



Development of a New Framework and Methodology for Social Assessment of Recycled Water Schemes

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ABSTRACT

The framework and methodology for social assessment follows concepts based on integrated water management and technology as the holistic process. This study was initially undertaken through literature review, collection and analysis of actual data from areas where water reclamation scheme have been in operation. The data obtained helped with identification of information gaps and communication deficiencies. The social assessment of technology might create some controversies, especially over environmental and health impact associated with a long term use of recycled water. This concept also implies that scientific research should support public debate, allowing greater public evaluation of the scheme its implications and consequences. This study could confirm that social assessment of water reclamation and reuse is considered in broad context and it suffers institutional separation and differentiation from economy and technology. It is fair to assert that, political economy and technological research are seen to be quite different from social research and it is often considered in a largely interpret technology and environmental contexts.

Keywords: Framework and methodology; Social assessment; Recycled water scheme; Case study; Community participation management

1. INTRODUCTION

Implementation of water reclamation and reuse plans is no doubt a challenging task involving multidisciplinary expertise and adaptation of systemic approach based on the following aspects:

- Evaluation of current and future water resources an integrated scheme involving potable water, stormwater, sewage and recycled water
- Development of a long term water demand profiles taking into account demographic growth, climatic conditions,
- Planning for future infrastructure needs including customers and their water needs
- Identification of likely socio-economic impediments such as project funding, life cycle costing, price of water services, recycled water quality and level of human contact
- Consideration of stakeholders needs and role of public in the decision-making process
- Treatment technology used and method of recycled water delivery to customers ie dual water supply system, indirect potable reuse (river, dam, aquifer), or direct potable supply.

Over the centuries, water engineering practices related to design, development and operation of a bulk urban water supply

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schemes, have resulted in gaining significant public confidence, particularly in managing water quality and protection of public health. Although recycled water is not supplied in bulk on such scale (except for some commercial, industrial and agricultural purposes), there is no reason, why future plans would not include such possibility for urban residential areas. However, such move would require a dramatic shift in our current water infrastructure design and utilisation concepts. There are key fundamental components that shape community attitudes and satisfaction with recycled water use. These are evolving around the water economy and public health and safety, and they are closely related to the concept of bulk urban water reclamation:

- Costs of implementing high level wastewater treatment
- Cost of a separate additional pipeline (dual reticulation system)
- Public health concerns related to potential risk of cross contamination of potable water supply
- Public acceptance of planned potable reuse (indirect or direct)

While it should not be ignored the fact that there are alternatives to the bulk recycled water supply and direct human consumption need not be part of a comprehensive solution to enhance urban water resources, because only a small proportion of the water now consumed needs to be of potable quality.

The use of recycled water has been promoted under the banner of sustainable water management. Impetus for these policies has been provided by growing water scarcity driven by urban population growth and rising water consumption. One of the most popular arguments and justification for development of recycled water projects are based on the fact that public is expected to support unconditionally sustainability policies that involve:

- Conservation of water resources, particularly potable water, and
- Pollution control and environmental protection arising from wastewater generation

A paradoxical situation arises from the above statements, whereby the community is willingly and unconditionally embracing sustainability principles; however they don't directly benefit from any of the above. On the extreme, it is expected that they would cover the full cost of wastewater treatment and recycle water production which are often much higher than drinking water supply. At the same time, the water suppliers (state government agencies) benefit from deferral of major headwork and reduction of operating costs of wastewater disposal and potable water systems.

2. DECISION MAKERS CONFRONTING PUBLIC

One of the worrying features of the consideration over the future alternative water resources being either recycled water or desalinated sea water is that this is being introduced without the benefit of community consultation.

The community rejection of the proposal to use recycled sewage in the Towoomba water supply has led water authorities to precede such approaches to water without public plebiscite. Water-recycling plants are in operation, under construction or in advanced planning stages in Brisbane, Canberra and Sydney, for which there has been little or no independent research to explore the long-run health risks of such projects and no public discussion of them (Troy, 2008). In late 2006, NSW Government decided to construct a desalination plant to ensure a continuous supply of potable water. The key to this contentious decision making process was summarised by one of the leading newspapers

reporting that:

- “Plans for a desalination plant in Sydney have been released for public consultation.”
- “The decision to build the plant is final, says the minister.”

The above examples illustrate current climate for the decision making and the tokenistic nature of the participatory process, rather than open public consultation.

3. FRAMEWORK AND METHODOLOGY CONCEPT FOR SOCIAL ASSESSMENT

The framework and methodology for social assessment follows concepts based on integrated water management and technology as the holistic process. The social assessment might create some controversies, especially over environmental and health impact associated with a long term use of recycled water. This concept also implies that scientific research should support public debate, allowing greater public evaluation of the scheme its implications and consequences. Literature review confirms that social assessment of water reclamation and reuse is considered in broad context and it suffers institutional separation and differentiation from economy and technology. It is fair to assert that, political economy and technological research are seen to be quite different from social research and it is often considered in a largely interpret technology and environmental contexts. People have very strong links and interact very well with their environment socio-cultural, economic and biophysical surroundings. For these reasons they have strong links with a wide range of specialist issues that might result in positive or negative impact in one or all of the following:

- Health and safety

- Aesthetic
- Cultural and heritage
- Demographics
- Development impacts
- Economic and fiscal impacts
- Infrastructure
- Resource issues
- Leisure and tourism
- Political impacts (institutional, human rights, governance, democratisation etc.)

The objective of the social assessment is to ensure that development of water reclamation scheme maximises benefits (social, economic and environmental) and minimises impact in the same areas. It is important to identify impacts associated with water reclamation projects in advance. This would most certainly improve decisions, applying any necessary interventions and mitigation measures that can be implemented to minimise the harm and maximise the benefits from these projects. One of many reasons behind selecting this approach is to achieve practical outcome in a fair and undisruptive process and by overlaying social assessment over the technical, economic and environmental issues; there are better chances of a better understanding of the whole. The message is that social assessment of such issues has been long neglected but is emerging as a powerful contributor to policy analysis because it gives voice to matters that other disciplines and established policy processes have neglected (Dale et al., 2001).

4. KEYS TO SUCCESSFUL IMPLEMENTATION OF WATER REUSE

Designing and managing a participatory planning process for water recycling is not a simple or straightforward exercise and it requires a combination of specialised resources and techniques. In most situations public understanding of the issues surrounding water recycling project is poor and often does

not trust the sources but it continues to develop during participation process. The community has good capability to reach sound conclusions if given correct information from a trusted source. Fundamental to the successful practice of recycled water program are the following guiding principles:

a) Public health and recycled water safety.

The essential foundation for successful implementation of water reclamation projects is the capability of producing water of a desired quality to provide adequate public health protection and meet the environmental and socio-economic goals than can be practically achieved. Health risks associated with recycled water is judged by regulatory and health authorities (Toze, 2005). The Department of Health (DoH) through protocols, codes of practice and legislation, can maintain absolute power in deciding any issue in relation to recycled water supply. The community sees the role of DoH as an independent, expert, authoritative, competent and capable. The Department's role is to maintain this status in assessing risks, to maintain the role of guarding the public's health interests at all times and to directly communicating these issues to the public.

b) Public health and recycled water safety.

Like many activities in modern society the use of recycled water carries risks, which vary depending on the application and use of recycled water for non-potable application does not carry any direct health risk to humans. These concerns increase in the context of water reuse, where the pathway of potential exposure to humans is more direct. Protection of public health in water reclamation projects achieved by:

- Reducing or eliminating concentrations of pathogenic bacteria, parasites, and enteric viruses in the reclaimed water,
- Controlling chemical constituents in

reclaimed water, and/or

- Limiting public exposure (contact, inhalation, ingestion) to reclaimed water.

The quality of the recycled water is crucial to the health and safety of the community, and must not be compromised. Despite a long history of water reuse the question of acceptable safety of water reuse is broadly defined and delineation of acceptable health risks has been hotly debated. In addition to regulatory approaches, quantitative microbial risk assessments have been applied to provide a more rigorous assessment of health risks associated with various water reuse applications. Enteric viruses have received the most attention because of their low-dose infectivity, long-term survival in the environment, monitoring difficulties, and the limited extent of removal and inactivation that occurs in conventional wastewater treatment. The studies of health risks from water reuse concluded that no clear deleterious health risks have been observed (Falconer, 2007). The Australian Guidelines for Water Recycling: Managing Health and Environmental Risks (Phase 1) (NRMMC, 2006) outline a 12 step framework for the management of recycled water quality and use, recommending:

- Commitment to responsible use and management of recycled water quality with stakeholders such as the community;
- Assessment of the recycled water system, including hazard identification and risk assessment;
- Preventative measures for recycled water management, including the identification of critical control points and implementation of multiple barriers;
- Operational procedures and process control;
- Verification of recycled water quality and environmental performance;
- Protocols for management of incidents and emergencies;

- Operator, contractor and end user awareness and training;
- Community involvement and awareness and training;
- Validation, research and development;
- Documentation and reporting;
- Evaluation and audit; and
- Review and continuous improvement.

Public consultations about water recycling have occurred nationally and internationally for decades. Cross-national research into the experience of water reuse has been conducted by (Marks, 2002). Table 1 shows identified range of factors that commonly influence people's attitudes to recycled water use in the context of other common risk factors.

Studying public perception, decisions people make, behaviour, reluctance to change, is often a lag between 'rational' actions and emotional— a psychological rejection of recycled water as unclean or disgusting.

c) Treatment technology and system reliability.

There are many methods of wastewater treatment that can be successfully employed to produce any desired water quality for

residential, commercial, industrial, environmental and agricultural applications. As human contact with recycled water increases, further treatment methods become necessary. Despite high degree of available treatment, planned direct human consumption of recycled water will not be acceptable due to several social reasons. The fundamental principles for recycled water use should meet the following criteria:

- Recycled water quality should be safe and appropriate for intended use.
- Treatment process technology must ensure removal of chemical, microbiological or physical contaminants up to the level that does not cause any reasonable risk to the consumer
- Recycled water quality for food production should meet all necessary standards that are applicable to potable water sources.
- Recycled water quality assurance must incorporate process controls, management of operations, testing and monitoring protocols at critical stages of the treatment process and final product water quality.

Table 1 Public risk perception (adapted from Marks et al, 2002)

Perceived risk area	No. of people	Perception of high risk			
		None	Low	Mod	High
Air pollution caused by cars	260	0.4	12.7	43.8	43.1
Chemicals in drinking water	260	3.8	27.7	37.3	31.2
Misuse of chemicals and poisons in the home and garden	260	1.9	22.7	35.0	40.4
Germs in drinking water	260	4.6	31.9	29.6	33.8
Air pollution caused by industry	260	0.4	7.7	38.8	53.1
Food additives	260	2.3	30.4	43.8	23.5
Pesticides and chemicals used in farming	259	1.2	22.0	42.1	34.7
Recycled water supplied at the Sydney Olympic Park	260	30.8	56.2	10.4	2.7
Pollution of Australia's rivers, lakes and streams	260	1.9	23.8	43.5	30.8
A rise in the world's temperature caused by the GHG effect	260	3.5	15.4	37.3	43.8
Genetically modified food	260	6.2	36.5	34.6	22.7

- Recycled water risk assessment should take into account treatment technology, recycled water quality, the likelihood of exposure, dose response and ratio of infection to illness.
- The frequency of monitoring and testing shall be determined by reliability of the treatment process and recycled water applications.

Awareness of trace contaminants is leading to adoption of multiple barriers with highly advanced treatment processes such as reverse osmosis (RO). Implementation of multiple barrier treatment processes is the foundation of safe water recycling programs. System reliability relies on performance of the whole process and incorporates some degree of redundancy without compromising quality of the final product. Reliability depends on several elements such as; mechanical and electrical components, water quality monitoring, effective process operation, recycled water distribution and supply. In fact scheme reliability applies to the entire process operation, however it could be best ensured where effective controls can be applied to manage risk of the final product or recycled water quality. The multiple barriers used in recycled water scheme include application of:

- Membrane filtration techniques: microfiltration (0.2 micron), ultrafiltration (0.04 micron), reverse osmosis (0.0001 micron).
- Ultraviolet Light Disinfection
- Sodium Hypochlorite (chlorine) disinfection

The multiple -barrier treatment processes are designed to minimise or almost eliminate presence of any contamination in recycled water. The regular water quality monitoring and testing facilitates any necessary intervention, but improves confidence, stability and consistency of the process.

d) Research science and knowledge sharing.

Scientific knowledge and expertise underpins decisions, selection of options and the information contained within national and international guidelines developed by various scientific institutions. The relation between scientific knowledge and community lays in providing independent advice and understanding regarding various aspects of water reclamation e.g. health aspect, technical capability, environmental and economic impact, etc. While scientists apply academic theories to various scale experiments, properly designed research programs, systematic investigation, measures and test are the major factors that govern people's decisions and whether to accept or reject the scheme. Researches also provide invaluable scientific predictions, actual data, targets and input to water planners, policy and decision makers that can be used to address complex community concerns.

e) Costs and benefits of wastewater reuse.

The reuse of treated wastewater and stormwater is definitely an expensive process to procure non-conventional water resource, but only if considered outside the urban water cycle and environmental context. This scenario improves dramatically when all tangible and intangible elements are included in cost-benefits equilibrium; such as costs offsets for major water and wastewater headwork, conservation of natural water resources, pollution elimination and environmental protection, etc. While financial analyses are important and useful, they provide too limited context with which to evaluate the social benefits of a project. This is because a financial analysis focuses strictly on revenue and cost streams internal to the water agency, and these cash flows are not the same as the true worth or value of most water reuse or desalinization projects to the community as a whole.

f) Recycled water price. Along with water quality, recycled water pricing is one of the most controversial, yet important factors for the decision-makers and community. Both these issues are resolved without community involvement during planning, implementation and operation. Information on community attitudes towards recycled water price is inconclusive. This is probably influenced by the current lack of transparency and consistency in water pricing and recycled water in particular. So far pricing decisions seem to be based on political decisions rather than sound economic principles.

Customers do not really understand how water prices are determined; rarely do they know the unit price per kL of water, the volume of water they consume, the make-up of water bill, etc. Community does have minimal influence on government's decisions regarding price setting process. Consequently any research on community willingness to pay for recycled water or community attitudes towards pricing is futile.

The dominant precedence has been set for the price of recycled water to be lower than drinking water irrespective of actual production costs. Studies of water pricing in Australia reveal great range of social issue and principles that directly influence price setting process and rationale behind. Pricing structure is inconsistent and is mostly resulting from combination of issues listed below:

- Poor understanding of the project economic structure;
- An improper costs allocation often resulting in substantial discrepancy between the costs of the same or essentially similar product;
- Prices are determined in relation to drinking water price;
- Neither recycled or potable water prices are established to reflect actual cost;
- Price mechanism are regularly applied to manage demand and encourage water savings, e.g. step pricing;
- Recycled water pricing is sometime set lower to encourage customers to use it;
- Price setting, especially for potable water and sewage disposal, is usually determined arbitrary by recommendation from Water Authorities. Water authorities are bound to pay regular dividends to government to cross subsidize other portfolios;
- Recycled water costs (capital and operating costs) are reported high and pricing is done in complete isolation of savings and benefits e.g. tangible avoided costs from reduced sewage flows and meeting potable water demands;
- Access and sewer mining is generally permitted by any water authority, however none of the collected sewer charges and savings are made available to recycled water plant operators;
- Recycled water schemes should not compete economically with potable water supply;
- Water pricing system is based primarily on volumetric and a fixed charge for a base volume; and
- Price of sewage disposal paid by households is fixed by water authority and is based on percentage of water used (discharge factor) and property value and includes no incentive to limit disposal.

For example, reported production costs of recycled water could vary between projects from as little as \$0.50/kL (Booker, 2000) to \$1.45, \$3 or even \$4.00/kL (Radcliffe, 2004). Table 2 (Moran, 2008) lists the known costs of recycled water schemes around Australia and indicates that none of the currently operating water reclamation schemes apply full cost recovery mechanisms, or integrated water pricing structure including savings and benefits to recycled water supply.

Table 2 Cost of recycled water in Australia (Moran, 2008)

Location	Use of recycled water	Cost estimate (\$/kL)
Western Sydney Recycled Water Initiative	Environmental flow replacement, residential & agriculture	\$5.80
Rouse Hill, NSW	Residential	\$3.00-\$4.00
Melbourne Eastern , STP		>\$3.00
Sydney Water Indirect Potable Reuse	Indirect Potable	\$2.23-2.61
Sydney Olympic Park	Residential	(O&M costs only) \$1.60
Redcliffe City opportunities, QLD	Irrigation and Residential	\$2.50
Springfield, QLD (existing)	Residential	\$1.45
SA opportunities	Industrial and municipal	\$1.40
High quality industrial water	Industrial	\$0.85 - \$1.40
Redcliffe City opportunities, QLD	Irrigation	\$0.80
Logan City opportunities, QLD	Parks and gardens	\$0.80
Toowoomba opportunities, QLD	Agriculture	\$0.45
Some rural and regional towns	Golf Courses and Parks	Least cost disposal option

For comparison purposes, potable water price charged by Sydney Water in 2010/11 is set at \$2.01 and the price of raw water supplied by Sydney Catchment Authority is 56 cents a kilolitre. In a survey of residents who were living in a dual supply development, NRMCC (2006) reported that the majority of people expected to pay less for using recycled water because of the water quality and certain limitations on use. People generally consider recycled water to be of lower quality than drinking water and therefore expect to pay less.

Are people prepared to pay a price that reflects the full costs of recycled water supply? In order to answer this question it is imperative to establish what these costs are in the first place. The goal of any pricing policy for recycled water should be long term sustainability of total water supply. That is, the future supply of water (both fresh and recycled) must be sufficient to meet the needs of a growing population. The proposal builds on the objective of sustainability but includes market forces, community co-operation, and price signals, in the mix of controls to achieve the

desired outcomes. Three ways water supplies can be made sustainable are by: (i) reducing demand; (ii) increased recycling; and (iii) continuing to increase primary supply through desalination.

Role of Media in Engaging the Community. The mass media is recognised as a pivotal tool for the building and mobilisation of public opinion. The print media, in particular, plays a significant role in introducing issues and shaping their importance in public consciousness. There is a need to create a broad-based media platform to address the concept of sustainable development and related issues in a comprehensive and dedicated manner. It is important to engage national media (TV, radio, press) and professional organizations in supporting national water reuse agenda and to provide positive, constructive and informative coverage on urban water management. Showcase, emphasize and encourage urban water reuse schemes and water initiatives across the country.

CONCLUSIONS

- Successful implementation and management of water reclamation scheme or public infrastructure project are strongly dependent on the involvement and collaboration between government, private sector organisations and communities.
- Key considerations for gaining public acceptance include: (i) effective communication and provision of information, (ii) trust in water Authority, (iii) value of public survey, (iv) risk identification and management, and (v) concerns over potential effects of trace contaminants in reclaimed water and minimize the potential risk to public health.
- Participatory approach to planning of water reclamation schemes is a learning process for all.
- Traditional education programs identify community as a target to learn about treatment technology, risk and operational management, and a range of other economic and environmental issues. Developers and managers would also need to learn from the community (landscapers, builders, irrigators, residents, industrial process operators, water managers, etc.) about water as a product; its applications, where is used, when is used and how much is used.
- Commitment to openness and transparency is a fundamental prerequisite to effective communications about water recycling projects. There is a need for government, community, scientists and the water industry professionals to embark on comprehensive programs comprising awareness, attitudes and perceptions management.

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