How to pay for a dam

The public and private benefit and payment instrument options for the Waimea Community Dam

NZIER report to Tasman District Council

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Key points

This report considers how to deal with the provision for environmental flows in the proposed Waimea (Lee Valley) Community Dam, and also the provision for future demand for water from irrigation, residential and industrial growth. Both these provisions incur costs for which there is no clear owner, raising the question of whether Tasman District Council (and its ratepayers) have a role in funding on behalf of the community that benefits.

Guiding principles for funding infrastructure services with a high proportion of fixed costs from their high initial construction cost include:

- Each unit of use should recover the marginal cost imposed by that use (which will be low and insufficient to cover the fixed costs)
- Fixed costs can be recovered by supplementary charges in the least distortionary way possible, either based on exacerbator pays or beneficiary pays or a combination of the two
- The base on which charges are set – land area, water volume or value enabled by water – materially affects the distribution of costs across the dam's contributors.

Enhanced environmental flows can provide a range of valuable services to amenity, biodiversity retention, cultural and recreational activities, but these are not readily valued with either market or non-market valuation methods. Many of these services do have the characteristics of economic public goods, so it is efficient for them to be funded by a local council that can tax the community that benefits.

The dam will enable the minimum flow for environmental purposes to be raised to 1100 litres / second from the 800 litres / second in the new rules without the dam. This discretionary environmental enhancement is the marginal benefit of the dam for environmental purposes. This enhancement requires 30% of the dam's design capacity, but the marginal cost may be less than 30% of cost if there are economies of scale.

Dams are long lived structures for which it is easy for current generations to pay most of the cost while benefits extend into a long term future, creating an inter-generational transfer from current generations to future generations. That can be countered by taking on long term debt so that future generations pay more towards the benefits they receive from the infrastructure.

Extending the term of debt from 25 to 35 years, other things held equal, would reduce the costs for TDC on environmental flows and current and future water supply by 11%. This applies whatever the total dam cost, and whatever the share of those costs attributed to environmental flows.

Figures used in this report are illustrative, but they do show that there are substantial cost implications for TDC in the cost allocated for environmental flows and the timeframe over which the dam is paid for. Principles outlined are relevant to determining the share of costs to be split between users now and in the future.

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1. Introduction

Tasman District Council has approached NZIER for advice on the attribution of costs of the proposed Waimea Community Dam, in particular the 30% of the cost proposed to be borne by TDC ratepayers for the public benefit of securing environmental flows. TDC has also asked for advice on how funding for the dam could be split across different contributors in the district, e.g. between general rates on a differentiated or undifferentiated basis, or uniform charges based on water consents or actual use; and about how the costs for providing capacity in the dam for future users should be paid for and by whom.

1.1. The issue in brief

There are two fundamental questions in this request: a) what proportion of the cost of the dam to attribute to the community to cover the “public good” improvement in environmental flows, and b) what instrument would best recover those costs from within the TDC residents (including provision for future use)?

The current proposals provide for allocation of capacity on hydrological considerations, as outlined in Table 1 below.

Table 1 Availability of water from dam in irrigated area equivalents

Allocated to:	**Dam Capacity**						
	Equivalent hectares		***% of Dam Capacity***	***Current***	***Future***	***Current***	***Future***
Environmental							
Environmental flow		3,328	30%	3,328			
Extractive users							
Urban Water Supply							
Current Water Supply (TDC)	620		6%	620		6%	
Future Water Supply (TDC)	780		7%		780		7%
Future Regional Supply (NCC)	515		5%		515		5%
Total Urban Water		**1,915**	**17%**				
Other Users (Irrigators)							
Direct Access to Aquifer							
Current permits	3,800		34%	3,800		34%	
Future Capacity	1,000		9%		1,000		9%
Total direct access		***4,800***	**43%**				
Indirect Access to Aquifer							
Current permits							
Future Capacity	1,050		9%		1,050		9%
Total indirect access		***1,050***	**9%**				
Total Other Users		**5,850**	**53%**				
Total extractive users		**7,765**	**70%**	4,420	3,345	40%	30%
Total Dam (User+Environment)		**11,093**	**100%**	**7,748**	**3,345**	70%	30%

Source: NZIER, from data supplied by Tasman District Council

Current and future uses of water for urban consumption and irrigation purposes have been expressed as equivalent hectares of irrigated land at 300 m^3/hectare/week. The increment of storage required to provide the desired environmental flow of 1100 litres/second at Appleby Bridge has been expressed in similar manner to be 3,328 hectares equivalent, 30% of the total irrigable area equivalents provided by the dam storage. A further 30% of that capacity is being provided for future potential uses, comprising 12% for future urban supply for Tasman and Nelson councils, and 18% for future irrigation. Securing water for TDC's current urban water supply accounts for 6% of capacity, and current permitted irrigation accounts for 34%.

The dam was originally proposed as a co-operative company with voluntary subscription, but this faced problems in covering costs that are unattributable to current users. One way of attracting subscription would be to lower the costs to be recovered by attributing portions of the dam's capacity to environmental uses, to be covered by ratepayers as public goods. Table 2 shows the implications of attributing varying portions to environmental uses, drawing from an economic assessment undertaken by Northington Partners in 2010, which estimated the cost of installing the dam at $41.6 million, with a further $0.4 million in annual operations and maintenance. Annualised over 25 years at a rate of 7.2% (Northington's estimate of TDC's weighted average cost of capital) this amounts to an annual cost to recover from the dam of $4.03 million, which would imply a charge of $519.55 recovered from each equivalent hectare of use from the dam. This level of charges has raised objections from the growers who would be expected to pay them, as they are high relative to the gross margins per hectare earned from some irrigated land uses (e.g. field vegetables), raising questions about their continued viability and what land use activities would replace them.

Table 2 Implications on dam cost recovery of attributing costs to environmental purposes

	Northington	TDC	Excluding environmental shares of			
	2010	2014	10%	20%	30%	40%
	$m	*$m*	*$m*	*$m*	*$m*	*$m*
Cost of installing dam	41.6	69.0	62.1	55.2	48.3	41.4
Annualised over 25 years @ 7.2%	3.63	6.03	5.43	4.82	4.22	3.62
Annual operations & maintenance	0.40	0.50	0.50	0.50	0.50	0.50
Combined annual cost	4.03	6.53	5.93	5.32	4.72	4.12
Annual charge per irrigated hectare	$519.55	$840.69	$763.06	$685.43	$607.80	$530.17

Source: NZIER, drawing on Northington (2010) and TDC

Since the 2010 report the estimated costs of the dam have been revised, and a recent TDC press release stated them to be around $69 million in 2017 when the dam is expected to be built. Annualised on the same basis as the 2010 figures, this would result in a combined annual cost of $6.5 million which equates to $840 per hectare equivalent served by the dam. Excluding costs on environmental grounds lowers the cost per irrigated hectare equivalent to be recovered from the 7,765 hectares equivalent of extractive users. This is illustrated in the right hand columns of Table 2, which suggest it would require more than 40% allocation to environmental flow to recover the increased costs at an annual charge per hectare equivalent at a similar level to that in the 2010 report.

The proposal now is to provide the dam as a council controlled operation, to enable funding through the Council's revenue raising powers and also access to the Public Works Act for compulsory purchase of land. TDC would bear the risk of development but recover costs allocated to different users and activities benefiting from the dam.

1.2. The context

This advice is prepared in light of the Local Government Act 2002 Section 101, which requires councils to consider the following in funding their activities and projects.

(3) The funding needs of the local authority must be met from those sources that the local authority determines to be appropriate, following consideration of —

> (a) in relation to each activity to be funded —
>
> > (i) the community outcomes to which the activity primarily contributes; and
> >
> > (ii) the distribution of benefits between the community as a whole, any identifiable part of the community, and individuals; and
> >
> > (iii) the period in or over which those benefits are expected to occur; and
> >
> > (iv) the extent to which the actions or inaction of particular individuals or a group contribute to the need to undertake the activity; and
> >
> > (v) the costs and benefits, including consequences for transparency and accountability, of funding the activity distinctly from other activities; and
>
> (b) the overall impact of any allocation of liability for revenue needs on the community.

New Zealand Treasury guidelines (2002) recognise two bases on which common costs of services may be recovered: beneficiary pays and exacerbator pays. The Act's section 101(3)(a)(ii)-(iii) reflects the "beneficiary pays" principle, that costs should be borne in proportion to the benefits created by the shared infrastructure. Section 101(3)(a)(iv) expresses the "exacerbator pays" principle, that costs should be borne by those whose actions necessitate the building and maintenance of infrastructure.

The question of who should pay for the environmental flow component of the Waimea Dam also needs to be seen in the context of the Resource Management Act and its purpose (as expressed in Part II) of sustainable management of natural and physical resources, which the Act defines as enabling communities to provide for their well-being while observing certain environmental constraints. The affordability of new infrastructure affects the current consumption possibilities of residents/ratepayers, so is relevant to consideration of community well-being.

This paper proceeds by

- Setting out general economic principles and considerations in the provision and payment for long-lived infrastructure;
- Applying those principles to the particulars of the Waimea Dam proposals.

2. Paying for long lived infrastructure

The Waimea Dam is being proposed to provide security of water supply, to both extractive users like irrigators and the reticulated water supply system for residential and industrial users, and in-stream “environmental” use. If built it will have the following characteristics:

- A large piece of infrastructure which would be difficult and costly to replicate in the context of the Waimea catchment – i.e. it would occupy a virtual monopoly in provision of water augmentation in the catchment
- Its scale means it affects a broad range of users, both extractive and non-extractive “passive use” beneficiaries
- If the dam is to secure funding to proceed it needs to generate revenue flows to allow it to at least break even.

The building of any large long-lived infrastructure faces the problem of paying for the initial investment. Economics has established principles for applying to infrastructure like dams, flood-banks, roads and reticulation networks. It uses discounted analyses in economic assessment to account for effects that occur at different time periods, and to draw conclusions about the efficiency of resource uses.

Efficiency looms large in economic assessments, because it is both capable of being measured and it provides guidance on how to make the most of available resources. Other criteria that can enter into economic considerations include the equity or “fairness” of an arrangement: this depends on socio-political value judgements about which economics has no clear contributions to make, beyond identifying how actions affect the distribution of costs and benefits across the economy. Another criterion is that of sustainable management of natural and physical resources, as stated in section 5 of the RMA, which can be approached in economics by considering how actions affect the probability of natural and environmental resources surviving as a source of value to future generations.

Government guidance on recovery of shared costs from public investments suggest using the exacerbator pays or beneficiary pays principles, or a combination of the two. These guidelines are reflected in legislation, including the Local Government Act (see s 1.2 above), the RMA and the EEZ and Continental Shelf (Environmental Effects) Act. Exacerbator pays provides a floor for cost attribution, for it would be clearly inefficient to charge a group less than the costs they impose on the environment or infrastructure in question. Similarly it would be inefficient to charge the group more than the benefits it obtains from the infrastructure. These guidelines provide a fairly wide band within which efficient cost allocation of joint costs across groups will fall, but little precision of just how much to allocate to whom.

The economic principles that are particularly relevant to the provision and cost recovery for a dam include:

- The nature of environmental benefits and their value
- The characteristics of public goods and their implications for decision-making and provision
- The principles of efficient pricing of infrastructure services
- The role of intergenerational transfers in optimal provision and funding of infrastructure.

We outline the main points and principles here, to guide the expectation of what might be an efficient means of paying for the Waimea Dam.

2.1. The value of environmental benefits

Although environmental effects are often not traded in markets they still have economic value. Changes in environmental condition can be assessed following the approach of the Millennium Ecosystem Assessment (MEA 2005),[1] which sees the environment as a collection of natural assets delivering a number of services of value: provisioning services (e.g. sufficient water), regulatory services (such as waste assimilation and nutrient recycling), cultural services (e.g. creating settings valued for their amenity, recreational or cultural uses) and supporting services (e.g. general ecosystem functioning that supports the other service flows) (Figure 1).

This framework suggests freshwater resources can be important for all the categories of ecosystem service except fibre and fuel – and in view of the kinetic energy stored by a head of water, they can be viewed as contributing to "fuel" for motive power and electricity generation. More obviously they provide supporting services (waste assimilation, detoxification and nutrient cycling), regulatory services (biodiversity retention, micro-climate regulation through soil moisture replenishment) provisioning services (as source of food products and water) and cultural services (through creating settings for recreation, amenity and cultural associations).

Under the MEA approach environmental effects are not services but factors that affect services. As the RMA is oriented towards managing effects on the environment, effects need to be translated into their service impact to assess their likely economic value.

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1 Millennium Ecosystem Assessment, (MEA 2005) Ecosystems and Human Well-being: Synthesis. Island Press, Washington, DC.

Millennium Ecosystem Assessment, (MEA 2003) Concepts of Ecosystem Valuation Chapter 6 in Ecosystems and Human Well-being: a Framework for Assessment; Island Press http://www.maweb.org/documents/document.304.aspx.pdf

Figure 1 Natural value: types of ecosystem services

Provisioning services	**Regulating services**	**Cultural services**
Products obtained from ecosystems	Benefits obtained from regulation of ecosystem processes	Non-material benefit obtained from ecosystems

Supporting services
Services necessary for production of all other ecosystem services

Examples of ecosystem services	**Ecosystem**									
	Cultivated	Dryland	Forest	Urban	Inland water	Coastal	Marine	Island	Mountain	Polar
Cultural & amenity	●	●	●	●	●	●	●	●	●	●
Freshwater			●		●	●			●	●
Food	●	●	●	●	●	●	●	●	●	●
Fibre & fuel	●		●			●				
Novel products	●	●	●		●		●			
Biodiversity regulation	●	●	●	●	●	●	●	●	●	●
Air quality & climate	●	●	●	●	●	●	●	●	●	●
Natural hazard regulation			●		●	●				
Human health		●	●	●	●	●				
Detoxification		●	●	●	●	●	●			
Nutrient cycling	●	●	●		●	●	●			

Source: Millennium Ecosystem Assessment 2005[2]

As environmental effects are not traded in markets there are no readily observable monetary values to be attached to them. But economic values for such non-market effects can be inferred in various ways, such as:

- The avoidable tangible costs caused by environmental effects on activities: for example, a river's curtailment of damage caused by droughts
- The cost of the next best alternative means of providing the same service as the environment (e.g. cost of alternative supply of water other than in situ natural sources and flows)

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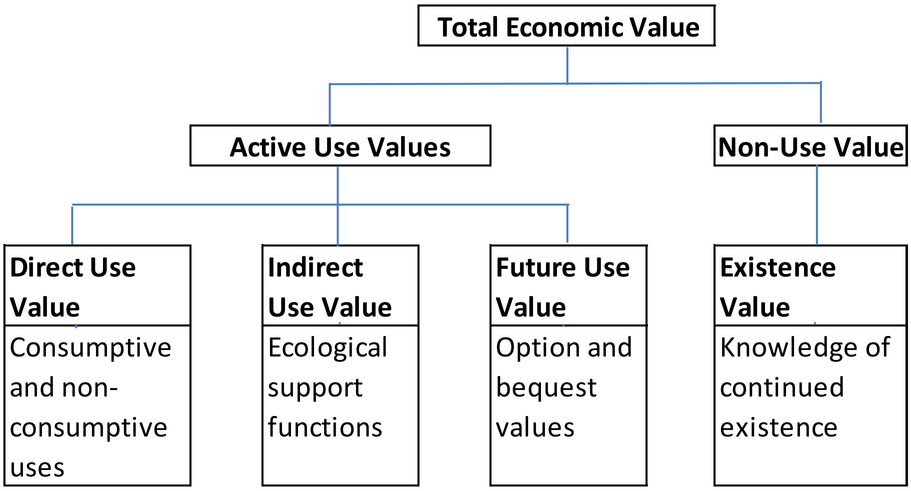
2 Millennium Ecosystem Assessment, (MEA 2005a) *Ecosystems and Human Well-being: Biodiversity Synthesis*. World Resources Institute, Washington, DC. http://www.maweb.org/documents/document.354.aspx.pdf
Millennium Ecosystem Assessment, (MEA 2005b) *Ecosystems and Human Well-being: Synthesis*. Island Press, Washington DC.

- Value inferred from the price of associated marketed goods (e.g. the “revealed preference” approaches such as inferring a value premium in property prices in proximity to clean waterways)
- Estimating public willingness to pay to secure environmental outcomes from direct questioning of a sample of those affected – the “stated preference” approach - which depends on clear articulation of an environmental change to which the surveyed population can respond.

The value to people of ecosystem services has a number of components which are not often separable. The “Total Economic Value” of natural assets comprises “use values” (such as the value of current fish catches), “future use values” (such as the option value of retaining fish stocks for future catches) and “non-use or passive-use values” (an expressed preference for continued existence of a resource, irrespective of expectations of use) (Figure 2).

Figure 2 Components of Total Economic Value



Source: NZIER, Pearce & Warford 1993, Pagiola 2004[3]

Stated preference non-market valuation methods have received a lot of attention for capturing future use and non-use components of value which are not fully covered by other valuation methods. Such methods received wide recognition following the 1989 *Exxon Valdez* oil spill, as a result of which the so-called “NOAA” panel[4] of experts (including two Nobel laureate economists) provided a set of

3 Pearce DW & Warford JJ (1993) *World without end*, Oxford University Press; Pagiola S, von Ritter K & Bishop J (2004) *Assessing the economic value of ecosystem conservation*; The World Bank, Washington DC

4 NOAA stands for the US National Oceanic and Atmospheric Administration www.noaa.gov

recommendations for valuations suitable for use in judicial settings.[5] The practical usefulness of this endorsement of stated preference methods divided opinion at the time[6] and continues to do so.[7]

Over a hundred non-market valuation studies of willingness to pay for environmental attributes are recorded on the New Zealand Non-market Valuation Database at Lincoln University[8]. They address the economic value of terrestrial sites or species, recreation or water quality, but most are site- or species-specific, with results which vary with methods used and contextual factors. Such non-market valuation studies commonly result in high values for obscure species relative to what New Zealanders are observed to pay towards conservation, and the techniques may be distorting responses and deriving values that are not strictly comparable with other costs used in economic assessments.[9] Very few have been relied on in policy decisions in New Zealand to date. More attention to validating results against observed behaviour is required to provide greater confidence in the results.

Although some researchers advocate using results of non-market valuation studies in one setting to infer values applied in similar settings elsewhere – a process known as "benefit transfer" – this depends on the existence of sufficient reliable studies and details of their implementation from which to control for the contextual factors that influence the result. Reliable, precise estimates of non-market values for environmental flows in this case do not exist and would be costly and time-consuming to obtain.

The economic value of the augmented flows in the Waimea will be a composite of tangible effects (value for irrigation, replenishment of aquifers) and less tangible components (retention of habitat for biodiversity, fishing or hunting). The non-market component will have a mix of use and non-use value, but there is little evidence in New Zealand of how big they might be.

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5 Arrow K, Solow R, Portney PR, Leamer EE, Radner EE & Schuman H (1993) "Report of the NOAA Panel on Contingent Valuation": Federal Register, 58(10) 4601-4614

6 Diamond, P.A and Hausman, J.A (1994) 'Contingent valuation: is some number better than no number?'; *J. Econ. Perspectives* 8(4), 45-64.; Portney P (1994) 'Contingent valuation debate: why economists should care'; *J. Econ. Perspectives* 8(4), 3-17

7 Carson R (2012) 'Contingent valuation: a practical alternative when prices aren't available'; *Journal of Economic Perspectives*, 26(4) 27-42; Haussman J (2012) 'Contingent valuation: from dubious to hopeless'; *Journal of Economic Perspectives*, 26(4) 43-56; Kling CL, Planeuf DJ & Zhao J (2012) 'From Exxon to BP: has some number become better than no number?'; *Journal of Economic Perspectives*, 26(4) 3-26;

8 Lincoln University (2012) New Zealand Non-market valuation database; http://www2.lincoln.ac.nz/nonmarketvaluation/

9 Clough P (2010) Realistic valuations of our clean green assets, NZIER Insight 19/2010 http://nzier.org.nz/sites/nzier.live.egressive.com/files/NZIER%20insight%2019%20-%20Realistic%20valuations%20of%20our%20clean%20green%20assets.pdf

2.2. Role of public goods

Public goods in economic terms are those that are both non-rival and non-excludable in consumption: non-rival because once provided, they are available for all to use without detracting from their availability for others' use and non-excludable because it is impracticable to monitor and charge for use and exclude non-payers from enjoying the benefits. If private firms cannot exclude users or make them pay for services, private investment in public goods will be less than the socially optimal level, so governments commonly intervene in such goods' provision, recovering their costs by taxing the community that benefits.

Taxing current generations will reduce their private saving and capital accumulation for future use, so public investment is both an antidote to a market failure caused by public good characteristics and a substitute for private capital. Public capital is efficient as long as the public investments are chosen carefully and the return from public capital exceeds that which would have been earned from private capital.

The classic examples of public goods are defence at national level, and street-lighting at local level, as each provide a service that is non-rival and non-excludable for the scale at which they occur. Historically many more services have been provided as if they were public goods than are now recognised as such, including infrastructure such as power generation and transmission facilities which are delivering a service (electricity) which is clearly rival in consumption. There are also now recognised to be variants on the pure public good e.g.:

- Non-pure or congestible goods, where consumption is non-rival up to the point where capacity is fully utilised, but they become rival in consumption and congested beyond that point – in effect the marginal cost of adding an extra user is close to zero below the threshold of congestion, but can be quite costly beyond there. Roads are an example of a congestible good.
- Common pool goods have high rivalry but low excludability, as exemplified by marine fisheries which are prone to over-capitalisation (too many boats) and a wasteful race for fish unless restrained by property rights to the fisheries defined through such measures as individual transferrable quota.
- Toll goods are highly excludable but exhibit low rivalry most of the time, as exemplified by wastewater networks and long distance power transmission.
- A variant of toll goods are so-called club goods, where use may be non-rival or congestible but the assets that provide the goods are excludable at reasonable cost. This is a characteristic of club facilities, where it is feasible to exclude non-members, but where facilities themselves are often non-rival for much of the time and may not warrant the transaction costs of fee charging. It is also a characteristic of many local government services such as parks and streets which are excludable by virtue of distance which excludes non-residents from receiving much benefit from them.

Infrastructure services are generally not pure public goods as they display varying degrees of rivalry in consumption (congestion), but both their large scale and low marginal costs per unit of use give them characteristics similar to public goods. In addition, some infrastructure may provide spin-off benefits that more closely fit the public good definition, such as river management that is adapted to maintain natural habitats in particular conditions.

Table 3 illustrates a division of infrastructure facilities in terms of their varying degrees of rivalry and excludability in consumption. Those towards the bottom right hand corner of the table are close to private excludable goods and provide little basis for provision as public goods. Those towards the top left hand corner have more of the collective characteristic of public goods and have been provided as if they were public goods. Common pool goods are those that have high rivalry but low excludability, i.e. it is impractical to charge for individual use, but they are still subject to congestion. Toll goods are more in the nature of "club goods", in which use is excludable at reasonable cost and they are less likely to suffer congestion.

Table 3 Public good characteristics of infrastructure

CHARACTERISTICS OF INFRASTRUCTURE SERVICES: RIVALRY AND EXCLUDABILITY			
		Rivalry in consumption	
	Low	Medium	High
Excludability of consumption	*Public goods*		*Common pool goods*
Low	Traffic control on roads, airports/airways, harbours		Urban tertiary roads
Medium	Railway switching & signalling; National trunk roads, rural tertiary roads; urban transport signalling	Surface irrigation dams & canals; secondary roads	Water supply piped - common terminal equipment (e.g. fire hydrants)
High	Wastewater management, street sewers, treatment plant & pumping stations	Airport runways & gates; Ports and piers; Railway railbeds; Telecomms basic networks, local & long distance; Mass transit tracks & rails	Airport ground services; Power generation, transmission, distribution; Loading equipment for ports, rail & air services; terminal equipment in telecomms; piped water terminal equipment
	Toll goods		*Private goods*

Source: NZIER, adapted from Kessides 1993

Dams occupy a middling position in the table, for although they provide services that are largely excludable and rival in consumption (water allocation) they also perform functions that are not (river flow regulation). The determining characteristics are of the services provided rather than the physical infrastructure itself, and dams have a wider range of externality effects than other infrastructure as they are an integral part of a wider "infrastructure" of naturally occurring water bodies.

Even where infrastructure services have characteristics similar to public goods, this does not mean they are necessarily best provided through a public agency. Taxpayer subscription may be necessary to obtain the socially desired level of service, but this could be channelled through a publicly owned entity or contractual arrangements with private suppliers, depending on the capabilities, costs and risks of the options, and their likely effectiveness, efficiency and equity in practice.

Against these characteristics the condition of natural environmental resources, like the quantity and quality of in-stream water in natural watercourses, has the appearance of a public good. Environmental quality is often under the control or regulation of public or government agencies, and the cost of those agencies' activities is commonly covered by their respective taxpayers. But that does not necessarily mean the full costs of providing for environmental quality are covered in that way: the cost of regulation commonly falls on those being regulated. Identifying something as a local public good is not sufficient to conclude that its full costs should be covered by local taxpayers.

2.3. Options for efficient pricing of infrastructure

Efficient pricing of goods and services arises when price is set at the marginal cost of the goods and services used, but this does not work well with infrastructure services where high initial costs translate to high fixed costs incurred irrespective of use. The marginal cost per use is very low, so pricing at marginal cost for such infrastructure would not ensure sufficient revenue to cover its costs. A supplementary charge component is needed to recover the fixed costs if the project is to break even. There are various choices:

- Average charge per user: this averages the total cost of service supply in the year by some measure of the benefitting population. However, this is generally not efficient as it means some people will have to pay more than the marginal value they get from the service. If payment is voluntary, the high price can deter use and lead to deficit in revenues, and also in less of the service being used than would maximise the value from the underlying assets. Even if people have to subscribe to the service (as in public infrastructure) inefficiency remains as people are required to pay more than their marginal benefit.
- Fully distributed costs (FDC): the charge per user aims to recover the marginal (variable) cost of use plus a share of fixed costs distributed according to some measure of use or interest in the infrastructure – e.g. water allocated or used. This is more efficient than average cost pricing to the extent that the method of distribution more closely matches individual users' benefits received or contribution to exacerbation, but it is still inefficient in charging some more than their marginal benefit gained. The distribution of cost recovery across the population depends on the base used to determine the fixed cost recovery – different results will be obtained if distributing according to the volume of water used, the amount of demand in irrigated hectare equivalents, or the value of production gained from the augmentation of water supplies.
- Ramsey pricing: the charge per user recovers the marginal cost of use plus a share of fixed costs, where the latter are loaded onto each charge in inverse proportion to the users' demand elasticity – i.e. those whose demand is most price sensitive pay least towards fixed costs, and vice versa for the least price sensitive. This is more efficient than average cost or FDC pricing as it is less distorting to use of service and ensures better utilisation of capacity. But it is difficult to determine the price elasticities to implement this precisely.

- Multi-part pricing: this has explicitly separate charges for use (covering marginal cost) and access/membership (contribution to fixed costs). It is the most efficient because the use charge is closest to marginal cost and least distorting of use. The access charge can also be based on Ramsey principles, differentiating between the most and least price-sensitive users seeking access to the infrastructure. This is an approach commonly used for club facilities, with a membership fee and charges for congestible facilities used.
- Optional multi-part pricing: this also enables a range of charge options to be offered so that users can choose the method that suits their use patterns best, increasing the volume of use and the range of users over which to spread the fixed costs. Examples include any service that offers season tickets or individual use charge options, car hire companies that offer payment by kilometre or daily rates with unlimited kilometres, and telecommunications companies offering a range of plans and pre-pay options with varying mixes of use charge and access charge.

One further characteristic of infrastructure pricing is that it is common to charge higher for use at peak times, as it is use in the peak that causes congestion and drives the need for upgraded capacity. This is partly an expression of exacerbator pays – charge more for those whose peak use necessitates costly upgrades – but also partly beneficiary pays, as peak prices will only be paid by those willing to pay the higher prices who get benefit from use in the peak periods, while others may find it worthwhile to shift their use out of peak periods. Peak pricing both raises revenue and regulates use by incentivising demand restraint at periods when the infrastructure supply is tightest relative to demand.

This brief review of price options suggests that setting a charge at a flat rate per unit of irrigable land, although administratively simple to apply, is unlikely to be the most efficient means of recovering costs for infrastructure such as a dam. As a pricing mechanism it is likely to distort water use behaviour, encouraging land use changes to higher yielding (and more water intensive) enterprises than the current mix in the district, creating costs and disruption in the transition. It would be more efficient (although administratively more complex) for dam charging to recognise that the costs of the dam are necessitated by growing demands for water in the peak summer period when water flows are lowest, and use charges that, at least in part, differentiate by actual water use and individual contributions to peak demands.

2.4. Role of intergenerational transfers

Infrastructure often consists of very long-lived assets, so decisions on what to build and how to fund it have inter-generational implications. There is in principle a “Golden Rule” level of investment at which the present value of consumption is maximised across present and future generations. There can be too much capital accumulation if investment costs are borne mostly by current generations, reducing their consumption for the benefit of future generations. Conversely there can be too little capital accumulation if current generations consume too much, increasing costs borne by the future (as in the case of deferred maintenance of capital in favour of current consumption). The correct balance is an empirical question and depends on assumptions made about discount rates and the contribution of infrastructure to future incomes. However, the Reserve Bank of New Zealand has estimated that a range of investments in property, shares, farms and fixed interest instruments have had higher rate of return than New Zealand's long term rate of economic growth, suggesting that New Zealand does not suffer from over-accumulation of capital (Coleman 2012).

If all the benefits of a public investment are captured by the generation that builds it, it is efficient for that generation to tax itself to the point where the return from public investments is equal to the opportunity cost of private investment forgone. However, in the case of durable public goods that create benefits captured by subsequent generations, such a pattern would be unduly restrictive on current consumption and give future generations a partial free ride on the infrastructure they inherent. Private investment can also be less than optimal, so it can be efficient for governments to intervene to achieve a more socially optimal level of investment. It is efficient for the current generation to spread the cost into the future by incurring debt, leaving more in their pockets for other private investment and current consumption, and shifting to future generations more of the cost of infrastructure they use, reducing the inter-generational transfer.

The stock of public capital can be raised with little decrease in local private capital accumulation if debt is purchased by foreign rather than local lenders. If increases in long lived public infrastructure are funded directly on a pay as you go basis, the first generation pays a disproportionate share of the cost, creating implicit transfer to future generations. If funded by debt repaid by taxes, future generations face more of the cost of infrastructure and there is less inter-generational transfer.

Enduring natural and environmental resources are capital assets with inter-generational significance. An economically sustainable resource usage path is one in which the present value of current and future welfare derived from resources is non-declining over time. This depends on the assumption that when one generation uses natural resources it can create sufficient inter-generational assets to improve the well-being of future generations as well: e.g. it can create artificial capital of equivalent or greater value than the natural resources it is depleting.[10] As natural or environmental capital becomes increasingly scarce, its social value rises and it becomes worth giving up more value from further depleting the resource to secure the current use, future use and non-use benefits of its conservation.

A society can consume too much of a natural or environmental resource if its price is too low relative to its social cost, as is the case of resources that have poorly defined or unenforceable property rights or characteristics of open access giving rise to the well-known "tragedy of the commons" – too many resource users with incentive to exploit a fixed stock of resource before others do leads to excessive expenditure of effort on exploiting the resource, in turn causing overuse, degradation and too little conservation for the future. If a society depletes its natural resources too quickly, or

[10] Depletion of natural resource creates an "economic rent" or value in excess of its costs of use, and in theory this rent can be invested in other capital to create a sustainable flow of income into the future from which current and future generations equally benefit. In practice this is rarely done, and examples such as Norway's sovereign wealth fund from the royalties from its oil production are notable as exceptions rather than the rule.

pollutes too much, there is an inter-generational transfer which can leave the future worse off and with no redress on previous generations whose decisions caused this outcome. To the extent that environmental degradation is capitalised into property values, some of the future costs of clean-up will also be borne by current generations, but this will not be efficient if the adverse effect on property value is spread more widely than those whose actions have most impact on causing the degradation. In principle depletion of environmental resources or natural capital should be "priced" directly to reflect the societal cost of that depletion, so every decision on resource use faces the full social cost of that use.

Although taking on debt can be contentious for councils and other public bodies, it is efficient to build up debt to pay for well-chosen investment in long-lived assets that will benefit future ratepayers. While sound public finance requires that the current account should be run in balance, deficits are okay if they indicate net investment in capital projects that yield long term net benefits. Work done by Local Government New Zealand indicates that New Zealand Councils are fiscally responsible on the whole – if anything too cautious in paying too much from current ratepayers and too little on future loan repayments on long lived assets.[11] Although there may be uncertainty about the long term growth of population and the rating base to fund future repayments that should not preclude the use of debt to fund future-oriented infrastructure which can generate future revenue streams.

[11] http://www.lgnz.co.nz/assets/Publications/Fiscal-measures-parameters-and-benchmarks.pdf

3. Application to Waimea Dam

In this section we consider how the principles outlined in section 2 can be used to inform the attribution of costs of the Waimea Dam to Tasman District Council (TDC), and what choices the Council has among instruments and timing of repayments for distributing costs among its current and future residents. This assessment is stylised and high level rather than focusing on the detail of who gets to pay what, in order to focus on the direction of cost allocation and its efficiency and inter-generational consequences.

We understand the likely cost of the Waimea Dam is currently uncertain until actual tenders for building have been received, but that TDC currently expects a cost of around $69 million and is likely to use figures of $60 million, $70 million and $80 million in public consultation. We use this range of costs as our starting assumption for the cost of the dam, annualised at 6.5% over 25 years, as summarised in Table 4.[12] We also follow the convention of assuming that any costs incurred to date in considering the future dam are "sunk" costs of no relevance to the decision on whether to commit future spending on implementation of the dam.

Table 4 Distribution of capital costs

Capitalised over	*25*	*years at*	*6.5%*
	$m	*$m*	*$m*
Total capital cost	60	70	80
	$m/yr	*$m/yr*	*$m/yr*
Annualised $m/yr	4.92	5.74	6.56
Attributed to			
Environmental flow	1.48	1.72	1.97
Extractive users			
Current Water Supply	0.27	0.32	0.37
Future Water Supply	0.35	0.40	0.46
Total Water Supply	0.62	0.72	0.83
Future Regional Supply	0.23	0.27	0.30
Current permits	1.69	1.97	2.25
Future direct access	0.44	0.52	0.59
Future indirect access	0.47	0.54	0.62
Total $m/yr	**4.92**	**5.74**	**6.56**

Source: NZIER

12 The annualisation is based on a table loan formula that has a constant repayment throughout the term, and is different from TDC's practice of repaying a constant annual portion of principal plus interest, with declining annual repayments over time.

Following the physical capacity proportions in Table 1 above, environmental flows are allocated 30% of the dam costs, current water supply is allocated 6% and future water supply use for TDC is allocated 7%. On the same basis percentage shares are allocated to regional future supply (potential Nelson City demands) and both current and future irrigation uses. Assuming TDC can recover the costs of current and future uses from the users and ratepayers that stand to benefit from the dam, this still leaves the environmental flows and regional future demands as unattributable to specific beneficiaries in Tasman District. These amount to 35% of the cost of the dam and, in the absence of funding from outside (e.g. Nelson City Council) would fall on TDC's general ratepayers by default. On the same basis current irrigators would meet 34% of the cost and future irrigators 18% of the cost.

The TDC Long Term Plan 2012-2022 gives details of prospective income, expenditures and balance sheet changes over an 11 year period (including provision for the dam at a lower cost from year 4). This shows the council relies on rates for about 60% of its income, with a share rising from 56% in 2011/12 to 62% in 2021/22. The rates split between general and targeted rates changes from 52:48 at the start of that period to 49:51 at the end, with a slight increase in share of total rates attributable to targeted water rates. Total rates rise from $60.4 million in 2012/13 to $101.9 million in 2021/22, at an average annual rate of increase of 6.1%. The average annual increase of general rates is 4.3%, of targeted water rates 9.0%, and of other targeted rates 7.7%.

Against this background and the three cost levels for the dam shown in Table 4, the annualised costs of TDC's share of the dam are equivalent to an additional 3-4% of its total rates in 2013/14, and respectively to 21%, 25% and 29% of annual finance charges, and 11%, 13% and 14% of the Council's current and non-current public debt. These are significant additions to the accounting figures. The Council does not have depreciation reserves to soften the impact on its ratepayers.

3.1. Cost allocation matters

3.1.1. What are the costs to be allocated?

Table 1 in section 1 above indicates the derivation of the proposal that 30% of the cost of the dam should be attributed to environmental flow enhancement, and by implication to TDC's general ratepayers as a local public good. The proposal is based on the assumption that provision for environmental flow enhancement is an additional or marginal cost imposition on the dam project to be allocated accordingly, but that depends on the correct identification of the marginal or incremental component.

In their 2010 report to the Waimea Water Augmentation Committee (WWAC), Northington Partners on page 5 describe the reasoning behind provision for environmental flows in the storage capacity.[13] This assumes a minimum in-stream environmental flow of 600 litres/second at Appleby Bridge could be met with 8.2 million m^3 capacity while meeting unrestricted demand in the design drought. WWAC has elected to provide enhanced stream flow of 1100 litres/second, raising the storage requirement to 12 million m^3, leaving an incremental storage capacity of 3.8 million m^3, approximately 30% of the overall live storage volume.

Since that report was written, Commissioners have considered a range of flow/rationing and allocation combinations including 500, 650 and 800 litres / second, to compare the best minimum flows for the full range of values of the river. The Commissioners' PC 45-48 Hearing Report made recommendations on the strength of which TDC has adopted changes to the Tasman Resource Management Plan with new rules for water allocation, based on a minimum flow of 800 litres/second without the dam, or 1100 litres/second with the dam. The low flows of 500 and 650 litres/second were not considered to provide sufficient protection to all extractive and in-stream uses of the river, and even 800 litres / second was considered a compromised environmental flow. However, as 800 litres/second is an acceptable minimum without the dam, the incremental gain in environmental flows from the dam would be the 300 litres / second additional flows to meet the higher minimum, a 37% increase. The additional storage required to meet this new minimum indicates the incremental cost of the environmental flow.

The incremental cost of extra capacity

The foregoing discussion has been based on the expectation that 30% of capacity translates to 30% of the cost, but this may not be the case. There are economies of scale in dam construction such that increments of capacity can be added at less than proportional increments of cost: much of the cost is in securing the foundations for the dam and associated structures which can be enlarged and strengthened at relatively low cost.

The relationship between scale and construction cost is a matter for engineers to determine, and may already exist in estimates of variants of the current proposal.

3.1.2. Public and private goods in cost allocation

As indicated in section 2.2 above, public goods are those things which are non-rival and non-excludable in consumption and best provided with support from a public authority able to tax the community that benefits. Maintaining increased river flows for environmental enhancement provides services that fit the description of a public good in that they are practically non-excludable and non-rival, with benefits widely enjoyed across the community. But it may also provide services that produce private benefits that are not public goods.

13 Northington Partners (2010) Financial and Economic Assessment of Water Augmentation in the Waimea Catchment; report to Waimea Water Augmentation Committee

Such private benefits can arise if the enhanced river flows improve soil moisture, raise the water table and aid recharge of aquifers in land adjacent to the river. These are private benefits because they can reduce drought stress on plant and animal production which will raise outputs or reduce costs for private land uses. How significant these are for an incremental increase in minimum flow from a statutory minimum of 800 l/s to 1100 l/s is a matter for hydrologists and agronomists to determine, before attempting to attach an economic value to this service of the dam.

If it does result in a significant value gain for landowners, it would in principle be efficient to charge them up to the expected value gain from the flow, although in practice it would be difficult to determine a level of charge appropriate for different land uses, given the variation in soil types and current land uses in the valley. We have no way of determining how significant these benefits might be, but suspect they may be less than the margin for error around estimating them.

Public good benefits include improvements in amenity, in biodiversity habitat, in the cultural associations of healthy rivers and enhancement of the river as a setting for recreation and related activities (e.g. fish harvesting). In principle there is an economic value from enhancements in environmental flows, which may be manifested in changes in the price of properties alongside improved stretches of waterway, the implicit value of increased recreational activity along such stretches (where value is obtained by such things as savings in travel costs incurred to access alternative sites),[14] or the more intangible sense of well-being from knowing the river is in better health and providing habitat for wildlife.

We have not found much evidence of uses of the Waimea River that could quantify the non-market values. The Waimea River Park Management Plan (2010) describes the Council's policies towards maintaining the river berms primarily for soil conservation. It notes the park as a rare accessible strip of natural surroundings in an intensely developed rural landscape and it identifies a wide range of recreational uses in and along the river, including swimming, walking, fishing, hunting, horse-riding, cycling, boating and four-wheel driving, but it gives no indication of the scale of this activity or its sensitivity to water flows in the river.

As indicated in section 2.1 above, there are no readily available economic values to apply to the environmental flow improvement caused by the Waimea Dam. In such cases authorities commonly do not explicitly value such improvements in economic terms, but rather implicitly weigh up the change in bio-physical conditions in other ways. The economic question then becomes, is the improvement "worth" the opportunity cost of resources used or regulation employed to achieve the improvement? This comes down to a value judgement that may be informed by what value has been inferred in similar situations elsewhere, but is rarely dependent on such comparisons because other situations are not exact analogies and have distinct contextual characteristics that can influence the result.

[14] Note that although changes in property value or in recreational travel costs are also "private" values, non-market valuation does not use them directly, but rather inputs them into econometric analysis to infer a value for the environmental service being examined. The result is therefore a generalised value to non-specific people for the amenity or recreational benefit provided by the environmental feature which is used as an indicator of value of the public good.

Priorities among water uses

There is a question for legal interpretation of where the RMA would see the onus of responsibility lying for additional storage capacity required to ensure environmental flows. For instance, there are two basic options for viewing whether the environment, or the needs of communities, have the prior claim to water flows e.g.:

- In one view, the natural river flows exist and the minimum flows determined by the regional or unitary authority must be maintained, so any extractive use is constrained by the limits that creates on water availability, and any augmentation is primarily caused by and attributable to the extractive users;
- In another view, the natural river flows are a resource to be utilised through allocations authorised by the regional or unitary authority, so the imposition of a minimum in-stream flow is a restriction on those allocations and the economic potential they provide, so the costs of augmentation are attributable to the change in rules driven by community views of the importance of water, with costs attributable to that community.

The first bullet is most aligned to an excerbator pays position that would be seeking funding for the dam in proportion to measures of the costs imposed on the natural environment. Such an approach might consider collecting more from those who use water in peak periods when demand is highest relative to natural flows, as it is use in the peak which generally drives expansion of capacity in collective infrastructure. Such an approach however would face practical difficulties in monitoring use in the peak which could change as land uses change. That in turn creates a risk of a mismatch between revenue collection and costs needing to be met.

It is the second bullet that appears implicit in the current proposal that the community of Tasman District ratepayers should pay 30% of the Waimea Dam to cover the cost of providing additional capacity to secure environmental minimum flows. The current proposals are more aligned to the beneficiary pays principle. As some allocation of minimum flow is provided for through statutory processes (as described in section 3.1.1 above) it is only the 300 litres / second incremental enhancement of the minimum flows that is open to question.

To value this increment it is necessary ideally to consider the biophysical effects of the increment on services to amenity, biodiversity, cultural and recreational use, attach values to each of these incremental gains and compare these combined totals with the incremental cost. For instance, if data on river flows and associated water quality indicators exist, it would be possible to determine how many days in the year were not suitable for non-market uses such as recreation or biodiversity retention, how that would change with the higher water flow, and what that implies for the value of the improvement in terms of the consumption of recreation or reduced risk to biodiversity. In practice we have found neither the values nor biophysical effects with which to do such calculation.

3.1.3. Cost recovery over time

As indicated in Table 1 above, about 30% of the capacity of the dam is being provided for future use, including 7% for TDC’s urban and industrial uses, 5% for regional use by Nelson City Council, and 18% for future increase in irrigation area. Providing for the future can be less costly than building new or adapted schemes when new demand materialises, but raises the risk of building excess capacity should the demand not materialise as soon as intended, reducing the pool of beneficiaries and increasing the average costs for those subscribing to the project.

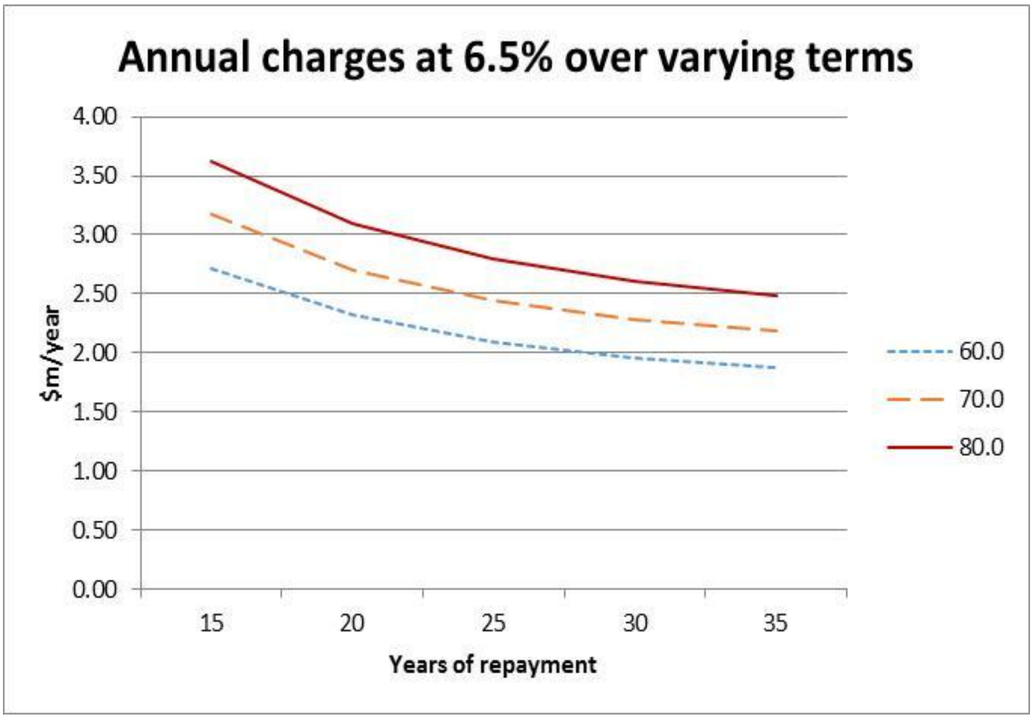
We focus discussion on providing capacity for future growth in demand for reticulated water supply from urban and industrial users. There is a bigger issue about how to fund growth in future irrigated area, which is an issue that apparently has no owner unless potential beneficiaries (future irrigators) can be induced to contribute to the dam or some other entity covers that portion of the cost. It would also be a large share of cost for TDC to cover, and one with some risk if insufficient new users are brought into the scheme. About half of that 18% is for future use with indirect access to the Waimea River and its aquifers, uptake of which is likely to require further investment in off-farm infrastructure like canals and pumping stations to distribute water. As funding arrangements for the dam are still being developed, we do not address that issue here.

If current ratepayers pay for added capacity that will not be used until some unspecified point in the future, they have reduced ability to spend on other things now or for accumulating their own capital for future contingencies. Since dams are long lived infrastructure that will continue to benefit economic activity long after current ratepayers have gone, one solution to the front-end loading of the cost of their provision is to debt fund their construction and so shift some of the cost onto future generations who will benefit from the infrastructure.

The effect of this is illustrated in Figure 3, which shows how annual repayments for the 3 potential capital costs of $60, $70 and $80 million, and annualised at the same discount rate, vary with changes in repayment terms. Under any price assumption, repaying the loan in 35 years leads to 31% smaller annual repayments than repaying it in 15 years, and 11% less than repaying it over 25 years. Extending the loan prolongs the repayment and means a higher nominal sum paid than paying off the loan quickly. However, if the interest rate on loan repayments is the same as the Council’s discount rate reflecting its opportunity cost of capital, all timing options are the same in present value terms. So a council can relieve repayments on its current ratepayers by extending the repayment period to 35 years in line with the maximum period for initial resource consents.

Figure 3 Changing costs with varying terms

Based on table loans with constant annual repayments



Source: NZIER

The TDC's long term plan refers to a policy of holding down debt. However, not all debt is created equal, and while aversion to debt is prudent with respect to borrowing for current consumption, taking on debt is more defensible for investment in assets with a high probability of delivering positive return into the long term. Taking on debt for the Waimea dam is a way in which TDC can relieve its current ratepayers for costs that will benefit the future, and shift the balance towards consumption now and away from consumption in future.

3.1.4. Value obtained from different uses of water

The assumption in the 2010 Northington report that capital cost is evenly allocated among all users in a flat rate per irrigable hectare is an example of average cost pricing, which is not the most efficient means of pricing for reasons outlined in section 2.3 above. It can also be regarded as a form of FDC pricing in that the fixed costs of financing the dam are proposed to be spread evenly in proportion to the area of irrigable hectares accessible to the dam's improved water supply.

The chosen base across which the full costs are distributed has an influence on the distribution across users, and on the efficiency of FDC pricing. Different results will be obtained if spreading the fixed costs according to area irrigated, volume of water used or value of produce obtained from irrigation. All FDC bases are arbitrary and inefficient to some extent, but spreading costs according to a measure of value created by the irrigation is less inefficient than alternatives that do not take account of economic value. This is because access to greater supply security for water creates value for the access holders, which is an economic rent from the resource. Basing FDC on a measure of the output value created by the irrigated areas taps into that rent and would shift the charge closer to the marginal benefit obtained by water users, to the extent that those who gain most from the water's productivity also pay the most. Conversely, those who for various reasons are less able to take advantage of the water will suffer less imposition on their income flows if charges reflect production values than is possible with charges based on flat rate per area.

3.2. How to charge ratepayers

We assume choices of instrument for charging ratepayers for TDC's contribution to the Waimea Dam are principally those of rates or uniform annual charges. Other potential revenue instruments, such as development charges under the Local Government Act, or financial contributions under the RMA are charged to new developments to provide for either infrastructure upgrade to accommodate increased demands created by the development, or to provide for compensatory measures for its environmental impacts. Neither of these situations is analogous to the recovery of Council's costs incurred in contributing to the Waimea Dam. The situation is more closely aligned to Council's provision of other infrastructure like local roads and parks, which are commonly funded out of rates.

Two key choices in applying rating instruments for public goods are:

- Whether to use a charging base reflecting the monetary value or some other characteristic of rateable properties
- Whether to apply this generally across the district or targeted at particular sub-sets of property within the district?

The dam provides services in securing water for the Council's water supply scheme, recovering costs through its charging mechanisms, and environmental flows covered by rates or annual charges. Table 5 summarises these instruments' characteristics.

Table 5 Choices of charging instruments

	Charge base	General	Targeted
Rates	Rateable $ value	Suits services where the benefit given varies with the value at risk (e.g. flood defences, stormwater)	Suits services where the benefit is confined to particular areas or type of property
Uniform charges	Non-monetary unit (e.g. per property, per connection)	Suits services where the benefit does not vary with property value (e.g. connection to reticulated water supply)	Suits services where the benefit is confined to particular areas or type of property

Source: NZIER

From the outline in Table 5, public good characteristics are not particularly closely related to value at risk, which would suggest a uniform charge rather than a rate per dollar value. An exception to this might be if the Council has a policy of collecting rates according to ability to pay, in which property value rates might be preferred on the grounds that higher value properties are likely to have better off owners, although there can be situations where this presumption is not correct (e.g. pensioners are often asset rich and income poor).

How to spread the charges could be guided by how widely the benefits are felt. In-stream water flows have characteristics of a local club good in that most of the amenity and recreational benefits accrue to those living nearby, although it is possible that some benefits will be more widely spread.

For instance, if Waimea water flows were critical to the survival of a native species which was important for maintaining the diversity of native plants and animals found in the district, preservation of that species could be viewed as a responsibility of the wider district community rather than just those in the locality in which it is found. That might justify a portion of the Council's costs of the scheme being met by the general rate across the district rather than a location-specific target rate. However, we have found no evidence of any such exceptional source of widespread benefit across the district associated with increasing environmental flows to 1100 l/s.

3.3. Sensitivity to changes in underlying assumptions

The allocation of dam costs to TDC in Table 4 was based on the assumptions that 30% of the cost of the dam is attributable to environmental flows, and capital costs are annualised over 25 years at 6.5% interest, in line with TDC's current borrowing capabilities. We now look at the effect of changing some of these assumptions.

Table 6 shows the effects of extending the payment period from 25 to 35 years (assuming a table loan at 6.5%). The effect is to reduce the annual payments for all contributing parties by 11% compared to the results in Table 4. Thus the payments towards environmental flows and to future regional demands both decrease by 11%, as do the costs recovered from current water supply customers and current water permit holders. Different discount rates would change the reduction percentage but the percentage reduction would be the same for all levels of dam cost.

Table 6 Sensitivity to length of time for cost recovery

Capitalised over	*35*	*years at*	*6.5%*
	$m	*$m*	*$m*
Total capital cost	60	70	80
	$m/yr	*$m/yr*	*$m/yr*
Annualised $m/yr	4.38	5.11	5.84
Attributed to			
Environmental flow	1.32	1.53	1.75
Extractive users			
Current Water Supply	0.25	0.29	0.33
Future Water Supply	0.31	0.36	0.41
Total Water Supply	0.55	0.65	0.74
Future Regional Supply	0.20	0.24	0.27
Current permits	1.50	1.75	2.00
Future direct access	0.40	0.46	0.53
Future indirect access	0.41	0.48	0.55
Total $m/yr	**4.38**	**5.11**	**5.84**

Source: NZIER

Table 7 shows the effects of changing the attribution of dam costs to environmental flows from 30% to 20%, for sake of illustration. That might arise if it was determined that the marginal cost of enlarging the dam for environmental purposes was less than proportional to the incremental increase in storage volume because of economies of scale.

At each of the three capital cost levels, the annualised cost of environmental flow is reduced by about 33% compared to the corresponding figures in Table 4. If TDC general ratepayers are paying less on the environmental flows, other contributors will have to pay more to cover the full annualised cost. How that gets distributed across users is subject to determination among the contributing parties, but one way it could be done would be to spread the additional cost across all other contributors in proportion to their shares of total costs (excluding environmental flows). The results of that redistribution are shown in the clear columns in Table 7. In each cost level, although environmental flows decrease by 33%, the payments of other contributors towards provision for current and future use would increase by about 14%. The overall effect for TDC's general ratepayers who cover the unattributable cost of environmental flow and future regional supply would be a reduction of 27% compared to their annual costs in Table 4.

Table 7 Sensitivity to share of cost for environmental purposes

Capitalised over	*25*		*years at*		*6.5%*	
	$m		*$m*		*$m*	
Total capital cost	*60*		*70*		80	
	$m/yr		*$m/yr*		*$m/yr*	
Annualised $m/yr	4.92		5.74		6.56	
Attributed to						
Environmental flow	0.98	0.98	1.15	1.15	1.31	1.31
Extractive users						
Current Water Supply	0.27	0.31	0.32	0.37	0.37	0.42
Future Water Supply	0.35	0.40	0.40	0.46	0.46	0.53
Total Water Supply	0.62	0.71	0.72	0.83	0.83	0.95
Future Regional Supply	0.23	0.26	0.27	0.30	0.30	0.35
Current permits	1.69	1.93	1.97	2.25	2.25	2.57
Future direct access	0.44	0.51	0.52	0.59	0.59	0.68
Future indirect access	0.47	0.53	0.54	0.62	0.62	0.71
	0.49		0.57		0.66	
Total $m/yr	**4.43**	**4.92**	**5.16**	**5.74**	**5.90**	**6.56**

Source: NZIER

These figures are illustrative and in practice there may be other effects that alter the results. For instance, an improvement in water security and access could lead to change in property values and hence their rating capability, so that rates collected would be redistributed across TDC's ratepayers. An implication of this is that current and future permit holders may be paying more as ratepayers as well as whatever charges are levied on them as users of the dam. That does not affect the distributions across categories in Tables 4, 6 and 7, but it does mean that the cost to individuals in the non-council user categories would be higher than indicated in the tables. Such redistribution of rateable values depends on the Council's approach to attribution of rating liability and we have not attempted to model it here.

Other potential differences from the illustrations lie in the cost of arranging financing, the possibility of different interest rates on longer term loans to reflect different risks, and the possible use of refinancing arrangements to extend the term. These depend on the Council's attraction to its lenders, and are not modelled here.

Despite limitations, the illustrations do show that there are substantial cost implications for TDC in the base assumption of the incremental share of dam capacity used to provide public goods, and also in extending loan repayment periods so that future users pay more of the cost of the infrastructure they inherit. Both these are relevant to determining the share of costs to be split between active and passive users of the Waimea Dam.

3.4. Summing up

The foregoing indicates that in covering the cost of long-lived asset of Waimea dam, charging the marginal cost that users impose on the infrastructure will not be sufficient to cover the full cost of the dam. A supplementary charge to cover the unattributable fixed costs is needed, which can be shared across residents based on either beneficiary pays or exacerbator pays principles. Charging those who are actual or potential beneficiaries may be practically simpler than charging on an exacerbator pays basis.

The distribution of cost recovery can be spread across different groups within the district according to the characteristics of the benefits they receive:

- Current water users benefit from improved reliability of supply, and costs can be recovered by a variety of mechanisms:
  - Volumetric charges reflecting volume of actual use
  - Area equivalents reflecting potential volume of use
  - Capital values reflecting value enhancement from access to water
- Future users within the district are those on properties with potential to benefit, and can be recovered by mechanisms not reliant on actual use
- Future users outside the district have potential to benefit, but until a formal cost sharing arrangement is reached cannot be charged, so their cost share falls on the Council to bear, and is most effectively spread as widely as possible across the District's constituents through general rates
- Environmental flows have public good characteristics and its costs are most effectively covered by spreading them widely across the District through general rates.

The benefits of the dam will accrue both in the near present and long term future, so sharing of cost between current and future users can be achieved by:

- Spreading the cost of dam into the future through long term loan arrangements, to relieve current users of bearing some of the cost
- Ensuring properties with potential to benefit from future use are attributed that part of the cost associated with provision for that future use.

There are choices to be made on mechanisms to use, but clearly volumetric charges cannot be applied to future uses that have yet to occur. Future users are not yet in the district but the properties they will occupy are, and their values may increase with improved access to water, so property value could be appropriate for charging for unrealised future benefit.

Environmental flows are not generally associated with property value changes across the wider district, so a uniform on charge on property may be considered more equitable than one on rateable value.

4. Conclusions

This report has examined the economic implications for funding the public good component of the environmental enhancements provided by the Waimea Dam. It also considers how to handle the provision for future growth in demand from customers who are not yet in Tasman District, but who will benefit from the supply security provided by the dam.

In common with other infrastructure, the Waimea Dam faces the challenge of funding a high up front cost of construction which will provide benefit over the long term by enabling uptake of water for new development. Unlike some other local infrastructure (like roads, parks) there is a potential revenue stream generated from the dam. Irrigation dams that provide security of water and confidence to invest in improved water-using husbandry generally do result in substantial potential revenue, although how soon that is realised depends on the net benefits from investment for private water users and the rate of uptake in using the new secured water.

How much cost to attribute to enhanced environmental flows depends on the non-enhancement starting point, and whether minimum environmental flow is something that has to be provided in the river, or a discretionary amount. In the case of Waimea Dam, attributing 30% of the cost to the public good of environmental flows may be overstated if 30% extra capacity can be provided at less than 30% extra cost, or if there are significant private benefits attributable from the additional flows, through such processes as raising the water table on adjacent lands.

The question of whether the environmental flow produces public goods for Tasman ratepayers of a value that is worth the cost that they will incur is one that we have not been able to quantify in this report. Ideally this would be based on consideration of the increment of services to amenity, biodiversity, cultural and recreational use achieved by increasing water flows above the statutory minimum, and then examination of what that implies for economic value gain in the community, but we have not found any quantitative indicators on which to base such an assessment.

Any reduction in the share of cost attributable to public good environmental flows increases the cost to be recovered across all other users or beneficiaries of the dam. This is likely to result in a reduction in the total cost recovered through TDC's general rates bills and shift it to more targeted charges for specific extractive water users.

As a long lived infrastructure there is a risk of over-recovering the dam's costs in the early stages and under-recovering from future users, effecting an inter-generational transfer that relatively impoverishes current residents in favour of future residents who are likely (on historical experience) to be better off than current residents. The solution is to spread more of the cost of the dam into the future with long term repayments, so that future generations pay more towards providing the source of on-going benefits they receive.

Local councils and their constituents are often reluctant to build up debt, with good reason if that debt is used to fund activities largely oriented to current consumption or which provide no tangible return. But debt funding is efficient and arguably more equitable for long lived infrastructure which is likely to yield increased production and revenue flows to pay for it, as is the case with Waimea dam.

Debt funding is also part of the answer to providing for future growth, although carrying added risk over whether and when the new growth in demand to pay for it will be realised. The dam provides for 7% capacity to cover growth in urban and industrial demand, which is an imposition on TDC’s water supply operations but one where some relief would be granted by lengthening the repayment period.

Appendix A References

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