Conservation Pricing of Water and Wastewater

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I. Introduction: the Role of Prices

This paper addresses the role of the price mechanism in water and wastewater conservation generally. Despite the reams of material written on water issues and water policy, very little of it addresses the role of water prices. Written for an audience of local water and wastewater utilities, government planners, industry professionals and advocates of watershed protection, this paper addresses the potential for water pricing strategies to be used to both stimulate conservation and raise revenue to meet clean water needs.

Most of us learned in elementary school that water is indestructible and will simply be recycled through the hydrologic cycle. Recent experience has brought the more sobering insight into the hydrological cycle: that water cannot be treated as a perfectly renewable resource. Withdrawals from our watersheds for drinking and industrial water and subsequent wastewater treatment are processes that, at today's scale, have large "unpriced" external effects: land use consequences, biological degradation, and water quantity depletion. In view of these encroaching resource limits, it is important to begin considering how to translate these causal relationships through the price mechanism to reflect the underlying ecological costs to society. With expansions in water and wastewater capacity posing significant environmental battles in most major metropolitan areas, the need for conservation and planning is greater than ever. While there are many ways to promote conservation, the focus of this paper will be on prices.

The most frequent economists' response to the imperatives of environmental protection and resource conservation is to use the price mechanism more strategically. "Full costs" refers to the complete societal costs (environmental, social and actual) that pertain to the production and consumption of a good or service. Economics shows us that social welfare is maximized when all costs are reflected in prices. This is sometimes referred to as "full cost pricing" or the "polluter pays principle." Only then do our production and consumption decisions take into account all costs to society, resulting in the most appropriate balance of supply and demand. When prices are artificially low, we tend to consume too much. When prices are artificially high, we tend to consume too little.

The "polluter pays" principle is enormously popular among economists but it is important to emphasize that it usually suggests only a <u>theoretical</u> optimum. For political and social reasons, it is rare to see an "externality" fully priced and charged. This would mean identifying all the environmental effects of the product or process at each stage in the economic cycle from production to waste, assigning those effects a monetary value and using the tax system or other authorities to add this total monetized value to the price.

For full internalization, the technical and political obstacles can be formidable. More often than not, some "directionally correct" price change is suggested. European countries are further along in implementing these kinds of price changes, alternately called "price correction," "ecological tax reform" or "green fees".   In the U.S., approximately 1/3 of electric utilities practice a form of demand management via "peak hour pricing" of electricity. By pricing electricity in order to encourage consumers to modify their levels and patterns of electricity consumption, these participating electric utilities were able to shave 4% of the total peak load in the United States. (Energy Information Administration, 1996)

Another example of price correction in the U.S. is in the area of municipal solid waste. Some 4000+ communities have established what EPA terms "pay-as-you-throw" programs (also known as unit pricing or variable-rate pricing) where residents are charged for trash collection based on the amount thrown away. This creates a direct economic incentive to recycle more and to generate less waste. More on this can be found at the EPA web *Pay As You Throw* web site (http://www.epa.gov/epaoswer/non-hw/payt/).

As with many other resources, it is unlikely that water and wastewater prices will ever fully reflect the "full cost" or "internationalization" approach favored by environmental economics, but there are some "directionally correct" pricing structures designed to encourage conservation. These rate structures are taken up in Section III.

- ***To Stimulate Conservation***

From an environmental economics perspective, pricing can be an extremely valuable public policy tool. Prices can be more than a means of meeting revenue requirements or even turning a profit. Environmental economists have long advocated bringing the price mechanism more fully in line with “full costs” so that “users” might respond to “market signals” – reflecting the true and full costs of production and consumption. Since water is basic to life, and certainly to our quality of life, the pricing of water can be a powerful means of signaling this importance and scarcity to water users, most of whom experience very little connection between their water usage and their total bill. In our current era in which water demands are increasing while water supplies are constant or diminishing, it is important to apply economic tools to communicate the true value of fresh water.

- ***To raise revenue.***

In the Environmental Protection Agency’s Office of Water, “the gap” is a shorthand expression for discussing the capital needs requirements (projected needs minus projected revenues) of water and wastewater systems over the next several decades. New estimates for wastewater systems alone show sharply rising capital needs requirements in the next century, something on the order of $200 billion (in discounted, present value terms) over the next 20 years. This is much higher than the $120 billion previously estimated in EPA’s 1996 *Clean Water*

Needs Survey (EPA, 1996).

During the early decades of the new millennium, we expect sharply rising capital needs due to:

many sewage treatment plants becoming candidates for replacement (with their useful lives expiring);

more stringent drinking water and wastewater standards driving up treatment costs;

increasing expense and controversy associated with developing new sources of water; and

non-point source pollution requiring greater abatement.

To meet the growing financial needs driven by these, more strategic pricing of water and wastewater can play a greater role. Current sewer bills average approximately $200 per household per year. (Raftelis, 1998). A back-of-the envelope calculation on these sewer charges alone shows that if our nation’s 83 million sewered households were to experience a doubling of their sewer bills, revenues in excess of $16 billion per year would result, providing annual revenue sufficient to remove the estimated future capital shortfall for infrastructure investment in wastewater.

To summarize, pricing strategies can address “the gap” in two ways: to lower demand for water and wastewater services (or slow the growth rate in demand); and to raise revenue. In the water sector, these imperatives are becoming increasingly important.

II. The Water Sector

♦ *Heavily Subsidized and Mostly Publicly Owned*

Over the past 200 years, water management in this country has been dominated by large government decisions concerning agriculture, water rights, transportation, hydroelectric power, manufacturing, and drinking needs. The U.S. Bureau of Reclamation and the Army Corps of Engineers focused on large scale “development” of water resources during a time in history when water was believed to be abundant and easily renewed. Dams, canals, aqueducts and reservoirs were built to move water from where it was abundant to where it was needed, or to store it for use during dry seasons. The federal government financed much of that work, and the Department of the Interior's Bureau of Reclamation played a key role. As its name suggests, the goal of that agency was to “reclaim” arid lands.

Today, the water allocation problem is more difficult than ever due to a number of forces: increased population, periodic drought, depletion of groundwater, degradation of water quality, land use concerns and competition among water users [agriculture, recreation, urban drinking water and industrial use]. In the arid West where fighting over water rights has a long history, some institutional reform of water policy is underway to better manage the agricultural use of water. Fueling all of these stressors is the historic underpricing of water.

During the 1970s and 1980s, EPA's Wastewater Treatment Construction Grants Program was a major source of federal funds, providing more than $60 billion for the construction of public wastewater treatment projects. With the 1987 amendments to the Clean Water Act, Congress set 1990 as the last year that grants would be appropriated, phasing out the construction grants program by shifting the method of municipal financial assistance from grants to loans provided by State Revolving Funds. The twenty year era of the federal Construction Grants program (1972 - 1992) produced a significant decline in the daily pollutant loads discharged by sewage treatment plants. Environmental benefits were achieved, but an unintended and unforeseen result was the weakening of a price mechanism that might have served to guide the supply and demand for water more prudently. The true cost of water development and wastewater treatment has taken a back seat to large, institutional decisions concerning economic development, water rights, location of hydropower and other industries, river navigation, and agricultural irrigation.

States generally retain ownership of natural or public water within their boundaries; and state laws and regulations govern the allocation of the rights of private parties and government entities to use such water. State water codes almost always allocate water according to a “grandfathered” system of “first in time, first in right” (appropriative rights) or according to proximity of land ownership (riparian rights). While water uses must be “beneficial”, allowable withdrawals are generally unpriced (“free”).

Large scale water projects conducted by the Bureau of Reclamation and the Corp of Engineers have subsidized water supply for most sectors. All told, the institutional character of the water sector and the influence of governments has greatly subsidized water prices and imbued the water sector with deep political roots and economic norms – not unlike other infrastructure sectors such as roads, airports, energy, etc. For wastewater treatment, the Construction Grants Program provided more than $60 billion for the construction of public wastewater treatment projects and subsidized 55 - 75% of the capital costs of construction. Under the Clean Water State Revolving Fund, the average “subsidy” is considerably lower: SRF loans are repaid at interest rates approximately 3 percentage points less than market rates.

♦ ***Laws and Regulations***

Rate setting can be constrained by the legal and regulatory codes that vary across states and local jurisdictions. Most states will have something of a “water code” type law that codifies the rights of public water and wastewater utilities as well as the state’s authority over investor-owned utilities.

At the federal level, the Clean Water Act contains language that governs how prices are set for wastewater treatment plants funded under the Construction Grants Program and the State Revolving Fund loan program. User charge regulations under the Act require that wastewater operating, maintenance and replacement (OM & R) costs be recovered proportionately from each user or class of user. This places restrictions only on cost recovery for OM & R and then, only in the case of wastewater flows. EPA user charge regulations do not prohibit conservation rate structures for wastewater capital costs identified separately from OM & R charges. Nor do the regulations prohibit conservation rate structures based on metered drinking water [rather than wastewater]. Since most residential water is metered through drinking water intakes (and not wastewater outflows), this regulation does not present a significant impediment to conservation pricing. In general, EPA user charge regulations [for recipients of Construction Grants for wastewater treatment plants] only restrict how OM & R is charged and does not place restrictions on other types of charges.

♦ ***Politics and Public Education***

Publicly owned systems are subject to oversight and competing interests from local county, city or regional governing boards, water authorities or commissions. For publicly owned utilities, elected officials are too often influenced by short-term vote-seeking motivations. In addition to resisting higher prices for fear of retaliation at the ballot box, elected officials are more likely to give short shrift to the need to create depreciation reserves or other financial mechanisms to finance inevitable system replacements. Politically, elected officials can view askance those rate structures that require pricing above cost recovery. Elected bodies tend to favor limiting municipal utilities to recovering actual costs plus debt coverage costs to secure the ability to borrow in the capital market. In addition, both citizens and elected officials may wish to keep water and wastewater prices low in order to attract economic development. In recognition of the competing interests that effect rate structures, EPA's 1989 publication *Building Support for Increased User Fees* (EPA, 1989) was introduced to provide guidance on how to conduct an effective public education program that emphasizes the connection between higher fees and the financial and operating integrity of a water or wastewater utility as well as much-needed maintenance and repair of pipes, pumps and manholes. In a public education program for conservation-oriented rate structures, public acceptance is improved when such rates are tagged to:

avoidance or deferral of the price tag associated with capital improvement programs such as expansion and upgrades;

avoidance of the need to develop a new water supply source, as for example, in moving from groundwater to surface water;

the collateral benefits associated with water conservation:

pollution prevention through reduced water withdrawals and wastewater flows, habitat protection and energy conservation;

the potential to pay for conservation measures such as metering, improved water accounting, leak detection, water-use audits, retrofits, reuse and recycling, and landscape improvements.

Clearly, information plays a role in how water users respond to price. To the extent that the public can be assured of the appropriate use of revenues derived from higher prices, conservation rate structures stand a far better chance of succeeding.

III. Rate Structures and Practices in the Water Sector

♦ *Current Pricing Practices in the Water Sector*

Water's importance to our survival renders it, quite literally, "priceless" but this intrinsic value of water is frequently left out under the traditional pricing method -- known as cost-based pricing -- which is an accounting system designed to ensure the financial self-sufficiency of water and wastewater systems. This pricing method quantifies the costs of capture, treatment and conveyance. As such, this method can often obscures the larger but less quantifiable societal interests in preserving our water resources. Moreover, given the very high fixed costs associated with water and wastewater facilities, cost-based pricing can pre-dispose rate setting against variable (i.e. commensurate with usage) charges and thus can run counter to conservation goals.

Cost-based pricing does not to be in conflict with conservation pricing. Supplementing cost-based pricing with incentives for consumers to manage demand is a combination that serves both financial and environmental goals. Another term that is sometimes used is "demand management pricing" to reflect the underlying motivation to lower water demand (or slow the rate of demand growth).

Water and wastewater demand can be manipulated by price *to some degree*. Water for necessities (sanitation, cleaning and cooking) is far less responsive to price than water for more discretionary uses (lawn watering, car washing, swimming pools). Water policy analyst Janice Beecher reviewed over 100 studies of the price elasticity of demand – with the following conclusions (Beecher, 1994):

- The most likely range for elasticity of residential water demand is -.20 to -.40, meaning a 10% increase in price lowers demand by 2 - 4%.

- The most likely range for elasticity of industrial demand is -.50 to -.80, meaning a 10% increase in price lowers demand by 5 - 8%.

Clearly, water is "inelastic", meaning that when the price increases, consumption decreases but at a lower rate than the increase in price. Unlike such large factors as the weather, population growth, local geology and hydrology, and the economy; water managers can influence water rates, albeit with an appreciation for the consumers' response. Moreover, utility managers need to consider that price increases will not likely affect the behavior of many middle and upper income groups. For these groups, stiffer price increases or other conservation strategies might be tried.

Two rate surveys give us some insight as to existing industry practices with regard to conservation pricing. The Raftelis Environmental Consulting Group's *1998 Water and Wastewater Rate Survey* depicts 31% of 151 surveyed communities using increasing block rates. The American Water Works Association's 1998 survey of the residential rate structures of 827 utilities shows approximately 22% employing increasing block rates and 2% employing seasonal rates. For commercial and industrial customers, increasing block rates are slightly less common. This data can be viewed at www.awwa.org/h20stats/resrate.htm.

To be precise, it should be noted that both of these results pertain to water rates structures, not wastewater. However, best professional judgement allows us to infer an equivalence between the two. Most residential wastewater is not metered but is instead billed in proportion to water coming into residences (drinking water) or by some other formula. To the extent that residential wastewater rates derive from water usage and rate structures, some form of price incentive for wastewater conservation exists in a significant portion of sewered communities.

♦ ***Conservation Rate Structures***

Prices can be used to modify customer behavior to use less water at the tap, stop and prevent leakage and waste, and send less wastewater for treatment. To achieve the efficiency gains that will enable water system managers to postpone the need for new capital outlays, water utilities and local governments will need to expand their toolkit to include the widest array of conservation-oriented initiatives using prices as well as measures like universal metering, water accounting and use audits, retrofitting and public education. The Office of Water's *Water Conservation Plan Guidelines* provides guidelines for utilities on conservation planning and the conservation measures listed above, of which conservation pricing is listed as one component (EPA, 1998). This paper takes the pricing concept several steps further and discusses particular rate structures.

The general types of conservation pricing options are:

- **repeal of volume discounts;**
- **increasing block rates;**
- **seasonal rates; and**
- **excess loading or excess use charges.**

Their names suggest the general working for most of these rate structures. Eliminating volume discounts would remove any existing disincentive for conservation. Charging a higher unit price rises as use rises is the most popular form of conservation pricing. Less common are seasonal rates, where prices rise and fall according to water supplies and weather conditions (with higher prices usually occurring between April and October). With all of these options, consumers have an incentive to conserve.

IV. Key Issues for Utilities, Communities and Water Planners

In addition to the politics of competing interests that can dominate rate setting, three key issues emerge: the service population's ability to afford higher rates, the effects of conservation rates on a utility's revenues, and their actual effectiveness in reducing water demand. These are discussed below.

- ***affordability***

The best rate design involves taking into account the characteristics of particular customer classes. In considering conservation pricing, a utility, water planning body or local government might consider the service area population's *ability* to pay higher rates. Appropriately designed programs oriented towards customers with limited resources can mitigate the hardship of rate increases on low-income families. Not only does this have humanitarian benefits, well-designed affordability programs can benefit the utilities in avoiding the costs associated with increased arrearages: late payments, disconnection notices and service terminations.

The American Water Works Association Research Foundation (AWWARF) issued the most comprehensive report available on rate structures designed to mitigate the costs of water service for low-income customers (AWWARF, 1998). Entitled *Water Affordability Programs*, this report lays out 5 rate structures that can be considered as model affordability programs. "Lifeline" rate structures can mitigate undue hardships for qualifying low-income customers by charging a lower rate for the portion of their monthly water supply which is considered non-discretionary (the basic amount needed for sanitation, cooking, cleaning, etc.). Beyond this "lifeline amount" (e.g. 8,000 gallons per month), a higher rate will take effect. Alternatively, a discount can be applied to the fixed portion of the bill, e.g. the meter charge, service charge or other such fixed amount. This method also maintains incentives to conserve.

Utilities can also offer budget billing programs, elderly discounts and conservation assistance to assist low-income families.

According to the Raftelis Environmental Consulting Group's recent water survey, a number of water and wastewater facilities across the nation have instituted water payment assistance programs that provide discounts for low-income or elderly customers. (Raftelis Environmental Consulting Group, 1998). Water utilities in the following states have these special discount programs:

California
Delaware
Massachusetts
Minnesota
Montana
New Mexico
Ohio
Oklahoma
Oregon
Pennsylvania
Texas
Washington

Section V covers a number of assessment tools and information sources that may be helpful in considering conservation oriented rate structures.

- ***revenue stability***

In the small body of literature on water pricing, revenue instability is the most frequently cited problem with various forms of conservation rates (Beecher, 1994). This is because conservation rates can shift cost recovery from fixed charges to variable charges (rates based on use). Utilities also worry that price increases may reduce their sales in an unpredictable manner, leading to less certain revenue streams. If consumers respond with a higher-than-expected reduction in water use, conservation can cause utilities to experience reduced revenues and an unstable cash flow.

One way to mitigate this concern is to gather reliable data on the local service area's "elasticity of demand." Computer models are available to estimate price elasticities for different customer classes, and hence, the revenue effects of conservation rate structures. To properly design rates as well as to maintain financial stability for the utility, it is necessary to make some demand forecasts. Existing demand studies can be used to *approximate* usage responses in a general benchmarking approach, or computer models can be used (in conjunction with detailed customer records) to specify consumer responses to price with greater accuracy. Section V describes some of the tools available for making these estimates.

A second way to mitigate concern about revenue instability is to create a revenue stabilization fund that can be used to even out the collection of revenue, particularly during droughts. In this case, the utility must be able to collect revenues in excess of annual expenditures in some years so that it can draw on the fund during revenue shortfalls that result from lower than expected consumption. In addtion, there must be either legal safeguards or a strong political will to protect these reserves. Surpluses can be used to fund conservation programs or build a reserve for future capacity expansions or upgrades.

- ***effectiveness***

Studies of the effectiveness of conservation pricing are few and far between, however, University of Georgia Professor Jeffrey L. Jordan in a 1994 article in the *Water Resources Bulletin* gave us some insight into a rapidly suburbanizing county in the southeast U.S. In 1991, Spalding County, Georgia (part of the Atlanta SMA), went from a decreasing rate structure to an increasing rate structure. Without any other conservation program being instituted, average yearly water use per customer fell by 5% (Jordan, 1994).

More recently, Jordan has written in the *Journal of the American Water Works Association* to report on results of a 59 question survey sent to those utilities identified as using some type of conservation rate structure. (Jordan and Albani, 1999). For those 12 systems where the authors had data that could show the *effectiveness* of a rate change, Jordan and Albani were able to show that yearly average consumption dipped 8 percent and peak-demand-month usage declined 7 percent.

Jeffrey Jordan is also the author of a number of papers providing analysis and information on water issues in the state of Georgia. Entitled the *Georgia Water Series,* Jordan's papers and other information can be found at http://www.griffin.peachnet.edu/water.

V. Assessment Tools and Information Sources

The references section that follows is a complete listing of all source material used for this paper. Some particularly noteworthy reports and software packages are first highlighted below.

- ***Helpful reports and software***

To effectively manage demand, a utility must be able to determine future water needs. New water demand forecasting models have enabled water planners to go far beyond the traditional method of estimating future water needs where estimates simply resulted from multiplying per capita use times projected population. More sophisticated forecasting software now takes into account the socioeconomic characteristics of a service area and the breakdown of water uses into customer classes. Utilities can see how seasonal changes, weather changes and changes in sectoral composition will affect water demand. Most importantly, for the purposes of conservation pricing, estimates of customer response to changes in user charges can be derived.

IWR-MAIN Water Demand Analysis Software is a software package developed under sponsorship of the Army Corps of Engineers Institute for Water Resources. IWR-MAIN has been updated and continually modified since its first inception in 1982 so that its most recent versions are usable on a personal computer. The acronym IWR-MAIN stands for Institute for Water Resources – Municipal and Industrial Needs. Version 6.1 was introduced in 1995 and is being used for southern California, Las Vegas, Alabama, Florida and Georgia. Information on availability and use of the IWR-MAIN Water Use Forecasting Model may be obtained by contacting the Army Corps of Engineers' Institute for

Water Resources found at http://www.wrsc. Usace. Army.mil/iwr/.

The Environmental Protection Agency's Office of Water has issued two reports aimed specifically at the water and wastewater pricing issue. The first such report, entitled *Building Support for Increasing User Fees*, is a helpful guide to the public education needed to price clean water at rates more commensurate with its value (EPA, 1989). This report stresses that rate adjustments are most effective when used in conjunction with a public education program. This report can be viewed and downloaded electronically from EPA's web site at http://www.epa.gov/clariton/clhtml/pubtitle.html.

A follow-on to this report came in 1993 with *Evaluating Municipal Wastewater User Charge Systems* which serves as a guide to provide information needed to comply with EPA's construction grant user charge system regulations (EPA, 1993). This report can be ordered free of charge from the National Service Center for Environmental Publications whose catalog can is found on EPA's web site at http://www.epa.gov/ncepihom/catalog.html.

Finally, the American Water Works Association has a 1999 version of their manual *Water Rate Structures and Pricing* (AWWA, 1999). This is the most comprehensive guide available on all issues associated with water pricing. In 1998, the research arm of AWWA, the American Water Works Research Foundation (AWWARF), produced the most extensive treatment yet on rate design for affordability. It's entitled *Water Affordability Programs*. Browsing the web pages that list publications for both AWWA (http://www.awwa.org) and AWWARF (http://www.awwarf.com) can yield information on the purchase on these and other documents relevant to rate design issues.

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Web Sites

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http://www.awwa.org

American Water Works Research Foundation
http://www.awwarf.com

Georgia Water Series

http://www.griffin.peachnet.edu/water/

Institute for Water Resources, U.S. Army Corps of Engineers
http://www.wrsc. Usace. Army.mil/iwr/

U.S. Environmental Protection Agency

Office of Wastewater Management
http://www.epa.gov/owm

Office of Groundwater and Drinking Water
http://www.epa.gov/ogwdw