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COMPREHENSIVE STUDY  
FOR  
BROOMFIELD EMERGENCY WATER SUPPLY

FOR

THE UNITED STATES ENERGY RESEARCH  
AND DEVELOPMENT ADMINISTRATION  
ROCKY FLATS PLANT  
GOLDEN, COLORADO

ROCKWELL INTERNATIONAL  
ATOMICS INTERNATIONAL DIVISION  
ROCKY FLATS PLANT

Prepared by:

URS Company  
3955 East Exposition Avenue  
Denver, Colorado 80209  
Project 7028  
August, 1977

ADMIN RECORD

OU03-A-000582

CLASS  
REVIEW

*ESB* 8-22-77



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1/193

COMPREHENSIVE STUDY  
FOR  
BROOMFIELD EMERGENCY WATER SUPPLY

ERRATA  
August 26, 1977

Page I-3, fifth para - in second line "1979" should be  
"1978"

Page II-4, first para under 2 - Project Background.  
In second line, insert "Research" after Energy.

Page III-2, second para - in sixth line "6MGD" should be  
"6MG"

Page III-2, fourth para - in third line, "1980" should  
be "1979"

Page VI-1, second para - in second line, "1979" should  
be "1978"

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August 22, 1977

Mr. Charles R. Rose, Project Manager  
Rockwell International  
Rocky Flats Plant  
P. O. Box 464  
Golden, Colorado 80401

Re Broomfield Emergency Water Supply  
URS #7028  
77-RF-1034

Dear Mr. Rose

This report represents completion of our Contract dated April 6, 1977, and ammended on July 20, 1977, and on August 11, 1977.

The report summarizes the engineering analysis and other considerations of the alternative emergency water supplies for Broomfield, Colorado.

We have appreciated the opportunity to work with Rockwell International and the Energy Research and Development Administration on this challenging and exciting project.

Yours very truly,

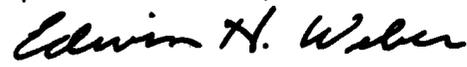
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I REPORT SUMMARY

A Scope

The Energy Research and Development Administration (ERDA), through a prime contractor, Rockwell International, operates Rocky Flats Plant for research and handling of nuclear materials. Operation of the plant is viewed by some persons as having the potential to render the water in Great Western Reservoir unsuitable for use as a public water supply for the City of Broomfield, Colorado.

The purpose of this study is to provide a comprehensive engineering and cost analysis of all potentially feasible alternatives to furnish an emergency water supply for the City of Broomfield, Colorado. The scope of the study includes discussion of the problems of public relations, water rights, and contractual relationships, as well as advantages and disadvantages of each alternative from both the government's and Broomfield's points of view.

B Description of the Study

The study included gathering data regarding Rocky Flats operation, Broomfield's water system, and all other water systems that offer potential as an emergency water supply for Broomfield.

The duration and time frame of the potential emergency to be studied were established by consensus between ERDA, Rockwell International, and the consultant. The decision was to assume a one-year duration for the emergency and that the emergency could occur at any time in the future. A contract between Denver and Broomfield limits the capacity of the Broomfield Water Treatment Plant, and this limit establishes the amount of the emergency supply required if Great Western Reservoir could not be used. Broomfield has designed and will shortly have under construction an addition to the water treatment plant which will treat a total of 80 MGD.

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The study analyzed both potential treated and raw water alternatives. Treated water supply alternatives were limited to those systems located in proximity to Broomfield. Raw water supply alternatives were limited to those systems that could provide adequate storage capacity and could utilize Broomfield's present raw water rights

Discussions were held with all of the entities that own or operate the potential alternative emergency supplies. These entities were cautious during the discussions. No simple, easy solutions emerged to provide an emergency water supply to Broomfield

All of the potential treated and raw water alternatives that appeared to have any merit were analyzed and estimates made of their costs

C. Description of Alternatives

- 1 Alternatives for treated water supply from Denver, Westminster and Arvada were analyzed
- 2 Raw water supply alternatives, including sources and/or storage, were analyzed for the following

- Denver system
- Englewood system
- Clear Creek
- Farmers Reservoir and Irrigation Company
- Coal Creek
- South Boulder Creek
- Groundwater Supplies
- South Platte River
- Barr Lake
- Rocky Flats Lake
- Rock Creek

Marshall Reservoir  
Blunn Reservoir  
Standley Reservoir

D Summary of Recommended Alternatives

The following tabulation presents the evaluation of the alternatives

The Denver treated water system is the best short-term and long-term emergency supply. This emergency supply is physically available at present and would require the least cost to provide the standby facilities.

The Denver treated water system would require construction of some \$621,000 worth of standby facilities and the acceleration by several years of the construction of facilities in the Broomfield system to transport the emergency water. Purchase of a year's supply of treated water as an emergency supply would cost about \$580,000, and additional pumping would cost \$20,000 per year.

The Broomfield-Denver contract limits the amount of water available to Broomfield from Conduit No. 81 to 9.7 MGD on a maximum day rate. For the long-term, purchase by Broomfield of the remaining capacity in Denver Conduit No. 81 would be required to provide 15.8 MGD capacity. Such a purchase would require approval by Denver.

Present supplies from Denver would provide an emergency supply without curtailment of use through 1979, and with curtailment of sprinkling through 1982. The 15.8 MGD would provide an emergency supply without curtailment through 1983, and with curtailment of sprinkling through 1990.

An alternate recommended long-term emergency supply is via a new raw water reservoir and use of Broomfield's raw water supplies. The

Blunn, Coal Creek, and Standley Reservoirs alternatives appear to be the most viable. Any of these reservoirs will have a construction cost in the \$5-6 million range.

BROOMFIELD EMERGENCY WATER SUPPLY ALTERNATIVE MATRIX

<u>Alternative</u>	<u>Description</u>	<u>Capital Cost</u>	<u>Annual Operating Cost</u>	<u>Implementation</u>
<u>Treated Water</u>				
Denver	Utilize present Denver Connection	\$ 621,000*	\$600,000	<ol style="list-style-type: none"> <li>1 Construct pump station and transmission main</li> <li>2 Amend Broomfield-Denver Contract Service Area to include all of Broomfield</li> <li>3 Construct additional treated water facilities in Broomfield system prior to time normally required to transfer emergency water</li> <li>4 Broomfield-Denver contract presently limits maximum day demand to 9 7 MGD Potential to provide 15 8 MGD</li> </ol>
Westminster	Connect to Westminster treated water system	\$1,203,750	\$600,000	<ol style="list-style-type: none"> <li>1 Construct pump station and transmission main</li> <li>2 Westminster system capacity limits service to non-summer load season</li> </ol>
Arvada	Connect to Arvada treated water system	\$2,400,000	Indeterminate	<ol style="list-style-type: none"> <li>1 Construct transmission main</li> <li>2 Dependent upon construction of a new raw water reservoir and treatment plant</li> <li>3 Requires a strong financial commitment on Broomfield's behalf</li> </ol>

\*Would also require acceleration of construction by Broomfield of additional treated water storage and transmission facilities to transport the emergency water through the Broomfield system

BROOMFIELD EMERGENCY WATER SUPPLY ALTERNATIVE MATRIX

<u>Alternative</u>	<u>Description</u>	<u>Capital Cost</u>	<u>Annual Operating Cost</u>	<u>Implementation</u>
<u>Raw Water</u>				
Rocky Flats Lake	Use Rocky Flats Lake as Alternative Raw Water Storage	\$2 5-2 8 million	\$ 68,000	1 Rocky Flats Lake present and potential expansions result in insufficient capacity 2 Rocky Flats Lake proximity to plant site makes location less desirable
Denver	1 Use Denver storage or 2 Purchase raw water from Denver	\$2 5 million ±	\$74,000	1 Denver has indicated that neither raw water nor raw water storage capacity is available
Rock Creek (Proposed)	Construct new raw water storage on Rock Creek	\$4 8 million ±	\$148,000	1 Proposed Rock Creek storage proximity to plant site makes the location less desirable
Coal Creek (Proposed)	Construct new raw water storage on Coal Creek	\$4 9 million ±	\$167,000	1. Under study by Bureau of Reclamation for two possible sites 2 Location is desirable
Marshall Reservoir	Reservoir exists	\$4.6 million	\$165,000	1 Location is desirable. 2 Abandoned coal mine underlies the dam and is a potential hazard.

BROOMFIELD EMERGENCY WATER SUPPLY ALTERNATIVE MATRIX

<u>Alternative</u>	<u>Description</u>	<u>Capital Cost</u>	<u>Annual Operating Cost</u>	<u>Implementation</u>
<u>Raw Water (Continued)</u>				
Blunn Reservoir (Proposed)	Arvada has initiated design of new reservoir on Ralston Creek	\$4 3 million±	\$110,000	1 Location is desirable
				2 Arvada has indicated willingness to include capacity for Broomfield
Standley Reservoir	Reservoir exists but all storage is owned by FRICO or Westminster	\$4 1 million±	\$126,000	1 Location adjacent to Great Western Reservoir is less desirable
				2 Storage capacity is not available for purchase

II PROJECT DESCRIPTION

A PROJECT SCOPE

1 General

The Scope of Work for the Comprehensive Study Broomfield Emergency Water Supply is reproduced here, in part All of the remainder of this section (headed 1 General) quotes from the above document

"SCOPE

1 1 *Purpose*

*The purpose of this study is to determine the best immediate emergency water supply for the City of Broomfield, Colorado, in the unlikely event that their existing water supply from the Great Western Reservoir may become radioactively contaminated by the Rocky Flats Plant and rendered unsuitable for drinking water in accordance with limits set by the Code of Federal Regulations Title 10 - Part 20 106 (10CFR20 106), and to evaluate the need of an emergency supply after the current surface water control and water recycle projects are completed*

4 *Description of Study*

*The comprehensive study on the Broomfield Emergency Water Supply shall be conducted in two phases Phase I shall determine the best emergency supply capability that can be used in the immediate future, if the normal supply from the Great Western Reservoir should be curtailed due to the unlikely event of radioactive contamination from the Rocky Flats Plant Phase II shall determine if an emergency supply is required after current water control and water recycle projects have been completed \**

\*This report is to cover only Phase I

4 1 Phase I

The main objective in Phase I is to provide Broomfield with an emergency water supply without compromising the existing water quality while awaiting the completion of the current Rocky Flats water control and recycle projects

The Architect-Engineer (A-E) shall study, as a minimum, the alternatives listed in 4.1 1 through 4.1.4 and prepare a report which shall include

- Engineering Design Criteria
- Estimated Construction Costs
- Acquisition Costs
- Construction Schedules
- Estimated Yearly Operational Costs
- Problems in public relations, water rights, ownership, leases, contracts, water tap installations, etc
- Advantages and Disadvantages from both the Government's and Broomfield's viewpoints of each Water Supply Alternative
- Viability of alternates from the Denver Board of Water Commissioners viewpoint

4 1 1 Purchase the remaining available 3/7 capacity in the jointly-owned Denver-Broomfield Conduit No 81 water supply system, and arrange to purchase treated water from the City of Denver during an emergency. The system shall be used as is or with very minimal modifications

4 1 2 Purchase the remaining Conduit No 81 capacity as above, but provide the necessary modifications to supply 5.5 MGD through the 3/7 portion of the system on an emergency basis only at normal operating pressure

4 1 3 Same as 4 1 2, but with a capability to supply emergency water to Broomfield with a capacity equal to the planned capacity of their water treatment plant Included in this section shall be the analysis of the potential of additional treated water supply from the Westminster, Colorado Municipal System via the connection to Conduit No 81 at 128th and Huron

4 1 4 Obtain raw water from the Ralston Reservoir or the South Boulder Diversion Canal which are both owned by the City of Denver Provide capability to supply water from both sources since the diversion canal is inoperative during the winter months and for other occasional short time periods Utilize the Rocky Flats (RF) Lake for water storage The RF Lake is located southwest of the plant site on State land and is privately leased Install a buried pipeline from the RF Lake to the Broomfield Water Treatment Plant by-passing the Great Western Reservoir The flow from RF Lake to Broomfield's Water Treatment Plant would be by gravity

Determine the maximum capacity available utilizing the existing 10-inch pipeline from Ralston Reservoir as is, and also determine the modifications required to provide emergency water to Broomfield with the maximum planned capacity of their water treatment plant

The A-E shall also make recommendations regarding the necessity and the cost of increasing the RF Lake storage capacity to provide a 90-day supply for emergency water for Broomfield Included in this section shall be the analysis of the potential of additional raw water supply from

- a *The Gross Reservoir System including Englewood's Ranch Creek System*
  - b *The Church Ditch*
  - c *Irrigation companies or individual irrigators in the general area of Broomfield*
  - d *The proposed Coal Creek Canyon Project of the Bureau of Reclamation*
- 4 1 5 *Evaluate other reasonable emergency sources as deemed appropriate by the A-E and as approved by the Contracting Officer "*

2 Project Background

The United States government, as represented by first the Atomic Energy Commission (AEC) and currently the Energy and Development Administration (ERDA), operates the Rocky Flats Plant through a prime contractor *"for research, development, production, testing, stockpile surveillance, and transportation of nuclear materials "* The plant has been in operation since 1953 and the present operator, the Atomic International Division of Rockwell International, has been the operating contractor since July 1, 1975

The boundaries of Rocky Flats include about 6,550 acres of land in the western portion of the Walnut Creek drainage area about nine miles south and west of the City of Broomfield The plant buildings occupy about 385 acres and are enclosed by a security fence The west boundary of Rocky Flats is within a quarter of a mile of Colorado Highway 93 and the east boundary adjacent to Indiana Street Because of the natural terrain, almost all of the surface runoff from the security-fence-enclosed plant site flows northeast along Walnut Creek This location data is shown on Figure 1

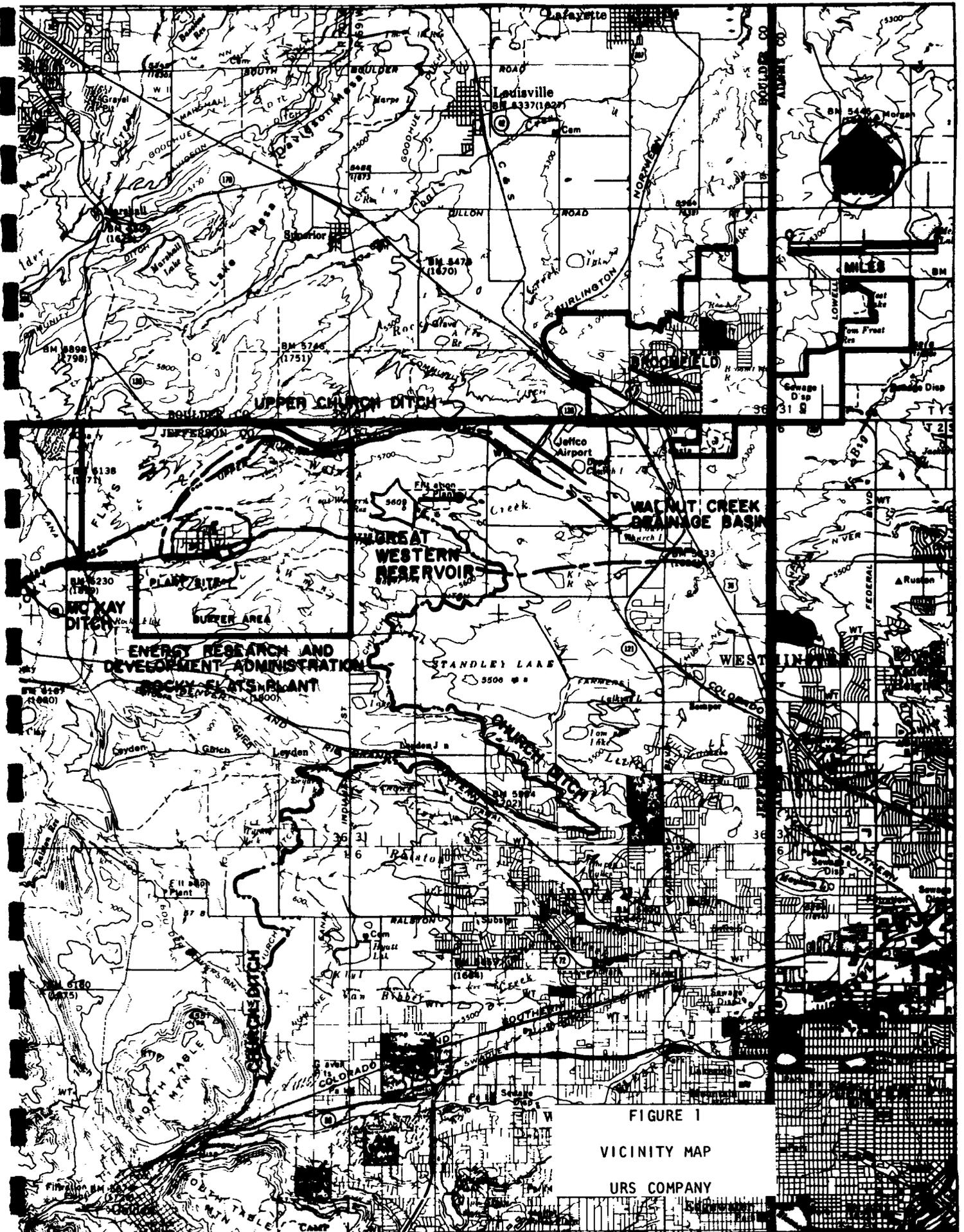


FIGURE 1  
VICINITY MAP  
URS COMPANY

Official plant weather records indicate the prevailing winds at Rocky Flats are from the west and south. During the fall and winter months, frequent westerly winds with gusts in excess of 60 miles per hour have been recorded.

The Great Western Reservoir is located just east of Indiana Street and intercepts drainage from Walnut Creek. Great Western Reservoir has a capacity of about 3,100 acre-feet of live storage and is the storage for the Broomfield Water Treatment Plant that serves the western portion of the City of Broomfield, Colorado.

Water is supplied to Great Western Reservoir primarily through the Church Ditch from Clear Creek and from the natural runoff of Walnut Creek. Also, a small amount of water is supplied in average or above average water years from the McKay and Upper Church Ditches out of Coal Creek. These three ditches are shown on Figure 1.

The water supply for the Rocky Flats Plant is from the Denver raw water system and is treated in a small plant on the plant site. The wastewater is treated in two separate systems -- one for the sanitary water and one for the process water. The effluent from the sanitary wastewater plant and a very small portion of the surface drainage are detained in small ponds on the site, sampled and batch released.

During early 1973, a shipment of scrap material was received at the Rocky Flats Plant for recovery of usable materials. This shipment, according to a letter to Broomfield from B. W. Colston, Area Manager of the then Atomic Energy Commission, dated September 24, 1973, and further amplified in a news release of December 20, 1973, from James R. Nicks, Assistant Area Manager for AEC, contained tritium, a radioactive isotope of hydrogen.

Tritium was not known to be contained in the scrap at the time of shipment and is an isotope not normally handled at the Rocky Flats Plant. Thus, the scrap shipment was processed routinely and the radioactive material was inadvertently allowed to enter the plant's waste system and the sanitary land fill.

The Colorado Department of Health, during its monitoring process in April 1973, found indications of unusually high concentrations of tritium in the waters of Walnut Creek. After very careful and comprehensive tests by federal, state, and Rocky Flats authorities, it was determined that tritium was present in the waters of Great Western Reservoir.

The Colorado Department of Health, by letter of September 17, 1973, officially notified Broomfield that tritium was measured in both Walnut Creek and Great Western Reservoir in unusually high levels. The concentrations in Great Western Reservoir were measured at 23,000 pico curies per liter (pCi/l) in June, 1973, and 10,000 pCi/l on October 25, 1973. Subsequent measurements have been as follows:

1974 Average	=	8,221 pCi/l
1975 Average	=	2,300 pCi/l
1976 Average	=	993 pCi/l
1977 Average	=	668 pCi/l

(January-June)

The 1973 level of tritium was unusual when compared to the normal levels in the state or when compared to measurements upstream of the Rocky Flats Plant. The tritium background level for the front range is 550 to 1,000 pCi/l. The federal guide for tritium levels in drinking water supplies in effect in 1973 was 1,000,000 pCi/l. The Safe Drinking Water Act, Public Law 93-523, has recently established an annual average standard of 20,000 pCi/l effective June 24, 1977.

Based upon the records available, the tritium levels in Great Western Reservoir have been well below the federal standards, even under the new Safe Drinking Water Act.

3 Statement of Problem

The problem is one of perception on the part of the citizens of Broomfield and this perception is reflected in the attitudes of the officials of the City of Broomfield. This official attitude is contained in almost every document on this matter from the City of Broomfield.

The concensus of all official and unofficial attitudes of the representatives of Broomfield is . . . *"The City of Broomfield feels that no risk to its drinking water supply is acceptable for the health and welfare of its citizenry "*

Since the fall of 1973, there have been on-going communications with Broomfield by AEC and its successor, the Energy Research and Development Administration, Dow Chemical, and, since July 1, 1975, Rockwell International as operator of the Rocky Flats Plant, the State of Colorado, and numerous other parties on both official and informal bases.

In addition, in December 1974, Colorado Governor Richard D Lamm and Second District Congressman Timothy Wirth established a committee and charged it with *"developing options, alternatives, and recommendations to enable the Governor and the Congressmen to fully understand and deal with the Rocky Flats operation "* One of the recommendations of the committee, as contained in the "Final Report - Lamm/Wirth Task Force on Rocky Flats" dated October 1, 1975, was

*"Regarding the Broomfield Water Supply, the Task Force investigation has revealed the following facts with respect to the Broomfield Water Supply from the Great Western Reservoir. Operation of the federal facility at the Rocky Flats Plant has resulted in radioactive and toxic material contamination of the Great Western Reservoir. However, studies by the Colorado Department of Health and the EPA have determined that the present level of contamination does not pose a threat*

*to the people of Broomfield Notwithstanding, plans by the Rocky Flats Plant to install a sophisticated water treatment and recycling plant, the Task Force believes no static water supply should be used for human consumption while it is still subject to potential contamination from the Rocky Flats Plant*

*Therefore, we recommend that Governor Lamm and Congressman Wirth request that the Federal government, in cooperation with the City of Broomfield and all appropriate County and State officials, provide the City of Broomfield with an alternate source of water to replace the water which Broomfield receives from the Great Western Reservoir "*

This report was transmitted to Robert C Seamans, Jr , Administrator of ERDA, on October 22, 1975 A portion of his reply dated December 31, 1975, is reproduced here

*"The matter of Broomfield's water supply deserves special comment ERDA has studied with special care the nature of the Broomfield water supply and the Task Force suggestion that the Federal Government provide an alternate source of water The liquid effluent treatment system at Rocky Flats produces water of very high quality and provides extraordinary safety redundance Environmental monitoring programs by ERDA, EPA, and Colorado Department of Health confirm this water quality and safety Nevertheless, although we have confidence in the effectiveness of the several effluent control improvements which are being and have been implemented by ERDA, we recognize and understand the desire of the citizens of Broomfield to assure themselves of a water supply that is completely safe and that is adequate to meet their city's growing needs*

*In order that everything possible be done to alleviate this citizen concern, Rockwell is being asked to review the existing monitoring network in conjunction with Broomfield and the Colorado Department of Health to see if there are possible changes which might improve Broomfield's confidence in the reliability of the monitoring system or the*

reaction time within that system. In addition, ERDA will undertake discussions with the Denver Water Board to try to arrange an alternate supply of water to be available against the unlikely contingency that Rocky Flats Plant operations would render the Great Western Reservoir unsuitable for municipal use (Emphasis added) Implementation of these additional measures should provide every reasonable assurance to the citizens of Broomfield in this matter "

It is also important to note the comments of an ERDA Report Review Task Group that reviewed the Lamm-Wirth Task Force recommendations. The comments of this ERDA Report Review Task Group were contained in attachments to Dr. Seaman's letter of December 31, 1975. These comments appear to be definitive of the limits of the commitment by Dr. Seaman's

"COMMENTS

In recognition of Broomfield's concern regarding the quality of the water in the Great Western Reservoir and the interest of the citizens of Broomfield in assuring that their water is safe from future contamination, ERDA commissioned an independent study of the relationship between Rocky Flats Plant effluents and the Great Western Reservoir. This study was conducted in 1974 by the Engineering Sciences Company of Austin, Texas, and it considered separate recommendations made by an engineering firm employed by Broomfield before the ERDA review was undertaken. The comments and suggestions of Broomfield also were solicited.

This comprehensive study resulted in 28 recommendations to ERDA for improvement of the liquid effluent control mechanisms in effect at the Plant. All of these recommendations were adopted by ERDA and implementation of all but two has been either initiated or completed. The exceptions are recommendations for total Plant water recycle, which has been authorized by Congress, and for a dam and impoundment system to eliminate surface water runoff and to capture releases which might occur by accident. The water impoundment project will be requested by ERDA for FY 1978 funding approval. With the ultimate addition of total Plant

*water recycle and emergency impoundment, Rocky Flats will have the only system of this kind known to us for an industrial operation*

*No process effluents are released from the Plant site. The sanitary effluent which does go offsite is processed at the recently installed tertiary treatment facility, thus providing additional assurance that this outfall continues to meet existing drinking water quality standards. Accomplishment of such extraordinary precautionary measures is indicative of ERDA's desire to be responsive to every environmental aspect of the Rocky Flats operation.*

*Considerable concern has been expressed by the Lamm-Wirth Task Force over 'radioactive and toxic material contamination of the Great Western Reservoir'. Concentrations of radionuclides in the Great Western Reservoir, as summarized below, are indicative of the current effluent control program. These data support the ERDA conclusion that no known health or safety hazard exists in the Great Western Reservoir by reason of the past or present operation of the Rocky Flats Plant.*

*While the existing circumstances do not appear to justify replacement of the Great Western Reservoir at Government expense, ERDA feels compelled to do everything reasonable to alleviate citizen concern over future contamination. To this end, ERDA will review with the Colorado Department of Health the existing monitoring network for effluents entering the Great Western Reservoir in an effort to identify any available improvements to these detection systems and to implement any improvements which will provide for increased public confidence as to system reliability and reactor time.*

*Although the possibility of a future release from Rocky Flats which would render the Great Western Reservoir unsafe is very remote, ERDA has begun discussions with the Denver Water Board to examine the availability of alternate water as a contingency. This water would be purchased at Government expense as a substitute for Great Western Reservoir water in*

*the event that any occurrence at the Rocky Flats Plant renders the present water supply unsuitable for municipal use. These discussions are likely to be influenced by the capacity of the existing line from Denver to Broomfield and by the Denver Water Board's judgment as to availability of water for such contingency allocation."*

#### 4 Study Purpose and Objective

The purpose and objective of the study was to carry out a comprehensive analysis of the potential water supplies that could provide Broomfield with emergency water service. This analysis evaluated both treated water and raw water options from the standpoint of availability, cost, time schedule, public acceptance, and achievability from the legal and contractual points of view.

The technical staff of Rockwell International at Rocky Flats has contacted the water supply entities in the area and has carried out a comprehensive in-house analysis of this problem. The results of this analysis offered no simple solution to the problem. The constraints of Colorado water law, the strong competition for any available water in the area by municipalities, industry, and agriculture, and the uncertainty of the Denver Water Board's abilities to develop additional water supplies and treatment facilities have combined to preclude any relatively simple, straightforward solution.

B Rocky Flats Plant Water Facilities

1 Present System

The water supply for the Rocky Flats Plant comes from the Denver Moffat System. The sources are either the South Boulder Diversion Canal or Ralston Reservoir. The South Boulder Canal transports water from Gross Reservoir to Ralston Reservoir, and although the canal has operated year round, the present plan is for the canal to be operated only from April through October. Water from the South Boulder Diversion Canal flows by gravity through a 12-inch buried water line to the Rocky Flats site.

The alternate point of supply from the Denver system is a connection to the outlet works below Ralston Reservoir. The water is pumped from this point via a 10-inch buried water line to the Rocky Flats site. This system is capable of delivering 10-MGD to the plant site.

Rocky Flats has a 10-MGD water treatment plant to provide for its internal needs for potable water. In addition, untreated water from the Denver system is used for cooling tower make-up and miscellaneous uses, such as plant and shrub watering and road sprinkling.

At the present time, all of the wastewater from the plant's sanitary system is treated in a 450,000 gpd-capacity three-stage wastewater treatment plant. The effluent from this plant is retained in holding ponds and monitored. After testing verifies the water meets all discharge standards and ERDA guidelines, the water is released to Walnut Creek.

Wastewater from the plant's process system, which might contain chemicals or radioactive wastes, is treated separately by the precipitation and clarification process and the liquids removed by evaporation. The residue is shipped off-site to a national waste repository.

Most of the surface water runoff from the plant site flows into the Walnut Creek drainage to the east of the plant and then into the Great Western Reservoir. The surface water runoff from the southern edge of the plant site flows into the Woman Creek drainage. A small amount of the runoff is collected in on-site detention ponds for analysis and later release.

2 Future System - Under Design or Construction

The Rocky Flats Plant has under construction advanced sanitary and process wastewater systems that will be closed-loop recycling processes. No wastewater from either system will be released off the plant site, instead, wastewater will be processed to remove all solids and contaminants and then used for make-up water in cooling towers and boilers. Recycling will reduce the amount of new water added to the Rocky Flats system from the Denver source.

Also under design are a series of detention ponds that will collect the surface water runoff from the security-fence-enclosed portion of the plant site. The collected water will be analyzed and processed, if necessary, before being released to the downstream water courses.

The timing of stormwater runoff from the plant site will be affected by this system by reducing the peak flows and delaying the flows but not changing the total stormwater volume. The ponds will collect the flows during the storm, and after test verification of non-contamination, the water will be released. Should any of the surface water detention ponds be found to contain materials in excess of the federal discharge limits, the water will be processed as necessary to meet the required limits.

C Broomfield Water Facilities

The City of Broomfield serves about 19,000 people and has two separate water systems. The original system, with its raw water storage in Great Western Reservoir, serves the westerly parts of the city. The second system, with treated water supplied by Denver under permanent contract, serves the easterly part of the city. The distribution mains for the two systems are interconnected, but separation is maintained by closed valves.

Broomfield's system serves slightly more than half the population. This system utilizes water from Clear Creek via the Church Ditch, from the natural runoff of Walnut Creek, and from Upper Church and McKay Ditches out of Coal Creek. This supply produces an average annual yield of about 2,400 acre-feet from the Clear Creek water and about 500 acre-feet from the other sources.

Raw water is stored in Great Western Reservoir, located one mile south and west of Jefferson County Airport and just east of the Rocky Flats Plant site. This reservoir has active storage of approximately 3,100 acre-feet and is used primarily to provide carry-over storage from spring runoff for release later in the year. The reservoir has very little capacity for year-to-year storage to even out the wet-dry year cycles.

### III STUDY METHODOLOGY

#### A Study Criteria

##### 1 Project Assumptions

###### a Duration

The duration of any potential emergency is very difficult to determine. For this reason, considerable discussion was held with the personnel from both ERDA and Rockwell operating the Rocky Flats Plant, and some preliminary analyses were made.

The result of the discussion and analysis was the selection, for purposes of this study, of a one-year duration for the potential emergency. This would take into account the seasonal variation in water use and in water supply. It also would allow a period sufficient for a comprehensive review of the "causes and effects" of the emergency and allow time to carry-out any remedial work that might be necessary.

###### b Time Frame

The timing of potential emergency was also subject to considerable discussion primarily to determine the amount of emergency supply which must be available.

Broomfield's water system planning is premised upon expansion of both the Broomfield system and Denver system to meet the needs of the growing community. Comprehensive utility plans, prepared for Broomfield in 1973 and updated in 1975, are now being implemented for the two systems.

The Broomfield supply system will be expanded, according to present plans, to provide 8-MGD maximum day date.

This will include purchase of the necessary additional water rights, expansion of the raw water pumping station and the treatment plant, some additional water lines and pumping to balance the system at 8 MGD

The Denver system is planned by Broomfield to be expanded in two stages. The first will be to add the treated water distribution, transmission, and storage facilities necessary to utilize the full 9.7 MGD available under the present Denver contract. The Broomfield Comprehensive Utility Plan prepared in 1975 suggests that 6 MGD additional storage and about 8000 lineal feet of 8-14 inch mains will be needed before 1980. The second stage will be to add treated water pumping and transmission facilities to utilize 15.8 MGD available with the purchase of the remaining capacity in Conduit No. 81. Broomfield has the first right, by contract, to the remaining capacity in Conduit No. 81 and has initiated negotiations to purchase the capacity.

For the purpose of establishing the relationship of present water use by the customers on the Broomfield system and projecting this use into the future, the population developed in the Broomfield Comprehensive Utility Plan was used. This data is presented in Figure 2.

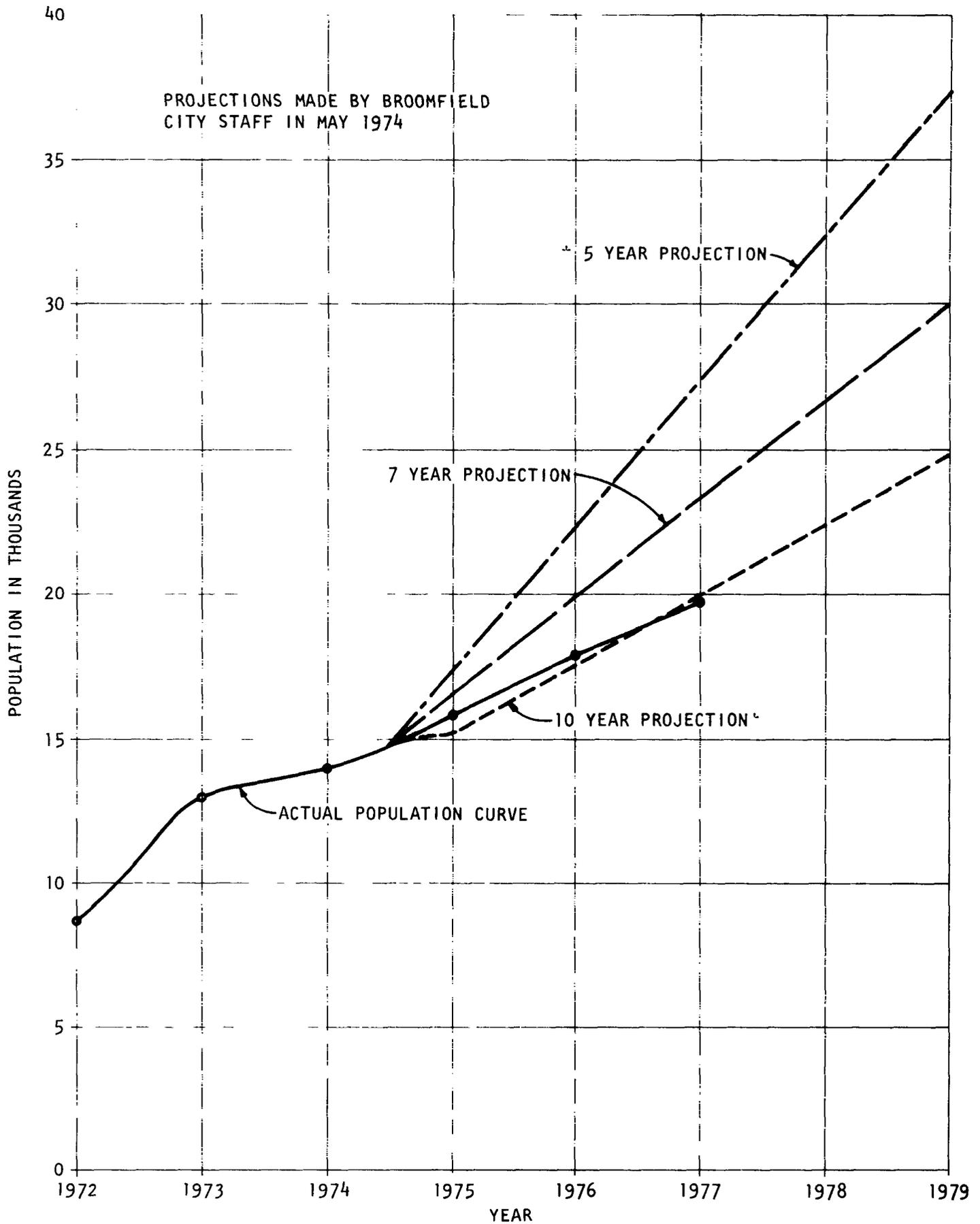
The Rocky Flats Plant closed-loop sanitary wastewater recycling plant will be completed by 1979 and the surface water control program completed by 1980. These two projects will reduce substantially the potential of making the water stored in Great Western Reservoir unsuitable for use.

## 2 Special Considerations

### a Broomfield Planning for Future Water Supplies

When compared with other cities of its size, Broomfield has been far-sighted in its water system planning. This planning has included development of the maximum practical

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BROOMFIELD POPULATION PROJECTIONS

FIGURE 2

water supply and treatment from the existing Broomfield system. It has included also a permanent contract with the Denver Water Board for a major supply to supplement the Broomfield system.

These two completely separate sources have provided Broomfield with the best and most reliable system practical. At the same time, Broomfield has aggressively pursued the expansion capability of both systems to accommodate future growth.

The enlargement of the Broomfield supply system to 8 MGD is presently underway. Included in the enlargement are all of the aspects of the physical system to balance with the 8 MGD treatment plant capacity.

Also, Broomfield has entered into a joint development contract with Westminster for wastewater treatment, under a plan envisioning the reuse of any legally available plant effluent.

Broomfield has not only planned for but also has pursued the most practical sources of future water supply. It is these potential water supplies that offer the most promise to provide emergency supplies.

b Broomfield Cost Sharing

Broomfield is justifiably reluctant to accept as an "emergency water source" the supplies that the City has nurtured and invested in to ensure availability when required for future growth. However, the Broomfield officials have indicated a willingness to share in the costs and benefits of joint development. Joint development of these projects,

which would be used initially for the emergency supply and to meet normal demand as growth in population occurs, may offer the most flexible and immediately available alternative

c Level of Service

The levels of service to be provided under emergency conditions are to be as nearly equal to the present as possible. However, the term "emergency conditions" suggests that some levels of service other than full and complete should be considered.

The amount of water required for domestic, commercial, and industrial purposes is accepted as a fixed requirement. The amount of water required for irrigation of lawns and landscape planting in both public greenways and private yards is assumed to be subject to some reduction.

For purposes of this study, curtailment similar to that currently being imposed upon Denver water users by the Denver Board of Water Commission was assumed.

The Denver water system has experienced a one-third decrease in summer demand and an even greater decrease in maximum day demand during 1977. Water restrictions which limit lawn irrigation to three hours every third day have been used to achieve this reduction. Broomfield has a restriction program of two specific one and one-half hour watering periods every third day and reports a reduction in water use of 20% on a summer day. The Broomfield situation is not directly comparable because of additional customers that have been added to the system since 1976.

For purposes of this study, two levels of service are analyzed. first, providing an emergency supply with non-curtailed demands, and second, providing an emergency supply with curtailment resulting in a one-third decrease in the maximum day demand and a one-third decrease in total summer demand. Figure 3 shows the projection of normal and emergency water use demands.

The curtailed demand level as experienced on the Denver Water System this summer provides water for all normal domestic, commercial, and industrial purposes and also provides enough water to maintain lawns, trees, and shrubs.

## B Sources of Information

A great deal of information was gathered from many sources in conducting this study. This material should be helpful in the evaluation and implementation stages. For this reason, a single copy of all the material was compiled, indexed and delivered, with the report, to Rockwell International.

### 1 Entities

Development of an emergency water supply for Broomfield is of interest and concern to a great number of public and private entities. These entities and individuals can have considerable influence on the alternative selected as a result of this study. The process of decision making by the various entities involved can be slow and at times at variance with a solution to the problem of the Broomfield emergency water supply.

To date, the entities and individuals involved have been most helpful, informed and responsive to requests for information.

The major entities involved include the following:

BROOMFIELD EMERGENCY WATER SUPPLY STUDY  
 URS COMPANY NO 7028

IF ALL OF CONDUIT #81 IS  
 NOT ACQUIRED, EMERGENCY  
 SUPPLY WILL REMAIN AT  
 55% OF NORMAL USE AFTER  
 1985

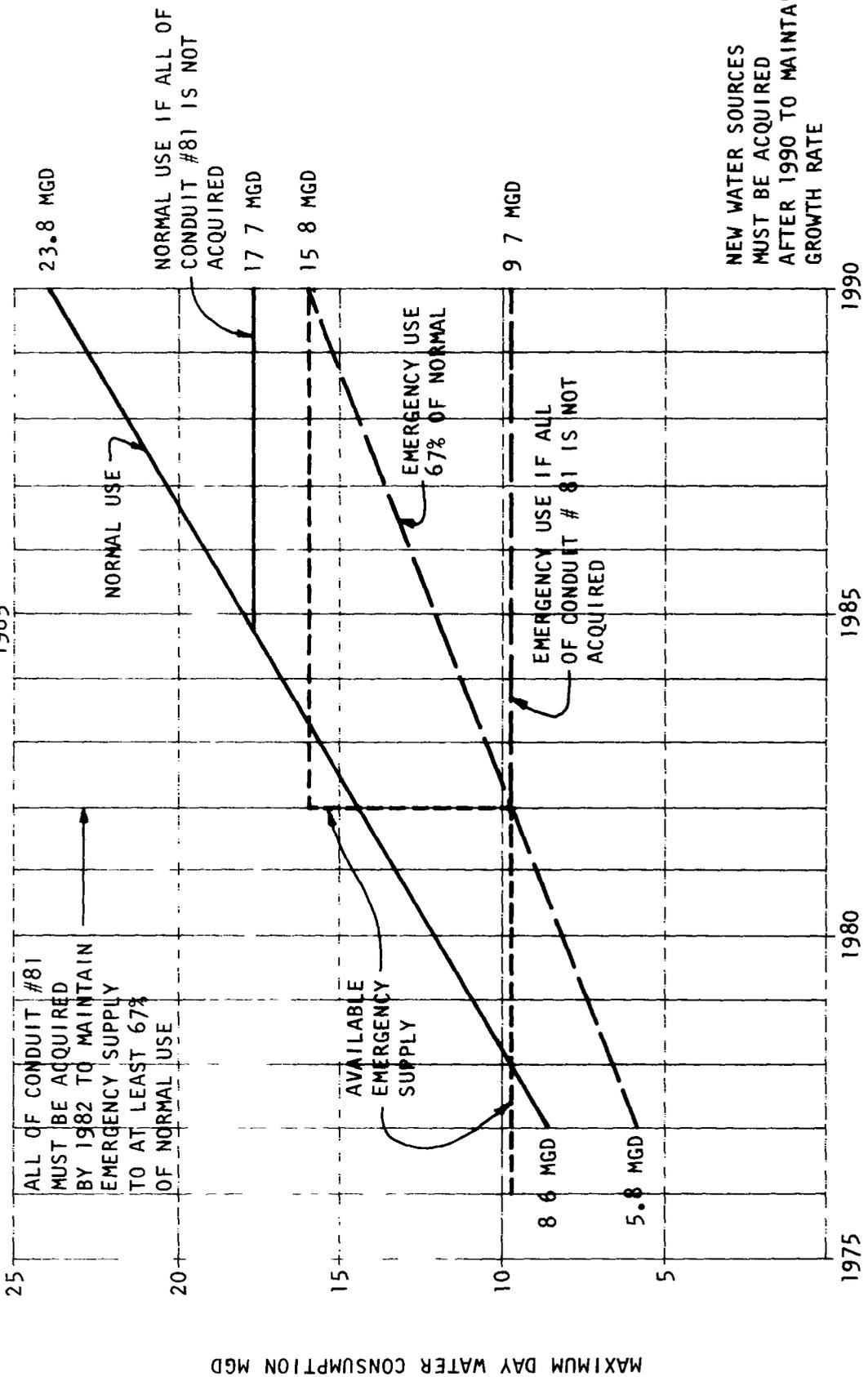


FIGURE 3 PROJECTIONS OF COMBINED SYSTEM NORMAL AND EMERGENCY WATER USE DEMANDS

Rockwell International, prime contractor who operates the Rocky Flats Plant for the Energy Research and Development Administration, an agency of the United States government

Energy Research and Development Administration, the federal agency with responsibility for the operation of the Rocky Flats Plant

City of Broomfield, owner of Great Western Reservoir, which is located on the natural drainage course downstream from the Rocky Flats Plant and is the source of the City's raw water supply

Other entities that have been most informative and helpful in the conduct of the study include

City of Westminster

City of Arvada

Denver Water Department

Farmers Reservoir and Irrigation Company

Information about potential water rights and storage has been gathered, on an informal basis, from

Marshall Lake and Irrigation Company

South Boulder Creek Water Users Association

Colorado Department of Fish and Wildlife

Colorado State Engineer's Office

## 2 Prior Studies

Furnishing of an emergency water supply to Broomfield has been the subject of numerous prior studies on both a formal and informal basis

These studies include

Monitoring and analysis of the Walnut Creek water supply by the Colorado Department of Health, Environmental Protection Agency, ERDA, Dow Chemical, Rockwell International, Broomfield and others

Studies and correspondence regarding alternate or emergency water supplies for Broomfield by the Lamm-Wirth Task Force, ERDA, Rockwell International, Dow Chemical, Broomfield and its consultants, and others

Studies of the Broomfield and metropolitan water supplies and facilities by Broomfield and its consultants, Colorado Legislature Metro Water Study Committee, Denver Regional Council of Governments, Westminster, Denver Board of Water Commissioners, and others

A listing of these sources is given as part of the appendix to the report

### 3 Analysis

This project was constrained slightly by the 140-day time frame of the study. However, this was adequate to carry-out all except the most exhaustive studies necessary for this project, and the time available was adequate to reach some positive conclusions and recommendations.

The conduct of the study included a literature search of all available studies, reports, correspondence, contracts, and other materials that related to the project. One copy of all material is transmitted with the final report.

Meetings have been held, both formally and informally, with the entities listed above. Minutes of the formal meetings were developed as a part of the record for this project.

The remaining data gathering was on an informal basis by members of the consultant's staff and by the sub-consultant on water rights, Leonard Rice Consulting Water Engineers, Inc. The information, data, records, and materials obtained were reviewed and, where appropriate, checked by the consultant's staff. Additional studies and analysis of all the material were carried out by the consultant's staff and form the basis for this report.

The conclusions and recommendations of this report are the result of this input and the analysis of the Consultant's staff.

4 Cost Estimating

The cost estimates included in this study are to provide a comparison between alternatives. For that purpose, basic construction cost per unit of capacity information was acquired from the Denver Water Department for 1977 level costs.

The Denver Water Department cost data is shown in Table 1.

Data provided by the Rockwell International staff responsible for preparation of cost estimates, suggests the following factors should be added to that basic contract cost:

Denver Plan	5%
Engineering and Inspection Costs	15%
Contingency Cost of Contract Plus Engineering Cost	25%
Escalation Cost per Year Compounded	12%

For example

Denver Alternative Emergency Connection

Right-of-Way Cost	0
Construction Cost	
5500 L F 20" main at \$41.00/ft	= \$225,000
5.8 MGD Pumping Station @ \$32,500/MGD	= <u>188,500</u>
Sub-Total	\$414,000

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Denver Plan add 5%

Engineering and Inspection add 15%

Total of both plans is 20%

$$1.20 \times \$414,000 = \$496,800$$

Contingency Cost add 25%

$$1.25 \times \$496,800 = \$621,000$$

Use 150% of Contract Cost from Table 1

TABLE 1

CONTRACT CONSTRUCTION COSTS \*

RESERVOIRS (\$/MG) (MG = Million Gallons)

1 to 2 MG	-	\$412,000.00
3 to 5 MG	-	329,000 00
6 to 9 MG	-	274,000 00
10 to 15 MG	-	171,000 00

PUMP STATIONS (\$/MG) (MGD = Million Gallons/Day)

Low Head Station	-	\$ 32,500 00
High Head Station	-	37,500 00
Dual Lift Station	-	Use approximate valves i e Low Head x cost/MGD + High Head x cost/MGD

PIPELINES (\$/FT ) (FT = Lineal Foot)

16-inch	-	\$ 31 00
18-inch	-	38 00
20-inch	-	41 00
24-inch	-	46 00
30-inch	-	64 00
36-inch	-	73 00
42-inch	-	89 00
48-inch	-	108 00
54-inch	-	138 00
60-inch	-	182 00
66-inch	-	193 00
72-inch	-	229 00
78-inch	-	262 00
84-inch	-	297 00
90-inch	-	327 00

\* These costs are at 1977 levels as developed by the Denver Water Department

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IV INVESTIGATION AND DESCRIPTION OF ALTERNATIVES

A Treated Water Alternative Systems

1 Engineering Design Criteria

The engineering design criteria for the treated water system were primarily those presently used by Broomfield's engineering staff

Pressure

Pressures should not be more than 110 psi or be less than 40 psi (pounds per square inch) The pressure variation between static and operating conditions should not exceed 25 psi at any location

Capacity of Facilities

Water treatment capacity, or in the case of the Denver supply, Conduit No 81 capacity, should equal or exceed the maximum day water demand rate

Treated water storage capacity should be equal to or exceed that required to supply all demands for water at demand rates greater than the maximum day water demand rate This would include demands imposed upon the system for both domestic and fire protection purposes

Pumping stations should be of capacity to equal or exceed the maximum hour water demands with the largest pump out of service

Transmission lines should be of capacity to minimize pressure losses in the system A rule of thumb limits transmission line head losses to not more than one foot per thousand feet of pipe length The distribution system should be looped and reinforced by lines large enough to provide the maximum day

demand plus fire flow. The minimum line size should be 4-inch diameter and all lines feeding fire hydrants should be at least six inches in diameter.

## 2 Restrictions

The emergency supply to be designed for in this study is that to replace the future 8.0 MGD treatment capacity of the Broomfield water system. For purposes of this study, it was assumed that, since this supply was for emergency only, some restrictions on water demand could be imposed. Thus, the engineering design was based on two-thirds of the maximum day rate, or 5.3 MGD. A more detailed discussion of the possible curtailment of use under emergency conditions is found on page III-5.

## 3 Broomfield Treated Water Systems

The City of Broomfield is served by two water systems. The original system, or Broomfield supply, includes raw water storage in Great Western Reservoir and the Broomfield Treatment Plant. The Broomfield supply system serves the westerly portion of the city. The second system, with treated water supplied by Denver, serves the easterly part of the city. The distribution mains for the two systems are interconnected, however, separation is maintained by closed valves.

### a Broomfield Supply System

The treated water portion of the Broomfield supply system includes a water filtration plant located about one mile east of Great Western Reservoir and about one mile southwest of the Jefferson County Airport. The plant has a capacity of 5.5 MGD and is presently being expanded to 8.0 MGD. Raw water is delivered to the treatment plant from Great Western Reservoir by gravity. After treatment, the water is pumped to treated water storage which consists of three tanks with a total capacity of 6.95 MG and located adjacent to the

Jefferson County Airport Pumping capacity to transfer the water from the treatment plant to the storage is 6 0 MGD and presently is being expanded to 8 0 MGD The transmission lines are large enough to serve the system when the system reaches 8 0 MGD capacity

The Broomfield distribution system presently extends well into the Denver contract service area As development continues, it is expected that portions of the distribution system will be connected to the Denver system so that only the area west of Main Street will be served by the Broomfield supply system This will occur as additional water customers are added west of Main Street to increase maximum day use to 8 0 MGD to match the ultimate capacity of the Broomfield treated water system

It is the intent of the City to use the Broomfield supply system to the limit of its capacity and to delay transferring areas to the Denver system as long as possible This policy will take full advantage of the lower cost of the Broomfield system which delivers water at about 2/3 the cost of Denver water Denver also has a system development charge (tap fee), presently \$1575 per 3/4-inch connection, that is imposed on each tap added to the Denver system

Pressure reducing valves divide the Broomfield distribution system into two zones These pressure reducing valves are necessary to protect the area generally east of U S 287 from excessive static pressures in the water mains

Expansion of the Broomfield water system to 8 0 MGD will require Broomfield to acquire substantial additional water rights to increase the raw water supply, to increase the raw water pumping capacity, to expand the water treatment

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plant, to increase the treated water pumping capacity, and to add additional mains to the distribution network

When the 20-inch main on Main Street is transferred to the Denver system, it will probably be necessary to provide additional mains to the Broomfield system to offset the resulting loss of capacity. One possibility would be to provide a 1/2 mile long interconnect of the 18-inch and 14-inch mains on Miramonte Street.

The Mile-hi system, located north of the City, is not included in the Denver Contract Service Area. However, because of the time necessary to construct mains to connect the Mile-hi system to the Broomfield supply system, service to the Mile-hi area has been provided from the Denver system on a temporary basis. The Mile-hi system, which presently includes 170 taps and has a potential for 500 taps, will be transferred from the Denver system to the Broomfield system in the near future.

The agreement between Denver and Broomfield limits the capacity of the Broomfield supply system to 7.0 MGD. Reconciliation between the limits of the contract and the capacity of the proposed Broomfield Water Treatment Plant was not achieved prior to completion of this report.

b Denver Supply System

In August 1971, the City of Broomfield and the Denver Board of Water Commissioners entered into an agreement whereby Denver would supply treated water to Broomfield at the maximum day rate of about 9.7 MGD. Broomfield paid about \$3,100,000 or some \$320,000 per MGD to purchase the initial capacity in Conduit 81.

The contract required that Broomfield construct the necessary pumping and transmission facilities at its expense to convey

the water from Denver. The pumping station and transmission line, Conduit No. 81, were oversized with the excess capacity beyond 9.7 MGD paid for and owned by Denver. The capacity of the Denver system to deliver water to Broomfield's eastern boundary is about 15.8 MGD. The excess capacity, an additional 6.1 MGD, is not presently used. The Broomfield-Denver contract gives Broomfield the first opportunity to purchase the remaining capacity, and Broomfield is presently negotiating to obtain this additional capacity for future growth. This additional 6.1 MGD capacity would cost at least as much as the original 9.7 MGD. Or 6.1 MGD capacity at \$320,000 would cost about two million dollars at the original prices. The purchase price would probably be more to reflect some return on the Denver investment.

The Denver-Broomfield Pump station located at Washington Street and 96th Avenue was constructed to accommodate 7 pumps, each with a capacity of 5 MGD operating against a head of about 350 feet. At the present time, 3 pumps have been installed. Capacity is adequate to meet the 9.7 MGD maximum day rate with one pump on standby.

At 128th Avenue and Zuni Street, where Broomfield's master meter on Conduit No. 81 is located, a pressure regulating valve has been provided to limit maximum pressures into the Broomfield system to about 145 psi.

The Broomfield-Denver contract defines the geographical area in which the Denver water may be served. At present, a large portion of the service area eventually to be served by Denver is still being served by the Broomfield system. As demands on the Broomfield system increase, areas including Mile-Hi will be transferred to the Denver system. Any such connections

to the Denver system will, by contract, be of a permanent nature and subject to the system development charge.

To utilize the 6.1 MGD additional capacity from the Denver system would require additional transmission and treated water storage capacity. The present Denver system storage consists of a single tank with a capacity of 3.0 MG and is just adequate to meet the needs of the present. As the rate of water use increases, additional treated water facilities will have to be provided on the Denver supply system by Broomfield.

Figure 4 shows the boundaries defining the Broomfield and Denver service areas as well as the present configuration of each of the major facilities in the distribution systems.

#### 4 Broomfield's Treated Water Demands

Present maximum day demand, without restrictions, is estimated at 5.5 MGD in the Broomfield system and 3.1 MGD in the Denver system, totaling 8.6 MGD. By 1985, maximum day use is expected to increase to 8.0 MGD in the Broomfield system and 9.7 MGD in the Denver system, totaling 17.7 MGD. It is assumed that Broomfield-Denver contract limits on the Broomfield system will prevent further expansion beyond 8.0 MGD. If the remaining capacity of Conduit No. 81 is acquired, Denver system usage is expected to expand to 15.8 MGD by 1990, for a total maximum day usage of 23.8 MGD. Figure 3.

#### 5 Potential Emergency Treated Water Sources

##### a Denver

Broomfield receives treated water from Denver under a permanent contract. This contract limits the amount of water that Broomfield may purchase to 9.7 MGD maximum day rate. However, the

capacity of the delivery system that transports Denver water to Broomfield can be increased to 15.8 MGD merely by adding one pump to the pump station at 96th and Washington

The Denver-Broomfield contract was written to give Broomfield the first right to purchase the remaining capacity in this delivery system to provide 15.8 MGD on a maximum day rate. Broomfield has initiated negotiations to purchase the additional capacity to provide for its increased water use due to population increases. At the time of this report, a contract had not been signed granting Broomfield the extra water supply from Denver. In fact, Denver has indicated a reluctance to commit the additional water until the proposed Foothills Water Treatment Plant is completed.

The terms of the Broomfield-Denver contract restrict the geographical area in which the Denver water may be used. Boundaries of the area in which Broomfield may serve Denver water are shown on Figure 4.

The Denver system offers a potential emergency treated water source for Broomfield. The separation between the two systems in Broomfield is achieved by closing valves in the distribution system. These valves could be opened and Denver water would immediately flow directly into the Broomfield system. (See Figure 5.)

The western-most section of Broomfield is at a higher elevation than that portion of Broomfield served from the Denver system. Water pressure from the Denver system serving higher elevation areas would be low. In the case of the

Jefferson County Airport area, the pressure would be so low as to be unsatisfactory if the distribution valves between the systems were opened to supply all of Broomfield

The treated water storage located at the Jefferson County Airport would be unable to function due to its higher elevation if connected directly to the Denver system

Physically, the Denver treated water supply could be used to provide an emergency water supply to the entire Broomfield system with the addition of one transmission line and a pumping station to lift the water to an elevation to fill the storage tanks at the airport. The proposed transmission main would transport water from the Denver supply system and connect to a transmission main on the high pressure Broomfield supply system. These proposed new facilities would provide adequate water pressure to the higher elevation areas on the west side.

The cost of the 5,500 lineal feet of 20-inch main and a 5.8 MGD capacity pumping station required to provide adequate water pressure to the higher elevation areas is estimated to be \$621,000 at 1977 construction costs.

Normal operation of the Denver Service Area system on the east side of the city will eventually require additional storage and transmission capacity to fully utilize the entire 9.7 MGD from the Denver supply. Additional facilities beyond those necessary to utilize the 9.7 MGD will be required to utilize the 15.8 MGD from Denver. Broomfield has plans to provide these facilities as the demand for water from the Denver system increases. Use of Denver treated water as an emergency supply would accelerate the need for these facilities. The specific facilities required

and the timing of their development would depend upon the postulated timing of the emergency

The demand on the Broomfield water treatment plant is expected to reach the capacity of 8.0 MGD before 1980 according to Broomfield's population projections. The use of Denver treated water as an emergency source would require that additional transmission and storage capacity be available in the Denver portion of the Broomfield system as a contingency for use during an emergency. This extra capacity would be equal to that amount of water required for the emergency supply. The maximum amount of emergency capacity required would be the entire 8 MGD capacity of the Broomfield water treatment plant. This required standby capacity would be less if water use were curtailed through sprinkling regulations for the duration of the emergency.

The relationship between the capacity required for unrestricted use of the Denver supply system and the requirement for transmission of emergency supply through the Denver system is dynamic. To illustrate this fact, under one condition to provide emergency standby capacity would require Broomfield to construct facilities about eight years earlier than normal for unrestricted maximum day water demands. Under another condition to provide emergency standby capacity would not require any additional facilities.

Curtailment of water use for sprinkling during the period of emergency would reduce the standby capacity required. The present maximum day use of 5.5 MGD from Broomfield plant and 3.1 MGD from Denver would require standby capacity in the eastern portion of the Broomfield system for use in the western portion of  $\frac{2}{3}$  of 5.5 or 3.7 MGD. However, a  $\frac{1}{3}$  reduction of the Denver system use with restrictions ( $\frac{2}{3}$  of 3.1 = 2.1 MGD) would provide 1.0 MGD of that capacity.

Therefore, under present conditions, the Broomfield system would require an emergency standby capacity of 2.7 MGD. The amount of standby capacity required for the Broomfield system will increase to 4.3 MGD by about 1979-1980, and thereafter decrease until it approaches zero as the supply from Denver reaches twice that from the 8-MGD Broomfield Plant.

The 33% reduction in the 15.8 MGD usage in the Denver supply system portion of the system could satisfy the curtailed demands of the Broomfield supply system portion  $[2/3 (15.8 + 8.0) = 15.8]$ . This fact is shown in Figure 3.

The amount of water contractually available from the Denver system would be the limiting factor for this source of emergency water. Reference to Figure 3 indicates the capability of Denver treated water as an emergency supply.

The present 9.7 MGD supply would be adequate to serve the full Broomfield system maximum day demand through 1978. With a curtailment of the sprinkling water use to achieve a 33% reduction in maximum day demand, the 9.7 MGD would be adequate through 1982.

Increasing treated water available from the Denver system to 15.8 MGD would serve the Broomfield system maximum day demands through 1983. With a restriction on sprinkling water use to achieve a 33% reduction in maximum day demand, the 15.8 MGD would be adequate through 1990.

To utilize Denver treated water as an emergency supply for Broomfield would require

- (1) Construction of a transmission main and pump station to supply the high pressure Broomfield system and the storage tanks located at the Jefferson County Airport
- (2) Ammending the Broomfield-Denver contract to allow service of Denver water to the entire City of Broomfield during periods of emergency
- (3) Construction of additional treated water storage and transmission mains in the Broomfield system normally served with Denver water at a date earlier than would normally be required This amount of standby capacity required will vary with time

The annual costs to purchase and pump this water from Denver, assuming a one-year duration for the emergency and use of 950 MG of water is \$600,000

b Westminster

Westminster is geographically the municipal water system in closest proximity to Broomfield

The Broomfield and Westminster treated water systems are physically connected at about 128th and Huron This connection, which also includes a tie to Denver Conduit No 81, is to provide short term emergency water only It has been utilized once to transport Westminster water to Broomfield when the Conduit No 81 pump station was temporarily out of service

The twelve-inch Westminster main at 128th and Huron is near an extremity of the Westminster system and has a capacity of less than 1 0 MGD

The closest Westminster transmission water line of sufficient capacity to provide adequate emergency water supply is the 24-inch main at 120th and Sheridan.

To connect this 24-inch Westminster main to the Broomfield system would require construction of 13,000 lineal feet of 20-inch main and a 5.8 MGD high lift pumping station. This system would provide a capacity of 5.8 MGD and is estimated to cost \$1,203,750 (See Figure 5 )

Connection of this 20-inch main from the Westminster system would be to the 16-inch Broomfield main at Burbank and the railroad tracks. The proposed pump station would provide adequate pressure to lift the water into the storage tanks at the Jefferson County Airport.

The annual costs to purchase and pump this water from Westminster, assuming a one-year duration of emergency and use of 950 MG of water is \$600,000.

Discussions with the Westminster officials indicated a willingness to assist Broomfield in times of emergency by providing as much water as possible without adversely affecting the ability to serve the citizens of Westminster.

Westminster's treated water system would be able to provide an emergency treated water supply to Broomfield during the non-summer load period. However, to do so would require replacement to Westminster storage in Standley Lake of the raw water used to serve Broomfield. Broomfield's Church Ditch supply can be delivered to Standley Reservoir by gravity.

During the summer load period, Westminster's ability to provide an emergency treated water supply to Broomfield

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would be very limited. Westminster officials indicated the maximum period of assistance might be three or four days.

The present Westminster treatment capacity is about 21.0 MGD. Imposition of a demand of some 5.3 - 5.8 MGD for Broomfield would be a significant portion of this capacity.

c. Arvada

Arvada is located approximately six to eight miles south of Broomfield.

Arvada has completed a preliminary design of a new raw water reservoir (Blunn Reservoir) on Ralston Creek directly north of North Table Mountain. A new water treatment plant is also planned by Arvada in conjunction with this reservoir. These planned facilities are shown on Figure 6.

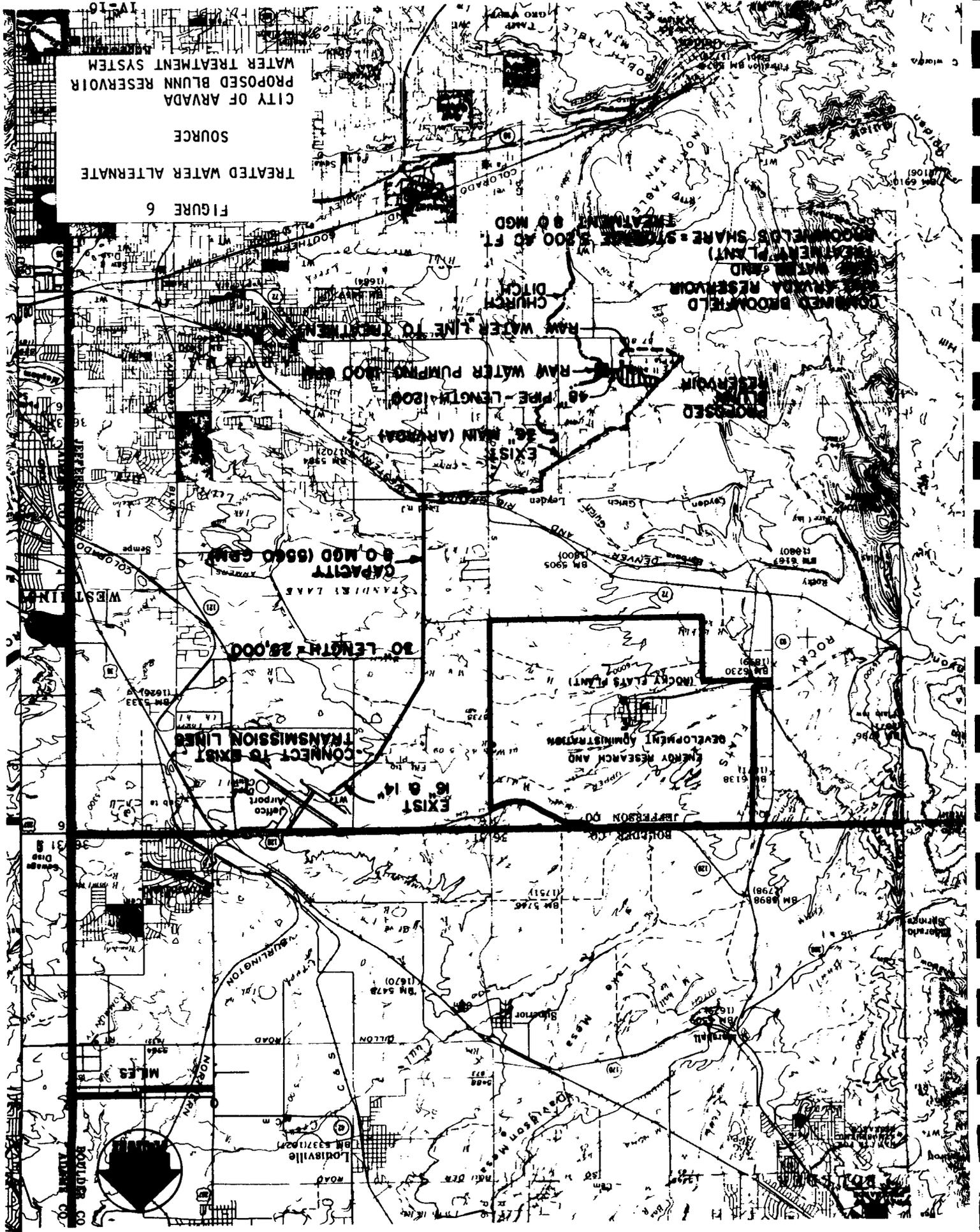
Arvada has the financing available for construction of the Blunn Reservoir and water treatment plant. However, the most accelerated construction schedule would not complete the project prior to 1979 - 1980.

Representatives of Arvada have indicated a willingness to consider providing an emergency treated water supply to Broomfield from this proposed new facility. To do so would require a contract and substantial financial commitments on Broomfield's behalf. These commitments would be necessary to provide sufficient incentive to cause Arvada to construct the extra capacity and make it available to Broomfield.

Under this approach, Arvada indicated the possibility of providing an emergency treated water supply to Broomfield.

CITY OF ARVADA  
 PROPOSED BLUNN RESERVOIR  
 WATER TREATMENT SYSTEM  
 SOURCE  
 TREATED WATER ALTERNATE

FIGURE 6



1A-16

on a "when available basis " Any raw water applied to Broomfield's benefit would have to be replaced during the same water year Such replacement of raw water could be possible as Arvada plans to pump from the Church Ditch into Blunn Reservoir Broomfield's primary water supply is also the Church Ditch

The physical facilities to transport treated water from the Arvada-Blunn treatment plant would be 25,000 lineal feet of 30-inch transmission main This main is estimated to cost \$2,400,000

Arvada is unable at this time to indicate the sales price for any water that could be sold to Broomfield from these proposed facilities Such water sales costs would include, among other costs, a share of the new Blunn Reservoir and Blunn water treatment plant construction and operations costs

## 6 Environmental Considerations

The following is a list of general environmental factors which have been identified as being relevant and applicable to the implementation of the various treated water alternatives

- a Construction of required pumping and pipeline facilities could cause disruptive entanglements and interference with adjacent properties
- b Acquisition of right-of-way or easements for required pump stations and pipelines could remove properties from local tax rolls
- c Additional interconnections between existing systems provided by an alternative would provide local water service flexibility and reliability which could improve the public health, well-being and safety of the community

- d Physical improvements such as pump stations and pipelines could have minimal adverse effects on the visual quality of the landscape
- e Any alternatives would have little or no effect on erosion, water quality, air quality, noise, natural resources, ecology, and areas of natural beauty, recreation or scenic value.

Among the three treated water alternatives examined in this report, the Denver Alternate Emergency Connection requires the least amount of new facilities to be constructed and should cause the least amount of impact on the human environment

## B Raw Water Alternative Systems

### 1 Engineering Design Criteria

The criteria for engineering design of a raw water system as expressed by Broomfield would be as follows

#### Raw Water Storage

Alternative raw water storage facilities should be able to serve the same functions as the present Great Western Reservoir. These functions include storing all of Broomfield's water developed from rights in the Church, Upper Church, and McKay Ditches and from the drainage of the Walnut Creek Basin

The emergency facilities should be able to provide by replacement an amount of water equal to that in storage in Great Western Reservoir at the time of the emergency and to

provide storage for any water that might become available to Broomfield following the emergency

The size of the raw water storage facilities would depend upon their location and the source and location of the water to be utilized in the alternative storage site

#### Capacity to Supply the Treatment Plant

The emergency system should be of sufficient capacity to provide to the Broomfield Treatment Plant a supply at an 8 MGD rate

#### Water Supply

The emergency system should be designed to utilize the present water rights available to Broomfield

The exception to this criteria is the supply from surface runoff in the Walnut Creek Basin. A major release of radioactive contamination from the Rocky Flats Plant could render this source unusable as a public water supply

## 2 Broomfield Raw Water System

The City of Broomfield's raw water supply is derived from Clear Creek via the Church Ditch, Coal Creek via the Upper Church and McKay Ditches and Walnut Creek. This raw water supply is stored in Broomfield's Great Western Reservoir

The principal source of raw water is from the Church Ditch, which derives water from Clear Creek just west of the City of Golden. Flow is by gravity through Church Ditch to Walnut Creek, at which point it is pumped into the reservoir. Raw water pumping capacity is 12,000 GPM

The City of Broomfield owns 1,645<sup>+</sup> Church Ditch shares, which yield an average of 2,400 acre-feet per year. Indications are that in 1977, a dry year, the yield will be much less and not sufficient to meet demand requirements of the Broomfield system. Broomfield will purchase 500 acre-feet of raw water from Denver to supplement their raw water supply in this dry year of 1977.

Broomfield's records indicate the following amounts of water were pumped from the Church Ditch into Great Western Reservoir:

1973	1,675 acre-feet
1974	1,813 acre-feet
1975	3,202 acre-feet
1976	1,608 acre-feet
1977	1,375 acre-feet, January thru July

Walnut Creek's natural runoff flows into the Great Western Reservoir. The flow records on Walnut Creek are of very short duration and, thus, inadequate for hydrologic analysis. For the purpose of preliminary analysis, Walnut Creek's contribution to Broomfield's supply has been assumed to be:

Average Year	300 - 500 acre-feet
Dry Year	0 - 100 acre-feet
Wet Year	800 - 1000 acre-feet

- \* The runoff from Walnut Creek includes the effluent from the Rocky Flats sanitary wastewater process. As mentioned earlier, this process presently includes three-stage treatment and detention in holding ponds. The water from the ponds, approximately 50 - 100 acre-feet annually, is released only after monitoring to determine the acceptability for release into the natural water course.

The implementation of the closed-loop recycle of all plant wastewater will eliminate this small amount of supply from the Walnut Creek runoff into Great Western Reservoir

No accurate records exist of the volume of water available from the Upper Church and McKay Ditches that flow into Great Western Reservoir. Coal Creek, from which both Upper Church and McKay Ditches derive water, has very little flow except in wet years. Contributions to the Broomfield supply from these two ditches is negligible except in the few wet years.

The average Broomfield raw water yield is 2900 acre-feet including 2400 acre-feet from the Church Ditch and 500 acre-feet from the Upper Church and McKay Ditches and Walnut Creek runoff. This 2900 acre-feet is less than that required to support an 8 MGD water treatment plant. Broomfield has a program underway to acquire additional shares of Church Ditch water that will increase the total to 2100 shares. 2100 shares would yield an average of about 3000 acre-feet of water annually. The total yield from all sources then would bring the supply and treatment nearly into balance for an average year.

The dry year yield from the present Broomfield supply system is considerably less than the average because only the Church Ditch water can be relied upon to yield water. For example, in this drought year of 1977, the Church Ditch rights will probably yield less than 1400 acre-feet and little, if any, water will be obtained from the other sources.

Broomfield's raw water storage is in Great Western Reservoir which has a usable capacity of 3100 acre-feet. This 3100 acre-feet of storage capacity is adequate to store all of

the spring water yields available. This includes the present and the additional Church Ditch rights to be purchased. However, this capacity is not sufficient to store water from one year to the next to balance out wet and dry years.

3. Alternative Emergency Raw Water Supply Systems

Raw water alternatives to provide an emergency raw water supply will be discussed in three basic areas (a) sources, (b) storage, and (c) delivery systems

(a) Sources

It is assumed that any contamination by the Rocky Flats Plant would affect only the Walnut Creek Basin supply and the water in storage at Great Western Reservoir. Broomfield's Clear and Coal Creek water rights and water supplies could be the source of water supply for the raw water alternatives. These water supplies have previously been identified as primarily from the Church Ditch with small contributions from the Walnut Creek drainage and the Upper Church and McKay Ditches in all except the drier years.

The supplies from the Church Ditch are transferrable to alternative storage sites. The flows from the Upper Church and McKay Ditches can be intercepted and transported directly to the Broomfield Treatment Plant or to an alternative storage site.

The surface runoff from the Walnut Creek Basin which now is captured by the Great Western Reservoir could physically be contained and transferred to a new storage facility. However, this would not be feasible because a portion of the basin drains the Rocky Flats

Plant and would have been rendered unsuitable for use as a possible water source if Great Western Reservoir had been rendered unsuitable

The firm of Leonard Rice Consulting Water Engineers was utilized to assist in the evaluation of potential raw water sources. Mr. Rice and his firm are regularly involved in water rights matters in the Denver metropolitan area. Results of their consultation are included in the following discussion of water sources and storage.

Other sources of raw water supplies were analyzed including the following:

1 Denver Board of Water Commissioners

Discussions with officials of the Denver Water Department indicated that raw water is not available from the Moffat Tunnel system which is the source of the supply to Rocky Flats. Denver's Moffat Tunnel raw water yield is insufficient to provide the water required for the existing Moffat, Arvada, and North Table Mountain Water and Sanitation District treatment plants.

The Denver Water Department officials further indicated that this situation of raw water shortage on the Moffat Tunnel system would continue into the foreseeable future. The Denver water officials also stated that raw water storage was insufficient on the Moffat system to be able to provide storage capacity in Gross or Ralston Reservoirs to benefit Broomfield.

The officials of the Denver Water Department also indicated an inability at this time to consider sale of transmountain return flow for use by Broomfield. The purchase of transmountain return flow from the Denver Water Department to benefit Broomfield appears to warrant additional consideration and discussion with Denver water officials, however.

2 Englewood - Ranch Creek System

Englewood has recently completed a raw water project on Ranch Creek which connects to Denver's Moffat Tunnel system. Englewood and Denver have an agreement that provides Denver the yield of Englewood's Ranch Creek system in return for Denver providing a like amount of water to Englewood on the South Platte River.

This arrangement between Englewood and Denver is mutually beneficial. Each entity receives water where it can best utilize the supply.

Control of the Ranch Creek water is with Denver and for the same reasons mentioned in the Denver subsection, water from Ranch Creek is not available to be used by Broomfield.

3 Clear Creek

The potential of obtaining additional water supplies from Clear Creek was explored, and a small amount of water appears to be available through purchase of water rights from agricultural users. Broomfield has an active campaign underway to acquire these waters including another 500 shares of the Church Ditch rights.

Church Ditch shares are selling for about \$1,000 per share. Their yield to Broomfield is about 1.5 acre-feet per share during an average year and as little as 0.4 acre-feet per share in dry years.

The Farmers Highline Canal shares are selling for about \$16,000 per share. Their yield to Broomfield via Standley Reservoir would be about 16.4 acre-feet in an average year and 7.8 acre-feet in a dry year.

Several thousand acre-feet of water are available in Clear Creek during spring runoff in all except the dry years. This water could be made available to Broomfield via exchange for water rights on the South Platte River. However, because of the limited capacity of the Church Ditch during the period this exchange is possible, this potential offers little benefit to Broomfield.

4 Farmers Reservoir and Irrigation Company (FRICO)

FRICO owns and operates several ditches and reservoirs including the Church Ditch and a portion of Standley Reservoir. Standley Reservoir, located just south of Great Western Reservoir on the Woman Creek Drainage, has a decreed capacity of 49,060 acre-feet. Because of wave damage to the spillway and embankment the State Engineer has limited storage in Standley to 34,310 acre-feet. FRICO owns about 30,000 acre-feet of the available storage.

FRICO officials indicated that they are actively seeking additional water rights for FRICO's benefit and did not feel any water was available to benefit Broomfield.

FRICO and Westminster are presently negotiating an agreement to trade effluent from the Westminster Wastewater Treatment Plant for water in Standley Reservoir. The farmers downstream of Standley Reservoir would utilize the effluent from the wastewater plant, and Westminster would be able to use a like amount of FRICO water from Standley Reservoir.

A similar trade-of-wastewater effluent arrangement appears to be available to Broomfield. However, the complexity of the details of such an arrangement are beyond the scope of this project.

Standley Lake shares are being purchased by Westminster with an open offer of \$4,650 per share. If Broomfield also were to seek shares in Standley Lake, the yield to Broomfield would be 5.76 acre-feet per share on an average year and 1.47 acre-feet per share on a dry year.

#### 5. Coal Creek

Little water is physically available in Coal Creek in the wettest of years and none during dry years even to the holders of the most senior water rights.

The Bureau of Reclamation is exploring a storage project on Coal Creek to utilize water from both Coal Creek and South Boulder Creek. The timing and viability of this project are such that consideration is not warranted at this time.

6 South Boulder Creek

The possibility exists to acquire water rights on South Boulder Creek which are presently used for irrigation. South Boulder Creek waters could be delivered either into the FRICO-owned Community Ditch - Marshall Reservoir system or via the Denver Water Department's South Boulder Canal.

The Howard Ditch is representative of the better South Boulder Ditch rights although only a small amount of water is presently available from the Howard.

Howard Ditch shares are selling for \$16,000 per share. Their yield to Broomfield after transfer is estimated to be about 15.2 acre-feet per share with little variation in wet and dry years. This unusual pattern of yield is caused by Denver's Gross Reservoir decree skimming off all of the extra wet year yield.

7 Groundwater

The City of Broomfield has several deep wells and has terminated their use due to poor water quality. According to studies by the United States Geological Survey, shallow groundwater is not available except in very small quantities in the Broomfield-Rocky Flats area.

8 South Platte River

Water is available in the South Platte River and could be made available to Broomfield in the following manner:

- a. Exchange to Clear Creek during high spring flows
- b. By pumping through a pipeline into Great Western Reservoir (This alternative would be very expensive and was dismissed as not feasible )

One source of South Platte water would be Englewood. Englewood recently entered into a contract for 2000 acre-feet annually at \$125 per acre foot in a sale to Thornton.

#### 9 Barr Lake

Water is available in the Barr Lake area near Brighton through groundwater pumping and augmentation. (This alternative would be very expensive and was dismissed as not feasible )

#### (b) Storage

The Great Western Reservoir has approximately 3100 acre-feet of live storage which provides seasonal carry-over for the present Broomfield water supplies and a very small amount of carry-over storage for use in dry years.

Alternative storage systems would be sized to provide the same functions. In most cases, this would require storage of about 3100 acre-feet, however, the size might vary dependent upon any restrictions in the facilities used to transfer the water to and from the alternative storage sites.

The locations of all alternative storage sites are shown on Figures 7-19. They are

1 Rocky Flats Lake (Smart Reservoir)

Rocky Flats Lake has a capacity of 1000 acre-feet and is located just south of the Rocky Flats Plant. It is owned by the State of Colorado. Mr. Marcus Church has a long term lease for the fishing rights on the lake.

Rocky Flats Lake is presently too small to provide storage capacity to replace that available in Great Western. A 750-acre-foot expansion of the reservoir is possible. Even with this expansion the capacity would be too small unless Denver were the new supply source. The Denver system, as a source, could provide some of the storage difference required between the 3100 acre-feet available in Great Western Reservoir and the 1750 acre-foot capacity of an expanded Rocky Flats Lake.

Operationally, present Broomfield supplies could be pumped to Rocky Flats Lake and then flow by gravity to the Broomfield Water Plant as needed. Raw water available from Denver could be transferred to Rocky Flats Lake via the present system.

Rocky Flats Lake existing capacity could provide a 90-day emergency supply for Broomfield. However, the limited capacity of the existing or even the expanded Rocky Flats Lake is not sufficient for the one year duration of the emergency assumed in this study.

Rocky Flats Lake appears to be one of the less viable alternative storage sites because of its lack of storage capacity, excessive cost to expand,

and Broomfield's concern of the lake's close proximity to the Rocky Flats Plant

2 Denver System Storage

The Denver Water System has extensive water storage in excess of 500,000 acre-feet. This includes Ralston Reservoir (11,000~~0~~ acre-feet), Gross Reservoir (presently 45,000 acre-feet and planned 120,000 acre-feet), and a planned 12,000~~0~~ acre-feet storage on the Upper Williams Fork, all on the Moffat System.

Discussions with the Denver Water Department have indicated that neither storage capacity nor additional raw water supply is available at this time. The Department did indicate a possibility of raw water being available at some time in the future if the planned Foothills, Eagle-Piney, and Williams Fork expansions can be constructed.

3 Rock Creek Storage

A potential new reservoir site of adequate size on Rock Creek, north and west of the Rocky Flats Plant fenced security area, but on the plant grounds, could be constructed. The location in proximity to the Rocky Flats Plant is considered undesirable by Broomfield, and the cost of development would be high.

4. Coal Creek Storage

Two alternative potential new reservoir sites of adequate size could be built on Coal Creek, west of the Rocky Flats Plant. These two sites have been studied extensively by the Bureau of Reclamation as part of the Coal Creek Unit of the Front Range Study.

Present Broomfield supplies could be pumped to this reservoir and then be fed by gravity to the Broomfield Water Treatment Plant

The Coal Creek storage sites are potential alternatives of adequate size and in a desirable location. The main drawback is the high construction costs.

5 Marshall Reservoir

The existing Marshall Reservoir, located north and west of the Rocky Flats Plant, provides storage for irrigation use and would have to be enlarged to provide the necessary storage for Broomfield.

The dam is located over an abandoned coal mine and the State Engineer's Office would require a great deal of technical justification and study for any enlargement.

Present Broomfield supplies could be pumped to this reservoir and pumped again to the Broomfield Water Treatment Plant.

The Marshall Reservoir enlargement is of adequate size and in a desirable location. The drawbacks are high construction cost, double pumping, and the complication of the abandoned coal mine in enlarging the reservoir.

6 Blunn Reservoir

Arvada has completed preliminary design on a water storage facility, Blunn Reservoir on Ralston Creek south of the Rocky Flats Plant. Blunn Reservoir

would have from 4500 to 7600 acre-feet of live storage with Arvada's present needs about 3000 acre-feet. Arvada has indicated a willingness to discuss leasing or selling the excess storage capacity. Preliminary cost estimates to construct Blunn Reservoir range from \$1,200 to \$1,750 per acre-foot of storage. Present Broomfield supplies could be pumped to this reservoir and transferred by gravity to the Broomfield Water Treatment Plant.

Blunn Reservoir is a potential storage facility of adequate size and in a desirable location. The main drawback would be the large construction cost.

#### 7 Standley Reservoir

The Farmers Irrigation Company (FRICO) and the City of Westminster own Standley Reservoir, which contains 34,310 acre-feet of usable storage. The reservoir provides storage for water supplied by the various ditches and utilized by irrigators below the reservoir and for the municipal supply for the City of Westminster.

The storage capacity of Standley Lake is not being fully utilized. Because of damage to the dam structure by wave action during recent storms, the State Engineer has reduced the allowable storage in the reservoir.

Standley Reservoir offers potential storage to be acquired in several ways. These include purchase or lease of storage capacity from FRICO on either a permanent or emergency need basis, enlargement of

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the reservoir capacity, repair of the existing dam structure to allow full storage, or provision of alternate supplies to the irrigators who use water from Standley

Broomfield's Church Ditch water supply can be diverted by gravity to Standley, but pumping would be required to transfer the water from Standley to the Broomfield Treatment Plant

Broomfield has expressed some concern about the proximity of Standley Reservoir to Rocky Flats and downwind location of the Reservoir from the Rocky Flats Plant

Standley Reservoir offers adequate storage The major drawback will be the high cost of acquisition of storage and overcoming Broomfield's concern

In summary, the Coal Creek and Blunn Reservoir alternatives appear to provide the best storage potential, with Standley Reservoir also a strong possibility Within the accuracy of preliminary cost estimating, any of the three are very costly both for construction costs and additional pumping

The Standley Reservoir (which is in existence) and Blunn Reservoir (which is well toward completion of preliminary design) alternates should be easier to implement than to start a new project on Coal Creek

c Delivery Systems

The alternative raw water sources and storage all require delivery systems to utilize Broomfield's water rights and to transport the raw water to the Broomfield treatment plant

The following discussion includes the alternative systems which were investigated in some detail. These systems are shown in Figures 7-19. They include

(1) Raw Water Alternative No. 1

This alternative, shown on Figure 7, would include transmitting water from the Denver Ralston Reservoir via the existing Rocky Flats pump station and water line. Rocky Flats Lake would be increased in size from 1000 to 1750 acre-feet and a new 18-inch gravity conduit would be constructed from Rocky Flats Lake to the Broomfield treatment plant.

The capital cost of this alternative would be \$2.5 million and \$250,000 was estimated as the cost to purchase 2500 acre-feet of water for initial supply for transition to a new storage. The additional annual operations costs would be minimal.

This alternative is limited by inadequate storage and inability to obtain a satisfactory agreement to exchange Broomfield's water rights to Ralston Reservoir.

(2) Raw Water Alternative No 2

This alternative, shown on Figure 8, would include a new pump station and 14-inch pressure conduit from Ralston Reservoir to Rocky Flats Lake which, together with the existing 10-inch line, would furnish a capacity equal to Broomfield's emergency demand. Rocky Flats Lake would be increased in size to 1750 acre-feet and a new 18-inch gravity line would be constructed from Rocky Flats Lake to the Broomfield treatment plant.

The capital cost of this alternative would be \$2.8 million and \$250,000 estimated as the cost to purchase 2500 acre-feet of water for initial supply for transition to a new storage. The additional annual operations costs would be minimal.

This alternative is limited by inadequate storage and inability to obtain satisfactory agreement to exchange Broomfield's water rights to Ralston Reservoir.

(3) Raw Water Alternative No 3

This alternative, shown on Figure 9, would include a new 22-inch gravity line from Ralston Reservoir-Long Lakes directly to the Broomfield treatment plant.

The capital cost of this alternative would be \$2 0 million and \$250,000 estimated as the cost to purchase 2500 acre-feet of water for initial supply for transition to a new storage

This alternative is limited by inability to obtain storage and inability to obtain a satisfactory agreement to exchange Broomfield's water rights to Ralston Reservoir.

(4) Raw Water Alternative No. 4

This alternative, shown on Figure 10, would include diversion of water from the South Boulder Canal into Rocky Flats Lake and construction of an 18-inch gravity line from Rocky Flats Lake to the Broomfield treatment plant

The capital cost of this alternative would be \$2 5 million and \$250,000 was estimated as the cost to purchase 2500 acre-feet of water for initial supply for transition to a new storage. The additional annual operations costs would be minimal

This alternative is limited by inadequate storage and inability to obtain a satisfactory agreement to exchange Broomfield's water rights to the South Boulder Canal

(5) Raw Water Alternative No 5

This alternative, shown on Figure 11, would include diversion of water from the South Boulder Canal into a proposed 3000 acre-foot reservoir on Rock Creek and construction of a 24-inch gravity line from the reservoir to the Broomfield treatment plant

The capital cost of this alternative would be \$4 2 million and \$250,000 was estimated as the cost to purchase 2500 acre-feet of water for initial supply for transition to a new storage. The additional annual operations costs would be minimal.

This alternative is limited by the inability to obtain a satisfactory agreement to exchange Broomfield's water rights to the South Boulder Canal.

(6) Raw Water Alternative No 6

This alternative, shown on Figure 12, would include diversion of water from South Boulder Canal into a proposed 3000 acre-foot reservoir on Coal Creek and construction of a pump station and 20-inch pressure line from the Coal Creek Reservoir to the Broomfield treatment plant.

The capital cost of this alternative would be \$4 3 million and \$250,000 was estimated as the cost to purchase 2500 acre-feet of water for initial supply for transition to a new storage. The additional annual operations costs would be minimal.

This alternative is limited by the inability to obtain a satisfactory agreement to exchange Broomfield's water rights to the South Boulder Canal

(7) Raw Water Alternative No 7

This alternative, shown on Figure 13, would include diversion of water from South Boulder Creek into a 3000 acre-foot enlargement of Marshall Lake and the construction of a pump station and a 20-inch pressure conduit to the Broomfield treatment plant

The capital cost of this alternative would be \$4.6 million and \$250,000 was estimated as the cost to purchase 2500 acre-feet of water for initial supply for transition to a new storage. The additional annual operations costs would be minimal.

This alternative is limited by the inability to obtain a satisfactory agreement to exchange Broomfield's water rights to South Boulder Creek

(8) Raw Water Alternative No 8

This alternative, shown on Figure 14, would include participation with Arvada in the proposed Blunn Reservoir to obtain 3000 acre-feet of storage and construction of a 22-inch gravity line from Blunn Reservoir to the Broomfield treatment plant

The capital cost of this alternative would be \$4.3 million and \$250,000 was estimated as the

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cost to purchase 2500 acre-feet of water for initial supply for transition to a new storage. The additional annual operations costs would be minimal.

(9) Raw Water Alternative No 9

This alternative, shown on Figure 15, would include purchase of 3000 acre-feet of storage in Standley Reservoir and a pump station and pressure conduit to the Broomfield treatment plant.

The capital cost of this alternative would be \$4.1 million and \$250,000 was estimated as the cost to purchase 2500 acre-feet of water for initial supply for transition to a new storage.

The capital cost includes \$300,000 reimbursement to the Standley Reservoir farmers to make the emergency storage and water available and forego one year's crops.

This alternative is limited by the potential difficulty in negotiating the purchase of Standley storage capacity.

(10) Raw Water Alternative No 10

This alternative, shown on Figure 15, is the same as Alternative No 9 except without reimbursement to the farmers.

(11) Raw Water Alternative No 11

This alternative, shown on Figure 16, would include obtaining storage in (a) Coal Creek (3000 acre-feet), (b) Rock Creek (3000 acre-feet); (c) Rocky Flats Lake (1750 acre-feet), or (d) Blunn Reservoir (3000 acre-feet) and construction of a pumping station and pressure conduit to transport Broomfield's present water rights to the new storage location. Also included would be a transmission system from storage back to the Broomfield treatment plant.

The capital cost of this alternative would be

(a) Coal Creek	\$4.9 million
(b) Rock Creek	\$4.8 million
(c) Rocky Flats Lake	\$4.1 million
(d) Blunn Reservoir	\$4.2 million

The Broomfield water rights, excluding Walnut Creek rights, would be available to the new system.

Alternatives (a), (b) and (d) are adequate. Alternative (c) is limited by inadequate storage.

(12) Raw Water Alternative No. 12

This alternative, shown on Figure 17, would include enlargement of the existing West Lake, construction of a pumping station and pressure conduit (1) from Standley Reservoir to the Broomfield treatment plant, (2) from West Lake to Broomfield sewage treatment plant, and (3) from the Broomfield sewage treatment plant to the existing Broomfield deep wells.

This alternative would include purchase of transmountain wastewater effluent from Denver, augmentation from the deep wells, and exchange of wastewater with the Standley Reservoir interests in the Bull Canal or German Ditch

The capital cost of this alternative would be \$2 0 million and \$100,000 was estimated as the cost to purchase 1000 acre-feet of water for initial supply for transition to a new storage. The additional annual operation-cost would be minimal.

This alternative is limited by the uncertainty of the exchange-augmentation concept which will require substantial additional engineering and legal efforts costing several hundreds of thousands of dollars over several years, and is also limited by the lack of storage for present water rights.

(13) Raw Water Alternative No. 13

This alternative, shown on Figure 18, is similar to Alternative No. 11, with augmentation from wells near Barr Lake instead of the Broomfield deep wells.

The capital cost of this alternative would be \$4 6 million and \$100,000 was estimated as the cost to purchase 1000 acre-feet of water for initial supply for transition to a new storage. The additional annual operating cost would be minimal.

This alternative is limited by the uncertainty of the exchange-augmentation concept which will require substantial additional engineering and legal efforts costing several hundreds of thousands of dollars over several years, and is also limited by the lack of storage for present water rights. This alternative is also more than twice as costly as the similar alternative (12).

(14) Raw Water Alternative No 14

This alternative, shown on Figure 19, would include a pumping station and pressure conduit (1) from the South Platte River into Standley Reservoir, (2) from Standley Reservoir to the Broomfield treatment plant, and (3) from the Broomfield sewage disposal plant to West Lake.

This alternative assumes exchange-augmentation of Broomfield sewage effluent with Standley Lake water users and using water from Denver transmountain return flow as the augmentation and supplemental source.

Capital cost of this alternative would be \$5.1 million and \$100,000 was estimated as the cost to purchase 1000 acre-feet of water for initial supply for transition to a new storage. This additional annual operation cost would be about \$400,000 annually.

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This alternative is limited by both the uncertainty of the exchange-augmentation and the ability to purchase the Denver transmountain return flow. This concept would require substantial additional engineering and legal efforts costing several hundreds of thousands of dollars over several years.

(15) Raw Water Alternative No. 15

This alternative, shown on Figure 19, is the same as No. 14, with the augmentation and supplemental supply from Englewood.

Capital cost of this alternative would be \$5.1 million and \$100,000 was estimated as the cost to purchase 1000 acre-feet of water for initial supply for transition to a new storage. This additional annual operation cost would be about \$400,000 annually.

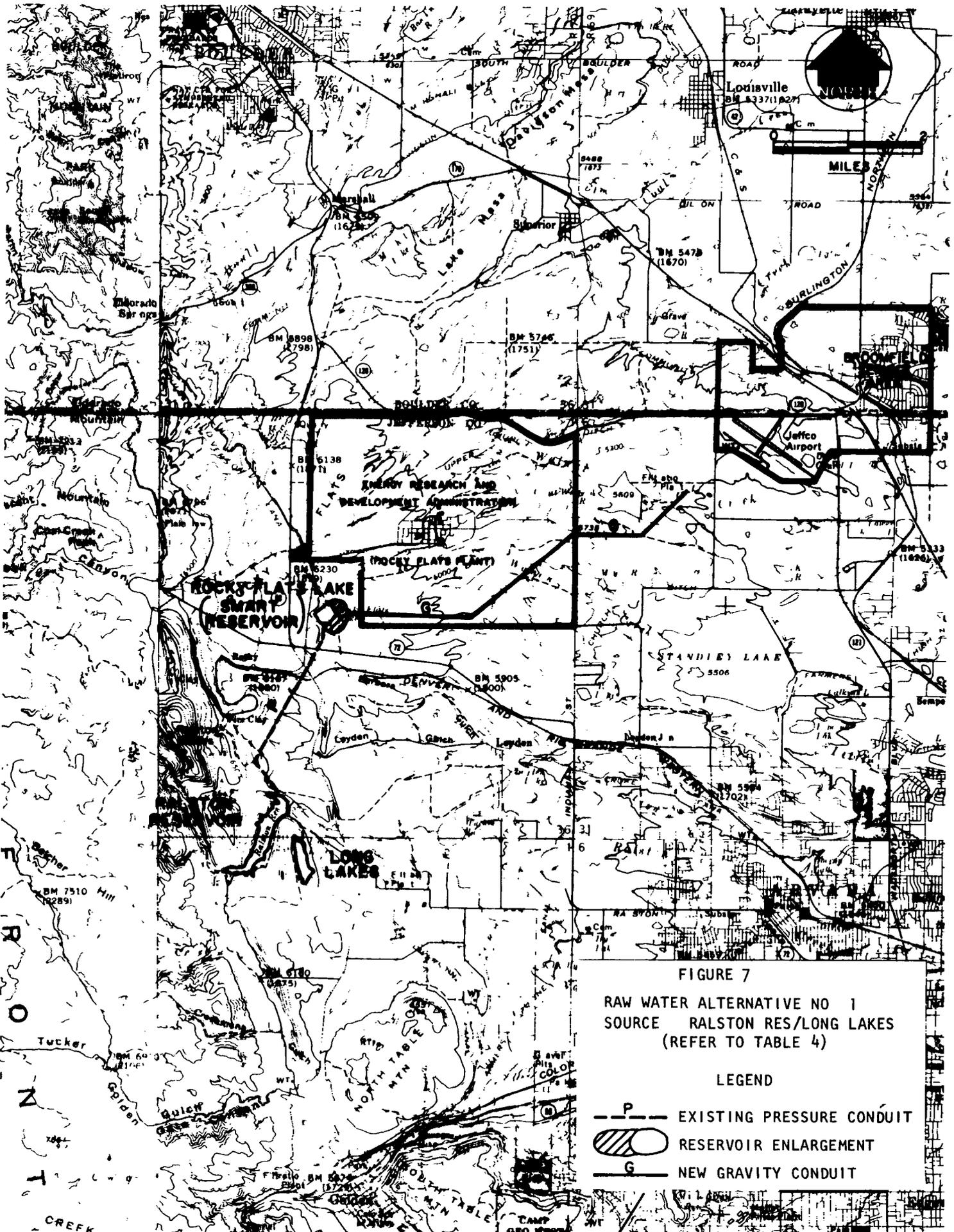
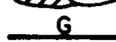


FIGURE 7  
 RAW WATER ALTERNATIVE NO 1  
 SOURCE RALSTON RES/LONG LAKES  
 (REFER TO TABLE 4)

LEGEND

-  EXISTING PRESSURE CONDUIT
-  RESERVOIR ENLARGEMENT
-  NEW GRAVITY CONDUIT

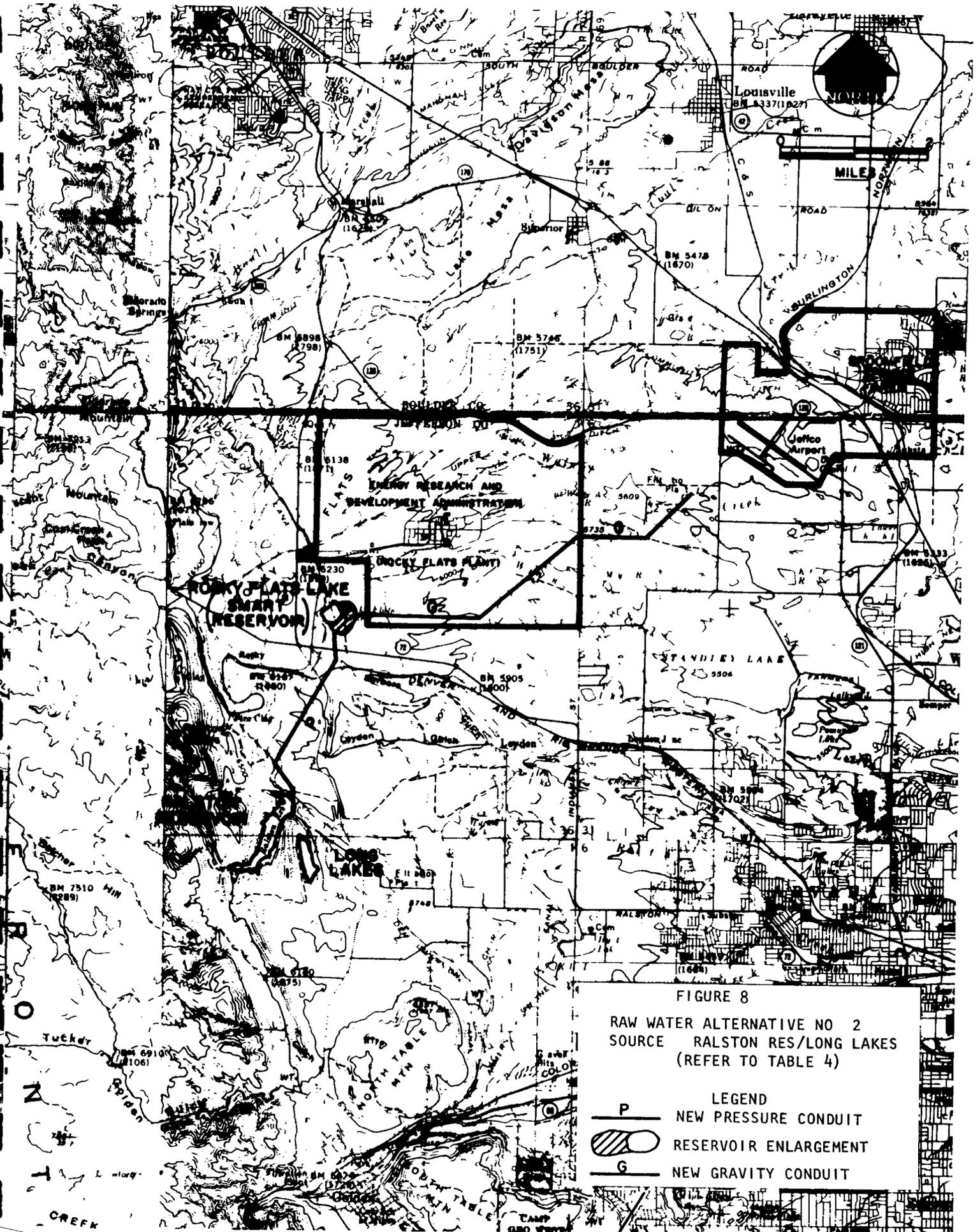


FIGURE 8  
 RAW WATER ALTERNATIVE NO. 2  
 SOURCE RALSTON RES/LONG LAKES  
 (REFER TO TABLE 4)

- LEGEND
-  P NEW PRESSURE CONDUIT
  -  RESERVOIR ENLARGEMENT
  -  G NEW GRAVITY CONDUIT

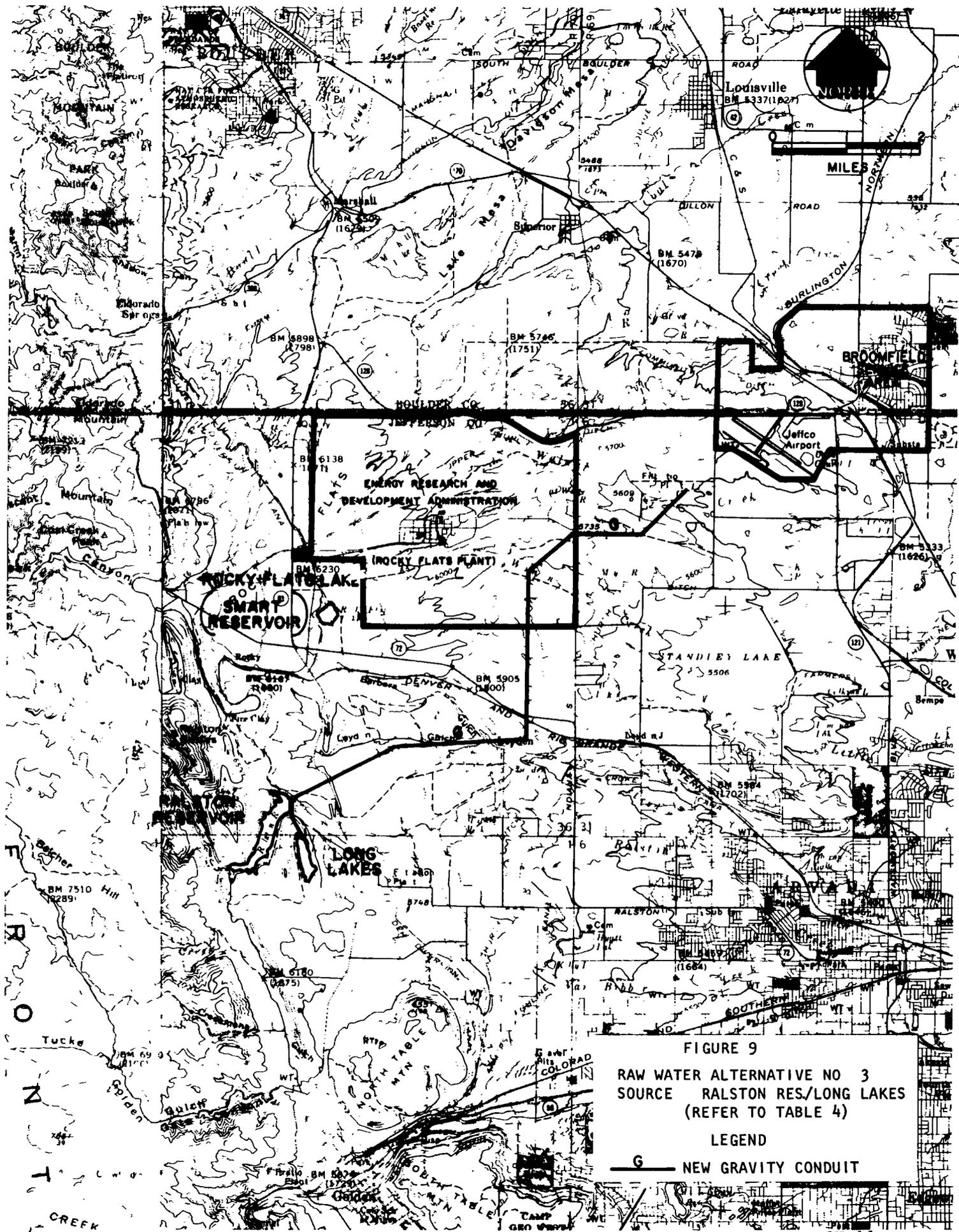


FIGURE 9  
 RAW WATER ALTERNATIVE NO 3  
 SOURCE RALSTON RES./LONG LAKES  
 (REFER TO TABLE 4)

LEGEND  
 G — NEW GRAVITY CONDUIT

88

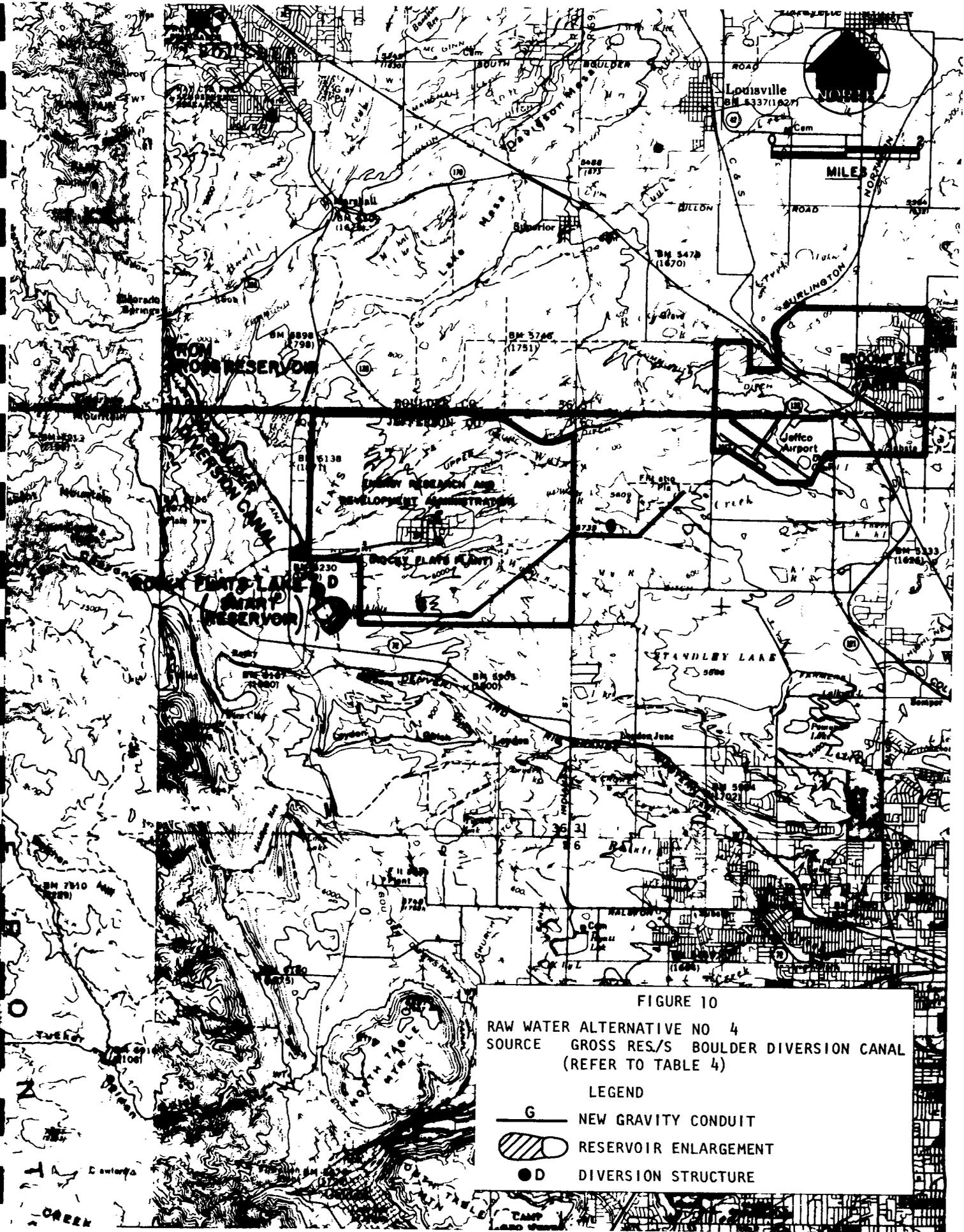
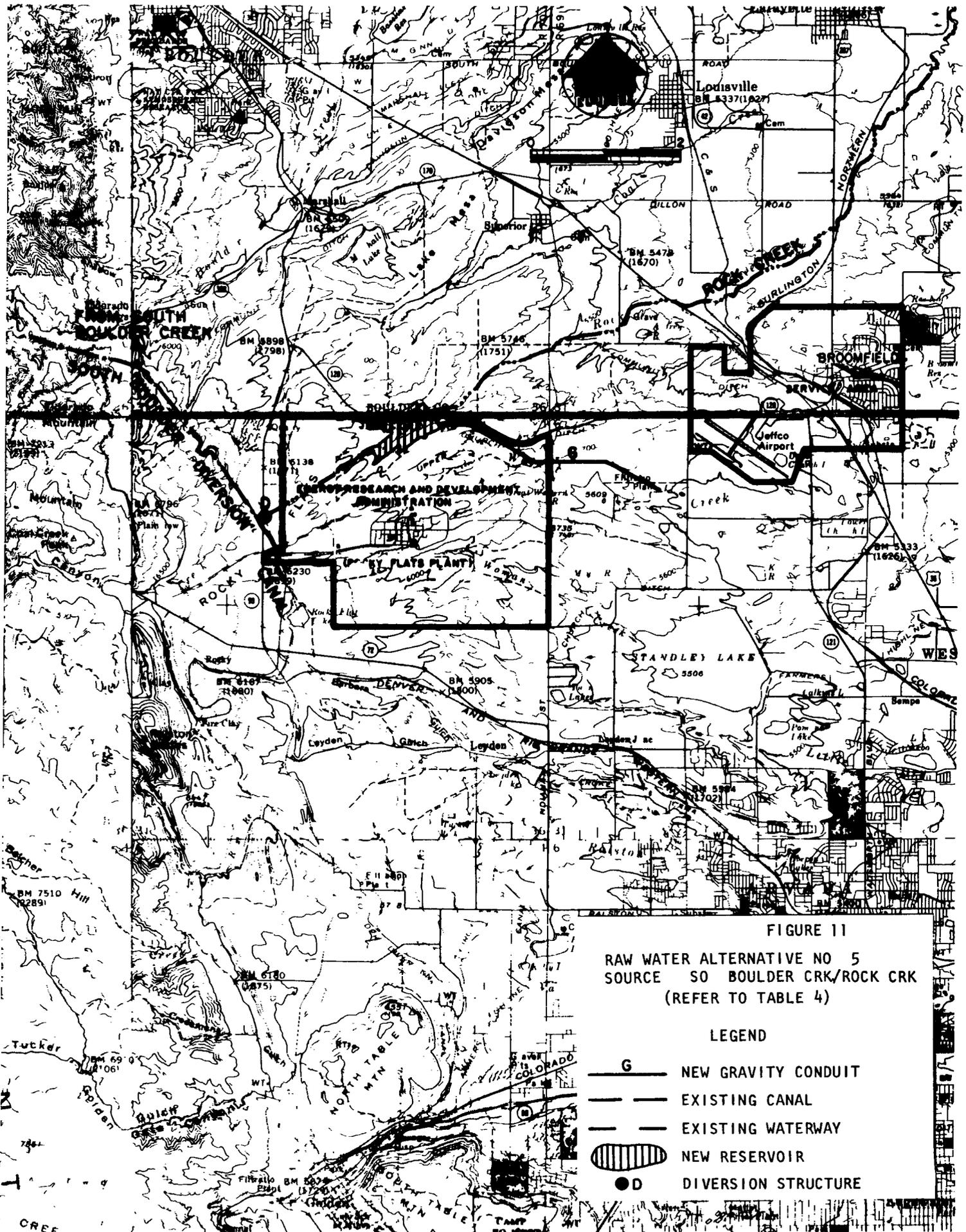


FIGURE 10  
 RAW WATER ALTERNATIVE NO 4  
 SOURCE GROSS RES/S BOULDER DIVERSION CANAL  
 (REFER TO TABLE 4)

LEGEND

- NEW GRAVITY CONDUIT
- RESERVOIR ENLARGEMENT
- DIVERSION STRUCTURE



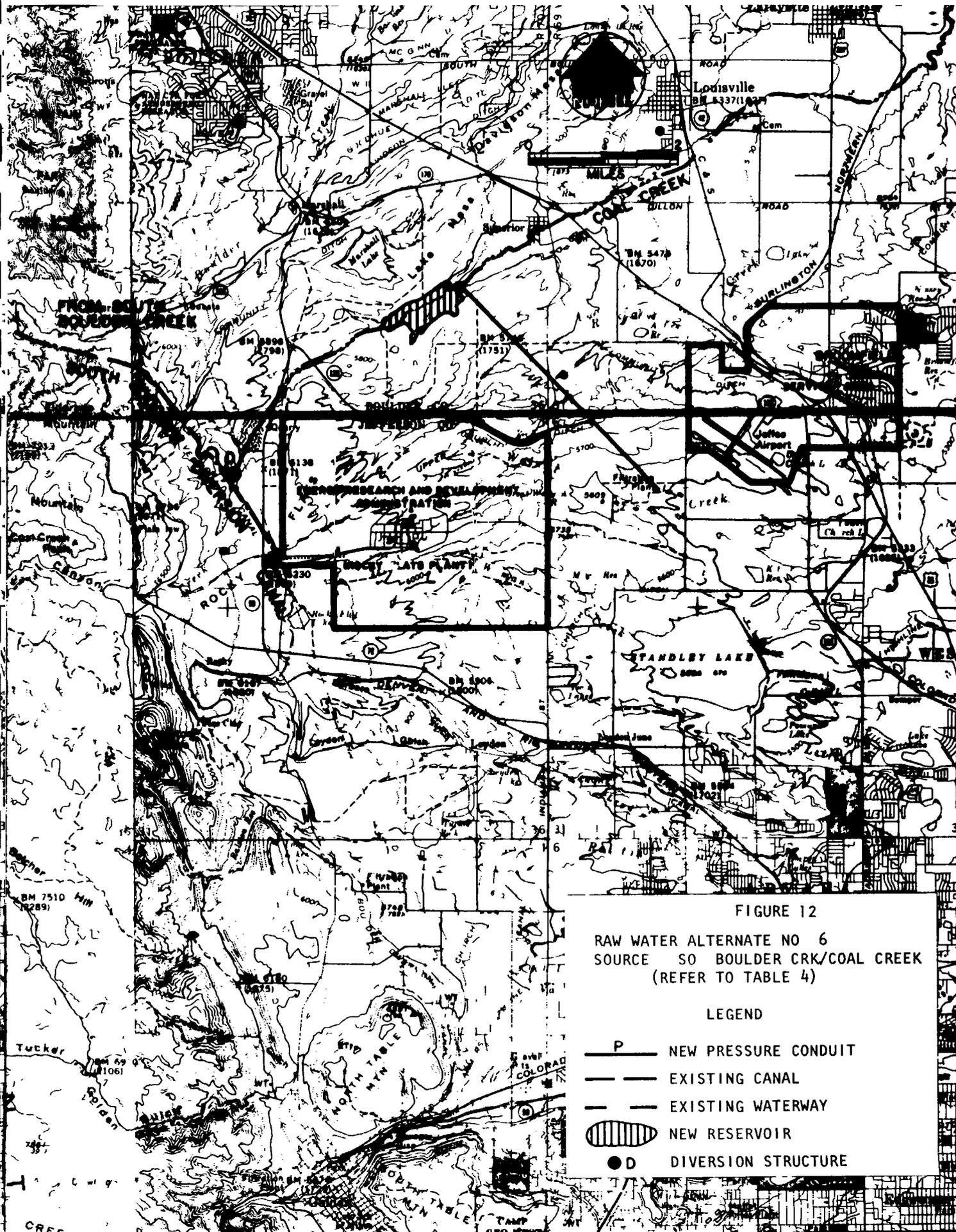


FIGURE 12

RAW WATER ALTERNATE NO 6  
 SOURCE SO BOULDER CRK/COAL CREEK  
 (REFER TO TABLE 4)

LEGEND

-  P NEW PRESSURE CONDUIT
-  EXISTING CANAL
-  EXISTING WATERWAY
-  NEW RESERVOIR
-  D DIVERSION STRUCTURE

91

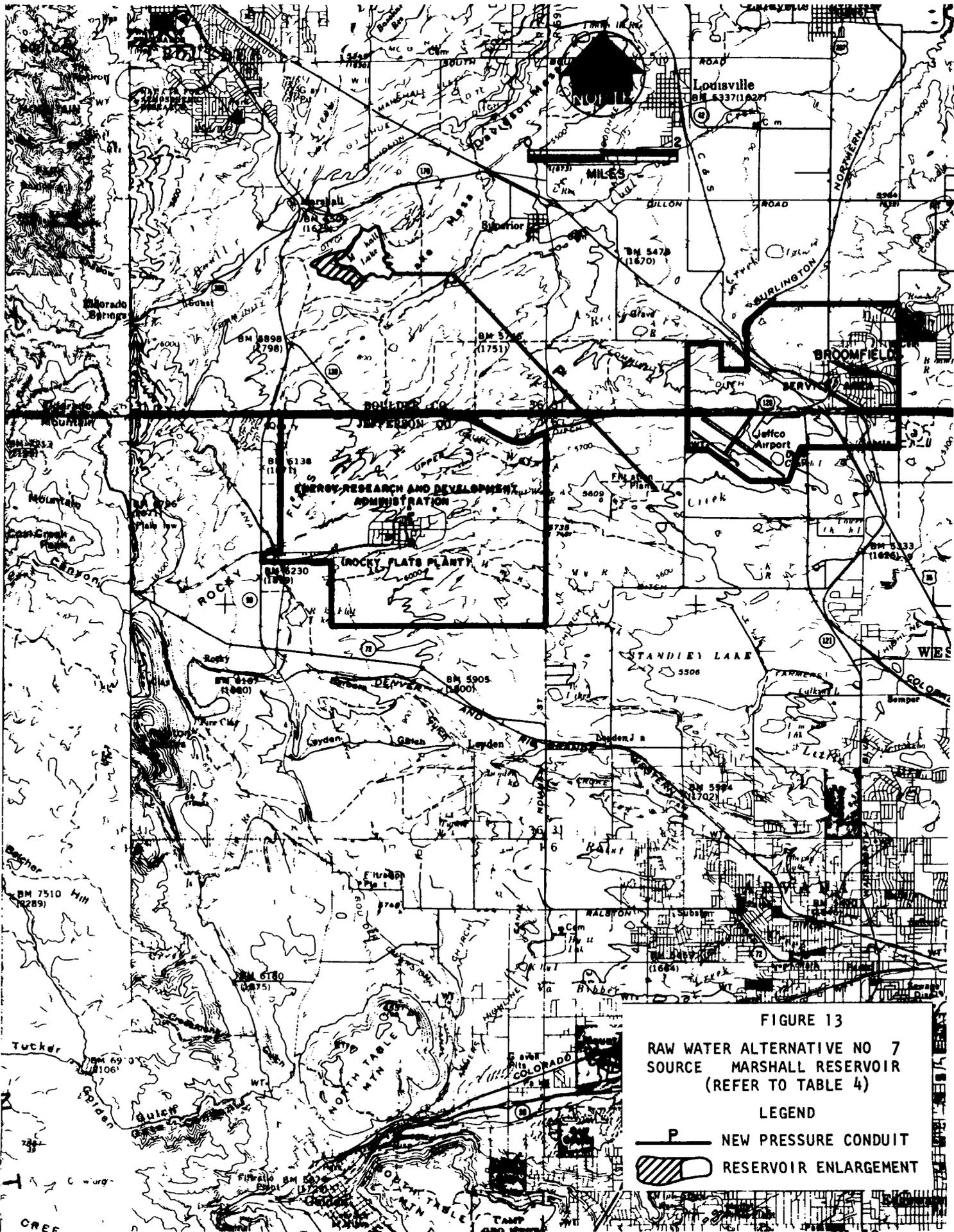


FIGURE 13  
 RAW WATER ALTERNATIVE NO 7  
 SOURCE MARSHALL RESERVOIR  
 (REFER TO TABLE 4)

LEGEND

**P** NEW PRESSURE CONDUIT

 RESERVOIR ENLARGEMENT

92

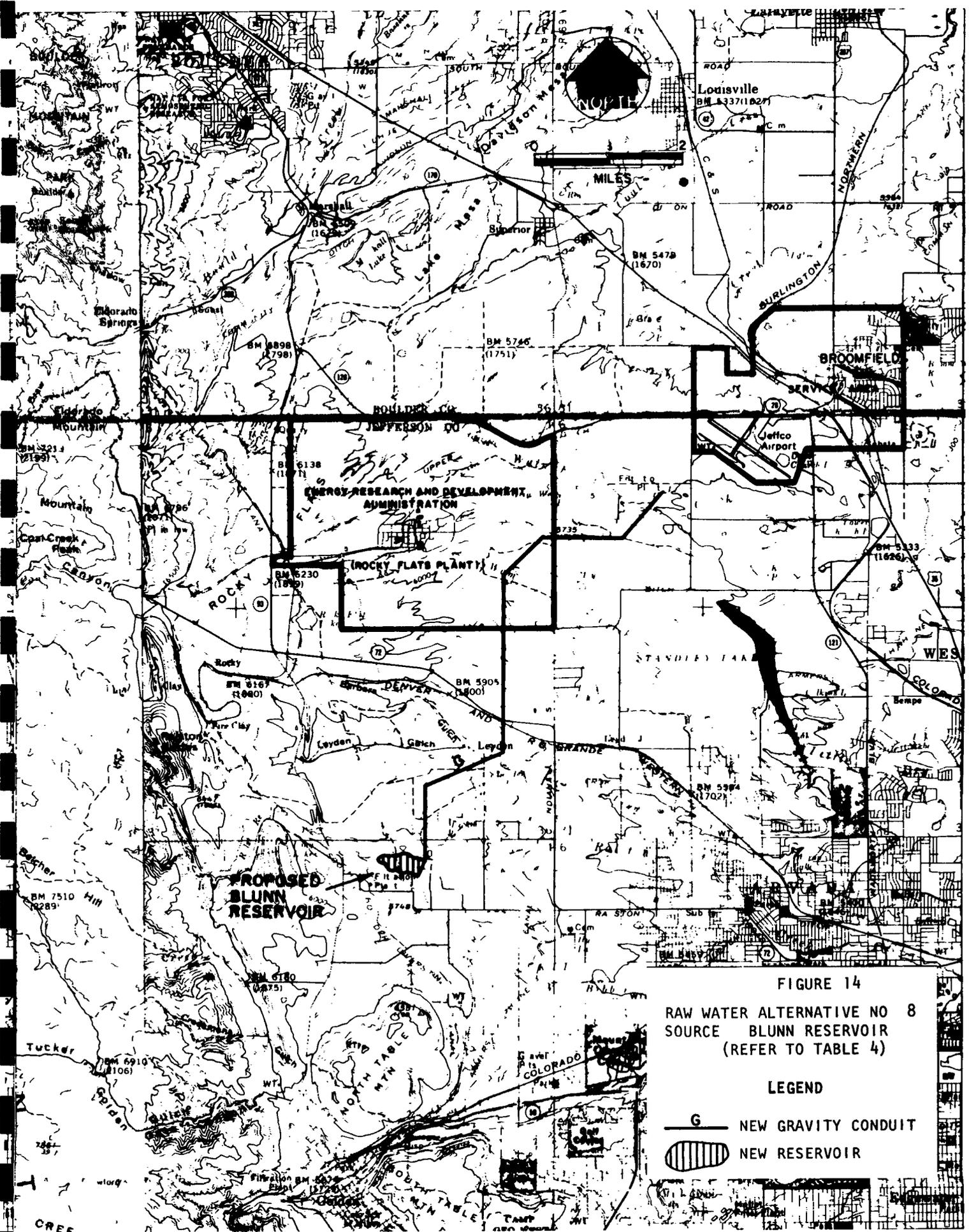


FIGURE 14  
 RAW WATER ALTERNATIVE NO 8  
 SOURCE BLUNN RESERVOIR  
 (REFER TO TABLE 4)

LEGEND  
 G NEW GRAVITY CONDUIT  
 [Hatched Area] NEW RESERVOIR

CREF

93

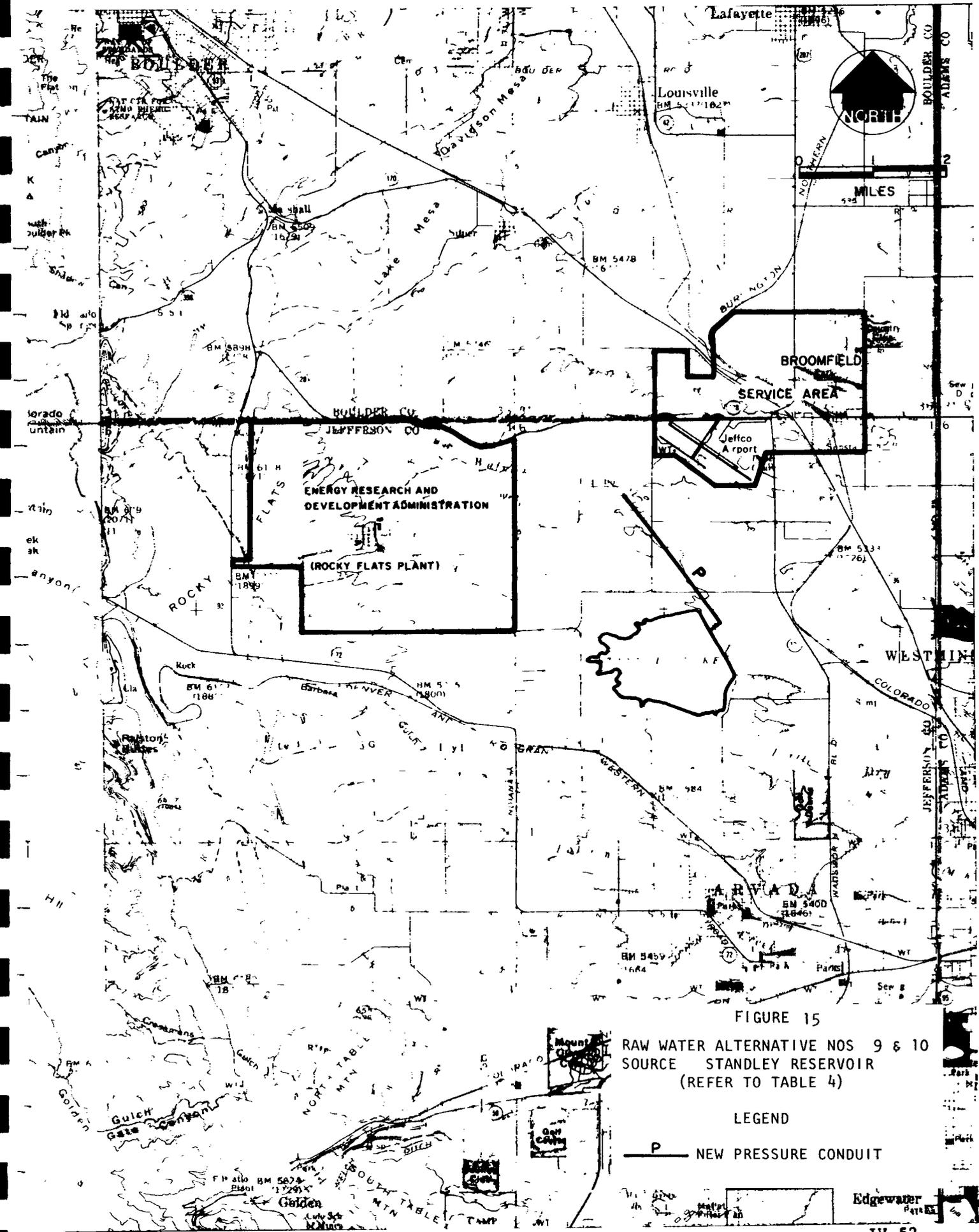


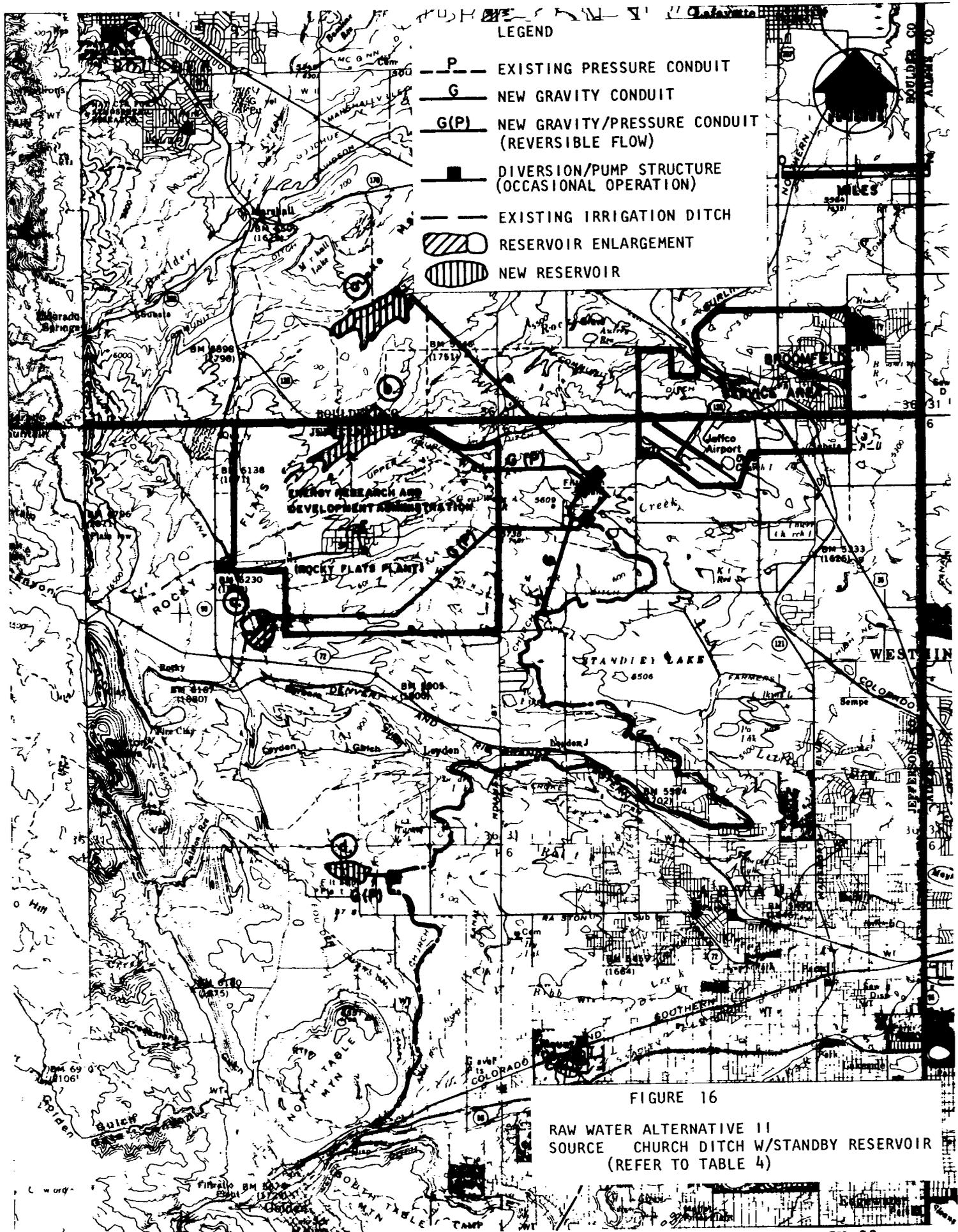
FIGURE 15  
 RAW WATER ALTERNATIVE NOS 9 & 10  
 SOURCE STANDLEY RESERVOIR  
 (REFER TO TABLE 4)

LEGEND

**P** — NEW PRESSURE CONDUIT

Edgewater  
 Park

94



95

V ALTERNATIVE EVALUATION AND ANALYSIS

TABLE 2

TREATED WATER SYSTEM MATRIX

<u>Emergency Scheme</u>	<u>Alternate Description</u>	<u>Considerations</u>
<u>Existing Conditions</u>	1 Interconnect Broomfield and Denver systems with 20" main in vicinity of Denver system storage Provide standby pumping station	1 Irrigation restrictions will be required after 1979
Normal Use		
5 8 MGD Broomfield system		2 Total volume and maximum day volume of water purchased from Denver will be greater than for normal operation
3 1 MGD Denver system		3 Emergency system can be put into operation by starting emergency pumps
<u>Emergency Conditions</u>		
2/3 maximum day and summer day use		4 Additional treated water storage and transmission mains will be required
5 3 MGD Broomfield system		5 The Denver Water Board is unwilling to make a commitment to supply emergency water beyond 9 7 MGD at the present time
		6 Cost
		5,500 L F of 20" main @ \$41 00/L F = \$621,000
		5 8 MGD pumping @ \$32,500 =
		7 Purchase of water and pumping cost (annual cost) = \$600,000

See Figure 5

TABLE 2 (Continued)

TREATED WATER SYSTEM MATRIX

<u>Emergency Scheme</u>	<u>Alternate Description</u>	<u>Considerations</u>
<u>Existing Conditions</u>		
Normal Use		
5 8 MGD Broomfield system	2 Interconnect Broomfield and Westminster systems with 20" main near 120th Avenue and Sheridan Provide standby pumping station	1 Peak demand during emergency (5 8 MGD) may exceed the capacities of Westminster distribution, filtration and raw water storage systems
3 1 MGD Denver system		2 Irrigation restrictions will be required for the Broomfield System and possibly for the Westminster System
<u>Emergency Conditions</u>		
2/3 maximum day and summer day use		3 Westminster is unwilling to make a commitment to supply emergency water for a period longer than about 3-4 days
5 3 MGD Broomfield system		4 Additional treated water storage and transmission mains will be required
		5 Cost 13,000 L F of 20" Main @ \$41 00/L F = \$1,203,750 40 MGD Pumping @ \$32,500
		6. Purchase of water and pumping costs (annual costs) = \$ 600,000

See Figure 5

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TABLE 2 (Continued)

TREATED WATER SYSTEM MATRIX

<u>Emergency Scheme</u>	<u>Alternate Description</u>	<u>Considerations</u>
<u>Existing Conditions</u>		
Normal Use		
5 8 MGD Broomfield system	3 Interconnect Broomfield and Arvada systems with 30" main Provide standby pumping station	1 Present Arvada treatment and transmission system is inadequate to provide water for Broomfield (Will require new Blunn treatment plant and major transmission main )
3 1 MGD Denver system		2 Irrigation restrictions will be required for the Broomfield System and possibly for the Arvada System
<u>Emergency Conditions</u>		
2/3 maximum day and summer day use		3 Arvada will require a strong financial commitment on behalf of Broomfield to oversize Blunn Reservoir and Blunn treatment plant
5 3 MGD Broomfield system		4 Emergency system can be put into operation by starting emergency pumps
		5 Additional treated water storage and transmission mains will be required
		6 Cost
		7 Purchase of water (annual costs) - Indeterminate

See Figure 6

TABLE 3

A TREATED WATER SYSTEM MATRIX - COSTS

Denver Alternate Emergency Connection\*\*

Right-of-Way Cost	-0-
Construction Cost	
5500 L F 20" Main @ \$41 00/L F	= \$225,500
5 8 MGD Pumping Station @ \$32,500/MG	= <u>\$188,500</u>
Subtotal	\$414,000
1 5 x	= \$621,000
Emergency Cost	
Additional Water	\$500,000
Pumping Cost	<u>\$ 20,000</u>
	\$600,000

Westminster Alternate Emergency Connection

Right-of-Way Cost	-0-
Construction Cost	
13,000 L F 20" Main @ \$45 00/L F	= \$ 585,000
5 8 MGD Pumping Station @ \$37,500/MG	= <u>\$ 217,500</u>
Subtotal	\$ 802,500
1 5 x	= \$1,203,750
Emergency Cost	
Additional Water	\$ 500,000
Pumping Cost	<u>\$ 20,000</u>
	\$ 600,000

\*\*The use of water from the Denver system as an emergency supply would require these improvements and additions to the water distribution, transmission and storage system to be accelerated beyond that required for normal growth

TABLE 3 (Continued)

Arvada Alternate Emergency Connection

Right-of-Way Cost	-0-
Construction Cost	
25,000 L F 30" Main @ \$64 00 L F	= <u>\$1,600,000</u>
1 5 x	= \$2,400,000
Emergency Cost	
Additional Water	Indeterminate
Pumping Cost	Indeterminate

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TABLE 4

RAW WATER SYSTEM MATRIX

<u>Emergency Scheme</u>	<u>Alternate Description</u>	<u>Consideration</u>
Provide a 3000 acre-foot alternative storage and utilize existing Broomfield water rights	1 Exchange of Broomfield water rights to Ralston Reservoir and expanded Rocky Flats Lake	1 Inadequate storage capacity 2 Inability to obtain exchange agreement 3. Capital Cost \$2.5 million 4. Annual O & M cost \$68,000
	2. Same as 1 above with addition of extra transmission conduit to Rocky Flats Lake	1 Inadequate storage capacity 2 Inability to obtain exchange agreement 3. Capital Cost \$2.8 million 4. Annual O & M Cost \$68,000
	3. Exchange of Broomfield water rights to Ralston-Long Lakes	1 Inadequate storage capacity 2 Inability to obtain exchange agreement 3. Capital Cost \$2.0 million 4. Annual O & M Cost \$74,000
	4. Exchange of Broomfield water rights to South Boulder Canal for storage in Rocky Flats Lake.	1 Inadequate storage capacity 2 Inability to obtain exchange agreement 3. Capital Cost \$82.5 million 4. Annual O & M Cost \$66,000

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TABLE 4 (Continued)

RAW WATER SYSTEM MATRIX

<u>Emergency Scheme</u>	<u>Alternate Description</u>	<u>Consideration</u>
5	Exchange of Broomfield water rights to South Boulder Creek and storage in a proposed Rock Creek Reservoir	1 Construction required to provide adequate storage capacity
		2 Inability to obtain exchange agreement
		3 Capital Cost \$4 2 million
		4 Annual O & M Cost \$148,000
6	Exchange of Broomfield water rights to South Boulder Canal for storage in a proposed Coal Creek Reservoir	1 Construction required to provide adequate storage capacity
		2 Inability to obtain exchange agreement
		3 Capital Cost \$4 3 million
		4 Annual O & M Cost \$167,000
7	Exchange of Broomfield water rights to South Boulder Creek for storage in the expanded Marshall Lake	1 Construction required to provide adequate storage capacity
		2 Inability to obtain exchange agreement
		3 Capital Cost \$4 6 million
		4 Annual O & M Cost \$165,000
8	Exchange of Broomfield water rights to proposed Blunn Reservoir	1 Construction required to provide adequate storage capacity
		2 Exchange is physically possible
		3 Capital Cost \$4 3 million
		4 Annual O & M Cost \$110,000

TABLE 4 (Continued)

RAW WATER SYSTEM MATR IX

<u>Emergency Scheme</u>	<u>Alternate Description</u>	<u>Consideration</u>
9	Exchange of Broomfield water rights to and obtain storage in Standley Reservoir Reimburse Standley Lake farmers for water and crop losses during emergency	<ol style="list-style-type: none"> <li>1 Purchase required to provide adequate storage capacity</li> <li>2 Exchange is physically possible</li> <li>3 Capital Cost \$4.1 million</li> <li>4 Annual O &amp; M Cost \$126,000</li> </ol>
10	Same as 9 above without reimbursement to Standley Lake farmers	<ol style="list-style-type: none"> <li>1 Purchase required to provide adequate storage capacity</li> <li>2 Exchange is physically possible</li> <li>3 Capital Cost \$3.8 million</li> <li>4 Annual O &amp; M Cost \$126,000</li> </ol>
11	<p>Pump Broomfield's water rights for storage in</p> <ol style="list-style-type: none"> <li>(a) Proposed Coal Creek Reservoir</li> <li>(b) Proposed Rock Creek Reservoir</li> <li>(c) Expanded Rocky Flats Lake</li> <li>(d) Proposed Blum Reservoir</li> </ol>	<ol style="list-style-type: none"> <li>1. Construction required to provide adequate storage at Coal Creek, Rock Creek and Blum sites. Rocky Flats storage inadequate</li> <li>2. Direct construction makes all of Broomfield water rights available</li> <li>3. Capital Cost               <ol style="list-style-type: none"> <li>(a) Coal Creek \$4.9 million</li> <li>(b) Rock Creek \$4.8 million</li> <li>(c) Rocky Flats Lake \$4.1 million</li> <li>(d) Blum Reservoir \$4.2 million</li> </ol> </li> </ol>

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TABLE 4 (Continued)

RAW WATER SYSTEM MATRIX

<u>Emergency Scheme</u>	<u>Alternate Description</u>	<u>Consideration</u>
11	(Continued)	4 Annual O & M Costs (a) Coal Creek \$115,000 (b) Rock Creek \$114,000 (c) Rocky Flats Lake \$132,000 (d) Blunn Reservoir \$101,000
12	Supplement Broomfield water rights by use of Broomfield's deep wells for an augmentation Exchange transmountain return flows from Broomfield wastewater plant for water in Standley Lake Expand West Lake Storage by 1000 acre-feet	1 Construction required to provide adequate storage 2 Augmentation-exchange program will require extensive litigation 3 Capital Cost \$3 0 million 4 Annual O & M Cost \$142,000
13	This alternate is similar to 12 The augmentation is from Barr Lake wells	1 Construction required to provide adequate storage 2 Augmentation-exchange program will require extensive litigation 3 Capital Cost \$5 6 million 4 Annual O & M Cost \$202,000

TABLE 4 (Continued)

RAW WATER SYSTEM MATRIX

<u>Emergency Scheme</u>	<u>Alternate Description</u>	<u>Consideration</u>
	14. Exchange Broomfield water rights to Standley Lake and supplement them with purchase from Denver of transmountain return flow available in the South Platte. Also exchange Broomfield waste water return flow to Standley Lake	<ol style="list-style-type: none"> <li>1. Construction required to provide adequate storage</li> <li>2. Augmentation-exchange program will require extensive litigation</li> <li>3. Purchase agreement required with Denver</li> <li>4. Capital cost \$5.1</li> <li>5. Annual O &amp; M Costs \$400,000</li> </ol>
	15. This alternative is similar to 14. The supplemental water would be purchased from Englewood out of the South Platte	<ol style="list-style-type: none"> <li>1. Construction required to provide adequate storage</li> <li>2. Augmentation-exchange program will require extensive litigation</li> <li>3. Purchase agreement required with Englewood</li> <li>4. Capital cost \$5.1</li> <li>5. Annual O &amp; M Costs \$400,000</li> </ol>

C Environmental Considerations

The following is a list of general environmental factors which have been identified as being relevant and applicable to the implementation of the various raw water alternatives

- a Construction of new reservoirs or enlargement of existing storage ponds and required pump stations, pipelines, and diversion structures would cause disruptive entanglements and interference with adjacent properties
- b Acquisition of right-of-way or easements for required facilities could remove properties from local tax rolls
- c New construction or enlargement of a reservoir could involve the following
  - (1) Enhance the opportunity for development of water related recreational activities
  - (2) Increase land values and land use of adjacent properties
  - (3) Impact the natural environment either positively by enhancing the natural beauty and scenic value of the area, or negatively by utilizing undeveloped areas and disrupting the natural setting
  - (4) Significantly affect the local drainage patterns, erosion and flood control characteristics, water quality, plant and wildlife ecology, and potential use of the specific drainageways and adjacent areas
- d Additional water sources would complement the development plan of the community and provide local water service flexibility and reliability which could improve the public health, well being, and safety of the community

As the implementation process for any alternative is advanced, a full and comprehensive examination should be made of all impacts to minimize any adverse effects on the human environment

Among the raw water alternatives examined in this report, the systems involving Raiston or Standley Reservoirs as storage facilities would have the least amount of environmental impact assuming that little modification to the existing reservoirs is required. The alternatives involving the proposed Blunn Reservoir as a storage facility should not add any environmental impact concerning the reservoir site beyond that which is associated with the initial design. New reservoirs on Coal Creek and Rock Creek or enlargement of existing storage ponds such as Rocky Flats Lake, Marshall Reservoir, or any reservoir in the vicinity of Bloomfield would cause a significant amount of environmental impact.

Each of the raw water alternatives requires varying types of physical improvements such as pipelines, pumping facilities, and diversion structures. The magnitude of impact caused by these improvements is directly related to size, extent, and type of new facility required. The alternatives that require a minimum of new facilities would cause a minimum amount of environmental impact.

## VI CONCLUSIONS

### A Preferred Alternative Description

#### 1 Short-Term Emergency Supply

The preferred short-term alternative to provide emergency water to Broomfield is to purchase treated water from Denver. This could provide an immediate supply that is readily available and usable and is the least costly alternative available.

The present 9.7 MGD capacity from Denver could meet the entire needs of Broomfield until 1979, and with restrictions on sprinkling until 1982. Construction of a pipe line and pumping station (construction cost of \$621,000) are required to lift the water to the Broomfield system storage near the Jefferson County Airport. However, emergency service could be provided on a temporary basis until this construction could be completed. Broomfield would also be required to accelerate the construction of some transmission and treated water storage improvements to make full use of this water.

The approval of the Denver Board of Water Commissioners would be required if Broomfield is to serve water outside of the contract service area, even on an emergency basis. Nearly all of the Broomfield service area west of Main Street is outside of the Denver Contract Service Area as shown on Figure 4.

This preferred alternative would require the purchase of additional water from Denver and the repumping of that water into the treated water storage near the Jefferson County Airport. The purchase costs for water are estimated to be \$580,000 per year for 9.5 MG based upon 1980 usage, and the additional pumping costs for 1980 estimated to be \$20,000 per year.

All of the other short-term emergency alternatives studied are not recommended because they are not immediately available or are too costly. Substantial construction would be required for any of the other alternatives.

The Westminster treated water alternative and the Denver raw water alternative from South Boulder Canal could be implemented in a short time-frame. However, neither of these entities, Westminster nor Denver, were able to commit water for such emergency supplies except for a very short time -- a few days.

## 2. Long-Term Emergency Supply

### a. First Preference - Denver Treated Water

The preferred alternative to provide emergency water for Broomfield over the long-term would be to purchase treated water from Denver. This is the least costly and most readily available source.

Beyond 1982, to provide the emergency supply even on a curtailed use basis would require that Broomfield acquire the additional capacity in Conduit No. 81. This will increase the amount available to Broomfield to 15.8 MGD. 15.8 MGD will provide the entire needs of Broomfield until 1982, and with restrictions on sprinkling until 1990.

Broomfield is presently negotiating with Denver for the purchase of this additional capacity. To use the full 15.8 MGD will not require construction of any additional facilities earmarked solely for this purpose. Broomfield will be required to accelerate the installation of another pump in the Denver Pump Station and to accelerate construction of transmission and treated water storage facilities to accommodate this supply.

b Second Preference - New Raw Water Reservoir

This alternative becomes preferred if Broomfield is unable to acquire the additional capacity in Denver Conduit No 81 and requires acquisition of storage to replace Great Western Reservoir. This could be from Standley, Blunn, or Coal Creek Reservoirs.

These alternatives would require major capital outlays (several millions of dollars) for the storage capacity and conveyance systems to transport the Broomfield water from its source into storage and to the Broomfield Treatment Plant. The costs of all alternative storage and conveyance systems are in the same range, \$5-6 million. The pumping costs associated with these alternatives are comparable to those presently required to lift the Church Ditch water into Great Western Reservoir.

If there is a long-term potential that Great Western Reservoir could be rendered unsuitable for public water supply by the Rocky Flats Plant, then the Walnut Creek surface supplies would be rendered unsuitable also. Thus, any alternative to provide new storage must provide a water supply equal to that presently available to Broomfield from the Walnut Creek drainage. The Walnut Creek supply produces little water in dry years, but nonetheless is a valuable asset because of its yield during other years.

B Preferred Alternative Evaluation

There are no simple and inexpensive alternatives available to provide Broomfield with an emergency water supply. The fierce competition for water supply in the northwest metropolitan area and the requirement of municipal users for a firm supply during both high and low run-off years combine to complicate any easy solutions.

The Broomfield emergency water supply maximum day demand ranges from 5.3 to 8.0 MGD. The magnitude of this demand is so large as to be beyond the capability of all except the largest treated water system.

The Broomfield emergency water supply total storage requirement is about 3100 acre-feet. The magnitude of this demand is beyond that readily available from any present storage system.

The Denver treated water alternative offers an immediately available emergency water supply which could be implemented in a short period of time. This would allow adequate time to evaluate the long-term potential hazard to the Broomfield water supply of the continued operation of the Rocky Flats Plant.

## APPENDIX A STUDY ORGANIZATION AND COORDINATION

### Organization

Figure A-1 presents the project schedule that was followed during the course of the study. A total of ten formal project meetings were held with ERDA/Rockwell International representatives each serving as a milestone event signifying a specific task accomplishment.

Special assistance was provided by the consulting firm of Leonard Rice Consulting Water Engineers, Inc. in analyzing water rights and the availability of raw water in the North Metro Area.

A special study review was obtained from Dr. J. E. Flack, Professor of Civil Engineering at Colorado University. Dr. Flack has a wealth of expertise in Colorado water resource management and provided his valuable overview to assure the study analysis was complete and comprehensive.

Numerous informal discussions took place with various entities throughout the study. A specific contact made well into the study with the City of Arvada provided information concerning the proposed Blunn Reservoir and modifications to their water treatment facilities. An investigation of this data resulted in the addition of both a treated and raw water alternative to the study and is included in this report. Since, however, this information was obtained late in the alternative evaluation phase of the study, the inclusion of the additional alternatives caused, in part, the requirement for a time extension to complete the project.

### Coordination

Prior to and during the course of the study numerous meetings were held with various entities which are directly involved with the project.

These meetings provided a substantial amount of information and background related to the emergency water supply concept for Broomfield. The discussion which transpired during the following meetings have been documented in the form of minutes and memorandums which are included in this appendix.

<u>Meeting Date</u>	<u>Meeting Participants</u>
January 27, 1976	ERDA Rockwell International City of Broomfield
January 28, 1976	Rockwell International City of Broomfield Colorado Department of Health
March 29, 1976	Rockwell International Broomfield Utility Department
April 28, 1976	Rockwell International Broomfield Utility Department
May 4, 1976	Rockwell International Rocky Mountain Consultants
May 14, 1976	Rockwell International Chief of Dams and Reservoirs, Division of Water Resources, State of Colorado
October 22, 1976	ERDA Rockwell International City of Broomfield Denver Water Department
September 3, 1976	ERDA Rockwell International City of Broomfield
April 6, 1977	ERDA Rockwell International URS Company
April 19, 1977	ERDA Rockwell International URS Company

Meeting Date

Meeting Participants

May 4, 1977

ERDA  
Rockwell International  
URS Company

May 6, 1977  
(Two separate meetings)

ERDA  
Rockwell International  
City of Brookfield  
URS Company

ERDA  
Rockwell International  
Barnet Water Department  
URS Company

May 9, 1977

ERDA  
Rockwell International  
Brookfield Utilities Department  
URS Company

May 11, 1977

ERDA  
Rockwell International  
City of Westminster  
URS Company

May 17, 1977

ERDA  
Rockwell International  
URS Company

June 1, 1977

ERDA  
Rockwell International  
URS Company

June 2, 1977

ERDA  
Rockwell International  
City of Brookfield  
URS Company

June 30, 1977

ERDA  
Rockwell International  
URS Company

July 6, 1977

ERDA  
Rockwell International  
City of Avon  
URS Company

August 1, 1977

ERDA  
Rockwell International  
URS Company

Meeting Date

Meeting Participants

August 5, 1977

ERDA  
Rockwell International  
URS Company

August 11, 1977

ERDA  
Rockwell International  
URS Company

Many other meetings, discussions, and contacts have been made concerning the project which are not listed above and which have not been documented as those included in this Appendix. However, the information contained in the following meeting notes represents a thorough summary of the project's many facets and considerations.

Atomica International Division  
Rocky Flats Plant  
P O Box 464  
Golden, Colorado 80401  
(303) 494 3311  
Contractor to  
Energy Research and Development  
Administration

Rockwell  
International

February 6, 1976

76-RF-0278

Mr W M Lamb  
Area Manager, ERDA, RFAO

Summary of Broomfield Water Contingency  
Status as of February 5, 1976

### JANUARY 27 MEETING WITH DENVER WATER BOARD

A meeting was held on January 27, 1976 with the Denver Water Board, Broomfield, ERDA, and Rockwell International to discuss a contingency water plan for Broomfield. The list of attendees is attached.

The Denver Water Board commented that they do not have adequate water to make commitment to supply Broomfield with water for an indefinite period of time however, they were willing to consider contingency emergency supplies. The Denver Water Board is not now contracting for any new water customers. This posture derives from the unavailability of adequate treatment facilities and reservoir capacities. If the contingency is experienced in the middle of a dry summer, there just may not be enough water without added facilities now held up by environmental considerations.

The question of the quantity of water required for Broomfield tends to revolve around the fact that Broomfield now provides water to approximately 9600 persons and the Denver Water Board to 8-00 persons. These numbers will reverse themselves in the near future because the new Broomfield construction is in the area that uses the Denver water services. The Denver water line to Broomfield is 48" in diameter of which Broomfield purchased 30" equivalent. Denver owns the difference. Thirty inches will supply 9.7 million gallons of water per day, which is adequate to support approximately 13,000 people. The development of Broomfield, projected to be 30,000 persons in 1981, would require the entire 48" line which can supply approximately 15.8 million gallons per day. The Denver Water Board investment in the 48" line is ~2.25 million dollars and may be purchased from them.

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LSON W  
ER SW  
STAND W DI  
S P W  
ELE AL I  
PFF RD  
PC  
LINGER M  
RE  
R RE  
SYM  
NGER SE I  
Y D A  
P P J  
RER W V  
MAN RB  
PE  
DVR MR  
N TIE  
R CRT  
C W G  
ON RM  
W  
IG  
N RL  
LVEY W F I  
N D G  
EN FG  
IAN W A I  
H P J  
R E C  
D W L  
R E  
E  
A R W L  
S P E C C L  
N N W M  
P R E  
WARD I M  
M P O M A  
O V I S O N N J  
L T H R  
S T R M  
V O A E  
A N E R M R  
D R E C H T D  
L E A N S P O  
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AUTH CLASSIFICATION  
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121

Mr. W. M. Lamb

Page 2

February 6, 1976

Any contingency supply must provide an amount of water equivalent to that which Broomfield derives from Great Western Reservoir. At present, this is 5 1/2 million gallons per day. Broomfield is developing expanded treatment capacity to increase the Great Western output to 8 million gallons per day (this was to be done in 1974 but the tritium incident delayed City action). Increased capacity will be available in about one year. The contingency supply should provide 8 million gallons per day.

The Denver Water Board does not permit mixing of their water with other water supplies because of problems of guaranteed purity. This can be overcome with the installation of appropriate check valves. The water pressure in the Den. water lines is not adequate to supply the entire City of Broomfield and it will be necessary to install pumping capabilities to fill storage tanks at the Jefferson County Airport.

Conditions upon which we can work out an agreement with Denver would be based upon our bringing what pressure we can to facilitate the environmental acceptance of the Foothills Treatment Plant and Eagle Nest Reservoir. Additional areas of concern are the East Gore and Pincy Reservoirs. The Denver Water Board wishes, during the period in which they are supplying water to Broomfield, to use the water rights to Church Ditch storage. Broomfield will not be using that water during the contingency period. This appeared to be acceptable to Broomfield.

The Denver Water Board and the City of Broomfield will forward to us by February 6 their criteria and needs so that a joint criteria can be prepared from which an estimated project cost can be derived. An architectural and engineering firm, agreed upon by ERDA, Broomfield, and the Denver Water Board, can then be selected.

I recommend that ERDA secure option on the Denver water line so that it will not be released during our planning phase for the contingency water plan.

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Mr. W. M Lamb  
Page 3  
February 6, 1976

**JANUARY 28 MEETING WITH CITY OF BROOMFIELD  
AND COLORADO DEPARTMENT OF HEALTH**

On January 28, a meeting was held with the City of Broomfield and the Colorado Department of Health to review the Rocky Flats Waterborne Effluent Monitoring Program for 1976. In addition to this review, a very brief discussion was held concerning many of the Rocky Flats Internal Environmental Controls and procedures. Attached is a list of these topics.

The plant environmental controls and procedures were reviewed to demonstrate that water leaving the Rocky Flats Plant will not be accidentally subjected to chemical contamination. Broomfield and Colorado Department of Health personnel expressed satisfaction with our 1976 Waterborne Effluent Monitoring program.

The City of Broomfield is in the process of developing emergency plans. It was requested that Rocky Flats supply the participants with information relative to anticipated warning time, volume of water, concentration of plutonium, etc., that might result from dam failure during a defined flood condition. This type of information is pertinent to determine time constraints in implementing a contingency plan.

Following is a list of the attendees:

G. Wilson	City of Broomfield
W. B. Barstow	City of Broomfield
G. B. Morrill	McCall-Ellingson & Morrill (Broomfield Consultant)
B. L. Krist	Colorado Department of Health
M. L. Hanrahan	Colorado Department of Health
R. W. Hawes	Atomics International
D. D. Hornbacher	Atomics International
M. A. Thompson	Atomics International

ORIGINAL SIGNED  
BY D. COCKERAM

Robert E. Yoder, Director  
Health, Safety and Environment

REY wj  
Orig and 1 cc - Mr. Lamb  
Enc

cc J. A. Stout - ERDA RFAO

NAME

REPRESENTING

Glen Shellenbaur	Denver Water Department
Burt Kochner	Rocky Flats - Rockwell
Chuck Pose	Rocky Flats - Rockwell
Robert E. Yoder	Rockwell - Rocky Flats
Edward H. Sitzberger	Rockwell - Rocky Flats
William B. Barton	Broomfield
Gip Wilson	Broomfield
Thelma Banschbach	Broomfield
Earl W. Bean	Energy Research & Dev Agency
Bob McBurnie	Denver Water Department
George DiCiero	City Manager, Broomfield
Walter Spader	Mayor, Broomfield

# INTERNAL CONTROLS AND PROCEDURES

1. Runoff Control
2. Oil and Chemical Spill Control
3. Waste Handling Control
4. Excavation Control
5. Hazardous Chemicals Purchase Control
6. Liquid Effluent Discharge Control
7. Process Liquid Control
8. Land Fill Control
9. Construction Control
10. Material Control
11. Buffer Zone Control
12. Building Inspection Procedures
13. Operating Procedures
14. Safety Analysis Reviews

Fell

Cruc

Robert

Edna

Will

Gir

The

APR 13 1976

April 12, 1976

Public Utility District

FROM: C. P. Pose

# 2102

TO: Building 124

Phone: 2469

Minutes of Meeting with Captain, Broomfield Utility Dept.,  
March 29, 1976

In attendance: H. P. Ellis, F. L. Pichler, C. P. Pose, I. M. Silberstein  
of Pechell International and Captain from Broomfield

Purpose of the meeting was to discuss preliminary criteria for an  
emergency water supply for the City of Broomfield. The meeting generally  
centered around clarifying the items mentioned in Mr. Parson's letter  
to B. L. Yoder dated 1/30/76. It was decided to hold the meeting despite  
the illness of Mr. Bustow, the Broomfield Public Works Director, who had  
compiled most of the data contained in the January 30 letter.

1. Mr. Wilson was told that the items to be discussed were for  
exploratory purposes and were not to be construed as  
commitments.
2. Broomfield currently has a maximum future capacity of 9.0 MGD from  
Great Western and 9.7 MGD from the 4/7 interest in the Denver  
Water Board's Conduit No. 81 for a total of 17.0 MGD. Mr. Bustow  
further estimated that Conduit 81 could carry 15.8 MGD after the  
addition of (3) new pumps at the pump station located at 94th  
Ave and Washington Street. This capacity is 1.0 MGD short of the  
17.7 MGD possible with Great Western available. The question was  
raised whether the limiting factor was Conduit 81 or the Denver  
Water Board's line feeding the pump house. This item will be  
checked with the Denver Water Board. (Note capacity might be  
available since 9.7 MGD is 4/7 of 17.0 MGD--not 15.8 MGD)
3. Mr. Wilson was asked if Broomfield was saying that a second  
pipeline parallel to the existing pipeline would be required  
if the additional 1.9 MGD could not be squeezed out of the  
existing line. He stated that a second line did not appear  
feasible but that the added capacity by some means was desirable.
4. The question was raised about the possibility of a partial water  
curtailment to shave the peak consumption back to the 15.8 MGD.  
Mr. Wilson thought that this was practical.
5. The total emergency and equalization storage requested by  
Broomfield is 13.3 MG, (75% of 17.5). The existing storage  
capacity consists of (1) 3.0 MG tank at the north edge of town,  
and (3) tanks of 3.2, 0.75, and 3.0 MG capacity located at the  
Jeffco Airport. The total storage capacity of these tanks is

9.95 MG which means that an additional 3.3 MG tank would be required to provide the desired 13.3 MG storage. This tank would be located adjacent to the single 3.0 MG tank at the north edge of town.

6. Denver Water Board Conduit No. 81 runs from the Denver-Broomfield pump station located at 94th and Washington to 128th and Zuni. The Denver Water Board also does maintenance work only on the 36" main between 128th and Zuni and the point where the main connects with the Broomfield loop at 128th and Lowell.
7. Broomfield has 1700 shares of Church Ditch water at 1.7 acre feet each. This water is taken from Clear Creek near Golden and flows by gravity to both Standley Lake and the east side of Great Western Reservoir. The water is pumped from the ditch into Great Western Reservoir. The ditch is in service from about mid-May to mid-August, hence the requirement for storage capacity.
8. The new pump station requested in Mr. Barstow's letter would be located near Midway Street west of Highway 287.
9. The City of Westminster has a 30" potable line which crosses Conduit 81 at 128th and Ingon Street. They also have a 6" potable water line which is close to Broomfield's potable water lines west of the airport at 111th and Simms. Mr. Wilson stated that it might be possible to purchase some water from Westminster to make up some or all of the 1.9 MGD deficit.
10. Mr. Wilson also mentioned that he knew of underground water rights which were for sale in the Eldorado Springs Area and in the Barr Lake Area. Approximately 750 Acre Feet/yr (0.67 MGD) is available from the Eldorado Springs Area and 1,450 Acre Feet/yr (1.34 MGD) in the Barr Lake Area. Asking price for the Barr Lake Area water is \$1,500/Acre Foot or \$2.25 million.
11. Mr. Wilson was aware that the Denver Water Board would insist upon getting water rights from Broomfield for an equivalent amount of water which they might supply to Broomfield. Mr. Wilson thought that Broomfield could trade water rights to Denver if raw water from the South Boulder Diversion Canal or Ralston Reservoir were piped directly to the Broomfield Water Treatment Facility. He indicated that an open ditch would not be a satisfactory means of transporting the water to the plant because of the possibility of contamination.

Photo Listed  
April 12, 1976  
Sheet 3

12 Mr. Wilson gave the names of (1) member of the Denver Water Board Engineering Dept. who were familiar with the Denver Supply System to Proctorfield, Jim Poddington, Ext 203 and Dave Holt, Ext 204

*C.P. Pose*

C P Pose

CRP Int

Distribution

I M Callaghan  
V D Crossland  
H R Hill /attn F I Pichter  
I M Sitzberger  
D G Wilson  
R J Yoder

Minutes of Meeting with W. P. Barto and G. Wilson (9)

DATE April 28, 1976

TO Those Present  
ATTN:

FROM R. I. Richter  
ATTN: Building 441

ROOM 2057

SUBJECT Minutes of Meeting with W. P. Barto and G. Wilson  
Broomfield Public Works Department, April 28, 1976

In attendance: R. P. Ellis, D. G. Wilson, R. I. Richter, L. M. Sitzberger of Rockwell International and W. P. Barto and G. Wilson from Broomfield

The meeting was held to discuss the preliminary Broomfield contingency water supply proposals prepared by Rockwell and to confirm the basic ground rules that are being used in the overall contingency water supply study.

1. Immediate, temporary (short term) and permanent (long term) solutions to Broomfield's water supply were briefly discussed. At this time Denver water could be distributed in sufficient quantity to supply Broomfield in case of an immediate emergency with slight curtailment in service in some areas. Growth demands are expanding so fast that in a few years the supply would be insufficient. (An agreement with the Denver Water Board would be required and should be made as soon as possible)

The suggestion was made by Rockwell that immediate, short term and permanent proposals be included in the contingency water supply study.

2. Broomfield and Rockwell agreed the basic ground rules should be
  - a. Open ditches will not be used to carry water across Rocky Flats land where radioactive contamination could be a potential problem. Buried pipelines will be acceptable.
  - b. Raw water at 8 million gallons per day would be required to replace the maximum supply that will be developed from the Great Western (G-W) Reservoir.
  - c. The equivalent alternate storage capacity of the G-W Reservoir (3,100 acre feet) will not be required if a dependable alternate supply could be assured.

3. Rockwell asked Broomfield if they knew about The Front Range Water Study that has been made in the Boulder-Denver-Longmont area. Mr. Parstow suggested that we contact Robert Brind with Rocky Mountain Consultants in Longmont, Colorado (Ph 772-5282) for information on this study. We mentioned that this long range study could have some bearing on the interim water supply study.

4. Mr. Birstow delineated Broomfield's main goals with respect to a contingency supply to replace water from the G-W Reservoir. They ask for a suitable raw water supply of 8 million gallons per day (MGD) delivered to their water treatment plant. At present their water treatment plant is operating at 5.5 MGD, but has the potential to process 8 MGD using water from the G-W Reservoir. Their Church Ditch rights consist of 1,645 (approx) shares which are equal to 1.46 acre foot per share based on dry year runoff flow rates. (This is equivalent to 782,596,000 gallons per year or 2.14 MGD which is far less than the 8 MGD requirement. This disparity represents a serious problem which should be resolved with Broomfield before the completion of the study.)

Church Ditch runs only about 14 weeks per year. Broomfield has filling rights\* on McKay Ditch and Upper Church Ditch which flow into G-W Reservoir. These rights do not represent a dependable source and are not as highly valued as normal shared water rights.

5. A brief review was made of the new and previously proposed alternatives for supplying Broomfield with contingency water. A summary of the comments on each follows.

a. Enlarge storage capacity of Standley Lake using existing Church Ditch rights to fill and transfer water from storage to the Broomfield Water Treatment Plant via Church Ditch. This proposal was not acceptable to Broomfield officials since Standley Lake may have some contamination potential from the viewpoint of the Broomfield City Council.

\* Water remaining in the ditch unused by other share holders

Those Listed  
Page 3  
April 28, 1966

- b Purchase storage rights in Marshall Lake, install pumping station and underground pipeline to the Broomfield's Water Treatment Plant. This plan was totally acceptable to Broomfield. Broomfield would trade Church Ditch water rights with the Denver Water Board for water and storage rights in Gross Reservoir Arrangement. For storage rights in Marshall Lake would be made with the present owners. (Additional water rights would need to be purchased or negotiated to meet Broomfield's 8 MGD requirement)
- c Purchase the remaining capacity of Conduit 81, adding pumping units, increasing storage capacity, etc. This plan has many disadvantages from Broomfield's point-of-view. It removes planned growth potential. It will not meet the 8 MGD requirement and it could mean total control of Broomfield's water supply and planned land use by the Denver Water Board. New water users would be required to pay Denver plus Broomfield water tap fees.
- d Enlarge and use Rocky Flats Lake for storage, divert water from Ralston Reservoir and the South Boulder Diversion Canal to the lake, install pipeline to Broomfield's Water Treatment Plant, etc. This was quite acceptable to Broomfield. The possibility of pollution via air borne releases was mentioned as a possible disadvantage.
- e Same as proposal "d" except that a new reservoir would be proposed north-west of the central plant site. Same comments as "d".
- f Purchase and deliver water from existing Barr Lake area wells (about 23 miles east of Broomfield). Broomfield did not object to this proposal but suggested that water be delivered to their water treatment plant even though it is potable without further treatment. This is necessary since constant water quality monitoring and chlorination is required by state law.

- g Install a reverse osmosis unit to purify Great Western Water Broomfield officials agreed with us that psychological problems would exist Purified water would need to be mixed with Denver water to improve the taste Cost may be large
- h Divert water from Ralston Reservoir to Church Ditch then to Broomfield Water Treatment Plant with additional storage and pumping units Broomfield's existing settling basin is not large enough and silted water would create problems in the water treatment plant Additional silt removal equipment or an underground pipeline from Ralston Reservoir would be required.
- a. Obtain water from other sources such as existing artesian wells in Eldorado Springs, Mayham Lake in Westminster, etc The Eldorado Springs wells would produce about 67 MGD which is less than 1/10th the required flow rate. Storage rights to the Mayham Lake (Mud Lake) are available. (A total of 570 acre feet would be available). Piping this water to the Broomfield Water Treatment Plant would probably not be justified economically

Other sources of water such as purchasing water rights from South Boulder Creek users require further investigation.

- 6 The 100-year postulated maximum flood criteria used by the U S Army Corps of Engineers and others in determining runoff is questioned by Broomfield. They feel the actual runoff rate would be much greater than the figures used

*F E Richter*  
F E Richter

FER sh

Distribution

W D. Crossland  
H. R. Ellis  
D G Mason

F E. Richter  
E W Sitzbenger  
R I Yoder

132

Nov 4, 1976

The above

F I Richter  
C P Rose

Notes from Meeting with Robert C Brand -  
Rocky Mountain Consultants (RMC)

In attendance C R Rose and F I Richter of  
Rockwell and P C Brand of RMC

The meeting was held to discuss the Front Range Water Study made by RMC and to pick up copies of this study. They agreed to let Rockwell have copies of the study on a loan basis.

- (1) Mr Brand recommended that we get the approval of an associate engineer, who actually made the study, before furnishing us with the copies. He will mail this material to us this afternoon.
- (2) Mr Brand stated the Coal Creek Water and Sanitation Association Inc., consisting of the communities of Lafayette, Louisville and Superior, are planning to construct a series of three dams along Coal Creek east of Highway 93. The capacities of these reservoirs would be 32,000 acre feet (AF), 16,500 AF and 9,000 AF. Another "ideal" dam site exists along Coal Creek in the area where the present Idealite quarry exists. This quarry will be abandoned in the near future. The South Boulder Diversion Canal flume traverses the southern section of this dam site. It would be necessary to encase this flume in concrete or relocate it if full use of the area's water storage potential were to be realized. Considerable capacity would be available without filling to the level of the flume.

Most of the water for filling these reservoirs would be obtained from either the Denver Water Board or from additional western slope diversion. Coal Creek has an average flow of 4,500 AF per year. The drought year flow is only 38 AF.

Construction of a new filter plant is planned below the last dam. The filter plant would have a 5 million gallon per day (MGD) capacity with staging capability for the addition of 5 MGD increments up to 25 MGD.

Those Listed  
Page 2  
May 4, 1976

Broomfield's long range contingency supply could be built into this system. Mr Brand suggested we contact Mr Leon Wurl, City Manager of Louisville, for further details of this plan

- (3) Mr Brand stated the Marshall Lake dam is located on a fault caused by collapsing coal mine shafts under the structure. The weakened dam limits the amount of water that can be stored safely. He stated it would probably be cheaper to build a new dam than to repair the existing structure.

Marshall Lake has 1,000 shares of ownership which represents 500 AF during a dry year, 4500 AF during an average year and up to 10,000 AF during a wet year.

Marshall Lake is owned by the Farmer's Reservoir and Irrigation Company, Northglenn, Colorado. Their Attorney, Robert Dick (phone 892-5664) may be contacted for additional information.

- (4) Mr. Brand mentioned the dam structure for Great Western Reservoir has shifted to the east. The amount or the severity of the shift was not known. This may limit the future use of this reservoir.
- (5) Mr Brand suggests we contact Mark Davidson of the State Division of Water Resources to obtain official data on storage capacities of reservoirs and the physical condition of various dam structures such as Upper Church Reservoir, Rocky Flats Lake, Great Western Reservoir, etc.
- (6) We asked if water could be obtained from the Big Thompson Project through the Northern Colorado Water Conservancy District. Mr Brand stated water could not be transferred out of the Northern Colorado Conservancy District by existing decree. The southern limits of the district extend south of Boulder as shown in the attached map - short of Rocky Flats and the City of Broomfield.

Those Listed  
Page 3  
May 4, 1976

(Further legal investigation should be made into this possible water source to determine the intent of the above mentioned decree. Since our need for water is unique, in that it would be used in the event of a remote emergency, perhaps the limits of the decree would not apply)

- (7) Mr Brand stated that another federal water study grant for \$90,000 is ready for presidential approval. This study will be an extension to the Front Range Study and will be made for the U S Bureau of Reclamation

*F E Richter*  
F E Richter

*C R Rose*  
C R Rose

FRE CRR sh

Distribution

D J Cockeram  
W D Crossland  
H R Ellis  
E G Kunz  
~~F~~ E Richter

C R Rose  
F M Sitzberger  
M A Thompson  
R E Yoder

June 15, 1976

TO Those Listed

FROM H. F. Lillis  
F. L. Richter  
C. R. Rose

Notes from Meeting on May 14, 1976  
with S. Mark Davidson, Chief of Dams and Reservoirs  
Branch, Division of Water Resources, State of  
Colorado

In attendance: H. F. Lillis, C. R. Rose, and  
F. L. Richter of Rockwell International,  
S. Mark Davidson and A. Petersen of the  
Colorado Division of Water Resources

This meeting was arranged to discuss the existing dams and  
reservoirs that may affect the Broomfield Contingency  
Water Study and to discuss state laws and regulations  
governing new dam construction

1 Reservoirs

a Rocky Flats Lake (Smart Reservoir)

According to state record, the dam was enlarged  
in 1957. There are two 40-foot spillways located  
on opposite ends of the structure. The reservoir  
covers 58 acres and holds 617 acre feet (AF) of  
water.

Marcus F. Church is listed as the owner, but this  
is an apparent error since the reservoir is lo-  
cated on state school land.

The dam is considered by the state to be in good  
condition.

b Marshall Lake

State records indicate that the dam is 30 feet high  
and is in fair condition. It was inspected in  
1973 with no "adverse comments". There are no  
state restrictions on the use of the reservoir at  
this time. However, Mr. Davidson informed us  
that the state would not be enthusiastic about

increasing the storage capacity since the dam has a bad historical record (this was not recorded in the inspection reports that we reviewed) Only one defect was noted. An inspection report made in May, 1969, indicated that there was a minor seepage problem near the south embankment.

The capacity of the reservoir is 10,462 AF and the surface area is 298 acres. The reservoir is owned by the Limer's Reservoir and Irrigation Company.

d Great Western Reservoir

The state considers the Great Western dam to be a stable structure for current use. There are no existing restrictions. Some restrictions would be placed on recreational use and to prevent the reservoir from being used at full capacity for extended periods of time.

The capacity of the reservoir is 3,026 AF.

f Stanley (Lake) Reservoir

According to Mr. Davidson, this dam has been a problem since it was constructed due to unusual soil conditions that cause slippage. Several years ago this problem was checked by adding large quantities of fill material on the back face of the dam.

g General

During the discussion, Messrs. Davidson and Pearson stated that most dams constructed along the front range have structural problems due to soil conditions and due to old "horse-drawn" equipment construction methods.

2 Dam Regulations

A court decree is now required before a new dam can be built or an existing dam enlarged. A source of water must be available before the decree is granted.



October 22, 1976

10. These Limited

FROM: I. I. Richter  
C. R. Rose

Notes from meeting on October 22, 1976 with  
Representatives from the Denver Board of Water  
Commissioners at their Hillton office

In attendance: W. P. Spider, W. B. Pirstow and G.  
Wilson of Broomfield; C. R. Rose, D. G. Mason,  
F. I. Richter and F. I. Yoder of Rockwell Inter-  
national, B. L. Crist of USBDDA, and T. Valocchi,  
B. Schuler, C. F. Shellenbaum and R. D. Wiley of  
the Denver Water Department

The meeting was arranged to review the "Scope of Work" for  
the study that will be made by an outside architect-engineer  
(A-E) on the Broomfield Emergency Water Supply and to review  
the list of A-I's to determine those that would be acceptable  
to all parties

Messrs. G. F. Shellenbaum and B. Schuler stated that Denver  
would "do what they can" to help solve Broomfield's emergency  
water supply problem in case the Great Western Reservoir  
becomes contaminated. However, they expect to ration water  
to their customers next summer, and possibly for the next  
4 years due to the lack of treatment capacity. They may not  
be able to help-out if an emergency situation should develop.  
The Water Board also expressed a concern over the need of an  
emergency water supply considering the water control projects  
now underway at Rocky Flats. Broomfield suggested that Denver  
could use their water rights in Clear Creek during an emergency.  
Bill Schuler stated that they have no way of diverting Clear  
Creek water into their system. C. Rose suggested that since  
the City of Arvada is constructing facilities to use Clear  
Creek water, a trade could possibly be arranged. They could  
use Broomfield's Clear Creek rights and Broomfield could use  
an equal amount of water that is normally provided from  
Ralston Reservoir.

Denver wanted to know

1. How big the problem is?
2. How long it would endure?
3. What is the probability of having a  
contamination incident?

R. Yoder stated that the A-I study will cover aspects such  
as these

Info Listed  
Page 2  
October 22, 1976

Denver will comment in about 10 days on the "Scope of Work" and give us a list of A-L's acceptable to them

The following individuals were designated as contacts on this project

W R Barstow	City of Broomfield
G I Shellenbaum	Denver Water Department
C R. Rose	Rockwell International
E W Bean	ERDA

*CR Rose*  
C R Rose

*F F Richter*  
F F Richter

Distribution

D J Cocleram  
W D Crossland  
*Mc* H R Ellis  
E G Kunz  
- F E Richter  
C R Rose  
E M Sitzberger  
R E Yoder  
D G Mason

1

Organization

Telephone

2 Mr. [Redacted]

City of [Redacted]

409-3301

3 Mr. William [Redacted]

Public [Redacted]  
City of [Redacted]

409-3301

4 Mr. [Redacted]

Public [Redacted], City of  
Bloomfield

409-3301

5 Mr. [Redacted]

Rockwell International

407-2105

6 Mr. [Redacted]

Rockwell International

407-2957

7 [Redacted]

U.S. FDA

407-2542

8 Mr. [Redacted]

Denver Water Department

222-5511 Ext 401

9 Mr. [Redacted]

Rockwell International

407-2714

10 Mr. [Redacted]

Denver Water Department

222-5511 Ext 207

11 Mr. [Redacted]

Denver Water Department

222-5511 Ext 267

12 Mr. [Redacted]

Rockwell International

407-2706

13 Mr. [Redacted]

Denver Water Department

222-5511 Ext 268

14

15

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17

18

19

20

\* - CONTACTED

City of Broomfield #6 Garden Office Center Broomfield, Colorado 80

September 20, 1976

RECEIVED FOR ADDRESSEE BY  
CORRESPONDENCE CONTROL  
ROCKY MOUNTAIN INTERNATIONAL  
BY *[Signature]*

9-27-76

Mr. Robert E. Yoder, Director  
Health, Safety and Environment  
Rocky Flats Area Office  
P. O. Box 028  
Golden, Colorado 80101

Dear Mr. Yoder

On behalf of the Mayor and the City staff, I wish to convey our sincere appreciation for progress made to date on the Broomfield emergency water supply problem. With the exception of those reservations listed below, we concur with the scope of work as outlined by yourself, Mr. Bill Lamb, and Mr. Chuck Pore on Friday, September 3, for a comprehensive study of the problem, and agree that such a study is the appropriate next step. The only reservations we have are

- 1 That the scope of work will not limit the consultant to strictly radioactive contamination potentials, but will include other potential contaminants as well
- 2 That the engineering study address the City's previous recommendations for a facility for the retention of all Rocky Flats effluent and storm water runoff. This facility would permit such water to be carefully tested before released into Great Western Reservoir. Any subsurface water subject to contamination should also be carefully addressed in this section of the study
- 3 That in Phase II of the study, namely "the evaluation of the need for an emergency supply after current surface water control and water recycle projects are completed," will not discount airborne, underground and flood damage contamination potentials
- 4 That any numerical data contained within the scope of work will be rechecked by the consultant prior to use. Some typographic errors have been noted
- 5 That no one lose sight of Broomfield's position that the ultimate solution should eliminate any dependence on a water supply system that is subject to radioactive or other unusual industrial contamination threats

Attached, as requested, is a list of five consultants that we feel suitably qualify for the type of study project being considered. We are prepared

76-R-1472

142

76-R-1472

Mr. Robert F. Yoder  
September 20, 1976  
Page 2

to meet with you and Denver Water Board representatives at your convenience  
to discuss the next step

If you should have any questions regarding the above, please do not  
hesitate to call either myself or Mr. Barstow

Sincerely,

*George Di Ciero*  
R D

George Di Ciero  
City Manager

GDC rg

cc Walter P. Spader, Mayor  
Bing Barstow, Director of Public Works  
Gip Wilson, Operations Superintendent

MEMORANDUM

April 18, 1977

To File URS NO 7028  
ROCKWELL CONTRACT NO 60041-D

FROM S C BEHRENS

SUBJECT Broomfield Emergency Water Supply Study  
Orientation Meeting

On April 6, 1977, a meeting was held at Rocky Flat Plant to accomplish the following

- 1 Sign contract for subject project
- 2 Receive notice to proceed on subject project
- 3 Generally discuss the scope of work

Those in attendance were as follows

Rockwell International

D M Hogan  
Church Rose  
F E Richter

URS COMPANY

R C McWhinnie  
John Tracy  
E Weber  
S C Behrens

After the contract was signed a number of items were discussed related to the concept of the project some of which were as follows

- 1 Project Coordination - Bi-weekly meetings are to be held to discuss the work progress and project status. The first meeting was scheduled for Wednesday 4/20/77, at 9 00 am at which a project plan schedule would be presented and discussed. Each of these meetings is to follow a planned agenda and will provide an opportunity for a transfer of information. The place for the meeting will alternate between Rocky Flats and URS offices. (The first meeting date was subsequently changed to 4/19/77 at 9 00)
- 2 ERDA Involvement - Dr Yoder may want to attend the bi-weekly meetings to keep abreast of the study
- 3 Broomfield Involvement - Contact with Broomfield may be desirable for the following reasons
  - a Determine various types of systems and system capacities to be examined
  - b Determine existing water rights and planned system improvements
  - c Coordinate system funding and implementation responsibilities

Rockwell representatives will arrange whatever meetings they feel are necessary

- 4 Project controversy - Broomfield's problem has received national attention. The results of this study will be examined intensively and will have to be well documented.
- 5 Project Background Information - Rockwell will send us all previous correspondence and project data. This data will include Rocky Flats raw water system and information on the water recycle plan recently prepared.
- 6 Phase II - Rocky Flats Water Recycle Study and plan drawings have been completed. (Re Rocky Mountain News article of March 30, 1977) This project is proposed to be in full operation by 1979. The scope for Phase II of the project has not been specifically defined and will be identified and accomplished under a subsequent contract.

The meeting was concluded by establishing Rocky Flats as the place for the first bi-weekly meeting.

MEMORANDUM  
4/25/77

TO File 7028  
FROM Ed Weber  
SUBJECT Broomfield Emergency Water Supply  
Meeting with Rockwell International

The first bi-weekly meeting was held at the Rocky Flats Plant at 9 00 AM,  
Tuesday, 4/19/77

Those in attendance were

Rockwell International

Dan Hogan, Chuck Rose  
and Others

ERDA

Dr Yoder and  
Others

URS Company

R C. McWhinnie  
S C Behrens  
Ed Weber  
Harold Kline

Steven Behrens presented a memo of the first orientation meeting, the proposed progress schedule and followed with the summary of tentative study alternates. Several copies of the schedule and summary were given to Rockwell personnel.

Ed Weber briefly described the Broomfield and Denver water systems serving Broomfield and some of the possible difficulties which may be encountered in interconnecting the systems.

All meetings between URS personnel and other organizations concerning this project will be attended by at least one representative from Rockwell. Questions and requests for data should be presented to Rockwell in writing.

Rockwell will consider the desirability of having a representative from Broomfield attend future bi-weekly meetings.

Numerous comments and questions were raised during the discussion of alternatives, some of which were the following:

- 1 Standley Reservoir should be considered as a source for raw water with a connection to the Broomfield Water Treatment Plant (WTP). Ownership of water rights in Standley Reservoir will necessarily be evaluated. ERDA/Rockwell will furnish URS with a statement concerning the contamination probabilities related to Standley Reservoir.

MEMO  
File 7028  
4/25/77

- 2 Church Ditch should be considered as a source of raw water with either an enclosed conduit system to the WTP or a conveyance of Broomfield rights to Standley Reservoir for storage with a connection from Standley Reservoir to the WTP
- 3 The possibility of the Denver Water Board assuming control of the Broomfield WTP to provide additional capacity to their system appears small because of the following
  - a The DWB's present position on not expanding service to outlying areas
  - b The DWB has not looked favorably on assuming the operation of a WTP with such a small capacity relative to their plants
- 4 Clarification of the various amounts of "emergency" water supply provided to Broomfield has to be made. Our present assumption concerning the required levels of service for this supply are the following
  - a Emergency treated water alternatives should provide the following supply capacities to the Broomfield service area.
    - (1) Minimal existing service - 2.0 MGD
    - (2) Maximum existing service - 5.5 MGD
    - (3) Maximum future service - 8.0 MGD

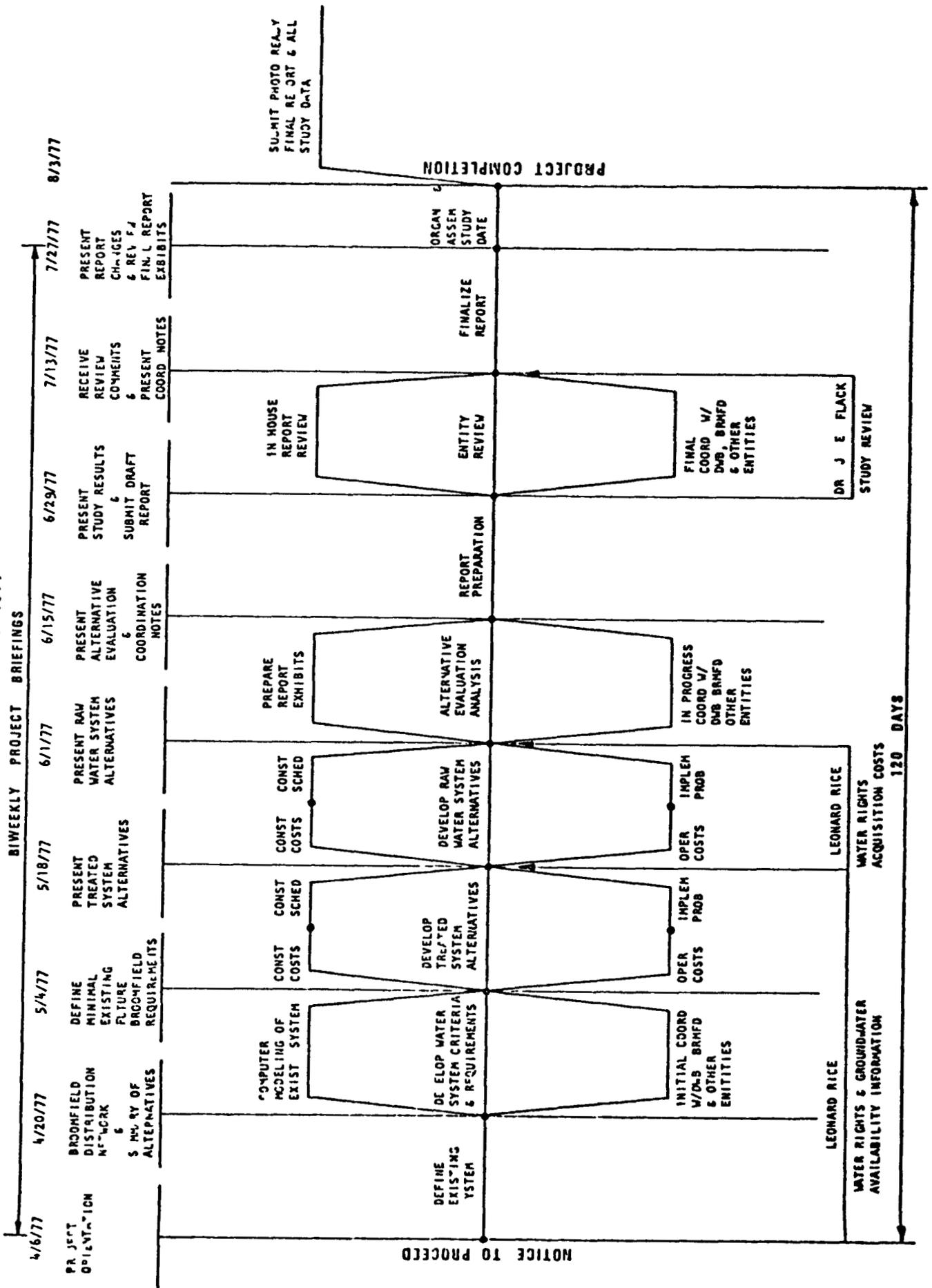
These amounts are based on present and future planned supply provided by the Broomfield WTP. It is assumed that the existing 4/7 capacity of conduit 81 (9.7 MGD) will adequately serve the future Denver service area.
  - b Emergency raw water alternatives should provide a continuous supply to the Broomfield WTP to facilitate its planned capacity of 8.0 MGD serving the Broomfield service area.
- 5 Various combinations of treated water and raw water alternatives should be investigated on a cost and time frame basis. Implementation feasibility should be included in this evaluation.

The meeting was concluded with the establishment of the next bi-weekly meeting to be held on 5/4/77 at 9:00 AM at the HAS offices.

# BROOMFIELD EMERGENCY WATER SUPPLY STUDY SCHEDULE- PHASE I

URS COMPANY NO 7028 APRIL 1977

BIWEEKLY PROJECT BRIEFINGS



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CITY OF BROOMFIELD, COLORADO  
DEPARTMENT OF PUBLIC WORKS  
SECTION 201

MINIMUM DESIGN STANDARDS FOR WATER DISTRIBUTION SYSTEM

201-1 0 General All water distribution system design shall take into account the requirements of the City of Broomfield Standard Specifications for Water Main and Service Line Construction

201-2 0 Design Flow The design of the water distribution system shall be based on the following

Maximum hour flow	1,000 g p c d
Maximum day flow	550 g p c d
Average day flow	200 g p c d
Population per tap	4 0 persons
Fire flow (residential)	1,500 g p m
Fire flow (industrial or commercial)	3,500 g p m

May be from more than one fire hydrant providing the additional hydrants are accessible to any possible fire location

For service areas consisting of 60 taps or less, peak per capita design consumption shall be obtained by interpolation in the following table

<u>No Taps</u>	<u>Peak Consumption (Gal Per Cap Per Day)</u>
60	1,000
50	1,150
40	1,360
30	1,670
20	2,250
10	3,750
5	6,000
3	7,500
1	10,000

201-3 0 Pressure Requirements All areas shall be designed to have a maximum static head of 120 feet (12.7 psi) and a minimum static head of 100 feet (4.3 psi) Distribution systems shall also be designed to maintain a 20 psi residual pressure during required fire flow and a 30 psi residential residual during peak residential flow Pressure zones shall conform to existing City of Broomfield ones as shown on the Master Water System Plan

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201 - 4 0 Fire Hydrant Spacing In residential areas, fire hydrants shall be spaced 500 feet apart measured along street curb line and at an overall spacing that will average not less than one hydrant to 200,000 square feet throughout an individual subdivision. Where blocks are over 500 feet in length, intermediate hydrants shall be placed in the center of the blocks. A hydrant shall be placed in the end of each cul-de-sac over 300 feet in length. Fire hydrants shall be located on the northeast corner of intersections if possible.

In business and industrial areas, hydrants should be spaced not greater than 150 feet apart and shall cover not more than an average of 90,000 square feet per hydrant

201-5 0 Pipe Size and Spacing Primary and secondary feeder lines shall be located in accordance with the current City of Brookfield Master Water System Plan. Distribution mains shall normally be 6 inch pipe where the length of the main between branches is less than 800 feet; otherwise 8 inch pipe shall be used. Four inch mains when approved by the Department of Public Works may be installed on permanent dead-ends less than 300 feet long when a permanent blow-off is provided. All piping shall be looped wherever possible. Mains at ends of long cul-de-sacs shall be looped along lot lines to adjacent streets. Where approved by the Department of Public Works, dead-ends may be provided on cul-de-sacs less than 300 feet long with a permanent blow-off or fire hydrant at the dead-end. Dead-ends on any line that will be tapped for service before being extended shall be provided with a temporary blow-off or fire hydrant. Dead-ends on lines that will not be extended shall be provided with permanent blow-offs or fire hydrants.

201-6 0 Valve Spacing: Valves shall be placed with a maximum length of line required to be out of service at one time of 1500 feet on primary feeders and 800 feet on all smaller mains. Valves shall also be placed at each fire hydrant and permanent blow-off. Typically, every intersection will have at least two valves, and more where required to allow for the lesser number of homes being out of service at one time. All valves having a nominal diameter of 10 inches or greater shall be geared butterfly valves.

Air vacuum valves shall be installed at high points on primary feeders and where venting high points in a fire hydrant isn't feasible on distribution mains.

201-7 0 Hydraulic Design: All pipes shall be designed to have a maximum velocity of 10 feet per second. Distribution Mains shall be designed using a Hazen-Williams friction coefficient "C" equal to 100. Primary feeders may be designed using a "C" of 130.

201-8 0 Pipe Materials All pipe used in distribution systems shall be either cement-lined cast iron or ductile iron pipe. The designer shall specify the pipe class as required for specific project conditions. See City of Brookfield Standard Specifications for Water Main Construction for details on pipe and installation.

201-8 0 1 Poly (Vinyl-Chloride) (PVC) Pressure Pipe. All pipe shall be as AWWA Standard C-900-75 requires-PVC 1120 Class 150 or 200. All valves and "r's" will be cast iron or ductal iron.

201-9 0 Location (Typical) Water mains shall be typically located 12 feet north or east of the centerline of the street, unless approved otherwise by the Department of Public Works

At street intersections, valves shall be located at the property lines extended. Fire hydrant gate valves should be placed near the main. When fire hydrants are connected to transmission mains or any mains larger than 8 inch, the gate valves shall have a retrained connection directly to the tee off the main.

In all instances, the water mains shall extend to the extremities of the property or subdivision served. A main serving one lot shall extend all the way across the frontage for that lot. Mains serving a subdivision shall extend to the center of boundary streets or to boundary lines.

201-10 0 Bedding and Cover The need for pipe bedding shall be determined by the designer for the project involved. All pipe shall be installed with 4 1/2 feet of cover from finished grade of street to the top of the pipe barrel.

201-11 0 Service Connections See City of Broomfield Standard Specifications for Water Service Line Construction for details on service stub-ins and house service connections.

MEMORANDUM

5/4/77

TO File URS #7028

FROM S C Behrens

SUBJECT Broomfield Emergency Water Supply - Bi-Weekly Meeting

A bi-weekly meeting was held at the URS offices at 9 00 a m , Wednesday, 5/4/77 Those in attendance were

Chuck Rose - Atomics International	Bob McWhinnie - URS
W D Crossland - Atomics International	Steve Behrens - URS
Ron Ellis - Atomics International	Ed Weber - URS
Ron Foster - ERDA	Harold Kline - URS

I briefly reviewed the schedule and introduced two topics of discussion for the meeting

- 1 Study assumptions for treated water alternatives
- 2 Information requirements from DWB, Broomfield, and Westminster

Ed Weber presented a list of assumptions pertaining to the treated water system criteria that are intended to be used as a basis for developing the various study alternatives The ensuing discussion brought up a number of study considerations, some of which were as follows

- 1 The assumption of 8 0 MGD maximum service to the Broomfield system was agreed upon due to the following
  - a 8 0 MGD is the generally accepted maximum planned capacity of the existing Broomfield Water Treatment Plant (WTP) as stated in Broomfield's letter to Atomics International dated 1/30/76
  - b Broomfield has reviewed and accepted the scope of work for the project which contours provisions for studying an emergency supply equal to the planned capacity of their WTP which was assumed to be 8 0 MGD
  - c A Broomfield WTP capacity of 12 MGD has been mentioned in the past, but will not be considered in our study
- 2 RFP's Water Recycle Project is to be completed in June, 1978, and the Surface Water Control Project is scheduled for completion in late 1979 or early 1980 Is there a maximum intermediate amount between the 5 5 MGD (present maximum usage) and 8 0 MGD (future maximum usage) that we should use for emergency service criteria?
  - a URS estimates that Broomfields total maximum requirements will reach 17 7 MGD by 1985

- b Our study will include an analysis of a 1980 intermediate emergency service requirement based on the assumption that no emergency system will be required after the recycle and surface water control projects are complete
- 3 Study report should present a matrix of alternatives identifying combinations of service criteria, requirements and implementation considerations from which ERDA could select a desired course of action. ERDA should be able to use this report as a basis for negotiation with Broomfield to arrive at an agreement which satisfies Broomfield's emergency needs and facilitates their future requirements
  - a Matrix should incorporate existing, 1980, and 1985 service requirements
  - b Matrix should examine various subalternatives such as imposed sprinkling restrictions, variations of Denver/Broomfield service area relationships, and system interconnection options
- 4 Cost considerations for the various treated and raw water alternatives should include
  - a Inflation rate of 12%/year projected to midpoint of construction
  - b Easement costs for conduit installation outside government property
  - c Breakout of facilities Broomfield would necessarily have to provide in normal planned expansion of their system such as storage on the Denver system, additional water mains to serve new areas, and required pumping and valve facilities

Bob McWhinnie presented three memorandums identifying informational requirements from the Denver Water Department, Westminster, and Broomfield. It was agreed that meetings be held with these entities at the earliest opportunity to allow for an orderly progression of work. Meetings were subsequently arranged with:

- 1 Denver Water Department  
Mr. L. G. Golfin, Manager  
1440 N. Golfway  
1:30 P.M., Friday 5/6/77
- 2 City of Broomfield  
Mr. George DiGeroni  
Building 11 RFP  
9:30 A.M., Friday 5/6/77

The meeting was concluded by establishing the next bi-weekly meeting time and place to be 9:00 A.M., Wednesday, 5/8/77, at RFP

M E M O R A N D U M

May 9, 1977

TO File URS #7028

FROM S C Behrens

SUBJECT Broomfield Emergency Water Supply  
Coordination Meeting with Broomfield

On Friday, May 6, 1977, a meeting was held with representatives from the City of Broomfield to discuss the general subjects identified on the attached memo dated May 2, 1977, and previously discussed in a meeting held on April 28, 1976. Those in attendance were as follows:

	<u>Name</u>	<u>Organization</u>	<u>Title</u>
1	G M Galmish	ERDA	Branch Chief Manager & Constructor
2	Earl Bean	ERDA	Asst Mgr for Operations
3	Joe Watt	ERDA	Asst Manager Const
4	Ron Foster	ERDA	Project Engineer
5	Robert Yoder	Rockwell	Director Health & Safety
6	W D Crossland	Rockwell	Director-Support Operations
7	Chuck Rose	Rockwell	Project Manager
8	William Barstow,	City of Broomfield	Director of Public Works
9	Gip Wilson	City of Broomfield	Operation Super
10	Tom Duran,	City of Broomfield	Lab Specialist
11	Susan Townsend	Denver Post	Reporter
12	Bob McWhinnie	URS Co	Principal-in-Charge
13	Stephen Behrens	URS Co	Project Manager
14	Ed Weber	URS Co	Project Engineer

Many items were covered during the meeting of which the following represents a summary of all of the specific points that were raised:

- 1 Broomfield expressed their concern over the phrase "unlikely event of radio-active contamination" in our contract in that it was vague, qualitative, and presumptuous. Any results from this study expressed in like terms would be unacceptable to Broomfield. It was decided that an estimated probability should be developed during the study.
- 2 Broomfield would prefer an emergency system for the Broomfield Service Area that would be capable of supporting the proposed expansion of the existing water treatment plant to an 8 MGD capacity. Broomfield gave the following information:
  - a Growth rate of Broomfield is 11-12%/year
  - b Long term flexibility is lost by solely considering Conduit 81 whose capacity of 9.7 MGD will be exceeded for the Denver Service Area sometime between 1983 - 1987

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- c Total demand for both service areas is currently 8.6 MGD (Max-day use)
  - d Broomfield system operates at about 2/3 of the cost of the Denver system.
  - e Any emergency system involving Conduit #1 would require extensive back-up mechanical and electrical pump systems
- 3 Broomfield has initiated action to acquire water from Denver Water Department to carry them through this summer's expected shortage and have thus far received only a negative response
  - 4 To obtain the total 9.71 MGD capacity in Conduit #1, additional "hardware" (pump and storage capacity) would be required over what is presently on the line
  5. Broomfield would prefer that the emergency system would incorporate a raw water source located upslope from WFP with the water conveyed to the WFP in a closed conduit system
  - 6 Summary of potential raw water sources discussed were
    - a Englewood/Ranch Creek Water - believed to originate in the DAB - S Platte System and is not readily transmissible to Broomfield.
    - b McKay and Upper Church Ditches seem unfeasible because both originate in Coal Creek which does not have a reliable water supply in sufficient quantity
    - c. Barr Lake groundwater may be useful as a source of water for exchange for upstream water.
    - d Farmer's water rights in Standley Res may be feasible. Broomfield has negotiated to purchase water from the Farmers Reservoir & Irrigation Company on an emergency basis for \$30/one inch - share which with an average annual yield of 1.46 ac-ft would be equal to approximately \$60/ac-ft
  - 7 Broomfield expressed their desire to cooperate fully with the study. They are experiencing a great deal of public concern over the current water shortage and the contamination possibilities from their citizens. The City Council would in all probability support a favorable solution to both problems and be open to a fair and equitable sharing of the costs for an agreed upon solution
  - 8 Broomfield's immediate concern is the current drought and a water shortage this summer. They expressed concern that they will not be able to draw down G-W reservoir below the 440 ac-ft level due to public reaction to the water quality below that point. The lowest acceptable outlet of G-W is at the 150 ac-ft level. Because of public concern over contamination the water between 440 and 150 ac-ft is felt by them to be questionable due to the amount of suspended solids. Maintaining the water level at 440 level may leave Broomfield with a water shortage of 800 ac-ft this summer

- 9 Broomfield would like to stay involved with the Study and welcomed the opportunity to express their interests and concern They indicated their willingness to share any and all information concerning their existing system and arrangement with the DWB
- 10 Broomfield indicated they were not concerned with air-borne contamination of water supplies
- 11 Broomfield indicated storage in Standley Lake would be an acceptable alternative for them, but they would prefer a source of supply to the West of the RF plant
- 12 Broomfield asked about the possibility of wells as a source They were advised that wells did not look like a feasible alternative
- 13 Broomfield was advised that for study purposes a 1 year emergency duration would be used to insure that any proposed solutions would be workable during any season of the year
- 14 Broomfield would have no objection to an open ditch raw water supply alternative outside the Walnut Creek Basin

M E M O R A N D U M

May 2, 1977

To Chuck Pose - Pockwell International  
From Robert C. McHinnis  
Subject Broomfield Water Study - Information from Broomfield

We suggest an early meeting with George DiCiero - City Manager, William Burstov, Director of Public Works, and Gip Wilson, Utilities Superintendent, to discuss the following general subjects

- 1 A treated water supply from Denver or Westminster in case of emergency due to contamination of Great Western Reservoir. We need to establish what Broomfield's feelings and wants are and then to evolve our ideas and theirs into a general set of criteria for treated water service to be approved by Pockwell and LPDA and transmitted to Broomfield.
- 2 A raw water supply from any source in case of emergency due to contamination of Great Western Reservoir.
- 3 We should also establish at this first meeting that ERDA can only consider paying for the improvements necessary to provide an alternate source of supply. Any betterments must be paid for by Broomfield.
- 4 We need, also, to ask Broomfield to list any other considerations they would like to see included in the study. In requesting this shopping list, Broomfield must be reminded of the fact that ERDA is not a source of funding for other than an emergency water supply and perhaps not even that.

We need to open the communications with Broomfield and bring their thinking along parallel to the study and report. Otherwise, I am afraid we face the chance of Broomfield's not accepting the study results.

- 5 We need to determine from Broomfield their water service area and the amount of water to be served from the Broomfield system and from the Denver system. Also, a list of the planned improvements to the Broomfield water system would be helpful.

M E M O R A N D U M

May 6, 1977

TO File - URS #7028

FROM S C Behrens

SUBJECT Broomfield Emergency Water Supply  
Coordination Meeting with Denver Water Department

On May 6, 1977, a meeting was held with the Denver Water Department in their offices to discuss several matters concerning our study identified in the attached Memo dated May 2, 1977, which was previously sent to the DWB Those in attendance were as follows

1	J L Ogilvie, Manager	Denver Water Board
2	R D Wiley	Denver Water Board
3	Bob McWhinnie	URS Company
4	Stephen C Behrens	URS Company
5	Ed Weber	URS Company
6	Ron Foster	ERDA
7	R E Yoder	Rockwell
8	W D Crossland	Rockwell
9	C Rose	Rockwell
10	H R Ellis	Rockwell

At the start of the meeting Chuck Rose briefly presented the background to our study and its current status "Rocky" Wiley then presented written responses to the seven items contained in the Memo, dated May 2, 1977 After a brief study of these responses, the following points of clarification were discussed

- 1 The DWB is reluctant to increase or extend any service outside Denver at the present time Broomfield has requested additional service to which the DWB has prepared a negative response
- 2 The DWB has no raw water available for purchase out of Gross or Ralston Reservoirs, nor is there any additional storage capacity in either of these facilities
- 3 The DWB has been receptive and agreeable in the past to trading treated water for raw water rights If Broomfield could provide raw water rights to the DWB (possibly from Church Ditch) additional treated water could be conveyed to Broomfield in Conduit 81 in return
- 4 The DWB would not be interested in assuming the operation of the Broomfield Treatment Plant as a condition of receiving raw water in return for supplying additional treated water to Broomfield
- 5 The DWB would be unwilling to enter into an emergency water supply agreement with Broomfield which exceeded the service currently under contract (9.7 MGD) If however, a dire emergency did occur which endangered life or public health or safety, the DWB probably would consider providing necessary assistance

- 6 Englewood/Ranch Creek water is believed to originate in the DWB - S. Platte River System and would not be available to Broomfield. This, however, will be checked and further clarification will be made.
7. The DWB would provide the following information as requested at the meetings:
  - a Additional system information concerning Conduit 81 and the pump station located at 8th and Washington.
  - b Up-to-date cost information regarding water facilities installation, operations and engineering.

Attachment Denver Water Department's written response to question about Denver's ability to provide an emergency supply.

Federal Print  
FO E 5 7 2  
Contract Colorado  
(703) 49-3011  
Contractor to  
Engineering and Development  
Administration

Rockwell  
International

May 4, 1977

77-RF-0721

James L. Ogilvie, Manager  
Denver Water Department  
144 West Colfax Ave  
Denver, Colorado

Dear Sir

Attached is a memorandum from Robert C. McHinnic, of the  
URS Company, containing items of information which URS needs  
for a study which they are doing for Rocky Flats on an  
Emergency Water Supply for the City of Broomfield. I  
understand that Mr. McHinnic scheduled the meeting with  
you for May 6. We appreciate your prompt scheduling of  
this meeting as the URS Company is working on a tight  
schedule and needs answers to the attached questions  
before proceeding.

Sincerely yours,

Charles P. Pose  
Project Manager

CPR Int

Enc. zero

cc  
P. C. McHinnic, URS Company  
Clara Schellenbar, Denver Water Board

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JAMES L OGILVIE  
Secretary Manager



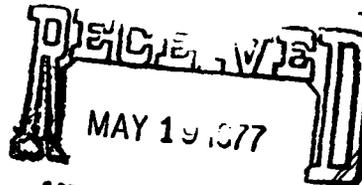
# Board of Water Commissioners

144 West Colfax Avenue Denver, Colorado 80202 Phone 222 5511

COMMISSIONERS  
CHARLES F BRANNAN President JAMES B KENNEY JR 1st Vice-President  
WILLIAM G TEMPLE JOHN A YELENICK RICHARD S SHANNON JR

May 10 1977

Mr Charles R Rose  
Pockwell International  
Rocky Flats Plant  
P O Box 464  
Golden, Colorado 80401



URS OFFICE COPY

Dear Mr Rose

This is in response to your letter of May 4, 1977 which requested information required by the U R S Company's Emergency Water Supply Study for the City of Broomfield

As requested, we have provided herewith answers to the questions presented in Mr McWhinnie's memorandum of May 2, 1977

This is the same information which was extended to you at our meeting of May 6, 1977 If you have any further questions concerning such please contact me

Sincerely,

J L Ogilvie  
Manager

JLO/jmp

Encl

cc Robert C McWhinnie ✓

M E M O R A N D U M

May 2, 1977

To Chuck Pose - Rockwell International  
From Robert C McWhinnie  
Subject Broomfield Water Study - Information from Denver Water Department

We suggest you transmit the contents of this memorandum to J L Ogilvie, Manager of the Denver Water Department, with a copy to Glen Schellenbalm, Manager of Marketing, and that you request an early appointment to discuss these matters and impart the need for prompt resolution of the matter to allow the study to be completed on schedule

- 1 If Broomfield wishes to exercise the option to purchase the remaining capacity in Conduit #81, would the terms and conditions be those expressed in the contract between Denver and Broomfield? If not, what would be those conditions?
- 2 The Denver Water Department's long range plans, as described in the 1975 Metropolitan Water Resources & Requirements Report, suggest a number of water mains would extend north from the Denver system into the Broomfield area. What are the future plans and policies of the Water Department regarding the availability of water for additional areas and the proposed schedule for these aforementioned facilities?
- 3 Does Denver have any raw water available from the South Boulder System at Gross or Ralston Reservoirs or anywhere between that Broomfield might purchase?
- 4 Would any storage capacity be available to Broomfield at either Gross or Ralston Reservoirs?
- 5 If Broomfield were to obtain raw water in the South Boulder System, under what conditions would the Water Department transport this water in the South Boulder System? Do the same conditions hold for its Englewood Panch Creek water?
- 6 Does the Water Department have any suggestions of sources of water supply that might be available to Broomfield?
- 7 We need to know the operating condition, both present and future, at the Conduit #81 pump station including size and number of pumps and the system head curve

With summer demands exceeding present treatment capacity, construction of a fourth treatment facility, Foothills Complex, is essential. The Foothills complex has continued to be delayed because of unexpected federal environmental demands and subsequent delays in reviewing final preparation and publishing of environmental impact studies by federal agencies. Until this complex becomes available, the Department's ability to provide treated water will continue to be impaired. The answers given below assume that the constraints imposed by the lack of treatment capacity will be overcome and allow additional capacity to be available to the system in the near future. However, until the Board is assured of this additional capacity, the further extension of our service commitments is questionable.

- 1 The Board will honor the terms and conditions expressed in the Broomfield contract in leasing water delivered through Conduit No. 81. In this regard, the Board will require any distributor leasing water to pay a proportionate share of the cost of facilities at a rate to be determined by the Board, but in no event at a rate less than the proportionate contribution by Broomfield. Preference will be given Broomfield for use of the additional capacity provided that it is demonstrated to the satisfaction of the Board that such capacity requested by Broomfield will provide a return to the Board equal to or greater than the anticipated revenue through other distribution contracts. However, additional capacity will be extended only to that extent which the Board deems as non-injurious to its present customers.
  
- 2 Primary expansion of transmission facilities will depend upon the Department's ability to finance and support additional raw water supplies and treatment facilities such as Eagle-Piney and construction of an East Slope storage reservoir and Foothills Complex which are deemed essential before granting further extension of service. Future plans of the Department would call for extending facilities as new areas are developed and based on the capacity purchased from Department facilities. The water service policies of the Department will be determined greatly by the availability of raw and treated water and the political and economical constraints existing at that time. Accordingly, a detailed schedule for future facilities can not be presented.

- 3 At the present time, the Denver Water Department does not have a surplus of water in its Moffat Collection System. In fact, there is a water shortage in this system which is one of the main reasons the Department is implementing a water restriction program this year
- 4 The Department utilizes the entire storage capacity of Raiston Reservoir except during the winter months when it is impossible to keep the reservoir full because South Boulder Canal is inoperable. The Department also uses the capacity of Gross Reservoir to the maximum extent possible with the present water supply. Although Gross Reservoir does not fill and spill every year, the Department does use all of that facilities capacity to maximize the yield in those years when the supply is large enough to meet direct flow demands and fill the reservoir.
5. Although there is no excess raw water available at this time in the Department's Moffat Collection System, the conditions for transporting water to Broomfield if it were to become available would probably include, but not be limited to, the following items
  - a. Deliveries of said water would be made at a point directly below Gross Reservoir, or at a mutually agreeable point on South Boulder Canal, or at a point immediately below Raiston Reservoir, or at the point where the Raiston Clear Creek Canal discharges into Clear Creek.
  - b. Broomfield would be entitled to use the capacities of the Department's facilities only to the extent that the capacity was not needed for the Department's purposes.
  - c. Any modifications to the Department's existing facilities which would be required to supply water to Broomfield would be made at Broomfield's expense.
  - d. Broomfield would absorb its pro rata share of transportation losses incurred in the carriage of its water.

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e The timing for and flow rates of delivery of Broomfield's water would be subject to the Department's discretion

The same conditions would apply to water derived by Denver from Englewood's Ranch Creek System

6 The Denver Water Department presently does not have any excess water available to Broomfield and is not aware of any other sources that may be available at this time

7 The Board assures Broomfield of its intent to supply to its distribution system 9.7 MGD under those conditions as set forth in its contract. Future operation of Conduit No. 81 and the pump station will also be determined as additional treatment capacity and raw water supplies are developed

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M E M O R A N D U M

May 9, 1977

TO File URS #7028  
FROM S C Behrens  
SUBJECT Broomfield Emergency Water Supply  
Technical Coordination Meeting with Broomfield

On May 9, 1977, a meeting was held in Broomfield as a follow-up to the study orientation meeting held at Rocky Flats Plant on Friday, May 6, 1977. Those in attendance were as follows

Gip Wilson - Broomfield	Chuck Rose - Rockwell
Mike Middleton - Broomfield	Steve Behrens - URS
Ron Foster - ERDA	Ed Weber - URS

Items discussed at this meeting were as follows

- 1 Several proposed changes are being contemplated to both the Broomfield and Denver Service Areas. Several areas now on the Broomfield system but located in the Denver Service Area (by contract) are going to be transferred to the Denver System. This is a conflict with the general desire of the city to become totally self-sufficient. Specific line changes were discussed and will be incorporated into our network distribution runs.
- 2 Additional storage is required on the Denver System which we can assume will be placed adjacent to the existing storage facilities at the existing location.
- 3 Additional pumping facilities and back-up systems would be required to furnish Broomfield with an emergency supply in Conduit 81.
  - a The pump station at 96th and Washington currently has three pumps (2 active & 1 standby). The station was believed to have been ultimately planned for seven pumps at 5 MGD each providing a capacity of 35 MGD.
  - b Jerry Kavanaugh with the DWB has detailed information concerning this system.
- 4 Broomfield has had to furnish emergency service to the Denver system for approximately 2 weeks due to a power outage at the pump station on Conduit 81.
- 5 The emergency agreement between Broomfield, Westminster and the DWB was presented, and discussed. A three way connection at 128th and Huron St with Conduit 81 and a 12" pipe from Westminster is the interlocking basis for this agreement.

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- 6 Various sources of raw water were discussed. The Broomfield service area is facing a water shortage this summer of an estimated 800 acre ft. Actions considered to remedy this situation have included:
  - 1 Purchasing water from DWS - negative response
  - 2 Purchasing raw water from FRICO in Church Ditch - possible source still being examined
  - 3 Mandatory water restrictions - will coincide with DWS possible restrictions
- 7 An exhibit showing water usage between irrigation and other uses was presented and discussed. Estimated irrigation use in the summer months amounted to 25% on the Denver System and 33% on the Broomfield System.
- 8 Various network assumptions and changes were presented to Broomfield on a layout map. Mike Middleton said he would study them and relay his comments to us later in the week.
9. Gip Wilson indicated that Broomfield expansion would probably have to be on the Denver Service Area since it is uncertain the Broomfield WTP will reach its intended capacity of 8.0 MGD because the possibilities of finding enough raw water to supply the WTP 8.0 MGD are extremely remote. To date it is not clear whether they can find enough water to increase the supply to the WTP from 5.5 to 8.0 MGD. They are actively looking for more raw water but have not had much success.
10. Gip Wilson said that 98% of GW water comes from Church Ditch. This percentage would be even higher except for experiencing a big down pour contribution which provided a great amount of water from the drainage area around WTP which increased the percentage from other sources. (This percentage was higher than what was expected)

SCB/dmv

MEMORANDUM

May 11, 1976

TO File URS #7028  
FROM Weber and Behrens  
SUBJECT Broomfield Emergency Water Supply Meeting at Westminster

on May 11, 1977, a meeting was held in Westminster to discuss the possibility of obtaining emergency water service from Westminster Present at the meeting were

Marvin Thurber	Director of Operations, - Westminster
Steve Garman	City Manager, Westminster
W D Crossland	Rockwell, Int
C Rose	Rockwell, Int
Frank Richter	Rockwell, Int
Ron Foster	ERDA
Steve Behrens	URS Co
Ed Weber	URS Co

Westminster can supply emergency water only for periods not longer than 3 or 4 days

Present treatment capacity is 21 MGD for the maximum day For periods of maximum demand as long as a week, the capacity is reduced to 85%

Westminster experienced 13% growth during the past year and is the fastest growing city in the area

Westminster increased the height of the dam at Standley Lake and in effect constructed a new reservoir on top of the existing one 24,000 acre ft of storage was added at this time with 12,000 A-F going to FRICO and the top 12,000 ft to Westminster The maximum water surface elevation is 96 ft

Because of damage to the riprap, the state engineer has restricted the water surface elevation to 89 ft thereby depriving Westminster of 7,500 acre ft of storage Fourteen percent of the bottom 30,000 acre ft belong to Westminster and Thornton Westminster has difficulties dealing with FRICO concerning costs for repairs and maintenance At the present time, Westminster is in poor shape on raw water supply

Westminster is attempting to increase their raw water supply with exchange agreements with FRICO Westminster will use the water from Standley Lake and will return it to the farmers Highline Canal after it passes through the sewage treatment plant Water lost during use must be replaced Thurber suggested that this would be an advantageous arrangement for Broomfield to pursue with the agricultural users on Bull Ditch It may be necessary to store the sewage treatment plant effluent down stream for the farmers

An interconnection between Broomfield and Westminster at 120th and Sheridan would be desirable for both cities for emergency service Thurber gave URS data on pressures and flows at this location for the ultimate system peak day demand We are to call Ed Ross of Henningson, Durham, & Richardson (HDR) (861-1300) if more information is required

We also looked at a map showing possible potential sites that had been studied by Woodward-Clyde. Some of these appeared to be downstream from Broomfield and could be useful for water exchange

At the end of summer, water level in Standley drops to about elevation 70.

Wells in the northern metro area can produce 20-60 gpm.

SCB/dmv  
EW/dmv

M E M O R A N D U M

May 17, 1977

TO File URS #7028

FROM S C Behrens

SUBJECT Broomfield Emergency Water Supply - Bi-Weekly Meeting

A bi-weekly meeting was held at Rocky Flats Plant at 10 00 a m , Tuesday, 5/17/1977 Those in attendance were as follows

G M Galmish	ERDA	R E Yoder	Rockwell
Earl Bean	ERDA	W D Crossland	Rockwell
J A Watt	ERDA	Chuck Rose	Rockwell
R Foster	ERDA	D G Mason	Rockwell
B McWhinnie	URS	H-R Ellis	Rockwell
S Behrens	URS	F Richter	Rockwell
E Weber	URS		
H Kline	URS		

I briefly reviewed the schedule and introduced 4 topics for discussion

- 1 Review memorandum notes from recent coordination meetings
- 2 Present and discuss Treated Water Alternative Matrix
- 3 Englewood/Ranch Creek raw water agreement with DWB
- 4 Brief summary of project to date

We first discussed the "draft" memos of the meetings held on May 6, 1977, with Broomfield and the DWB Chuck Rose presented ERDA/Rockwell review comments which we were to incorporate into the final memos and return to ERDA/Rockwell for distribution I presented memorandums of a subsequent meetings with Broomfield on May 9, 1977, and Westminster on May 11, 1977

We then discussed a Treated Water Alternative Matrix which covered 2 alternate water sources (Denver and Westminster) at 3 levels of Service (Existing Future, and Ultimate) The following is a summary of some of the comments concerning this Matrix

- 1 The matrix presented is only in draft form showing tentative information Data shown will be checked, expanded, and presented in a more final form at our next Bi-Weekly Meeting
- 2 The identified water requirements for the various levels of service were assumed on the basis of information received from Broomfield, DWB, and a 1973 report prepared for Broomfield by NHPQ "The Water System Plan" This information included
  - a Population projections
  - b Capacity of Conduit 81
  - c Capacity of Broomfield WTP
  - d Factors for Max Day and Peak Hour water use based on average day values

Max Day = Average Day x 2 75

Peak Hour = Average Day x 2 75 x 2 19

- e Emergency Levels of Service was derived by dividing normal average day levels by 1.5 which reflects experience information between winter & summer usage.
- 3 Any assumed population projections used to establish levels of service criteria should be checked and confirmed with other responsible agencies.
  - 4 The expansion and reduction factors are very sensitive at this time and will be compared to the most recent experience information available.
  - 5 Cost figures shown represent present day values and are based on information received from the DWS. No evaluation has yet been made of costs relating to R.O.W., water rates, or operations.
  - 6 The final matrix tabulation should show consistent considerations between levels of service. Since gross storage or modifications to conduct BI are the responsibility of Broomfield to provide normal service in future or ultimate years, these considerations should be identified but not compared to the existing system in terms of costs or requirements.

Ed Weber then presented an initial interpretation of the DWS agreements with Englewood and Climax concerning the availability of the Ranch Creek raw water. A summary of this interpretation includes the following:

1. Climax helped develop the Ranch Creek collection system and will retain water rights from Williams Creek in exchange for Ranch Creek water rights
2. Denver has agreed to transport and control the Ranch Creek water via the Moffat Tunnel System if adequate capacity is available in exchange for an equal amount of raw water out of the South Platte System.
3. An estimated amount of raw water available to Englewood is 3000 ac-ft to which climax has 1st rights and is not readily deliverable to the Broomfield Water Treatment Plant

At the conclusion of the meeting I briefly summarized the progress of work to date by reviewing the schedule and outlining the following events which have transpired this far

- 1 4/6/1977 - Project Start & Orientation Meeting @ RFP
- 2 4/19/1977 - 1st BI-Weekly Meeting @ RFP
- 3 5/4/1977 - 2nd BI Weekly Meeting @ URS
- 4 5/6/1977 - Broomfield Coordination Meeting @ RFP
- 5 5/6/1977 - DWS Coordination Meeting @ DWS
- 6 5/9/1977 - Broomfield Coordination Meeting @ Broomfield
- 7 5/10/1977 - Westminster Coordination Meeting @ Westminster
- 8 5/17/1977 - 3rd BI-Weekly Meeting @ RFP

Several upcoming events were discussed to include:

- 1 Presentation of tentative Raw Water Alternative Matrix at next BI-Weekly Meeting

2 Coordination meeting with FRICO

3 Informational request from the DWB concerning the purchase of Denver sewage effluent as a reuse raw water source for Broomfield (a "rough draft" letter was given to Chuck Rose for transmittal to the DWB)

The next Bi-Weekly meeting time and place was set at 10 00 a m , Wednesday, June 1, 1977, at URS

M E M O R A N D U M

June 1, 1977

TO URS #7028  
FROM S C BEHRENS  
SUBJECT Broomfield Emergency Water Supply - Bi-Weekly Meeting

A bi-weekly meeting was held at the URS office at 10 00 A M Wednesday, June 1, 1977 Those in attendance were as follows

R E Yoder - Rockwell	Ron Foster - ERDA
W D Crossland - Rockwell	Bob McWhinnie - URS
Chuck Rose - Rockwell	Steve Behrens - URS
Frank Richter - Rockwell	Ed Weber - URS

A Raw Water Alternative Matrix covering 15 alternatives was presented for discussion The following is a summary of comments that were raised concerning this Matrix

- 1 The information contained in the Matrix is very tentative at this time and will be checked, expanded, and presented in a more final form during our Alternative Evaluation Analysis
- 2 The assumed criteria for each alternative was to provide Broomfield with a supply equal to the future capacity of their existing water treatment plant (WTP) of 8 0 MGD or a years supply of raw water at approximately 2500 AF excluding the existing Church Ditch source which supplies Broomfield with approximately 700 AF per year
- 3 All cost figures represent "first cut" estimates and will be researched more thoroughly and presented in more detail during the Alternative Evaluation Analysis
  - a Rocky Flats (RF) Lake is owned by the State of Colorado as school property and would have to be purchased from the state possibly on an exchange basis for other suitable land
  - b Mr Church has fishing rights to RF Lake which may have to be compensated if purchasing the lake would prohibit the use of these rights
  - c Conduit installation should be located to minimize the amount of trench easement required This includes placing the new conduit on as much property owned by RF Plant and Broomfield as possible
  - d Energy costs for each alternative should be evaluated and included in the analysis
  - e Estimates of both time and legal fees for possible adjudication of each alternative will be examined and presented in final form during the Alternative Evaluation

MEMORANDUM

June 2 , 1977

TO File URS #7028

From S C Behrens

Subject Broomfield Emergency Water Supply Study Meeting with  
Broomfield to Present Treated and Raw Water Alternatives

On June 2, 1977, a meeting was held at Rocky Flats Plant with representatives from ERDA, Rockwell and Broomfield to discuss various tentative treated and raw water alternatives for providing Broomfield with an emergency water supply Those in attendance included

Rockwell - R O Williams	ERDA - E W Bean
Rockwell - R E Yoder	ERDA - W M Lamb
Rockwell - W D Crossland	Brmfd - Walt Spader
Rockwell - C R Ross	Brmfd - George DiCiero
Rockwell - J E Dorr	Brmfd - Bing Barstow
ERDA - R L Foster	Brmfd - Gip Wilson
ERDA - J A Watt	URS - Bob McWhinnie
	URS - Steve Behrens

A Treated Water Alternative Matrix covering 2 alternate sources and a Raw Water Alternative Matrix identifying 17 alternate systems were presented for discussion The following is a summary of comments that were raised concerning these matrices

- 1 Any emergency water supply system providing a level of service that requires water restrictions such as limiting irrigation would be unacceptable to Broomfield
- 2 Broomfield stated that Conduit #81 would be an acceptable emergency water supply source and should be considered as long as it does not constitute an encroachment on an opportunity to provide normal water capacity to the future growth of Broomfield
- 3 Reuse alternatives offer a real possibility for an emergency source system Broomfield would be receptive to working out trade agreements similar to what Westminster is doing with downstream users off the FRICO (Standley Reservoir) system
- 4 Broomfield's primary desire is to replace Great Western Reservoir with a new reservoir at an acceptable site with a delivery system to the existing Water Treatment Plant Broomfield realizes the problems in acquiring additional water and acknowledged their responsibility in this area to provide for the future growth of their community They would like to have their ultimate system safe and free of any concern over possible contamination and feel this would be best accomplished thru a new reservoir site
- 5 Broomfield acknowledged that either a reuse or new reservoir alternative would require a substantial amount of time to implement, and offered the

possibility of accepting a combination of alternatives as a solution. For example a treated water alternative could be implemented as a short range solution with plans for reuse or a new reservoir as a long range solution.

There was a general consensus that a number of alternatives presented did not appear to be viable at this time. It was also suggested by Brookfield that alternatives involving reuse or a new reservoir seem to offer the best solution and should be pursued in detail.

As a result of this meeting, direction was given to the study from which various courses of action could be developed.

SCB/dmv

MEMORANDUM

July 8, 1977

TO File URS #7028  
FROM S C Behrens  
SUBJECT Broomfield Emergency Water Supply Study  
Bi-Weekly Project Meeting

On Thursday, June 30, 1977, a project meeting was held at Rocky Flats Plant to review the work accomplished to date and discuss future activities. Those in attendance were as follows:

Rockwell International	ERDA
W D Crossland	E W Bean
C R Rose	J Watt
H R Ellis	R Foster
Ms Schulte	

URS

B McWhinnie  
S Behrens  
E Weber  
H Kline

The project schedule called for a submittal of the draft report for review by ERDA/Rockwell and other entities during the following two weeks. Since the draft report had not yet been prepared there will have to be some adjustments made in the remaining time frame of the project. The exact extent of adjustment in terms of any need for a contract time extension had not yet been determined. It appears, however, that a tentative submittal date of the draft report on July 12, 1977, could be achieved with some of this required time being taken from the period allocated to finalize the report (7/13/77 to 7/27/77).

Several items were submitted for review which included the following:

Revised Report Outline  
Report Figures #1-7  
Report Tables #1-3  
Cost Tabulation Sheet

Several items were discussed concerning the report preparation which included the following:

- 1 Use of USGS Quadrangle and Front Range base maps for report figures
- 2 Cost estimates should follow ERDA/Rockwell format and should include all standard adjustments
- 3 Report format should represent a technical document and present only the factual data in a clear and understandable manner

- 4 Report should include the alternatives related to the Blunn Reservoir being proposed by Arvada.

After the general meeting was adjourned the topic of cost estimates was introduced to Mr W R Whitworth who provided the following information as a basis for formulating report data

- 1 Construction Costs

- a Labor rate based on Union Plan Rates and Bacon-Davis Wage Rates
  - b. Include 28% Labor Costs for Burden (FICA, Unemployment etc )
  - c Include 10% Labor Cost for Supervision
  - d Include 22.5% of Labor and Material Costs for Overhead, Profit, and Bonding
  - e. Include 5% of all of the above for Denver area adjustment
- 2 Admin/Maint Costs - 2% total construction costs seems reasonable
  - 3 Acquisition Costs - Use personal historical data and local research.
  - 4 Engineering and Inspection Costs - Use 15% Construction Costs.
  - 5 Contingency Costs - Use 25% of all of the above.

This information was furnished as a guide for preparing the study document. All costs are to be shown as present worth values from which FPA/Societal can apply escalation factors for time and inflation.

SCB/dmv

M E M O R A N D U M

July 6, 1977

TO File URS #7028  
FROM R C McWhinnie  
SUBJECT Broomfield Emergency Water Supply Study  
Meeting with City of Arvada

On July 6, 1977, a meeting was held with representatives from ERDA, Rockwell and Arvada to discuss possible inter-relationships of the project with Arvada's future water plans. Those in attendance were as follows:

Ron Culbertson, City Engineer, Arvada                      Chuck Rose, Rockwell  
Rich Widmer, Development Engineer, Arvada                  Bob McWhinnie, URS  
Ron Foster, ERDA

URS requested a meeting with Mr. Culbertson to discuss the possibility of purchase or lease of water storage in Arvada's proposed Blunn Reservoir on Ralston Creek.

Mr. Culbertson gave some general information on the Blunn Project and provided Xerox copies of pertinent pages of the pre-design report by Engineering Consultants, Inc. of Denver.

Blunn Reservoir is planned at 5,000<sup>+</sup> acre-feet active storage plus 800<sup>+</sup> acre-feet inactive storage and is about 92 feet high. There is some extra capacity (2,000 acre-feet<sup>+</sup>) and additional capacity could be added in the same physical site.

Water sources are Ralston Creek, Ralston Reservoir under a raw water contract with Denver, Church Ditch and Farmers Highline via pumping up to the reservoir.

Mr. Culbertson further stated that Arvada had explored alternatives and decided on the Blunn Project for the following reasons: Denver wasn't interested in providing additional raw or treated water to Arvada. Arvada felt it could operate its own supply and treatment system cheaper than it could purchase from Denver. Arvada needs water storage to maximize its present Ralston and Clear Creek water rights and the raw water available from Denver. Arvada wishes to retain its independence through a separate water system.

Mr. Widmer added that the latest Arvada population estimate was 82,000<sup>+</sup> people and the overall plan called for 120,000 persons.

Boettcher is reviewing the financing of the Blunn Project and adjustments will be made to the tap fees and water rates to pay for the project.

Arvada would want to protect its interests in the Blunn Project and retain all possible options. For that reason, Arvada would probably prefer to lease water storage or other facilities rather than joint venture projects.

The Blunn Project will probably be constructed starting in a couple of years.

178

4  
URS #7028  
July 6, 1977

Ron Foster indicated this was an exploratory meeting to gather basic data and this project would be included as one of numerous possible alternatives to provide the Broomfield water supply. After review of the Broomfield Alternative Water Supply Report, if further interest is developed official contact will be made via letter to Mr. Culbertson.

Mr. Culbertson, in turn, stated that such a formal request would be required in order for his office to set in motion any official response. However, this meeting could provide preliminary information about the possible terms of any lease/purchase of water storage in Blum.

Mr. Rose asked about reuse of Arvada water, and Mr. Culbertson stated the only water supply available for such a program would be the non-tributary wells (about 1 MGD capacity) and the 1 MGD Arvada wastewater treatment plant on Clear Creek. Arvada expects to utilize this reuse by exchange.

Mr. Culbertson also indicated that Arvada would consider the possibility of increasing the size of its proposed new water treatment plant to include capacity for Broomfield. He further indicated the present water transmission and distribution system in Arvada is pretty well in balance with the demands and that it would be unable to provide an 8 MGD demand for Broomfield without major and costly additional facilities.

cc Ron Culbertson, Arvada

Attachment Cost Data from ECI Blum Pre-design Report

MEMORANDUM

August 20, 1977

TO File - URS #702  
FROM R C McWhinnie *RCM*  
SUBJECT Review of Report Draft

The following review meetings were held with personnel of ERDA and Rockwell International to review the draft report

August 1, 1977, at Rocky Flats

C R Rose	Rockwell International
F K Richter	Rockwell International
R Foster	ERDA
R C McWhinnie	URS Company
S C Behrens	URS Company

August 5, 1977, at URS Company

C R Rose	Rockwell International
R Foster	ERDA
R C McWhinnie	URS Company

August 11, 1977, at Rocky Flats

C R Rose	Rockwell International
F K Richter	Rockwell International
R Foster	ERDA
R C McWhinnie	URS Company

## APPENDIX B TREATED WATER SYSTEM DISTRIBUTION ANALYSIS

### System Analysis

The objective of this study is to evaluate feasible alternatives for providing Broomfield with an emergency water supply while awaiting the completion of the Rocky Flats surface water control and water control and recycle projects (which are scheduled to be in full operation in 1979) As part of this study, consideration was to be given to purchasing the remaining 3/7 capacity of Conduit No 81 which conveys treated water from Denver to Broomfield and to consider 3 levels of service for an emergency supply These levels are based on the existing and proposed capacity of the Broomfield Water Treatment Plant

Service Level 1 - Existing condition with 5.5 MGD maximum day use in the Broomfield Service area and 3.1 MGD maximum day use in the Denver Service area These are the present day demands with no restrictions on use

Service Level 2 - Future planned service of 8.0 MGD maximum day use in the Broomfield Service area and 9.7 MGD maximum day use in the Denver Service area Maximum day demands, with no restrictions on use, are expected to reach these values in 1985

Service Level 3 - Ultimate planned service of 8.0 MGD maximum day use in the Broomfield Service area and 15.8 MGD maximum day use in the Denver Service area Maximum day demands, with no restrictions on use, are expected to reach these values in 1990

The Denver Water Board has indicated reluctance to sell the remaining 3/7 capacity of Conduit No 81 at this time because of a critical shortage of treated water throughout the metropolitan-wide

system. The decision will probably be deferred until after the completion of the proposed Foothills Treatment Plant, which is at least four years away, and will also be dependent on the available raw water supplies at that time.

The 4/7 capacity of Conduit No. 81 now owned by Broomfield can supply 9.7 MGD, which is sufficient water to meet all of the normal maximum day needs of both supply systems serving Broomfield until 1978. After this date, because of anticipated population growth, the percent of the normal maximum day needs that can be met will decline, reaching 67% by 1982, three years after the scheduled completion of the Rocky Flats water control and recycle projects mentioned above.

The present restrictions imposed by the Denver Water Board have, to date, reduced maximum day consumption to less than 67% of the normal maximum day use and still provide for adequate watering of lawns. These restrictions will probably be imposed every summer until completion of the Foothills Treatment Plant, so that it can be assumed the 4/7 capacity of Conduit No. 81 can adequately supply all of Broomfield on an emergency basis, with some sprinkling restrictions, until about 1982.

After 1982, if the remaining capacity of Conduit No. 81 is not purchased, the available emergency supply will decrease to 55% of normal maximum day use by 1985 as growth continues, and would remain at that level continuously, since further growth would not be possible unless new water sources are found to meet normal needs.

When the remaining capacity of Conduit No. 81 is purchased, an emergency supply to meet the normal needs of the City will be available until 1983, after which the percent of normal maximum day needs that can be met will decline to 67% by 1990 and remain at that level continuously unless, of course, other new water sources are found.

In summation, the 4/7 capacity now owned by Broomfield will adequately provide an emergency supply of treated water until the surface water control and water control and recycle projects at Rocky Flats are completed in 1979, and with sprinkling restrictions, for several years beyond. If an emergency supply is needed permanently or until a replacement raw water source can be provided for Great Western Reservoir, purchasing the remaining 3/7 capacity of Conduit No. 81 by 1982 would provide capacity for full system demands until 1983, and with sprinkling restrictions, permanently. Broomfield would have to purchase the added capacity of Conduit No. 81 by 1985 to meet normal growth needs, and this could serve as a permanent emergency supply of at least 67% of normal maximum day use. Figure B-1 illustrates the relationships of projected normal and emergency water use rates for a combined system operating entirely on Conduit No. 81.

Broomfield will be required to make substantial improvements after purchase of the remaining 3/7 of Conduit No. 81 for the development of the distribution and storage system in the Denver Service area. This will include mains to serve new areas and to increase the transmission capacity between the master meter and the storage facilities at the far end of the system to fully use the 15.8 MGD which will then be available. Additional storage capacity of about 12 MGD will also be required, and it is presumed at this time that all of it will be constructed at the present site.

The use of water from the Denver system as an emergency supply would require these improvements and additions to the water distribution, transmission and storage system to be accelerated beyond that required for normal growth. Figure B-2, entitled "Projection of Broomfield Service Area Maximum Day Water Use Rates" shows the relationship of the projected normal maximum day use rate and the available emergency supply.

BROOMFIELD EMERGENCY WATER SUPPLY STUDY  
 URS COMPANY NO 7028

IF ALL OF CONDUIT #81 IS NOT ACQUIRED, EMERGENCY SUPPLY WILL REMAIN AT 55% OF NORMAL USE AFTER 1985

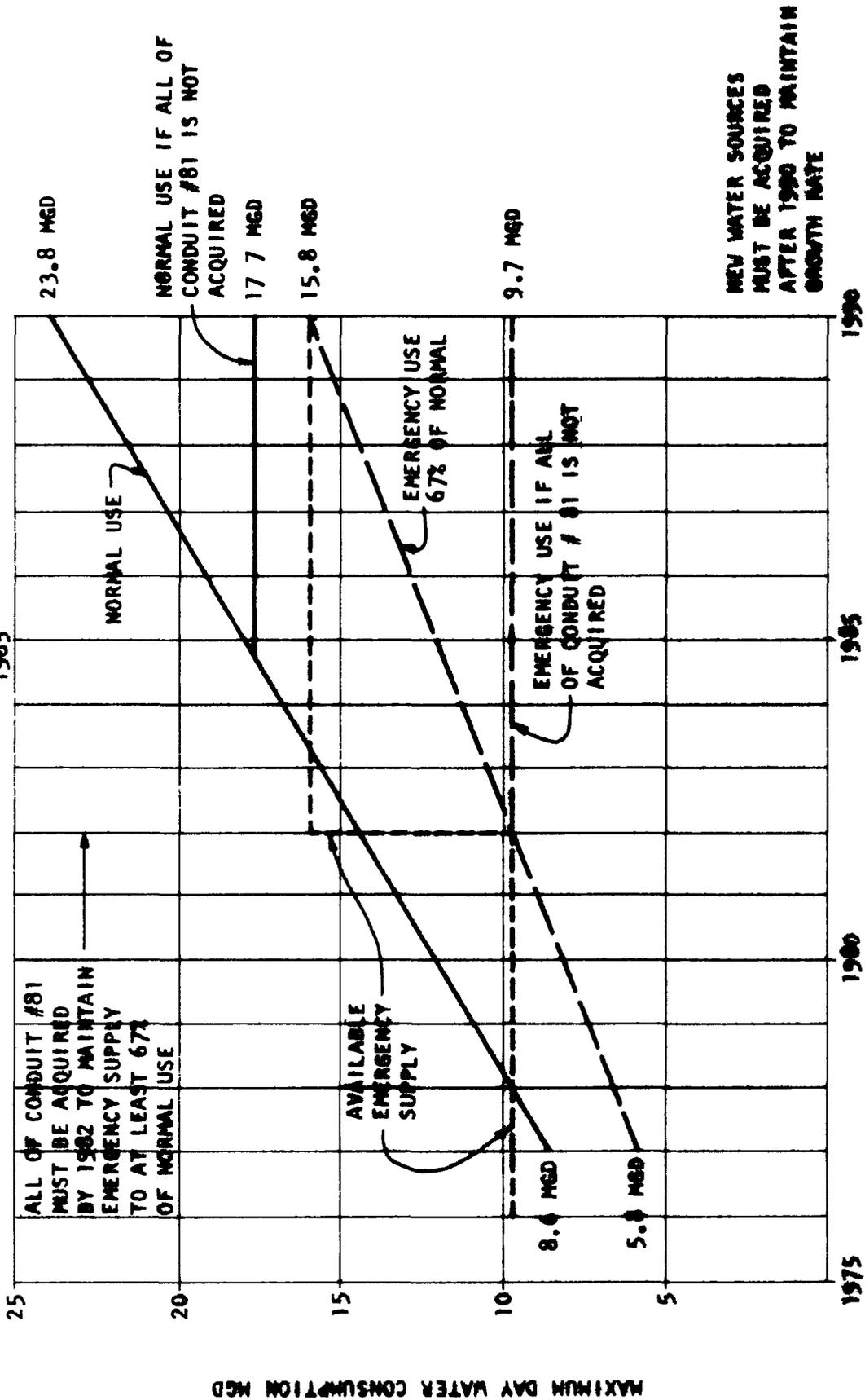


FIGURE B-1 PROJECTIONS OF COMBINED SYSTEM NORMAL AND EMERGENCY WATER USE REQUIREMENTS

BROOMFIELD EMERGENCY WATER SUPPLY STUDY  
 URS COMPANY NO 7028

IF ALL OF CONDUIT #81 IS  
 NOT ACQUIRED, EMERGENCY  
 SUPPLY WILL REMAIN AT  
 55% OF NORMAL AFTER 1985

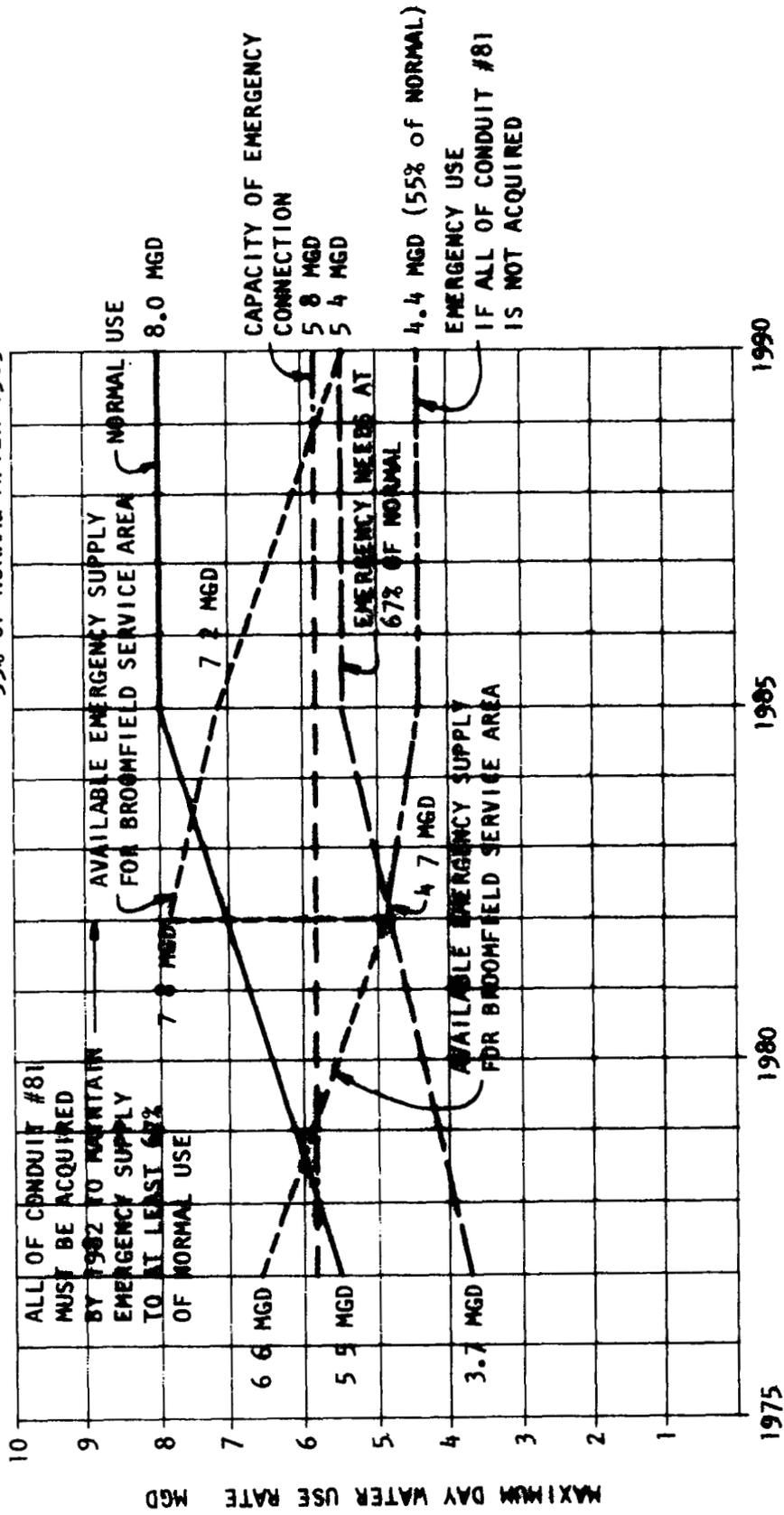


FIGURE B-2 PROJECTION OF BROOMFIELD SERVICE AREA MAXIMUM DAY WATER USE DEMANDS

At present, in 1977, the normal maximum day demand for the Broomfield Service area is 5.5 MGD, while the excess capacity in Conduit No. 81 above the normal demands of the Denver Service area is 6.6 MGD. The normal demands of both systems could be met until some time between 1978 and 1985. After 1978, increased restrictions on sprinkling will be required until the maximum day use is reduced to 4.7 MGD (67% of 7.0 MGD) in 1982.

After 1982, if the remainder of Conduit No. 81 is not acquired, restrictions on sprinkling must be increased until maximum day use is reduced to 4.4 MGD in 1985 and will remain at that level thereafter.

If all of Conduit No. 81 is acquired and if adequate interface capacity is provided between the systems and additional transmission capacity provided within the Denver system, the full normal maximum day needs of both systems could be met until 1983. After this date, gradually increasing sprinkling restrictions would be required, decreasing the maximum day use to 7.2 MGD in 1985 and 5.4 MGD in 1990 and thereafter.

An interface connection between the two systems with a capacity of 5.8 MGD (4,000 GPM) would be adequate to supply the emergency needs of the Broomfield system.

#### Network Distribution Analysis

Water distribution network checks were made for each emergency supply source connection to the existing system and to an expanded system which included several proposed future system modifications. These checks were made using the analysis techniques contained in "A Computer Program for the Analysis of Pressure and Flow in Pipe Distribution Systems" by Don J. Wood of the Civil Engineering Department of the University of Kentucky as revised in 1975. The distribution analysis performed with this program, which has been used by the City

of Broomfield, revealed that a workable connection could be made with each emergency supply source and not violate any established design criteria

The following is a description of the computer program which analyzes steady state pressure and flow in pipe distribution systems transportation liquids

"This computer program is a fourth generation version of the original program. Over 500 engineering firms have acquired previous versions of this program and feedback from the users have provided the information necessary to improve this program so it can be easily applied to all normal pipe systems with minimum chance of user error, and give rapid, accurate solutions. Features of this program can be listed as follows:

- 1 Any type of pipe system configuration can be handled
- 2 Pressure or flow requirements can be specified
- 3 The system can contain any number of storage tanks, pumps, valves, meters, etc
- 4 Pumps can be described in a number of ways including inputting head-flow data from operating curves
- 5 The system can contain pressure regulators which isolate entire low pressure regions or various single pressure regulators distributed throughout the system
- 6 Check valves which only allow flow in only one direction can be included
- 7 Flow units of CFS, GPM, MGD or SI (standard international) can be used
- 8 Data preparation is simple even for large systems with complex geometry and the computer will detect and identify the majority of user errors
- 9 Pipes can be easily added or taken out of the system by using a feature which allows the user to identify certain pipes as restricted pipes which effectively removes them from the system
- 10 Complete output is provided including pressures, elevations and grade lines at all junctions, head losses in lines at all valves, pump heads, flowrates and flow velocities.

- 11 The procedure is relatively fast. Typical computer times for the IBM 370-165 located at the University of Kentucky are as follows: systems under 50 pipes take less than 1 second, a system of 80 pipes takes about 2-3 seconds and a system of 180 pipes takes about 12-15 seconds to analyze one situation.
- 12 The analytical procedure used in the program has the characteristic that it will converge for all situations. This is a significant advantage over other procedures which will not converge to a solution for certain conditions.
- 13 No assumptions (such as initial flowrates or pressures) are required.
- 14 Any number of situations can be analyzed with the same computer run - any parameter can be changed - a special feature allows all flow demands to be changed by a constant factor.
- 15 A data check can be specified which will check and output the data for any run including any number of changes. This allows the user to verify his data and can be used to avoid making runs with incorrect data."

Computer runs were made for average day use, maximum day use, and peak hour use for the following conditions:

- 1 Service level 1 with the present configuration of mains and service areas under normal conditions.
- 2 Same as previous runs under 1 except that all outflows were reduced to reflect sprinkling restrictions and with provision to supply 2,690 GPM by pumping from the Denver system to the Broomfield Service area.
- 3 Service level 2 with the future configuration of mains and service areas under normal conditions.
- 4 Same as the previous runs under 3, except that all outflows were reduced to reflect sprinkling restrictions and with provision to supply 3,200 GPM by pumping from the Denver system to the Broomfield Service area. The emergency maximum day flow of 9.7 MGD used in this run is limited to 55% of the normal maximum day flow of 17.7 MGD and is not adequate to meet emergency requirements in 1985. An emergency supply of 9.7 MGD will be

adequate until 1982, when the normal maximum day demand for the combined systems is estimated at 14.5 MGD.

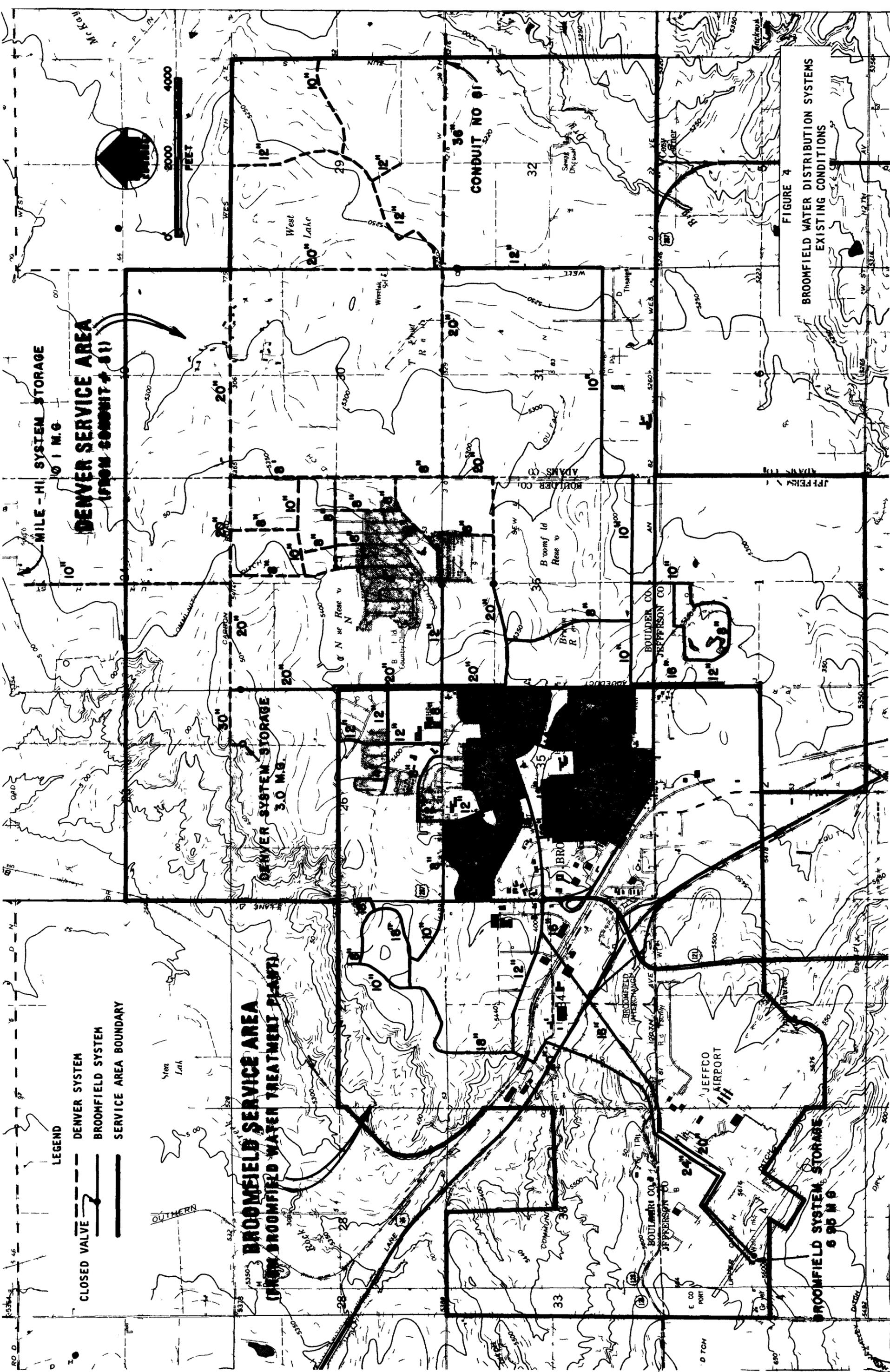
- 5 Service level 3 with the future configuration of mains and service areas, under normal conditions. Analysis of the computer output shows that increased transmission capacity must be provided between the master meter and storage facilities for a maximum day demand of 15.8 MGD in the Denver Service area.
- 6 Same as the previous runs under 5, except that all outflows were reduced to 67% of the previous runs to reflect sprinkling restrictions and with provision to supply 4,000 GPD by pumping from the Denver system to the Broadfield Service area. If the increased capacity is provided between the master meter and the storage facilities for a normal maximum day demand of 15.8 MGD in the Denver system, the system will be adequate to convey the emergency flows for both systems.

## RESOURCE MATERIALS

- 1 Hydrology of a Nuclear-Processing Plant Site, Rocky Flats, Jefferson County, Colorado, U S Geological Survey, Open-File Report 76-268, By R Theodore Hurr, Denver, Colorado March 1976
- 2 Liquid Waste Control and Miscellaneous Improvements, Invitation No 292-72-3, Prepared by The Ken R White Company, Denver, Colorado March, 1972
- 3 Final Report Lamm-Wirth Task Force on Rocky Flats, October 1, 1975
- 4 Comprehensive Utility Plan, Broomfield, Colorado, Amendment No 1, July, 1975 Prepared by Nelson, Haley, Patterson and Quirk, Inc , Consulting Engineers
- 5 Comprehensive Utility Plan, Broomfield Colorado, October, 1973 Prepared by Nelson, Haley, Patterson & Quirk, Inc , Consulting Engineers
- 6 Metropolitan Water Requirements & Resources 1975-2010, Volumes I, II & III, Prepared for Colorado State Legislature, Metropolitan Denver Water Study Committee
- 7 Summary of sampling results attached to letter from B W Colston, Area Manager, USAEC to the Honorable John Elliott, Mayor of the City of Broomfield, September 24, 1973
- 8 Soils Investigation for Increased Water Retention, Rocky Flats Plant, Jefferson County, Colorado Prepared by The Ken R White Company, June 8, 1971
- 9 Denver Regional Council of Governments and the Urban Drainage and Flood Control District Rainfall Runoff Information Supplemental Publication No 6 to Project REUSE Final Report May, 1972
- 10 U S Atomic Energy Commission Investigation of the Tritium Release Occurrence at the Rocky Flats Plant November, 1973

RESOURCE MATERIALS - (Continued)

- 11 URS--John A Blume "Seismic and Geological Investigations and Design Criteria for Rocky Flats Plutonium Recovery and Waste Treatment", San Francisco, California, September 1972
- 12 Wheeler, W W, and Associates "Hydrologic Investigation--Rocky Flats," Report prepared for C F Braun & Co, September, 1972
- 13 "Draft Omnibus Environmental Assessment for the Rocky Flats Plant of the U S Energy Research and Development Administration," May, 1975
- 14 "Investigative Report of the 1973 Tritium Release at the Rocky Flats Plant in Golden, Colorado," Radiation/Noise Control Branch, Hazardous Materials Control Division, U S. Environmental Protection Agency, July, 1975
- 15 "An Engineering Study for Water Control and Recovery", by Engineering-Science, Inc., supplied to the Task Force by RFP on July 1, 1975
- 16 Colorado Department of Health "U S AEC Rocky Flats Plant Surveillance Report", December, 1974
- 17 Handbook of Water Resources and Pollution Control, Van Nostrand Reinhold Company 1976 Water Storage and Distribution Chapter by Robert E. McWhinnie and Paul R. Johnson.
- 18 Public Water Supply Treatment Technology, American Water Works Association, 1973 by Elwood L. Bean, J E Flaek, Herbert Hudson, J E Singley and Robert C. McWhinnie.
- 19 Water Quality Criteria, 1972 National Academy of Sciences Panel on Public Water Supplies
20. "Protection of Water Supply from Radioactive Contamination", by Nelson, Naley, Patterson and Quirk, Inc., Greeley, Colorado, March 1974



**LEGEND**

CLOSED VALVE 
  
 DENVER SYSTEM 
  
 BROOMFIELD SYSTEM 
  
 SERVICE AREA BOUNDARY

SHERMAN  
 LANE  
 WEST LAKE

**BROOMFIELD SERVICE AREA**  
 (FROM BROOMFIELD WATER TREATMENT PLANT)

DENVER SYSTEM STORAGE  
 3.0 M.G.

MILE - HI SYSTEM STORAGE  
 10.1 M.G.  
**DENVER SERVICE AREA**  
 (FROM CONDUIT # 61)

CONDUIT NO 61

**FIGURE 4**  
 BROOMFIELD WATER DISTRIBUTION SYSTEMS  
 EXISTING CONDITIONS

BROOMFIELD SYSTEM STORAGE  
 6.95 M.G.

JEFFCO AIRPORT

BROOMFIELD INTERCHANGE

BROOKFIELD

BOULDER CO.

JEFFERSON CO.

ADAMS CO.

ROCKY MOUNTAIN

WEST LAKE

CONDUIT NO 61

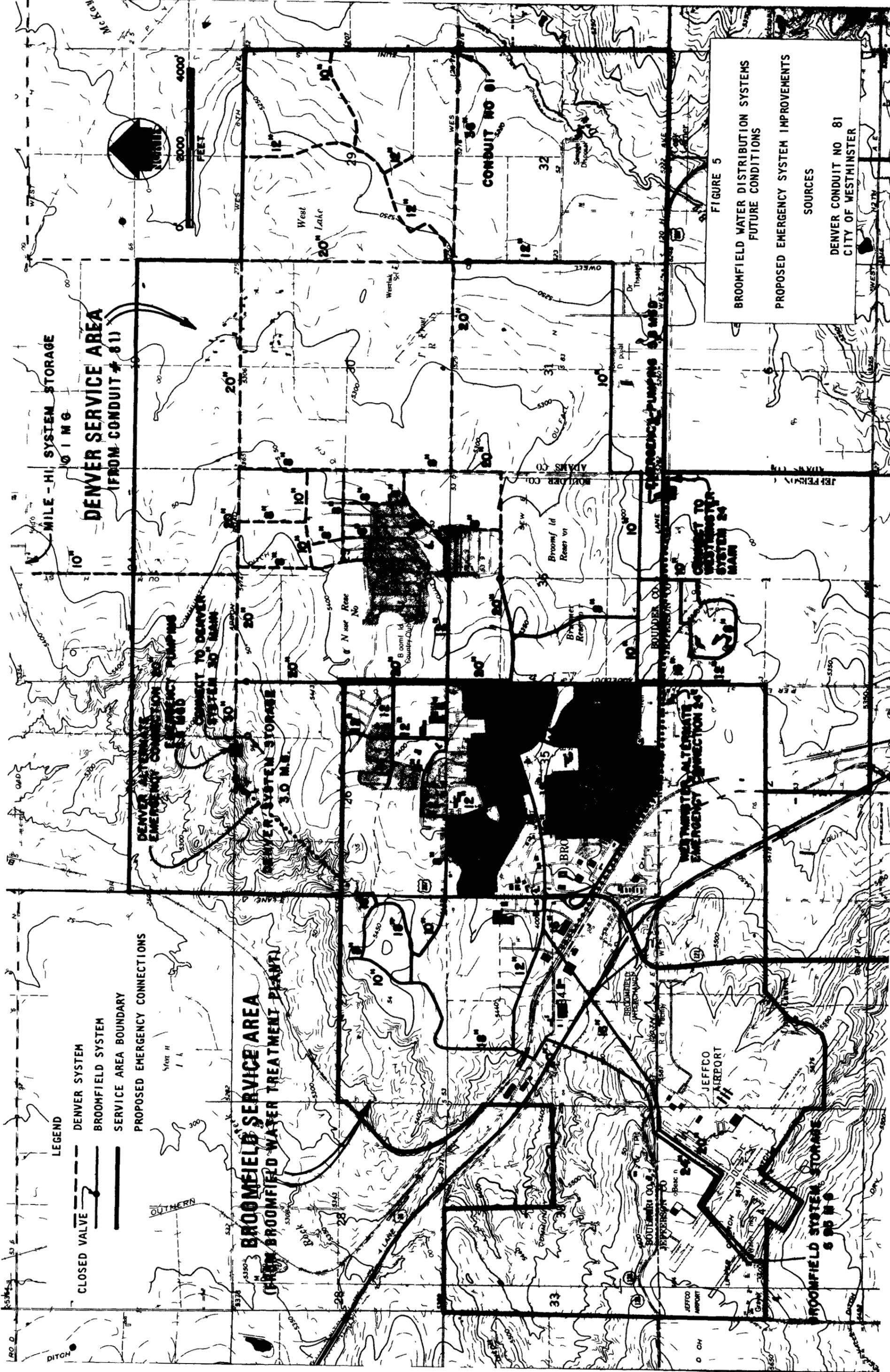


FIGURE 5  
 BROOMFIELD WATER DISTRIBUTION SYSTEMS  
 FUTURE CONDITIONS  
 PROPOSED EMERGENCY SYSTEM IMPROVEMENTS  
 SOURCES  
 DENVER CONDUIT NO 81  
 CITY OF WESTMINSTER

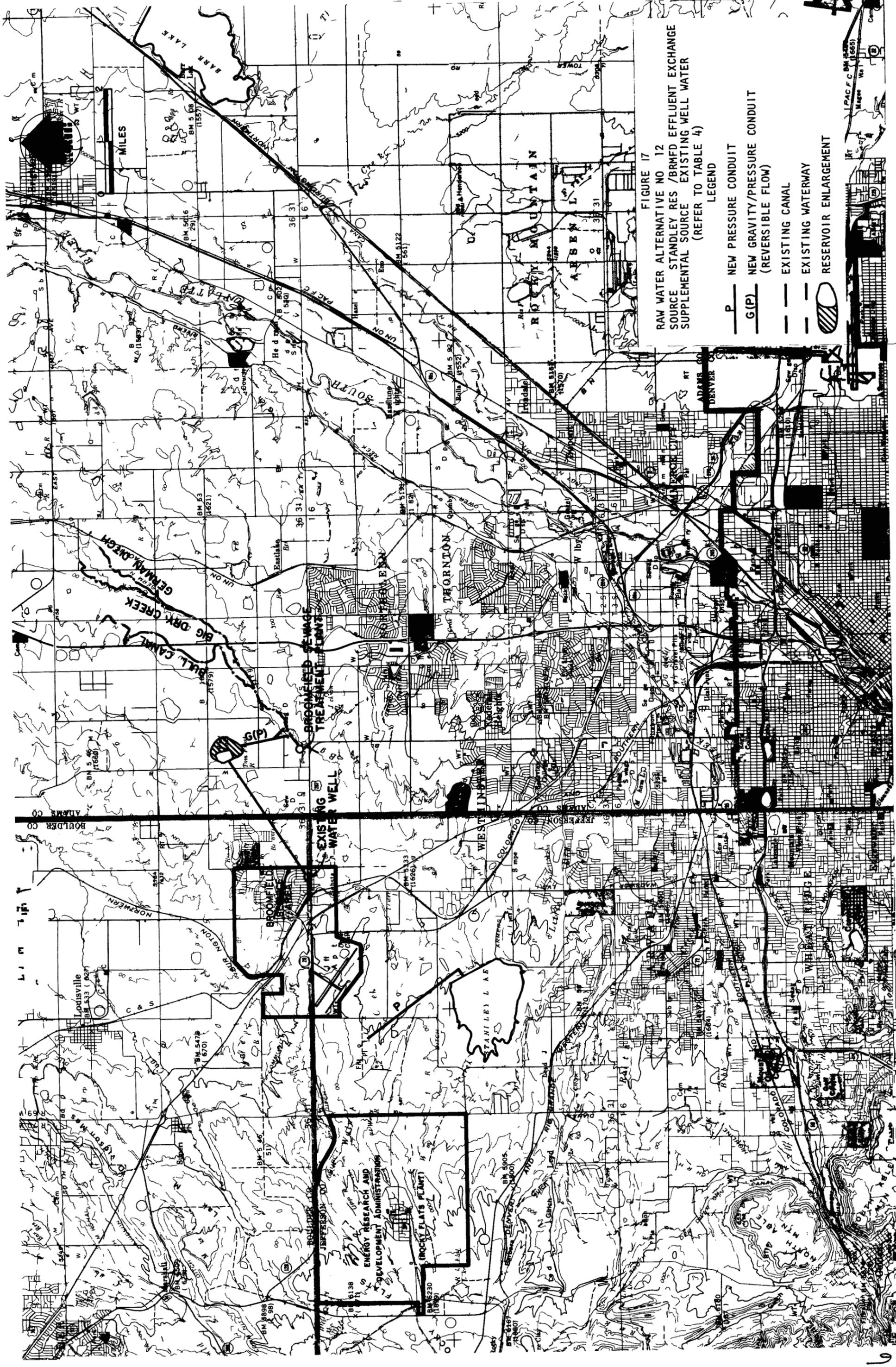


FIGURE 17

RAW WATER ALTERNATIVE NO 12  
 SOURCE STANLEY RES /BRMFD EFFLUENT EXCHANGE  
 SUPPLEMENTAL SOURCE EXISTING WELL WATER  
 (REFER TO TABLE 4)

- LEGEND
- P** — NEW PRESSURE CONDUIT
  - G(P)** — NEW GRAVITY/PRESSURE CONDUIT (REVERSIBLE FLOW)
  - EXISTING CANAL
  - EXISTING WATERWAY
  - ▨ RESERVOIR ENLARGEMENT

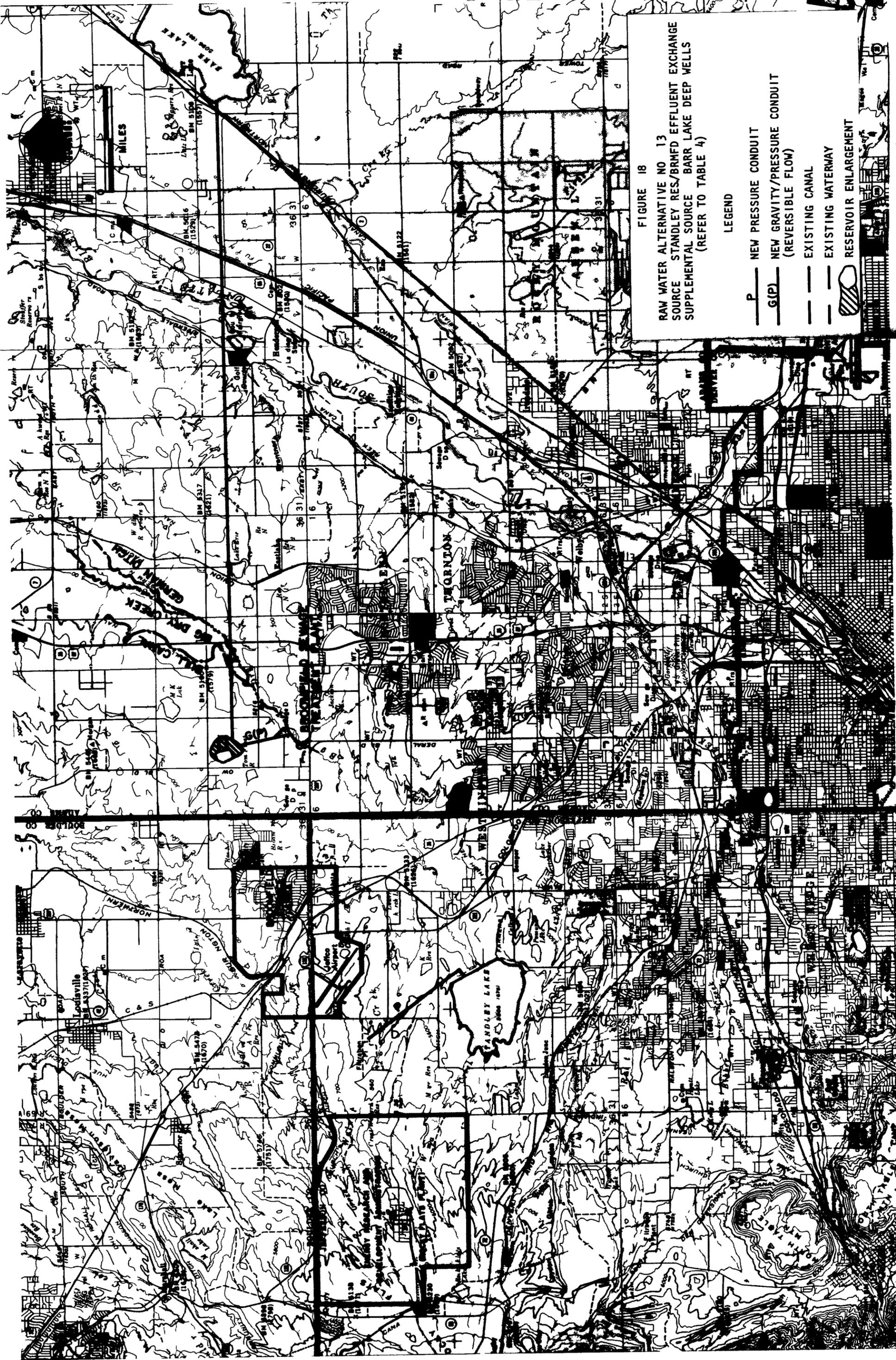


FIGURE 18

RAW WATER ALTERNATIVE NO 13  
 SOURCE STANLEY RES./BRMFD EFFLUENT EXCHANGE  
 SUPPLEMENTAL SOURCE BARR LAKE DEEP WELLS  
 (REFER TO TABLE 4)

LEGEND

- P** — NEW PRESSURE CONDUIT
- G(P)** — NEW GRAVITY/PRESSURE CONDUIT (REVERSIBLE FLOW)
- EXISTING CANAL
- - - EXISTING WATERWAY
- ▨ RESERVOIR ENLARGEMENT

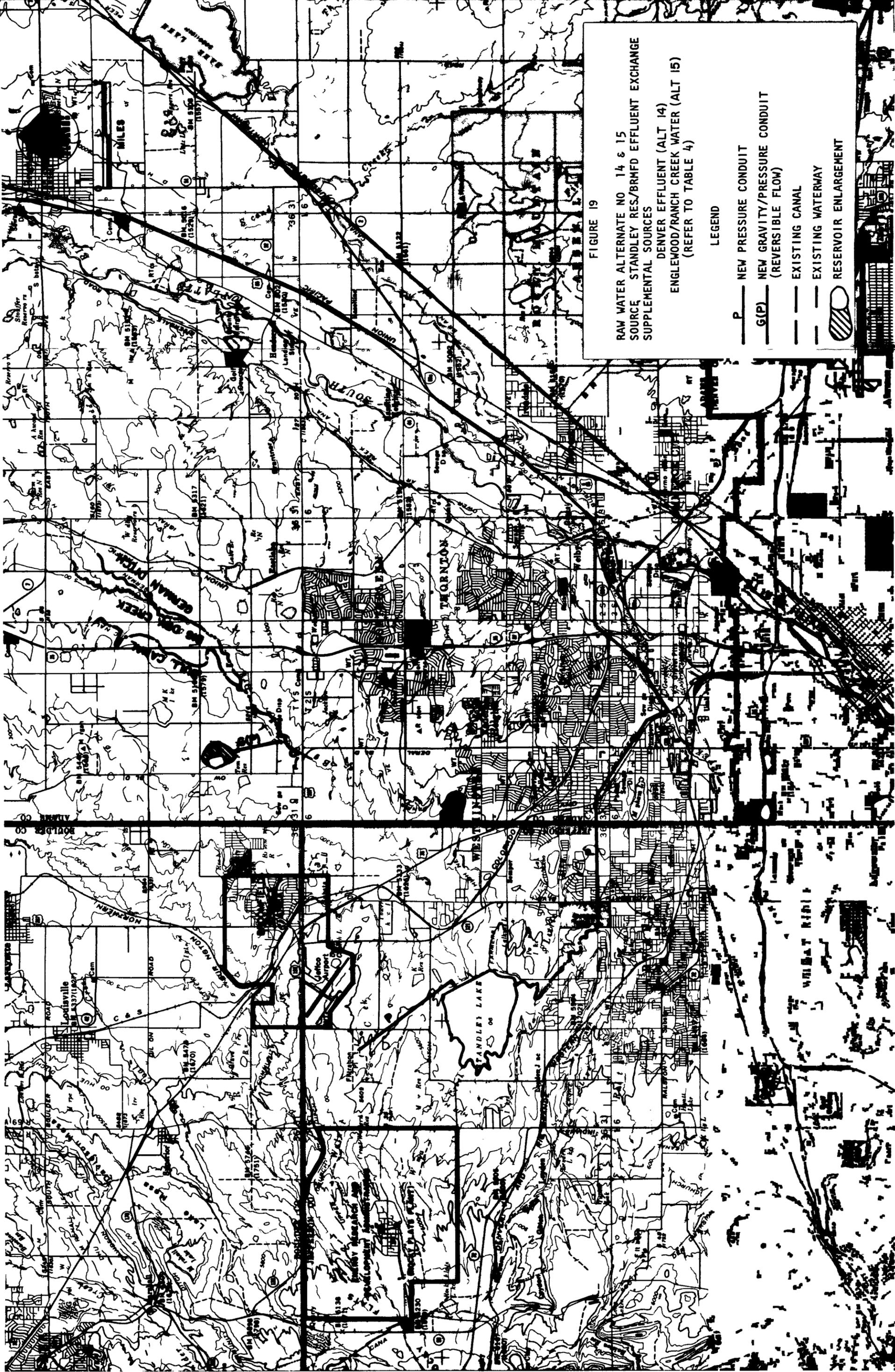


FIGURE 19

RAW WATER ALTERNATE NO 14 & 15  
 SOURCE STANDLEY RES./BRMFD EFFLUENT EXCHANGE  
 SUPPLEMENTAL SOURCES  
 DENVER EFFLUENT (ALT 14)  
 ENGLEWOOD/RANCH CREEK WATER (ALT 15)  
 (REFER TO TABLE 4)

LEGEND

- P** — NEW PRESSURE CONDUIT
- G(P)** — NEW GRAVITY/PRESSURE CONDUIT (REVERSIBLE FLOW)
- — — — — EXISTING CANAL
- — — — — EXISTING WATERWAY
- RESERVOIR ENLARGEMENT

# FIGURE A-1 BROOMFIELD EMERGENCY WATER SUPPLY STUDY SCHEDULE

URS COMPANY NO 7028 APRIL 1977

BIWEEKLY PROJECT BRIEFINGS

