# Pricing Water As If All Resources Matter

by

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## Introduction

During the past several years, I have become increasingly enamored with the matter of water pricing, having become a bit disenchanted with the power of water marketing to make needed strides toward allocative efficiency. Water markets have likely enhanced efficiency and will continue to do so, but they're not ubiquitous, and even where they do exist, they are saddled with a lot of baggage. Some of this baggage is well acknowledged as necessary, like third-party protection, but it does increase transaction costs and limit the allocative prospects of water marketing. I also am concerned about marketing's potential for efficiently balancing the private and public demands for water. Not only does the public good nature of most recreational, aesthetic, and biodiversity demands cause underparticipation in water markets, but the technical requirements for interfacing competing private and public demands are too burdensome to hope for efficient results under current market structures (Griffin and Hsu 1993).

Some of the water marketing's baggage is behavioral. For example, our publicly elected leaders are prone to preachments espousing what we might call a water theory of value. I'm referring to statements like "water is necessary for life," "water is required for economic growth," etc. We can all wince twice when we hear these words. Once to recognize that this kind of talk licenses all kinds of costly public endeavors intended to increase water supply. And a second time to realize that we have yet to accomplish our educational missions. Now, couple our leaders' preachments and support for water supply expansion with the behavior of a water utility manager who operates a natural monopoly and is empowered to undertake water supply enhancements, including raw water purchases, and pass the costs on to customers. There's little to suggest that these enhancements are efficient, unless water prices to final consumers are correct. For various reasons, water at the household tap tends to be underpriced, so the manager's acquisitions are based on a faulty level of demand. As a consequence of all these considerations, when I hear of a new water market transaction, I don't automatically presume that social good has been served.

So I've come to believe that we've got the cart before the horse in championing water marketing so much over the past 20 years. I guess economists are predisposed to place their faith in market instruments, but I try to be mindful that the first theorem establishes marketing as a possible means to an end – it is not an end.

Why might water pricing do better? For one thing, most people pay for the private water they use, so everyone is exposed to the inducements of prices. Each water utility or district designs a set of rates that simultaneously applies to hundreds or thousands of customers. Water pricing has the potential to be a powerful instrument, but changes are needed.

In this paper I share my simple understanding of some of the opportunities to obtain better resource allocations using better water prices. The resources which are potentially better allocated as a consequence are not restricted to water.

## Better Pricing

Where then are the major points of departure between current pricing and better pricing? They lie in two general categories: marginalism and nonaccounting opportunity costs.

**Marginalism**

By marginalism I refer to the general advantages of marginal cost pricing, but the matter is deeper than simply replacing average cost water prices with marginal ones. There are two difficulties here: separable costs and the myriad of margin concepts.

*Separability*

When the accounting practices recommended for and used by water utilities are examined, one soon notices the separation maintained among functions; costs are separately recorded for wastewater treatment, wastewater collection, water production, water distribution, etc.. The accountants are on to something here that has not fully penetrated the pricing recommendations of water resource economists. Even if you do not consume a single drop of water, your home's connection to the water distribution system is still responsible for costs. There's administration of your account in the form of billing and meter reading, and there's costs of maintaining the distribution system, part of which you are marginally responsible for. The upshot is that a portion of your water bill should be independent of your consumption, and this portion, ideally, should be the marginal cost caused by your home in the absence of any metered water consumption.

Similarly, the members of irrigation districts cause costs independent of the amount of water they receive. Again, these costs are largely associated with water conveyance and system administration. As an interesting example, for the irrigator to take delivery of even one gallon of water, canals must be fully wetted. Hence, I daresay that even the lion's share of conveyance losses are marginally <u>un</u>related to the irrigator's water deliveries. If my claim is true, the marginal cost of water to the irrigator excludes the majority of conveyance losses. These conveyance losses are functionally dependent on the character of the distribution system, not the amount of water delivered to a client. This point has implications for pricing that disagrees with our literature (see Chakravorty, Hochman, and Zilberman for example), so it is an interesting issue. As with other system costs, any conveyance losses that cannot be attributed to a particular connection are common costs for the irrigation district and cannot be recovered with a marginal rate of any kind.

Thus far I have been distinguishing between two valid parts of rate schedules, a connection charge and a water charge. Both should be based on margin principles. There is a third rate schedule element that can be very noteworthy for urban utilities. New connections are quite distinct from existing connections in that there is new infrastructure to install and new water supplies to develop or purchase. Economic efficiency again requests that new connections be charged the marginal cost of their addition to the system. These costs can be very high, so it is not surprising that utilities have made serious strides in this direction in recent years. New connection charges can be several thousand dollars in parts of the western U.S.. I cannot say that these rates are correctly calculated according to economic principles, but I can say that they are socially useful signals for people and businesses making decisions about where to locate themselves.

When taken together, water charges, connection charges, and new connection charges are improbable budget balancers for the utility. Hence, a fourth element of the rate structure is needed to equate utility revenues with costs. But this fourth instrument should not interfere with any of the marginal cost signals. The following simple billing system is commendable in this regard.

$$\text{Bill} = M + p\cdot(w - \overline{w})$$

where
M is the monthly connection or meter charge,
p is the marginal cost of water,
w is metered water consumption, and
$\overline{w}$ is the billing threshold.

The billing threshold, $\overline{w}$, is chosen so as to balance the utility's budget. Unlike typical tiered rate structures where different consumers may face different prices, thus bucking efficiency, every client faces the same price here. With this system, rents received by the utility are distributed without upsetting efficiency very much. Each connection is granted an equal share of these rents by the billing threshold device.

Returning to the matter of separability, a point intended by this paper's title is to highlight the importance of not including the wrong values in final water prices. It is not appropriate, either in our pricing doctrine or our economic modeling of optimal water allocation, to lump together all the costs of water capture, storage, treatment, pressurization, and conveyance and then assign all these costs to the total cost of water.

*Which Margin?*

The dominant economic advice pertaining to pricing is to rely upon forward-looking short run marginal costs (Kahn 1988). While this position serves efficiency well, it may be frustrating on other fronts. For example, its use can imply some serious variability in water price, due to climatic or seasonal changes in supply and demand. Because it has been practical, at least to this point in time, to only read meters once a month and to only differentiate summer and winter rates, there have been important limits to the applicability of economist's prime suggestion.

When we start looking for a second-best "marginal" concept upon which to base rates, multiple options emerge and the choices become confusing. In addition to the long-run vs. short-run dichotomy, we start using adjectives like inframarginal, historical, Turvey, and average marginal (Beecher, Mann, and Landers 1991). The tradeoff between what is efficient and what is pragmatic gives rise to all sorts of variants, because pragmatism is a less definitive master – it admits subjective perspectives on what is or is not good rate-making practice.

**Nonaccounting Opportunity Costs**

In addition to the application of marginalism, better pricing must be mindful of the opportunity costs of water. Unfortunately, the accounting perspectives that dominate rate making do not attend to some important opportunity costs. I call these nonaccounting opportunity costs, or NOCs, and there are three potentially important categories: the marginal value of raw water, marginal user cost, and marginal capacity cost.

The marginal value of raw water arises primarily from surface water scarcity, and the customary failure, both for utilities and irrigation districts, is that this value is not reflected in finished water prices. Because the water entitlements held by these organizations are not perceived as having costs, their values do not find their way into rates, thus losing an important signal. Even when a city utility goes out and buys a permanent water right, thus incurring an accounting cost, the impact on rates is temporary. Once the city has recovered the purchase price from consumers, the added right joins the rest of the city's unvalued inventory.

For ground water values, the applicable opportunity cost of raw water is commonly referred to as its marginal user cost. Here, the appropriate social value must recognize the foregone future value of depletion, discounted to present value. Again, water purveyors do not add this NOC to current rates. Its omission, like others, begets water overuse and spurs water managers to overinvest in water supply expansion.

Sometimes, it is not the base water supply that is scarce but the infrastructure providing water. To avoid accelerating infrastructural expansions beyond an efficient pace and to gain the greatest net benefits from the available system, rates should ration infrastructural capacity by including marginal capacity costs in rates. Basically, the marginal capacity cost is that addition to rates needed to align demand with supply.

Taken together, these NOCs might recommend substantial increases in water rates, and because they are not accounting costs for a utility or district, substantial excess revenues could be generated for utilities. This raises the importance of finding an acceptable mechanism for maintaining the nonprofit (or limited profit) status of our water utilities. That is, the billing threshold instrument noted previously, or a similarly nondistorting device, becomes more useful if we are to incorporate NOCs in prices.

I have another paper that explores these opportunity costs more carefully, and it is available for download at my website (http://ron-griffin.tamu.edu/). One of the matters noted there is that the accounting stances of utilities and districts are not sufficient to fully capture these NOCs, even if these organizations were inclined to incorporate them. A good example is marginal user costs. Cities and districts don't general manage complete aquifers, so a portion of the opportunity costs lies external to their jurisdictions. I have argued that the upshot is that another authority may be useful to specify the level of NOCs to be included in finished water prices. That is, perhaps government policy should be created to tell each water purveyor the amount of marginal user cost that must be included in final water prices. This would vary of course from aquifer to aquifer, and the same advice could specify the marginal value of raw water on a basin-by-basin basis.

## Examples

Some approximately real world examples help to solidify some of these issues.

### Tiered Rates – San Antonio

Figure 1 provides San Antonio's basic seasonal water pricing system for residential users. The exhibited rates are finished water prices in $ per thousand gallons, and they omit the flat charge that must also be paid monthly. San Antonio is one of the U.S.'s ten largest cities, so it provides water to industries on a wholesale basis and it sells water at a markup to people outside city limits. Hence, there are many more elements of San Antonio's rate structure than the content of Figure 1.

The simple point relayed by this rate structure is that it signals several different marginal prices of water, depending on what tier the consumer is in. But are there really different marginal costs of water applicable at the same time? No, at different times of the year, different marginal costs are to be expected, but the utility's marginal cost of water in July are the same for each client regardless of the tier they are in. A thousand-gallon change in water consumption has the same impact on operating costs regardless of whether it comes from a tier 1 or a tier 4 household. This system encourages tier 1 consumers to consume water to the point that their marginal benefits are $0.72 while encouraging tier 4 consumers to go to marginal benefits of $3.49. That's quite a difference. If water was a more portable commodity, there would be some serious arbitrage opportunities here.

Some people argue that increasing block rates such as these save water. There are at least two problems with this argument. First, it ignores satisfaction losses, profit losses, and the value of nonwater resources substituted for water. Second, it ignores the fact that first tier rates may be motivating overuse of water by small consumers. It is unclear whether underuse by large consumers outweighs overuse by small consumers.

**Raw Water Value – San Antonio**

San Antonio uses a renewable ground water source for its water supply, but demand increases have lifted scarcity enough to initiate a substantial institutional change. The process of adjudicating ground water rights is well underway, and within a year or two, these initial endowments will be firmly assigned. Some evidence about the regional value of water has been emerging from this young marketplace. Like other water marketplaces, this one will shepherd water from irrigation to urban use.

It is clear that irrigators are taking notice and are beginning to recognize the opportunity cost of their water use. Households in San Antonio are not being presented with these same signals however. Although raw water is scarce, San Antonio does not ordinarily includes its value in rates. If it did, what would be the implications for tap water price and water use?

Initial transactions indicate higher values than this, but let us employ $50 per acre foot as the regular value of San Antonio's raw water. This converts to a little more than 15 cents per thousand gallons. This constitutes better than a 5% increase in rates (inclusive of $1.50 per thousand gallon sewerage rate), so a demand elasticity of –0.4 would imply a consumption decrease in excess of 2%. The latter is not a large amount, but bear in mind that this calculation targets only one of the deficiencies of contemporary urban water pricing.

**Capacity Cost – College Station**

When the ground water-reliant City of College Station installed a fifth well a couple of years ago, it cost about $1.5 million to do so. The immediate purpose of this well was to provide peak load water during the height of August and September water use. During the winter months, it only took two wells to supply College Station residents when this new well was installed. The rising demand which caused this project resulted mainly from urban growth. If new connections to the city water supply were properly priced, the price would include the cost of this well and several other items. Growth hastens the pace of water supply expansion, and a new connection's marginal influence on these costs, discounted to present value, is the efficient new connection fee (Turvey 1976).

As a first approximation to converting the well's cost to a new connection fee, assume demand is not increasing over time in the absence of urban growth (although demand may still be seasonal). Due to real income increases and the positive income elasticity of water demand, this assumption is false, but it is not far from the truth. The most efficient pattern of new well investment is the one maximizing net present value. Rather than install wells in advance of demand, as is common for allegedly better managed communities such as College Station, the NPV-maximizing schedule normally does not install a new well until some of the demand has already materialized. Thus, for a while demand will exceed supply for an efficient regime, and it is during this period that efficient prices should include a marginal capacity cost to ration demand efficiently.

Each new connection alters this schedule slightly, and it is the NPV difference between the two optimizing schedules (one with the new connection, one without it) which should compose the new connection fee. A rough attempt at this ideal might simply allocate the well's cost across the new connections it serves on an average basis. Assuming the well can produce three million gallons per day to serve households using peak loads of 600 gallons per day, it can provide water for 5000 households. That gives us $300 per new connection for water-producing infrastructure alone; there is still treatment, storage, and distribution capital to add on as well.

If we were to charge the $1.5 million to water production and raise water price accordingly, we would misstate both the marginal cost of water as well as the marginal cost of a new connection. This would subsidize urban development and thereby missignal location decisions.

**Marginal User Cost – College Station**

As users of depleting ground water, College Station residents should face finished water prices that include marginal user cost. But they don't, and I know of no community that does incorporate marginal user cost in its rates. Computation of this NOC requires a dynamic model optimizing the net present value of water use over time. A dissertation on this subject constructed a 100-year dynamic program of water resource use for College Station's aquifer (Merrill 1997). Optimal investment in wells is a choice variable in this model as well as the amount of water to pump. The depth of this aquifer makes it expensive to exploit, so there are only three users: City of Bryan, College Station, and Texas A&M.

Results for College Station indicate that finished water prices are about $1 per thousand gallons too low considering marginal user cost. That constitutes more than one-fourth of the optimal, first-period price of tap water, and if water was priced this way, the impact on depletion would be sizeable. Even more importantly, model results show that summed marginal user cost and marginal capacity cost more than triples in real terms during the forthcoming 30 years, thereby making a greater contribution to price than the summed accounting costs. Hence, the stakes are rising with respect to the omission of these NOCs, as they undoubtedly are in many other areas employing depletable water resources.

## Conclusions

As an economist, I perceive the issue of water conservation as not having to do with saving water. Conservation is about balancing our use of water with the things we derive from water and the things we substitute for water. These same tradeoffs are encountered when we strive to price water better. Pricing better does not automatically imply pricing higher. If we are to refine our water prices so as to improve welfare, then there is a complicated and interrelated set of prices which must be modified. I touched on a few elements of this set here, but there are certainly others. We cannot get water prices right unless we get the prices of water-related resources right at the same time.

All in all, I find these issues to be complex. Where I was once content to wave off the problem of pricing as simply a matter of replacing average cost prices with higher marginal cost prices, I now see that the problem is deeper. As I have inspected the contemporary practice of rate making, I am impressed by the insights available from both the public utility literature and the accounting-dominated concerns of existing rate-making institutions. There's a real challenge here, but the allocative efficiency goals we tote also have a lot to offer I believe. Economists have argued before for institutional innovations to address specific resource or environmental problems long before society was ready to listen. Eventually, the remedies we offer for inefficient water pricing can be another example, but we cannot be casual about it if we are to contribute.

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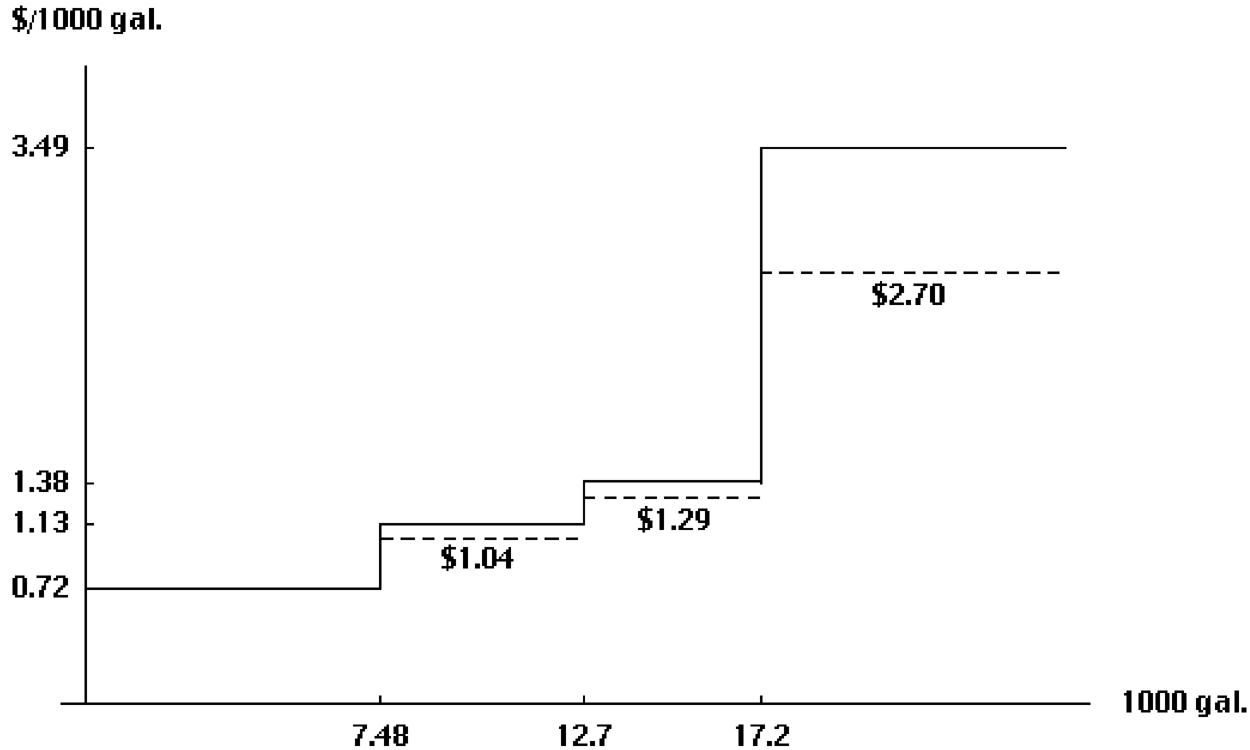


**Figure 1. Winter (- - -) and Summer Residential Water Prices**