

# Virginia Beach's Response To the 1980-81 Drought

by Sandra K. Birch and Gary Ulrich\*

## I. Conclusions

A study of Virginia Beach's response to the 1980-81 rather than initiate building code modifications. drought, the most severe of this century in many parts of Virginia, gives utility managers and local government officials information on the kinds of control measures that can be effectively applied in times of water shortage. The city's pricing, regulation, and education programs were examined and the following conclusions were reached:

1. Assessing monetary penalties for excessive water use is the most effective incentive to conserve. Across-the-board rate increases do not result in significant reductions in water use.
2. An allocation program with surcharges, based on a maximum-usage allowance, is an equitable rationing plan. Such a plan should be in place and well publicized before a shortage occurs.
3. Requests for voluntary conservation and a ban on nonessential uses of water do not result in a statistically significant reduction in water consumption. Volunteer programs also have the potential of penalizing conserving citizens if rates are increased to compensate for lost revenue.
4. The public's perception of the fairness of a conservation program is critical to its success. Cooperative, conserving citizens should not carry non-conserving ones.
5. Until further research under more controlled conditions can be conducted, utility officials should work with the building permit department, builders, and local building

suppliers to encourage voluntary use of water conservation equipment in new and remodeled construction

6. A successful conservation program requires a continuing, well-conceived public education effort. This conclusion is supported by the results of many previous case studies.

This study is one of several done for the U.S. Office of Water Research and Technology (OWRT) in response to a National Academy of Sciences recommendation that OWRT should encourage research in water conservation.

Virginia Beach was selected for study because (a) during the drought it began several conservation programs that could be documented; (b) the availability of its computerized billing records facilitated program evaluation; (c) its recent rapid growth—a 90 percent increase in building units between 1970 and 1980 permitted a clearer assessment of the impact of building code modifications than a city with a slower growth rate would have; (d) most of its municipal water is supplied to residential customers, a supply pattern characteristic of many communities; (e) it is located in a region with high seasonal temperatures and low rainfall, thereby requiring it to include conservation in its water management plan on a permanent rather than crisis-oriented basis.

## II. Introduction

The drought that began in the spring of 1980 and continued for 18 months was the most severe in many parts of Virginia in this century. From June through September 1980, the area east of the Blue Ridge Mountains experienced its driest four months

\*Instructor, Virginia Water Resources Research Center, and Assistant Professor of Statistics, Virginia Tech, respectively

since 1895. By mid-August, reservoirs serving Southeast Virginia dropped to 65 percent of capacity, and mandatory conservation was enacted in Virginia Beach and other southeastern localities. By October, the drought had dropped the reservoirs to almost half their capacity, and water rationing plans, the first of their kind in Virginia, took effect for more than 690,000 customers in Norfolk and Virginia Beach. The mandatory conservation measures initiated in Virginia Beach in August 1980 were not lifted until the following August.

At the request of Virginia Beach and Norfolk, Gov. John N. Dalton declared an emergency under the Emergency Services and Disaster Act of 1973. By November, 72 localities had been declared drought disaster areas.

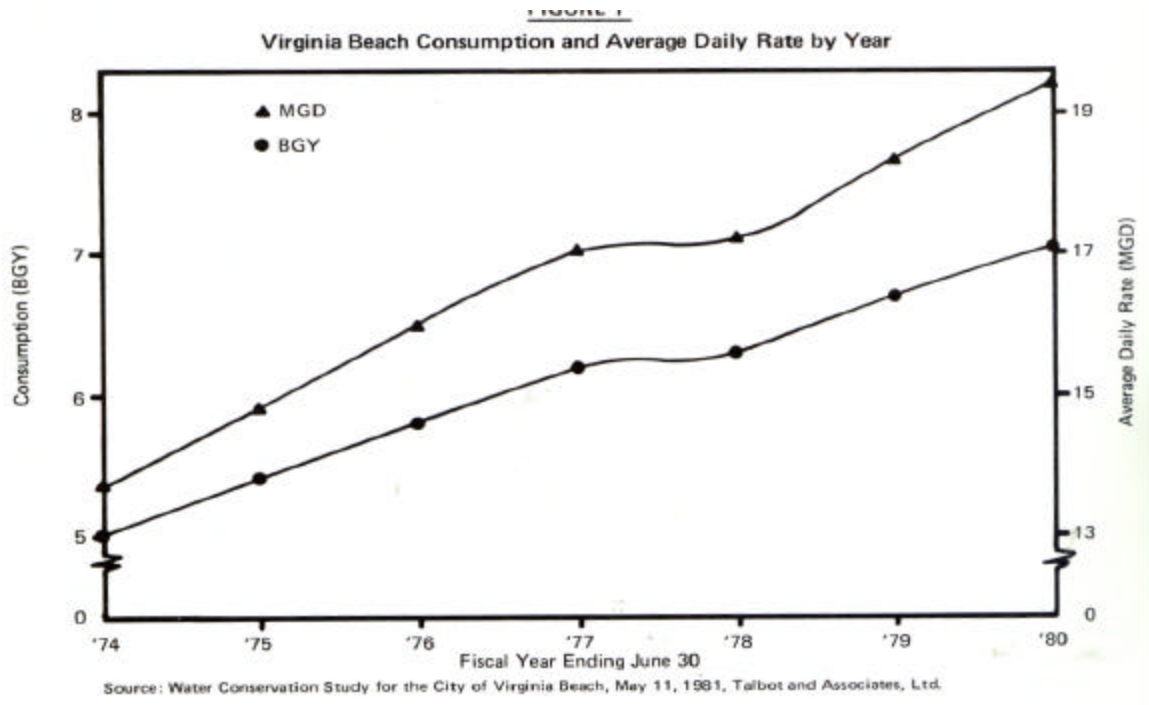
During the summer of 1980, record-breaking temperatures, below-average rainfall, and a high customer demand for water threatened water supplies. In Southeast Virginia, there were 15 consecutive days during August with temperatures 90 degrees or higher, tying the record set in 1977, when the area was also affected by a drought. During the 1977 drought,

the Norfolk water system, which serves area military installations, its own residents, and those of Virginia Beach, supplied a *high* of 84 million gallons a day (MGD). In 1980, consumption during the first days of August *averaged* 84 MGD. Part of this increase may be accounted for by about a 5 percent increase in the number of customers served by the utility, but most of it probably reflects the national trend of increase per capita consumption.

Figure 1 depicts the annual daily consumption rate and the total yearly consumption for the past seven fiscal years (July 1-June 30) in Virginia Beach. The uniform slopes of the curves indicate a relatively constant increase in demand of about 1.1 MGD per year. The only exceptions appear during fiscal years 1977 and 1980 when the effects of the droughts and accompanying conservation programs leveled off water consumption.

### Virginia Beach's Water Supply

Although Virginia Beach (population 262,199) is the second most populated city in Virginia and one of the fastest-growing cities in the United States, with



a 57.5 percent population increase in the last decade [City of Virginia Beach Department of Planning, 1980], it does not have its own major source of water. The city must rely on the City of Norfolk for most of its drinking water, even though 52 of Virginia Beach's 310 square miles are covered with water.

Back Bay, the largest body of surface water in the city, is brackish and contains a national wildlife refuge. Most of the important freshwater lakes in the city are owned by the City of Norfolk and cannot supply all the water Virginia Beach needs. Fresh groundwater is largely confined to the first 100 feet below the surface. Withdrawing water sufficient to meet the city's needs would most likely lead to saltwater intrusion and damage to many of the wells in the city. Desalination of seawater is a possibility that may have to be developed if less economical alternatives are not found in the future. Virginia Beach [1981] has studied more than two dozen sources for its water supply in the 21st century.

Since the 1920's, the City of Norfolk has provided the bulk of Virginia Beach's potable water. About 2 percent is supplied by Virginia Beach's Pembroke filtration plant from seven wells. Two private firms with a total of 1,085 customers have their own wells and lines in the city, and approximately 16,000 homes have private wells for potable and non-potable use. A 20-year contract between Norfolk and Virginia Beach, signed in 1973, provides for the sale of surplus water to Virginia Beach. Before the drought, Virginia Beach was purchasing just under 20 MGD on the average and 28 MGD during peak months. During the drought, the city was limited to 75 percent of its normal allotment.

Tourism, second only to agriculture in terms of revenue, contributes to the city's peak water consumption during the summer months. The \$190-million tourist industry generates \$16 million in local taxes and provides employment for 13,000 people. To accommodate the tourists' water demands within the allotment reduction, Virginia Beach contracted with the City of Suffolk and Isle of Wight County to increase Norfolk's raw water supply by 16 MGD. Virginia Beach later encountered many legal problems in obtaining permission from Norfolk to treat and distribute the additional water.

### **III. Virginia Beach's Response to the Drought**

As might be expected, Virginia Beach turned to

water conservation strategies to cope with the 1980-81 drought. Conservation has proved to be an effective method of solving many water supply problems, including both short- and long-term droughts. During a drought in 1977, for example, many California communities achieved water-use reductions of up to 60 percent [New England River Basins Commission, 1980]. Such conservation is achieved through supply and demand management.

#### **Supply Management**

Supply management is designed to conserve within the production and delivery systems. There are five aspects to supply management: metering, leak detection and repair, pressure reduction, watershed management, and evaporation suppression.

Virginia Beach is metered and can account for all water used and lost throughout its delivery system. It conducts a continuous leak detection program, and since most of the city's 880 miles of water lines are less than 20 years old, there is only a 4 percent (152 million gallons a year) loss through leaks. The national average ranges from 10 to 15 percent. Water pressure is kept between 40 and 52 psi, well below the recommended upper pressure value limit of 63 psi [Talbot and Associates, Ltd., 1981]. The two remaining supply management programs, watershed management and evaporation suppression, are the responsibilities of the water supplier, the City of Norfolk.

#### **Demand Management**

Since Virginia Beach does not produce the majority of its municipal water and those aspects of the supply management program that could be implemented were being carried out before the drought, the city had to rely on users to conserve within their homes or businesses, that is, it had to rely on demand management to get through the drought. Strategies of demand management are pricing, regulation, and education.

By examining the demand management strategies used by Virginia Beach, this study follows one of the recommendations made to the Office of Water Research and Technology (OWRT) by the National Academy of Sciences [1978]:

Because of the importance of developing the capacities of major sections of the nation to enhance their practices of conservation, OWRT should sponsor research on behavior aspects of implementing domestic water saving programs.. OWRT should also be interested in technology assessment of potential changes in water use practices, and this might be appropriately included in the water conservation research program [p. 61. 1981, the City of Norfolk raised

the wholesale price of water by 19 percent because of inflation and reduced consumption. Virginia Beach passed along the increase to its customers by raising the price to \$1.44 per thousand gallons.

### Pricing

There are essentially six types of water rates. All but the first rely on the use of meters.

1. Flat rate: Used in unmetered systems. Each customer pays the same amount, no matter how much or how little is consumed. There is no incentive to conserve.
2. Decreasing block rate: The price per unit of water decreases as consumption increases. There is no conservation incentive.
3. Uniform rate: The price per unit is constant and the cost increases in direct proportion to the amount used. There is some encouragement to conserve, especially if the unit price is high.
4. Increasing block rate: The customer is charged a certain amount for an initial block of water. The rate for succeeding blocks increases with each block. Since the price per unit of water used increases with consumption, this rate offers a good incentive to conserve.
5. Peak or seasonal rate: Used to encourage conservation, this rate attempts to reduce water use by charging more for water delivered during periods of greatest demand. For example, a residential user may be charged significantly more per unit of water anytime the user's monthly usage exceeds 130 percent of his average winter monthly use [Flack, 1981].
6. Lifeline rate: The consumer is charged a low, fixed rate for enough water to meet essential needs. This rate is usually established for low income elderly. There is some incentive to conserve so that the maximum amount allowed within the low rate is not exceeded.

During the period under study, Virginia Beach increased its water rates three times. In July 1980, while still under a declining-rate structure, the price of water was set at \$1.06 to \$1.02 per thousand gallons. On January 1, 1981, the city initiated a uniform rate structure and set the price at \$1.31 per thousand gallons. At the same time, water service charges and sewer maintenance fees were also increased. In July 1981, the City of Norfolk raised the wholesale price of water by 19 percent because of inflation and reduced

consumption. Virginia Beach passed along the increase to its customers by raising the price to \$1.44 per thousand gallons.

The cost of running a utility during a drought generally increases while revenue from water sales decreases. Rate increases must compensate for the reduced water sales because, unlike many businesses, a water utility cannot cut back its operations when production is reduced. During the drought, Norfolk's water utility incurred higher costs for chemicals and also for energy because more pumping was needed as water levels in surface impoundments and aquifers dropped.

One may expect that an increase in the uniform water rate should lead to a decrease in the amount of water used, but several studies (including Andrews and Hammond [1970], Hollman and Primeaux [1973], Linaweaver and Howe [1967]) argue that pricing has no significant effect on residential water consumption. The primary reason, according to Milne [1976], is that the amount of money spent on water represents a very small portion of the total family income. Affluent families, who have the greatest opportunities to reduce consumption (since they often have large lawns and more than the average number of water-using appliances and plumbing fixtures), spend an even smaller part of their incomes on water.\*

### Regulation

Regulation programs can be used to achieve both short- and long-term, high- and low-percentage reduction goals, and average or peak goals. According to the New England River Basins Commission [1980], demand management programs can achieve up to 10 percent water consumption reductions in annual use and 50 percent reductions in seasonal demand. The Virginia Beach program included a ban on nonessential water uses, an allocation program with surcharges (rationing), a water connection moratorium, and building code modifications.

---

\*A certain amount of latitude does exist for using pricing as a conservation measure, however. When Hanover, Massachusetts, increased the price of water by 70 percent, it achieved only a 3 to 5 percent decrease in average daily use but a 15 to 20 percent increase in peak use. Dallas, Texas, instituted a rate structure that reduced its peak consumption from 434 MGD during July 1974 to 385 MGD during 1977. Under the scheme, customers using less than 20,000 gallons a month paid 61 cents a thousand gallons from October through May and 79 cents a thousand gallons from June through September [Rice and Shaw, 1978].

### **Ban on Nonessential Uses**

The City Code of Virginia Beach, section 37-11, outlines the two steps Virginia Beach officials can take to conserve water in an emergency, as well as the associated legal and economic penalties for noncompliance. The first step is a water use ban that restricts the nonessential uses of water, including:

1. Watering of shrubbery, trees, lawns, grass, plants, or other vegetation, except from a watering can or other container not exceeding three (3) gallons in capacity.
2. Washing of automobiles, trucks, trailers or any other type of mobile equipment, excepting in facilities operating with a water recycling system approved by the city, or except from a bucket or other container not exceeding three (3) gallons in capacity; provided, further, that any facility operating with an approved water recycling system must prominently display in public view a sign stating that such a recycling system is in operation.
3. Washing of sidewalks, streets, driveways, parking areas, service station aprons, exteriors of homes, apartments, commercial or industrial buildings, or any other outdoor surface, except from a bucket or other container not exceeding three (3) gallons in capacity.
4. The operation of any ornamental fountain or other structure making a similar use of water.
5. The filling of swimming and/or wading pools, or the refilling of swimming and/or wading pools which were drained after the effective date of the order.
6. The use of water from fire hydrants for any purpose other than necessary governmental operations.
7. The serving of drinking water in restaurants, cafeterias, or any other establishment unless requested to do so by the individual being served.

### **Rationing**

The New England River Basins Commission calls rationing the most effective technique for relieving water shortages. Generally, however, officials like to avoid the administrative problems associated with this strategy. By the end of September 1980, rainfall was 4 inches below normal, and Norfolk's reservoirs were down to 50 percent capacity. Based on weather forecasts and the rapid rate with which supplies were declining, rationing was inevitable.

When a nonessential-use ban fails "to preserve sufficient supplies for the citizens of Virginia Beach," the city manager is empowered in step two of the city's mandatory conservation plan to institute rationing.

Since Virginia Beach buys surplus water from Norfolk, it had to follow Norfolk's lead in imposing rationing. When Norfolk announced a rationing pro-

gram to reduce consumption by 25 percent, Virginia Beach had to follow suit, or it would have been penalized just as any other customer for any water used over this 75 percent allotment. However, Virginia Beach did not choose the same kind of rationing program as did Norfolk. Since both programs may be among the first on the East Coast, a description of each follows.

**Norfolk's Rationing Plan** On October 15, 1980, Norfolk ordered a 25 percent reduction in water consumption. The average daily consumption for residential and commercial customers was computed for 1979. Residents were charged according to the following schedule:

1. The current rate of \$0.92 per thousand gallons for quantities below their allotment.
2. The rate of \$2.67 per thousand gallons for quantities between 75 percent and 100 percent of the amount of their average daily consumption during the previous year.
3. The rate of \$13.37 per thousand gallons for consumption over 100 percent.

Those residents (about 15 percent of the 55,000 residential customers) averaging less than 6,000 gallons a quarter were not subject to rationing.

Certain inequities of the system were investigated after the first penalty bills were issued. Large (non-conserving) water users in 1979 had much larger allocations than those customers who conserved in 1979. Norfolk decided that households should be allowed a maximum of 50 gallons a day per person, thus relieving those who had conserved in 1979 from the burden of penalties. Furthermore, even if a family used its normal allotment before October 15 and then reduced its consumption to 75 percent, it was penalized on its quarterly statement. Consequently, to fine-tune the system, all fines issued for the first billing period were waived if the billing period included any time before October 15, the date the rationing plan became effective. This involved the first quarterly billing period for residences and the first monthly billing period for large users.

Residential customers did not receive their first penalties until February 1, 1981. Further action by the Norfolk City Council pushed back the starting date of the rationing program from October 15 to November 1, 1980. An appeals board was established to ensure that all households received

an allotment of 50 gallons of water a day per person, and a concentrated effort was made to investigate allocations exceeding 300 gallons a day per household.

**Virginia Beach's Plan** When Norfolk reduced Virginia Beach's allocation to 75 percent of its August-1979 August 1980 consumption, the city sought an equitable method of passing the necessary reductions on to its customers. On October 13, 1980, the Virginia Beach City Council passed an ordinance establishing an emergency water allocation and rate plan. The Department of Public Utilities computed the average daily use per person as approximately 80 gallons of water a day during the 1979-80 period, or 15,000 gallons per household for each of the two-month billing periods. According to the Virginia Beach Planning Department, an average household had three persons. Taking 75 percent of the 15,000 total, the utility set 11,000 gallons per 60-day billing period as the allocation goal for all households. Thus, each household was allotted 184 gallons a day.

Any family, regardless of size, that used less than 11,000 gallons during the two-month billing period paid the regular rate of \$1.06 per thousand gallons before January 1, 1981, and \$1.31 per thousand gallons after January 1, when a rate increase went into effect. The \$1.06 rate was retained after January 1, however, to compute surcharges. The regular rate was also charged to any family, regardless of size, that could show that its usage was below 50 gallons a day per person. For example, a family of five could be allotted 250 gallons a day or 15,000 gallons over a 60-day billing period. The family had to submit to the city evidence of family size.

As a surcharge, residences were charged \$4.10 per thousand gallons of water used in excess of 11,000 gallons but less than 18,000 gallons for a 60-day billing period (18,000 = 100 gallons a day per person for a family of three). Virginia Beach proposed a maximum penalty rate of \$14.70 per thousand gallons that would apply when the amount of water used by a family unit of fewer than seven persons was in excess of 18,000 gallons per 60-day billing period or when a family unit of more than six used in excess of 50 gallons a day per person. Commercial and nontaxed operations were billed at the rate of \$4.10 per thousand gallons for water between 75 and 100 percent of their annual average two-month use and at \$14.70 per thousand for water more than 100 percent of their annual average two-month use.

The plan differed from Norfolk's because the city-wide residential use per capita for 1979 was

computed before the 75 percent allocation was figured rather than figuring the 75 percent allocation

on an individual family's water use for 1979. The system was designed so that households which conserved before the drought would not be penalized and nonconserving households would not receive large allocations. Customers with no previous billing records had their allocations based on data from similar accounts.

The new rate structure was effective on meter readings beginning October 1, 1980 (later changed to December 1), and the earliest bills affected by the plan arrived in early December. On October 15, Virginia Beach customers received cards detailing the previous year's average use and their allocation. The allocation cards may have been somewhat misleading, however, as they referred to a flat-percent reduction plan, similar to Norfolk's, when, in fact, the city was utilizing a maximum-allowance usage program. If a conserving family of six averaged 20,000 gallons of water per billing period in 1979, its allocation card would show a 75 percent usage goal of 15,000 gallons. If the rule of 50 gallons a day per person were applied, the family could use up to 18,000 gallons per billing period. On the other hand, a two-member wasteful family that used the same 20,000 gallons per billing period in 1979 would get the same allocation but would be penalized for any water used over the 11,000-gallon goal.

Since the utility had no record of family sizes, appeals to the 11,000-gallon maximum could not be made until the first bills were issued. The details of the appeals process follow.

1. Households with four or more permanent residents which used no more than 50 gallons of water a day per person. Holiday visitors or college students home for weekend visits did not qualify as permanent residents.

If a household consisted of more than three persons, the limit was 50 gallons a day per person or 3,000 gallons per person for each 60-day period. So a family of four could use up to 12,000 gallons at the regular rate. Anything between 12,000 and 18,000 gallons would cost \$4.10 per thousand gallons. A family of five could use 15,000 gallons without a penalty; a family of six could use 18,000. The maximum rate of \$14.70 per thousand gallons would apply for amounts over 18,000. In a household of more than six, the regular rate would apply to all consumption up to 3,000 gallons a person

per 60day billing period. Anything over that amount would cost \$14.70 per thousand gallons. A family of eight could use up to 24,000 gallons a billing period but would pay the maximum penalty for any water over this amount.

2. Hospitals, nursing homes, and convalescent homes. City officials worked with administrators to set realistic water quotas.
3. Those who needed extra water for treating a proven medical condition, including doctors, dentists, persons needing kidney dialysis, and those for whom physicians had prescribed frequent tub baths.

Surcharges were not paid until a decision on the appeal had been made. Customers who deducted the surcharge without filing an appeal letter could have had their water shut off for delinquency.

The mayor of Virginia Beach was originally opposed to the plan because it would affect only about 55 percent of the city's 60,000 water accounts when the billing period began in October 1980. The other 45 percent would not be affected until the next two month billing cycle began in November 1980. To rectify this apparent imbalance, all city water customers were made liable to penalties for overuse for at least one 60 day period, regardless of the supply of water on hand.

Virginia Beach did not exceed its 75 percent allocation of 14.9 MGD, so the city waived the fines imposed for the first billing period. Based on computer output, warning cards were sent to 2,000 customers outlining the penalties that would have been imposed had they not been waived by the city council. Again during December and January, the city as a whole did not exceed its allotment. However, penalties were instituted this time because, the council concluded, conservers-94 percent of the city's residents-should not have to carry the nonconservers, and nonconservers should pay for what they use; penalties offered incentive to conserve; penalties maintained credibility for the public utility in future conservation programs; and fines helped make up for lost revenues.

Fines totaled \$193,000 by early February. The penalties provided an incentive for making household repairs to augment savings. One household received a \$504 water bill, later reduced to \$70 after three leaky toilets were discovered and repaired.

The allocation system for motel and hotel customers was revised on May 1, 1981, upon the recommendation of Talbot and Associates, Ltd., a Virginia Beach engineering consulting firm. The revised system was based on an average water use of 214 gallons per unit. Computing 75 percent of this 1980 average, each motel or hotel complex was allowed 160 gallons per unit. The number of units per complex was determined by billing records and surveys conducted by the public utility personnel.

#### **Water Connection Moratorium**

On September 26, 1980, the flushing of new water mains at construction sites was halted. This was, in effect, a moratorium on new water hookups in subdivisions under construction. Flushing, which requires large amounts of water, must be done to clear the lines of sediment so that clear water can be delivered to customers. The utility director said that construction could proceed without water and the flushing restriction would only have an impact on the building industry if it remained in effect for several weeks.

Nearly 1,200 homes and businesses under construction in Virginia Beach were unable to hook into the city's water system. At least 1,000 of those affected by the ban were home buyers whose builders had already paid the \$120 meter fee, but whose meters had not yet been installed. The only exception to the ban was for residences in low-income areas where existing well water was contaminated and the city was installing lines with federal funds.

The ban remained in effect until the water reservoirs rose to about a 100-day supply. Before that level was reached, however, digging shallow wells to serve individual homes or small groups of homes was allowed. Builders who had unsold houses hooked up to city water could transfer the hookups to other houses with buyers. All dwellings were connected to water lines as they were completed, but locked meters ensured that no water would pass through the lines. This action prevented a backlog of hook-up work so homes would not be cut off from water any longer than necessary once the moratorium was lifted. The moratorium was lifted on April 17, 1981.

#### **Building Code Modifications**

Since September 1, 1978, the City of Virginia Beach had required the installation of water saving fixtures in new or remodeled homes. Its building code sets the amount of water per

toilet flush, the gallons per minute that may flow through a shower head or lavatory sink faucet, bans continuous flow or continuous flush toilets and urinals in public lavatories, and specifies that all car wash installations are to recycle water. The modifications had gone into effect as a result of the 1977 drought.

### Education

While pricing and regulations are mandatory measures imposed on water customers, education is voluntary. Users may or may not respond to requests to conserve. A review of previous studies revealed more conflict than consensus on the relationship between knowledge and behavior. Baumann [1981] states, "Contrary to conventional wisdom, the fact that an individual is informed about an issue and the range of alternative courses of action is no guarantee he or she will act upon that information" [p. 29].

E. Scott Geller [1981], a behavioral psychologist at Virginia Tech, believes that "just telling someone to do something, whether it's ecologically sound or not, will not change behavior, because alone, it cannot bring consequences closer to the behavior" [p. 211]. On the other hand, some educational researchers [Pettus, 1976; Watkins, 1974; Bowman, 1974; Cohen, 1973] have concluded that knowledge on an environmental topic produces favorable attitudes and behaviors. Watkins [1974] points out that "inadequate solutions to water problems have arisen from inadequate knowledge of water" [p. 58], while researchers in Colorado indicate that long-term, drought-related problems originate from local citizen apathy because of a lack of education on water affairs [Howe et al., 1980].

The use of information, appeals, and incentives has been examined in a variety of contexts relating to specific conservation topics, such as fuel consumption and litter control. Taken overall, studies suggest that information and appeals alone have little effect in generating behavior leading to conservation and that incentives are necessary [Agras, Jacob, and Lebedeck, 1980]. Since Virginia Beach used educational techniques in conjunction with other demand management programs that offered incentives, it was not possible to factor out the single effect of education. Thus, each theory concerning the connection between knowledge and behavior cannot be proven or disproven.

Regardless of conflicting behavioral and sociological data, public education to promote water conservation has been highly recommended by a number of sources. The *Great Lakes Basin Water*

*Conservation Plan* [Meyer, Clemens, and Whitehill, 1978] states, "Public education through information dissemination is the most vital component of a comprehensive water conservation strategy, for the role of public participation in conserving resources and public funds is essential" [p. 23]. The New England River Basins Commission believes that "public information programs have been used frequently and successfully as the only conservation program for reducing water demand" [1980, p. 46].

A 1980 study by Water and Man, Inc., concluded that "drought, pollution, groundwater depletion, water for energy, . . . and scores of other problems will continue to plague us. Education is our best hope in meeting and solving these problems" [p. 7]. This conclusion is supported by researchers in California who believe a "well-planned educational program is needed to create a 'water conscience' which will overcome the commonly held view that water is abundant and that wasted water is of little consequence" [California Department of Water Resources, 1978, p. 33].

According to John Lattie of the East Bay Municipal Utility District, the most important aspect of a shorter long-term continuing water conservation program is public relations. Any program will be ineffective unless it is communicated properly to the public. Goals of such a program include achieving public understanding of: (1) The nature and extent of the problem. (2) The effect on individual customers of regulations or a rationing program. (3) Actions customers can and cannot take to meet the requirements of a conservation program. (4) The economic costs particularly why a water bill does not decrease when water use decreases. (5) Other miscellaneous information such as leak detection and water bills.

Virginia Beach initiated education programs as one method to reduce its water usage. The components of its education program can be divided into three categories: direct mail, news media, and personal contact.

#### Direct Mail

A brochure distributed with the July-August water bills and entitled *Water: It's Time to Conserve It* reviewed water-saving practices in the bathroom (where 75 percent of the water in a home is used), in the kitchen, and



elsewhere. A one-page insert was mailed in the November-December water bills to notify customers of the upcoming rate changes to begin January 1, 1981. A similar bill insert mailed in the next cycle explained how utility bills were computed.

### **News Media**

The Virginia Beach area is served by two major newspapers distributed by the same publishing company. The *Virginian-Pilot* is the morning edition with 131,068 subscribers, and the *Ledger-Star* is the evening edition with 96,040 subscribers. Three times weekly, both papers include an insert, the *Beacon*, directed at Virginia Beach residents.

Both newspapers carried extensive coverage of the drought with articles ranging from specific conservation practices to news about conservation regulations. Rules on the computation of surcharge penalties were outlined in more than 30 articles. Public interest stories carried titles such as "Water Wasters Get Scolding" and "Water Bill May Rival Mortgage." Daily water statistics for the Tidewater area were published, as well as progress reports on the successes and failures of the conservation program. Coverage of the water dispute between neighboring Tidewater communities, Virginia Beach's efforts to find additional water supplies, and the effects of the drought on agriculture and other businesses also kept news of the drought in the papers.

In January 1981, each radio and television station broadcasting in Virginia Beach was sent a questionnaire requesting information about its coverage of the drought and its specific public education efforts regarding water conservation. Many stations do not keep records of their programming and were unable to respond. However, six did return the questionnaire. Their drought education efforts included public affairs programs, frequent news stories, and public service announcements. One station cosponsored with the City of Norfolk four water-saver workshops. Another regularly broadcast Agricultural Stabilization and Conservation Service reports. A third ran 50-minute telephone talk shows which allowed listeners to ask questions of guests about the drought and conservation techniques.

### **Personal Contact**

**Customer Service** Customers who suspected errors on their water bills could request that a utility service inspector check the water meter and/or the customer's plumbing fixtures at no charge. If a faulty meter was discovered, the bill was adjusted. If an unusually large consumption was caused by defective internal plumbing fixtures or water lines, the customer could send a letter to the utility stating when repairs were completed. Subsequent meter readings would be obtained for an indication of reduced water consumption, and if consumption was

reduced a minimum of 25 percent, a plumbing adjustment was applied to the bill. The utility also noted any unusual and substantial increases in consumption and notified customers by letter that they might have leaks or seepage in or around their homes.

### **Student and Adult Education Programs**

The Virginia General Assembly in Joint House Resolution 268, sponsored by Tidewater legislators and passed in 1979, recommended that public school curricula should include a program stressing the need for water conservation and the techniques by which conservation can be accomplished. Researchers have identified school programs as effective in achieving water conservation [Weeks, 1979]. According to the California Department of Water Resources [1978], "a curricular program built around water awareness materials will have lasting effects on the students' attitudes and will also affect the students' families" [p. 25].

The superintendent of customer relations in Virginia Beach participated in several school programs involving an oral presentation and slides depicting the city before and after the drought. Students who completed a water conservation project designated by the cooperating teachers were awarded a "Participation and Achievement Award" acknowledging their successful completion of a Home Water Conservation Study and designating them as "Willing Water Savers for the City of Virginia Beach." The certificates were signed by the director of public utilities and the superintendent of customer relations.

The Virginia Cooperative Extension Service in Virginia Beach conducted several adult education programs. In October, two programs were conducted for the city's extension homemakers clubs. In addition, 40 science and ecology teachers received water conservation instruction and teaching packets.

### **Exhibits**

In October 1980 and May 1981, exhibits were cosponsored by Virginia Beach at a local shopping mall. Other sponsors included the State Water Control Board, the Virginia Water Resources Research Center, and the Virginia Cooperative Extension Service. On September 26, 1980, the Extension Service sponsored an exhibit at the Farmer's Market. A similar conservation exhibit sponsored by the Norfolk Extension Service at a Norfolk shopping mall was well attended by Virginia Beach residents, according to responses to a participants' questionnaire.

**Hotel/Motel Audits** During the drought, service personnel of the water utility conducted surveys of a majority of the hotels and motels in the resort beach area regarding specific water conservation programs implemented in the resort complexes. In addition, utility personnel conducted a water use audit of cooperating motels and hotels. The manager or owner toured the facility with the service inspector who pointed out potential problem areas and offered suggestions.

## IV. Results

The case study of Virginia Beach attempted to document the types of conservation strategies implemented by the city and to assess quantitatively and qualitatively their impact. A statistical methodology was applied in an effort to determine relationships between water consumption and the various components of the demand management program.

### Data Collection

The Virginia Beach study was begun four months into the 1980 drought. It was not possible to plan data collection in advance, so data which had been compiled for other purposes were used. Although these data sets had the advantage of being collected without the knowledge of the sample subjects, they did not have the built-in controls necessary for a thorough statistical analysis, nor were the sets available in a desirable format. Computerized baseline data were available only for the period since January 1979. Billing records before January 1979 were stored on microfiche, and retrieval was uneconomical. While billing data for the most recent two-year period could be displayed by account number on the computer terminal monitor, information for one billing period was recorded on individual microfiche cards. Thus, a year of two-month billing data would be scattered among six separate microfiche cards. As a result, January 1979 was a practical and economical starting date.

Two-month billing created another problem when monthly and daily consumption totals were desired in the analysis. The utility staggers the reading of meters throughout the two-month period. Therefore, a prorated scheme was used to adjust the two-month staggered readings. For example, if a meter reading is taken on May 10, the water usage for the month of May is computed to be 10/60 of the March 10 to May 10 consumption and 20/60 of the May 10 to July 10 consumption. An implicit assumption made in this scheme is that water use is uniformly distributed over the 60-day period. Even if this assumption is violated, any conclusions drawn will not be invalidated but will only be more conservative because true differences in monthly water usage may be averaged out.

Two sources were used to determine monthly totals between January 1979 and March 31, 1981. The monthly billing information sent by Norfolk to Virginia Beach provided civilian and military consumption totals for the city. One problem encountered was that the master meter between the two cities was not read consistently on the last or first day of each month but rather on the last working day of each month. Consequently, the meter may have been read on May 29 and June 30, accounting for a 32-day month. The second data source was daily use totals read on the master meter by Virginia Beach public utility personnel. These meters were not read consistently at the same time of day, and daily manual readings were discontinued on April 2, 1980. At that time, a Telemeter recorder was installed on the master meter between Norfolk and Virginia Beach. The Telemeter did not function properly for daily readings until mid-August 1980, so four and one-half months of daily use figures are unavailable. After August 15, data from the daily totals supplied by the Telemeter system were available. A combination of the Norfolk billing data and the manual and Telemeter readings was used to determine monthly and daily water use totals and averages.

### Data Analyses

To assess the impact of the conservation strategies employed by Virginia Beach, a citywide residential water use, a building code, and total daily water use surveys were conducted.

#### Citywide Residential Water Use Survey

The citywide water use survey was designed to provide monthly average and monthly total usage for residential water use. The monthly averages were used to study water consumption during predrought and drought conditions for apartments and singlefamily residences and to determine approximately when the water conservation programs' effects were evidenced.

Water information for this survey was obtained from the Virginia Beach utility's computerized billing records. Staggered, two-month readings were adjusted to yield an estimate of the monthly usage for each sampled account. Since the study was concerned only with active accounts, zeros and missing values were eliminated from the analysis.

Single-family residences and apartments required separate sampling schemes because of the sampling directories available. For single-family residences, the water utility's meter books were used to implement a two-stage cluster sample

with proportional subsampling. Each of 376 meter books had an average of 150 households, dividing the city into various "meter-reading" neighborhoods, that is, each book comprised accounts in the same vicinity. The books were used as clusters and 45 books were randomly selected from the 376. A random 5 percent subsampling scheme was used to choose accounts from the 45 selected books. The completed sample contained data from 370 households out of the 56,267 single-family residences in Virginia Beach. To select the apartment sample, a list of the 2,436 active multi-family accounts was obtained from the water utility, and 152 accounts were selected randomly from this list.

After the billing data were corrected and adjusted, estimates of total monthly and average monthly usage were obtained for the residences. The formulas used for these estimates are given in Cochran [1977].

The estimated total monthly consumption figures are averaged over days of the month and plotted in *Figure 2*. Monthly totals for the entire city are plotted on line 1, civilian use on line 2, and military use on line 5. These data were obtained from master meter readings. The monthly totals for single family residences, line 3, and multi-family residences, line 4, were derived from the individual billing records of the sampled accounts and multiplied by a factor to estimate the total citywide consumption for both types of residences.

The following results from the statistical analysis were noted: (1) There was an increase in water use in the sample of single-family residences during the first months of the city's voluntary and mandatory conservation program. (2) Comparing 1980 with 1979 usage, significant reductions were noted for these residences beginning in October 1980. This observation coincides with the initiation of step 2 of the city's mandatory conservation program, that is, initiation of the allotment program. (3) Similar significant decreases in water use for the multi-family residence sample were not noted until December 1980. (4) No significant reductions in water use were noted in July 1980 and January 1981, the dates of the price increases. While the January 1981 water use mean for single-family residences is significantly less than the mean for January 1980, the price increase did not produce a significant decrease in water use during January 1981 over the December 1980 mean figure.

Several observations can be made about the accuracy and dependability of the water billing data and the above adjustments. Over the two-year period of study, the population probably grew as much as 10 percent. Some of this growth is not reflected in the monthly totals. In addition, because of previous droughts in Virginia Beach, many households had in-

stalled wells to supplement their water supply, while other homeowners had retrofitted their homes with water-saving plumbing fixtures. These factors would affect the data results only if the homes were retrofitted or supplied with well water after January 1979, the period of data collection, since the observations compare 1979 usage to 1980 usage by matched months.

It was suspected originally that the averaging scheme employed in this study would create a lag of up to a month before significant changes in water use patterns would appear in monthly averages. *Figure 2* indicates, however, that the consumption trends for each of the single- and multi-family residences appear similar to the total citywide consumption and very little lag time is observed. It should also be noted that residential accounts during the summers of 1979 and 1980 do not parallel the increases in total consumption for the city since water consumption attributed to the tourist industry is excluded from the residential totals. The city's peak water consumption during the summer is illustrated in *Figure 3*. This comparison of predrought (baseline) and drought monthly totals supports the conclusions reached in the statistical analysis, namely, consumption in 1980 did not decline significantly over 1979 figures until October 1980.

### **Building Code Survey**

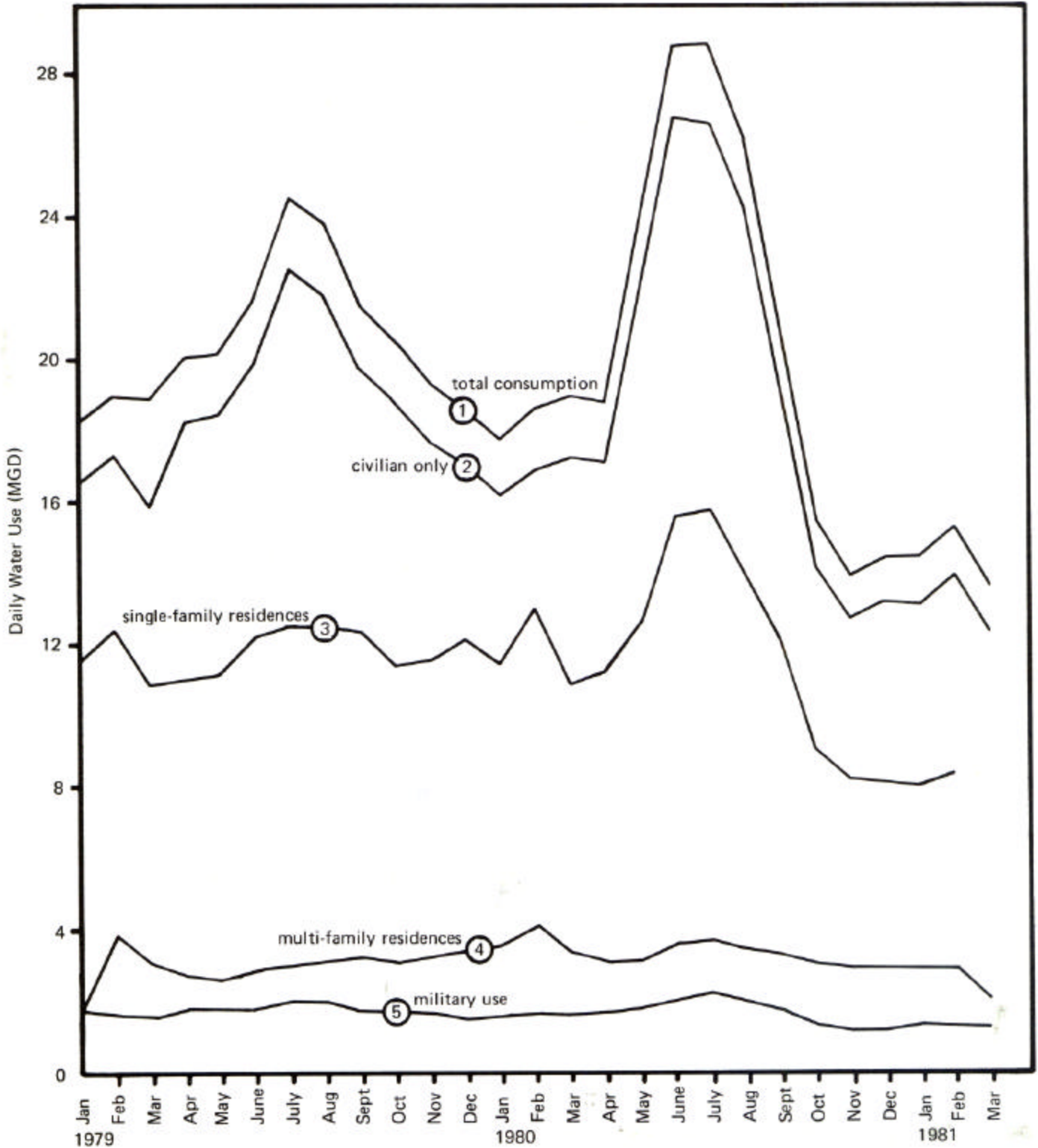
The building code survey was designed to determine if significant conservation had been achieved in singlefamily dwellings fitted with water-saving plumbing fixtures in accordance with buildingcode regulations. The data used were the two-month bills adjusted to yield estimates of monthly water usage.

A random sample of homes built after the City Code building amendment went into effect was selected, along with a random sample of homes built before the building code amendment was adopted. The prebuilding code sample was taken from homes built between 1975 and 1978 and was matched on the basis of size and construction with the homes in the postbuilding code sample. The information and sample were provided by the Virginia Beach Planning Department, which used building permit records and a systematic sampling scheme. The final sample contained 410 households-155 prebuilding code single family residences and 255 post building code single family residences.

Results showed that many of the homes built after June 1978 had considerably higher average consumption means during the summer and early fall months than homes built before June 1978, the date of the building

code amendment. An explanation offered by the utility was that new homes required large

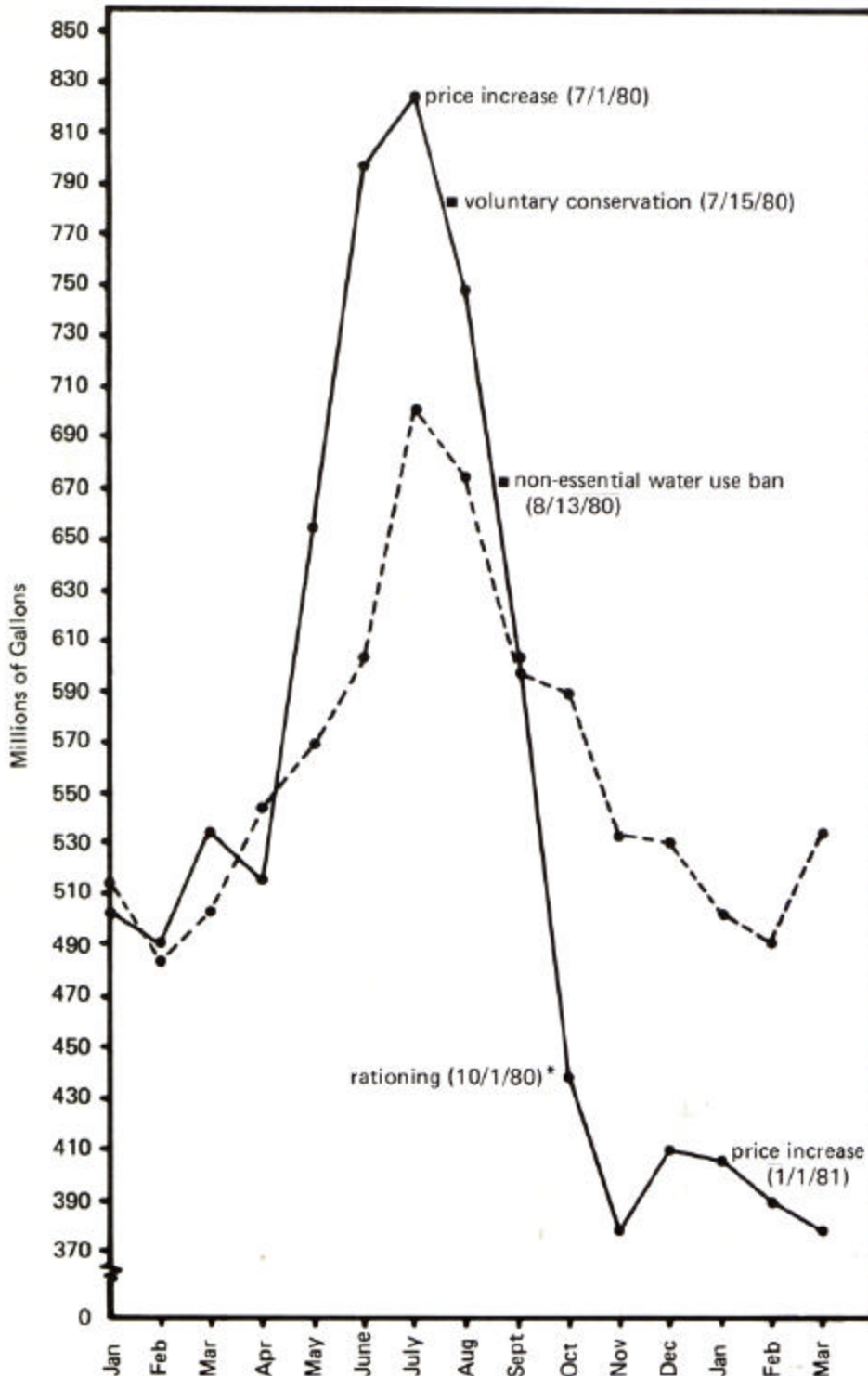
**FIGURE 2**  
**Estimated Total Monthly Consumption Averaged Over Days of the Month**



amounts of water for installation of lawns, and since this is not of interest when comparing average water use, the most extreme outliers (any monthly usage

more than double the monthly mean in the given year) were first eliminated from the billing data. With the data thus corrected, average monthly usages were then computed for both the pre- and postbuilding code samples.

**FIGURE 3**  
Comparison of Predrought and Drought Citywide Monthly Totals



\*Date around which statistically significant decreases in water use (as compared with 1979) are noted.

The resulting data, which matched billing records on a month-to-month basis, did not support the hypothesis that water use was less for homes built after the 1978 building code amendment than for homes built before the amendment. In fact, for some months, the opposite appears to be true.

#### Daily Water Use Survey

The daily totals represent master meter readings taken by the city for both total city-wide consumption and total military consumption. Total civilian consumption can be obtained as the difference of these two values. Regressions were performed to determine which variables could be used to predict total daily consumption, and a quadratic relationship was found between the Julian date and total daily consumption for all three totals. This confirms the fact that water usage peaks in the summer months. The year also was of importance, reflecting the growth effect in the population and the changing patterns of water consumption over the two-year period. One surprising fact that emerged from the regressions was that the day of the week was not significant in predicting daily consumption in any of the regressions. The regressions were used to obtain 95 percent prediction intervals about the total consumption for 1979. Monthly averages of water use, averaged over days of the month,

were computed using these data, and the obtained values were plotted in *Figure 2*, lines 1 and 2. It must be noted that daily totals were read by the utility for interval uses only and therefore may not be highly accurate, particularly since the meters were read at different times of the day. External events such as broken water mains, fires, holidays, and the filling of water tanks also could have affected the daily readings severely. The prediction intervals may be interpreted as the region where future observations are expected, with 95 percent confidence, to fall. Between October and mid-December 1980, and Feb-

ruary and March 1981, there was a definite break in the water use patterns. Since these observations fell outside the prediction intervals established with 1979 data, a significant difference in water use was evidenced.

### Print Media Study

To obtain an index of the influence of the print media, methods developed by Agras, Jacob, and Lebedeck [1980] were used. In a study of the 1977 California drought, researchers developed an index to measure a local newspaper's coverage of the drought.

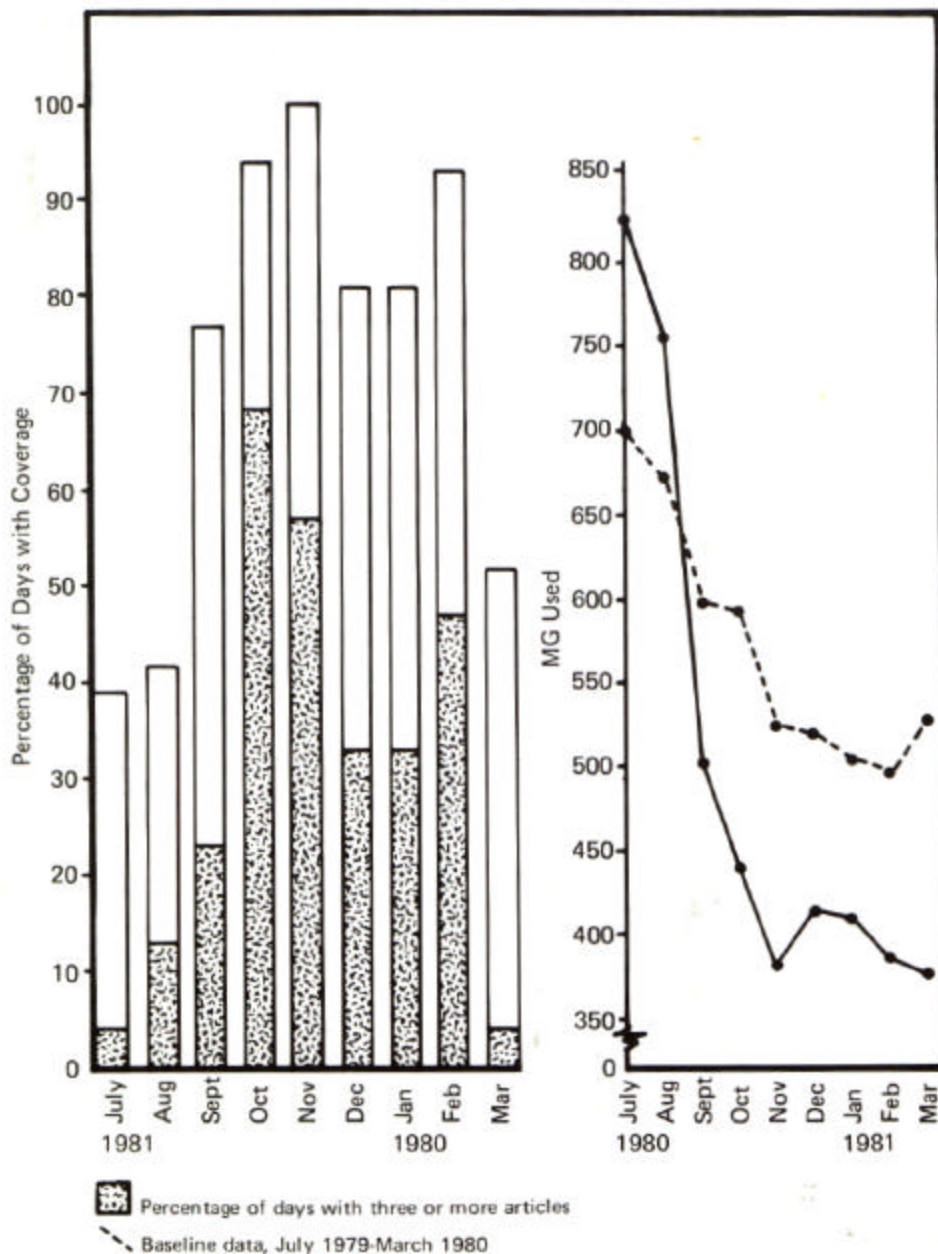
Both the length (in column inches) of the articles and the number of issues a month with drought articles were measured. Agras et al. discovered that the percentage of days with drought articles was highly correlated with statistical functions that use both the column inches and percentages of articles as variables. Therefore, a percentage of issues a month with at least one article on the drought was chosen as the simplest index. Criteria for determining if a news article were dealing with the drought were that the subject matter concerned water rationing and conservation or the articles explicitly used the word "drought" or implicitly referred to the drought by using related words.

The total number of news articles appearing in the *Ledger-Star*, *Virginian-Pilot*, and *Beacon* was translated into percentage of days of coverage. The results are reported in *Figure 4*. One observation that can be noted is the coincidence of high levels of media coverage with reduced total water use figures and with the percentage in reductions over 1979-1980 baseline totals.

In addition to the four quantitative surveys reported above, this study also used a qualita-

FIGURE 4

News Coverage of Drought and Monthly Water Consumption



tive survey of the water conservation practices of the motels and hotels in the beach resort area.

#### Hotel/Motel Survey

During the 1980-81 drought, utility service inspectors conducted surveys of most motels and hotels in Virginia Beach's resort area. The results of the 87 hotels/ motels responding to the questionnaire:

1. Flow restrictors had been installed in all rooms of 47 motels/hotels within the previous two years. Three additional complexes had installed the restrictors in some rooms; 37 had not.
2. Water-conserving float assemblies had been installed in all toilet tanks of 37 motels/hotels. Four additional complexes had installed the assembly in some rooms; 46 had not installed any assemblies.
3. Three complexes with restaurant facilities had installed faucet flow restrictors and/or toilet float assemblies in their restrooms.
4. Programs for informing guests of ways in which they could help conserve water were in use in 25 motels/hotels. Sixteen were informing their guests orally at the time of check-in, and nine motels were informing guests by letters or signs in the rooms. According to some of the remaining 62 managers/owners, they would not require guests to be inconvenienced by practicing water conservation, particularly in light of the costs of in-season room rental.

## V. Conclusions and Recommendations

The drought of 1980-81 was much more severe than the drought of 1977, and Virginia Beach, like the state of Virginia, had no long-range plan for coping with a prolonged water crisis. To correct this apparent short-sightedness, the city hired a local consulting firm, Talbot and Associates, Ltd., to make recommendations for such a plan. The final recommendations included water conservation strategies as part of a permanent water management program. Traditionally, water conservation has been used only during water shortages-a temporary solution to a temporary problem-but conservation strategies should be a fact of life for Virginia Beach as well as for other communities.

Water conservation is an effective and efficient way of solving many water supply problems, including the effects of a severe water shortage. Because so many strategies to influence Virginia Beach's water consumption were used for a relatively short time, it was not possible to quantify each effect of individual components of the water conservation program, but the available statistical and quantitative data evoke several observations and recommendations. Discussion of each component within Virginia Beach's demand management program follows.

### Pricing

Even though price increases were not initiated by Virginia Beach as an incentive for conservation, the effects of this demand management strategy on conservation were statistically analyzed. The analysis reveals that no significant decreases in water use occurred immediately after the July 1980 increase even though voluntary conservation measures were instituted two weeks later, and a nonessential-use ban went into effect six weeks later. While not statistically significant, the adoption of a uniform rate in January 1981 appears to have some effect on decreasing consumption.

Virginia Beach's experience with rate increases confirms the literature. Because the city has a median family income of more than \$20,000, the increases were not expected to be a conservation incentive, but rather a means to cover inflationary costs and lost revenues.

Virginia Beach should consider implementing an increasing-block rate or peak-season pricing system. The effects of such systems on the tourist industry would have to be carefully studied, but this study indicates that Virginia Beach residents are responsive to programs, such as rationing, which have the potential to increase water costs significantly.

### Ban on Nonessential Uses

During the first two days of the ban, about 100 citizen complaints of apparent violations were recorded. Of these, only 11 were actual violations and generally involved homeowners who were watering lawns and washing cars. Many alleged violators had private wells which were unaffected by the ban. Originally, violators were warned by public utility service personnel, with summonses issued only after the second offense.

In September 1980, however, because of the continued severity of the drought, the public utility requested that the police department begin issuing summonses to all violators and that police officers, rather than utility personnel, respond to citizen complaints. Additional correspondence from the utility to the police department in October 1980 requested that the names of all persons convicted of violating section 37-11 (d) of the City Code be sent to the utility. The utility then determined if water service was to be terminated.

Between August 1980 and April 1981, six persons were convicted of the Class III misdemeanor in violation of the water use ban. Fines ranged from court costs (\$13) to court costs plus \$50. Several explanations of the relatively low number of convictions may be offered. First, it was difficult to obtain a conviction since violators had to be caught in the act. A person standing by a clean car, with a shut-off hose in hand, for example, was insufficient evidence of violation. Second, car washing and/or lawn watering traditionally have not been considered "crimes," and the seriousness of these temporary water use offenses was not realized. Third, peer pressure or a "law-abiding" characteristic of Virginia Beach residents prohibited violations of the City Code during the emergency. When watering lawns, for example, many homeowners and businesses posted signs to announce they were using private wells.

An alternative to enforcement is the adoption of account allotments. The allotment, or rationing, program, would thus be initiated before a crisis situation developed. Water customers would have the option of using their allotment as they chose, including washing cars or watering lawns. An intensified education program, however, would inform the customers of the water and money costs of nonessential uses. Those portions of the nonessential water use ban that lend themselves more easily to enforcement (such as requiring the installation of reuse systems in car washes) could also be adopted at this stage.

## **Rationing**

The assessment of monetary penalties for excessive water use (above the rationed allotment) was the most effective pricing incentive in the conservation program. Statistically significant decreases in water use for single-family residences were noted only after the rationing program was announced on October 1, 1980. Similar decreases were not noted for multifamily residences, however, until December 1980, probably because most individual apartments are

not metered and apartment dwellers do not pay directly for their water use. During the study, water use reduction in multi-family residences was never as statistically significant as reduction in single-family residences. Thus, the incentive to save water and money is not as strong in these cases as it is for single-family households, which pay water costs directly. After the landlords received the first billings during the rationing phase and noted the potential penalties, they may have begun to encourage their tenants to conserve by initiating education programs.

The rationing program adopted by Virginia Beach is more equitable than Norfolk's program. Virginia Beach households that had established conservation habits were not penalized by additional and unreasonable reductions, and the appeals system could account for exceptions. A total of 5,500 allotments was appealed, with 97 percent exceptions approved. Approximately 2,000 commercial allotments were appealed, with a 75 percent approval rate. A future appeals system should allow for more flexibility, however, which must be accomplished by the establishment of an appeals board.

In future rationing programs, information sent to consumers or printed in the media must be written as clearly as possible. The allocation cards sent to Virginia Beach residents during the drought probably were misleading since the cards referred to a flat percent reduction plan, similar to Norfolk's, when, in fact, the city's program was based on maximum allowance usage. New programs should be most explicit about rate policies.

It is also recommended that penalties for excessive use not be rescinded even if the city does not exceed its allotment. Maintaining expressed penalties lends credibility to the public utility for future conservation programs, and the fines help make up lost revenues. Further, as noted in the data results, the penalties appeared to offer conservation incentives. Conservers should not subsidize nonconservers, who should pay for what they use.

## **Water Connection Moratorium**

The moratorium on construction in Virginia Beach was a most controversial regulation, with reactions ranging from criticism of the city for crippling the relatively large building industry to praise of its means of slowing Virginia Beach's too-rapid growth. The main water savings achieved through this measure were probably realized through the ban on flushing water mains rather than through the ban



on individual home hookups, since many of those new homes would have been occupied by Virginia Beach residents who had been using water in other parts of the city. Some residents, and at least one Virginia Beach councilman, thought the moratorium was a symbolic gesture to appease Isle of Wight County and Suffolk, locations where Norfolk wanted to drill wells to combat the drought. Isle of Wight and Suffolk officials had criticized the two cities for letting new homes and buildings hook up to water lines in the face of a water emergency.

## **Building Code Modifications**

Results of the building code survey revealed significantly lower consumption means for residences constructed after adoption of the new building code in only two of the months between July 1980 and February 1981. Before eliminating the data outliers, the consumption mean figures for post building code accounts were consistently higher than the prebuilding code accounts. These results conflicted with an informal study conducted by Talbot and Associates, Ltd., a local consulting firm in Virginia Beach, which indicated, for a different housing sample, a lower consumption level (between 1 and 24 percent) for post building code homes. The Talbot data could not be statistically analyzed since individual household water use variances were not available.

It is possible that the homes constructed in the prebuilding code sample may have retrofitted after the 1977 drought, thus making them comparable to the post building code sample. In addition, this study did not match homes on the basis of the number of occupants, a necessary comparison. Future studies must control and match more carefully the independent variables, such as type of home, number of occupants, and size of lawn.

The director of Virginia Beach's building permit department reported that the building code amendment to the City Code was accepted and even endorsed by plumbers and builders. No complaints and no violations were reported.

Encouraging water conservation through a building code is desirable because the installation costs of conservation fixtures are minimized if they are installed at this time and selection of the most desirable fixtures for the specific project is easiest then. Though not required by the code regulations, builders are encouraged to tailor floor plans with conservation in mind, installing, for example, minimum hot water runs and insulated hot water pipes. Drought-resistant plants can be used in a

building's original landscaping, and good soil preparation can be provided at least cost.

## **Education**

One of the most important aspects of a short- or long-term water conservation program is public education. No matter what kind of program is requested, it will be ineffective unless it is properly communicated to the public. Thus, education should be included with all other demand management programs.

### **Direct Mail**

Virginia Beach employed a cost-efficient method of direct mailing by inserting brochures and single-page information sheets into the bimonthly billing statements. The utility should assume that the customer has limited knowledge of the city's water problems, billing system, or residential water conservation methods. It should furnish, therefore, well-timed, clearly written information to its customers. One of Virginia Beach's billing inserts, for example, was intended to explain the January 1981 rate increases. Since Virginia Beach is on a two-month billing cycle, this particular insert might have been clearer if the water service and sewer maintenance charges were quoted on a two-month basis rather than a one-month basis. This change would have avoided a number of customer questions on billing charges.

The water utility might also consider a billing insert or newsletter in a separate mailing to disseminate information about retrofit conservation devices. Such devices as faucet aerators, flow-reducing showerheads, toilet tank inserts, and hot-water pipe insulation should be brought to the attention of consumers. These devices are all relatively inexpensive, can be installed easily by the homeowner, and pay for themselves in a short time. Any retrofit devices advertised by the utility must be available in local hardware and plumbing supply stores. The utility may need to work with the hardware dealers through a newsletter or personal contact to encourage the marketing of the items. In carrying the message and merchandise of water conservation, the home center dealer can make a profit and serve the community as well.

### **News Media**

Since increased radio coverage of the drought coincided with periods of water use reduction, those stations that conducted special programs on the drought are to be commended and encouraged to continue carrying similar programming. Several radio stations expressed an interest in receiving water conservation information to be used in special programs. The utility should send regular news announcements to the area stations regarding conservation techniques, practices, and utility policies and plans. Specific information requested

frequently by customers, for example, could be the subject of public service announcements or interviews.

Newspapers also contributed to the water conservation effort by running many varied articles relating to the drought in general and water conservation in particular. As noted in the data analysis, there is a strong relationship between the quantity of articles on the drought and a decrease in water consumption figures. Water utility personnel should continue to supply news story suggestions to the media.

### **Personal Contact**

#### **Customer Service**

Random observations of the utility's customer service department revealed that numerous and frequent customer inquiries were handled efficiently and competently. John Lattie [1977], public information director for the East Bay Municipal Utility District, suggests that the preparation of a fact sheet or interoffice newsletter listing typical customer questions and personnel responses would assist customer service personnel and ensure that accurate information is disseminated. Public statements made by the utility should be available to all staff members who deal with the public. Logging of the types of calls would give officials an idea of the program's impact and would indicate those areas in need of further information dissemination. For example, if by their questions customers seem unusually confused by the appeals system, the utility could consider such measures as a full-page newspaper advertisement, a television spot, or a special newsletter mailing.

#### **Student and Adult Education Programs**

The utility made a good beginning with the initiation of its school visit program and awarding of the "Home Water Conservation Study" certificates. Classroom education is probably most effective as a long-term program. Expansion of Virginia Beach's current education program would involve the acquisition of audio-visual aids-films, posters, curriculum materials, and other types of printed materials. Continuance of an ongoing education program for both students and adults requires commitment of money and staff. The establishment of a speakers bureau would involve such a commitment. Utility staff members, in addition to the superintendent of customer relations, could be trained to present programs to both adult and school groups. Films, site-specific slides, and a variety of materials for distribution to groups would contribute to the effectiveness of the speakers program. Availability of an organized program could be advertised by sending a letter to all schools, service, social, civic, and other organizations, as well as area television and radio stations. Continued participation in the city's speakers bureau should also be encouraged.

### **Exhibits**

Data from a questionnaire filled out by Virginia Beach residents passing by a water conservation exhibit in Norfolk in October 1980 revealed that residents were aware of the existing water shortage. They indicated they would practice some of the conservation habits or would purchase some of the retrofit equipment illustrated in the exhibit.\*

### **Hotel/Motel Audits and Survey**

Water use audits indicate that the utility must work with the hotel and motel managers to encourage the continued retrofitting of bathroom facilities. The city should purchase conservation equipment at bulk rates and offer the items to the motels and hotels at a reduced rate. Virginia Beach officials should invoke section 15.1-37.2:1 of the Virginia Code, which states the city can require the installation of retrofit water conservation devices in buildings constructed before July 1, 1978.

Many Virginia Beach residents, through the media or to the customer service personnel, expressed dissatisfaction that they were restricted in their water use while the tourists did not have the same restrictions. More stringent conservation requirements of motel/ hotel owners and guests would alleviate some resident concern and save additional water supplies. The resort managers and owners must be assisted with appropriate educational strategies to use with guests, for example, signs in the lobby or brochures in guest rooms.

The 1980-81 drought will not be Virginia's last drought. Contingency water plans must be developed. Virginia Beach and other communities in the state and nation need to plan long-range water management programs now to cope with future water supply problems. Perhaps this documentation and assessment of the demand management programs instituted by Virginia Beach can contribute to the development of these plans.

---

Information on films, curricula, and exhibits related to water conservation is available from the Virginia Water Resources Research Center.

## VI. General Recommendations

No one water conservation program such as that of Virginia Beach is adaptable in its entirety to all communities. However, this case study should provide utility managers and public officials in other localities with a number of possibilities and the tested results of actual experiences. Recommendations related to the three demand management programs initiated by Virginia Beach follow.

### Pricing

The results of the study did not indicate that an increase in water rates contributed to a statistically significant reduction in water use. These recommendations, based on other research, may be made, however:

1. Utilities should establish rate systems that encourage conservation, that is, uniform, increasing block, and/or peak or seasonal rates.
2. Utilities that do not wish to initiate a rationing program should consider a temporary uniform surcharge to cover costs created by water use reductions.

### Regulation

1. The assessment of monetary penalties for excessive water use was the most effective pricing incentive in the conservation program. The allocation program with surcharges, based on a maximum usage allowance, was more equitable than Norfolk's flat percent reduction plan. Once imposed, penalties should not be unilaterally rescinded.
2. Since requests for voluntary conservation and the ban on nonessential uses did not significantly reduce water consumption, an allocation program (rationing) should be initiated before emergency conditions and in lieu of or preceding a mandatory ban on nonessential uses. To avoid enforcement problems and allow for a choice of individual later if reduction expectations are not met.
3. Utilities should prepare in advance for allocation programs by:
  - a. Establishing an appeals process.

- b. Updating billing records to include the number of family members.
- c. Estimating allotment amounts and program costs for a range of anticipated water deficiencies which would be updated periodically.
- d. Enlisting the support of community members during and after the establishment of an allocation program.

4. The study did not support the generally accepted hypothesis that building code modifications are effective in promoting water conservation. Until further research is conducted, under more controlled conditions, utility officials should work with the building permit department, builders, and local building suppliers to encourage use of water conservation equipment in new and remodeled construction rather than initiate building code modifications. It is more efficient to install water-conserving systems (plumbing fixtures, drought-resistant landscaping, drip sprinkler systems, short hot-water runs, etc.) during construction rather than to retrofit homes and yards at a later date. Copies of the Virginia Beach building code modifications could be circulated, along with data which outline potential water and money savings connected with such systems. Utilities should offer a reduction on water hook-up fees if conservation systems are installed.

### Public Education

Though the specific effects of education were not statistically isolated, other research and a qualitative evaluation of Virginia Beach's conservation program have established the importance of a well-informed public in gaining support for any demand management program. It is recommended that utilities:

1. Encourage the teaching of water conservation techniques in the public schools. Support agencies, such as the Virginia Water Resources Research Center can provide curriculum assistance.
2. Designate at least one utility staff member as the "water conservation officer." Responsibilities would include making presentations to school and community groups, serving as the liaison between the utility and support agencies in the state

and assuming responsibility for keeping up-to-date on conservation techniques and research.

3. Keep all personnel who deal with the public current on conservation techniques, water situations, and departmental actions relating to water use programs. An inter-office newsletter is recommended.
4. Disseminate water conservation information by:
  - a. Keeping local television and radio stations frequently informed of current water situations, particularly in times of drought.
  - b. Providing newspapers with accurate and current information which utilizes a variety of reporting formats.
  - c. Disseminating conservation information in times other than emergency situations so that conservation can become a way of life for community residents, rather than only a temporary response to a temporary situation.
  - d. Advertising the availability of speakers and utilizing slide shows

(with site-specific slides included), films, and exhibits on water conservation.

5. Encourage local retailers to offer conservation equipment. Assist the merchants by advertising the types and availability of equipment through bill inserts or other media. Consideration should be given to the bulk purchases of flow restrictors (approximately \$0.06 each), displacement bottles, or other devices as give-away items. State-supported agencies can provide lists of suitable products.
6. Offer free home water-leak inspections and meter checks. Monitor consumption figures and notify customers if substantial increases are noted.
7. Work with local businesses and institutions that use large quantities of water-hotels, motels, restaurants, hospitals, schools-to find ways to reduce wasteful water use. Conduct water use audits of these organizations. In emergency situations, motel guests should be expected to comply with water reduction mandates. Water should be served in restaurants only upon request.

*This special report is based on work done for a regional project sponsored by the Office of Water Research and Technology, U.S. Department of the Interior. A copy of the complete report is available from the Water Center upon request.*

## VII. References

- Agras, W. Steward, Rolf G. Jacob, and Melissa Lebedeck, 1980. "The California Drought: A Quasi-Experimental Analysis of Social Policy." *Journal of Applied Behavioral Analysis* 13(4): 561-70.
- Andrews, Richard A. and Martha R. Hammond, 1979. *Characteristics of Household Water Consumption in Three New Hampshire Communities*. Water Resources Research Center, University of New Hampshire, Durham.
- Baumann, Duane D., 1981. "Information Programs and Consumer Adoption of Water Conservation." Abstract. *Water Conservation-81: A National Conference*. April 1981, Denver.
- Bowman, Mary Lynne Cox, 1974. "Assessing College Student Attitudes Toward Environmental Issues." *Journal of Environmental Education* 6(2):1-5.
- California Department of Water Resources, 1978. *A Pilot Water Conservation Program*. Bulletin No. 191. Sacramento.
- Cochran, W. G., 1977. *Sampling Techniques*. 3rd edition. John Wiley and Sons, New York.
- Cohen, Michael R., 1973. "Environmental Information Versus Environmental Attitudes." *Journal of Environmental Education* 5(2):5.
- Flack, J. Ernest, 1981. "Residential Water Conservation." *Journal of the Water Resources Planning and Management Division, ASCE* 107:85-95.
- Geller, E. Scott, 1981. "There'll Be Some Changes Made." *Virginia Tech* 3(4):20-24.
- Hollman, Kenneth and Walter Primeaux, Jr., 1973. *The Effect of Price and Other Variables on Water Consumption*. Water Resources Research Institute, Mississippi State University, Mississippi State.
- Howe, Charles W. et al., 1980. *Drought-Induced Problems and Responses of Small Town and Rural Water Entities in Colorado: The 1976-1978 Drought*. Water Resources Research Institute, Colorado State University, Fort Collins.
- Lattie, John, 1977. "Public Education for Water Conservation." *Community Water Management for the Drought and Beyond*, pp. 46-57. Governor's Office of Emergency Services, State of California, Sacramento.
- Linaweaver, R. P. and Charles W. Howe, 1967. *The Impact of Price on Residential Water Demand and Its Relation to System Design and Price Structure*. Department of Environmental Engineering Science, Johns Hopkins University, Baltimore.
- Meyer, L., R. Clemens, and D. Whitehill, 1978. "Water Conservation in Municipally Supplied Areas." *Great Lakes Basin Water Conservation Plan, Revised Draft*. Great Lakes Basin Commission, Ann Arbor, Michigan.
- Mine, Murray, 1976. *Residential Water Conservation*. Report No. 35. Water Resources Center, University of California/Davis.
- National Academy of Sciences, 1978. *Water Conservation Research*. Commission on Natural Resources, National Research Council, Washington, D.C.
- New England River Basins Commission, 1980. *Before the Well Runs Dry*. Boston.
- Pettus, Alvin, 1976. "Environmental Education and Environmental Attitudes." *Journal of Environmental Education* 8(1): 49-54.
- Rice, I. M. and L. G. Shaw, 1978. "Water Conservation-A Practical Approach." *Journal of the American Water Works Association* 70(9):480-82.
- Talbot and Associates, Ltd., 1981. "Water Conservation Study for City of Virginia Beach." Virginia Beach, Virginia.
- Virginia Beach Department of Planning, 1980. *Virginia Beach 1980, A Statistical and Development Information Package*. Virginia Beach, Virginia.
- Virginia Beach Department of Public Utilities, 1981. *Water Position Paper: A Commitment to the Future*. Virginia Beach, Virginia.
- Virginia House of Delegates, 1979. Joint House Resolution 268, passed February 1979.
- Water and Man, Inc., 1980. *Water Education: Comprehensive Assessment, Vol. 2*.
- Watkins, George A., 1974. "Developing a 'Water Concern' Scale." *Journal of Environmental Education* 5(5):54-58.
- Weeks, Anne, 1979. *Water Management Planning for Illinois Communities*. Special Report 9. Water Resources Center, University of Illinois at Urbana-Champaign.

## Water Center Special Reports

Special Reports still in print are available at no charge. Those out of print, which must be photocopied, are available at the cost of \$1.50, with a check or money order accompanying the request.

No. 1

*Recommendations for Improving Water Resources Management in Virginia*

William R. Walker, William E. Cox

Published April 1976 (free)

No. 2

*Expanded Alternatives for Water Supply in Southeastern Virginia*

William B. Anderson, William E. Cox, Leonard A. Shabman

Published April 1978 (free)

No. 3

*Impact of the 1977 Clean Water Act Amendments on Industrial Dischargers*

John Quarles

Published May 1978 (free)

No. 4

*National Water Quality Goals: An Overview of the 1977 Clean Water Act Amendments*

from *Environment Reporter*

Published May 1978 (\$1.50)

No. 5

*Federal Water Policy Initiatives: An Evaluation of Presidential Recommendations to Congress* Warren Viessman, Jr.

Published October 1978 (free)

No. 6

*A Comparison of the 1977 Water Policy Review and the 1978 Federal Water Policy Proposals*

Warren Viessman, Jr.

Published November 1978 (\$1.50)

No. 7

*Virginia Water Law: A Functional Analysis with Respect to Quantity Management*

William E. Cox, William R. Walker

Published February 1979 (\$1.50)

No. 8

*Mercury Contamination in Virginia Waters: History, Issues, and Options*

Contains an article from *Science* with additional narrative and notes by the Water Center staff

Published March 1979 (free)

No. 9

*Nonpoint Pollution Control: Best Management Practices Recommended for Virginia*

Clara B. Cox

Published November 1979 (free)

No. 10

*Public Recreational Rights on Virginia's Inland Streams*

William E. Cox

Published January 1980 (free)

No. 11

*Water Resources Council Revisions of Its 1973 "Principles and Standards"*

Margaret S. Hrezo

Published August 1980 (free)

No. 12

*From Cropland to Concrete: The Urbanization of Farmland in Virginia*

Margaret S. Hrezo

Published October 1980 (free)

No. 13

*Virginia's Most Important Water-Related Problems* Clara

B. Cox

Published August 1981 (free)

No. 14

*Norfolk vs. Suffolk: Proposed Agreement Leaves Important Issues Unsettled*

Margaret S. Hrezo

Published November 1981 (free)

No. 15

*Costs and Legal Issues of Reserving Water Supply Sites for Future Use*

L. Leon Geyer and Leonard Shabman

Published June 1982 (free)

**Virginia Tech does not discriminate against employees, students, or applicants on the basis of race, sex, handicap, age, veteran status, national origin, religion, or political affiliation. Anyone having questions concerning discrimination should contact the Equal Opportunity/Affirmative Action Office.**

Virginia Water Resources Research Center  
Virginia Polytechnic Institute and State University  
10 Sandy Hall (0444)  
Blacksburg, Virginia 24061

