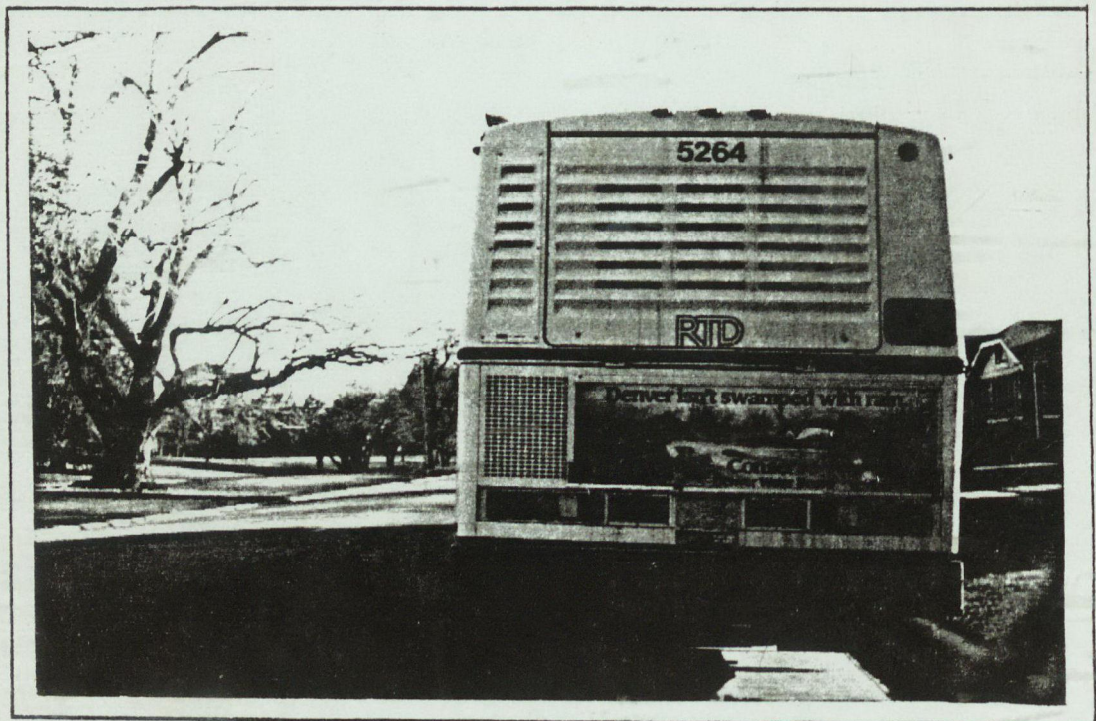




DENVER'S WATER CONSERVATION PROGRAM

COMPLIANCE REVIEW FOR 1989
PURSUANT TO THE FOOTHILLS CONSENT DECREE



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**DENVER'S WATER CONSERVATION PROGRAM
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PURSUANT TO THE FOOTHILLS CONSENT DECREE**

prepared by the
U.S. Environmental Protection Agency
Region VIII

I. Executive Summary

The 1979 Foothills Consent Decree provides that Denver, through the Denver Water Board (DWB), implement water conservation measures to reduce water consumption. The Region VIII Office of the Environmental Protection Agency (EPA) was assigned responsibility for monitoring Denver's conservation program to evaluate Denver's progress and good faith efforts to attain the goals, or targets, listed in the Consent Decree and recommend future water use goals.

EPA has completed its third compliance review of Denver's water conservation program, pursuant to the Consent Decree. EPA concludes that Denver has progressed in good faith to implement water conservation as specified in the Foothills Consent Decree. However, Denver's water conservation efforts to date have not achieved the water use goals which should have been attained by 1989. Denver's water use for 1989 was five percent higher than the goal established under the Consent Decree.

Information provided in a study conducted by Water Resources Engineering (WRE), as well as comments received from the Denver Water Department (DWD) and the public, have been considered in preparation of this compliance review. Comments directed specifically to the WRE study are addressed in the report entitled "Analysis and Evaluation of Denver's Water Conservation Program, Addendum to Parts I and II Final Draft Reports", presented to the National Environmental Health Association and the U.S. Environmental Protection Agency, Region VIII, June 8, 1990. Copies of this report are available from EPA. Replies to public comments received on water conservation policy issues pursuant to the Consent Decree are provided in this document.

Quantifying of water savings requires the selection of an appropriate indicator of water consumption. The Foothills Consent Decree water use goals for Denver were calculated using the target consumption for a given year, as a percent reduction from the base period of the 1968-1977 water use in terms of gallons per capita per day (GCD). One problem with the use of the GCD statistic is the uncertainty of yearly population data and the dependence of GCD on this data. EPA concludes that water use is more appropriately defined in terms of gallons per account per day (GAD) and recommends that GAD be used in future evaluations. EPA's previous compliance reviews in 1982 and 1986, relied upon DWD's statistical procedure to normalize the data to account for changes in water use based upon weather variables, primarily temperature and rainfall. EPA concludes that the anomalies of weather are just as readily accounted for using long term (9-year) running average of water use. The advantage of the long term running average water use statistic is that it provides a unique and certain assessment of water use goals suitable for public comprehension of whether the goals of the Consent Decree are attained.

Previous EPA evaluations have focused on numerical targets in establishing future water conservation goals. This compliance review has taken a different approach and recommends program monitoring and implementation of certain programs, or their functional equivalent in terms of program accomplishments, in addition to numerical goals. EPA's established goal for 1999 recommends DWD meet the goals it should have attained by 1989, plus an additional 6 percent reduction from the 1989 goal. The water conservation program needed to meet the additional reduction of 6 percent by 1999, incorporates the established water program currently being implemented by DWD, with expansion of program monitoring, direct delivery of replacement household plumbing, and provision of professional landscape services to commercial properties. EPA's recommended program would require substantial additional costs and staffing by DWD to meet the 1999 goal. Initial costs for EPA's recommended program are nearly \$2.8 million in 1991 for water conservation elements designed to reduce water demand (known as demand-side elements). This is compared to the 1990 DWD budget of \$1.7 million for demand-side water conservation program elements. DWD has budgeted \$4.2 million in 1990 for mandatory metering and leak detection program elements. These efforts are intended to augment supply, known as supply-side elements. EPA recommends a supply-side budget of \$4.7 million for 1991. Denver's mandatory metering program is acceptable to meet the goals EPA recommends for 1999. Leak detection efforts should be expanded to meet the EPA program recommendations. EPA also recommends that DWD establish an annual public audit evaluating water conservation program accomplishments.

Substantial changes in the Denver Water Board's water conservation policy occurred in 1989. During that year, DWB modified its rate structure to foster conservation, expedited a mandatory residential metering program, and began an \$80 toilet retrofit rebate program. DWB has substantially improved its water conservation program with adoption of these efforts. These new conservation efforts represent the organization's current commitment to water conservation aimed at achieving firm water savings in addition to promoting the virtues and ethics of water conservation through public educational efforts.

II. Background

The Foothills Project is comprised of Strontia Springs Dam in Waterton Canyon, a 3.4 mile diversion tunnel, and the Foothills Water Treatment Plant. In reviewing the DWD application for a right-of-way permit across federally-managed land, the Department of the Interior determined that an Environmental Impact Statement (EIS) was required by Section 102(2)(c) of the National Environmental Policy Act (NEPA). In addition to the NEPA requirements, right-of-way permits were required from both the U.S. Bureau of Land Management and the U.S. Forest Service and a "404" Dredge and Fill permit was required from the U.S. Army Corps of Engineers.

As the Foothills Project was under review from 1976 through 1978, it generated considerable public controversy over environmental impact, the adequacy of alternatives, the efficiency of water use in Denver, the potential impact of the project on residential development patterns and subsequently, the ambient air quality in Denver.

In 1978, the City and County of Denver, through DWB, and the Homebuilders Association of Metropolitan Denver, filed suit against the Secretary of the Interior, several Federal agencies (including EPA), and organizations and individuals in response to concerns regarding the possibility of permit denial, as well as delays in the federal decision (City and County of Denver, et. al., v. Cecil D. Andrus, et.al.). A counter suit was filed by opponents of the

Foothills Project in Federal District Court in Washington, D.C. (National Wildlife Federation et. al., Plaintiffs, v. Secretary of the Department of the Interior, et. al., Defendants).

These two suits were settled out of court in February 1979, through the signing of the Foothills Consent Decree, also referred to as the Foothills Settlement Agreement. In signing the Consent Decree document, the litigants agreed to permit the Foothills Project to proceed and that, among other provisions, a water conservation program would be implemented by DWB. EPA has the responsibility to monitor the program, evaluate DWD's progress in meeting the conservation goals, and to recommend future water use goals.

The Consent Decree assigns the following responsibilities to the Regional Administrator of EPA Region VIII:

- 1) Monitor the water conservation program of the Denver Water Board;
- 2) Evaluate Denver's progress and good faith efforts to attain the water conservation goals set forth in the decree; and,
- 3) Recommend water conservation goals for 1984, 1989, and 1999.

III. Previous EPA Evaluations

The previous EPA evaluations, pursuant to the Consent Decree, were conducted in 1982 and 1986. Below are extractions from the conclusions of those EPA evaluations.

A. 1982 Conclusions

"The DWD's Water Conservation Program reflects an effort to foster water conservation. The program contains innovative concepts to develop a conservation ethic which is essential to the goal of more efficient water use. In particular, the DWD is to be complimented on its Evapo-Transpiration and Xeriscape (public educational) programs as they both provide practical, cost-effective approaches to promoting water conservation. However, the overall program, as implemented thus far, is still developing and continued emphasis is necessary for the goals of the program to be fully realized. There is room for program expansion and improvement, particularly in the areas of public education and awareness.

The DWD has not linked the elements in the Institutionalized Water Conservation Plan to specific water conservation goals. The absence of this correlation could make scheduling implementation of needed conservation measures more difficult.

The DWD still has not published a schedule to progress toward the Board's commitment to achieve 100% metering. Metering affords water management benefits far beyond water conservation, but could save 12,000 to 19,000 acre-feet per year (AFY). The absence of total metering also limits DWD's ability to consider potential rate structure modifications which other communities have found useful for managing water supplies.

The baseline 209 gallons per-capita per-day (GCD) ten-year average water consumption stated in the Consent Decree was based on inaccurate population estimates and water use which resulted in a goal in 1981 of 203 GCD. When corrected, the actual 1981 goal should have been 211 GCD. The actual water use in the Denver system in 1981 was

226 GCD. Measured against this recalculated goal, it is obvious that overall water consumption was not reduced, in spite of the water conservation effort. However, if weather history and water use are considered, the expected consumption would have been 245 GCD. This suggests that the water conservation program may have resulted in a 19 GCD, or about an 8% reduction."

B. 1986 Conclusions

"EPA has suggested that the original 1984 goal of 199 GCD be adjusted to 208 GCD, based on corrected population figures and water sales. Actual water use in 1983 was 205 GCD. Furthermore, the expected consumption or anticipated demand would have been 232 GCD. This suggests, but does not prove, a reduction of 27 GCD over what might have been. Therefore, from a quantitative analysis (recognizing the limitations discussed in Chapter III) the DWD has exceeded the 1984 goal of a 5% reduction in per capita water consumption.

Although the Department met the adjusted conservation goals established in the Consent Decree, there appears to be substantial opportunity to improve the overall commitment to water conservation, as well as to improve program effectiveness. In EPA's 1982 report, "Evaluation of Denver's Water Conservation Program", EPA noted that the DWD had not linked the elements of the "Institutionalized Water Conservation Plan." To date, there has been no internal comprehensive programmatic review of the DWD conservation efforts and only recently has the original 1979 Conservation Plan been updated. There is no long-range plan which would establish standard guidelines for water conservation practices. In general, there appears to have been little or no follow-up to determine program effectiveness. The absence of conservation planning and direction raises questions about the Water Department's commitment to the principle of water conservation. However, the March 4, 1986 Policy Statement indicates a definite interest to implement an effective conservation program.

The previous ambiguity of roles and responsibility for water conservation within the Department may have been solved by the recent reorganization. Hopefully, the new conservation section will provide the focal point needed to establish and implement a successful program. Unfortunately, general water conservation activities (excluding the successive use pilot plant) have accounted for only 0.1% of the DWD's annual budget (1983) which reflects a low priority for water conservation.

EPA's 1982 report recommended that the Department broaden its public awareness efforts by initiating a cooperative metro-wide attempt to foster water conservation. A metropolitan-wide water conservation organization, Metropolitan Water Conservation, Inc., has recently been founded and Denver is a Charter member. While it is too early to judge the effectiveness of this new organization, it is clear that there currently exists a void in terms of measuring general public awareness of the benefits and trade-offs of water conservation.

Despite the support for metering, the DWD still has not published a plan or schedule to progress toward the Board's commitment to achieve 100% metering. Metering affords water management benefits far beyond water conservation, and could save approximately 10,000 acre feet of water per year based on the DWD's own estimates. This is about the same yield as the Williams Fork Project. The absence of total metering also limits DWD's ability to consider potential rate structure modifications which other communities have found useful for managing and conserving water supplies.

In summary, the DWD appears not to have aggressively pursued the previous EPA recommendations. Even though there have been reduced GCD levels, these "calculated" reductions appear inconsistent with the past limited commitment to promote and implement water conservation. Hopefully, the Board's recent (March 4, 1986) Policy Statement, which directs the Department to develop a comprehensive water conservation program, will elevate the priority given to water conservation within the Department."

IV. Process for 1989 Compliance Review

To obtain national expertise and working experience, EPA chose to utilize the services of a consultant to assist in the 1989 evaluation. Through an EPA grant administered by the National Environmental Association, Water Resources Engineering (WRE), located in Freemont, California was awarded the contract. The primary consultant evaluation team included: Gustavo Arboleda, President of WRE; Dr. William Bruvold, Professor, University of California at Berkeley; Richard Bennett, Manager of the Water Conservation Department of the East Bay Municipal Utilities District; and John Nelson, Chairman of the American Water Works Association Conservation Committee and Manager of the North Marin Water District in Novato, California. WRE, and their special consultants, were tasked with examining DWD's water conservation program from 1979 through 1989, as well as evaluating successful conservation programs in other communities and their applicability to Denver. WRE developed recommendations for cost-effective conservation programs that would be achievable by Denver, without change in lifestyle.

V. EPA-Recommended Water Conservation Program

The following program elements, or their functional equivalent in terms of program accomplishments, are recommended to achieve the Foothills Consent Decree goals for 1999 (See Table 1 and Figure 1 on the following pages). EPA believes these programs would be cost effective for DWD and are based upon achieving what DWD should have attained by 1989 plus 6 percent reduction between 1989 and 1999. DWD needs to implement a water conservation program that will reduce water use by 10 percent by 1999 to "catch up" to the Consent Decree goals which would then total 16 percent total water use reduction for the 20-year period between 1979 and 1999. To reach this goal, average consumption per account should be reduced from the current average of 831 GAD to 744 GAD. This is a 6 percent reduction from 792 GAD, which is the 1989 consent decree goal in GAD. With the exception of conservation pricing and public education, the details of the following program elements are described as "Program C" in the WRE Part II report (WRE 1990b, Chapter 4, Appendix B, and Appendix C).

To understand how EPA's recommended program compares with DWD's current water conservation program, Table 2 presents DWD's currently implemented water conservation program. Estimated water use savings from the DWD program were provided for the year 2010, rather than 1999 as provided in the WRE reports pursuant to the Consent Decree. Of particular interest is DWD's 1990 demand-side water conservation budget which increased 438 percent in two years from the \$388,000 actual expenditures in 1988 to the projected 1990 budget of \$1.7 million for demand-side program elements.

TABLE 1
EPA-Recommended Water Conservation Program

Water Conservation Program Element	Estimated DWD 1991 Annual Costs (1000 \$) ¹	Estimated Water Savings by 1999 (AFY) ¹	Key Program Accomplishment by 1999
Demand-side Elements			
Single and Multi-Family Residential Water Audits--Device Installation	\$836	3,327	30% single, 60% multi- family residences audited ²
Single and Multi-Family Residential Ultra Low Volume Toilet Ordinance (1.6 gallons per flush)	60	1,730	ordinance by 1992
Single and Multi-Family Residential Ultra Low Volume Toilet Rebates	1,578	4,178	25% penetration
Commercial Water Audits	78	390	17.5% penetration
Industrial Water Audits	24	243	25% penetration
Large Turf Audits (parks and public land irrigation)	82	1,404	80% penetration 312.5 acres/year
Ascending Block Rate Structure	minimal	3,500 ³	effective March 1, 1990
Public Education and ET program including Xeriscape demonstration	137 ⁴		
Sub-Total Demand-side elements	\$2,795	14,772	
Supply-side Elements			
Metering	4,122 ⁵	11,827	complete by 1993
Leak Detection	531	890	1,154.5 miles/year
Non-Potable Reuse/Denver Airport	NA ⁶	2,300	
Sub-Total Supply-side elements	\$4,651	15,017	
Total Costs and Water Savings	\$7,446	29,789	

Footnotes for Table 1

- 1 WRE 1990b. The WRE report estimates annual costs of each of these program elements from 1991 through 1999. The estimated costs for 1991 are listed here to show the initial direct annual costs only. These costs do not include administration and management.
- 2 WRE 1990b. The residential audit program should achieve 9,300 single-family and 731 multi-family audits per year with the following market penetrations by 1999 for single and multi-family residences respectively: 15.6 percent and 39.9 percent penetration for showerheads, 20.3 percent and 54.2 percent penetration in toilet displacement bags, 4.8 percent and 9.6 percent penetration for toilet leak repair, and 8.4 percent penetration in irrigation audits (WRE, 1990b, Appendix B).
- 3 DWD 1989b. DWD estimated 3,500 AFY water savings by 2010 associated with the rate structure change effective March 1, 1990.
- 4 DWD 1990b. Water savings from public education, including the ET program element, are attributable to other programs.
- 5 DWD 1990b. This annual cost would continue until metering is completed by 1993.
- 6 Richard P. Arbor Associates 1989. Costs are not applicable since the cost for wastewater reuse at the New Denver Airport is expected to be less than conventional wastewater treatment.

FIGURE 1
Consent Decree Goals and Estimated Water Use with EPA's Recommended Program

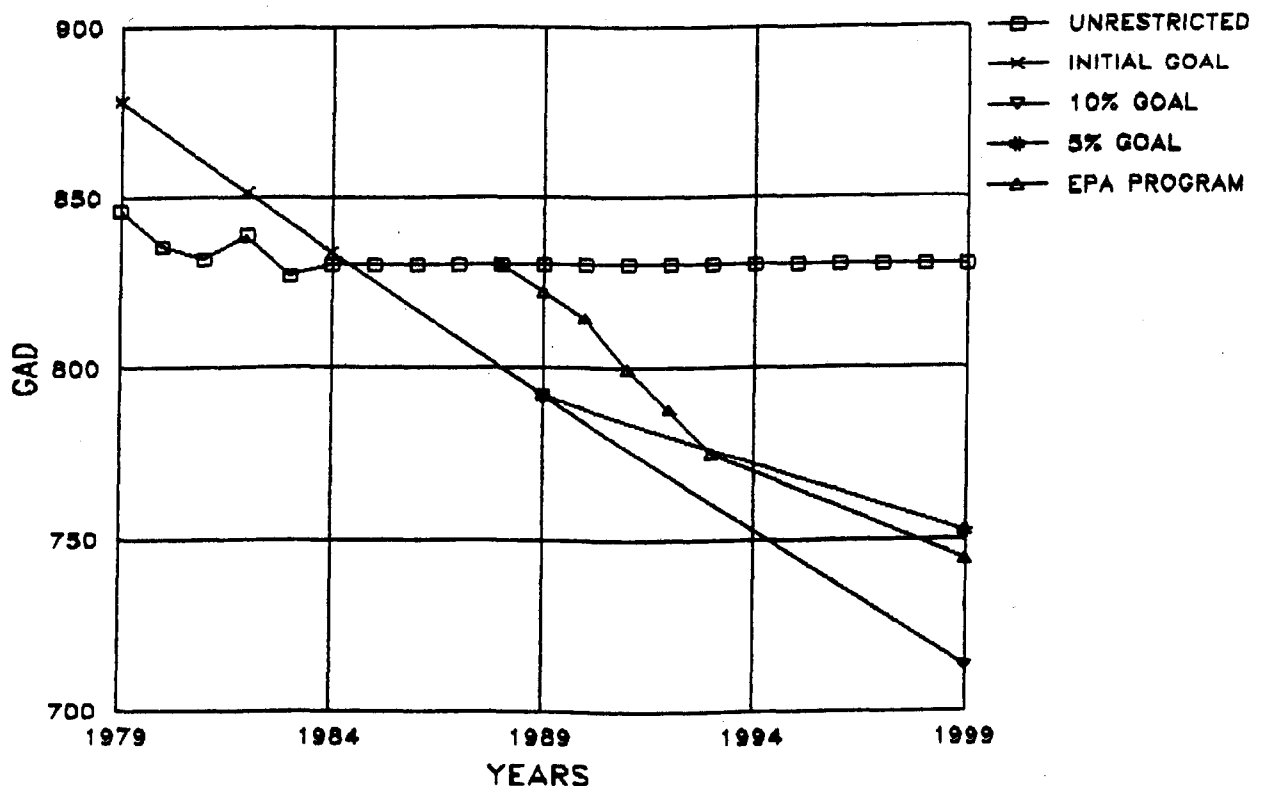


TABLE 2
Denver Water Department Water Conservation Program

Water Conservation Program Element	Budgeted DWD 1990 Annual Costs (1000 \$)¹	Estimated Water Savings by 2010 (AFY)²	Notes
Demand-side Elements			
Single and Multi-Family Residential Water Audits, toilet dams installed showerheads distributed	\$ 142	1,600	volunteers based upon installing new meters
Single and Multi-Family Residential Low Volume Toilet Ordinance (3.5 gallons per flush)	minimal	3,400	ordinance adopted State- wide in 1989
Single and Multi-Family Residential Ultra Low Volume Toilet Rebates	300	1,400	
Commercial and Industrial Water Audits	216	1,200	contract for industrial audits awarded May 1990
Large Turf Audits (parks (and public land irrigation)	165	900	budget is for the parks demonstration program
Ascending Block Rate Structure	minimal	3,500 ³	effective March 1, 1990
Public Education and ET program including Xeriscape demonstration	137 ⁴	2,200	20% participation in ET 10% reduction in water use
General Conservation	741 ⁵		
Sub-Total Demand-side elements	\$1,701	14,200	
Supply-side Elements			
Metering	4,122 ⁶	13,800	complete by 1993
Leak Detection	45	400	
Non-Potable Reuse/Denver Airport	NA ⁷		
Sub-Total Supply-side elements	\$4,167	14,200	
Total Costs and Water Savings	\$5,868	28,400	

Footnotes for Table 2

- 1 DWD 1990b. This document shows the budget for 1990 and actual expenditures through the period January 1, 1990 until March 31, 1990. In May 1990, DWD awarded a contract to the firm of Black and Veatch for a total of \$215,617 to conduct industrial audits, most of which will be spent in 1990.
- 2 DWD 1989b. This document estimates water savings for the year 2010. DWD has not produced estimates of water savings for each year as shown in the WRE reports, nor provide information on the expected market penetration to be achieved for each program element.
- 3 DWD 1989b. DWD estimated 3,500 AFY water savings by 2010 associated with the rate structure change effective March 1, 1990.
- 4 DWD 1989c. Water savings from public education are attributable to other programs. Waters savings from voluntary compliance with the ET program is assumed by DWD to provide 1,200 AFY reduction by 2010. DWD estimates an additional 1,000 AFY savings associated with the retrofit of 5 percent of existing and 10 percent of new lawns to low water use landscaping.
- 5 DWD 1990b. DWD has budgeted \$740,742 for general conservation activities in 1990 which includes administrative overhead. Of this amount, \$7,415 was spent between January 1 and March 31, 1990.
- 6 DWD 1990b. This annual cost would continue until metering is completed by 1993.
- 7 Richard P. Arbor Associates 1989. Costs are not applicable since the cost for wastewater reuse at the New Denver Airport is expected to be less than conventional wastewater treatment. Total wastewater reuse savings are expected to be 3,900 AFY when the airport project is complete (DWD, 1990). The City of Denver is studying reuse at the new airport and has not yet committed to this water conservation program element.

In order to compare the Consent Decree goals in GCD with GAD, the following tables are presented. Table 3 shows the Foothills Consent Decree goals in gallons per capita per day (GCD). Table 4 shows these same goals in gallons per account per day (GAD) and the EPA-recommended goals for 1999.

TABLE 3
Foothills Consent Decree Goals

Period Ending	Consent Decree Goal (GCD)	Percent Incremental Decrease	Percent Total Decrease
1968-77 (base)	219 ¹		
1981	212	3	3
1984	208	2	5
1989	202-198	3-5	8-10 ²
1999	184-173	5-10	13-21

Footnotes for Table 3

- ¹ This is the adjusted base period use to reflect 1980 census population data. The 1979 population estimate implied in the Consent Decree was erroneously high. The Consent Decree base period use was estimated to be 209 GCD.
- ² In 1986, EPA selected an additional 3 percent goal to be achieved by 1989. This was based upon normalizing the data to correct for weather factors. Using the normalized procedure, EPA concluded that DWD had achieved an 8 percent reduction by 1984. With the additional 3 percent goal, a goal which totalled 11 percent reduction by 1989 from the base period was established by EPA.

TABLE 4
EPA-Recommended Water Conservation Goals

Period Ending	Consent Decree Goal (GAD)	Percent Incremental Decrease	Percent Total Decrease
1968-77 (base)	877		
1981	851	3	3
1984	834	2	5
1989	792 ¹	5 ²	10
1999	744	6	16

Footnotes for Table 4

- ¹ Denver's average usage per account for 1980-1989 was 831 GAD which is 5 percent above the 1989 goal. To obtain the EPA-recommended goal of 744 GAD by 1999, a total reduction of 10 percent is needed from current use.
- ² The 5 percent goal is selected by EPA for this compliance period since the normalized procedure is no longer useful which established a total of 11 percent reduction goal by this period.

A. Key Program Elements of the EPA-Recommended Program

The following discussion highlights those key elements of a water conservation program necessary for DWD to meet the goals of the Consent Decree based upon achieving the 1989 goal plus an additional 6 percent reduction in water use by 1999. In general, these program elements are being implemented by DWD at the current time. However, DWD's current water conservation program, with the exception of the mandatory metering program, should be expanded to obtain the percentage of customer participation necessary and other objectives to obtain water savings at the recommended level. EPA's recommended program concentrates on permanent or firm water savings based upon updating the city's plumbing, improving irrigation procedures, and providing wastewater reuse at the New Denver Airport.

1. Program Monitoring

The effectiveness of conservation practices can only be determined by detailed monitoring. A detailed schedule for implementation of each program element is essential. For example, annual program accomplishments would specify completion of a certain number of residential audits, inspection of a certain number of acres of large commercial landscapes, or other such program accomplishments. Funds spent on each conservation program element should be accounted for separately to judge success. This information would be used to determine if the expenditures were cost-effective. Cost-effective means whether reduced water use was accomplished at less cost to DWD than the cost of the next water supply component (i.e. based upon marginal cost avoidance).

It is essential that water use patterns be analyzed by customer class (WRE 1990b, page 5-13.) DWD's billing procedures include multi-family accounts and commercial accounts in a single code, thus negating the ability to distinguish water conservation success or failure between these accounts. DWD's computerized data base should be revised to provide monthly use of metered water consumption by customer class and billing sector and to generate statistical assessments of this information. Residential water use should be monitored on a pilot basis to access the water use change anticipated for low flow showerheads, toilet displacement devices, and the \$80 toilet rebate program. Similarly, the accounts associated with large turf audits and industrial water audits should be monitored for water savings progress. Newly metered account monitoring should be given high priority since 40 percent of the estimated water savings is associated with converting flat rate accounts to metered accounts. Data are needed to test the assumptions of growth rates, customer acceptance, retention, and current market saturation. EPA recommends customer surveys annually to judge satisfaction and retention of installed devices. DWD's existing billing system is near maximum capacity and for this reason will be improved in the next two or three years. Including conservation monitoring data in the revised billing system is essential for effective program administration. See WRE's Part II report for a complete description of the elements of the recommended monitoring program (WRE 1990b, pages 5-12 through 5-18).

2. Residential Water Audits

DWD should expand its residential water audits program. Single-family and multi-family audits recommended by EPA would include installation of low flow showerheads, toilet displacement devices (dams or bags), toilet leak repairs, and landscape irrigation guidance. The estimated cost is \$61 per household. A total of 9,300 single-family residential and 731 multi-family water audits annually should be completed to have 30 percent of Denver's single-family residences and 60 percent of multi-family residences participating by 1999. Water savings for this program element are estimated to be 3,327 AFY by 1999. The residential audits should achieve the following market penetrations for single and multi-family residences respectively: 15.6 and 39.9 percent penetration for showerheads, 20.3 percent and 54.2 percent penetration in toilet displacement bags, 4.8 percent and 9.6 percent penetration for toilet leak repair, and 8.4 percent market penetration in irrigation audits (WRE, 1990b, Appendix B).

3. Ultra Low Volume (ULV) Toilet Ordinance for New Construction

Ordinances requiring installation of toilets in new single and multi-family construction using less than 1.6 gallons per flush should be adopted for the DWD service area. ULV toilet ordinances for new and renovated construction are in effect for a large percentage of the nation, including New York, Massachusetts, the Delaware Basin States, Minnesota, and California. Renovation of existing toilets would be covered by the ULV Toilet Rebate Program. There is no additional direct cost to DWD since the ULV fixtures would be required by the ordinance. Costs are associated with reduced revenue. About 7,500 new residences in the Denver service area annually would be affected by these ordinances. Water savings for this program element are estimated to be 1,730 AFY by 1999. According to WRE, to achieve this water savings, the ULV ordinance should be in effect by 1991. DWD observes it will be difficult to get such an ordinance by 1991 to cover its entire service area since a statewide ordinance is unlikely (DWD 1990, page 11). Implementation by each district, city, or county is another possibility. Delay in passing the ULV ordinance would diminish the estimated savings. EPA believes it reasonable to expect a ULV ordinance could be in passed by 1992 to cover the entire DWD service area.

4. Ultra Low Volume Toilet Retrofit/Rebate

DWD began a program in January 1990 to provide a rebate of \$80 for the installation of ULV toilets. ULV toilets used 1.6 gallons or less per flush. This program would replace, or retrofit, existing toilets which used 3.5 to 7 gallons per flush. A total of 13,960 toilets in single-family and 3,950 toilets in multi-family residences need to be installed annually to have 25 percent of Denver residences with new ULV toilets by 1999. Water savings for this program element are estimated to be 4,178 AFY by 1999. DWD observes that the estimate provided in the WRE report for water use savings from ULV retrofits may be too high since the assumption was based on converting toilets using 5.5 gallons per flush (DWD 1990a). The sale of toilets using 3.5 gallons per flush has been common since the early 1980s, but the current market penetration in Denver has not been well established. If the current market penetration in Denver of 3.5 gallons per flush toilet is significant, then this program element would not achieve the anticipated water savings estimated by WRE. For 1991, the budget needed for this program element is \$1,578,000, while the 1990 DWD budget for this program element is \$300,000. The \$80 toilet rebate program is the most expensive demand-side conservation element. It yields 35 percent of the estimated total water savings, but requires 58 percent of the total demand-side budget.

5. Commercial Water Audits

Commercial water audits include inspection of plumbing, cooling equipment, instructions on efficient landscape practices, and identification of repair or replacement of fixtures. A total of 850 commercial water audits annually are needed to have 70 percent of Denver's estimated 11,000 commercial accounts participating in this element by 1999. Water savings for this program element are estimated to be 390 AFY by 1999. To achieve this water savings, commercial audits should achieve a market penetration of 17.5 percent (WRE 1990b, page B-26).

6. Industrial Water Audits

Industrial water audits would examine process and cooling water systems for leaks and assess improvements to inefficient equipment. The potential for water conservation by industry in Denver is not well established. This element assumes 15 percent water reduction per participating account can be achieved. A total of 60 industrial water audits annually are needed to all of Denver's estimated 300 industrial accounts participating in this element by 1996. Since there are a small number of industrial accounts, it is assumed that this program would last five years and then be discontinued. Water savings for this program element are estimated to be 243 AFY by 1999. To achieve this water savings, 25 percent on these accounts need to implement water conservation measures.

7. Large Turf Audits

DWD staff would evaluate commercial and public large turf areas on-site to produce customized irrigation schedules for each site. Specific information about the rate and timing for each irrigation zone would be developed using soil infiltration rates and irrigation application rates. Water savings for this program element are estimated to be 1,404 AFY by 1999. A total of 312.5 acres of large turf audits annually are needed to have 80 percent of Denver's estimated 3700 acres of parks, golf courses and highway medians audited by 1999.

8. Leak Detection

Denver should expand its on-going leak detection program using sound amplifying equipment to cover the entire system every other year. The approximate cost is \$457 per mile surveyed. Water savings for this program element are estimated to be 890 AFY by 1999. The total estimated costs per year would be \$531,000. To achieve this water savings, 1154.5 miles of leak detection surveys would be needed each year.

9. Metering

Metering involves the installation of water meters at all previously unmetered residential accounts. DWD proposes to complete a mandatory metering program by December 31, 1993 (DWD 1989b). As of October 1989, DWD had completed 24,050 meter installations with approximately 63,000 remaining. Water savings for this program element are estimated by DWD to be 11,827 AFY by 1999. The total costs for 1990 would be approximately \$4.2 million. This cost would continue annually until metering is completed by the end of 1993.

10. Non-potable Reuse Associated with the New Denver Airport

This element includes the use of non-potable treated sewage effluent for irrigation associated with the New Denver Airport and the surrounding Airport Gateway Development. Water savings for this program element are estimated to be 2,300 AFY by 1999 (DWD 1990a, page 6). The estimated costs, determined to be less than conventional wastewater treatment costs, were outlined in a report prepared for Denver's New Airport project (Richard P. Arbor Associates, 1989, page 3.)

11. Pricing -- Denver's Ascending Block Rate Structure

Some forms of rate structures, including seasonal and ascending block rates have been observed to provide incentives for reducing water use and therefore would contribute to water conservation efforts. Beginning March 1990, DWD changed its declining rate structure to an ascending block rate structure. The residential rate for use above 15,000 gallons per month per residential user is 24 percent greater than the first 15,000 gallons per month (DWD 1989c, page 2). This assumes that the fixed \$6 bi-monthly service charge is not considered as part of the initial block rate. In order to keep the revised rate structure revenue neutral (i.e. neither increase nor decrease total revenues to DWD), the first block of water use is 19 percent lower than the declining block rate structure used prior to March 1990. The effect this water rate change will have on customer water use is uncertain.

The consultants retained by EPA to evaluate DWD's conservation program did not agree on the effectiveness of DWD's or other ascending block rate structures. Mr. Nelson believed that little or no water savings would result because consumers are unlikely to change water use when the cost is low (EPA 1990, page 46). Mr. Nelson referred to a California community near Novato, where the price of water was four times Denver's rate, yet the community was having trouble getting 10 percent water conservation. Mr. Nelson pointed out that the programs recommended in WRE's Part II report are more cost-effective to the customer since DWD would transfer money directly to the customer in terms of rebates and audits. Professor Bruvold, another expert participating in EPA's review, observed that water use will decline with increased marginal costs and referred to research studies that appear to establish the elasticity of demand for urban water use. Elasticity is the percentage of change in demand associated with a one percent increase in price. A survey conducted for the U.S. Army Corps of Engineers showed a wide range of estimated elasticities of demand for urban water use from 0 to -1.41 (Roy F. Weston, 1984). A study in Tucson, Arizona, estimated an elasticity of -0.7, based upon an average price model (Billings and Day 1989). DWD estimated water savings for its ascending block rate program based upon an elasticity of -.05 in the winter and -.43 for summer use. Based upon these assumptions and reductions for interactions with other conservation programs, DWD estimated 3,500 AFY in water savings would result from its conservation pricing change by 2010 (DWD, 1989b).

EPA recommends that the results from DWD's 1990 rate structure change be evaluated and tested against the elasticity estimates provided by DWD. If these factors are appropriate, then water savings would progress towards the 3,500 AFY estimated savings by 2010. DWD should monitor its rate change effects. This could be accomplished by having control groups of residences inside and outside the city where rates differ substantially.

12. General Education and Public Information

DWD water conservation programs that involve education and informational efforts are focused in three areas: 1) promotion of the ET program; 2) promotion of low water use landscaping; and, 3) general information provided to the public and students at secondary schools and high schools regarding water use practices.

a. ET Program

DWD has an on-going program which publishes the daily evapotranspiration (ET) rate primarily for guidance for Kentucky Blue Grass lawn watering. DWD estimated 1,200 AFY water savings by 2010 based upon 20 percent participation and a reduction of 10 percent for each household following the program. It is recognized that 20 percent participation is an optimistic goal significantly higher than current levels of participation (WRE 1990b, page 2-12).

b. Low Water Use Landscaping

DWD has an on-going public education program which promotes the value of low water use landscaping using drought-tolerant shrubs and grasses. This program includes distribution of literature, demonstration gardens, sponsorship of public seminars in low water use landscaping, public service announcements concerning alternative plants and turfs, and irrigation methods and scheduling. DWD estimated 1,000 AFY water savings by 2010 based upon changes in residential landscaping (DWD 1989c). DWD assumed market penetration by 2010 of 5 percent for existing and 10 percent for new homes which is consistent with values reported in California (WaterPlan 1989). DWD assumed a reduction of 30 percent of outdoor water use for low water use landscaping. WRE observes this value could range from 5 percent to 50 percent depending upon the details of the landscape plan and its management (WRE 1990b, page 2-15). Since 51 percent of residential water use in Denver is associated with lawn watering, conversion of existing and new homes to low water use landscaping could make a significant contribution to water conservation goals.

Conversion of existing lawns, either at single-family residences or commercial areas, was evaluated by WRE using the WaterPlan analysis and based upon the assumptions used, was determined to lack cost-effectiveness. The cost and water savings assumptions used to evaluate landscape conversions included a savings of 15 percent in outdoor water use and an installation cost of \$5000 dollars per average size lot. These costs are associated with obtaining the services of a professional landscape architect, the retail price of replacement shrubbery, and labor for installation. DWD should monitor the sales of low water use trees, shrubs, and turf in the Denver area for estimates of sales of drought-tolerant plants. Such monitoring would be used to test the assumption of the market penetration of low water use landscaping.

c. Public Information and Educational Programs

The public information and education portions of DWD's water conservation program are considered the "foundation of the water conservation effort" (WRE 1990b, page 2-18). (In 1989, DWD adopted mandatory metering, rate structure changes, and the toilet rebate program to augment its program.) No water savings are attributable to the public information and education portions of the water conservation program. Reductions in water savings by plumbing improvements, improved irrigation management, and behavioral changes resulting from public education efforts are assumed to be part of other program elements. EPA agrees with DWD's observation that many "traditional" water conservation elements, such as public education, are based upon the "habits and attitudes of water users which may not be reliable over the long term" (DWD 1990a, page 1). DWD devotes a significant amount of staff time, including that of its Water Conservation Officer, to general public, secondary, and high school education.

EPA concludes DWD should expand its water conservation emphasis from general education to water conservation programs designed for firm water savings.

B. Other Water Conservation Program Elements by DWD

There are several other water conservation program elements currently undertaken by DWD. Water savings associated with these program elements do not contribute directly to water savings. These other program elements include the potable reuse pilot program, emergency measures to conserve water, and the use of alluvial groundwater for park irrigation.

1. Potable Reuse -- Successive Use Program

DWD has invested heavily in a pilot potable reuse facility designed to treat 1.0 million gallons per day. The Denver pilot studies, which began in 1979, have been a technical success demonstrating the necessary water treatment technology for safe reuse. The pilot plant is expected to cease operations in 1991. Due to the high cost of reclaiming wastewater to drinking water standards, potable reuse is not planned as an element of water conservation in the foreseeable future.

2. Emergency Measures to Conserve Water

DWD's water conservation program includes a procedure to impose voluntary and mandatory water use restrictions due to a drought or other emergency (such as dam or conduit failure). Since such measures are imposed only during emergencies and then rescinded, no water savings are attributable to imposing emergency measures to conserve water. A drought contingency plan would be implemented in stages according to the severity of the drought. The first stage involves voluntary outdoor use restrictions. At the second stage, mandatory restrictions are imposed employing "the regulations used in 1977" (DWD 1989a, page 25.) DWD should consider amending these regulations to determine if recent California experiences in reducing demand during drought would be useful in Denver. Among the strategies to consider is restricting outdoor water to night and early morning hours and the imposition of substantially higher rates during a drought.

3. Alluvial Groundwater for Park Irrigation

DWD is considering the use of groundwater from Cherry Creek or the South Platte River alluvium to irrigate Cherry Creek Park, Pulaski Park, Burns Park, City of Takayama Park, City of Karmue Park, JFK Golf Course, Willis Case Golf Course, Washington Park, and other open space in the area (Presentation by Dave Little, DWD, Citizen's Advisory Committee meeting, May 2, 1990). These parks and open space are irrigated with treated potable water and thus such measures would save the cost of water treatment. Irrigation from an alluvial groundwater source would reduce surface water flows since the water would be directly drawn from stream flow. Pursuant to Colorado water law for prior appropriation, DWD would exchange these diversions in lieu of other direct stream diversions. This program element would not provide water savings to DWD in the same manner other water conservation program elements which would, if proven firm, delay the need for additional water supplies.

C. Effective Administration of Conservation Programs

The following are some observations regarding the leadership, organization, and budget necessary for more effective water conservation administration by DWD.

1. Leadership and Organization

As in previous EPA reviews, this review indicated the conservation program continues to lack a definite focal point within the DWD's organization. Water conservation was not identified as a major function under any of the DWD's divisions. An organizational change occurred in 1990 which placed most of the conservation function in the Administration Division. Activities described in the Water Conservation Plan of DWD, Summer 1989, are carried out by a number of operational divisions. While a Water Conservation Officer is the focal point for public education and informational programs within the Public Affairs Department, monitoring of water conservation efforts is carried out by the Planning Division, and the metering program by the Administration Division. An organizational chart for water conservation is not presented in DWD's Water Conservation Plan. The Water Conservation Plan "is one of concepts" (DWD 1989a, page 3.) The entire section of this report devoted to "Staff and Budget" reads:

"This proposal is one of concepts. When the Board approves the concepts and anticipated water savings, then specific personnel and budget requirements will be assimilated. Those items are not included here. The only dollar amounts are occasional references to value of water saved as compared to costs of developing new supplies.

In the 1960s, President John F. Kennedy directed the National Aeronautics and Space Administration (NASA) to "put a man on the moon by the end of this decade." NASA at the time did not have the research data, the technology, the budget nor the vision. We, however, are more fortunate than they. We have the vision, much of the data, most of the technology and a portion of the budget. The Denver Water Department and staff will find the ways and means to accomplish the goals directed by the Board."

EPA finds this generalized approach inadequate. The DWB agreed to the basic concept of water conservation eleven years ago. That was the appropriate time to establish generalized concepts and objectives. Making suitable budget and staff commitments to accomplish water conservation should have become an established procedure eleven years into the program. To accomplish the task of updating the city's plumbing and irrigation equipment to meet the goals agreed to by Denver in the Foothills Consent Decree, appropriate staff and budgets should be specified. Education and public information, which were considered the "foundation of the water conservation effort" from 1979 through 1989, have been shown to be inadequate to meet the goals of the decree. The WRE 1990 Part II report presents the type of detailed budget and personnel requirements for specific water conservation program elements DWD should pursue to achieve the goals EPA has recommended pursuant to the Consent Decree.

Substantial changes in the DWB's water policy occurred in 1989. In 1989, DWB modified its rate structure, expedited its metering program, and began the \$80 toilet rebate program. The DWB has substantially improved its water conservation program with adoption of these conservation efforts. These programs represent the organization's current commitment to specific water conservation programs aimed at firm water savings, which is an expansion of its efforts beyond promoting the virtues and ethics of water conservation.

2. Budget

The above described EPA-recommended conservation program would be expected to result in 29,789 AFY of water savings by 1999 (See Table 1). This program includes initial expenses for demand-side elements in 1991 of about \$2.8 million, plus \$400,000 in lost revenues from reduced consumption due to conservation. These costs do not include administrative and management costs by DWD. Foregone revenue would eventually amount to \$3.3 million in 1999 as the program succeeds in reducing water use. In contrast, the 1988 DWD budget for its water conservation program was only \$388,000 in demand-side elements, which does not include reduced revenues. For 1990, DWD has budgeted \$1.7 million for demand-side conservation efforts and another \$4.2 million for the metering and leak detection program elements. The total demand-side costs for the EPA-recommended program at the 6 percent level (i.e. excluding metering and leak detection costs) would have an estimated present value cost of \$33.5 million with a benefit/cost ratio of 1.4 for DWD (WRE 1990b, page F-2).

EPA estimates that the DWD staff would need to be increased from its current 3 employees to approximately 15 employees to accomplish these demand-side conservation programs. Approximately 10 employees would conduct the residential audits (assuming teams of two accomplishing four audits per day). For the employees conducting these residential audits, one should have practical experience in the installation and repair of household plumbing and the other practical experience in the design and operation of commercial lawn watering systems, as well as turf and soil conditioning experience. One or two staff would be involved with the commercial and industrial audits and will need to have mechanical engineering experience in a wide variety of industrial processes. DWD has issued a contract to an engineering firm to begin commercial and industrial audits (Presentation by Dave Little, DWD, Citizens Advisory Committee Meeting, May 2, 1990). Two staff will be needed to perform large turf audits (WRE, 1990b, page B-33). These employees should be professional landscape architects with several years field experience in commercial turf management.

VI. Recommended Program For Additional Water Savings

The following program elements may be needed to achieve the Foothills Consent Decree goal for 1999, based upon replacing any unsuccessful program elements or to achieve additional cost-effective reductions in water use by DWD. The following discussion highlights additional water conservation program elements which may be needed as a supplement to the recommended EPA program. These programs are not undertaken by DWD at the current time.

A. Expand Successful Program Elements

If DWD is successful at reducing water demand with a particular program element, that program element could be expanded, expedited, or otherwise improved. For example, the residential audit program recommended by EPA is designed to cover 30 percent of the homes by 1999. Additional staff could be used to expedite this effort to cover more residences by 1999.

B. Non-potable Reuse for New Developments

In addition to the New Denver Airport and the associated Gateway development, Denver may have cost-effective opportunities during the next decade to use non-potable reclaimed wastewater for park and open space irrigation. Due to the location of the Metro Sewage facility and the high cost of new transmission facilities, conversion of existing open space irrigation within Denver to non-potable reuse will remain costly. Opportunities for wastewater reuse may arise with some of the suburban distributors on the DWD water system, especially if they are near wastewater treatment facilities.

C. Low Water Use Landscape Retrofits

A substantial increase in water rates or substantial reduction in landscaping retrofit costs is needed to change the high costs and poor economic return in terms of water savings associated with converting existing lawns to low water uses. Of course, homeowners can and do decide to convert lawns to less water demanding landscapes for a variety of other reasons which may include conservation ethic, desire for variety in plantings, and reduction in maintenance and labor costs. In order to have residential low water use landscape conversions become cost-effective, DWD could consider the following approaches.

As an incentive to low water use landscape conversions, the North Marin Water District near San Francisco offers a rebate program which pays the consumer to replace Kentucky Blue Grass with drought-tolerant grasses or shrubbery. This utility offers a rebate of \$.50 per square foot for removal of turf and conversion to low water use landscaping. The program has been successful for commercial properties but, thus far, few single-family residences have taken advantage of the utilities' offer (Presentation by John O. Nelson, North Marin Water District, EPA's Water Conservation Conference, Tucson, Arizona, February 15, 1990.)

To successfully implement low water use landscaping in Denver, several factors would have to be present. First, public interest in the advantages of maintaining an attractive, but different landscape, would need to be generated. Such interest appears to be growing in Denver. This is related to Denver's public educational efforts. A recent seminar on low water use landscape planting, sponsored by DWD, had over 250 people in attendance. Second, some means of reducing the cost of landscape conversion should be developed. The following means have been suggested:

- o A utility rebate offer by DWD equal to the avoided cost of a new water supply perhaps on the order of \$.50 per square foot.
- o A demonstration program based on obtaining drought-tolerant plants at wholesale cost. Drought-tolerant plants at low cost may become available through the Denver Botanic Gardens in cooperation with the Center for Plant Conservation, Boston, Massachusetts.
- o A demonstration program featuring job training for professional landscapers and a job training service for summer teenage employment to reduce labor costs of landscape conversion.

D. Pricing for Conservation

The reduction in water consumption due to rate modifications will depend upon customer response. An estimate of water savings from pricing is based upon the expected effect of elasticity of demand for Denver's water. While Denver's recent rate structure modification incorporates approximately a 25 percent higher ascending block rate, which is generally viewed as fostering conservation, the success of the rate change remains to be determined. By 2010, DWD estimates that 3,500 AFY of water savings will result from the ascending block rate structure implemented in March 1990. If this estimate of water savings from the pricing change proves incorrect, then EPA recommends that DWD modify its rate structure. If the revised rate structure does not reduce demand as expected, DWD could consider the following revisions among other strategies: a) further increases in the block rate designed to provide at least 3,500 AFY in water savings by 2010; b) revising the rates to provide at least a 25 percent higher rate in the ascending block, incorporating the \$6 bi-monthly service fee into the first block; c) implement differential rates during drought emergencies; d) increase the rate up to the marginal cost of the next water supply component; e) implement rates based upon customer usage with price increases if exceeded; or, f) rebate a portion of the tap fee in response to proven customer water use reductions.

Further increasing the price to achieve a water use reduction of 3,500 AFY by 2010 would be consistent with DWD's policy statement of October 3, 1989. Increasing the block rate to the intended 25 percent difference between the first and second residential rate structure, including the fixed \$6 bi-monthly service charge, would be consistent with the intended DWD policy direction of having a 25 percent ascending block rate.

Increasing the block rate within the constraint of keeping the overall rate revenue neutral would tend to benefit the smaller residential users at the expense of larger users. Generally, water use is directly associated with lot size. WRE concluded that less water waste occurred on larger lot sizes.

Differential rates during drought emergencies may achieve substantial water use savings according to experiences in Oakland, California. Notifying the public of much higher rates to be expected during a drought emergency may foster changes in landscaping to avoid higher water bills.

Increasing the rate up to the marginal cost of the next water supply component is viewed by some as a rational basis for water supply pricing. The use of marginal cost pricing is based upon anticipated future expenses, rather than the current costs associated with delivering water. (Similarly, WRE used the cost of future water supplies to judge the cost-effectiveness of the water conservation program elements.) The Denver City Charter provides ... "rates will be as low as good service will permit" (DWD 1989a, page 22). DWD has stated ... "It is not the purpose of a conservation program, nor is it necessary for water conservation, to charge more for water service within the City and County of Denver than the costs of providing this service, or to prevent the aggregate rates from being 'as low as good service will permit'" (DWD, 1989a, page 22). It has been suggested that a city charter amendment may be required in order to implement marginal cost pricing in Denver. This problem could be eliminated if Denver utilized such increased revenue to pay for additional cost-effective conservation measures, such as toilet or landscape rebates.

One method of conservation pricing is to establish rates based upon current consumption goals per household and penalize use above such goals. Scottsdale, Arizona is in the initial stages of implementing a pricing system which would establish higher water costs when a set water use is exceeded. The city is now advising consumers of this new program to "condition" them to the new system and to assess public reaction. Residential water use goals per household in Scottsdale would be based upon past consumption considering the number of persons per residence, lot size, and other factors. As proposed, a progressively increasing conservation rate would be charged to those customers who exceed their goal and a discount provided to those who are below their goal (Leonard Dueker, 1990).

Providing a rebate of part of the tap fee in response to customer water use reductions is a different approach. A recent article, using Denver as a case study, suggested that a rate structure could be based upon converting tap fees, which are relatively high in Denver, from a set amount per residence to an amount based upon actual water use (John R. Morris, 1989). The relatively high costs of tap fees in Denver are repaid in the mortgage. Transferring part of this substantial fee back to the customer could provide a definite incentive to water conservation. Minimal administrative costs would be associated with this approach since the burden of reducing water consumption rests with the residential and commercial property owner. The North Marin Water District offers discounted tap fees for new developments when certain water conservation practices are included.

VII. Major Policy Issues

The following are the major policy issues raised during EPA's 1989 review of DWD's water conservation program.

A. Interpretation of the Consent Decree Goals

The Foothills Consent Decree goals have been subject to various interpretations throughout the years. The WRE report identified and examined three different interpretations (WRE 1990a, page 4-5). EPA agrees with the WRE finding, that Case 1 is the most reasonable of the three. The Case 1 interpretation computes the target consumption for a given year as a percent of the base of the 1968-77 consumption value. The method does not incorporate a normalization for temperature and precipitation. EPA concurs, as the WRE report states, that by using a 9-year running average, the effects of temperature and precipitation are accounted for and therefore do not affect the consumption target (WRE 1990b, page 4-5).

B. GAD versus GCD

EPA agrees with the conclusion and recommendation provided in the WRE report which states, "The utilization of GAD as the indicator of water consumption is more accurate because it does not depend on questionable population estimates, as the GCD unit does; GAD depends on the consumption from a given sector, available from DWD water consumption files, and on the number of active accounts within that sector, also available in DWD files. The GAD is a more flexible and representative unit, since practically all of the water used in the DWD service area can be associated with an account number, and since every account has a specific category attached to its identification codes, the use of GAD allows the tracking of consumption by individual billing sectors and different types of accounts" (WRE 1990b, page 4-4). EPA recognizes that although GAD is an improvement

over GCD, it has its limitations. One example is that GAD is affected by changes in the average number of persons per household. Another potential weakness that has been pointed out, is the method's inability to distinguish larger buildings that may have replaced smaller ones, which contained fewer occupants.

EPA recognizes that at present, there is no state-of-the-art method of measuring consumption in a precise manner. However, measuring in terms of GAD remains the most reasonable method. Until a more accurate method is found, EPA recommends that the unit of measurement be changed from GCD to GAD.

C. Measurement of Accomplishments Based upon Goals versus Programs

Because of the inherent uncertainty of water savings estimates, successful water conservation efforts should be evaluated based upon specific program accomplishments rather than estimates of the changes in water use consumption. A program at least as stringent as the EPA-recommended program, which is described as "Program C" in the WRE report, plus conservation pricing, is necessary to meet the 6 percent reduction goal by 1999. The monitoring objectives, parameters, and procedures, as specified by WRE, are recommended standards to establish that DWD has accomplished these program goals (see WRE 1990b, pages 5-12 through 5-17). In addition, periodic evaluations by DWD should be prepared for public review. Annual program expenditures, staffing, cost, and accomplishments in terms of market penetration should be presented in the annual self-monitoring report.

D. Water Conservation Impacts to Stream Flow

DWD indicates that water conservation may reduce return flows to the South Platte River. DWD observed that water conservation programs aimed at reducing consumptive use, such as low water use landscaping, would reduce the need for additional water supply projects without the potential to change downstream flow. According to DWD, other water conservation measures which reduce non-consumptive use, such as ULV toilets and metering, would accomplish the same goal of reducing the need for new water supplies, but affect the downstream environment because there would be less return flow (DWD 1990a, pages 2 and 3.) DWD expects to issue new water taps against the "increased" firm water supply obtained from water conservation. Improvements in efficiency in the non-consumptive portion of Denver's water use would be water that was formerly returned to the South Platte River. DWD is obligated to return the non-consumptive use portion of the water it obtains from the South Platte River basin. This "no-injury" rule is intended to protect the rights of downstream junior appropriators who are dependent on upstream return flows for their own rights. As the letter from the east-slope conservancy districts and irrigation associations demonstrates, downstream juniors are vigilant in protecting against the change in use DWD is contemplating (letter to Hubert Farbes, DWB, from the Central Colorado Conservancy District, Northern Colorado Conservancy District, and the Irrigationists Association, November 15, 1989.)

However, DWD imports about one-half of its water supply from the west slope of Colorado. DWD has a right to consume all of its transbasin water. Downstream junior appropriators are not entitled to return flows that result from transbasin diversions. Return flows associated with diversions from the South Platte basin would remain undiminished by more efficient use of transbasin water. The contemplated water conservation program could be shown to improve the efficiency of use of transbasin sources. EPA concludes that DWD could expect to issue new taps associated with all the firm water saved by water conservation efforts.

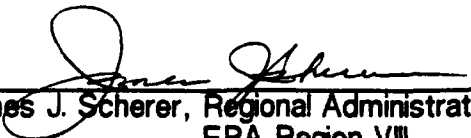
Improvements in urban water use efficiency from a successful water conservation program in Denver may, indeed, cause a reduction in South Platte return flows. From an environmental prospective, any decrease in return flow to the South Platte could be offset by a corresponding increase in stream flow in the Colorado River Basin as Denver diverts less water for its diminished needs.

VIII. Achieving Water Conservation by DWD in the Future

This is the final EPA compliance review under the Consent Decree. At this point, eleven years since the Consent Decree, there is recognition that DWD has failed to act on previous EPA recommendations. For example, in prior reviews EPA pointed out the lack of central management for water conservation, the need to link the elements of the program to specific water conservation goals, the need to determine the cost-effectiveness of each program element, the need for public surveys to establish assumptions of interest and market penetration, and the need to extensively monitor program activities. EPA recommendations to complete the metering program, promote public awareness, and promote low water use landscaping are being pursued effectively. In addition, DWD has adopted the new elements of a toilet rebate program and the ascending block rate structure. Nevertheless, much additional effort by DWD will be essential to budget, staff, and implement the water conservation program elements recommended by EPA. Determined implementation of residential, commercial, industrial, and large turf audits, a new ULV ordinance, toilet rebates, non-potable reuse at the New Denver Airport, and expansion of the leak detection program, in addition to on-going metering, are necessary for DWD to achieve the goals of the Consent Decree. DWD should implement a program designed to achieve the intent and purpose of the Consent Decree in a clear and unambiguous manner.

IX. Conclusions

Based upon the information presented in this statement, I have concluded that the Denver Water Department failed to obtain its water conservation goals for 1989 consistent with the Foothills Consent Decree. I have established the goal for 1999 to be a further reduction of 6 percent based upon gallons per account per day (GAD). By 1999, the average consumption per account in Denver should not exceed 744 GAD. The current average consumption is estimated to be 831 GAD. To achieve this goal, the Denver Water Department should undertake the specific programs recommended in this statement, or their functional equivalent in terms of program accomplishments, and prepare an annual public report on the progress of these efforts. Should the Denver Water Department dispute the establishment of this water conservation goal, the Department may appeal the matter to the U.S. Army Corps of Engineers District Engineer in Omaha, Nebraska, pursuant to the conditions and terms of Section 5(c) of the 1979 Foothills Consent Decree.


James J. Scherer, Regional Administrator
EPA Region VIII

6-14-90
Date

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XI. Glossary

ascending block rate structure – higher cost per unit of water as consumption increases

AFY – acre feet per year

demand-side measure – those measures affecting the water user; including education and public information, audits, replacement of fixtures, rate modifications, and incentive and regulatory programs

DWD – The Denver Water Department

DWB – The Denver Water Board

elasticity – percentage of change in demand associated with a one percent increase in price

Evapo-Transpiration rate – a unit of measurement, derived from a model incorporating temperature and rainfall to obtain an efficient irrigation rate (The ET rate in Denver is designed primarily for Kentucky Blue Grass.)

GAD – gallons per account per day

GCD – gallons per capita per day

low volume toilet – a toilet using 3.5 gallons per flush

market penetration – the percent of the homes or businesses retaining the water saving device throughout its useful life

non-potable reuse – water not fit for human consumption, used for other purposes including: landscape irrigation or, potentially, waste transport in toilets

normalize – in this text, normalization refers to the correction in the water use demand model by regression analysis to correct for temperature and precipitation effects upon water use

retrofit – refers to the replacement of plumbing (toilets, showerheads) and landscapes to a water saving device, or low water use landscape

supply-side measure – those measures which impact the utility's infrastructure but have no direct effect on customer water use patterns; including the measuring and monitoring of water consumption, leak detection and repair to improve the supply and distribution system's efficiency, and to minimize water losses; also encompasses metering

ULV toilet – ultra-low volume toilet, using less than 1.6 gallons per flush

Xeriscape – the term developed by DWD for low water use landscaping