The Changing Perception of Wastewater Reuse in Australia and New Zealand.

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Key Words: Wastewater, reuse, sewage, perceptions, Australia, New Zealand

Abstract

In Australia, New Zealand and other parts of the world, the perception of wastewater or sewage as a "waste" is progressively changing to the concept of a "resource". Primary inter-related influences in the changing perception include population pressures and associated increased demand for water, degradation of environmental conditions, tighter environmental protection legislation, increasing cost of water, and the progressive desire for sustainable development. As a consequence of these factors and improved treatment technology, reuse schemes using treated sewage are gradually becoming more acceptable and even necessary in some places.

As a result of the semi-arid to arid conditions in some areas of New South Wales, environmental legislation that penalises discharges to the environment and the increasing cost of water, the development of reuse programs is becoming an attractive alternative to direct disposal. In New Zealand, indigenous cultural beliefs are a driver for land application, however climatic conditions and the availability of suitable land resources can limit opportunities for reuse.

This paper looks at the factors influencing the changing perception of wastewater in New Zealand and Australia (focusing on NSW). It reviews the environmental and planning legislation controlling wastewater reuse and assesses the influence of local environmental conditions on the development of reuse schemes. The paper presents a number of case studies that illustrate how these factors have affected the uptake of wastewater reuse in both Australia and New Zealand, and it raises the question of how current practices and trends will affect the future development of reuse schemes.

Introduction

Human settlements rely on the provision of natural resources, such as water. However, water is a scarce resource in many parts of the world. Reasons for water scarcity may include low rainfall, lack of space to resource the water, lack or monetary resources, or pollution of existing water resources. In areas affected by these limitations, the inadequate provision of a regular and reliable source of water can adversely affect social and economic development within the community.

Treated human wastewater can be a reliable source of water which can be utilised in many aspects of human life such as industrial uses (e.g. cooling water), agricultural and landscape irrigation, residential and commercial non-potable uses, etc. There is even now technology (although costly) to treat sewage to generate potable water.

The reuse of human wastewater for potable purposes and even non-potable uses (e.g. dual water supply for car wash, flush toilets, etc) has often been disregarded as inappropriate from a social perspective. In the last half of the 20th century, there has been however a rise in environmental consciousness in response to scientific evidence of the vulnerability of the earth and its limited resources (Burgin, 01). The last decades have seen the introduction of worldwide environmental protection legislation and a trend towards sustainable development. As part of this process, the perception of human wastes (including wastewater) has been progressively changing from the concept of a "waste" to a "resource". As water resources become scarcer, this changing perception is likely to progress even further.

Factors influencing the changing perception of wastewater in New Zealand and Australia (focussing on NSW) and a number of study cases that illustrate how these factors have affected the uptake of wastewater reuse in both countries, are discussed below.

Australia (NSW)

Water is a scarce resource in many parts of Australia. Areas of New South Wales (NSW), the most populated and industrialised state in Australia, are semi-arid (particularly inland) and development is dependent on reliable sources of water supply. Other parts of Australia face the same problem. The NSW Government notes that "NSW is now at the limits of its available water resources – both licence embargoes over much of the State and our commitment to the Murray-Darling Basin Cap are causing uncertainty over access to water – however our major water using industries still depend on continued access to water" (DLWC, 2001). The NSW EPA (2001) also notes that the availability of water is a constraint to the future growth of NSW regional centres. In that respect, the use of wastewater can play a significant role in fulfilling water needs in NSW.

Treated sewage in NSW's sewage treatment plants (STPs) has traditionally been discharged to inland waterways or the ocean in accordance to Environment Protection Authority (EPA) licence conditions. However, in recent years there have been a growing number of proposals in Australia where treated wastewater is to be used as a resource in irrigation schemes, industrial uses, or dual water supply for residential areas. The EPA (2001) indicates that outside the greater metropolitan area, about 12% of sewage effluent is now reused with the remainder being discharged to waterways. It is also noted that between 1993-94 and 1996-97, total effluent reuse in NSW and the ACT have increased by 44% (EPA, 2001).

There are a number of inter-related factors that have contributed to the growing number of wastewater reuse schemes in NSW. These include:

- tighter environmental protection and sustainable legislation;
- population pressures and associated increased demand for water;
- increased costs of water resources; and
- a growing community desire for sustainable development.

These factors and four wastewater reuse study cases are discussed below.

NSW Statutory Context

The *Environmental Planning and Assessment Act 1979* (EP&A Act) sets the framework for planning and land-use management in NSW. Planning decisions, such as the development of wastewater reuse schemes, are made within the context of the EP&A Act and environmental planning instruments (including state environmental planning policies (SEPPs), regional environmental plans (REPs) and local environmental plans (LEPs)) established under the EP&A Act. Planning decisions at the local level are often the responsibility of local government and are achieved through LEPs. Planning NSW (the former Department of Urban Affairs and Planning) is responsible for setting overall directions for land use and planning and for decisions on state or regionally significant developments.

One of the objectives of the EP&A Act is to encourage Ecologically Sustainable Development (ESD). The United Nations Commission on Environment and Development defined ESD as 'development that meets the needs of the present without compromising the ability of future generations to meet their own needs' (WCED 1987 as reported by EPA (2001)). The principles include a) the precautionary principle, b) the intergenerational principle, c) conservation of biological diversity and ecological integrity, and d) improved valuation and pricing of environmental resources. Proposals in NSW are required to consider the four principles of ESD. The need to consider ESD in the planning process could be considered as a factor in favour of the development of wastewater reuse schemes. Direct discharge of wastewater to the environment (e.g. a river or the ocean) can be considered unsustainable and therefore difficult to justify under ESD. On the other hand, a well-managed reuse scheme is closer to being sustainable and therefore more consistent with ESD.

In addition to the planning legislation, there is environmental legislation in NSW that can influence the development of wastewater reuse schemes including (but not limited to) the *Protection of the Environment Operations Act 1997* (POEO Act) and the *Water Management Act 2000* (WM Act). There is also legislation for sewerage and water service providers, such as the *Sydney Water Act 1994* or the *Hunter Water Act 1991,* which encourage the reuse of wastewater.

The POEO Act, which commenced operation on July 1999, regulates, amongst other things, discharges to water. The Act is based on the principle of ´pay to pollute´. The EPA through the POEO Act licensing system penalises emissions to water, indirectly promoting sustainable wastewater reuse programs. The POEO Act introduces the Load-Based Licence scheme in which licence fees are estimated based on pollutant loads (licences under past pollution control legislation were based on chemical concentrations). The Act therefore provides financial incentives to wastewater generators to reduce discharges.

The WM Act was introduced in NSW in January 2001 and will progressively be implemented. The WM Act is based on the ESD principles. The WM Act can place restrictions on the collection and use of surface stormwater and groundwater indirectly promoting the use of other water sources. Water use, water management works and aquifer interference activities require approvals under the WM Act in accordance with water management plans to be developed for water systems (e.g. rivers, aquifers, wetlands, etc.). The Act requires that, in sharing water, allowance for the fundamental health of the water systems has first priority (DLWC, 2001).

Sydney Water is the State Owned Corporation responsible for provision of water and sewerage systems in the Sydney, Illawarra and Blue Mountains regions. Sydney Water serves a market of nearly four million customers (Sydney Water, 2002). Sydney Water's enabling legislation includes the *Sydney Water Act 1994* (SW Act). A licence is granted to Sydney Water under the SW Act, which "permits Sydney Water to provide, construct, operate, manage and maintain systems and services for providing sewerage services and disposing of wastewater". Under the SW Act there are requirements in relation to sewage discharge and reuse for Sydney Water. Section 27(1) of the Act states that the Corporation is to adopt, as an ultimate aim, the prevention of all dry weather discharges of sewage to water, including from ocean outfalls, except to the extent that this is necessary to safeguard public health or prevent environmental degradation, or both. Under the Act, Sydney Water is required to gazette on a five yearly basis a projection of the amount of effluent to be reused, intercepted or otherwise prevented from discharge. Other water and sewerage service providers such as Hunter Water have legislation that promotes the reuse of wastewater.

Population Pressure, Demand for Water and Cost of Water

NSW has a population of just under 6.5 million people-approximately one-third of the total Australian population of just over 19 million people (ABS, 2000). The population of NSW is projected to grow to 7.6 million by 2026 (DUAP, in press). This is a projected increase of roughly 1.4 million people over a 30-year period.

According to the Australian Bureau of Statistics (2000), water use in NSW/ACT increased from 9,439,186 ML in the year 1993/94 to 11,055,336 ML in 1996/97. This represents an increase of approximately 17% over a period of 3 years. The agricultural sector is the largest user of water, taking approximately 65% of all water extracted in NSW. In 1996-97, household water use was estimated to be 580,423 ML, or 4% of total extraction.

The EPA (2001) notes that in the inland areas of NSW, the availability of water is a constraint on the future growth of regional centres. Recent estimates suggest that town water supplies will be limited to 2% increases per year for a period of 10 years. Allocations after this may compete on an open trading market with agricultural water use (DLWC, 2000). Population growth and tourism also place stress on water sources along the NSW coastal areas.

In recent decades the cost of reliably supplying water from natural sources in NSW has escalated dramatically (DLWC, 2000b), and continued price escalation is expected. Water pricing in NSW is determined by the Independent Pricing and Regulatory Tribunal (IPART). IPART determination for bulk water pricing recommends that water pricing should reflect environmental costs and that the principle of "full cost recovery" is implemented (DLWC, 2000b). One of the actions of the NSW Water Conservation Strategy (DLWC, 2000b) is that the government ensure that water rates and charges progressively move to reflect the full economic cost of water use and water quality degradation.

Growing Community Desire for Sustainable Development

There is an increasing acceptance of ecologically sustainable development (ESD) principles locally, nationally and internationally. Legislative initiatives, strategies, action plans, policies and programs that incorporate ESD principles have been instigated at all institutional levels from the United Nations, national government, business organisations, corporations, and networks of community groups (EPA, 2001).

As discussed above, Government Departments in NSW have adopted ESD principles through enabling legislation, strategies and/or guidelines. This is largely the reflection of a community desire for sustainable development. Sewerage and water service providers such as Sydney Water, have as a principal objective to conduct its operations in compliance with the principles of ESD (Sydney Water, 2002).

The National Health and Medical Research Council, the Australian and New Zealand Environment and Conservation Council and the Agriculture and Resource Management Council of Australia and New Zealand (2000) note that public acceptance of treated wastewater for use in a variety of actual and hypothetical applications has been widely surveyed. They state that there is a high level of goodwill towards the concept of treated wastewater use and attitudes towards the practice are fairly consistent.

Study Cases

As examples of the increasing acceptability of wastewater reuse in Australia, four recent study cases where wastewater reuse schemes are proposed, considered or being implemented in NSW are presented in this paper. These include:

- Wallacia, Silverdale, Warragamba and Mulgoa Sewerage Scheme and Effluent Irrigation Program
- Tamworth Sewerage Scheme and Effluent Irrigation Program
- Cooling water for the Illawarra Cogeneration Project
- Rouse Hill Domestic non-potable reuse Program

Wallacia, Silverdale, Warragamba and Mulgoa Sewerage Scheme and Effluent Irrigation Program by Sydney Water

This proposal by Sydney Water involved the provision of a sewerage scheme for the villages of Wallacia, Silverdale, Warragamba and Mulgoa, located about 50km southwest of Sydney. Residents in these villages managed their sewage through the use of on-site sewage management systems. As a consequence of the poor operation of these on-site systems, the quality of stormwater and watercourses in the area had deteriorated, showing increases in pathogenic microorganisms and nutrient loading, particularly in periods of wet weather.

A component of the proposal included an effluent irrigation scheme at a 50 ha dairy farm. Effluent generated by the scheme would be used for pasture irrigation, with any unused effluent discharged to a tributary of the Warragamba River. It was expected that discharge would only occur during wet weather and cooler months in winter when irrigation demands are low.

The EIS prepared for the proposal (CH2M HILL, 1999) estimated that approximately 70-85% of the annual effluent volume would be reused. During periods when effluent is being directed to reuse, treatment plant operation would be adjusted by reducing chemical dosing to retain higher nutrient concentrations in effluent. This would provide some cost savings in the operation of the STP and would reduce the need for fertilisers on the irrigated area. Another benefit of the scheme was the reduced volume of water abstracted from the Nepean River by the farm.

The development of the proposal involved a comprehensive investigation of options. Five broad strategies were investigated during the planning process. For each strategy several options were considered. The broad strategies were:

- Enhanced Existing On-Site Management.
- Treat Locally and Discharge.
- Transfer to Existing STP and Discharge.
- Non-Potable Reuse.
- Potable Reuse.

One of the Non-Potable Reuse options (i.e. local treatment with partial effluent reuse as an integral part of the proposal) was selected as the preferred sewage management option. The preferred option was selected after a process incorporating the results of the community and government consultation, an options study, preliminary assessment of environmental issues and economic and financial evaluations. The consultation process showed the general support of regulators and the community to the non-potable reuse option. Ultimately, the planning process ensured that one of the most sustainable options was selected.

Tamworth Sewerage Scheme and Effluent Irrigation Program by Tamworth City Council

The City of Tamworth is served by two Sewage Treatment Plants (STPs). These are the Swan Street STP and the Westdale STP. Both of these STPs have been producing effluent, which is high in nutrients (nitrogen and phosphorous) (CMPS&F, 1997 & CH2M HILL, 2000).

In recognition of the need to provide increased sewage treatment capacity, and to upgrade effluent quality to meet changing environmental performance expectations, Tamworth City Council (TCC) and the Department of Land and Water Conservation (DLWC) developed the Tamworth Sewage Treatment Strategy in 1994 which

entailed the closure of the Swan Street STP with sewage transferred to an augmented Westdale STP and a 35% effluent reuse scheme (CMPS&F, 1997).

As a result of changes to environmental legislation in NSW since 1994 and emerging trends in water resource and environmental management, TCC reviewed this strategy. Consequent to the change in strategy direction, CH2M HILL prepared an EIS in 2000 for the Augmentation of the Westdale STP and a 100% effluent reuse scheme. The scheme included an effluent reuse farm covering 1,590 ha including effluent storage, and an 8.4 km transfer pipeline from the Westdale STP to the reuse farm.

Reuse alternatives considered in the EIS process included 35% effluent reuse, 100% effluent reuse and 100% river discharge. Alternative reuse options such as dual water supply and irrigation of urban open space were considered as part of the EIS (CMPS&F, 1997) for 35% reuse.

A number of factors influenced the decision to adopt 100% effluent reuse as an integral component of the Tamworth Sewerage Scheme. Key factors included the potential long-term financial returns, reduced nutrient and salt load on the Peel River and expressed community preference for a scheme that includes effluent reuse and that was sustainable in the long term. These motivations were further heightened by the introduction of the LBL and the associated financial implications for TCC.

Illawarra Cogeneration Project (ICP) by Duke Energy International

Duke Energy International (DEI) has proposed to build a cogeneration plant (the ICP) at the BHP Steelworks in Port Kembla NSW. Negotiations about the proposed ICP are still underway between BHP and DEI. It was proposed to use fuels that are by-products of the iron and steel making process to produce steam and electricity.

Energy generating plants require significant volumes of water for cooling water purposes. The required cooling water flow for the condenser at the proposed ICP was estimated at 650 ML/d. Two cooling water system options were initially considered; an open circuit and an enclosed system.

Using an open circuit cooling tower system would require the use of large volumes of ocean water (up to 650 ML/d), which would need to be discharged to the harbour at temperatures higher than originally collected. Using a closed circuit would require a source of water to make up for water evaporated in the cooling tower (in the order of 9-11.5 ML/d). Wastewater generated by an enclosed system would be about 1.5 ML/d.

During the planning phase it was determined that the open system would potentially require compliance with environmental legislation (e.g. possible licences from DLWC to collect water and from the EPA to discharge water to the ocean). It was also determined that Government Departments would unlikely agree with this option. Based on that, the open system option was early rejected.

Several options for the supply of cooling water and discharge of wastewater from the enclosed cooling water system were then considered in the EIS (CH2M HILL, 2001) including:

- Townwater supply;
- BHP´s industrial water supply (within steelworks);
- Seawater supply;
- Untreated Dam Water (dam located over 20 km north west);
- Coal Mine water (coal mines located approximately 10km west); and
- Effluent from the upgraded Wollongong STP (located about 1 km north of the steelworks).

At the time of finishing the EIS two cooling water source options were short listed, the Wollongong STP and mine wastewater. All options presented advantages and disadvantages, however the planning process favoured the Wollongong STP option, as it was preferred by Government Departments and because of lesser environmental legislative requirements.

Under this option, the upgraded Wollongong STP would provide tertiary treatment effluent to the ICP. The advantages of this option included the reuse of Wollongong STP effluent instead of directly discharging it to the

ocean (with STP effluent use for cooling water purposes at the ICP and wastewater from the STP being re-directed to the STP), no need to use the water resources of the Illawarra, and the relatively low cost of the water.

Rouse Hill Domestic Non-potable Reuse Program by Sydney Water

As part of a co-ordinated water cycle management program designed to help protect the Hawkesbury-Nepean River, Sydney Water is introducing treated wastewater as a water resource to new properties in the Rouse Hill Development Area in Sydney's north west (Sydney Water, 2002).

Under this program, sewage is piped to the Rouse Hill Recycled Water Plant where it is treated and returned to homes in a separate pipeline. All homes in the area have two water systems, a drinking water system and a recycled water system. Any wastewater that is not recycled is released into the man-made wetlands in Second Ponds Creek. When treated wastewater is discharged to the river, the advanced treatment ensures that the impact on water quality is minimised. The program also includes pollution reduction measures on the stormwater system. The program is planned to provide recycled water by early 2002.

The Rouse Hill program is Australia's first full-scale application of domestic non-potable reuse, with the STP and the dual water distribution system being commissioned in late 1994. The EIS prepared in 1991 for the proposed Rouse STP (Manidis Roberts, 1991) indicated that unless specific measures were taken to control the environmental discharges from the ultimate expected population of 300,000 people, severe degradation of water quality in the Hawkesbury River would result. The program was therefore intended not only to reduce potable water consumption but also to reduce the environmental impacts of locating a large body of people near a major river system that is used for a number of recreational and industrial purposes.

Lessons learned from the Study Cases

Some conclusions drawn from the study cases discussed above include:

- Treated wastewater in NSW can potentially be a significant source of water. There are a variety of wastewater reuse options available covering (but not limited to) industrial, residential and agricultural uses. As treatment technology becomes cheaper and better, the number of feasible options could be expected to increase.

- Cost (initial and longer term costs) can be a significant factor in the development of wastewater reuse schemes. Demonstrating the financial viability of reuse schemes is therefore necessary prior to further consideration of reuse proposals. Factors that can impact on costing include initial capital cost, licensing and regulatory requirements (e.g. LBL discussed before) and on-going financial return.

- Proving the sustainability and “low” level of environmental impact of reuse schemes is an essential factor in the approval process (as well as in stakeholder acceptability). In the examples above, the planning process was generally supportive of sustainable wastewater reuse schemes. Government departments, regulatory authorities and the community appeared to be generally in favour (or at least not against it) of wastewater reuse proposals as compared with other options theoretically less sustainable (e.g. discharge to a river or the ocean).

- Potable reuse (direct or indirect) is still largely not socially acceptable. This is supported by EPA (2001) reports which note that community surveys show that the level of acceptance of potable reuse options is low

New Zealand

The reasons for implementing wastewater reuse schemes in New Zealand are often quite different to those in neighbouring Australia. New Zealand generally does not suffer from the same dry climatic conditions of Australia, which significantly affects the demand for reuse schemes. In addition to climatic conditions, there are a number of factors which influence the effectiveness and / or acceptability of wastewater reuse programmes in New Zealand, including soils, topography, legislation, land ownership, cultural values and cost as discussed below.

Water Demand, Topography, Soils and Land Ownership Issues

New Zealand’s location in the mid-latitude zone of westerly winds results in a relatively high average rainfall. The only areas with average rainfalls under 600mm are found in the South Island to the east of the main ranges

(Central and North Otago and South Canterbury). In the North Island, the driest areas are central and southern Hawkes Bay, Wairarapa and Manawatu, where the average rainfall is 700-1000mm/year. Of the remainder, much of it valuable farmland located in northern Taranaki and Northland has upwards of 1500mm/year. Over a considerable portion of both Islands rainfall exceeds 2500mm/year (MetService NZ, 2002).

In most areas of the North Island there are at least 130 rain days per years (days with at least 0.1mm of rain). The country's total annual precipitation is between 300,000 and 600,000 million cubic metres, and it has been estimated that New Zealand's consumption of water only approaches 2,000 million cubic metres per year (Statistics New Zealand, 2002). In the majority of New Zealand, the demand for water is significantly below the volume supplied by rainfall. This is reflected in the low cost of water supply in New Zealand.

An additional factor affecting the demand for wastewater reuse is the population distribution and land ownership. New Zealand has a population of just over 3,700,000, of which just over 2,800,000 are located in the North Island with approximately 1,000,000 located in Auckland. The majority of the population is therefore located in areas where climatic conditions do not significantly limit water supply.

Land availability and suitability in the areas of population concentration often limit options for reuse. Identifying a large suitable section of land for the application of treated wastewater is often difficult, complicated by multiple ownership. Very few large, single ownership sites with suitable characteristics for wastewater application are available and reuse schemes utilising a number of properties are difficult to manage and operate successfully[1].

Due to New Zealand's location on shifting tectonic plates, much of the countryside is particularly rugged, restricting the land use. Additionally many soil types limit the effectiveness of effluent irrigation reuse.

Environmental Legislation

The Resource Management Act 1991 (the Act) is New Zealand's primary environmental legislation, under which regional and district plans are developed and administered. While the Act does not provide specific guidance on the preferable means of wastewater disposal, it does state that the purpose of the Act "*is to promote the sustainable management of natural and physical resources*'. This means "*managing the use, development and protection of natural and physical resources in a way, or at a rate, which enables people and communities to provide for their social, economic and cultural well being and for their health and safety while –*

a) Sustaining the potential of natural and physical resources (excluding minerals) to meet the reasonably foreseeable needs of future generations; and
b) Safeguarding the life-supporting capacity of air, water, soil and ecosystems; and
c) *Avoiding, remedying, or mitigating any adverse effects of activities on the environment."*

A well-managed wastewater reuse scheme can often better achieve this purpose than direct discharge to a river or the coastal marine area. It is noted however that ensuring the effects of a wastewater reuse scheme are minimised are often compromised by factors outside of human control (as described in the section above).

The lack of specific controls in the Act, means that the development of wastewater reuse schemes is highly dependent on restrictions imposed through Regional and District Plans developed under the Act. Section 15 of the Act specifies that the discharge of contaminants into the environment is not permitted unless expressly provided for by a rule in a Regional Plan, resource consent or regulation. Whilst Section 9 of the Act restricts the use of land in any manner which contravenes a district plan.

Cultural Values

One of the main drivers for wastewater reuse or the application of wastewater to land in New Zealand is the relationship of the Maori culture with water. Water is considered by Maori to possess mauri, a life force. The discharge of contaminants to water reduces the waters ability to sustain life, thereby reducing its mauri. The ethic of Kaitiakitanga (guardianship/stewardship) of the environment creates a duty of Maori to protect and

[1] It is noted that not every type of wastewater reuse is influenced by the topography, soil type or land availability (for example industrial reuse). There are however, few known examples of human wastewater being reused in industrial processes in New Zealand. It is considered that this is most likely a reflection of the ease of obtaining good quality fresh water at low cost.

enhance the mauri of water for future generations. The traditional system of Kaitiakitanga is a holistic system, which ensures balance and harmony between the universe, the environment and the people.

The Act requires the recognition of the relationship of Maori and their culture and traditions. The requirement of the Act to recognise Maori values can be seen, in a way, to encourage the reuse of wastewater

Market Influences

Recent developments in the dairy industry are going to significantly affect the operation of current and future wastewater reuse schemes. As a result of increasing export market pressure the Dairy Research Institute has banned the application of any human wastewater products to pasture or fodder consumed by dairy cows. This was a particular issue in Taupo, where some hay produced from the land application scheme was being utilised by local dairy farmers (per comms Dr J Barnett, Dairy Research Institute, February 2002).

Other food industries have also indicated that they have similar concerns.

Wastewater Reuse Schemes in New Zealand

As a result of the many natural restrictions, there are very few true beneficial reuse schemes in New Zealand. There are a number of land application schemes, such as those used in Taupo and Rotorua, which dispose of wastewater to pasture or pine plantations. While these schemes do provide some nutrient value to crops, the benefits are not highly valued and the schemes are managed to maximise the volume disposed while minimising the adverse effects on crops. Additionally there are a number of wetland schemes, whereby man-made wetlands are utilised for final polishing of the wastewater quality prior to discharge. While the wetlands provide significant benefits through the provision of important habitat along with amenity value, they are a recognised form of wastewater treatment and are not considered true reuse.

One of the few truly beneficial reuse schemes is that used by Tauranga District Council. Tauranga District Council utilises "reclaimed water" on two public park areas and the Omanu Golf Course. In summer this scheme reuses approximately 2% of the total wastewater discharge from Tauranga City, though on average only 1% of the total wastewater is reused through the year (per comms Jelley G. Tauranga District Council, January 2002).

Comprehensive public and Maori consultation in the early 1990's resulted in community preference for treating wastewater and using it as a resource rather than discharging it into the ocean. As a result Council selected a scheme utilising an existing ocean outfall while also looking at ways to maximise wastewater reuse. The route of the treated wastewater pipeline created opportunities to consider irrigating a number of Council and community owned properties, and in 1994 a resource consent was granted for the irrigation of 10 sites within the Tauranga District, these included Council parks, roadside reserves, the airport, schools and Omanu Golf Club. The scheme was to benefit the environment by reducing the wastewater discharge to foreshore waters and provide nutrient enriched water for irrigation purposes reducing the demand on potable town supply and groundwater during peak periods (e.g. summer). Ultimately landowner concern regarding public health effects and potential management difficulties resulted in only three sites being irrigated; Omanu Golf Course and two Council reserves.

The resource consent process went smoothly with only three submissions being received, which were easily resolved. The only issue of contention was with respect to aerosols, and as a result the first summer was used as a testing period with specific aerosols trials being carried out (Korenhof, R. et al. 1995). Additionally, the consent conditions specified various buffer zone distances around property boundaries.

Council staff do not consider the scheme a significant success due to the difficulties incurred trying to achieve the wastewater quality levels specified in the resource consent. As a result of these difficulties the reuse scheme has been shut down occasionally. On one occasion this occurred during a critical dry period, resulting in the die off of grass at the Omanu Golf Course. The high costs associated with achieving the required levels of wastewater quality make the ocean outfall option (which has less stringent water quality criteria) more attractive. In addition to the increased treatment costs associated with the reuse scheme, the ongoing monitoring costs have also been noted as high.

Council staff at Tauranga District Council have mentioned that it will be desirable to seek more lenient wastewater quality criteria in future resource consents in order for their scheme to continue to operate efficiently (per comms Jelley G. Tauranga District Council, January 2002).

Another well known reuse scheme is the Levin sheme (which won the IPENZ Environmental award etc). All the treated effluent is pumped about 7 km to a coastal area previously notable for the wind blown sands which made the area a coastal hazard and unfarmable. The scheme gave the benefits of a road access, stabilisation of a coastal zone through growing grass to provide initial stabilisation and then overplanting with trees to give a long

term crop and potential future work (thinning etc) to the Maori owners (per comms Walmsley N, Beca Carter Hollings and Ferner Ltd, March 2002).

Challenges to Reuse, Future Trends and Conclusions

Although wastewater reuse is a growing practice in Australia (NSW), there are a number of challenges and issues that need to be considered:

- Cost: the treatment of wastewater for reuse (particularly high level treatment) and, for certain reuse options the installation of distribution systems, can be initially expensive compared to other water supply alternatives (eg. groundwater near the consumer);

- Institutional barriers: human health protection legislation or other statutory requirements can impose barriers in the approval of reuse schemes;

- Social acceptance: certain reuse options are generally not socially acceptable (e.g. potable reuse) and there is still some social apprehension to other reuse options (e.g. dual supply to residential areas).

Past experience shows that wastewater reuse programs in NSW are becoming more prominent, particularly in areas where water is a scarce resource. It could be argued that in the future this trend will continue, particularly as factors driving wastewater reuse continue to be prevalent. That is, anticipated increases in the cost of water, the progressive introduction of environmental legislation, and population pressure/demand for water will drive wastewater reuse schemes further in the future. Treatment technologies would be expected to become cheaper and more efficient, potentially expanding the spectrum of wastewater uses. Social acceptance to wastewater reuse would likely increase in the future (as long as it can be demonstrated that risks to the public are minimal). It is expected that wastewater reuse will keep growing in NSW and that the perception of wastewater will continue changing towards the concept of "resource".

In New Zealand there are a number of factors limiting the future uptake of effluent reuse as an acceptable alternative source of water. New Zealand's predominantly wet climate, difficult terrain, population dispersion and market influences are likely to be continual negative forces on the rate of adoption of reuse schemes. This will continue to be reflected in the cost of establishing and managing reuse schemes compared with direct potable water supply schemes. Notwithstanding, it is considered, that reuse schemes will continue to be considered as a valid disposal option due to the strong emphasis placed on cultural values in New Zealand. However, until the costs of water supply versus wastewater reuse balance, the uptake of wastewater reuse will be at a slower rate than in Australia.

Climatic and topographical variations in New Zealand may result in spatial differences in the uptake of effluent reuse, possibly with increased wastewater reuse occurring in areas such as Hawkes Bay, central and north Otago and south Canterbury. Increased reuse in these areas may take the form of smaller neighbourhood schemes to minimise the cost of transporting effluent in the areas with sparser populations.

Additionally the recent stance of the New Zealand Dairy Industry is likely to significantly affect the form of effluent reuse schemes in the future. As the dairy industry is a significant economic driver in New Zealand, it is likely that the acceptance of pasture based effluent reuse schemes will decline rapidly. This is likely to make way for more ingenious forms of effluent reuse.

References

Agroecology Research Group 1999. *Case Studies – Human Manure. Using Human Manure ("nightsoil") in the Tai Lake Region of China*. (www.agroecology.org/cases/nightsoil.htm, last updated 08/07/01)

Australian Bureau of Statistics (ABS) 2000a. *Australian Demographic Statistics, Cat. no. 3101.0.*

ABS 2000. *Water Account for Australia 1993-94 to 1996-97, Cat. No. 4610.0*

Burgin, Shelley (2001). *Changes in South Creek from a perspective of 20 years from today*. Centre for Integrated Catchment Management University of Western Sydney.

CH2M HILL Australia, 1999. *Environmental Impact Statement Priority Sewerage Program for Mulgoa, Wallacia and Silverdale*. Prepared for Sydney Water.

CH2M HILL Australia, 2000. *Environmental Impact Statement Tamworth Sewerage Augmentation and 100% Effluent Reuse Scheme*. Prepared for Tamworth City Council.

CH2M HILL Australia, 2001. *Environmental Impact Statement Illawarra Cogeneration Project.* Prepared for Duke Energy International.

CMPS&F, 1997. *Environmental Impact Statement Tamworth Sewerage Augmentation and Effluent Irrigation Scheme*. Prepared for Tamworth City Council.

Department of Land and Water Conservation (DLWC), 2000. *A Proposal for Updated and Consolidated Water Management Legislation for New South Wales: A White Paper.*

DLWC, 2000b. *NSW Water Conservation Strategy.*

DLWC, 2001. *Water Management Act - What it means for NSW.*

Department of Urban Affairs and Planning (DUAP) in press, *Employment and Journey to Work Patterns in the Greater Metropolitan Region-An Analysis of the 1996 Census Data.*

Department of Health, 1992. *Public Health Guidelines for the Safe Use of Sewage Wastewater and Sewage Sludge on Land.*

Environmental Protection Agency (EPA), 2001. *State of the Environment 2000*

Gunn, Ian 1998. *Water Reclamation and Reuse.* (unpublished paper)

Korenhof R, Potts R, Woods P, 1995. *Reclaimed Water Use on Public Parks – Both a Community Desire and a New Zealand First.* NZWWA Conference Paper 1995

Manidis Roberts Consultants, 1991. *Environmental Impact Statement for Proposed Rouse Hill Sewage Treatment Plant.* Rouse Hill Infrastructure Consortium.

Meteorological Service of New Zealand Ltd, 2002. *The Climate of New Zealand.* (Based on Meteorological Service of New Zealand Information Publication No. 15 – www.metservice.co.nz)

National Health and Medical Research Council, Australian and New Zealand Environment and Conservation Council and the Agriculture and Resource Management Council of Australia and New Zealand (November 2000). *Guidelines for Sewerage Systems - Use of Reclaimed Water.*

Statistics New Zealand, 2002. Environmental and Resource Management – Water Resources. (www.stats.govt.nz)

Sydney Water (2002). http://www.sydneywater.com.au

WCED 1987, Our Common Future, World Commission on Environment and Development, Oxford University Press, Oxford

Acknowledgements

The contribution of the following people is gratefully acknowledged:

Archer, H.	Beca Carter Hollings and Ferner Ltd, Christchurch
Barnett, Dr J.	Dairy Research Institute, New Zealand
Bryant, M.	Tamworth City Council
Campbell, A.	Beca Carter Hollings and Ferner Ltd, Auckland
Gunn, I	Auckland Uniservices Ltd, New Zealand
Jelley, G.	Tauranga District Council, New Zealand
Law, I.	CH2M HILL, Australia
McKay, T.	Sydney Water Corporation
Salisbury, R.	CH2M HILL, Australia
Shaw, S.	Duke Energy
Trevis, P.	Sydney Water Corporation
Walmsley, N.	Beca Carter Hollings and Ferner Ltd, Wellington
Watson, A.	Beca Carter Hollings and Ferner Ltd, Wellington