The economics of ocean outfalls and wastewater in Australia: A dog's breakfast?

Dr Boyd Blackwell[1]

1 National Centre for the Marine Environment, Australian Maritime College, PO Box 2276, Rosebud, Victoria, 3939, b.blackwell@amc.edu.au

Abstract

Much has been achieved in Australia since the release of the Hilmer (Hilmer *et al.* 1993) report in 1993, especially in the recent decade with water reform. Prices are beginning to reflect full costs of supply. Water entitlements are now tradeable instruments across the country. The same engagement of the reform agenda can not be said for urban waste water and ocean outfalls. Much of urban water conservation relies on prohibition or regulation.

This paper presents a theoretical framework for analysing the re-use and disposal of waste water in urban communities in Australia. Many of these communities, especially all the state capitals, rely on ocean outfalls to dispose of their waste water. The framework takes a broad view of the value of recycling water and helps to analyse why the market for recycling fails. The reasons are classic. Prices for water use do not reflect their full cost. Externalities are not internalised. Services are monopolised where natural monopoly theory is questionable. Much can be done to reform urban water use, the creation of waste water and its disposal. This paper provides a starting point for a way forward.

Key Words

Ocean outfalls, water re-use, urban water reform, recycled water, waste water

JEL Codes

Q25, Q53, Q57, I18, D42

Introduction

Water supplies, use and waste discharge are issues that have historically driven many political arrangements at local, regional and international scales. Water supplies in Australia are becoming scarce and waste water use is likely to become more viable if the full economic costs of water use are taken into consideration. Similarly, the use of ocean outfalls for waste water discharge is a contentious issue at all levels, with numerous examples of decisions concerning placement, use and changing use patterns being driven by political interests rather than broad social, economic, biological and environmental understanding.

Wastewater ocean outfalls have considerable impacts on the marine and coastal environment, especially for humans (health, psychological and ethical). How these impacts translate into economic and monetary values is a key question asked by this paper. Given the current drought and changing climate, waste water re-use is a pressing national and international issue.

Ocean outfalls dissipate high volumes of water in terms of domestic use. The dissipation rates, as reported by the Clean Ocean Foundation (2007) website, for some of the following sites are:

- The Gunnamatta outfall on the Mornington Peninsula, Victoria, 360ML/day (360,000,000 l/day);
- The Long Bay outfall in Sydney, 490ML/day; and

- Luggage Point in Brisbane, 190 ML/day.

By considering the wider social issues of :

- lost beach recreation;
- lost human health (ear infections, sickness etc.);
- lost marine and coastal habitats;
- psychological and ethical guilt aspects; and
- water re-use options,

within a social-economic framework, it may be sufficient to 'tip the scales' and warrant an outfall's closure. The research which develops from this paper is expected to provide strategic knowledge with substantial public policy implications for ocean outfalls, desalinisation plants, water re-use and coastal management in Australia and overseas.

Brief Literature Review

There is a paucity of specific literature in the field of lost beach and coastal foreshore values from outfalls. There is literature on the value of beach recreation in the United States (Bell and Leeworthy 1986) and from water quality improvements (Strand *et al.* 1985, Smith and Desvouges 1986, Bosckstael *et al.* 1989) and more recently in Australia in the estuary environment (Rolfe and Windle 2005). Blackwell (2007) makes a contribution to values for beach recreation in Australia.

The social cost benefit framework along with its limitations is well documented in the literature (Mishan 1972, 1998; Hanley and Spash 1993; Sinden and Thampapillai 1995; Department of Finance and Administration 2006).

Much of the indirect economic literature on waste water outfalls is provided as policy documents via various levels of government. For example, specifically in regard to ocean outfalls, there is the work conducted by various jurisdictions on the external costs (and benefits) associated with water use (NWC 2006a).

Waste Water Outfalls and Re-use: Benefits and Costs

The intention of the research to flow from this paper is that it may fill a knowledge gap in terms of identifying and estimating non-pecuniary negative externalities[1] caused from releasing waste water to coastal waters. Direct external costs may be borne by:

- recreational beach or coastal foreshore users (through smell and discolouration of the water and potential adverse health impacts) including lost tourism values (marine and coastal dependent businesses);
- ecosystems through ecological and biophysical impacts at the site of the outfall;
- society in general through social and cultural impacts (including the psychological impacts of breaching common ethical considerations from dumping waste into coastal waters); and
- property owners in the nearby vicinity of the outfall.

These direct external costs represent the forgone benefits from treating, re-using or recycling the waste water. Similarly, a number of indirect external costs from releasing waste water into coastal waters exist and these may be viewed as forgone benefits of re-using the water. Such indirect benefits include:

- extra water being available for the environment or other commercial, rural, residential and industrial uses through less take being required from regulated[2] or unregulated systems;

[1] A non-pecuniary external diseconomy or negative externality exists where a cost caused by one party is borne on a bystander and that cost is not taken into account in the first party's decision making.

- postponement of further infrastructure development and associated environmental costs; and
- possibilities of addressing saltwater intrusion issues and depleted coastal aquifer systems with recycled and treated waste water.

This paper proposes for future research to estimate the likely direct and indirect benefits from using or recycling the water at designated sites. Often these benefits are not readily quantified given their public good characteristics. Public goods typically exhibit non-rivalry, indivisibility and or non-excludability which means that the standard market forces such as correct pricing are not available to convey needed information to market participants. This means the market fails in providing the socially optimal level of output at the socially optimal price.

Demand for recycled water may exist at particular test sites for:

- human consumption;
- industry, agricultural and business use (e.g. some businesses already use water from the South Eastern pipeline and the Werribee Treatment Plant near Melbourne in Victoria);
- dealing with salt water intrusion and aquifer depletion;
- reducing water quality impacts for recreation, tourism, views, smells and possibly land values;
- ameliorating ecological impacts;
- reducing human health impacts;
- addressing psychological impacts for people whom create waste knowing that their waste water is adversely impacting on a coastal community or environment. Ethically many people may think this is wrong; and
- reducing waste and inefficiency of water use.

Of course recycling water comes at a substantial cost. However, a key question arising from this paper is: '*Do the public (and private) benefits from recycling surpass the costs*.' This research to be developed from this paper will attempt to quantify the externalities from changes in the quality and quantity of waste water outfall and the ability to use pricing as a mechanism to internalize these externalities in decisions over water use, waste water creation, disposal and reuse. In fact, the final report of the Productivity Commission (2006c) indicates:

> Using administrative arrangements to allocate water for environmental purposes conceals the opportunity cost of meeting environmental targets. Market mechanisms are usually a more efficient means of re-allocating resources.

As Quiggin (2006) and the Productivity Commission (2006c) have identified, using a consistent policy stance across jurisdictions and being careful to account for location and scale is likely to result in better outcomes for water use and the environment.

Significance and Innovation

Given the current drought and changing climate, waste water re-use is a pressing national and international issue. Winners and losers having much at stake in a given decision over an outfall, water reuse or alternative sources of supply. Every state and territory except the ACT has ocean waste water outfalls. The outfall of waste water into the ocean and coastal environment does not fit within the current scope of state water regulation. For example in Queensland the Department of Natural Resources and Waters' jurisdiction under the Water Act 2000 ends at the tidal limit. In the case of ocean outfalls, the nexus between water use and waste water creation is broken at the tidal limit and picked up by the Environmental Protection Agency. To bridge this nexus, state legislation needs to connect externalities with their original source. Outfalls and their legislative disconnect are currently missing from the purview of water reform policy.

[2] Some jurisdictions such as Queensland refer to regulated systems as *supplemented*: meaning that the flows are supplemented through the use of water infrastructure such as dams, barrages and weirs as apposed to the flow of the water body being regulated through the use of such structures.

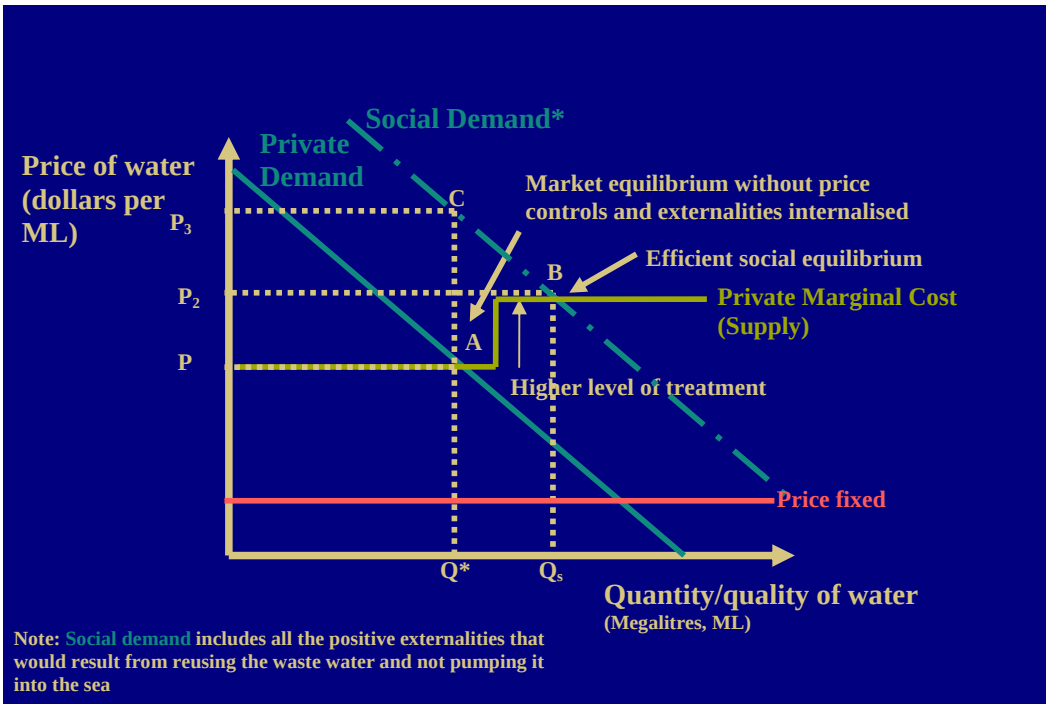
The research flowing from this paper is intended to deliver strategic economic information on the public benefits of reducing ocean outfall for re-use helping to advance change and better practice in Australian water management. The assessment of the public benefits will entail the use of state of the art economic valuation methods such as choice modelling, double bounded dichotomous choice contingent valuation, the individual travel cost method, and the hedonic pricing methods. By using scoping and pilot applications these methods will be fine tuned, and developments in their methodologies possibly achieved drawing on expert experience, both domestically and internationally from the field of environmental and non-market valuation (e.g. drawing on the domestic work of Blackwell 2003 and Rolfe and Windle 2005 and the work being conducted in the USA by the National Oceanic and Atmospheric Administration on water quality benefits, and valuation of coastal resources: <http://marineeconomics.noaa.gov/>. In addition, the ability to transfer estimates obtained from these methods at one site to other sites will be assessed and undertaken where conditions are suitable. Value transfer represents an innovative way to reduce the cost of the valuation exercise.

The research will also consider the policy implications of market based instruments to capture the public benefits of reduced ocean outfall. In the absence of a flexible pricing regime, the price elasticity of demand for water and waste water re-use is likely to be relatively low given prices for urban and rural water do not reflect scarcity. Thus, a tradable certificates arrangement may be better placed than using price to correct for these lost public benefits. For example, Hoffmann et al. (2004) found that the price elasticity of demand for urban water in Brisbane over the long and short term was relatively inelastic. While the price elasticity in Brisbane was found to be inelastic it was more elastic than the empirical evidence from others state capitals.

Conceptual Framework

The conceptual framework for this paper involves the use of a social economic framework taking account of the social costs and benefits of ocean outfalls and desalinisation plants. Figure 1 helps to analyse some of the alarming issues associated with the economics of ocean wastewater outfalls. The figure depicts the demand and supply for recycled water.

Figure 1: Demand and Supply for Recycled Water



In Figure 1 the private marginal cost or supply curve is given by the yellow kinked line. The kink in the line indicates that a higher level of treatment is required of current waste water for it to be recycled and reused. This higher level of treatment comes at a cost with additional plant and infrastructure and hence the kink in the curve. There is a change in total costs in order to provide additional recycled water but beyond this point there is capacity within the new plant to produce more water with minimal change in marginal costs. This is similar to bringing on additional power plants which run at a higher marginal cost as overall demand for power rises. The higher level of treatment allows a higher level of social demand to be achieved with an efficient social equilibrium at point B versus the current 'market' equilibrium at A. The amount of water recycled increases from Q* to Qs and the socially desirable price is P_2 which is higher than the current 'market' price of P or a government imposed essential service price as depicted by the pink line. The diagram also indicates that current levels of recycling are valued at P_3 in a social sense, higher than current values revealed in the 'market' by P. The difference from P_3 to P represents the external benefits from water recycling at the quantity of output Q*.

Why doesn't demand reflect the preferences of society?
Non-pecuniary external costs or diseconomies[3] of pumping water out to sea are dispersed and shared by many.

- It is difficult to link sickness in individuals to taking a beach visit and being contaminated by the ocean outfall.
- It is difficult for all those affected in society to get together to take action. The existence of a non government organizations such as the Clean Ocean Foundation and its struggle for survival provides evidence of this.
- While each of us, through the state, share the coastal waters and its ecology and resources, we don't necessarily see it as directly impacting on our hip pocket and we personally are not directly responsible.
- Nor is the damage that is done to the environment immediately obvious because the damage is below or in the water, at sites with restricted access.
- The members of the society impacted by the outfall don't charge (one that is commensurate with the externalities created) the service provider for dumping the waste water in their local sea (because the service provider has a permit to do so) and water users (the creators of waste water) are not then on-charged for the external costs of disposal at sea.
- The damage done to tourism, beach recreation and property values is not obvious nor has it been assessed. Assessment entails 'what if', which has a degree of uncertainty. A key research aim is to help assess the likely damages.
- The benefits from reusing the water are also dispersed. For example, treated water may be used to address salt water intrusion resulting from depleted coastal aquifers. As stated by NWC (2006, p. 8), there is need to better understand and manage Australia's groundwater systems and their 'connectivity' with surface water systems. While one user may see the aquifer as providing ample supply another may see their supply depleted substantially. Free access to a common property resource is likely to result in 'Tragedy of the Commons' (Hardin 1968) and because many coastal aquifers are accessible free of charge, use is not metered and is not reflective of the full costs. Further, aquifers can be replenished over time but at a relatively slow rate. Replenishment of aquifer may help in the long run in addressing salt water intrusion of coastal lands. In addition, typically ground water systems are managed by different agencies to the agencies that manage ocean outfall and waste water treatment. Therefore, agencies may not benefit financially from attempting to take account of external benefits from changing their business because of the non-excludable nature of these benefits.

[3] The general treatment of externalities is drawn from Tietenberg (2006) but the application is from the author's own experience and knowledge.

Why doesn't supply respond to demand?
The waste water service provider is typically a government owned or authorised monopoly (GOM) (the only provider) and is not exposed to market forces to respond to industry, agriculture and society's willingness to pay for recycled water (nor the associated external benefits).

- The GOM has no competitors.
- Prices for waste water treatment are typically set by government, usually reflecting cost of supply (but not demand conditions).
- Also, the GOM's accounts do not reflect any lost positive externalities from the ocean outfalls because these are external to their business.
- GOM's are established based on natural monopoly theory but this may be flawed in practice. For example, Saal and Parker (2000) found that the amalgamated Water and Sewerage Companies (WASC) of England and Wales was not displaying economics of scope between water and sewerage services. The Office of Water Services (OFWAT, 2004) discusses the implementation of competitive delivery of water services in England where competing companies share networks similar to that provided in the telephone communication sector.

Design and Methods
The research to flow from this paper will use non-market valuation methods to ascertain:

- lost values for beach recreation;
- health affects for humans;
- property value impacts using hedonic pricing from market values; and
- psychological and associated guilt impacts by attempting to transfer these concerns to monetary values.

The psychological impacts from knowing one contributes to an environmental or social wrong, as far as the author is aware, has not yet been translated into monetary economic values. The role of non-market valuation in revealing psychological impacts including ethical wrongs involved in economic tradeoffs will be a major line of inquiry in this research with the intention of driving public policy.

With the use of non-market valuation methods an appropriate survey instrument will be developed for users and non-users in relation to specific outfall sites in three states in Australia. Focus groups will be used in the design of an appropriate survey instrument. A pilot or pre-test will be undertaken to further refine the instrument. Data obtained from the survey will be collated, summarised, described and analysed. The analysis will include the estimation of welfare measures in order to provide initial estimates for some of the lost values for the population of users and non-users of outfall sites.

Conclusion

Ocean waste water outfalls provide local state and Commonwealth agencies with a key opportunity to reduce a significant social ill and at the same time create social and private goods. Water supplies in all Australian capital cities are scarce. By taking account of the benefits to society, including those to the market from reducing waste water outfalls, decisions over the amount and location of outfalls may be changed for the better. The social benefits of doing so in terms of improved health of community members and raised psychological and ethical wellbeing may be substantial. The ecological benefits may also be large. Improvements in the biophysical environment are likely to have spill-overs into our recreation and tourism sectors. All Australians have much to gain from thinking more smartly, from a broad social economic framework, about how we use our water, create waste water and dispose of it.

References

Bell, F.W. & Leeworthy, V.R. (1986) *An Economic Analysis of the Importance of Saltwater Beaches in Florida*, Florida Sea Grant College, February, Report No. 82, The University of Florida, Gainesville.

Blackwell, B.D. (2007) The Value of Beach Recreation: An Application to Mooloolaba Beach and Comparisons with Other Outdoor Recreation Sites, Paper submitted to *Economic Analysis and Policy*.

Blackwell, B.D. (2003) The Economics of Coastal Foreshore and Beach Management: Use, Safe Bathing Services, Erosion and Conservation, PhD Thesis, School of Economics, The University of Queensland, Brisbane.

Bockstael, N.E., McConnel, K.E. and Strand, I.E. (1989) "Measuring benefits from improvement in water: The Chesapeake Bay', *Marine Resource Economics*, Vol. 6, pp. 1-18.

Clean Ocean Foundation (2007) www.cleanocean.org.au, viewed 16 May.

Department of Finance and Administration (2006) *Handbook of Cost-Benefit Analysis*, Financial Management Reference Material No. 6, AGPS, Canberra. Also available as at 30 May 2007 from: www.finance.gov.au

Hanley, N. and Spash, C.L. (1993) *Cost-Benefit Analysis and the Environment*, Edward Elgar, Aldershot, Hants, England.

Hardin, G. (1968) 'The tragedy of the commons', *Science*, vol. 162. pp. 1243-1248.

Hoffmann, Mark, Worthington, Andrew and Higgs, Helen (2005) 'Modeling residential water demand with fixed volumetric charging in a large urban municipality: The case of Brisbane, Australia', *Discussion Papers in Economics, Finance and International Competitiveness*, June, No. 196, School of Economics and Finance, Queensland University of Technology, Brisbane. Also available as at 6 September 2006 from: http://www.bus.qut.edu.au/schools/economics/research/disc_pre2001.jsp

Mishan, E.J.(1988) *Cost Benefit Analysis: An Informal Introduction*, 4th Edn, Unwin Hyman, Boston.

Mishan, E.J. (1972) 'The futility of Pareto-efficient distributions', *American Economic Review*, December vol. 62, no. 5, pp. 971-6.

National Water Commission (NWC) (2006) *2005 National Competition Policy Water Reform Assessment*, NWC, Canberra. Also available as at 30 August 2006 from: www.nwc.gov.au

Office of Water Services (OFWAT) (2004) Greater Competition in the Water Industry Moves Closer, 18 October, PN 41/04, OFWAT, Birmingham, UK and available as at 12 April 2005 from: www.ofwat.gov.uk

Productivity Commission (2006c) 'Rural Water Use and the Environment: The Role of Market Mechanisms: Key Points', August, Productivity Commission, Melbourne, available as at 30 August 2006 from: http://www.pc.gov.au/study/waterstudy/finalreport/keypoints.html

Quiggin, J. (2006) *Water Reform in Australia: Strengths and Limitations of Market Based Mechanisms*, Submission to the Productivity Commission research study, Rural Water Use and the Environment: The Role of Market Mechanisms, University of Queensland, Brisbane. Also available as at 30 August 2006 from: http://www.pc.gov.au/study/waterstudy/index.html

Rolfe, J. & Windle, J. (2005) 'Valuing options for reserve water in the Fitzroy Basin', The *Australian Journal of Agricultural and Resource Economics*, vol. 49, no. 1, pp. 91-114.

Saal, D. and Parker, D. (2000) 'The impact of privatization and regulation on the water and sewerage industry in England and Wales: A translog cost function model', *Managerial and Decision Economics*, vol. 21, pp. 253-268.

Smith, V.K. and Desvouges, W.H. (1986) *Measuring Water Quality Benefits*, Khuwer-Nijhoff, Boston.

Tietenberg, T. (2006) *Environmental and Natural Resource Economics*, 7th edn, Sydney, Pearson Education.