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TESTIMONY BEFORE THE MARYLAND ADVISORY COMMITTEE TO THE U.S. CIVIL RIGHTS COMMISSION:
WATER AFFORDABILITY AND ACCESSIBILITY IN MARYLAND

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Testimony before the Maryland Advisory Committee to the U.S. Civil Rights Commission: Water Affordability and Accessibility in Maryland

(04 November 2021)

By Steve H. Hanke

About the Series

The Studies in Applied Economics series is under the general direction of Prof. Steve H. Hanke, Founder and Co-Director of The Johns Hopkins Institute for Applied Economics, Global Health, and the Study of Business Enterprise (hanke@jhu.edu).

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Testimony

Maryland Advisory Committee to the U.S. Civil Rights Commission

Water Affordability and Accessibility in Maryland

04 November 2021

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Introduction

Recently, increased attention has been placed on problems of water affordability, especially for minority communities. Water system revenue losses, inefficiency, mismanagement, lack of productivity, and federal mandates, to name a few problems, are rapidly escalating the cost of water for consumers. Because the Maryland Advisory Committee to the U.S. Civil Rights Commission focuses on the cost of water, especially its disparate impact on minority communities and protected classes of people, this testimony will focus on Baltimore.

Baltimore's demographic make-up is notable. Baltimore County has a population of 854,535 and Baltimore City has a population of 593,490. Baltimore City is 62% Black or African American, 31% White, and 5% Hispanic/Latino (United States Census Bureau, 2019). 21% of the population in Baltimore City lives below the poverty line (Marylanders Against Poverty, 2020). More specifically, 26.1% of Black or African Americans in Baltimore City and 22.5% of Hispanic or Latinos in Baltimore City live below the poverty line.

There have been serious problems with the water and wastewater systems in Baltimore for decades. These problems are endemic, growing, and will continue to adversely affect the affordability of water until their root causes -- mismanagement and system deterioration – are addressed. I submit that subsidies to treat the symptoms of these problems will only make matters worse, and that the cost of water will continue to rise until and unless private enterprise is able to aid the City in fixing its failing and cost-ineffective water and wastewater systems.

Baltimore's Water System

I have been an observer of Baltimore's water system for 52 years. Indeed, when I joined the Johns Hopkins faculty in 1969, I was mentored about the system by Prof. Abel Wolman, Prof. John C. Geyer, Prof. Charles Renn, and Dr. F. Pierce Linaweaver, who later became Baltimore's director of public works. I first surveyed the problems with Baltimore's water and wastewater systems in an official capacity when I was a member of Governor Marvin Mandel's Council of Economic Advisers (1976-1977). Gov. Mandel was, even 45 years ago, very concerned about the looming problems facing Baltimore's water and wastewater systems.

Baltimore's distribution system delivers treated water to Baltimore and the surrounding metropolitan area. The service area is approximately 560 square miles and provides potable water to approximately 1.8 million people (about 30% of Maryland's population). The water distribution system contains over 4,500 miles of water mains. The water mains connect to a series of pumping stations, reservoirs, and storage tanks. This system provides water to Baltimore City as well as parts of Baltimore County, Howard County, and Anne Arundel County (Baltimore City Department of Public Works).

System Maintenance Mismanagement

Baltimore has been in the grip of a water system crisis for a number of years. This is well documented in the press. Just a small sample of recent water-related headlines in *Baltimore Sun* tells this sad story: "Baltimore's water problems get worse as more pipes break amid warm spell," "Giant hole in downtown Baltimore intersection withstands downpours, but repairs to roadways and a second leak remain," and "Water main break floods Inner Harbor, causes train derailment; worker injured in nearby storm drain." (Duncan, 2018; Dance and Brown, 2019; Reed et. al., 2019,).

In December 2018, the *Baltimore Sun* published "By the Numbers: The Toll Winter Takes on Baltimore's infrastructure" (Zhang, 2018). This piece included a comprehensive list of water main breaks in Baltimore from January 2, 2015 to November 30, 2018. Over that period, 4,234 water main breaks were reported (Zhang, 2018). Most water main breaks occur in the winter, with February as the most active month for breaks (Simpson, 2021). In January 2018, there were 508 main breaks in Baltimore City and County, with as many as three dozen in one day. (Zhang, 2018). In February 2021, a spokesperson for Baltimore City's Department of Public Works (DPW) reported that the DPW was dealing with an average of 40-45 water main breaks every day (Simpson, 2021).

There is a reason for Baltimore's immense number of leaks, breaks, and water loss. Baltimore's water infrastructure remains outdated, with some of the oldest parts of the system built in 1855. In short, the system has not been properly maintained. Indeed, deferred maintenance has been an endemic problem for decades. And, to make matters worse, Baltimore has no systematic program for leak detection and control. Enormous amounts of water are being wasted in Baltimore, increasing the cost for all consumers. To control leaks, Baltimore would have to continuously repair and maintain the current water distribution infrastructure, which it

does not do properly. Without proper leak detection and control practices, Baltimore is in a doom loop.

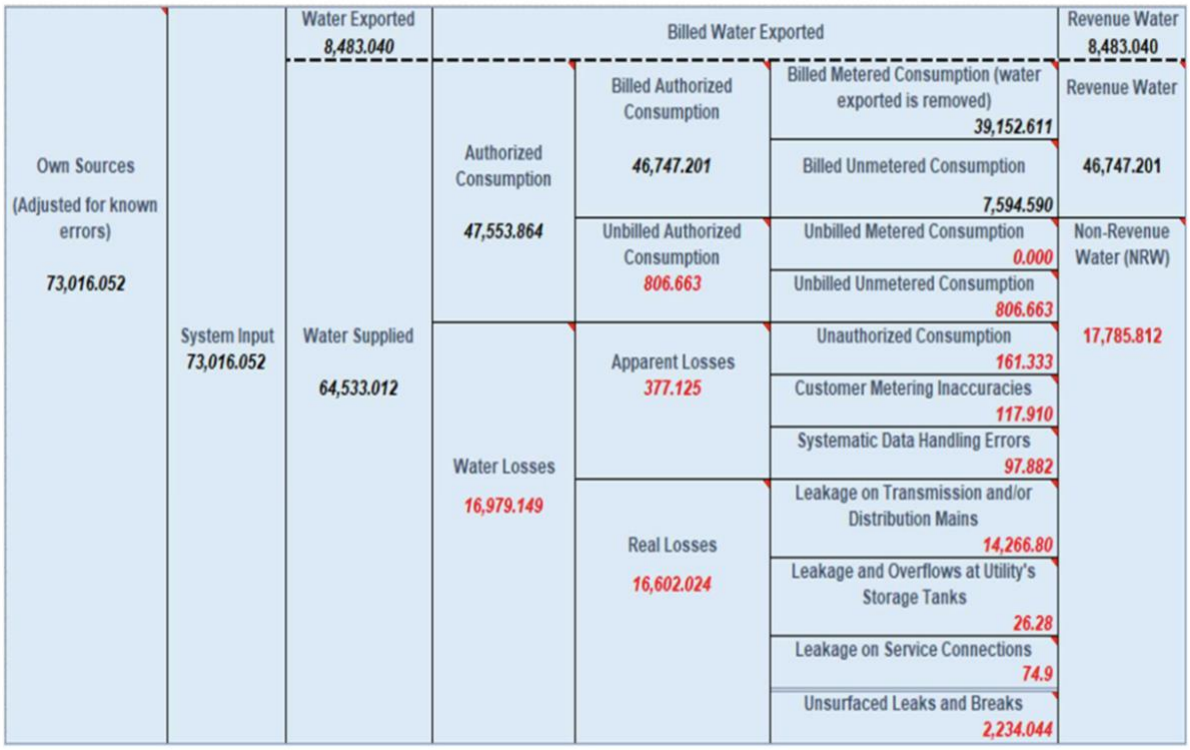
Starting in 2014, the DPW has been rehabilitating over 4000 miles of underground water infrastructure at a rate of 40 miles per year (Qureshi, 2018). At this rate, the system would take 100 years to be fully updated. At that point, the watermains that were renovated at the beginning of this process will likely already be overdue for an update.

The Maryland Department of the Environment requires water systems serving more than 10,000 people to submit a water audit report. These audits are conducted in order to determine a system's demand for water and assess whether it has the capacity to meet that demand. Audits are used to provide water utilities with a profile of their distribution system and water uses in order to have more effective management of their water and infrastructure (MD Dept. of Environment, 2019). These audits contain a comprehensive profile of a water distribution system, complete with data on water loss caused by leaks. If more than 10% of water withdrawn from a system is unaccounted for, a water loss reduction plan must be submitted (MD Dept. of Environment, 2019).

However, for some reason I have not been able to document, Baltimore City is statutorily exempt from complying with this state mandated water audit (MD Dept. of Environment, 2019). Despite this lack of transparency, researchers at the Johns Hopkins Institute for Applied Economics, Global Health, and the Study of Business Enterprise were able to obtain an internal water audit for Baltimore that the DPW had prepared for 2018, after spending hours haggling with DPW staff via email and at their offices. According to the report, 73,016 million gallons (MG) of water were produced by Baltimore's three water treatment plants in 2018. Of those, 8,483.05 MG of this water was exported to Howard County, which pays a lump sum for its water. This leaves 64,533.01 MG of water supplied to Baltimore City and County. However, only 72.4% of this water generated revenue. Water main leaks and breaks caused 16,602.02 MG of losses. This means that 25.7% of the total water supply of Baltimore was simply wasted away. In addition, another 1.9% of water supplied did not generate any revenue due to miscellaneous problems and system errors.

The summary table below tells the sad story of the decrepit state of Baltimore's water distribution system in 2018. It's clear why this information was not available to the public: since the city's unaccounted-for water far exceeds the state's 10% limit, a public audit would require Baltimore to submit a water loss reduction plan – which it does not possess and likely would not have the expertise and wherewithal to implement if it did.

Water Balance According to the FY 2018 Water Audit



Source: "FY 2018 Water Audit." *Baltimore DPW*: Office of Asset Management. September 2019.

Given these staggering numbers, it is logical to wonder if this level of water loss is normal for utility systems like Baltimore. The American Water Works Association's (AWWA) annual report allows for a comparison of Baltimore's losses in MG to similarly-sized systems. Baltimore's losses are significantly greater than most comparable systems. Excluding Philadelphia, which is also suffering from serious system deterioration and leakage, every other comparable utility system had considerably lower water losses than Baltimore. (American Water Works Association, 2016).

The extraordinary waste associated with the Baltimore system, is, among other things, a result of mismanagement and negligence. As mentioned above, there is no regular, comprehensive leak detection and control program employed by the Baltimore DPW (Hanke, 1981).

Operational Mismanagement

Baltimore's DPW is prone to operational mismanagement. One manifestation of that mismanagement deals with billing for water. Baltimore's previous water billing system was fraught with human error, sometimes sending customers bills that are tens of thousands of dollars over their proper bill amounts. Former Mayor Stephanie Rawlings Blake hailed the new digital system for billing that cost more than $80 million, which now sends readings directly to city managers, as a solution to the long history of billing errors (Opilo, 2021).

However, the system that was installed in 2013 is not trouble free. Meters are often broken, delivering readings that indicate that no water was being consumed. This results in millions of

dollars lost in uncollected bills. A joint report from the Baltimore City and Baltimore County inspectors general in December 2020 found that of the 8,650 repair requests for water meters, 95% of them went unresolved for more than a year (Opilo, 2021). Additionally, 14,000 meters were malfunctioning at the time of the writing of that report (Opilo, 2021). This lack of billing resulted in significant revenue loss.

Furthermore, the new digitized system is vulnerable to hacking. In May 2019, there was a ransomware attack on Baltimore's computer network, preventing Baltimore from issuing water bills for three months. Once the system was finally working, Baltimore mailed a combined bill for the months of May, June, and July. This naturally led to concerned, low-income customers who found it difficult to pay a $300-400 water bill at one time (Duncan, 2019).

The billing problems go on and on. For example, in November 2019, the wrong due dates were printed on 15,000 water bills for Baltimore County residents (Knezevich, 2019).

Wastewater System Mismanagement

If all this wasn't bad enough, Baltimore's wastewater system is arguably in worse shape than its water system. In 2004, there were 622 sewage backups reported in Baltimore. By 2015, the number had grown close to 5,000 (Dance, 2016). This problem is so great that the City of Baltimore has been slapped with a federal consent decree to reduce sewage pollution and modernize the City's century's old system by 2030 (United States of America and State of Maryland v. Mayor and City Council of Baltimore, Maryland, 2002). Interestingly, at the time of the original consent decree in 2002, the city did not even have complete maps of the wastewater distribution system and was unaware of the conditions of pipes underground (Pelton, 2016).

Following the consent decree, one of Baltimore's first sewage pollution reduction projects was the repair of a misaligned pipe at the head of the Back River wastewater treatment plant, which was causing a sewage backup for 10 miles. By the end of 2016, this and other projects had cost about $900 million, and it is just the start of necessary fixes outlined by the Consent Decree (Qureshi, 2018). Since the City failed to meet the original 2016 consent decree deadline, the new deadline of 2030 for all projects to be completed was agreed upon.

In 2018, over 189 million gallons of sewage tainted water leaked into Baltimore's waterways. This caused City of Baltimore officials to state that "[t]he public is advised to avoid direct contact with the receiving waters identified as impacted by these sanitary sewer overflows (SSOs). The water in all of our streams is considered impaired and may not meet applicable standards for full body contact recreation, including swimming, regardless of the impact of a specific sewer overflow. Accordingly, the City discourages full-body contact with all surface waters." (Baltimore City Department of Public Works, 2018).

Just one result of Baltimore's sewage nightmare is soaring rates for sewage treatment. On average, customers in 2017 paid three times as much as they paid in 2002 for wastewater services (Dance, 2017).

Financial Mismanagement

The DPW's Budget is divided into operating and capital budgets. Operating costs include day to day costs of running the utilities and administrative costs, while the capital budget is primarily for maintenance and repair.

The DPW's operating budget allocated to water and wastewater alone is a stunning 84% of the total. This amounts to 14% of the City's total operating budget of $3.8 billion. That's roughly equal to the Baltimore Police Department's portion of the City's operating budget. The Baltimore Fire Department, by comparison, accounts for only 8% of Baltimore City's operating budget (Baltimore City Council Bill #21-0080).

Of the City's total capital budget, which is $487.5 million, the DPW's allocation to water and wastewater takes up an incredible 56%. Baltimore City Transportation, by comparison, takes up only 15% of the City's total Capital Budget (City of Baltimore, 2021).

Given the deterioration of Baltimore's infrastructure, if the problem is going to be fixed, the capital budget will need to increase dramatically. But, increase by how much? We don't know the answer to that question because there has never been an analysis of the long-run marginal cost of water and sewage in Baltimore of the type that I have conducted in the past (Hanke and Wentworth, 1981).

Politicization of Baltimore's Water and Wastewater Systems and the Rewarding of Failure

Not only has Baltimore ignored the deterioration of the system and the gross mismanagement of its operations, but political activists have engaged in protecting the current mismanaged system by advocating against the use of the private sector and markets to assist the City of Baltimore in fixing and efficiently managing its system (Wenger 2014; Gwynn, 2020). This has further politicized the operation of the water and wastewater systems in Baltimore. To my knowledge, Baltimore is the only city in the United States that prohibits competition, private companies, and markets from mitigating the costs associated with remedying a serious problem.

In 2018, Baltimoreans voted in favor of Ballot Question E; a charter amendment "For the purpose of declaring the inalienability of the City's sewer system and water-supply system; excepting the sewer and water-supply systems, their operations and uses, from the Charter provisions otherwise authorizing the grant of franchises or rights relating to the operation or use of public property or places; and submitting this amendment to the qualified voters of the City for adoption or rejection (Baltimore City Charter Amendment, 2018). While this led many to consider Baltimore a "public water hero," in reality, banning privatization will not solve any of Baltimore's problems. According to Robert Powelson, president and chief executive officer of the National Association of Water Companies, "With the passage of Ballot Question E, Baltimore has summarily taken proven solutions for its water and wastewater system off the table. Baltimore leaders have allowed activists to turn its water services into a political issue instead of working to address system deficiencies and improve services to residents" (Powelson, 2020). I am in full agreement with Powelson's statement. It is backed by a significant body of

research and evidence (See: "A Synopsis of Prof. Hanke's Activities in the Water Resource Field: Selected Publications and Brief Comments").

The charter amendment flies in the face of common sense and all expert advice, including the World Bank's. In 2006, the World Bank published "The Challenge of Reducing Non-Revenue Water (NRW) in Developing Countries—How the Private Sector Can Help: A Look at Performance-Based Service Contracting." Indeed, the World Bank, an organization concerned with, among other things, making water affordable in developing nations, draws the conclusion that "In a well-designed NRW reduction strategy, the continued use of the private sector should be a matter of choice for the public utility" (Kingdom et. al., 2006). The charter amendment has made this choice impossible. It also contradicts a recent, definitive publication by the Brookings Institution: *Gaining Ground: Markets Helping Government* (Winston, 2021). In Dr. Winston's book, numerous examples from various public sectors illustrate the advantages of involving private firms in the management and operation of municipal enterprises.

It is clear that Baltimore's water system problems have been misdiagnosed. The root of the City's water nightmare is the current institutions that are in place, namely the DPW. It is the municipal water utility's inability to properly manage the system that is causing Baltimore's current dysfunctional state of affairs and the rising cost of water. All the charter amendment has accomplished is the protection of the very system that has brought Baltimore's public water and wastewater monopoly to its knees. In short, the change in the City charter rewards failure.

As further evidence of the politicization of Baltimore's water system, Baltimore enacted the Water Accountability and Equity Act in January 2020 (Tuser, 2020). This law created an Office of the Customer Advocate, which is designed to solve issues of unaffordable or inaccurate bills. The Act specifies that Baltimore residents will not be required to spend more than 3% of their household income on water services. Many supporters of the Act were also advocates for Baltimore's law banning the utilization of private water utilities and their services.

This law will not solve the "problems" that it addresses but will further aggravate the operational mismanagement that plagues Baltimore's water and wastewater systems. To implement the Water Accountability and Equity Act, the DPW would have to continuously obtain and update information about household income and cross-tabulate it with poverty thresholds by household size. Since these metrics are constantly changing, the Act, if ever implemented, would fall victim to a significant amount of waste, fraud, and abuse.

The Solution for Baltimore's Ailing Water and Wastewater Systems

In order to reverse the politicization of Baltimore's water system, which will only make operation and capital mismanagement problems worse as well as increase costs for the citizens of Baltimore, the charter amendment must be eliminated. This would allow for private enterprise and markets to assist the city in addressing its endemic water problems by tapping the competency and skills available in the private marketplace. And just how would that work? I have written and worked extensively in this sector, particularly with the large French water companies Compagnie Générale des Eaux, which is now Vivendi, and Lyonnaise des Eaux, now a subsidiary of Suez Environment, as well as with some of the large private water utilities in the

United States. In addition to my work in France and the United States with private water companies, I have worked in Argentina, Australia, Austria, Bulgaria, Canada, Indonesia, Israel, Poland, Sweden, and the United Kingdom. So, what follows is based on not only one book, many book chapters, and over 150 articles, but also a considerable amount of firsthand experience (See: "A Synopsis of Prof. Hanke's Activities in the Water Resource Field: Selected Publications and Brief Comments").

Comparative cost analyses of private versus public provision of goods and services give support to the conclusion that private firms are more cost-effective than public firms. Considerable evidence suggests that the public cost incurred in providing a given quantity and quality of output is about twice as great as private provision (Hanke, 1987). This result occurs with such frequency that it has given rise to a rule-of-thumb: "The Bureaucratic Rule of Two."

With the private provision of infrastructure, however, there is a potential problem: introducing and maintaining competition. This potential problem can arise because of the so-called natural monopoly character of many infrastructure projects. In short, even if there are no artificial barriers to entry, a monopoly will likely emerge because a single firm can produce goods and services more cheaply than multiple firms (multiple ports, bridges, etc. at the "same" location are not economically feasible).

Opponents of infrastructure provided by the private sector are quick to raise the specter of a monopoly. But, there is a way to solve the natural monopoly problem and introduce competition into the provision of private infrastructure. It involves a system of competitive bidding for privately owned infrastructure franchises. Though competition within a market may be impossible, the benefits of competition for that market may be attainable.

So long as there is vigorous bidding for an infrastructure franchise, the best of both worlds — avoidance of redundant facilities together with competitive prices — can be had. Such a system could ensure that the favorable incentive effect normally associated with private ownership and management of a firm (i.e. that private owners will control costs, enhance efficiency, etc. as a way of maximizing their profits) will actually come about.

The key to the franchise bidding approach to natural monopolies is the following: bidding for the monopoly franchise should not be in terms of a sum to be paid for the franchise, but in terms of the prices that the franchisee would charge and the services the franchise would provide the public on award of the right to be the exclusive supplier.

If the franchises were merely awarded to the bidder willing to pay the highest price for this exclusive right, competition would drive bids up to an amount equal to the present value of expected future monopoly profits in the market. This would transfer monopoly profits from the franchisee to whatever authority granted the franchise in the first place, but consumers would still pay monopoly prices.

Instead, an auction should be held in which the franchise is awarded to whichever bidder promises the best combination of price and quality to consumers. Here, competition would drive bid prices down to competitive levels for each possible level of service quality.

Theory is not necessarily reality, however. Indeed, some scholars have expressed reservations about franchise bidding. One set of concerns relates to the bidding process itself. Selecting a winner (i.e., determining an optimal price structure and mix of products) may be exceedingly complex, and there is no guarantee that bidding will be truly competitive. For example, new firms may be reluctant to bid on a franchise that has expired when the previous franchisee is also in the bidding, since the previous supplier is almost certain to be better informed about actual cost and demand conditions than are its rivals.

Another set of concerns relates to the likely behavior of the winning bidder during the term of the franchise contract. If the contract is for a reasonably long term, there must be some formula to allow for rate changes as costs, demands, and technologies change over time—or renegotiation must be allowed. If a formula approach is impractical and renegotiation allowed, the need for some sort of agency similar to a regulatory commission becomes apparent. Such an agency will also be needed to police the franchise contract, since the agreement will not be self-enforcing. Further problems can arise as the end of the contract approaches, as the franchisee may curtail maintenance operations and under-invest in new assets, leaving "the next guy" to cope with any resulting problems.

These are important but not intractable problems. Three aspects (the difficulty of selecting a winning bidder, the difficulty of specifying or renegotiating contracts, and the need to police the contract) require the existence of some sort of "buyers' agency" to represent consumers. These buyers' agents must be well-rewarded for monitoring the terms of the franchise contract. France provides evidence that highly skilled and highly paid civil servants can perform this task effectively.

However, critics of franchise bidding have asserted that such an agency would simply be reduced to performing the same tasks assigned to traditional government regulators — with the same difficulties and potential for inefficiency, abuse and corruption — leaving consumers no better off than they are now. This is not necessarily the case. The degree of technological complexity and the swiftness of technological change in the relevant industry are the crucial variables.

Selecting a winning bidder may be difficult where technology has created myriad potential service options. But where it is possible to specify a limited number of service standards, awarding the franchise may not be troublesome at all. And where the pace of technological change is not too rapid, it may be quite easy to agree on some sort of formula for price increases, and the possibility of midcontract renegotiation may never arise. Furthermore, enforcing the contract also will be facilitated in industries where the number of specified service standards is relatively limited. These three factors make the water supply a perfect example of an ideal candidate for franchise bidding.

The technology of water supply is well known and relatively static, and specifications about service standards and quality are readily formulable. All the critics' qualms about the practicability of franchise bidding recede in such a context. All one has to do is look at the operation of water and wastewater systems in France to confirm this (Hanke and Walters, 2011a; Hanke and Walters, 2011b).

The benefits of such a private system would be considerable. Giving the winning bidder a monopoly franchise will ensure that the firm is able to exploit all possible economies of scale in the provision of service, while requiring bidders to compete on price and service standards. This will prevent the firm from using its market power to overcharge or under-provide. Granting this monopoly franchise to private owners will harness the incentives of these owners to control costs efficiently in order to maximize profits.

To implement the system, the government need only create such a buyers' agency with a mandate to conduct the auction and devise the contracts for the construction, maintenance, or operation of the facilities. Once the franchise is granted, enforcement of the contract can itself be privatized (if enforcement is not done by the agency). An accounting firm, for example, could be retained to audit the franchisee and confirm that the terms of the contract have been observed.

To create additional incentives for franchisees to maintain and improve quality, contracts could require the franchisee to post a bond for the duration of the franchise. This bond would be forfeited to the contract enforcers if the franchisee is found to be in violation of the contract; it would serve essentially the same function as a "security deposit" on an apartment.

Once in place, the franchisee will have every incentive to aggressively control costs, adopt new technologies, etc., since every dollar of cost saved is an extra dollar of profit earned. If the firm's managers are not attentive to cost control, the firms' profits will fall, share prices will decline, and the firm will become a ripe target for takeover by owners seeking to reap the gains which would result from turning out (or better motivating) the inefficient management.

Concluding Observations and Recommendations

Most municipalities face daunting infrastructure problems. To solve them, well-tested methods of private provision must be embraced. Private infrastructure franchises that are properly designed and strictly policed hold the key for improved infrastructure provision and affordability.

The scheme briefly outlined above, if allowed in Baltimore, would not only eliminate the current maintenance, operational, financial, and other mismanagement problems that plague Baltimore's water and wastewater systems, but would also eliminate Baltimore's current transparency problem. That is because the contracts between Baltimore and the providers of private water and wastewater services would be publicly available, publicly policeable, and publicly auditable.

The current system in Baltimore, with the charter amendment's protection, is totally dysfunctional. Baltimore's current institutions must be changed. This would benefit the users of the water system because costs would be much lower and more affordable than otherwise would be the case. And, after all, it is affordability that we should be focused on.

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Appendix

A Synopsis of Prof. Hanke's Activities in the Water Resource Field: Selected Publications and Brief Comments

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The purpose of this selected bibliography is to frame my work in the water resource field. It is intended to put some order into a sphere of my activity that has evolved since 1967, the year that I published my first article in the *Journal American Water Works Association*.

Since my days as a graduate student at the University of Colorado, I have operated at the interface between economics and engineering in the water field. Indeed, my Ph.D. dissertation advisers were Morris E. Garnsey, a Professor of Economics, and J. Ernest Flack, a Professor of Civil Engineering. Although my Ph.D. was awarded in economics, my dissertation was published at the University of Colorado's Center for Urban Engineering Studies. After completing my graduate studies, I accepted an invitation to join The Johns Hopkins University, where I hold joint appointments in the Department of Environmental Health and Engineering and the Department of Economics. Over the years, I have been an economic adviser to a number of engineering firms, most notably Binnie & Partners in London and the Snowy Mountain Engineering Corporation in Australia. I have also served as an adviser to many water companies, most notably Lyonnaise des Eaux and Compagnie Générale des Eaux in Paris. These collaborations have afforded me the good fortune of working with some of the world's most important engineers in the water field, including Prof. John C. Geyer at Johns Hopkins and Messrs. M.J. Tixeront and M.F. Valiron in Paris. And when I mention Paris, I cannot do so without mentioning my work at the great École Nationale des Ponts et Chaussées. There were also other countries, in addition to the U.S. and France, where I worked on water research and infrastructure projects: Australia, Austria, Israel, and Sweden. To finish this introduction of my work at the interface of economics and engineering, allow me to mention the following interdisciplinary water journals in which I have had editorial responsibilities: *Water Resources Research*, *Water Resources Bulletin*, and *Water Engineering and Management*.

A concise overview of my work in the urban water resources field is contained in an interview I had with David B. Preston, the Executive Director of the American Water Works Association. It was published in "Face to Face", *Journal American Water Works Association*, Vol. 15, May 1983. A more in-depth overview of my work is contained in a monograph I wrote in 1981, *Studies in Water and Wastewater Economics*, which was published by the Department of Water Resource Engineering at the University of Lund in Sweden. Unfortunately, that publication is out of print and hard to find.

For items that are accessible and render a clear picture of my work in water resources, I have selected a few items from some 150 of my publications in water economics and engineering. They are grouped under five headings. I offer brief remarks to introduce each section below.

1. Water Demand

My contributions in water demand include the first sophisticated time-series study of the effect of water meter installation on water use. I also conducted one of the first pooled time-series, cross-section studies in which urban water demand, income, and price elasticities were estimated. Finally, I developed the only sophisticated method that, to my knowledge, has addressed the problem of how to properly design a sample for the collection of water use data.

- "The Demand for Water Under Dynamic Conditions", Water Resources Research, Vol. 6, No. 5, October 1970. Reprinted in: D. S. Watson (ed.), Price Theory in Action, 3rd Edition, Boston: Houghton Mifflin Company, 1973.
- "Some Behavioral Characteristics Associated with Residential Water Price Changes", Water Resources Research, Vol. 6, No. 5, October 1970.
- "An Optimal Sampling Procedure for the Collection of Residential Water Use Data", Water Resources Research, Vol. 15, No. 6, December 1979, (with A. Mehrez).
- "The Relationship Between Water Use Restrictions and Water Use", Water Supply and Management, Vol. 3, 1979, (with A. Mehrez).
- "Residential Water Demand: A Pooled, Time-Series, Cross-Section Study of Malmo, Sweden", Water Resources Bulletin, August 1982, (with L. de Maré).
- "Municipal Water Demands", in: J. Kindler and C. S. Russell (eds.), Modeling Water Demands. London: Academic Press, Inc., (London) Limited, 1984, (with L. de Maré)

2. Water Conservation

My work on water conservation represents some of the early quantitative analysis of the effects of various conservation measures on water use. These results were used to design optimal conservation strategies for urban water systems.

- "Potential for Marginal Cost Pricing in Water Resource Management", Water Resources Research, Vol. 9, No. 4, August 1973, (with R. K. Davis).
- "Conventional and Unconventional Alternative for Water Supply Management", Water Resources Research, Vol. 9, No. 4, August 1973, (with R. K. Davis).
- "Water Conservation: A Policy on Stilts", Journal American Water Works Association, Vol. 71, No. 9, September 1979.
- "A Cost-Benefit Analysis of Water Use Restrictions", Water Supply and Management, Vol. 4, No. 4, 1980.
- "Additional Comments on Cost-Benefit Analysis of Water Use Restrictions", Water Supply and Management, Vol. 4 No. 4/5, 1980.

- "Avantages et prix de revient du comptage de l'eau", Techniques et Sciences Municipales, 75^0 Annee, No. 6, Juin 1980.

- "L'Economie Reelle de la lutte contre le gaspillage de l'eau", Techniques et Sciences Municipales, 75^0 Annee, No. 2, Fevrier 1980.

- "Distribution System Leak Detection and Control", Water Engineering and Management - Reference Handbook 1981, April 30, 1981.

- "On Water: A Critique of Global 2000", in: J. Simon and H. Kahn (eds.), The Resourceful Earth. London: Basil Blackwell Publisher Limited, 1984.

- "The Economics of Canadian Municipal Water Supply: Applying the User-Pay Principle", in: C.A. Kent (ed.), Entrepreneurship and the Privatizing of Government. New York: Quorum Books, 1987.

3. Water-Wastewater Costing (System Design)

My work on water and wastewater costing has withstood the test of time. Indeed, some of the design criteria I developed for sizing wastewater interceptors are still in use.

- "Optimal Departures from Marginal Cost Prices for Local Public Services", in: Paul B. Downing (ed.), Local Service Pricing Policies and their Effect on Urban Spatial Structure. Vancouver, BC: University of British Columbia Press, 1977 (with G. E. Mumy).

- "Water Pricing: Backward or Forward-Looking Costs", Journal American Water Works Association, Vol. 707, No. 8, August 1978.

- "A Method of Integrating Engineering and Economic Planning", Journal American Water Works Association, Vol.70, No. 9, September 1978.

- "Etudes statistiques de prix de revient pour les canalisations d'eau usee", Techniques et Sciences Municipales, 75^0Annee, No^{0}10, Octobre 1980, (with R. W. Wentworth).

- "Statistical Cost Function Developed for Sewer Lines", Water and Sewage Works, Vol. 127, No. 12, December 1980, (with R. W. Wentworth).

- "On the Marginal Cost of Water Supply", Water Engineering and Management, Vol. 128, No. 2, February 1981.

- "On the Marginal Cost of Wastewater Services", Land Economics, Vol. 57, No. 4, November 1981, (with R. W. Wentworth).

- Costing and Pricing for Old and New Customers, Public Utilities Fortnightly, Vol. 198, No. 9, April 29,1982, (with J. T. Wenders).

4. Project Evaluation (Benefit-Cost Analysis)

A great deal of my work has focused on the theory and application of benefit-cost analysis. It has left me deeply skeptical about the possibility of implementing theoretically correct investment standards for public water projects. In short, one must proceed with caution.

- "Evaluating Federal Water Projects: A Critique of Proposed Standards", Science, Vol. 181, No. 4101, August 24, 1973, (with C. J. Cicchetti, R. K. Davis and R. H. Haveman). Reprinted in W. Niskanen, A. Harberger, R. Haveman, R. Turvey and R. Zeckhauser (eds.), Benefit-Cost and Policy Analysis 1972, Chicago: Aldine-Atherton, Inc., 1973.

- "Benefit-Cost Analysis Reconsidered: An Evaluation of the Mid-State Project", Water Resources Research, Vol. 10, No. 5, October 1974, (with R. A. Walker). Reprinted in: R. Zeckhauser, A. Harberger, R.H. Haveman, L. Lynn, W. Niskanen and A. Williams (eds.), Benefit-Cost and Policy Analysis 1974. Chicago: Aldine- Atherton, Inc., 1977 and R. H. Haveman and J. Margolis (eds.), Public Expenditure and Policy Analysis, 2nd Edition. Chicago: Rand McNally College Publishing Co., 1977.

- "Appraising Proposed Federal Standards for Water Resources Investment: Comment", Science, Vol. 187, No. 4171, January 10, 1975, (with C. J. Cicchetti, Robert K. Davis and R. H. Haveman).

- "Project Evaluation During Inflation", Water Resources Research, Vol. 11, No. 4, August 1975, (with P. H. Carver and P. Bugg). Reprinted in: R. Zeckhauser, A. Harberger, R. Haveman, L. Lynn, W. Niskanen, and A. Williams (eds.), Benefit-Cost and Policy Analysis 1974. Chicago, Illinois: Aldine Atherton, Inc., 1975.

- "Public Investment Criteria for Under-Priced Projects", American Economic Review, Vol. 65, No. 4, September 1975, (with G. E. Mumy)

- "Project Evaluation During Inflation, Revisited: A Solution to Turvey's Relative Price Change Problem", Water Resources Research, Vol. 17, No. 6, December 1981, (with R. Wentworth).

- "On the Feasibility of Benefit-Cost Analysis," Public Policy Vol. XXXIX, No. 2, Spring 1981.

- "'On Turvey's Benefit-Cost 'Short-Cut': A Study of Water Meters", Land Economics, Vol. 58, No. 1, February 1982.

5. White House Water Policy

I served as a Senior Economist on President Reagan's Council of Economic Advisers. In that capacity, I had an opportunity to put my scholarly work on water into practice. I was a member of what were, in those days, called White House cabinet councils, where I was responsible for the water resources and privatization portfolios. For an overview of how President Reagan and I were working on these matters, see my article in the August 2007 issue of *Globe Asia*, "Reagan the Intellectual".

One of my early initiatives on water was the advocacy of the private provision of urban water. Many of the Reagan administration's initiatives in this sphere were based on my work which dealt with the French methods for organizing the provision of water. The initial public announcement of our program was a piece I wrote for *The Wall Street Journal*. It launched a revival of the private provision of water in the U.S. and elsewhere.

My other White House activities in the water field revolved around benefit-cost analysis. President Reagan knew my research showed that the so-called "Federal Principles and Standards", which are used to evaluate water projects, were flawed and biased towards overinvestment. In consequence, I represented the White House in its effort to revise the "Federal Principles and Standards". In addition, and at a more operational level, the President tasked me with a reevaluation of all the water resource projects proposed by the Department of the Interior. Those projects needed to follow normal valuation and budgeting guidelines, and they also had to be examined by me, prior to approval. On my watch, no projects were approved.

- "Crisis-Ridden Water Systems Should Go Private", *The Wall Street Journal* (op-ed), September 3, 1981. Reprinted in: National Association of Water Companies Quarterly Vol. 22, No. 3, Fall, 1981, Water Engineering and Management, Vol. 129, No. 1, 1982, Journal American Water Works Association, Vol. 74, No. 2, February 1982, and Competition, Vol. 3, No. 8, July 1982.
- "The Privatization Debate: An Insider's View, Cato Journal, Vol. 2, No. 3, Winter 1982.
- "Face to Face", Journal of American Water Works Associations, Vol. 15, May 1983. Reprinted in: JHU Global Water Magazine. Baltimore: The Johns Hopkins University, October 18, 2010.
- "Privatization", in: J. Eatwell, M. Milgate and Peter Newman (eds.), The New Palgrave: A Dictionary of Economics, Vol. 3. London: The Macmillan Press Limited, 1987.
- "Privatizing Water Works", in: S.H. Hanke (ed.), Prospects for Privatization. New York, New York: The Academy of Political Science, 1987, (with S. J. K. Walters). Reprinted in: JHU Global Water Magazine, January 17, 2011, and Journal of Applied Corporate Finance, Vol. 23, No. 3, Summer 2011.
- "Reflections on Private Water Supply: Agency and Equity Issues", Journal of Applied Corporate Finance, Vol. 23, No. 3, Summer 2011 (with Stephen J.K. Walters).

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