

**National Water Commission Project**  
**Developing Future Directions for**  
**Australia's Urban Water Sector**

**Independent Review of**  
**Topic 5: Legal Frameworks &**  
**Property Rights**

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## EXECUTIVE SUMMARY

This paper reviews the two assessment reports prepared for Topic 5: Legal Frameworks and Property Rights, of the National Water Commission ('Commission' or 'NWC') project "Developing Future Directions for Australia's Urban Water Sector" ('Urban Water Project'). The two assessment reports and the reviewer's appraisal of them are summarised as follows:

### ***"Legal Frameworks and Property Rights" by D. E. Fisher***

D. E. Fisher is a professor of Law at Queensland University of Technology and the author of several books on environmental law and water law. His assessment report ('Fisher') describes the status of water law in Australia as it relates to urban water and suggests some directions for extending and reforming that law. It is a purely legal analysis, with no economic and little policy content; for example, there is no mention of such things as unbundling or third-party access or competition (other than one incongruous reference to "a competitive governance structure"). The two main themes (in addition to "sustainability", which is mentioned many times but not discussed substantively) in Fisher seem to be that none of the States (read 'States and Territories') has: (1) implemented urban "tradeable delivery entitlements" ('TDEs' in this review), even though (according to Fisher) these are contemplated or maybe even required by the Commonwealth Water Act of 2007 ('Act') and the National Water Initiative ('NWI'); or (2) given end users a legally enforceable right to be supplied, relying instead on a supplier's duty or obligation to supply end users. Fisher concludes with several long lists of things the law should define better and questions it should answer, but never explains what problems have been, are now being or might someday be caused by any of the many perceived gaps in the laws, or just how these gaps should be filled.

### ***"Review of Urban Water Entitlements in Australia" by Frontier Economics***

Frontier Economics is an international economic consultancy. Because this assessment report ('Frontier') was written in 2008 for the Joint Steering Committee for Water Sensitive Cities, which is part of the NWC/NWI program, the Commission and the NWI community should be familiar with its conclusions. It is a comprehensive assessment of the status of and potential for entitlements in various parts of the urban water cycle. It concludes that there are gaps in the legal definition of entitlements throughout the urban water cycle in Australia, but these may not be causing real problems and should be filled only where and when they are doing so. Furthermore, the primary objective in defining entitlements should be to reduce investment risks and increase efficiency, not to facilitate entitlement trading *per se*. In particular, TDEs (called 'tradeable end user entitlements' in Frontier) are unlikely to be cost-effective for urban potable water; "greater net gains" are likely to be achieved with "other market-based options, such as more efficient pricing". These conclusions and recommendations are strikingly at odds with those in Fisher – but strikingly similar to the views of this reviewer/economist.

These two assessment reports could hardly be more different in approach, style or conclusions, but together they raise questions about the role of urban entitlements in general and TDEs in particular. The success in Australia of tradeable rural water entitlements has created something of a fixation on tradeable entitlements, almost to the exclusion of other options. Because this reviewer shares Frontier's view that tradeable entitlements are not likely to be useful in urban water, this review discusses, in much more depth than called for by Market Reform's remit from the Commission, what rural tradeable entitlements really are and why they work, why tradeable delivery entitlements in urban water will not work, and

how a more promising approach to trading and markets based on source entitlements and efficient pricing might work.

The rural tradeable water entitlements that are widely regarded as successful in Australia are rights to take irrigation water directly from a source, usually a river, with little or no delivery system involved. Such rural water rights are called here tradeable source entitlements ('TSEs'), to distinguish them from the urban TDEs that are contemplated by policy and (according to Fisher) law in Australia. There does not seem to be a generally-accepted definition of a TDE, but this reviewer defines a TDE as an end user's contractual (or perhaps legislated) right to a supply of water with essentially the same quality, reliability and price characteristics of the water supply it gets now, but in a tradeable form.

While a rural entitlement is a simple right to source/river water, a delivery entitlement on any of the larger and more complex urban water systems that serve most of the Australian population – called here 'metro' systems to distinguish them from the smaller, simpler urban systems that serve regional towns – would be a complex and location-specific bundle of entitlements to water from several sources and to the services of many parts of a complex delivery system. This review discusses the conceptual and practical issues involved in making such a delivery entitlement tradeable on a metro water system, and concludes that such TDEs would probably not be workable in any useful sense and would surely not be the best solution to any problem in urban water. If Australian law is interpreted to require urban TDEs, the law or its interpretation should be changed.

A metro water market based on TDEs is not practical, but a market based on source entitlements combined with a way to convert source water into delivered water might be. The source entitlements could be rights to a share of natural water flows, e.g., the rural TSEs that have resulted in a lot of trading because there is no delivery system to worry about, or the Melbourne Bulk Entitlements ('BEs') that have resulted in no trading because there is a complex delivery system involved and no known way to manage it except to let Melbourne Water do essentially what it has always done. Source rights could be long-term contractual rights to desalinated ('desal') or other manufactured water, or short-term rights to rural water, or something else. The only requirement is that the source rights clearly define who should be credited with source water when and where it enters the metro water network.

Source rights should be transferable over time, to accommodate new entrants and other long-term changes in market structure, but need not be standardised or easily tradeable – as long as the water commodity itself can be easily traded on the network. The key to efficient trading and pricing of any network commodity, whether electricity or gas or metro water, is a market integrated with the processes that plan and implement physical operations on the network. For a metro water system, with its long-term storage and need to plan operations at least a year in advance, the most logical and practical approach is to integrate the market with the annual planning process.

This review describes how a market might be integrated with the annual planning and scheduling process on a metro water system, using Melbourne Water's Annual Operating Plan ('AOP') process as an example. The water prices produced by such an 'AOP Market'<sup>1</sup>

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<sup>1</sup> The concept of an AOP Market was first developed and proposed in "A Water Market for Melbourne: Exploring the Concept", a paper and series of presentations prepared by Market Reform and Farrier Swier Consulting in early 2009 as a contribution to the policy discussion of urban water markets in Australia and elsewhere.

would be the same everywhere over the entire water year if none of the modelled network constraints are binding and there are no surprises, but when the network is congested and/or expectations change during the year the prices could – and should – vary with time and location. A retailer or large water user (‘RoLU’) could use these prices to convert its source water into delivered water, which would make real trading possible in (e.g.) Melbourne. Such prices could also be used as reference prices in simple financial contracts to accomplish things that are not practical otherwise, such as giving each individual end user on the same network the level of supply security it wants (and pays for).

The bottom line recommendation of this review is that the Commission’s Urban Water Project should move the conversation about urban water beyond tradeable entitlements and focus on the development of markets in *water*, not markets in *rights to water*. Both economic logic and experience in other network markets, particularly electricity and (in Victoria) gas, suggest that the key to efficient trading and pricing on a network is a centralised market integrated with a network model and operations. Such an approach is certainly necessary if trading, and even efficient pricing, is ever to become a reality on a metro/urban water system; it might even be the best approach in those rural areas where tradeable source entitlements alone have proven inadequate because of complex hydrology and linkages between ground water and surface water.

## 1. INTRODUCTION

The Australian Government National Water Commission ('Commission' or 'NWC') has initiated a project entitled *Developing Future Directions for Australia's Urban Water Sector* ('Urban Water Project') to help it advise governments on the implementation of the National Water Initiative ('NWI'). As part of its Urban Water Project, the Commission identified fifteen topics relevant to the urban water sector, invited specific water sector experts to prepare assessment reports on each topic and commissioned independent reviews of these assessment reports. This paper is an independent review of the assessment reports prepared for the Commission's Topic 5: Legal Frameworks and Property Rights.

## 2. SUMMARY OF THE ASSESSMENT REPORTS

The Commission provided two assessment reports for Topic 5:

- "Legal Frameworks and Property Rights", by D. E. Fisher
- "Review of Urban Water Entitlements in Australia", by Frontier Economics

These two assessment reports are briefly summarised in this Section 2. Section 3 discusses the issues raised by the reports that seem to this reviewer most relevant to the Commission's Urban Water Project: the relative value of tradeable entitlements and efficient pricing as a way to introduce competitive market forces in the urban water sector, and how such efficient pricing might be accomplished – which requires some form of urban water market.

### 2.1. "Legal Frameworks and Property Rights", by D. E. Fisher

D. E. Fisher is Professor of Law at Queensland University of Technology and the author of several books on environmental law and water law. His assessment report ('Fisher') describes the status of water law in Australia as it relates to urban water and suggests some directions for extending and reforming that body of law.

#### 2.1.1. *Context of Urban Water Governance*

In Australian law, "water resources in their natural condition are 'common property' or a 'common resource'". The Crown – i.e., States (read, 'States and Territories') but not the Commonwealth – have "an exclusive right to the use, flow and control of water resources." Thus, any individual right to water must be conferred and defined by the State. The rights granted by the States can be and usually are quite limited, e.g., a "right of access to a share ... [or] to a particular quantity of a resource", or "to take water from an identified source for a particular purpose." "Rights of ownership or rights of property are remarkable for their absence." (p. 1)

#### 2.1.2. *Legal Constraints on Urban Water Governance*

"The Constitution ... does not confer upon the Commonwealth any legislative power with respect to water resources or water" and in fact says that the Commonwealth cannot "abridge the right of the State or the residents therein to the reasonable use of the waters of rivers for conservation or irrigation" and cannot acquire property except "on just terms". Thus, "water resources governance in Australia is a matter essentially for the States and Territories." (pp. 1 and 2)

Although the States (read 'States and Territories') can govern water as they think fit, by agreeing to the NWI they have committed themselves to develop a "nationally-compatible ...

system of managing surface and groundwater resources for rural and urban use that optimises economic, social and environmental outcomes”. “The reference to ... urban areas is particularly significant” because it indicates that the NWI processes and requirements apply to urban as well as rural water. (p. 2)

The water legislation of the Commonwealth and States “includes” strategic planning, broadly based on catchment areas or river basins. Such catchment areas or river basins may include urban areas, but there is no specific water planning for urban areas; as a result, urban water planning is fragmented. (p. 2)

“The idea of ... ecologically sustainable development is simple. It is to achieve simultaneously economic, social and ecological objectives in such a way that ... can be maintained into the future.” (p. 3)

### ***2.1.3. Emerging Legal Arrangements for Urban Water Governance***

The Commonwealth Water Act of 2007 (‘Act’) is the current legal framework for implementing the NWI and managing the Murray Darling Basin (‘MDB’). The Act has as one of its objectives the improvement of water security of all uses of MDB water and makes “critical human water needs” the highest priority water use for communities dependent on MDB water. Thus, the MDB planning processes must consider urban needs. (p. 4)

The NWI contemplates a market-based system of managing water resources. The Act identifies three types of tradeable water rights:

- “Water access rights ... are essentially rights to store, take or use water.
- “Water delivery rights ... [are rights] to have water delivered by an infrastructure operator.
- “Irrigation rights ... are rights to receive water from an irrigation infrastructure operator.” (p. 5)

The various States have “approached [their responsibilities under the Act] very differently”, but in all of them urban water “arrangements are formalised not in the form of rights of consumers of urban water but rather as duties imposed upon suppliers of urban water.” (p. 5) “It is only the [Act] which talks of water delivery rights ... while the [State] legislation ... is almost entirely based on the responsibilities of water supply service providers ...: (p. 7)

### ***2.1.4. A Framework for Future Urban Water Governance***

Fisher lists many issues that the law should address better than it does now, such as how water should be allocated among all possible users and uses, how domestic consumers’ rights should be defined so that they are enforceable in law and tradeable, and how water resources planning, urban water planning, urban land use planning and urban building control can be better integrated. It identifies the “major gaps in the present ... legal arrangements” as the lack of focus on urban water, the unclear definition of the legal rights of urban consumers, and the lack of integrated planning for “ecologically sustainable development”. (p. 7)

### ***2.1.5. Conclusions and Reviewer’s Summary Appraisal***

Fisher concludes by outlining an extensive agenda for the reform of urban water law, the main themes of which are: more emphasis on integrated planning for sustainability; definition of legally enforceable rights at all levels; and implementation of tradeable delivery



rights. Items included in this agenda but not mentioned elsewhere in Fisher are the needs to clarify who controls recycled or reused water and rainwater within a community or domestic premises.

After reading Fisher, this reviewer – not a lawyer, but an economist who has read a lot of law and contracts – is at least as confused about Australian urban water law as he was before. It may be that Australian law dealing with urban water is as imprecise, contradictory and confused/confusing as suggested in Fisher, but nothing in Fisher helps to clarify things. For example, Fisher uses the term “rights of access” in many different and seemingly inconsistent ways and then offers a definition: “Water access rights ... are essentially rights to store, take or use water.” (p. 5) But a “right to store water” clearly implies a right to use storage facilities, while a “right to take or use water” clearly implies a right to water itself. So is a “water access right” a right of access to the infrastructure or to water? Or is it sometimes one and sometimes the other? Or are such distinctions unimportant?

Another example concerns what is meant by a ‘right to have water delivered’ or a ‘water delivery right’. The first time this is mentioned in Fisher, “a right to ... *have water delivered* ... is dependent upon the existence of a network ... infrastructure operat[or] ... which itself has a right of access to water resources ... ” (p. 1, emphasis added), presumably so that the infrastructure operator can deliver ‘its’ water to the end user. But later, “water delivery rights” are rights “to *have water delivered* by an infrastructure operator” who need not control any water. (p. 5, emphasis added). So is my water delivery right a right to *delivered water from* an infrastructure operator who must itself own/control water so that it can deliver ‘its’ water to me, or is it a right to *have [my or a third party's] water delivered* to me by an infrastructure operator who may not even have any water itself?

Water is a physical substance; delivery is a service. To this reviewer, a right or entitlement to ‘delivery of water’ or ‘to have water delivered’ is a right to the service of delivering water, not a right to water itself; surely, nobody would confuse a ‘right to have furniture delivered’ with a ‘right to furniture’, delivered or otherwise. But nothing in Fisher contemplates rights to a water delivery service unbundled from a right to water itself, so all of these references in Fisher to a water delivery right or a right to have water delivered must mean a right to *delivered water* – the plain English way of saying a right to *water* that is *delivered*, e.g., a bottle of water on my doorstep.

Such (to this reviewer) imprecise language is not confined to Fisher. In Frontier, a “water delivery right” is defined as “the right to be supplied from the water source to a defined location, such as the point of consumption”, (p. 12) clearly implying a right to delivered water, not just a right to delivery service. So, more in deference to common usage than to logic, in this review a ‘water delivery right’ is interpreted as a ‘right to delivered water’ – but whether this is what Australian law always means is unclear to this reviewer.

Failure to be precise about these things does not matter much in a world of vertically integrated water utilities, which is the only world considered in Fisher. But a, or even *the*, principal characteristic of microeconomic reform in other network sectors, such as electricity, gas and telecoms, has been separation of the delivery service from supply of the commodity itself. How far and how fast such unbundling should or will go in urban water is an open question, but baby steps are already being taken. For example, Gladstone Area Water Board (‘GAWB’) in Queensland allows customers to contract for water supply with or without



delivery;<sup>2</sup> and Coliban Water in Victoria has provided delivery services for customers wanting to move their own water. Any analysis of the legal and property rights regime in water should consider the possibility of such unbundling and its implications for the law.

The principal concern in Fisher (other than sustainability) is that under Australian law urban suppliers (of water? of delivery services?) have an obligation to supply end users but end users have no right to be supplied by suppliers. This reviewer understands the legal distinction: I cannot sue a supplier for its failure to meet its (government-imposed) obligation to supply, but I could sue a supplier for failure to satisfy my (legislative or contractual) right to be supplied. But it probably makes little difference in practice, and if it does matter the current arrangements are probably better; nobody but the lawyers would win if every disgruntled water customer could haul the water supplier into court for violating its ‘rights’. Nothing in Fisher explains what real, or even legal, problems have been, are now being or might someday be caused by the fact that suppliers have an obligation to supply end users but end users have no right to be supplied by suppliers.

As the Act and NWI are interpreted in Fisher, not only should there be water delivery rights (interpreted in this review to mean rights to delivered water) but these rights should be *tradeable* for both rural and urban water. Again, nothing in Fisher explains why such tradeable rights are needed, how they might be defined and administered or what they might accomplish, but a lot in Fisher suggests that the States should get on with the job of defining and implementing them – whatever they are. The possibility that the States may have good reasons for not doing so, that maybe the Act/NWI are misguided in contemplating (requiring?) tradeable delivery rights on urban systems, is not considered in Fisher. Section 3.1.2 below argues that the States and not the Act/NWI (as interpreted in Fisher) are on the right track here.

## **2.2. “Review of Urban Water Entitlements in Australia” by Frontier Economics**

Frontier Economics is an international economic consultancy. This assessment report (‘Frontier’) was written in 2008 for the Joint Steering Committee for Water Sensitive Cities, which is part of the NWC/NWI program. Because the Commission and the NWI community should already be familiar with Frontier, this review provides only a brief summary, highlighting those matters that seem to this reviewer most relevant to the Commission’s Urban Water Project.

### **2.2.1. What Are Entitlements?**

“Broadly, ‘entitlements’ refer to the rights and obligations that a party has over a resource.” (p. iii) Efficient investment in and use of a resource require rights that are universal, secure, flexible, exclusive, long-term, transferable, divisible and enforceable.

“The ‘tradeable entitlements approach’ is a relatively new, market-oriented approach for defining property rights and rationing access to natural resources.” (p. iv) Tradeable

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<sup>2</sup> GAWB does not offer delivery without supply, so the unbundling here may be more apparent than real. It is possible/probable that GAWB offers supply without delivery only to accommodate some near-by customer(s) who asked for it because it was cheaper to connect directly to the GAWB reservoir outlet than to pay GAWB’s delivery charges (which may be ‘postage stamp’, and hence the same for a user next door as for one on the other end of the system ).

entitlements can be useful when a resource is scarce and homogenous, when exclusive and independent rights can be defined, when there are many market participants with heterogeneous demands, and when transactions costs are low. These conditions are often met in rural Australia, where tradeable water entitlements have had real benefits, but if/where these conditions are not met other approaches may be better, such as “contracts, deemed supply agreements and other statutory licences and rights”. (p. iv)

### 2.2.2. Current Water Entitlement Arrangements

In Australia, the highest-level rights to natural water reside in the Crown/States, which use a range of tools to meet water management objectives. The approach defined in the NWI includes three elements:

- a planning process to define the total water available and its allocation between consumptive and non-consumptive uses;
- clearly defined “tradeable perpetual shares (‘water access entitlements’) *in the consumptive pool*<sup>3</sup> and associated allocation rules”; (p. vi, emphasis added) and
- water use licences to protect third parties and the environment.

Rural water entitlements are assigned to bulk water authorities, irrigation companies or trusts, or individuals (mainly irrigators). Other licences apply to (e.g.) hydropower. Landholders have other statutory rights to access water on, under or adjacent to their land, but only for domestic and stock purposes. (p. vi)

For urban water supply, rights to natural water are typically conferred by the Crown/State to water supply authorities, who are required by law and regulation to supply urban customers with potable water. “Individual customers generally have standardised supply agreements or ‘deemed’ customer contracts established through regulation, rather than tradeable entitlements of the form commonly held by irrigators.” (p. vi)

The urban water cycle increasingly includes sources of water other than surface and groundwater. Desalinated seawater and recycled water are now supplied under contract. Property owners are generally “able to” [which, to this reviewer, is different from ‘entitled to’] utilise greywater within their property and rainwater collected on their roofs. (p. vi) Table 2 in the Executive Summary summarises the general entitlement status of all the above-mentioned types of water, plus sewage, treated effluent, stormwater and managed aquifer recharge (MAR).

### 2.2.3. Frontier’s “Overall Conclusions”

Frontier summarises its overall conclusions about tradeable entitlements under four headings, as follows:

#### *Sustainable Resource Management*

“Entitlements have an important role in ensuring sustainability where demand approaches the total available resource (increasing scarcity) ... [H]ow entitlements are defined and managed

<sup>3</sup> A tradeable perpetual share *in the consumptive pool* suggests a tradeable source right, so maybe the NWI does not contemplate/require tradeable delivery rights as suggested in Fisher. Of course, this may be splitting a fine definitional hair in an area where words are used rather loosely.

to ensure sustainability remains a key issue ... (e.g., rules-based versus formal defined shares or entitlements held by an environmental manager).” (p. x)

Excessive withdrawal of groundwater by landholders for garden watering is a growing issue for some aquifers; “tradeable entitlements as defined in the NWI may be appropriate and should be pursued.” (p. x) If stormwater harvesting, recycling and managed aquifer recharge (MAR) grow enough, the government may need to define clear environmental flow requirements and limits on aquifer injections to ensure sustainability. (pp. x – xi)

#### *Certainty and security of access*

Creating rights in one part of the urban water cycle can affect existing or potential rights in other parts; for example, householders removing greywater from the waste stream reduce the water available for recycling downstream. There is also some uncertainty about who has what rights to rainwater falling on private land and rooftops, to stormwater and to sewage. These rights could be and, where it is worth the trouble, should be better defined. In most cases, the objective should be to provide certainty and security of access to support investment, because tradeability has little value [presumably because the assets are collocated with the resource and moving either would be very costly].

#### *Facilitating Exchange and Efficient Allocation*

There is significant interest in Australia in markets for urban potable water and for expanded rural-urban trade. A companion report to Frontier (Frontier Economics, “Urban Water Markets,” December 2008) identified and analysed a range of market-oriented reform options for parts of the urban water cycle. That report concluded that tradeable delivery entitlements to potable water are unlikely to have net benefits, largely because of high transaction costs, and suggested that other market-oriented alternatives “such as more efficient pricing, would be likely to offer greater net gains”. (p. xii)

Markets on other parts of the urban water cycle are even less likely to be cost-effective, given the small size of the markets and the lack of an integrated network to transport and store such commodities as recycled water, rainwater, etc.

#### *Managing Third-Party Impacts*

Third-party impacts of the urban water cycle, such as pollution and threats to supply security, are managed through a range of non-market mechanisms such as planning, licensing and regulation. These regulatory controls create important constraints on, and could be affected by, any entitlement regime, particularly for new water sources. The possibility of using entitlements to manage third-party impacts, e.g., pollution entitlements, is not discussed in Frontier.

### **2.2.4. Conclusions and Reviewer’s Summary Appraisal**

Frontier covers a lot of ground and reaches a lot of conclusions about different things. The principal general conclusions are: there are holes in the legal definition of entitlements throughout the urban water cycle in Australia; these holes may not be causing real problems and should be filled only where and when they are; and the primary objective in defining entitlements should be to reduce investment risks and increase efficiency, not to facilitate entitlement trading *per se*, which is unlikely to have positive net benefits (except perhaps where the extraction of groundwater is concerned).

This reviewer finds the analysis and conclusions in Frontier clear, informative and persuasive, as far as they go (or could/should go, given Frontier's focus on entitlements). In particular, the reviewer agrees with the conclusion in Frontier (which is based primarily on the companion study "Urban Water Markets") that tradeable entitlements are unlikely to have net benefits for potable water, and that "greater net gains" are likely to be achieved with "other market-based options, such as more efficient pricing". (p. xii) However, Frontier does not explain how more efficient pricing might be achieved; in the opinion of this reviewer, an urban water market such as the one outlined in Section 3.4 below offers the best hope for such "more efficient pricing".

### 3. ENTITLEMENTS, PRICES AND MARKETS

The most important issues raised in Fisher and Frontier for the Commission's Urban Water Project concern what are called here tradeable delivery entitlements. Fisher and Frontier agree that TDEs have not been implemented in any Australian urban water system, but differ on how important this is: the legal analysis in Fisher suggests that TDEs are contemplated or maybe required by law and policy, but the economic analysis in Frontier concludes that urban TDEs have less promise than other market-based ways of managing urban water, particularly more efficient pricing. Of course, both Fisher and Frontier could be right: the law could require urban TDEs *and* they could be a bad idea.

This section explains this reviewer/economist's view (similar to the conclusions in Frontier) that TDEs are not the best solution to any real problem in urban water systems. It shows that the tradeable entitlements that have worked well for many rural water systems in Australia are tradeable *source* entitlements ('TSEs'), not TDEs, and then discusses why TDEs are unlikely to have positive net benefits on urban systems, or at least on the larger and more complex metropolitan systems – called 'metro' systems here to distinguish them from the smaller, simpler systems in regional towns. It then uses Melbourne as an example to outline how a system of source entitlements, combined with efficient trading and pricing of *water*, not of the *entitlements to water*, could produce the efficient and equitable outcomes that advocates of TDEs presumably want but that TDEs cannot deliver.

#### 3.1. Rural Source Entitlements vs. Urban/Metro Delivery Entitlements

Given the perceived success tradeable entitlements have had in stimulating economically beneficial trade in rural water in Australia, it is natural to think that tradeable entitlements might have similar benefits for urban water. But the rural experience must be properly understood if the right lessons are to be drawn from it.

This reviewer, when suggesting that the market concepts and processes used in electricity and (in Victoria) gas should be considered for urban water, is often reminded that "water is not electricity or gas, so what works there may not work here". This is true enough; but it is also true that an urban water system is not a rural water system, so what works 'there' may not work 'here' either. It is not enough to know *what works* in a specific situation; it is also necessary to know *why it works* in that specific situation if anything useful is to be said about whether it might or might not work in a different situation.

This section discusses what rural water entitlements are and why they work in Australia (where they do) and why the same type of entitlements will not, by themselves, work for urban water. It turns out that, when it comes to what is needed for efficient trading and pricing, the complex water network embedded in an urban/metro area may have more in common with an electricity network than with a river flowing through farmland.

### 3.1.1. What Rural Entitlements Are and Why They Work

Tradeable entitlements are not the panacea they are often thought to be in Australia, even where rural water is concerned. In particular, they have not worked well where the hydrology is complex and variable, or where surface water and groundwater are linked; such complex systems may need some version of pricing and trading arrangements proposed for urban/metro water below. But the objective in this section is to identify the main features of the simple rural water systems and the simple tradeable entitlements that, together, have supported successful water trading.

A typical tradeable irrigation<sup>4</sup> water entitlement in Australia (to simplify only a bit):

- Is a right to withdraw natural water from a specified part (called here a 'trading zone') of a rural river system managed by a Rural Water Authority (RWA);
- Is exclusive, in the sense that it is illegal to withdraw water without such a right (with limited exceptions for, e.g., hydropower or domestic and livestock use);
- Defines the quantity of water that can be withdrawn per (e.g.) week or month, usually as a specified fraction of the total irrigation water available as determined by the RWA and other (primarily environmental) authorities;
- Can be transferred/sold in whole or in part to another person, usually subject to preapproval by the RWA to assure that the conditions in the entitlement are met by the proposed buyer; and
- Imposes no charge on the water itself, although the RWA's costs of administration and some infrastructure costs may be recovered with volumetric (\$/ML) charges;

Such simple entitlements have been successful where it is possible to define stable trading zones within which multiple potential buyers and sellers can trade entitlements without lengthy and uncertain approval processes. Such a trading zone is typically all or part of a river valley. River flows may to some extent be regulated by dams, from which water is released by the RWA based on storage levels, expected rainfall, environmental factors and the needs of irrigators. A defined quantity of the flowing water is designated for irrigation, and an irrigation entitlement is a right to withdraw a fixed share of that designated irrigation water anywhere within the trading zone. There is no delivery system worthy of the name, only a source – the river. An entitlement holder takes its water from the source/river when it wants it, within its entitlement's constraints, even using its own pump.

A tradeable right to take water directly from the source/river is most accurately called a tradeable *source* entitlement ('TSE'). If the river is regarded as a *de minimis* delivery system, such an entitlement might be called a tradeable *delivery* entitlement, which seems harmless enough because there is little/no delivery system and hence little/no practical difference between a TSE and a TDE. But calling a rural entitlement a TDE is not harmless if it creates the misleading impression that an urban TDE modelled on a rural entitlement

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<sup>4</sup> Water withdrawn under a rural entitlement is called 'irrigation' water here, although in some cases it can be used for other things, such as agriculture (which includes dairying and livestock raising). The restrictions on the uses of entitlement water usually reflect social and political attitudes more than 'real' (e.g.) environmental or economic concerns, and are not discussed here.



might facilitate water trading as rural entitlements have done. To avoid this pitfall, tradeable rural entitlements are called TSEs in this review.

It may not always be easy to define the hydrologically and ecologically appropriate trading zones for and conditions on rural TSEs; and it is becoming increasingly difficult as a political matter to allocate the total available river/source water between irrigation and the environment. But once these things are decided, trading rural TSEs can be and often is as simple as trading a used car. Anybody wanting to sell a TSE can list it in the local newspaper or with the local estate agent, identify and negotiate with one or more potential buyers, choose and do the best deal, and then notify the RWA of the proposed change in ownership. The RWA usually must approve the trade, but approval delays and uncertainties have not been a serious problem in most rural water markets.

In summary, rural water markets in Australia have been successful where the water system is simple enough to define stable trading zones within which simple TSEs, defined as a right to take a specified share of the available water directly from the source/river, can be freely traded among multiple buyers and sellers with little approval delay or uncertainty. Simple TSEs have not been so successful on rural water systems with more complex hydrology and/or linkages between surface water and groundwater.

An urban, and particularly a metro, water system is much more complex than the most complex rural system. There is no logical or empirical reason to think that the kind of simple tradeable entitlements that have been successful on simple rural water systems would, by themselves, work for an urban, and especially a metro, water system, as discussed next.

### ***3.1.2. Why Metro Delivery Entitlements Will Not Work***

Urban water systems, like rural water systems, come in many shapes and sizes. Some systems regarded as urban may be small and simple enough that something called a tradeable delivery entitlement could have some benefit there. But TDEs cannot work on the large and complex urban – or metro – water systems that serve the larger Australian metropolitan areas.

A metro water system is operated by a Metro Water Company ('MWC'). The MWC:

- Is regulated and perhaps owned by (or is a department of) government, and has an obligation to supply water to all eligible persons/premises on a non-discriminatory basis;
- Has rights to water from several/many sources with different locations, quality, security and (increasingly so, with desal and the like) costs, and a complex and costly delivery network of pipes, pumps, storages and treatment facilities;
- Decides how much water to take or buy from each source, and how to use the network to deliver water to all connected persons/premises with high reliability and (approximately) minimum total cost within environmental and other constraints;
- Recovers its total water and network costs with relatively simple end-user tariffs that categorise end users by type – e.g., residential, commercial, industrial – and perhaps size, with the same tariff charges and, when necessary, the same water use restrictions applying to all end-users within a tariff category; and

- Allocates its costs – most of which are the fixed costs of infrastructure used jointly by all water users and hence are not ‘caused’ by any specific actions or end user – among tariff categories on a largely judgemental basis.

It is not clear what is generally meant or what should be meant by a TDE on a metro water system. Presumably something called a ‘delivery right’ or (in Frontier) an ‘end user entitlement’, should provide end users with more-or-less the same delivered water service they get under a standard tariff or service contract, just in a tradeable form. In particular, a TDE should not expose the end user to the risks of a specific source of water – that would be a tradeable *source* entitlement – or any increased delivery risk. Other studies have used other definitions of a TDE,<sup>5</sup> but the one just given seems to this reviewer to be most consistent with what most people, including those who advocate TDEs, seem to have in mind when they talk about a tradeable delivery entitlement.

The most common argument for metro TDEs is that tradeable entitlements work in rural water, suggesting that metro TDEs should be modelled after rural entitlements (TSEs here) as closely as practical. The following table lists the principal features of rural TSEs, with a summary comparison to the comparable features of metro TDEs in light of the description above.

*Table 1 – Comparison of a Rural TSE and Metro TDE*

A Rural TSE	A Metro TDE
Single Source Entitlement: Entitlement water is taken directly from the source/river with no delivery system involved	Complex bundle of entitlements to water from multiple sources and to the many delivery network assets and services necessary to deliver water from the source(s)
Exclusivity: Only TSE holders (with a few exceptions) can take water from the source/river	MWC must offer service to all eligible persons under standard tariffs, so TDEs would create two types of end user, those with TDEs and with standard tariffs/contracts
Water Quantity: A defined share of total water available as determined by God, politicians and environmental regulators (not necessarily in that order); the TSE holders, not the RWA, bear quantity risk	No natural definition of how much total water is available for TDE users (with desal, restrictions on non-TDE users, etc.); each TDE must define a water quantity and who bears the costs/risks when that quantity cannot be provided from natural water due to drought
Low Charges: Infrastructure costs/charges are low; no charge for water itself	Infrastructure costs/charges are high; incremental water costs could be high during a drought (with desal, etc.);

<sup>5</sup> See, for example, the 9 November 2007 Final Report of the Large User Water Market (‘LUWM’) Feasibility Study prepared for the Melbourne Bulk Entitlement Management Committee (‘BEMC’) by Farrier Swier Consulting in conjunction with Intelligent Energy Systems and Wedgewood White. This ‘LUWM Study’ assumed that a TDE (assumed there to be mandatory) would require a large user to manage its own source risk, which most large water users would not be able or willing to do. But large users often advocate urban TDEs, so they must have something different in mind, such as TDEs in which source risk is borne/managed by the entity backing the TDE, as assumed here.



A Rural TSE	A Metro TDE
Tradability: ‘Large’ trading zones defined by surface topography; delays and uncertainties in approving trades are ‘not bad’ (but may be bad and/or getting worse in complex rural systems)	Trading zones likely to be ‘small’ (e.g., an industrial estate) for large users; reviewing/approving trades could require lengthy study and negotiations, particularly when augmentations are involved

The most obvious and fundamental difference between a rural and a metro water system is that a metro system has a complex and costly delivery system, while a rural system has little or no delivery system. This logically implies that a right to delivered water can be a simple source right on a rural system, but would be a complex and variable bundle of source rights and network rights on a metro system. With such a fundamental difference, there is no logical or empirical basis for thinking that the simple entitlements that work for rural water would work for metro water; indeed, it would be astonishing if they did.

Another critical difference between a rural and a metro water system is that a rural system is used by TSE holders only and a metro system is used by everybody. Each holder of a rural TSE gets a fixed share of the irrigation water available and pays (presumably) the same fixed share of the RWA’s relatively small costs, while on a metro system the TDE holders would share the water sources and the large, costly infrastructure with all other end users. Even with the MWC managing source risk, small water users would almost surely find TDEs not worth the trouble,<sup>6</sup> so only large end users would use them. Allocating costs and (during droughts) scarce water between large TDE holders and everybody else would be a significant addition to an already difficult economic, regulatory and political challenge. It would be difficult to know who is cross-subsidising whom, but likely that TDE holders would get a good deal at the expense of other end users – and virtually certain that the public would think so, whatever the reality.

The quantity limit in a rural entitlement is a specified fraction of the water available for irrigation as determined by higher authorities, but on a metro system the MWC could always get more water for TDEs by tightening restrictions on non-TDE end users, buying more high-cost (e.g.) desal water and, in the medium term of a few years, augmenting the system. Thus, a metro TDE would need probably-complex provisions defining the TDE quantity and who gets how much water and who pays what costs when that quantity cannot be provided from

<sup>6</sup> There have been proposals for trading delivered water among small consumers/households. See, for example, M. Young, J. McColl and T. Fisher, “Urban water pricing: How might an urban water trading scheme work?”, Droplet No. 5, 4 February 2007, University of Adelaide. The basic idea is to give each household an initial allocation of ‘cheap’ water and allow any unused ‘cheap’ water to be sold over the fence, or in an on-line tender process, or in an automated multi-step allocation/auction process, or ... This is fine in concept, but hardly seems worth the trouble to save, maybe, \$5/month per household; experience in electricity indicates that small users do not respond much to prices even when much larger dollar amounts are involved. A simple two-tier tariff with the higher tier at the scarcity price could have essentially the same (probably small) effect.

the drought-prone free sources. Defining and administering such provisions would be another source of real and perceived inequities and inefficiencies.<sup>7</sup>

And then there is the question of the tradeability of a TDE. Anybody should be allowed to sell its right to take water at a specific time and place to anybody else willing to take water at the same time and place, and there may be situations where a lot of TDE buyers and sellers are close together on the network – e.g., in an industrial estate – so TDEs could be traded freely within that trading zone. But, in general, transferring a withdrawal of any significant size to a significantly different location on the network will imply different system operations and costs, if it is feasible at all. Any TDE trade that might affect system operations – which could be any trade above some *de minimus* size – would have to be approved by the MWC. The MWC might be able to approve or disapprove some proposed TDE trades quickly, but in many cases would need to run operational models for a range of scenarios to make its decision. Most trades could be approved if the parties were willing to pay the costs of needed augmentations and operational changes, so the parties may ask the MWC to identify and price these. But this is not trading a TDE; it is using one untradeable delivery entitlement as a starting point for the negotiations needed to define another one.

In summary, a metro TDE could not be what a typical rural TSE is: a simple, exclusive and easily traded right to take free water directly from the source/river, with the quantity a simple fraction of a total amount determined more or less objectively by higher authorities. A metro TDE would need complex and probably customised provisions defining prices, quantities and conditions on transferability. TDE users would be large consumers using the same water sources and delivery network used by small non-TDE users, but would (if TDEs are worth much) get more value from those shared assets, creating serious issues of cross-subsidisation and discrimination. Auctioning TDEs and applying the proceeds to joint costs might reduce, but would not eliminate, cross-subsidisation issues.

So Frontier is correct (but understates the case) when it says that TDEs are unlikely to have positive net benefits on metro water systems, particularly compared to alternatives based on more efficient pricing.<sup>8</sup> If Fisher is also correct when it says that metro TDEs are required under Australian law or policy, the law or policy should be changed. If there is to be any significant trading on a metro water system, something other than TDEs will have to be developed. One – or, more likely, the only real – possibility is discussed next.

### 3.2. Source Entitlements, Commodity Pricing and the Network Problem

TDEs will not support efficient trading on a metro water system because a TDE would be a too-complex-to-trade bundle of entitlements to source water and network services. The implication is obvious: if a metro water market is to work, it must be based on unbundled source rights and network rights, somehow defined and traded. This section discusses source entitlements, their role in pricing the water commodity, and the problem they do not solve – the network problem.

<sup>7</sup> GAWB (which may not have a metro system in the sense used here) has contracts with large customers that are a form of TDE. However, during a drought GAWB would reduce contract quantities based on how much water each contract end user ‘needs’ to continue operations, not on the maximum quantities in that end-user’s contract, which would seem to make trading of contract quantities pointless as a protection against drought.

<sup>8</sup> The LUWM Study for the BEMC came to the same conclusion, albeit for a TDE that seems to be more like a TSE than a TDE as those terms are used in this review.

Victoria has taken the first half-step toward a metro water market, by defining – or promising to define; this reviewer is not sure of the current state of play – Bulk Entitlements (‘BEs’) to natural water captured by the Melbourne Water system. These BEs have been (may someday be?) allocated among the three parallel state-owned distribution/retailing monopolies that have been spun off from Melbourne Water. BEs were supposed to be tradeable, but are still being managed by Melbourne Water on a pooled basis under the policy supervision of a Bulk Entitlement Management Committee (BEMC) that includes the three retailers. In the opinion of this reviewer, the Melbourne BE process is stuck here largely because there is no way to convert a BE right to headworks water where and when it enters the network into a right to delivered water where and when it can be withdrawn to be used or sold. The concepts outlined below may provide a way forward for Melbourne and other metro systems.

### ***3.2.1. Source Rights and Commodity Trading***

A metro source right is a right to the water that enters a metro water system. A source right could be a simple TSE like a rural entitlement or a Melbourne BE – i.e., a tradeable right to a defined share or amount of natural water – or an untradeable version of the same thing. Or it could be a complex and difficult-to-trade contract right to the output of a desal or other manufactured water plant. The form and tradeability of a source right or entitlement are not important in the short run; all that is required is that the MWC knows whom to credit for the water where and when it enters the delivery system.

The suggestion that the form and tradeability of a water entitlement is not critical for a water market may be heresy in Australia, where the perceived success of rural water trading has created something of a fixation on entitlement trading. But very few commodity markets are based on active trading of entitlements to the physical commodity at its source – e.g., rights to 30 percent of the corn or 50 percent of the hogs produced on a specific farm – because these are usually too complex, individualised and ill-defined to be actively traded. For most commodities, it is the commodity itself, or standardised forward contracts for the commodity (always at a specific time and place), that are actively traded and priced. Source entitlements/rights must be tradeable in the long run to accommodate new entrants and other changes in market structure, but such trading is done outside the market, often through bilateral negotiations, and at prices that are derived from projected prices of the commodity in efficient, and usually centralised, markets.

The most fundamental economic feature of a source right is that the holder of the right bears the quantity and price risks of that specific source. If less or higher-cost water arrives from a source, the entities holding rights to that source will be credited with less water or pay more for it, with no averaging and cross-subsidisation through the tariff process as would tend to happen with a delivery right. Few end users or retailers would or should rely on a single, uncertain water source, so virtually anybody using source rights for anything other than high-risk gambling will need a well-designed portfolio of them in order to reduce source risks. The initial allocation of source rights need not create particularly good portfolios, because the rights can – and, because conditions will change, must – be traded later into portfolios that meet the needs of retailers and end users at any time. But the need to design and manage a portfolio of source rights will keep all end users except the largest and most sophisticated out of the wholesale water market.<sup>9</sup> Most end users will get their water from the MWC under

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<sup>9</sup> The LUWM Study came to the same conclusion for what are called there TDEs, but that seem to be more like TSEs than TDEs as those terms are used here.

regulated tariffs or from competitive retailers if and when these exist, just as they do in electricity and gas markets.

Once unbundled source rights have been defined and allocated, each retailer or large user ('RoLU') could, in principle, assemble a portfolio of such rights that covers its expected water needs for the next water year (or longer) with an adequate reliability margin.<sup>10</sup> But a RoLU should not lock in a portfolio of source rights without knowing the cost and feasibility of delivery from alternative portfolios. The next section discusses the problem of organising and pricing the delivery of water on a metro network.

### ***3.2.2. The Network Problem: Managing and Pricing Delivery***

In concept, delivery on a network could be managed and priced by decentralised trading of entitlements. The MWC could divide the capacity of each of its hundreds of network storages and pipelines and pumps and treatment plants into tradeable capacity entitlements ('TCEs' in, e.g., ML/month) and allocate or auction these to RoLUs. RoLUs could then trade these TCEs among themselves until each held a portfolio of network rights that would allow it to tell the MWC to move, store and treat 'its' water at different times and places on the network. For example, a RoLU might have rights to store 500 ML in Storage S12 and 300 ML in S7 during September, to move 250 ML through Pipeline P9 during October, to treat 200 ML in Treatment Plant T2 during November, etc., and then each month during the year could tell the MWC to store/move/treat the RoLU's water as directed within the limits of its TCEs.

Basing network operations on physical capacity rights that a RoLU could use to direct the movement of 'its' water around the network might work in very simple cases, but any attempt to do this on a complex metro system would be hopelessly inefficient. Nonetheless, experience from electricity suggests that the vague notion of basing a market on physical capacity rights will stay alive until serious attempts are made to define how such a market might actually work, at which point the notion will fade away. For example, it has been (is still being?) suggested that each Melbourne retailer should have rights to some of the capacity of various storages and pumps and pipelines on the Melbourne Water system so that each retailer could separately schedule delivery of its own BE water from the headworks reservoirs to Melbourne. The impracticality of such suggestions may help explain why the Melbourne BEs remain pooled and untradeable.

The main purpose of an integrated network is to link everything to everything else through a pool so that it is not necessary to (try to) move one person's commodity from where and when that person gets it to where and when that person needs it. In water, a little unbundling around the edges (literally) might be worthwhile; for example, some headworks storage might be unbundled from the main network and treated as a source of water to the network, so that an individual RoLU could hold 'its' source water there until it decides to put it into the network. But the bulk of the integrated network should be treated as such – as an integrated and centrally operated network that uses all the available water to meet all the demands at least cost, without trying to keep track of whose water is being stored or transported or pumped or treated where and when within the network.

Even if RoLUs have individual, non-pooled source rights, the MWC should continue to operate the delivery system as an integrated – and hence monopoly, and hence regulated –

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<sup>10</sup> This oversimplifies risk management issues, but is useful for this discussion of network issues.

network. If the sources and sinks of water on the network change gradually and predictably, the MWC can plan, design, build, augment and operate the network so that operational constraints are seldom binding. RoLUs can trade source entitlements and customers among themselves as they please, and then schedule their injections and withdrawals with the MWC, with no fear that these injections and withdrawals will be infeasible, because (by assumption in this paragraph) the system is never congested. When RoLUs trade source rights or customers, the MWC simply changes the names associated with some meters in its computerised accounting and billing systems that keep track of whose water enters and leaves the pool/network at different times and places. The MWC can recover its mostly-fixed costs with a set of access and usage charges applied to injections and withdrawals separately, not to fictional paths between specific injection and withdrawal points.

If things were this simple, TDEs of the type discussed in Section 3.1.2 might be operationally feasible, because transferring a TDE to a new location would have no operational effects; the new location would have been getting water anyway, just under a different name and/or commercial arrangement. TDEs would still be complex commercial contracts in which the seller would take and manage a lot of risk, and hence should not be offered by a regulated or state-owned MWC. But there is no reason a competitive retailer should not offer such contracts; risk management would be the principal *raison d'être* of such retailers, and there would be no issue of cross-subsidies between tariff and TDE customers. Perhaps large water users who want TDEs should advocate for source entitlements and competition among retailers (unless the cross-subsidies are what they really want).

Things on the network get more complicated if the pattern of injections and withdrawals can change unexpectedly. For example, if new sources of desal or recycled or purchased rural water come and go or operate sporadically on the system, or if regional water authorities buy water from or move water across the MWC system from time to time, the pattern of flows could change frequently and without much warning. Congestion could arise, or threaten to arise, at unexpected times and places, forcing the MWC to deny requests for new service or for water trades, or to reduce the reliability of existing service, or to incur higher operating costs – or all of the above. If the MWC tried to block all changes that might affect existing system users, it would lock in the *status quo*, which not even existing users (tomorrow's new/changed users) would appreciate. If the MWC tried to approve all changes the system might be able to handle, it would create costs and risks for existing users, which not even new users (tomorrow's existing users) would appreciate.

Injections, withdrawals and flows are becoming more complex and dynamic now on metro systems in Australia, largely in response to the recent drought. But complexity and change would surely increase even more and faster if independent RoLUs started trading source entitlements and customers, contracting with new sources, buying water from farmers, selling water to regional water authorities, etc. In the absence of some effective way to manage such dynamic changes, a responsible MWC must oppose opening up the market – again, perhaps helping to explain why Melbourne Water still manages the retailers' BEs on a pooled basis.

The alternative to resisting the movement toward markets is to develop market-based ways to accommodate the changes markets will produce. The MWC could/should develop and implement a process for planning and implementing system operations that can predict, price and control congestion efficiently when and where and as long as it exists. Congestion on a network is like friction in an engine – not something to try to eliminate at any cost, but something to plan and design for, reduce to the extent doing so is cost-effective, and generally learn to live with. Once congestion is being managed efficiently, considered



decisions can be made about where and when congestion is bad enough often enough that it is cost-effective to augment the network and where and when it is better to continue living with efficiently managed congestion.

The only practical way to manage dynamic congestion efficiently on a complex network is with a network market. The good news is that a lot has been learned about network markets over the past twenty years. The bad news is that most of that learning has been in electricity, and – as this reviewer is constantly reminded – “water is not electricity, so what works there may not work here.” But by looking beyond *what* works to *why* it works, it is possible to identify which features of the electricity model should be included in, and whether/how they should be modified for, a metro water market.

### 3.3. Network Market Concepts in a Metro Water Context

This section begins by discussing the basic features of a commodity network and the key concept that made network markets feasible in electricity and (at least in Victoria) gas: an integrated market/scheduling process. It then discusses how these concepts could be modified to reflect the special characteristics of a metro water system. The Annual Operating Plan (‘AOP’) process in Melbourne is used to illustrate how a market might be integrated into the scheduling procedures of a metro water system.

#### 3.3.1. *Water is Not Electricity or Gas – but a Metro Water System Is a Network*

Rural water, metro water, electricity and gas are all different. For one thing, rural and metro water are wet and electricity and gas are not. But in a schematic diagram, it is rural water that is odd-man-out: a metro water network looks a lot more like an electricity or gas network than it looks like a rural river. At the basic levels that matter for trading and pricing, urban water, electricity and gas are all network commodities that have more in common with each other than any of them have with rural water.

The basic feature/definition of a network is that everything is connected to everything else. This connectedness is valuable, because it creates a pool through which any of many sources can supply any of many sinks. But it also means that a physical action at any location/time ‘point’ on the network can affect the costs or physical feasibility of actions other location/time points on the network. These ‘network externalities’ require a central operator or coordination process to assure that all scheduled injections and withdrawals are simultaneously feasible across the network and over time given the various storage, transport, pumping and treatment capacities of the network. Once such a process is in place, it can/should be used, not just to prevent users of the network from interfering with one another, but to facilitate mutually beneficial trades while avoiding negative, and even exploiting positive, network externalities.

The existence of network externalities means that decentralised trading on a network will be at best complex and inefficient. Two parties considering a trade cannot know if the implied injections and withdrawals will be feasible on the network, because they do not know what other trades are being considered at the same time. So the central operator must review the set of all proposed trades that might interact with each other on the network – i.e., most/all trades anywhere on the network, over a period of a year or so on a network with long-term storage – to determine if all proposed injections and withdrawals are simultaneously feasible.

If the bundle of proposed trades is not feasible, the central operator will usually have no way to determine which proposed straws would have broken the network’s back, much less which are more valuable and hence should be given priority, so it will have to reject many/most/all

of them and tell the parties to try again. But the next bundle may be no more feasible than the last one was, so the central operator may have to tell traders to try again, and again, and .... Even if decentralised trading can find a feasible solution before the commodity must start flowing on the network, the resulting bundle of trades may be nowhere near the most valuable bundle the network could handle.

On a simple radial or ‘no-loops’ network, tradeable capacity entitlements might make decentralised trading feasible, but on a meshed and potentially congested metro water system decentralised trading of TCEs is hopeless, as discussed in Section 3.2.2 above. For trading and pricing to be efficient or even feasible on a complex and potentially congested network, whether the commodity flowing on that network is wet or dry, it is necessary to consider all proposed trades and the network capacities simultaneously.

### 3.3.2. *The Key: An Integrated Market/Scheduling Process*

The key to efficient trading and pricing on a network is to integrate commodity trading and pricing with system operations. For efficient trading and pricing in electricity, where total power inflows must (approximately) equal total power outflow over periods of a few minutes, the nearly-instantaneous central dispatch process is supplemented with or even converted into a spot market. This spot market considers simultaneously all the potential trades over the next 5-30 minutes to determine a set of trades or a ‘market schedule’, along with the associated market-clearing prices, by maximising the total gains from trade subject to the constraints in a model of the network.

The market schedule that is consistent with the market’s network model is sent to the system operators to implement using various mixes of more detailed network models and experienced judgement. The system operators try to implement the market schedules as far as possible, but may need to use ‘ancillary services’ to deal with unexpected changes or inaccuracies in the network model used in the market-clearing process. Sometime later, the market-scheduled quantities are settled at the market-clearing prices, and ancillary service payments are made to compensate actions taken in response to operator directions.

The first application of an integrated market/scheduling process in the UK in 1990 was crude<sup>11</sup>, primarily in ignoring the network, but it worked well enough to get a market going. Starting in 1995-96, first in New Zealand and then in the United States, market models began modelling hundreds or thousands of network constraints (and determining similar numbers of potentially different locational prices) to get market schedules that require less correction, and lower ancillary service payments, by system operators. In the Australian national electricity market, interstate but not intrastate transmission constraints are modelled. The details vary, but all of these network markets are based on the concept of using a market to determine schedules that are ‘almost’ feasible on the network and then letting system operators implement those schedules with no more ancillary services and payments than necessary.

Despite grumblings that gas is not electricity, in 1997 the concept of an integrated market/scheduling process was successfully adapted to the Victorian gas system.<sup>12</sup> Unlike

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<sup>11</sup> This reviewer was a substantial contributor to development of both the theory and the practice associated with this concept, starting in the UK.

<sup>12</sup> This reviewer was the principal designer of the market clearing logic initially used in the Victorian gas market.



electricity (but like water), a gas network must consider time and storage. The compact and complex Victorian gas system is unusual/unique, in that linepack must be carefully managed over the daily cycle by controlling the timing and location of gas injections relative to (mostly uncontrollable) withdrawals, so the kind of short-term, myopic market process used in electricity would not work. So a daily market process was developed to determine hourly schedules. The initial market/scheduling process was crude, determining hourly schedules but only a single price for the whole day, and requiring system operators to make significant ‘ancillary payments’ to deal with network constraints and unexpected within-day events. Later, the process was improved by adding several within-day updates of the hourly schedules and the price for the remainder of the day, which reduced the ancillary payments the operators had to make. Gas is not electricity, but the Victorian gas market is regarded as very successful by both system operators and market participants.

### ***3.3.3. Integrating a Market into Existing Operational Processes***

The main purpose of a network market is not to improve the short-run productive efficiency of network operations; monopoly system operators are usually pretty good at using existing assets efficiently. The main purpose of a network market is to produce prices that reasonably reflect the marginal costs of meeting demand given the way the system is actually operated; these short-run prices will improve allocative and dynamic efficiency, thereby reducing costs and hence prices in the longer run (relative to what they would otherwise have been). Given this objective, the best way to implement a network market, particularly in an area where it has never been done before – e.g., urban/metro water – is to leave the existing operational procedures more or less intact and add to these a pricing process and settlement system.

Existing operating procedures on a monopoly network may rely on rules of thumb and operator judgements, so real trading and pricing usually requires formalisation of the procedures, preferably as an economic optimisation problem. Again, the principal objective is to produce reasonably efficient short-run prices in a consistent and transparent (or at least reproducible) manner, not necessarily to improve short-run operational efficiency.<sup>13</sup> In electricity, near-real-time economic dispatch using formal optimisation is well-established, so adding a pricing and settlement system can be relatively easy – although this was not the case for the initial UK Pool.<sup>14</sup> In the Victorian gas case, daily operational optimisation software had to be created during market implementation; system operators were sceptical at first, but came around when the new software quickly found unexpected but surprisingly good solutions to some tricky operational problems.

Water system operators use computer models, including some based on optimisation, to inform their decisions, but their final operational plans and decisions rely heavily on experienced engineering judgement – much more so than in electricity or gas. Furthermore, this is likely to continue to be the case, given the complex and dynamic nature of water flows,

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<sup>13</sup> In fact, some short-run operational efficiencies may be lost in the formalisation process, because a formal process may not be able to find or should not allow all the tricks experienced operators know, and market prices may not provide the right incentives where (e.g.) integer or on-off decisions are involved. Operators must be able to override the schedules produced by an optimisation model under some conditions, but if they do this very often the transparency and consistency of the process and its results can be destroyed.

<sup>14</sup> The Central Electricity Generating Board (CEGB) had been using a heuristic dispatch algorithm that did not produce shadow prices. The initial pricing rules were made up/negotiated by people sitting around a table.

water quality and mixing, and environmental effects in pipelines/tunnels, treatment plants and reservoirs. But electricity and gas markets also rely on system operators to determine operational details using various tools and experienced judgement. In both cases, the integrated market/scheduling process operates in advance to determine market schedules that are then passed off to the system operators for implementation. The same division of labour between an integrated market/scheduling process and the system operators should be possible for metro water.

### ***3.3.4. An Example: Melbourne's Annual Operating Plan (AOP) Process***

To illustrate the division of labour between an integrated market/scheduling process and detailed system operations on a metro water system, consider the Annual Operating Plan process used in Melbourne.<sup>15</sup> The AOP is determined prior to each water year (beginning 1 July) and is then updated prior to each month during the year. The latest AOP specifies, for the current and each future month in the year, the amounts of water scheduled to be released from headworks storages, imported from rural areas, produced by the new desal plant, moved/stored/pumped/ treated within the network, and finally delivered to the three Melbourne retailers (and perhaps eventually to competitive retailers, to wholesale customers and to regional water authorities) during the month. The AOP schedules also include the amounts of water to be left in storage at the end of the year for use next year.

The AOP is determined in a consultative/political/technical process managed by Melbourne Water but including the three Melbourne retailers (through the BEMC) and the government of Victoria (the single shareholder of all the others). This consultative process agrees the planning scenarios (e.g., demand and rainfall/inflow assumptions), the storage policies, the water usage restrictions, the allocation of water among the retailers, etc., used by Melbourne Water in determining the AOP. As the increasing scarcity of water has led to tighter water restrictions and more complex and costly supply options, determining the AOP has involved more intense negotiations and more consideration of economics. In short, the AOP process is becoming more like a market.

The detailed actions taken during the year to implement the AOP's monthly schedules are determined by Melbourne Water using a variety of engineering models, operating rules and qualitative criteria, but ultimately relying heavily on the judgement of experienced system operators. As just discussed, it will probably never be possible or at least cost-effective to use formal optimisation to determine all the operational details of implementing the AOP schedules, but neither is it necessary to do so. System operators use a suite of tools and years of experience to find good ways to move water around the system from sources to sinks to meet the AOP schedules; all they need to do their job is AOP schedules that are at least 'almost always, almost' feasible on the network.

Thus, the Melbourne AOP process already has the division of labour needed for a network market: the monthly AOP schedules for the water year are determined initially and then updated each month in a high-level process that has many of the characteristics of a market, and are then implemented in detail by system operators. All that is needed to turn this into a network market much like those used in electricity and gas is a more formalised, optimisation-based market-clearing process for determining the initial monthly AOP

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<sup>15</sup> The description here reflects this reviewer's general understanding of the Melbourne AOP process, but may not be correct in some details.

schedules and associated prices and updating these each month, and a settlement system. The next section outlines how such a process might operate.

### 3.4. A Market-Based AOP Process or ‘AOP Market’

The daily market cycle used in the Victorian gas market can be ‘stretched’ to cover the annual AOP cycle just described, to produce an ‘AOP Market’. An evolutionary approach to developing an AOP Market is described in more detail elsewhere.<sup>16</sup> How such an AOP Market might operate is discussed in this section.

For ease of exposition, it is assumed here that the AOP Market is operated by a Water Market Operator (‘WMO’) and that the physical system is operated by a Water System Operator (‘WSO’); the WMO and the WSO could be within the WMC initially, although at least the WMO should be independent of the network owner/operator in the long run. A participant in the AOP Market is called a RoLU (retailer or large user).

#### 3.4.1. An AOP Market Process in Summary

The principal features of an AOP Market are outlined in the following points.

- The water year is divided into twelve monthly scheduling/pricing/settlement periods. Prior to the first month, each RoLU with source entitlements or contracts, and/or rights to last year’s end-of-year (‘EoY’) water left in storage, submits offers indicating the prices at which it will sell (forward contracts for) different amounts of water in each month at each source location. At the same time, each RoLU with water demands to meet submits bids indicating the prices at which it will buy (forward contracts for) water in each month at each demand location.<sup>17</sup> RoLUs and possibly a ‘water security trader’ (discussed presently) will also submit bids for EoY water to be held for the buyer’s account until next year.
- The WMO clears the AOP Market by maximising the gains from trade defined by RoLU supply offers and demand bids, subject to any constraints in a simplified model of the network – the ‘AOP Model’, which might start as an unconstrained ‘Big Tank’ model and then add constraints if necessary. The result of the market-clearing optimisation is a set of water buys/sells (‘AOP Schedules’) and market-clearing prices (‘AOP Prices’) for each month and each location. If no constraints are binding in the AOP Model, the AOP Prices are the same in all months at all locations. The AOP Schedules are settled at the AOP Prices and are sent to the WSO to be implemented essentially as they are now.

<sup>16</sup> See: “A Water Market for Melbourne; Exploring the Concept”, 14 April 2009, an industry discussion paper developed by Market Reform and Farrier Swier Consulting; a 28 November 2010 review by this reviewer of Topic 4: Pricing and Economic Reform, of the NWC’s Urban Water Project; and a 15 November 2010 submission to the Productivity Commission by this reviewer and Geoff Swier

<sup>17</sup> In principle a RoLU – or anybody else meeting credit requirements – could sell or buy forward contracts in the AOP Market for a future month even without rights to physical water or physical demands to meet in that month, planning to use later trades to close any gap between its forward contract position and its physical position prior to the delivery month. Such speculation would be risky and might be discouraged/prohibited as a matter of policy, at least for (e.g.) regulated retailers.

- Prior to each subsequent month, the WMO repeats the process for incremental quantities, using incremental buy/sell offers from RoLUs for each future month and each location. The incremental AOP Schedules are settled at the new AOP Prices and sent to the WSO for implementation. If nothing has changed since the last monthly process the incremental quantities should all be zero and the monthly prices should be unchanged.
- If the WSO cannot implement the AOP Schedules because of network constraints, it must use workarounds, such as running high-cost pumps or borrowing water from storage or delivering more or less than scheduled; these actions should, as far as practical, be market-based, e.g., the WSO should use the most recent market bids and offers to choose and compensate any required schedule changes. The WSO's net congestion management costs should be recovered with a general levy or tax (most easily, on water users, although this is a detailed design issue). If the costs of such congestion are high or frequent, constraints should be added to the AOP Model so that it produces (more nearly) feasible AOP Schedules. In the longer run, the network can be augmented to relieve the congestion if and when this is cheaper than continuing to manage the congestion efficiently.
- If government does not trust RoLUs to store enough EoY water to meet security criteria, a water security trader can be created to implement a government-approved storage policy by buying additional EoY water and reselling it next year. If government policy is more risk-averse than RoLUs, the water security trader will keep buying EoY water even when RoLUs have stopped doing so, and – if the market is more often 'right' – will lose money on average. If RoLUs hold back from buying EoY water because they fear their 'hoarded' water may be confiscated if their bet on drought pays off, the water security trader may on average make money on its inter-year arbitrage. The water security trader's losses (gains) should be recovered from (returned to) RoLUs with a water security charge (rebate) on all water used.

At the conceptual level, that is about all there is to an AOP Market, although obviously there would be many difficult and controversial details to work out in any AOP Market design process. What such a market looks like to the RoLUs using it, and how it might help to solve some of the problems in urban water, are discussed next.

### ***3.4.2. Delivery and Commercial Operations in an AOP Market***

If source entitlements, such as Melbourne's BEs, are ever to support real water trading, a RoLU with a diverse portfolio of source rights must be able to get its water from its various source times and locations to its various demand times and locations, even when the network may be congested at unpredictable times and locations. If an AOP Market is determining a water price at each location for each month, the RoLU can solve this problem simply by buying and selling (forward contracts for) water at different times and places. The following points explain how a RoLU would do this and other things in an AOP Market.

- The water prices determined in the AOP process are scarcity prices or short-run marginal cost ('SRMC') prices – or at least are the best estimates obtainable in a complex and uncertain world.
- The easiest, and probably best/safest, market strategy for a RoLU (at least one that is small relative to the market) is to start the year by selling (forward) inflow entitlement water where and when it is expected to arrive, buying (forward) water where and

when it is expected to be needed during the year, and offering at its incremental cost any high-cost water to which the RoLU is entitled. The RoLU can/should then make incremental trades in each monthly market to keep its net monthly positions small as events unfold and forecasts change. The delivery problem is solved (except for market price risks, discussed in the next section).

- A RoLU that thinks it can outsmart the market can try to buy low and sell high. For example, if a RoLU is confident in June that other RoLUs are underestimating how dry it will be between then and November, in the initial (pre-July) market it should not sell its November (and later) water forward and should even buy November forwards. If the RoLU is right about the drought, it will be able to sell November water for a nice profit later in the year. But if the other RoLUs were right, and particularly if it turns out to be wetter than even they had expected, the RoLU will have excess November water to sell later in the year, probably at lower and perhaps at distressed prices.
- If the RoLU's total source water equals its total takes for the year and all the water prices are the same all year – as they will be if there is no congestion in the network and no surprises during the year – the RoLU breaks even on all water transactions; in this case, its total delivery costs for the year are just the annual amount paid for network access (which should, ideally, be paid through fixed charges).
- If a RoLU takes more (less) water than it gets under its entitlements and contracts, it buys (sells) the difference at some average of the AOP Prices at the various times and places of its transactions.
- If there is congestion in the network – i.e., if some storages or pipelines or treatment plants or pumps are full (or empty) at some time during the year – the RoLU's water purchase costs for the year may be more (or less, if its implied water shipments are against the dominant flow) than the revenue generated by selling entitlement water; the RoLU's net delivery costs will be higher (lower) than its network charges. But this is just supply and demand at work on a network with scarce capacity, and there are ways to hedge against such congestion prices, as discussed in the next section.
- If conditions change unexpectedly during the year, the forward prices for future months will change during the year and those who guessed right will make more or lose less than those who guessed wrong. For example, if expectations half-way through the year shift toward 'drier', forward prices will increase and expected inflows of natural source water will decrease for the rest of the year. If the new expectations are correct, those who forward-sold more of their water early will have less to sell or more to buy at higher prices later. Those who did not forward-sell as much water will not be hurt as badly, but the reduced quantity of natural water they get may offset the higher prices so even they may be worse off than they had originally expected to be. The only likely winners are those who had fixed-price contracts with non-rainfall-dependent sources, e.g., desal.

This brief description of what it might be like to operate in a metro water market makes it look much more complex than trading in a rural water market – and so it is, because a metro water network is much more complex than a rural river valley. But this description focuses on things RoLUs could do if they wanted to gamble, and on what happens if congestion is significant, surprises occur, drought is extended, etc. In practice, RoLUs are likely to be conservative, and congestion, surprises and drought will (one hopes) be the exception rather



than the rule. But if congestion, surprises and drought occur they will create problems under any system, including a MWC monopoly; an efficient market provides the best incentives to plan for such events and to respond efficiently when they do occur.

### 3.4.3. Financial Transfer Rights ('FTRs')

An AOP Market makes it easy for a RoLU to use a portfolio of water sources to meet a portfolio of water demands: it simply sells its source water where and when it gets it, and buys water where and when it needs it. The problem is that the RoLU is then exposed to the difference between the prices it pays to buy water and the (probably lower, on average) prices it is paid when it sells water. The resulting net payment is just the competitive rent on congested/scarc network capacity, which should be paid for efficiency reasons. But congestion prices can be volatile and unpredictable, and RoLUs would presumably prefer a fixed delivery price.

This problem can, in principle, be solved with a financial contract called a financial transfer right ('FTR'). Unlike other contracts in an AOP Market, an FTR is a contract between a RoLU and the Market Settlement Administrator ('MSA'), not another RoLU. This is necessary because the MSA is the counterparty to all AOP Market transactions<sup>18</sup>, so when congestion appears and the RoLU pays a positive congestion price, the money accumulates in the MSA's account. There is nothing good to do with this volatile and unpredictable cash flow – called 'Black Hole Money' in the Australian electricity market – except to return it to the RoLUs who paid it in some way that does not distort the RoLUs' incentives to respond to AOP Prices.

The win-win solution here is for the MSA to sell 1 ML FTRs, under which the MSA pays the FTR holder any price differential (in \$/ML) between designated sink and source points. A RoLU with a source at A and a sink at B should be willing to pay for an annual FTR the expected value of the congestion prices from A to B over the water year, and if it does so it will have the equivalent of a 1 ML fixed-price delivery contract from A to B, i.e., if the RoLU injects 1 ML at A and withdraws 1 ML at B, any payment it receives under its FTR just cancels the congestion charge it pays. If the MSA sells no more FTRs than are simultaneously feasible on the network, it will always have enough settlement surplus to cover its FTR payments, with less of that pesky Black Hole Money to worry about.

Furthermore, the RoLU is paid the price difference whatever it does, and hence has no incentive to do anything except respond to the AOP Prices. Because an A-to-B FTR is a good hedge for any injection-withdrawal point pair with a price differential closely correlated with the A-B price differential, the RoLU can shop for cheaper water or better customers at other nearby locations and still be hedged against congestion costs. In effect, the AOP Market automatically unbundles the A-to-B FTR (which is a complex bundle of financial rights to many parts of the network) into its constituent pieces, which are then recombined with pieces of other FTRs to create the FTRs that are valued most highly by the market, and the RoLU is paid that value.

A system of FTRs can be complex and difficult to administer and to use. FTRs are used (under various names) successfully in US electricity markets, but how they might work on a

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<sup>18</sup> Or at least the *de facto* counter-party; the MSA may not legally be the central counter-party to all trading (in electricity, the legal treatment differs by market). As the administrator of the settlement mechanism, however, all monies move through its account.

metro water system and whether they would be worth the trouble are matters that would have to be investigated in a particular situation. The point here is that the prices produced by an AOP-type network market and financial contracts can provide the equivalent of firm delivery contracts without reducing market flexibility or incentives.

#### ***3.4.4. Financial Contracting as the Solution to Many Problems***

Any two parties who can buy and sell at the AOP Prices can enter into any sort of financial contract they can agree, and settle that contract against the AOP Prices, with no need for approval by anybody. Such financial contracting is a (relatively) easy way to solve problems that are difficult-to-impossible to solve without efficient pricing.

For example, a RoLU with a non-tradeable inflow entitlement could (in financial effect) sell any amount or any share of its inflow water in any month(s) to any other RoLU (or to a speculator outside the market, for that matter) for any price the parties agree, using a simple contract for differences ('CfD'). Such a CfD would say that the selling RoLU must pay the buyer the net difference (implying the buyer would pay the seller if the difference is negative) between the AOP Price at the inflow location and the contract price multiplied by the contract quantity in each contract month. The buyer could then buy the contract quantity of water at the inflow location at whatever the AOP Price is in each month, knowing that its CfD payment would result in a net price equal to the contract price.

As another example, consider the problem of giving each water user the level of supply security it is willing to pay for, when neighbours on the network may want very different levels of security. This is essentially impossible without the kind of efficient prices an AOP Market can produce, but with such prices and financial CfDs it is easy. Suppose large water user X needs Q ML of water every month, knows it can always buy water at the local AOP Price, but also knows the AOP Price will be financially disastrous during a drought. X can simply contract with a retailer for a CfD under which the retailer will pay or credit X the amount Q multiplied by the difference between the local AOP Price and an agreed contract price P (in \$/ML), when this difference is positive. The retailer can hedge its risk with a source contract and, if congestion is possible during a drought, an FTR from the source to X's location. Any water user can specify whatever Q and P it wants, and the retailer (or several competitive retailers, if and when these are allowed) can price the corresponding CfD. Water users who know they can always get water at the local AOP Price may prefer to self-insure against the price risk, but if enough of them want and are willing to pay for 'drought insurance' CfDs there will be retailers eager to offer them.

## **4. CONCLUSIONS AND RECOMMENDATIONS**

The assessment reports reviewed here – Fisher and Frontier – both focus on urban water rights and entitlements, but come to very different conclusions. The legal analysis in Fisher sees many gaps in Australian urban water law that should be filled, particularly the lack of legally enforceable end-user rights and tradeable delivery entitlements. The economic analysis in Frontier also finds gaps in the legal definitions of rights throughout the urban water cycle, but does not find that these are causing systemic problems and hence recommends that gaps be filled only when and where there is some identifiable reason and way to do so; Frontier also concludes that TDEs (called tradeable end-user entitlements in Frontier) are not promising for potable urban water, particularly compared to other market-based solutions such as more efficient pricing.



This reviewer/economist agrees with Frontier on all the points discussed here, particularly the importance of efficient pricing, but emphasises that there is no good way to get efficient prices without a reasonably efficient market. Decentralised trading of entitlements will not produce efficient trading or pricing on any but simple rural water systems – certainly not on complex metro water systems, but probably not even on simpler urban systems or rural systems with complex hydrology and/or linked surface and groundwater – so something else is needed to support efficient trading and pricing.

The very term ‘water system’ implies a network of some kind. Wherever network externalities are significant, trading of the commodity will be somewhere between inefficient and impossible unless it is integrated with the necessarily-centralised systems and procedures used to manage these externalities, whether it is electricity or gas or water that flows on the network. Just how the network market concepts developed over the past twenty years should be applied in a specific situation depends on ... well, the specifics of the situation. But those concepts, and the experience gained in applying them elsewhere, provide the best starting point for thinking about urban water markets.

This reviewer recommends that the Commission’s Urban Water Project advance the discussion of urban water markets beyond markets in *water entitlements* to markets in *water itself*, and then quickly on to the question of whether and how network market concepts and experience might be applied to metro/urban water systems, and even to those rural water systems where tradeable entitlements are not working well. If urban water markets are ever to become a reality, somebody will have to lead, or at least point the way, in a direction that might actually work.

The model urban water market outlined in this review – called here an AOP Market – is based on sound economic logic and twenty years of successful experience with network commodities that (other than not being wet) have much in common with metro/urban water. A low-risk, low-cost way to explore and develop this model further is outlined elsewhere.<sup>19</sup> The Commission should encourage further development of this urban water market model – along with any others it can find that have a basis in economic logic and real-world experience.

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<sup>19</sup> See: the 28 November 2010 review by this reviewer of Topic 4: Pricing and Economic Reform, of the NWC’s Urban Water Project, and; the 15 November 2010 submission to the Productivity Commission by this reviewer and Geoff Swier