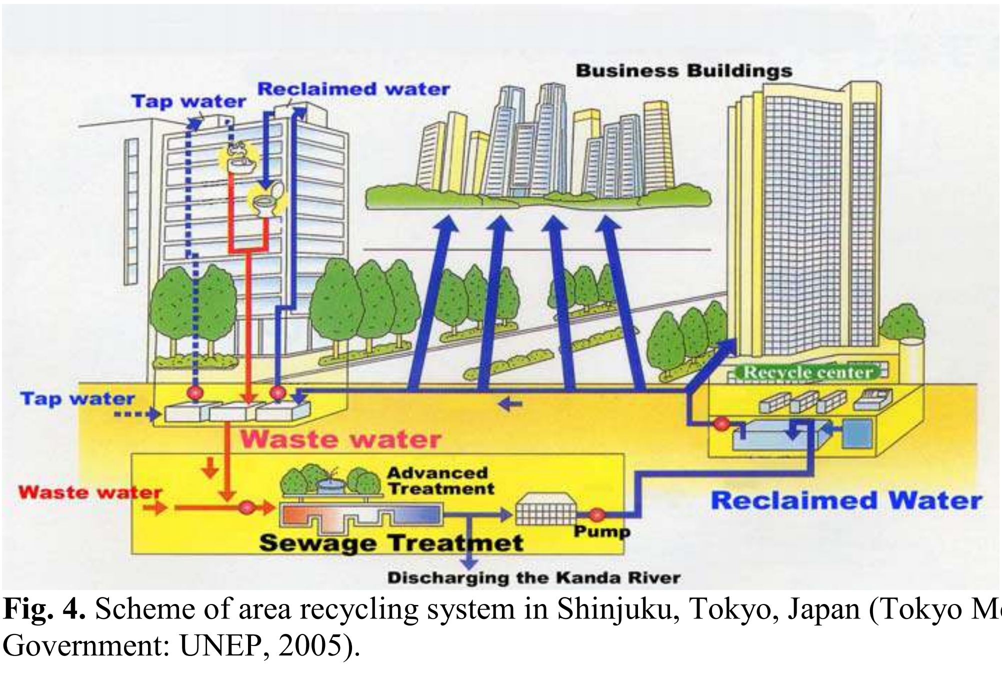

Fig. 4. Scheme of area recycling system in Shinjuku, Tokyo, Japan (Tokyo Metropolitan Government: UNEP, 2005).

Effluent reuse for environmental water enhancement

Effluent is regularly used for environmental enhancement, often assisting with the augmentation of streams, water features, and amenity ponds. In urban areas, the increasing expanse of concrete encourages rapid runoff, leaving many waterways suffering from low flow conditions in the absence of regular rain. Restoration of streams and ponds using reused water is common and it contributes to revive an aquatic life and return 'life' to urban areas.

When treated wastewater is used for water augmentation in surface water, the relevant water quality guidelines should be considered, including the potential that there may be humans contact. This may require the need for chlorination or UV irradiation etc. In addition to the hygienic aspect, removing nutrients can assist with reducing algal blooms and euthrophication.

An example of amenity effluent reuse is the moat at the Osaka Castle in Japan. In this case, 5,000 m^3/day of tertiary treated wastewater is added to the moat system.

Fig. 5. Example of reclaimed water use: Moat of the Osaka Castle (Osaka, Japan)

Effluent reuse for industry

Secondary effluent can be reused for industry with or without treatment and disinfection to meet intended purposes. Further information is provided in a following section.

Effluent reuse for groundwater recharge

Groundwater recharge using treated effluent is becoming increasing common and is being used to prevent declining of groundwater levels and to preserve the groundwater resource for future use. Compared to conventional surface water storage, aquifer recharge has many advantages such as negligible evaporation, little secondly contamination by animals, no algae blooming and can be less costly because no construction of dams and pipelines. In some countries benefits also include groundwater from saltwater intrusion and prevention of land subsidence.

Potable reuse of effluent

Growing populations and increasing constraints on the development of new water sources and existing infrastructure have spurred a variety of measures to conserve and reuse water. This has included the augmentation of potable water supplies with highly treated wastewater. This has only been made possible with improved water treatment technologies and water analysis techniques to detect microbial and chemical contaminants.

Reuse of industrial process water

Benefits of industrial water reuse

Industrial water use accounts for approximately 20% of global freshwater withdrawals (UNEP, 2005). There is scope for industries to invest in better water efficiency, including more recycling and management for freshwater conservation. Industrial water reuse has the following specific benefits, in addition to reduction in water consumption and pollution load to the environment:

- Potential reduction in production costs from recovery of raw materials in the wastewater;
- Less permitting and administrative burden from the reduction in wastewater toxicity and volume; and
- Heat recovery and reduced impacts from high temperature effluent to the ecosystem.

Industrial process water reuse can be through internal recycling and cascading use of industrial process water, from clean to dirty water. It can also be utilised for heating in production process or making hot water for domestic use through recovering its thermal energy.

Concerns of industrial process water reuse

Water quality concerns for industrial water reuse include scaling, corrosion, biological growth, and fouling. These concerns are often interrelated with one another, and can be prevented by a reduction of dissolved suspended solids, salts, ammonia, phosphorous and residual organics through treatment like flocculation and filtration.

WASTEWATER REUSE IN NEW ZEALAND

Extent of reuse

Rural New Zealand and primary industries have been reuse users in many cases for in excess of 20 years. Dairy shed and piggery effluent has since the early 1990s been applied predominately to land. Rural based processing facilities, such as meat plants and dairy factories, have also applied wastewater to land following varying degrees of treatment. Municipal wastewater from small to medium sized communities has also been regularly applied to land, with more communities in the 20 to 20,000 people equivalent treating and applying the wastewater to land. Very few large scale communities in New Zealand (i.e. greater than 50,000 people equivalent) reuse any collected wastewater.

Of the communities that do reuse wastewater, the majority apply it back to agriculture land. This practice has been enhanced and advanced over the last 20 years by the formation and ongoing running of the New Zealand Land Treatment Collective. Very few communities in New Zealand, especially of notable size, use treated wastewater for any other purpose than application to agricultural land or forestry.

In the majority of cases, the land application of wastewater is merely a means of discharging the water to the ultimate receiving environment. Possibly with the exception of the Taupo Land treatment scheme, very few if any systems would be operated to maximise irrigation or nutrient benefits of the applications, providing for excess drainage (non-deficit systems) or under conditions whereby nutrient application rates exceed the ability of the crops (and other nutrient attenuation processes) to utilise the nutrients.

Limitations to reuse

The predominant form of wastewater reuse in New Zealand is irrigation to agricultural and forestry land. Even these operations attract some concern, as there can be a real and perceived effect on crop quality. This is heightened in New Zealand given the country's dependency on exporting, with care needed not to compromise access to overseas markets. The use of treated wastewater in and around amenity and residential areas is poorly adopted in New Zealand. The reasons for this are varied. Possible reasons are summarised below:

Sector of the community	Specific group	Reason
Wastewater producers	Councils	Lack and unclear guidance in rules
	Developers	Costs associated needing additional treatment
	System owners	Potable water is cheap
	Home owners	Consenting restrictions
		Perception
Regulators	Regional Councils	Lack and unclear guidance in rules
	District Councils	Confidence in management
	Central government	Limited water allocation pressures
		Perception
Third party stake holders	Neighbours	Uncertain risks
	Interest groups	Perception
		Uncertain management
		Uncertain rules

The table above is interesting in that there is no technological reason why reuse is not pursued more. The predominant reasons would appear to be perception and economic divers. The economic drivers are likely to be two-fold, being the establishment of infrastructure and availability of low cost water supply and nutrient alternatives.

What is needed to increase reuse?

The incentives that drive global wastewater reuse have been typically absent in New Zealand. Some of these factors are discussed below:

Access to alternatives

The low cost and easy access to high quality potable water have meant that there is no premium to be paid for water of varying quality. However, this could be changing with initiatives such as the Ministry for the Environment's Sustainable Water Programme of Action (established in 2003) which looks at managing the countries freshwater resources. This program, coupled increasing rural pressure for irrigation, is meaning that some of the country's water resources are becoming fully allocated, which in term means that in order to provide for addition water greater effort and often cost is required. This applies to rural, industrial and urban water users alike. At some point there is the potential that it may be cheaper to reuse water from a wastewater source.

Infrastructure limitations

In many larger urban areas existing infrastructure is approaching its design capacity. This applies to potable water and wastewater, and includes the source procurement, storage, treatment, reticulation and discharge. While there is always the potential for upgrading, there is also the potential to consider concepts which allow the infrastructure (especially reticulation) to be retained with alternative ways to limit and reuse water close to its point of use. This may be as simple as sewer mining to recycle water for industrial, non-potable or amenity irrigation purposes. Consideration of close to source use of wastewater should be included in any infrastructure upgrade project.

Perception

Modern civilisation has seen the development of sanitary system, where one of the primary aims is to put distance between surplus bodily material and people to enhance public health. In many cases a fear has developed where we are repeatedly told that wastewater is harmful. While this may be the case, a balance is needed to allow the incorporation of new technology which renders the wastewater inert, matches the use of the wastewater with the risk to both human health and environmental damage, and provides for the affordable costs to the community as a whole.

In many cases expensive high technological solutions are adopted not because they are needed to minimise the risk to human health and environmental damage, but merely because the technology exists and people want the best outcome regardless of the costs.

Intensification

The intensification of land will likely result in reuse becoming a necessity. Rural intensification will result in the need to consider alternative water sources for irrigation and processing as full allocation of existing resources and also conveyance costs increase. Urban intensification may see reuse increase as a result of an increase in density and a desire for premium amenity facilities. In many cases upgrading existing urban water supply and discharge facilities may be too expensive, coupled with increasing unit costs of water supply.

Costs

The majority of the points above relate back to costs, and in particular supply and demand. As the demand goes up it puts a premium on the supply, thereby increasing costs. However, counter to this are technology advancements which are making possible what was not considered feasible only a few years ago, and at a lower cost. This includes higher levels of treatment, advances in reticulation techniques and better monitoring and detection.

Environmental sustainability

Some individuals, companies and communities are acknowledging the need to adopt an environmental sustainable agenda, which does not necessary mean putting wastewater down a pipe for someone else to manage. In many cases options other than the 'big pipe' solution are not considered. This is typically through being unaware or misconception about alternatives. May people like to stick to what they know, rather than challenging the way things have been done in the past and asking if historical practices are sustainable. When alternatives are considered, including reuse, their costs are often miscalculated due to a poor understanding of the alternative system. There is the possibility that the alternatives are more expensive, possibly only in the shorter term.

Despite the potential additional costs and the perceived 'newness' of reuse, some councils, developers and individuals are prepared to invest in alternatives to provide for a more environmentally sustainable outcome. An example is the laying of dual or triple reticulation within a new development to allow for greywater or non-potable water reuse.

WORKING EXAMPLES

There are numerous examples of reuse projects around the word. A selection from the author's recent experiences overseas will be provided at the LTC conference showing how reuse can be incorporated into existing and new communities.

CONCLUSIONS

Reuse of wastewater means different things to many people around the world, however the common element is using the water for a purposed that has a benefit, often to the betterment of economic and environmental factors.

Reuse can involve greywater and treated wastewater for potable reuse, non-potable reuse, production and amenity irrigation, industrial water supplies, air conditioning and many more purposes.

The predominant form of reuse in New Zealand has been the single use of a wastewater source for inefficient irrigation (i.e. a means of wastewater discharge). Typically in New Zealand excess water or nutrients are applied during reuse, thereby reducing the efficiency and beneficial elements of reuse.

Reuse in New Zealand has been limited due to lower cost options for water supplies and infrastructure upgrades. While reuse is acceptable in an agricultural and forestry setting, there are still real and perceived limitations with respect to impact on the sale and marketability of the crops produced. Similarly, the perception of public health risk is possibly the biggest single obstacle to reuse in existing urban settings.

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