Do Not Check Out

CITY OF COLORADO SPRINGS
PLANNING, DEVELOPMENT AND FINANCE DEPARTMENT

Monument Creek Drainage Basin Planning Study

Volume III
Appendixes A-B, D-H

Prepared By

CH2M HILL

in association with

Kiowa Engineering Corporation
Thomas & Thomas
Urban Edges

CITY OF COLORADO SPRINGS
PLANNING, DEVELOPMENT AND FINANCE DEPARTMENT

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Drainage Basin Planning Study

Volume III Contents

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Attachment 3

Project Newsletters

The Future of Monument and Fountain Creeks

Progress Report #1
October 1991

A report to the community on planning for stormwater management, resource protection, recreation and community development for the Monument Creek/ Fountain Creek Basins in Colorado Springs

Submitted by:
City Engineering Division (Contact Ken Sampley, 578-6606) and City Comprehensive Planning Division (Contact Craig Blewitt, 578-6692)
The City of Colorado Springs

Edited by:
Robert M. Searns for CH2MHILL, Inc.

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What are the Creek Basin Studies and Why is the City Pursuing These Studies?

The Planning Process

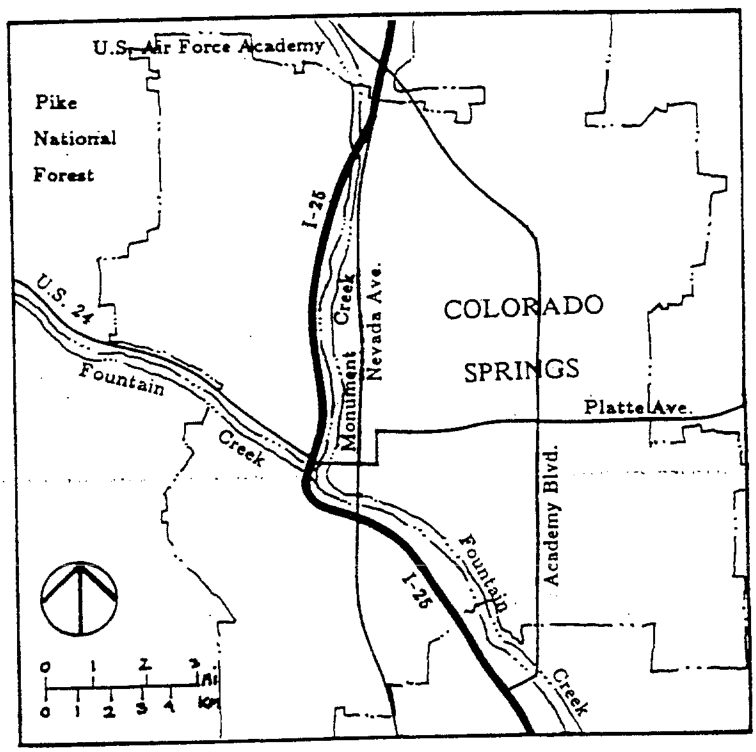
The process will address an 11-mile reach of Monument Creek and a 7-mile reach of Fountain Creek, with combined watersheds of 420 square miles. The objective of the plan is to address the safe conveyance of floodwater and to balance this need with other community objectives. These other objectives include: water quality, wildlife, open space, transportation and aesthetics. The plan will also consider the role of Monument Creek, I-25 and the surrounding properties in shaping the future character of Colorado Springs. A similar plan is being pursued at the same time along Fountain Creek and the findings of each plan will be coordinated into a comprehensive vision for these two major drainage systems.

The plan is being carried out as a joint venture between the City Engineering Division and the City Comprehensive Planning Division. Consulting services on Monument Creek are being provided under the direction of **CH2MHILL, Inc.** (engineering) in association with **Kiowa Engineering, Inc.** (engineering); **Thomas and Thomas, Inc.** (landscape architecture); **Urban Edges, Inc.** (multi-objective planning); and **Erik Olgeirson, Ph.D.** (ecologist). Consulting services on Fountain Creek are being provided under the direction of Muller Engineering, Inc. (engineering); Obering, Wurth & Associates (engineering); Thomas and Thomas (landscape architecture); Aquatic and Wetland Consultants, Inc. (ecology); and Geotechnical Consultants, Inc. (geology).

(continued on following page)

Why It's Needed

The Monument Creek and Fountain Creek Basins have a history of flooding, erosion and other problems associated with stormwater runoff. This fast-moving and sometimes violent flow of stormwater can threaten homes, businesses, bridges, utility pipes and other public and private infrastructure. More importantly, lives can be at stake. First and foremost, we have a legal obligation to safely manage storm runoff to minimize the damage and dangers. This management process includes both planning to limit development in flood-prone areas and structural measures which can help contain and convey water in a manner which causes the least damage.



However, there are other important integral considerations. Rivers and streams are a vital, yet endangered American resource. Although at times channelization and similar measures are necessary, the indiscriminate use of such can result in loss of stream habitat and wetland areas. Besides being places of beauty and solace, these areas sustain an overwhelming proportion of our wildlife. Fully, 75% of North American bird species depend on wetlands and stream corridors for survival—not to mention numerous mammals, fish and other species.

We also have a legal obligation to address water quality. In November of 1990, The U.S. Environmental Protection Agency published regulations addressing stormwater runoff. Now, we must address not only pollution from outlet pipes but from stormwater that runs off our streets, yards and roofs. This is most effectively done through well-planned stormwater management practices. Colorado Springs is required by federal law to pursue these pollution-reduction policies and practices.

This planning process is also tied to the U.S. Army Corps of Engineers review process under Section 404 of the U.S. Clean Water Act. (P.L. 92-500). The process includes a "Letter of Permission" (LOP) which requires a thorough look at environmental as well as storm drainage issues.

Finally, there is an opportunity to transform once troublesome streams into major urban recreational amenities—attractive places to hike, bicycle, explore nature and otherwise enjoy the outdoors close to home. While it must be recognized that stream corridors now exist within an urban setting and as such cannot be kept totally natural, attractive stream corridors can still be a focal point for quality urban redevelopment benefiting the community in many ways.

Lively Discussion and Many Great Ideas Expressed at the First Public Meeting

The First Public Meeting in this planning process was held on the evening of September 12, 1991. There were over 40 people in attendance. The meeting began with presentations by Gary Haynes, Ken Sampley and Craig Blewitt of the city staff describing the upcoming planning effort in both the Monument and Fountain Creek basins. Jon Sorensen and Jim Wulliman of CH2MHILL presented slides depicting some of the flooding and erosion problems along Monument Creek. Robert Searns of Urban Edges discussed the concept of multi-objective stream planning.

Following the presentations by staff and consultants, the meeting participants discussed visions for the future of the Monument and Fountain Creek corridors. Everyone seemed to recognize that flood damage reduction was also a key objective. Most people commenting called for a multi-objective approach. Preferred concepts included: resource preservation, trails (at least a minimum trail system to provide access and appreciation), recreation facilities, interpretive areas, systems of linear parks, quality redevelopment in the area and, where possible, "soft" (as opposed to "hard") structural treatment.

In addition to not wanting "hardscape" solutions, concerns were expressed about air and water pollution, widening of I-25 to eight lanes and trails being located too close to back yards. One notable suggestion called for "testing" each stream planning proposal for its consistency with multi-objective benefits such as wildlife preservation and recreation.

The discussion then turned to the economic and political considerations in implementing a multi-objective plan. People felt that a multi-objective stream corridor offered many economic benefits including increased property values, community redevelopment and tourism. They felt it was important to build a constituency of supporters for the project. Non-profit donations, military labor and volunteer projects were also cited as a way to implement projects.

Your Comments and Suggestions are Always Welcome

While we had a great turn-out at the first public meeting and many good suggestions, we always welcome additional comments and ideas. Please feel free to send your remarks to the attention of:

Mr. Ken Sampley, Civil Engineer Supervisor
or
Mr. Craig Blewitt, Senior Planner
c/o City of Colorado Springs
P.O. Box 1575 Mail Code 311
Colorado Springs, CO 80901-9983

Thanks for your participation in this exciting process!

Where We Will Go Next

The next step in the process includes an inventory of the creek corridor and the formulation of policies which will guide the planning process. The inventory will involve both touring the stream corridor and gathering technical data. The planning team will investigate such items as:

- Past and likely future flooding problems
- Erosion of the stream banks and stream bottom
- Risks to life and property posed by flooding
- The condition of the stream corridor as habitat for wildlife
- Opportunities for recreational and aesthetic benefits
- Water quality
- Future development opportunities along the corridor
- Land ownership and the needs of adjacent property owners
- What the community would like to see happen in the creek corridor

The study team will also develop planning guidelines. These guidelines will be developed by a multi-disciplinary team which will include engineers, planners, wildlife experts, environmental experts, landscape architects and other specialists. Representatives of citizen groups will also play a key role in shaping the guidelines and, ultimately, the plan.

The process also includes a field tour of the stream corridors, held on October 10, and attended by both the technical staff and citizens group representatives.

These guidelines will attempt to reconcile flood damage reduction objectives with the goal of preserving and enhancing the stream corridor as an important natural resource and recreational amenity. We will begin with the comments provided by the citizen participants at the September 12, 1991 public meeting and refine these in view of technical, economic, legal and political considerations. We will pursue the latest planning and engineering techniques which stress stream resource preservation and enhancement.

The findings of the inventory and the draft policy statements will be presented at the Second Public Meeting, tentatively scheduled for January 1992. We hope to have draft planning reports which address the range of considerations involved by March 1992, and a final plan in December 1992. These will also be presented for public review and comment. Please watch for announcements of upcoming public workshops.

City of Colorado Springs
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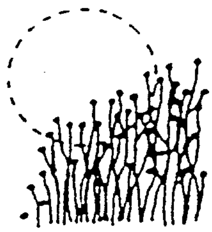
The Future of Monument Creek

Progress Report #2
April 1993



A report to the community on planning for stormwater management, resource protection, recreation, and community development for the Monument/Fountain Creek Drainage basin .

Draft Plans Ready for Review!

Draft Plans have been completed for the Monument and Fountain Creek Drainage Basin Planning Studies and the Pikes Peak Greenway. These Plans will be presented for public review and comment at a public meeting scheduled for May 11, 1993, 7:00 - 9:30 P.M. at the West Center for Intergenerational Learning.

Public Meeting Scheduled - May 11, 1993
7:00 - 9:30 P.M.
West Center for Intergenerational Learning
25 North 20th Street

Public input is essential to good planning. Your attendance and comments are welcome and encouraged.

Project Overview

Drainage Basin Planning Studies are being prepared for Monument Creek and Fountain Creek. These studies are being done in conjunction with the Pikes Peak Greenway Master Plan, a comprehensive plan for the north-south Monument/Fountain Creek corridor. The objective of the combined projects is to address the safe conveyance of floodwater and to balance this need with other community objectives for the creek corridors. These other objectives include water quality, wildlife habitat, open space, transportation, recreation, and aesthetics.

Public input is playing a critical role in identifying the problems to be addressed by the Plan, as well as recommended solutions. A Technical Advisory Committee was formed, and consists of representatives from various citizen interest groups and federal, state, and local resource agencies. This Committee has acted as a steering group to help identify problems, formulate goals and objectives, develop a range of alternative solutions, and evaluate the alternatives. The Draft Plans to be presented on May 11th are the product of this committee process.

We've Been Busy!

Inventory and Analysis

We have inventoried the existing conditions. These include: normal water flow and flooding characteristics, wildlife and vegetation, geomorphology (how the creek flows through surrounding landscapes), historic and cultural elements, land use, and recreational elements.

Goals and Objectives

- **Assure Public Safety and Welfare**
- **Protect and Enhance Aquatic and Ecosystems.**
- **Maintain and Enhance the Natural Beauty and the Quality of the Built Environment.**
- **Aid in Control of Pollution/ Enhance Water Quality.**
- **Maintain a High Level of Benefit to Cost.**
- **Promote Community Development**
- **Provide Recreational and Social Benefits.**

These goals were developed with the assistance of the Technical Advisory Committee. They also reflect the community values as expressed at the 1990 Colorado Springs Stormwater Management Workshop.

Opportunities, Constraints, and Alternative Development

For evaluation purposes, we have divided the Monument and Fountain Creek corridors into segments (called reaches) for purposes of analysis and planning. Monument Creek has been divided into seven (7) reaches and Fountain Creek into eight (8) reaches. Based upon the characteristics of the Creek corridors and the desired achievement of the Goals and Objectives, the following kinds of opportunities and constraints were defined.

Why is improving the Monument-Fountain Creek/I-25 Corridor important?

- Over 80,000 people travel along I-25 on a daily basis, many of whom are tourists getting their first impressions of Colorado Springs.
- Monument and Fountain Creeks carry the bulk of the storm water runoff generated within the Colorado Springs urban area.
- The main spine of the planned city-wide trails network runs along Monument and Fountain Creeks. All other existing and planned trails will feed into this primary trail corridor. When completed, the spine trail will serve non-motorized commuters and a growing number of recreational trail users.
- As the western and southern edge of the City's downtown, a major portion of the creek corridor is integral to the proposed "Park Ring" surrounding the Downtown as recommended by the Downtown Action Plan.
- The continuous stream flows and the large areas of remaining riparian vegetation support a diverse array of mammals, amphibians and reptiles, and birds making the creek corridor one of the city's most important wildlife habitats.

Examples of Opportunities:

- **storm water runoff conveyance**
- **continuous stream flow**
- **existing wildlife habitat and other environmentally important areas deserving protection**
- **potential park sites and landscaping opportunities**
- **potential continuous multi-use trail**
- **urban redevelopment opportunities**

Examples of Constraints:

- **severe creek bed and bank erosion at many locations.**
- **extensive dumping of debris within the floodplain and within view of the creeks**
- **extensive channel relocation and floodplain encroachment.**
- **utilities and roads threatened by erosion and flooding.**
- **structures in the channel which restrict flood flows.**
- **the mobile and dynamic nature of the creek.**

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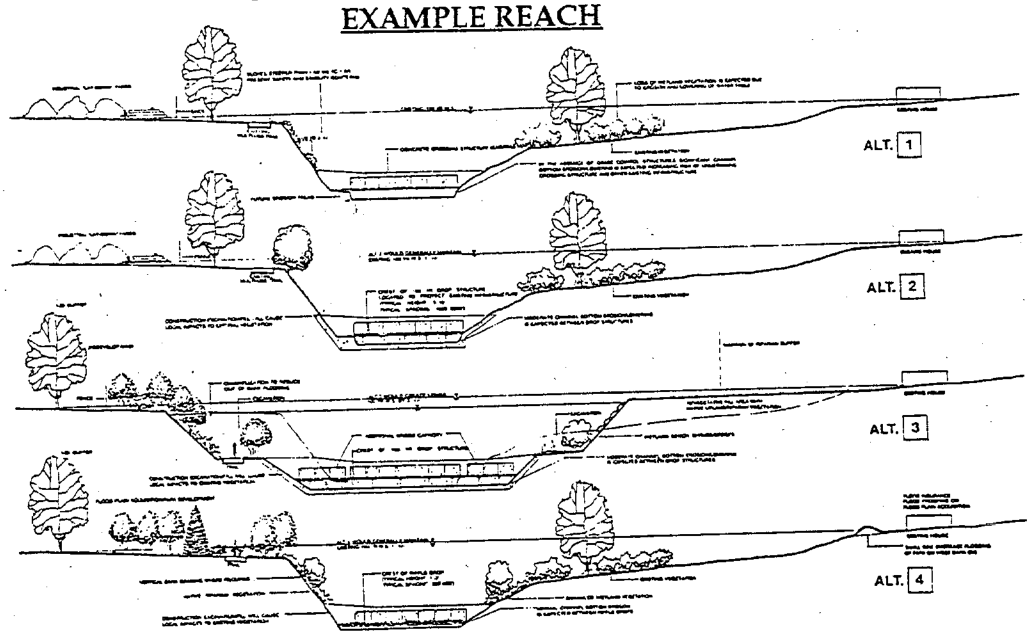
Alternative Development

The City and Consultant Team worked closely with the Study Group to refine a full range of development alternatives for each of the reaches. Three to four alternatives were developed for each reach. Generally, these alternatives may be categorized as follows:

Alternative 1 - No Action - Provides a baseline condition for alternative comparison.
Alternative 2 - Reactive Strategy - Action is oriented toward protecting existing infrastructure such as bridges and utility crossings endangered by undermining as a result of creek channel degradation.
Alternative 3 - Pro-active Strategy - Utilize conventional drop structures and bank stabilization to fully stabilize the entire creek corridor.
Alternative 4 - Pro-active Strategy with Ecological Restoration - Fully stabilize the creek channel utilizing naturalistic riffle drop structures enhanced with wetland and riparian vegetation.

EXAMPLE REACH



Where Will the Process Go Next?

The preliminary drafts of all three plans are now complete. We wish to present our ideas to you and elicit your input so we can proceed with the final phase of completion. Through the Summer and Fall, the plans will be presented to Citizen Groups, the Drainage Board, the Parks and Recreation Advisory Board, the City Planning Commission, and City Council for their consideration and formal adoption. Following this Public Meeting your comments will be evaluated and integrated into the final plans as appropriate.

Your Comments and Suggestions are Always Welcome

Please feel free to send your remarks to the attention of:

Mr. Ken Sampley, Civil Engineer Supervisor
or
Mr. Craig Blewitt, Senior Planner
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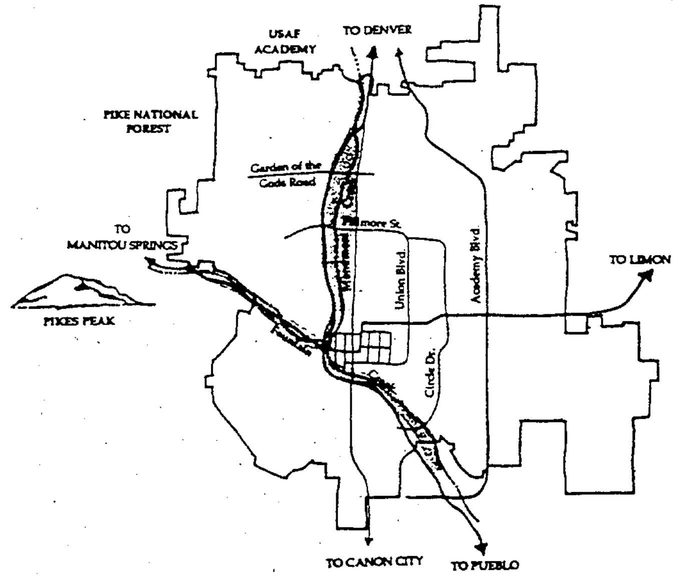
Colorado Springs, CO 80901-9983

Thanks for your participation in this exciting process!

IMPORTANT PUBLIC MEETING CONCERNING YOUR ENVIRONMENT:

The Monument Creek Drainage Basin Planning Study
The Fountain Creek Drainage Basin Planning Study
The Pikes Peak Greenway Master Plan

Public Meeting Scheduled -
May 11, 1993
7:00 - 9:30 P.M.
West Center for Intergenerational Learning
25 North 20th Street



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Appendix B
Baseline Hydrology Report

Attachment 1

Hydrology Report

BASELINE HYDROLOGY
MONUMENT CREEK
DRAINAGE BASIN PLANNING STUDY

Prepared for:

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Planning, Development and Finance Department
Engineering Division - MAIL CODE 435
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Prepared by:

Kiowa Engineering Corporation
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in Cooperation with:

CH2M HILL
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KIOWA Project No. 91.04.11
D20/R115

November 1991
Revised May 1992

SECTION I
INTRODUCTION

Summary

This report presents the analysis of baseline hydrology for Monument Creek. Discharges were generated utilizing the SCS dimensionless hydrograph method with kinematic wave routing within the HEC-1 computer model for numerous locations on the creek beginning at its headwaters and ending at its confluence with Fountain Creek. The hydrology model uses an elliptical rainfall distribution pattern based upon Hydromet 52. Maximum point rainfall amounts of 2.96 inches and 4.32 inches developed from the *NOAA Atlas 2, Volume III Colorado* were used. The projected discharges were generated assuming both existing and future land development conditions in the basin for 10- and 100-year return periods and a storm duration of 24 hours. Study results are summarized at key design points in Table 1.

The discharges shown in Table 1 are the results of the most detailed hydrologic analyses yet completed on Monument Creek and compare favorably to other studies and methods. The 100-year discharge is lower than that used in the Corps of Engineers' previous study by 13 percent. The lower discharge is reasonable when consideration is given to the methods and levels of effort used in both studies.

Table 1 Summary of Projected Discharges

Approximate Location	Design Point	Existing 100-Yr.	Future 100-Yr.	Existing 10-Yr.	Future 10-Yr.
South Boundary Air Force Academy	319	24,000	26,000	6,900	7,500
Confluence with Fountain Creek	515	27,900	32,800	7,650	9,270

Authorization

The Monument Creek Drainage Basin Planning Study was authorized under the terms of Contract Number 91C-2026 between the City of Colorado Springs and CH2M HILL. The contract was approved and authorized by the Colorado Springs City Council. This hydrology report has been prepared as a part of the overall Master Drainage Basin Planning Study for Monument Creek.

Purpose

The purpose of the drainage basin planning study is to identify and propose a storm water management plan to satisfy the existing and future needs within the Monument Creek Basin (the study area). The intent of determining a storm water management plan for the basin is to provide guidelines for future development in the basin and for future flood control projects. The hydrologic study provides the basis for the analysis of floodplain hydraulics, the determination of alternative flood control scenarios, and the sizing of flood control structures and related improvements along Monument Creek within the study reach.

Acknowledgments

During the preparation of the study, a number of government agencies and interested individuals were involved in a series of technical review meetings. Representatives from the U.S. Army Corps of Engineers (COE), Soil Conservation Service (SCS), Colorado Water Conservation Board (CWCB), Federal Emergency Management Agency (FEMA), and various City Departments provided valuable commentary during the development of the hydrology model. A listing of the individuals and their agencies who were involved in the coordination of the hydrology study has been presented below:

Name	Agency
Gary Haynes	City of Colorado Springs Engineering Division
Bruce Thorson	City of Colorado Springs Engineering Division
Ken Sampley	City of Colorado Springs Engineering Division
Bruce Beach	U.S. Army Corps of Engineers
Craig Blewitt	City of Colorado Springs Planning Department
Phil Boawn	U.S. Army Corps of Engineers
Dan Bunting	Regional Building Department
Doug Cain	U.S. Geological Service
Brian Hyde	Colorado Water Conservation Board
Larry Lang	Colorado Water Conservation Board
John Liou	Federal Emergency Management Agency
Alan Morrice	El Paso County Department of Public Works
Rick O'Connor	El Paso County Planning Department
Steve Schild	National Weather Service
Glade Wilkes	Soil Conservation Service

The hydrology coordination meetings provided useful direction and input to the study. The purpose of the meetings was to share information about hydrologic principles, and how they might be applied in the Monument Creek basin. Discussions pertained to rainfall type, rainfall amounts, areal adjustment of rainfall and its applicability, whether land above 8,000 feet in elevation contributed significantly to the flooding of the basin, storm tracking, average storm cell size, reservoir routing, stream gage analysis and its applicability to this basin, and historical flooding in the basin and in the region. The direction provided by the individuals and their agencies has greatly enhanced this report.

SECTION II
BACKGROUND

Scope

The specific scope of work for the hydrologic study included the following tasks:

1. Meet with the client (and others) to: insure compliance with the services required by this agreement, obtain existing data and general information from participating entities, solicit desires of participating entities and other interested agencies or groups, and avoid duplication of effort whenever possible by utilizing existing information available from other agencies.

2. Contact the local governments, individuals, and other agencies who have knowledge and/or interest in the study area.

3. Utilize City/County drainage policies and criteria and applicable information wherever possible.

4. Perform hydrologic analyses within the study area for both existing and future basin development conditions.

5. Identify existing and potential drainage and/or flooding problems.

6. Prepare a written report discussing issues examined in the study.

Summary of Data Obtained

A number of technical reports have been prepared for basins within the general study area. Listed below are technical reports collected for use in the preparation of this study:

1. *Monument Creek Study*, prepared by G.J. Weiss and Associates, dated March 1974.

2. *Mesa Drainage Study*, prepared by Parker & Associates, dated June 1976.

3. *Master Plan for Mesa Drainage Basin*, prepared by Gilbert, Meyer & Sams, Inc., dated March 1986.

4. *Roswell Drainage Area Drainage Study*, prepared by United Planning & Engineering Co., dated June 1978.

5. *Engineering Study and Revision of the Douglas Creek Flood Drainage Basin*, prepared by Lincoln-DeVore, dated June 1974.

6. *Douglas Creek Drainage Basin*, prepared by Leigh Whitehead & Associates, dated March 1981.

7. *Engineering Study and Revision of the North Shook's Run--Templeton Gap Drainage Basin*, prepared by Lincoln-DeVore, dated September 1977.

8. *Popes Bluff Drainage Study*, prepared by R. Keith Hook and Associates, Inc., dated November 1966.

9. *Hydrologic Engineering Study, Master Drainage Basin Study Rockrimmon South Drainage Basin*, prepared by Karcich & Weber, Inc., dated October 1976.

10. *Hydrologic Engineering Study of the Rockrimmon North Drainage Basin*, prepared by United Western Engineers, dated March 1973.

11. *Hydrologic Engineering Study of the Pulpit Rock Drainage Basin*, prepared by R. Keith Hook and Associates, Inc., dated March 1968.

12. *Dry Creek Drainage Study*, prepared by R. Keith Hook and Associates, Inc., dated November 1966.

13. *Pine Creek Drainage Basin, Drainage Basin Planning Study*, prepared by Obering, Wurth & Associates, dated October 1988.

14. *Pine Creek Drainage Basin, Drainage Basin Planning Study, Exhibit V: HEC 1 Printout*, prepared by Obering, Wurth & Associates, dated October 1988.

15. *Black Squirrel Creek Drainage Basin Planning Study*, prepared by URS Corporation, dated January 1989.

16. *Middle Tributary Drainage Basin Planning Study*, prepared by URS Corporation dated April 1987.

17. *Technical Addendum Middle Tributary Drainage Basin Planning Study*, prepared by URS Corporation, dated April 1987.

18. *Monument Branch Drainage Basin Planning Study*, prepared by URS Corporation, dated April 1987.

19. *Technical Addendum Monument Branch Drainage Basin Planning Study*, prepared by Wilson and Company, dated May 1989.

20. *Black Forest Drainage Basin Planning Study*, prepared by Wilson and Company, dated May 1989.

21. *Technical Addendum Black Forest Drainage Basin Planning Study*, prepared by Wilson and Company, dated May 1989.

22. *Drainage Basin Planning Study Jackson Creek (FOMO 4400)*, prepared by Claycomb Engineering Associates, Inc., dated July 1989.

23. *NOAA Atlas 2, Precipitation-Frequency Atlas of the Western United States, Volume III-Colorado*; prepared by U.S. Department of Commerce, National Oceanic and Atmospheric Administration, and National Weather Service, prepared for U.S. Department of Agriculture, Soil Conservation Service, Engineering Division, dated 1973.

24. *Hydrometeorological Report No. 51, Probable Maximum Precipitation Estimates, United States, East of the 105th Meridian*; prepared by the National Weather Service, Hydrometeorological Branch, Office of Hydrology, prepared for the U.S. Department of Commerce, National Oceanic and Atmospheric Administration, and U.S. Department of the Army Corps of Engineers, dated June 1978.

25. *Hydrometeorological Report No. 52, Application of Probable Maximum Precipitation Estimates - United States East of the 105th Meridian*; prepared by the National Weather Service, Hydrometeorological Branch, Office of Hydrology, prepared for the U.S. Department of Commerce, National oceanic and Atmospheric Administration, and U.S. Department of the Army Corps of Engineers, dated August 1982.

26. *Soil Survey for El Paso County, Colorado*, dated June 1981.

27. *City of Colorado Springs/El Paso County Drainage Criteria Manual*, prepared by City of Colorado Springs, El Paso County, and HDR Infrastructure, Inc., dated May 1987.

28. *Flood Insurance Studies for Colorado Springs, and El Paso County, Colorado*, prepared by the Federal Emergency Management Agency (FEMA), revised 1989.

29. *Flood Plain Information, Monument Creek, Colorado Springs, Colorado*, prepared for the Pikes Peak Area Council of Governments by the Department of Army, Albuquerque District, Corps of Engineers, dated May 1971.

30. *Twenty-Eight Biennial Report of the State Engineer to the Governor of Colorado*, Colorado State Engineer, Department of Water Resources, 1939.

31. *Flood Frequency Analysis Program*, HEC-WRC, U.S. Army Corps of Engineers, Revised June 1985.

32. *Magnitude and Frequency of Floods in the U.S.*, Part 7 Lower Mississippi River Basin, U.S. Department of the Interior (DOI), Geological Survey Water-Supply Paper, 1939-1949.

33. *U.S. Geological Survey Water Resources Data for Colorado*, Part I. Surface Water Records, U.S. Department of the Interior (DOI), 1976-1989.

34. *Guidelines for Determining Flood Flow Frequency*, U.S. Department of the Interior (DOI), Bulletin #17B, Editorial Corrections March 1982.

Mapping and Surveying

Mapping for use in this hydrologic effort consisted of U.S. Geological Survey (USGS) 7-1/2 minute quadrangles, and 1-inch to 200-foot scale, 2-foot contour interval planimetric topographic maps. The City of Colorado Springs' Department of Public Utilities provided the topographic mapping compiled from aerial photographs dated November, 1989. All topographic mapping was based upon the USGS vertical datum.

Drainageway site inspections were conducted throughout the study area, and photographs were taken documenting the key drainage features.

already been recognized as drainage basins by either the City of Colorado Springs or El Paso County. Some basins such as Monument Valley and Papeton have replaced basins previously recognized as "miscellaneous" basins. This was done in order to distinguish between the so-called "miscellaneous" basins within the study area.

The regional basins have been further subdivided into sub-basins. These sub-basins are roughly one square mile in area. Some basins may be slightly smaller or larger than one square mile depending upon the location of the most logical sub-basin divide(s). Each sub-basin has been assigned an alphanumeric designation. This designation is between four and six characters in length. The alphabetical characters in the designation represent the stream or the regional basin in which the sub-basin is immediately tributary. Table 6 shows the meaning of the alphabetical characters in the sub-basin designations. The numbers in the sub-basin designation are unique to each sub-basin. Each sub-basin has a unique number identifying it. However, with many different sub-basins the addition of the alphabetical characters allow for a quick determination of where within the Monument Creek basin that particular sub-basin lies.

Table 6 Regional Basin Designations

Code	Description	Code	Description	Code	Description
ICC	Ice Cave Creek	NMC	North Monument Creek	MC	Monument Creek
RM	Raspberry Mountain	PL	Palmer Lake	DWC	Dirty Woman Creek
TC	Teachout Creek	EG	Ensign Gulch	SBC	South Beaver Creek
HLC	Hell Creek	NBC	North Beaver Creek	BC	Beaver Creek
HYC	Hay Creek	JC	Jackson Creek	BF	Black Forest
SC	Smith Creek	MB	Monument Branch	MT	Middle Tributary
JV	Jack's Valley	DMC	Deadman's Creek	LR	Lehman Run
DV	Douglas Valley	WMC	West Monument Creek	BSC	Black Squirrel Creek
ELK	Elkhorn	KC	Kettle Creek	DRY	Dry Creek
SPC	South Pine Creek	CC	Cottonwood Creek	PC	Pine Creek
NR	North Rockrimmon	SR	South Rockrimmon	PB	Popes Bluff
DGC	Douglas Creek	TG	Templeton Gap	ROS	Roswell
PAP	Papeton	MES	Mesa	MVP	Monument Valley

Hydrologic data for each sub-basin was developed using the Soil Conversation Service (SCS) Dimensionless Hydrograph Model within HEC-1. Basin characteristics required for the SCS Dimensionless Hydrograph Method using HEC-1 are area, curve number, and SCS lag time (T_{lag}). Basin areas were planimetered to determine their area in square miles. Curve numbers were determined for each sub-basin utilizing the hydrologic soil type, ground cover (both existing and proposed), and Tables 5-4 and 5-5 of the City/County Criteria Manual. The calculation of the SCS lag time was based upon its relationship to time of concentration (t_c). The time of concentration for each sub-basin was determined by adding travel times for overland flow, channel flow, and pipe flow from the hydrologically most distant point in the basin to the outfall point. The parameters used in these calculations were determined from available topographic maps, soils maps, aerial photography, land use maps, and field investigation. Figure 3 shows the hydrologic soil types within the Monument Creek basin. For areas which are currently undeveloped and underlain with "Type A" soils, it was assumed that "Type B" soils would exist in the developed condition and the curve numbers were modified accordingly.

Five existing major flood control structures have been included in the hydrologic model. These structures are Rampart Reservoir, the Kettle Creek Detention Pond also known as the Air Force Academy Detention Pond, Briargate Detention Pond II, and the Chapel Hills Detention Ponds Numbers 1 and 2. The detention ponds were included in the hydrologic model because they are considered flood control structures by the State of Colorado. Rampart Reservoir was included based on discussions with the City of Colorado Springs Water Department regarding the operation of the Reservoir. Rampart Reservoir is not considered a flood control structure; however, due to the way the reservoir is operated it acts as a flood control structure.

The impact of proposed drainageway improvements have not been considered in the hydrologic model. Proposed improvements such as detention/retention basins and their effect upon peak discharges will be evaluated in the alternative planning phase. Future channel sections which may slow or speed up the travel time of peak flows will also be modelled in the alternative planning hydrology.

Sub-basin flows were routed and/or combined with other sub-basin flows to establish discharges at various points throughout the Monument Creek basin. Routing of flows was accomplished using the kinematic wave method. The kinematic wave method is based upon characteristics of each reach including length, slope, Manning's roughness, type of channel, bottom width of channel, and channel side slope. Flows from upstream sub-basins or design points (points of combined flow) were routed through the channel reach determining the channel storage and lag time for the routing. At design points, two or more hydrographs were combined to determine the outflow hydrograph at that particular point (in the input to the HEC-1 computer model design points are designed with the prefix "DP" and routing elements are designated with the prefix "RT").

Impervious Area

Land use assumptions for existing and future basin conditions were determined using a combination of zoning maps, City/County Comprehensive Plan(s), aerial photographs, transportation plan(s), and other related land use documents. Land use density and corresponding curve numbers were determined in accordance with the City/County Drainage Criteria Manual (refer to explanation in Section III, Impervious Area). Figure 6 depicts the proposed land use distribution assumed in the hydrologic modeling. Previously presented as Table 4 are the percent of imperviousness assigned for each of the land use categories presented on Figure 6. Tables 7 and 9 summarize the calculated SCS curve numbers (CN) for both the existing and future conditions for the Monument Creek basin. Table 8 presents the percent impervious calculations for the traffic zones used in the future condition curve number determination.

Design Rainfall

The *City/County Drainage Criteria Manual* identifies a number of procedures to be used in developing storm rainfall for input into hydrologic models. The criteria manual stipulates that two storm durations (2-hour and 24-hour) be checked to determine the critical design storm (the storm producing the greatest peak discharge) and recommends that the SCS Type IIA distribution be used to represent the 24-hour rainfall pattern. Rainfall depths shown in the criteria manual are based on *National Oceanographic and Atmospheric Administration (NOAA) Atlas 2*. Areal adjustments representing reductions in point rainfall depths to be applied to large watershed area are not discussed in the criteria manual.

Based on the results of initial hydrologic modeling and input received at the technical review meetings, several modifications were made to the procedures identified in the drainage criteria manual. The 24-hour storm was determined to be the critical design storm for the large watershed area associated with Monument Creek; therefore, results pertaining to the 2-hour storm are not shown. Similarly, the SCS Type II distribution was determined to consistently produce greater peak discharges (by as much as 40 percent) than the Type IIA distribution.

Point rainfall depths (2.96 inches for the 10-year storm and 4.32 inches for the 100-year storm) developed within the guidelines of the drainage criteria manual were areally adjusted based on three different approaches. The first approach consisted of multiplying the point rainfall depths by a reduction factor published in Hydrometeorological Report No. 51 (HMR 51).

SECTION III
STUDY AREA DESCRIPTION

The following sub-sections provide a description of the Monument Creek basin, climate, flood history, soils and geology, and impervious area.

Basin Description

The area of study for this report is the Monument Creek drainage basin. Monument Creek is a tributary to Fountain Creek which in turn is tributary to the Arkansas River. As shown in Figure 1, the confluence of Monument Creek and Fountain Creek occurs within the City of Colorado Springs, just southwest of downtown. The Monument Creek drainage basin contains an area of approximately 239 square miles. The basin is generally fan-shaped and oriented in a north-south direction. Figure 2 depicts the Monument Creek drainage basin in relation to the City of Colorado Springs and the Towns of Monument and Palmer Lake. Table 2 indicates the areas of the Monument Creek tributary.

Table 2 also indicates whether the sub-basin is a left or right bank tributary to Monument Creek. The left bank tributaries are generally high plains basins with some rolling hills. The general slope of these sub-basins is from east to west. These basins are generally characterized by grass cover with occasional areas of shrubs. Some areas include coniferous and deciduous trees. The coniferous trees in the left bank tributaries are generally found in the northeast portion of the Monument Creek basin in the area generally known as the "Black Forest". The right bank tributaries are typically mountainous sub-basins with steep slopes. These basins are generally covered with coniferous trees, grass, and shrubs. The total elevation difference within the basin is approximately 3,800 feet. The highest point in the basin is at an elevation of 9,727 feet above sea level and the elevation at the confluence with Fountain Creek is at an elevation of 5,945 feet.

Monument Creek is approximately 33 miles in length. The flow direction of the creek is west to east for approximately the first eight miles. Near the Town of Monument, the creek alignment changes to a southerly direction, parallel to the Front Range mountains, until its confluence with Fountain Creek at Colorado Springs.

Climate

The Monument Creek basin of El Paso County can be described in general as high plains and foothills, with total precipitation amounts typical of a semi-arid region. Winters are generally cold and dry. Precipitation ranges from 14 to 16 inches per year, with the majority of this precipitation occurring between April and September in the form of rainfall. Thunderstorms

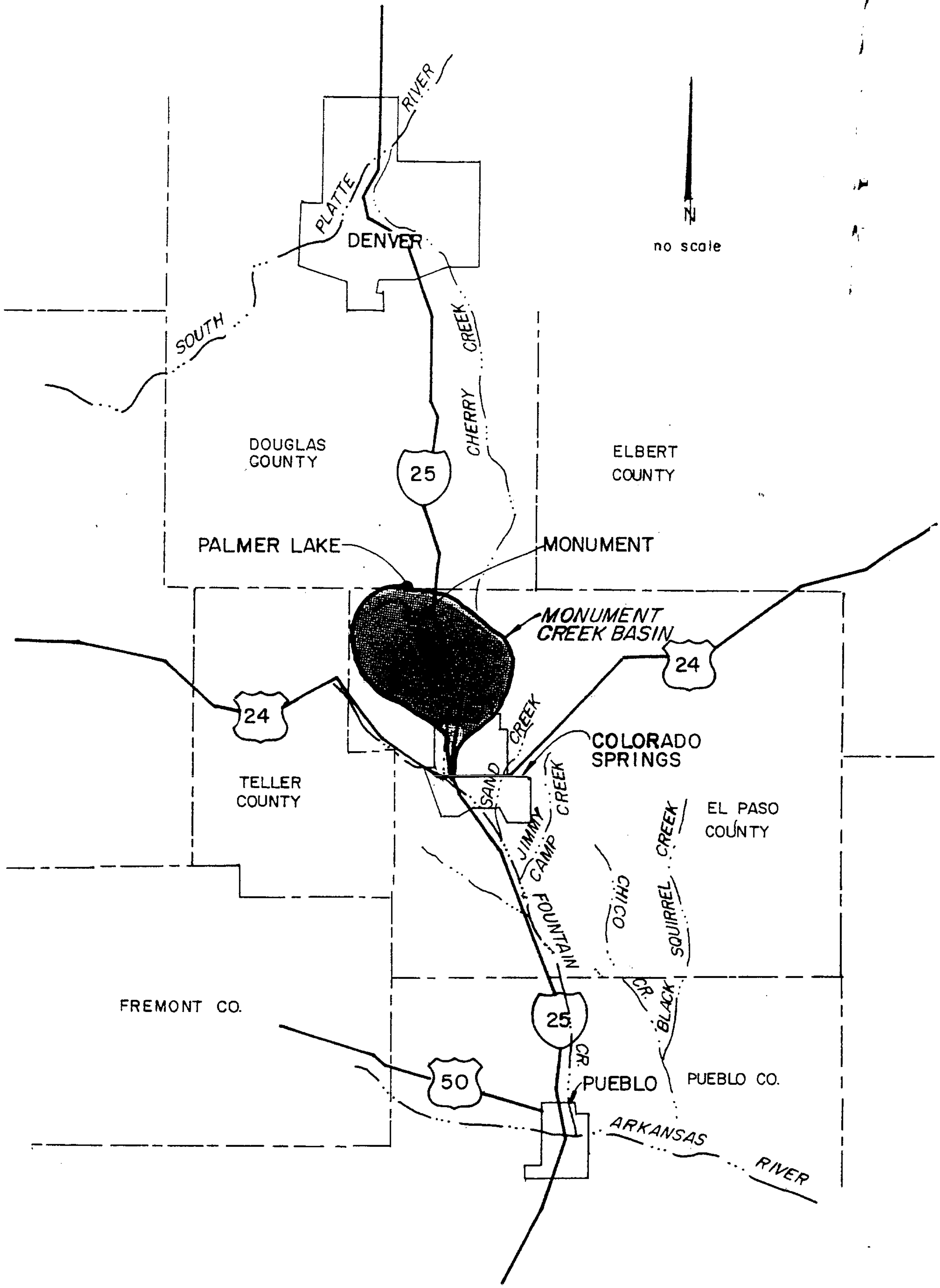


FIGURE 1
VICINITY MAP

PROJECTED CURVE NUMBERS

BASIN NAMES	AREA SQ MILES	SOILS DISTRIBUTION IN PERCENT				PROJECTED LAND USE DISTRIBUTION IN PERCENT												WEIGH % IMPERV	CURVE NUMBER
		GROUP A	GROUP B	GROUP C	GROUP D														
		PERV CN:	PERV CN:	PERV CN:	PERV CN:	ZONE 1	% AREA	IMPERV %	ZONE 2	% AREA	IMPERV %	ZONE 3	% AREA	IMPERV %	ZONE 4	% AREA	IMPERV %		
		39	61	74	80														
343	1.06	0%	100%	0%	0%	227	84%	8%	225	16%	14%							9%	64
345	0.99	0%	100%	0%	0%	227	20%	8%	225	35%	14%	171	45%	10%				11%	65
347	1.11	39%	61%	0%	0%	227	21%	8%	170	79%	41%							34%	68
349	1.25	85%	15%	0%	0%	212	100%	12%										12%	49
351	1.02	75%	25%	0%	0%	212	100%	12%										12%	51
353	1.06	66%	34%	0%	0%	212	72%	12%	170	28%	41%							21%	57
KETTLE CREEK	19.63																		
DC 355	0.80	0%	43%	0%	57%	402	100%	2%										2%	72
357	0.73	0%	47%	0%	53%	161	100%	16%										16%	75
359	0.64	0%	55%	0%	45%	161	100%	16%										16%	74
361	1.30	18%	9%	34%	40%	163	100%	30%										30%	78
362	1.19	0%	100%	0%	0%	161	100%	16%										16%	67
363	0.33	0%	100%	0%	0%	161	100%	16%										16%	67
364	0.69	17%	75%	0%	8%	161	100%	16%										16%	65
DRY CREEK	5.68																		
425	1.61	100%	0%	0%	0%	170	43%	41%	TYPE 4	57%	77%							62%	75
427	0.86	67%	33%	0%	0%	TYPE 4	100%	77%										77%	86
429	0.77	100%	0%	0%	0%	170	53%	41%	TYPE 4	47%	77%							58%	73
431	0.39	100%	0%	0%	0%	TYPE 4	100%	77%										77%	84
433	0.38	15%	69%	0%	16%	170	62%	41%	TYPE 4	38%	77%							55%	81
435	0.94	33%	55%	0%	12%	TYPE 4	100%	77%										77%	88
SOUTH PINE CREEK	4.95																		
437	1.18	0%	100%	0%	0%	226	100%	14%										14%	66
439	0.50	0%	100%	0%	0%	226	100%	14%										14%	66

PROJECTED CURVE NUMBERS

BASIN NAMES		AREA SQ MILES	SOILS DISTRIBUTION IN PERCENT GROUP A	GROUP B	GROUP C	GROUP D	PROJECTED LAND USE DISTRIBUTION IN PERCENT ZONE 1	% AREA	IMPERV %	ZONE 2	% AREA	IMPERV %	ZONE 3	% AREA	IMPERV %	ZONE 4	% AREA	IMPERV %	WEIGH % IMPERV	CURVE NUMBER
			PERV CN: 39	PERV CN: 61	PERV CN: 74	PERV CN: 80														
BS	246	1.02	0%	100%	0%	0%	227	48%	8%	222	52%	4%							6%	63
	247	0.63	0%	100%	0%	0%	227	12%	8%	222	88%	4%							4%	63
	248	1.52	0%	100%	0%	0%	227	100%	8%										8%	64
	249	0.39	0%	100%	0%	0%	227	37%	8%	222	45%	4%	218	18%	24%				9%	64
	250	3.36	0%	100%	0%	0%	227	100%	8%										8%	64
	251	1.26	0%	100%	0%	0%	227	100%	8%										8%	64
	252	0.96	0%	100%	0%	0%	227	100%	8%										8%	64
	253	0.88	0%	100%	0%	0%	218	100%	24%										24%	70
	254	1.09	0%	100%	0%	0%	218	80%	24%	212	20%	12%							22%	69
BLACK SQUIRREL CREEK		11.11																		
ELK	255	1.33	35%	66%	0%	0%	227	10%	8%	218	50%	24%	212	40%	12%				18%	61
	257	0.81	100%	0%	0%	0%	227	100%	8%										8%	44
	259	0.60	82%	18%	0%	0%	218	30%	24%	212	65%	12%	170	5%	41%				15%	52
ELK HORN		2.74																		
KC	321	1.31	0%	100%	0%	0%	225	100%	14%										14%	66
	323	1.67	0%	100%	0%	0%	227	43%	8%	225	57%	14%							11%	65
	325	1.13	0%	100%	0%	0%	226	100%	14%										14%	66
	327	0.84	0%	100%	0%	0%	227	30%	8%	226	29%	14%	225	41%	14%				12%	66
	329	1.14	0%	100%	0%	0%	227	78%	8%	225	22%	14%							9%	64
	331	0.68	0%	100%	0%	0%	225	100%	14%										14%	66
	333	1.36	0%	100%	0%	0%	227	83%	8%	226	17%	14%							9%	64
	335	2.03	0%	100%	0%	0%	227	62%	8%	225	38%	14%							10%	65
	337	1.05	0%	100%	0%	0%	225	100%	14%										14%	66
	339	0.93	0%	100%	0%	0%	225	100%	14%										14%	66
	341	1.00	0%	100%	0%	0%	227	92%	8%	225	8%	14%							8%	64

PROJECTED CURVE NUMBERS

BASIN NAMES	AREA SQ MILES	SOILS DISTRIBUTION IN PERCENT				PROJECTED LAND USE DISTRIBUTION IN PERCENT												WEIGH % IMPERV	CURVE NUMBER
		GROUP A	GROUP B	GROUP C	GROUP D														
		PERV CN:	PERV CN:	PERV CN:	PERV CN:	ZONE 1	% AREA	IMPERV %	ZONE 2	% AREA	IMPERV %	ZONE 3	% AREA	IMPERV %	ZONE 4	% AREA	IMPERV %		
		39	61	74	80														
275	0.82	0%	6%	0%	94%	402	100%	2%										2%	79
277	0.83	0%	8%	0%	93%	402	100%	2%										2%	79
279	0.49	0%	0%	0%	100%	402	100%	2%										2%	80
281	0.49	0%	0%	0%	100%	402	100%	2%										2%	80
283	0.92	0%	0%	0%	100%	402	100%	2%										2%	80
285	1.22	0%	0%	0%	100%	402	100%	2%										2%	80
287	0.69	0%	0%	0%	100%	402	100%	2%										2%	80
289	0.96	0%	0%	0%	100%	402	100%	2%										2%	80
290	0.57	0%	0%	0%	100%	402	100%	2%										2%	80
291	1.36	0%	4%	0%	96%	402	100%	2%										2%	80
293	1.00	0%	16%	0%	84%	402	100%	2%										2%	77
295	1.36	0%	0%	0%	100%	402	100%	2%										2%	80
297	1.12	0%	0%	0%	100%	402	100%	2%										2%	80
299	0.77	0%	0%	0%	100%	402	100%	2%										2%	80
301	0.93	0%	0%	0%	100%	402	100%	2%										2%	80
303	1.20	0%	0%	0%	100%	402	100%	2%										2%	80
305	1.12	0%	35%	0%	65%	402	82%	2%	212	18%	12%							4%	74
307	1.09	0%	8%	5%	87%	402	95%	2%	212	5%	12%							3%	79
309	1.14	0%	0%	0%	100%	402	100%	2%										2%	80
310	0.82	0%	0%	0%	100%	212	100%	12%										12%	82
311	0.74	0%	68%	32%	0%	212	100%	12%										12%	69
313	0.40	0%	100%	0%	0%	212	100%	12%										12%	66
315	1.09	0%	0%	13%	87%	212	100%	12%										12%	82
317	1.20	0%	100%	0%	0%	212	100%	12%										12%	66
319	0.51	0%	100%	0%	0%	212	100%	12%										12%	66
AF ACADEMY	44.66																		

PROJECTED CURVE NUMBERS

BASIN NAMES		AREA SQ MILES	SOILS DISTRIBUTION IN PERCENT GROUP A PERV CN: 39	GROUP B PERV CN: 61	GROUP C PERV CN: 74	GROUP D PERV CN: 80	PROJECTED LAND USE DISTRIBUTION IN PERCENT ZONE 1	% AREA	IMPERV %	ZONE 2	% AREA	IMPERV %	ZONE 3	% AREA	IMPERV %	ZONE 4	% AREA	IMPERV %	WEIGH % IMPERV	CURVE NUMBER
MT	233	1.47	0%	100%	0%	0%	218	82%	24%	212	18%	12%							22%	69
MIDDLE TRIBUTARY		1.47																		
JV	183	1.15	0%	87%	0%	13%	212	100%	12%										12%	68
	185	0.71	0%	100%	0%	0%	212	100%	12%										12%	66
	187	1.09	0%	100%	0%	0%	212	100%	12%										12%	66
	189	1.10	5%	95%	0%	0%	212	100%	12%										12%	65
DM	201	1.16	0%	5%	0%	94%	402	100%	2%										2%	79
	203	0.77	0%	50%	0%	50%	402	100%	2%										2%	71
	205	1.19	2%	95%	0%	5%	402	38%	2%	212	62%	12%							8%	66
	206	0.71	0%	60%	0%	40%	402	37%	2%	212	63%	12%							9%	71
	207	0.81	0%	91%	9%	0%	212	100%	12%										12%	67
	209	0.56	12%	88%	0%	0%	212	100%	12%										12%	63
	211	1.54	1%	99%	0%	0%	212	100%	12%										12%	65
LR	235	1.22	0%	10%	0%	90%	402	100%	2%										2%	79
	237	0.97	9%	79%	0%	21%	402	23%	2%	212	67%	12%							9%	71
	239	0.72	0%	72%	0%	28%	402	64%	2%	212	36%	12%							6%	68
	241	1.11	0%	100%	0%	0%	212	100%	12%										12%	66
	243	0.72	3%	96%	0%	0%	212	100%	12%										12%	65
	245	0.28	0%	100%	0%	0%	212	100%	12%										12%	66
DV	261	0.60	0%	100%	0%	0%	212	100%	12%										12%	66
	263	1.32	0%	100%	0%	0%	212	100%	12%										12%	66
	265	1.05	8%	92%	0%	0%	212	100%	12%										12%	64
	267	0.44	0%	100%	0%	0%	212	100%	12%										12%	66
	269	0.73	0%	100%	0%	0%	212	100%	12%										12%	66
	271	1.08	0%	100%	0%	0%	212	100%	12%										12%	66
WM	273	0.79	0%	86%	0%	14%	402	100%	2%										2%	64

PROJECTED CURVE NUMBERS

BASIN NAMES		AREA SQ MILES	SOILS DISTRIBUTION IN PERCENT				PROJECTED LAND USE DISTRIBUTION IN PERCENT												WEIGH % IMPERV	CURVE NUMBER
			GROUP A PERV CN: 39	GROUP B PERV CN: 61	GROUP C PERV CN: 74	GROUP D PERV CN: 80	ZONE 1	% AREA	IMPERV %	ZONE 2	% AREA	IMPERV %	ZONE 3	% AREA	IMPERV %	ZONE 4	% AREA	IMPERV %		
BF	191	0.57	0%	100%	0%	0%	220	100%	10%										10%	65
	193	0.83	0%	100%	0%	0%	220	50%	10%	219	50%	26%							18%	68
	195	0.60	0%	77%	24%	0%	219	100%	26%										26%	73
	197	0.52	0%	100%	0%	0%	219	72%	26%	212	28%	12%							22%	69
	199	0.62	0%	100%	0%	0%	219	62%	26%	212	38%	12%							21%	69
	200	0.76	0%	100%	0%	0%	219	100%	26%										26%	70
BLACK FORREST		3.90																		
SC	213	0.89	0%	100%	0%	0%	220	8%	10%	219	92%	26%							24%	70
	215	1.03	0%	100%	0%	0%	222	28%	4%	220	72%	10%							8%	64
	217	0.83	0%	100%	0%	0%	222	100%	4%										4%	62
	219	0.51	0%	89%	11%	0%	219	100%	26%										26%	72
	221	0.95	0%	100%	0%	0%	219	100%	26%										26%	70
	223	0.88	0%	100%	0%	0%	219	100%	26%										26%	70
	225	0.37	0%	100%	0%	0%	212	100%	12%										12%	66
SMITH CREEK		5.46																		
MB	225	0.95	0%	100%	0%	0%	222	7%	4%	219	30%	26%	218	63%	24%				23%	70
	227	0.43	0%	100%	0%	0%	219	50%	26%	218	50%	24%							25%	70
	228	0.24	0%	100%	0%	0%	218	100%	24%										24%	70
	229	0.44	0%	100%	0%	0%	218	100%	24%										24%	70
	230	0.45	0%	100%	0%	0%	218	100%	24%										24%	70
	231	1.07	0%	100%	0%	0%	219	21%	24%	218	58%	24%	212	21%	12%				22%	69
	232	0.26	0%	100%	0%	0%	218	31%	24%	212	69%	12%							16%	67
MONUMENT BRANCH		3.84																		

PROJECTED CURVE NUMBERS

BASIN NAMES		AREA SQ MILES	SOILS DISTRIBUTION IN PERCENT				PROJECTED LAND USE DISTRIBUTION IN PERCENT												WEIGH % IMPERV	CURVE NUMBER
			GROUP A	GROUP B	GROUP C	GROUP D														
			PERV CN:	PERV CN:	PERV CN:	PERV CN:	ZONE 1	% AREA	IMPERV %	ZONE 2	% AREA	IMPERV %	ZONE 3	% AREA	IMPERV %	ZONE 4	% AREA	IMPERV %		
			39	61	74	80														
	139	1.24	0%	0%	0%	100%	402	100%	2%										2%	80
	141	0.91	0%	0%	0%	100%	402	100%	2%										2%	80
	143	1.25	19%	16%	0%	65%	402	75%	2%	215	25%	12%							4%	71
HLC	145	0.58	0%	8%	0%	100%	402	60%	2%	215	40%	12%							6%	86
NBC	147	1.29	0%	0%	0%	100%	402	100%	2%										2%	80
	149	0.62	0%	0%	0%	100%	402	100%	2%										2%	80
	151	0.77	0%	0%	0%	100%	402	100%	2%										2%	80
	153	1.04	6%	41%	0%	52%	402	62%	2%	215	38%	12%							6%	71
BC	155	1.03	0%	97%	3%	0%	215	100%	12%										12%	65
HYC	157	0.72	0%	0%	0%	100%	402	100%	2%										2%	80
	159	0.64	0%	0%	0%	100%	402	100%	2%										2%	80
	161	0.73	0%	34%	0%	66%	402	68%	2%	215	32%	12%							5%	75
	163	0.73	0%	100%	0%	0%	215	100%	12%										12%	65
	165	0.44	0%	100%	0%	0%	215	100%	12%										12%	65
	167	0.60	0%	100%	0%	0%	215	72%	12%	212	28%	12%							12%	66
BC	169	0.77	0%	92%	7%	0%	215	100%	12%										12%	66
	171	0.39	4%	96%	0%	0%	215	80%	12%	212	20%	12%							12%	65
BEAVER CREEK		27.19																		
JC	173	1.01	0%	85%	15%	0%	220	100%	10%										10%	66
	175	1.16	0%	79%	20%	0%	220	100%	10%										10%	66
	177	1.40	0%	100%	0%	0%	220	100%	10%										10%	65
	179	0.73	0%	100%	0%	0%	220	100%	10%										10%	65
	180	0.65	0%	100%	0%	0%	215	78%	12%	214	22%	21%							14%	66
	181	0.16	0%	100%	0%	0%	220	20%	10%	219	65%	26%	215	15%	12%				20%	69
	182	0.24	0%	100%	0%	0%	219	60%	26%	215	33%	12%	212	7%	12%				20%	69
JACKSON CREEK		5.35																		

PROJECTED CURVE NUMBERS

BASIN NAMES		AREA SQ MILES	SOILS DISTRIBUTION IN PERCENT				PROJECTED LAND USE DISTRIBUTION IN PERCENT												WEIGH % IMPERV	CURVE NUMBER
			GROUP A	GROUP B	GROUP C	GROUP D														
			PERV CN:	PERV CN:	PERV CN:	PERV CN:	ZONE 1	% AREA	IMPERV %	ZONE 2	% AREA	IMPERV %	ZONE 3	% AREA	IMPERV %	ZONE 4	% AREA	IMPERV %		
			39	61	74	80														
	93	0.52	0%	94%	7%	0%	221	50%	15%	220	50%	10%							12%	67
	95	0.66	0%	100%	0%	0%	214	100%	21%										21%	69
	97	0.25	0%	64%	37%	0%	214	100%	21%										21%	73
DIRTY WOMAN CREEK		5.45																		
TC	99	0.47	0%	100%	0%	0%	220	100%	10%										10%	65
	101	0.74	0%	100%	0%	0%	220	100%	10%										10%	65
	103	0.21	0%	101%	0%	0%	220	100%	10%										10%	65
	105	0.83	0%	86%	14%	0%	214	100%	21%										21%	70
	107	0.44	0%	100%	0%	0%	220	37%	10%	214	63%	21%							17%	68
TEACHOUT CREEK		2.69																		
EG	109	1.24	0%	0%	0%	100%	402	100%	2%										2%	80
	111	0.75	0%	0%	0%	100%	402	100%	2%										2%	80
	113	0.98	0%	0%	0%	100%	402	100%	2%										2%	80
	115	0.85	0%	0%	0%	100%	402	100%	2%										2%	80
	117	0.47	0%	0%	0%	100%	402	100%	2%										2%	80
SBC	119	1.83	0%	37%	0%	63%	402	100%	2%										2%	73
	121	1.11	0%	0%	0%	100%	402	100%	2%										2%	80
	123	0.91	0%	0%	0%	100%	402	100%	2%										2%	80
	125	0.47	0%	0%	0%	100%	402	100%	2%										2%	80
	127	0.69	0%	0%	0%	100%	402	100%	2%										2%	80
	129	0.85	0%	0%	0%	100%	402	100%	2%										2%	80
	131	0.69	0%	0%	0%	100%	402	100%	2%										2%	80
	133	0.72	0%	0%	0%	100%	402	100%	2%										2%	80
	135	0.85	0%	0%	0%	100%	402	100%	2%										2%	80
	137	1.03	0%	0%	0%	100%	402	100%	2%										2%	80

PROJECTED CURVE NUMBERS

BASIN NAMES		AREA SQ MILES	SOILS DISTRIBUTION IN PERCENT GROUP A PERV CN: 39	GROUP B PERV CN: 61	GROUP C PERV CN: 74	GROUP D PERV CN: 80	PROJECTED LAND USE DISTRIBUTION IN PERCENT ZONE 1	% AREA	IMPERV %	ZONE 2	% AREA	IMPERV %	ZONE 3	% AREA	IMPERV %	ZONE 4	% AREA	IMPERV %	WEIGH % IMPERV	CURVE NUMBER
	55	1.07	0%	95%	0%	5%	402	57%	2%	214	43%	21%							10%	66
	59	0.37	0%	99%	0%	0%	214	100%	21%										21%	69
RASBERRY MOUNTAIN		2.42																		
PL	49	0.31	0%	100%	0%	0%	214	20%	21%	213	80%	25%							24%	70
	53	0.95	0%	100%	0%	0%	214	25%	21%	213	75%	25%							24%	70
	57	1.48	0%	92%	9%	0%	221	10%	15%	214	10%	21%	213	80%	25%				23%	71
	61	0.91	0%	88%	12%	0%	214	32%	21%	213	68%	25%							24%	71
	63	0.99	0%	98%	2%	0%	221	60%	15%	214	40%	21%							17%	68
PALMER LAKE		4.64																		
MR	65	0.78	0%	73%	0%	27%	402	100%	2%										2%	67
	67	0.72	0%	49%	13%	37%	402	33%	2%	214	67%	21%							15%	74
	69	0.72	0%	70%	0%	29%	402	80%	2%	214	20%	21%							6%	68
	71	0.96	0%	91%	0%	8%	402	35%	2%	215	30%	12%	214	35%	21%				12%	67
	73	0.53	0%	94%	5%	0%	214	100%	21%										21%	69
	75	0.32	0%	100%	0%	0%	214	100%	21%										21%	69
	77	0.24	0%	100%	0%	0%	214	100%	21%										21%	69
MONUMENT ROCK		4.27																		
DWC	79	0.50	0%	87%	13%	0%	221	100%	15%										15%	68
	81	0.66	0%	91%	9%	0%	221	100%	15%										15%	67
	83	0.61	0%	96%	4%	0%	221	100%	15%										15%	67
	85	0.36	0%	92%	8%	0%	221	100%	15%										15%	67
	87	0.66	0%	91%	9%	0%	221	100%	15%										15%	67
	89	0.45	0%	96%	4%	0%	221	50%	15%	220	50%	10%							12%	66
	91	0.78	0%	90%	10%	0%	221	100%	15%										15%	68

PROJECTED CURVE NUMBERS

BASIN NAMES		AREA SQ MILES	SOILS DISTRIBUTION IN PERCENT				PROJECTED LAND USE DISTRIBUTION IN PERCENT												WEIGH % IMPERV	CURVE NUMBER
			GROUP A PERV CN: 39	GROUP B PERV CN: 61	GROUP C PERV CN: 74	GROUP D PERV CN: 80	ZONE 1	% AREA	IMPERV %	ZONE 2	% AREA	IMPERV %	ZONE 3	% AREA	IMPERV %	ZONE 4	% AREA	IMPERV %		
ICC	01	0.87	0%	0%	0%	100%	402	100%	2%										2%	80
	03	1.12	0%	4%	0%	96%	402	100%	2%										2%	80
	05	1.07	0%	0%	0%	100%	402	100%	2%										2%	80
	07	1.17	0%	0%	0%	100%	402	100%	2%										2%	80
	09	1.05	0%	0%	0%	100%	402	100%	2%										2%	80
	11	1.19	0%	0%	0%	100%	402	100%	2%										2%	80
NMC	13	0.87	0%	0%	0%	100%	402	100%	2%										2%	80
	15	0.84	0%	0%	0%	100%	402	100%	2%										2%	80
	17	1.21	0%	0%	0%	100%	402	100%	2%										2%	80
	19	0.88	0%	14%	0%	85%	402	100%	2%										2%	78
	21	0.85	0%	0%	0%	100%	402	100%	2%										2%	80
	23	1.28	0%	0%	0%	100%	402	100%	2%										2%	80
	25	0.99	0%	0%	0%	100%	402	100%	2%										2%	80
	27	1.24	0%	0%	0%	100%	402	100%	2%										2%	80
	29	0.59	0%	0%	0%	100%	402	100%	2%										2%	80
	31	0.69	0%	0%	0%	100%	402	67%	2%	213	33%	25%							10%	82
MC	33	1.40	0%	0%	0%	100%	402	100%	2%										2%	80
	35	0.46	0%	0%	0%	100%	402	100%	2%										2%	80
	37	1.04	0%	0%	0%	100%	402	100%	2%										2%	80
	39	0.41	0%	0%	0%	100%	402	100%	2%										2%	80
	41	1.08	0%	0%	0%	100%	402	100%	2%										2%	80
	43	1.38	0%	0%	0%	100%	402	100%	2%										2%	80
	45	0.86	0%	2%	0%	98%	402	100%	2%										2%	80
	47	0.68	0%	97%	0%	3%	402	10%	2%	213	90%	25%							23%	70
UPPER MONUMENT		23.22																		
RM	51	0.98	0%	93%	0%	8%	402	52%	2%	214	25%	21%	213	23%	25%				12%	67

Table 9

TRANSPORTATION PERCENT IMPERVIOUS CALCULATIONS

ZONE	AREA	RESID AREA	FORCAST POP	CAPAC ULT	ADJ RES AREA	RESID DU/AC	RESID IMPERV	NON-RES AREA	ADJ NON-RES AREA	NON-RES IMPERV	UNDEV AREA	UNDEV IMPERV	WEIGHTED IMPERM
1	1558	382	9113	9197	378.51	12.01	93%	1167	1156.34	85%	23.15	2%	85.7%
6	1733	1052	14385	14385	1052.00	2.77	31%	383	383.00	85%	298.00	2%	37.8%
10	270	237	8242	8242	237.00	0.00	12%	0	0.00	85%	33.00	2%	10.8%
13	450	88	8386	8386	88.00	0.97	19%	331	331.00	85%	31.00	2%	66.3%
14	332	211	8634	8634	211.00	6.51	56%	86	86.00	85%	35.00	2%	57.8%
25	347	77	8634	8634	77.00	12.75	98%	241	241.00	85%	29.00	2%	81.0%
52	1522	788	1584	1584	788.00	5.69	50%	635	635.00	85%	99.00	2%	61.7%
53	317	102	1585	1585	102.00	4.33	41%	215	215.00	85%	0.00	2%	70.9%
54	91	74	10281	10281	74.00	3.69	37%	17	17.00	85%	0.00	2%	45.9%
55	878	770	10281	10281	770.00	3.89	38%	108	108.00	85%	0.00	2%	44.0%
152	1244	795	9113	9197	787.74	9.07	73%	423	419.14	85%	37.12	2%	75.1%
161	1918	1224	4232	6792	762.66	1.72	24%	203	126.49	85%	1028.86	2%	16.1%
162	93	80	24478	46104	42.47	6.44	55%	13	6.90	85%	43.62	2%	32.6%
163	3027	892	8634	8634	892.00	7.19	61%	395	395.00	85%	1740.00	2%	30.1%
164	2347	560	5420	5420	560.00	7.18	60%	388	388.00	85%	1399.00	2%	29.7%
165	240	143	24478	46105	75.92	6.14	53%	33	17.52	85%	146.56	2%	24.3%
170	3397	2239	22178	37171	1335.89	8.23	68%	940	560.85	85%	1500.26	2%	41.5%
171	5375	3144	6290	49468	399.77	7.08	60%	1648	209.55	85%	4765.68	2%	9.5%
172	2574	1035	25225	36171	721.79	7.20	61%	119	82.99	85%	1769.22	2%	21.1%
212	28197	2128	24478	46104	1129.82	0.00	12%	6406	3401.14	85%	23666.04	2%	12.4%
213	3387	2552	8523	10250	2122.02	1.60	23%	482	400.79	85%	864.19	2%	24.9%
214	3896	2594	7343	15559	1224.23	2.60	30%	1070	504.98	85%	2166.79	2%	21.4%
215	1699	1331	1921	5717	447.24	1.70	23%	235	78.96	85%	1172.80	2%	11.5%
218	2509	1947	5710	25531	435.45	5.86	52%	1859	415.76	85%	1657.79	2%	24.4%
219	1900	1381	4804	6718	987.54	2.00	26%	366	261.72	85%	650.73	2%	25.6%
220	6309	5026	6120	22695	1355.33	2.00	26%	838	225.98	85%	4727.70	2%	10.0%
221	4322	3528	3529	7880	1579.99	1.50	22%	602	269.60	85%	2472.41	2%	14.5%
222	6525	5039	1599	18618	432.77	1.50	22%	581	49.90	85%	6042.33	2%	4.0%
224	1669	262	383	8911	11.26	0.50	15%	72	3.09	85%	1654.64	2%	2.2%
225	4941	4581	2855	2855	4581.00	0.20	13%	95	95.00	85%	265.00	2%	14.1%
226	4520	4403	2678	2678	4403.00	0.20	13%	63	63.00	85%	54.00	2%	14.2%
227	12283	10345	3828	13035	3038.03	0.50	15%	1338	392.93	85%	8852.04	2%	8.0%
240	5993	895	30593	56948	480.80	2.00	25%	73	39.22	85%	5472.98	2%	4.4%
402	90000	0	0	0	0.00	0.00	12%	0	0.00	85%	90000.00	2%	2.0%

NOTE: IMPERVIOUS RESIDENTIAL PERCENT FOR ZONE 25 WAS ESTIMATED

Table 8

EXISTING CURVE NUMBERS

BASIN NAMES	AREA SQ MILES	SOILS DISTRIBUTION IN PERCENT				EXISTING LAND USE DISTRIBUTION IN PERCENT					WEIGHTED % IMPERV	CURVE NUMBER
		GROUP A	GROUP B	GROUP C	GROUP D	TYPE 1	TYPE 2	TYPE 3	TYPE 4	TYPE 5		
		PERV CN:	PERV CN:	PERV CN:	PERV CN:	IMPERV:	IMPERV:	IMPERV:	IMPERV:	IMPERV:		
		39	61	74	80	2	9	27	54	84		
409	0.52	0%	12%	0%	88%	78%	0%	0%	22%	0%	13%	81
411	0.84	0%	38%	0%	61%	0%	0%	0%	100%	0%	54%	86
MESA	4.22											
513	0.27	36%	21%	0%	43%	0%	0%	0%	100%	0%	54%	81
515	0.48	48%	29%	0%	24%	0%	0%	0%	100%	0%	54%	78
MONUMENT VALLEY	0.75											

EXISTING CURVE NUMBERS

BASIN NAMES	AREA SQ MILES	SOILS DISTRIBUTION IN PERCENT				EXISTING LAND USE DISTRIBUTION IN PERCENT					WEIGHTED % IMPERV	CURVE NUMBER
		GROUP A	GROUP B	GROUP C	GROUP D	TYPE 1	TYPE 2	TYPE 3	TYPE 4	TYPE 5		
		PERV CN:	PERV CN:	PERV CN:	PERV CN:	IMPERV:	IMPERV:	IMPERV:	IMPERV:	IMPERV:		
		39	61	74	80	2	9	27	54	84		
385	1.33	4%	15%	0%	87%	100%	0%	0%	0%	0%	2%	81
387	1.00	34%	29%	8%	29%	71%	29%	0%	0%	0%	4%	62
389	0.58	30%	31%	0%	40%	70%	30%	0%	0%	0%	4%	64
391	1.07	21%	62%	0%	16%	84%	16%	0%	0%	0%	3%	60
393	1.21	38%	47%	0%	14%	24%	0%	19%	0%	57%	53%	78
395	1.57	22%	25%	27%	37%	100%	0%	0%	0%	0%	2%	74
397	0.51	0%	51%	0%	49%	100%	0%	0%	0%	0%	2%	71
399	1.05	33%	29%	0%	38%	16%	0%	84%	0%	0%	23%	70
DOUGLASS CREEK	10.25											
481	0.99	0%	77%	23%	0%	66%	0%	0%	35%	0%	20%	71
483	1.40	18%	41%	41%	0%	0%	0%	0%	100%	0%	54%	82
485	1.12	82%	0%	0%	18%	26%	0%	0%	74%	0%	40%	67
487	0.70	8%	92%	0%	0%	0%	0%	0%	100%	0%	54%	80
489	1.38	33%	12%	46%	8%	0%	0%	0%	100%	0%	54%	81
491	1.10	78%	0%	0%	22%	0%	0%	0%	100%	0%	54%	75
493	0.75	0%	39%	0%	61%	77%	0%	0%	23%	0%	14%	76
495	0.99	13%	41%	0%	46%	89%	0%	0%	12%	0%	8%	70
497	0.89	0%	64%	0%	35%	0%	0%	0%	87%	13%	58%	85
499	0.35	33%	33%	0%	34%	33%	0%	0%	67%	0%	37%	74
501	0.34	32%	0%	0%	68%	66%	34%	0%	0%	0%	4%	68
503	0.98	1%	0%	12%	88%	100%	0%	0%	0%	0%	2%	80
TEMPLETON GAP	10.99											
505	0.41	15%	28%	28%	28%	0%	0%	0%	0%	99%	83%	93
507	0.72	44%	56%	0%	0%	0%	0%	0%	0%	100%	84%	90
ROSWELL	1.13											
509	1.29	69%	31%	0%	0%	18%	0%	0%	82%	0%	45%	69
511	1.17	22%	78%	0%	0%	0%	0%	0%	100%	0%	54%	79
PAPTON	2.46											
401	0.60	0%	24%	0%	77%	72%	0%	0%	29%	0%	17%	80
403	0.56	0%	50%	0%	50%	31%	0%	0%	70%	0%	38%	81
405	0.82	0%	44%	0%	56%	86%	0%	14%	0%	0%	6%	73
407	0.88	0%	46%	0%	54%	61%	0%	39%	0%	0%	12%	74

EXISTING CURVE NUMBERS

BASIN NAMES		AREA SQ MILES	SOILS DISTRIBUTION IN PERCENT				EXISTING LAND USE DISTRIBUTION IN PERCENT					WEIGHTED % IMPERV	CURVE NUMBER
			GROUP A	GROUP B	GROUP C	GROUP D	TYPE 1	TYPE 2	TYPE 3	TYPE 4	TYPE 5		
			PERV CN: 39	PERV CN: 61	PERV CN: 74	PERV CN: 80	IMPERV: 2	IMPERV: 9	IMPERV: 27	IMPERV: 54	IMPERV: 84		
	459	0.97	59%	41%	0%	0%	100%	0%	0%	0%	0%	2%	49
	461	1.07	54%	46%	0%	0%	100%	0%	0%	0%	0%	2%	50
	463	1.04	61%	39%	0%	0%	100%	0%	0%	0%	0%	2%	49
	465	1.70	30%	51%	0%	19%	59%	0%	0%	41%	0%	23%	67
	467	1.21	19%	62%	0%	19%	0%	0%	0%	100%	0%	54%	81
	469	0.90	70%	30%	0%	0%	0%	0%	0%	100%	0%	54%	74
	471	0.73	76%	24%	0%	0%	0%	0%	0%	100%	0%	54%	73
	473	0.47	85%	15%	0%	0%	0%	0%	0%	100%	0%	54%	72
	475	0.24	48%	29%	0%	25%	0%	0%	0%	100%	0%	54%	79
	477	0.16	72%	29%	0%	0%	0%	0%	0%	100%	0%	54%	74
COTTON WOOD CREEK		20.43											
	PR 479	1.15	20%	15%	15%	50%	65%	0%	0%	35%	0%	20%	74
PULPIT ROCK													
	PC 413	0.82	7%	86%	0%	7%	100%	0%	0%	0%	0%	2%	62
	415	0.78	0%	100%	0%	0%	100%	0%	0%	0%	0%	2%	62
	417	0.87	34%	66%	0%	0%	100%	0%	0%	0%	0%	2%	55
	419	0.54	100%	0%	0%	0%	100%	0%	0%	0%	0%	2%	40
	421	1.32	87%	0%	13%	0%	100%	0%	0%	0%	0%	2%	45
	423	0.38	30%	69%	0%	0%	100%	0%	0%	0%	0%	2%	55
PINE CREEK		4.71											
	NR 375	1.14	15%	20%	25%	40%	0%	100%	0%	0%	0%	9%	72
	376	1.06	32%	11%	49%	8%	11%	89%	0%	0%	0%	8%	65
NORTH ROCK RIMMON		2.20											
	377	0.90	0%	0%	36%	63%	94%	0%	0%	0%	6%	7%	79
	378	0.35	33%	0%	18%	49%	84%	0%	0%	0%	16%	15%	70
SOUTH ROCK RIMMON		1.25											
	379	0.67	0%	15%	0%	85%	100%	0%	0%	0%	0%	2%	78
POPES BLUFF		0.67											
	381	1.05	7%	44%	0%	49%	100%	0%	0%	0%	0%	2%	69
	383	0.88	36%	29%	0%	34%	87%	13%	0%	0%	0%	3%	60

EXISTING CURVE NUMBERS

BASIN NAMES		AREA SQ MILES	SOILS DISTRIBUTION IN PERCENT				EXISTING LAND USE DISTRIBUTION IN PERCENT					WEIGHTED % IMPERV	CURVE NUMBER
			GROUP A	GROUP B	GROUP C	GROUP D	TYPE 1	TYPE 2	TYPE 3	TYPE 4	TYPE 5		
			PERV CN:	PERV CN:	PERV CN:	PERV CN:	IMPERV:	IMPERV:	IMPERV:	IMPERV:	IMPERV:		
			39	61	74	80	2	9	27	54	84		
	343	1.06	0%	100%	0%	0%	100%	0%	0%	0%	0%	2%	62
	345	0.99	0%	100%	0%	0%	100%	0%	0%	0%	0%	2%	62
	347	1.11	39%	61%	0%	0%	26%	0%	74%	0%	0%	20%	62
	349	1.25	85%	15%	0%	0%	37%	45%	0%	0%	18%	20%	54
	351	1.02	75%	25%	0%	0%	95%	0%	0%	0%	6%	7%	48
	353	1.06	66%	34%	0%	0%	73%	0%	27%	0%	0%	9%	51
KETTLE CREEK		19.63											
	DC 355	0.80	0%	43%	0%	57%	100%	0%	0%	0%	0%	2%	72
	357	0.73	0%	47%	0%	53%	100%	0%	0%	0%	0%	2%	72
	359	0.64	0%	55%	0%	45%	100%	0%	0%	0%	0%	2%	70
	361	1.30	18%	9%	34%	40%	44%	56%	0%	0%	0%	6%	71
	362	1.19	0%	100%	0%	0%	0%	100%	0%	0%	0%	9%	64
	363	0.33	0%	100%	0%	0%	0%	101%	0%	0%	0%	9%	64
	364	0.69	17%	75%	0%	8%	0%	100%	0%	0%	0%	9%	62
DRY CREEK		5.68											
	425	1.61	100%	0%	0%	0%	38%	0%	0%	62%	0%	34%	59
	427	0.86	67%	33%	0%	0%	0%	0%	0%	73%	27%	62%	78
	429	0.77	100%	0%	0%	0%	50%	0%	0%	50%	0%	28%	55
	431	0.39	100%	0%	0%	0%	0%	0%	0%	100%	0%	54%	71
	433	0.38	15%	69%	0%	16%	0%	0%	0%	100%	0%	54%	81
	435	0.94	33%	55%	0%	12%	0%	0%	0%	100%	0%	54%	79
SOUTH PINE CREEK		4.95											
	437	1.18	0%	100%	0%	0%	37%	63%	0%	0%	0%	6%	63
	439	0.50	0%	100%	0%	0%	100%	0%	0%	0%	0%	2%	62
	441	1.70	0%	100%	0%	0%	100%	0%	0%	0%	0%	2%	62
	443	1.47	22%	78%	0%	0%	100%	0%	0%	0%	0%	2%	57
	445	1.26	0%	100%	0%	0%	100%	0%	0%	0%	0%	2%	62
	447	0.96	0%	100%	0%	0%	100%	0%	0%	0%	0%	2%	62
	449	1.10	21%	79%	0%	0%	100%	0%	0%	0%	0%	2%	57
	451	0.70	0%	100%	0%	0%	100%	0%	0%	0%	0%	2%	62
	453	1.24	0%	100%	0%	0%	100%	0%	0%	0%	0%	2%	62
	455	0.99	50%	50%	0%	0%	100%	0%	0%	0%	0%	2%	51
	457	0.84	61%	38%	0%	0%	100%	0%	0%	0%	0%	2%	48

EXISTING CURVE NUMBERS

BASIN NAMES	AREA SQ MILES	SOILS DISTRIBUTION IN PERCENT				EXISTING LAND USE DISTRIBUTION IN PERCENT					WEIGHTED % IMPERV	CURVE NUMBER
		GROUP A	GROUP B	GROUP C	GROUP D	TYPE 1	TYPE 2	TYPE 3	TYPE 4	TYPE 5		
		PERV CN:	PERV CN:	PERV CN:	PERV CN:	IMPERV:	IMPERV:	IMPERV:	IMPERV:	IMPERV:		
		39	61	74	80	2	9	27	54	84		
309	1.14	0%	0%	0%	100%	100%	0%	0%	0%	0%	2%	80
310	0.82	0%	0%	0%	100%	100%	0%	0%	0%	0%	2%	80
311	0.74	0%	68%	32%	0%	100%	0%	0%	0%	0%	2%	66
313	0.40	0%	100%	0%	0%	100%	0%	0%	0%	0%	2%	62
315	1.09	0%	0%	13%	87%	79%	0%	21%	0%	0%	7%	81
317	1.20	0%	100%	0%	0%	81%	0%	19%	0%	0%	7%	64
319	0.51	0%	100%	0%	0%	100%	0%	0%	0%	0%	2%	62
AF ACADEMY	44.66											
BS 246	1.02	0%	100%	0%	0%	100%	0%	0%	0%	0%	2%	62
247	0.63	0%	100%	0%	0%	100%	0%	0%	0%	0%	2%	62
248	1.52	0%	100%	0%	0%	100%	0%	0%	0%	0%	2%	62
249	0.39	0%	100%	0%	0%	100%	0%	0%	0%	0%	2%	62
250	3.36	0%	100%	0%	0%	100%	0%	0%	0%	0%	2%	62
251	1.26	0%	100%	0%	0%	100%	0%	0%	0%	0%	2%	62
252	0.96	0%	100%	0%	0%	100%	0%	0%	0%	0%	2%	62
253	0.88	0%	100%	0%	0%	100%	0%	0%	0%	0%	2%	62
254	1.09	0%	100%	0%	0%	100%	0%	0%	0%	0%	2%	62
BLACK SQUIRREL CREEK	11.11											
ELK 255	1.33	35%	66%	0%	0%	100%	0%	0%	0%	0%	2%	54
257	0.81	100%	0%	0%	0%	100%	0%	0%	0%	0%	2%	40
259	0.60	82%	18%	0%	0%	100%	0%	0%	0%	0%	2%	44
ELK HORN	2.74											
KC 321	1.31	0%	100%	0%	0%	100%	0%	0%	0%	0%	2%	62
323	1.67	0%	100%	0%	0%	66%	0%	34%	0%	0%	11%	65
325	1.13	0%	100%	0%	0%	100%	0%	0%	0%	0%	2%	62
327	0.84	0%	100%	0%	0%	100%	0%	0%	0%	0%	2%	62
329	1.14	0%	100%	0%	0%	75%	25%	0%	0%	0%	2%	62
331	0.68	0%	100%	0%	0%	7%	93%	0%	0%	0%	4%	62
333	1.36	0%	100%	0%	0%	21%	79%	0%	0%	0%	8%	64
335	2.03	0%	100%	0%	0%	45%	55%	0%	0%	0%	8%	64
337	1.05	0%	100%	0%	0%	22%	78%	0%	0%	0%	6%	63
339	0.93	0%	100%	0%	0%	31%	69%	0%	0%	0%	7%	64
341	1.00	0%	100%	0%	0%	100%	0%	0%	0%	0%	2%	62

EXISTING CURVE NUMBERS

BASIN NAMES		AREA SQ MILES	SOILS DISTRIBUTION IN PERCENT				EXISTING LAND USE DISTRIBUTION IN PERCENT					WEIGHTED % IMPERV	CURVE NUMBER
			GROUP A	GROUP B	GROUP C	GROUP D	TYPE 1	TYPE 2	TYPE 3	TYPE 4	TYPE 5		
			PERV CN:	PERV CN:	PERV CN:	PERV CN:	IMPERV:	IMPERV:	IMPERV:	IMPERV:	IMPERV:		
			39	61	74	80	2	9	27	54	84		
	205	1.19	2%	95%	0%	5%	52%	34%	0%	0%	14%	16%	69
	206	0.71	0%	60%	0%	40%	100%	0%	0%	0%	0%	2%	69
	207	0.81	0%	91%	9%	0%	100%	0%	0%	0%	0%	2%	63
	209	0.56	12%	88%	0%	0%	100%	0%	0%	0%	0%	2%	59
	211	1.54	1%	99%	0%	0%	100%	0%	0%	0%	0%	2%	61
LR	235	1.22	0%	10%	0%	90%	100%	0%	0%	0%	0%	2%	79
	237	0.97	9%	79%	0%	21%	64%	0%	0%	0%	35%	31%	78
	239	0.72	0%	72%	0%	28%	100%	0%	0%	0%	0%	2%	67
	241	1.11	0%	100%	0%	0%	100%	0%	0%	0%	0%	2%	62
	243	0.72	3%	96%	0%	0%	68%	0%	0%	32%	0%	19%	67
	245	0.28	0%	100%	0%	0%	59%	0%	0%	41%	0%	23%	70
DV	261	0.60	0%	100%	0%	0%	33%	0%	67%	0%	0%	19%	68
	263	1.32	0%	100%	0%	0%	39%	0%	61%	0%	0%	17%	67
	265	1.05	8%	92%	0%	0%	84%	0%	0%	16%	0%	11%	63
	267	0.44	0%	100%	0%	0%	61%	0%	0%	0%	39%	34%	74
	269	0.73	0%	100%	0%	0%	100%	0%	0%	0%	0%	2%	62
	271	1.08	0%	100%	0%	0%	47%	0%	53%	0%	0%	15%	67
WM	273	0.79	0%	86%	0%	14%	100%	0%	0%	0%	0%	2%	64
	275	0.82	0%	6%	0%	94%	100%	0%	0%	0%	0%	2%	79
	277	0.83	0%	8%	0%	93%	100%	0%	0%	0%	0%	2%	79
	279	0.49	0%	0%	0%	100%	100%	0%	0%	0%	0%	2%	80
	281	0.49	0%	0%	0%	100%	100%	0%	0%	0%	0%	2%	80
	283	0.92	0%	0%	0%	100%	100%	0%	0%	0%	0%	2%	80
	285	1.22	0%	0%	0%	100%	100%	0%	0%	0%	0%	2%	80
	287	0.69	0%	0%	0%	100%	100%	0%	0%	0%	0%	2%	80
	289	0.96	0%	0%	0%	100%	100%	0%	0%	0%	0%	2%	80
	290	0.57	0%	0%	0%	100%	100%	0%	0%	0%	0%	2%	80
	291	1.36	0%	4%	0%	96%	100%	0%	0%	0%	0%	2%	80
	293	1.00	0%	16%	0%	84%	100%	0%	0%	0%	0%	2%	77
	295	1.36	0%	0%	0%	100%	100%	0%	0%	0%	0%	2%	80
	297	1.12	0%	0%	0%	100%	100%	0%	0%	0%	0%	2%	80
	299	0.77	0%	0%	0%	100%	100%	0%	0%	0%	0%	2%	80
	301	0.93	0%	0%	0%	100%	100%	0%	0%	0%	0%	2%	80
	303	1.20	0%	0%	0%	100%	100%	0%	0%	0%	0%	2%	80
	305	1.12	0%	35%	0%	65%	100%	0%	0%	0%	0%	2%	74
	307	1.09	0%	8%	5%	87%	100%	0%	0%	0%	0%	2%	79

EXISTING CURVE NUMBERS

BASIN NAMES	AREA SQ MILES	SOILS DISTRIBUTION IN PERCENT				EXISTING LAND USE DISTRIBUTION IN PERCENT					WEIGHTED % IMPERV	CURVE NUMBER
		GROUP A	GROUP B	GROUP C	GROUP D	TYPE 1	TYPE 2	TYPE 3	TYPE 4	TYPE 5		
		PERV CN: 39	PERV CN: 61	PERV CN: 74	PERV CN: 80	IMPERV: 2	IMPERV: 9	IMPERV: 27	IMPERV: 54	IMPERV: 84		
BF 191	0.57	0%	100%	0%	0%	100%	0%	0%	0%	0%	2%	62
193	0.83	0%	100%	0%	0%	73%	0%	14%	14%	0%	13%	66
195	0.60	0%	77%	24%	0%	53%	0%	48%	0%	0%	14%	69
197	0.52	0%	100%	0%	0%	100%	0%	0%	0%	0%	2%	62
199	0.62	0%	100%	0%	0%	81%	0%	19%	0%	0%	7%	63
200	0.76	0%	100%	0%	0%	47%	0%	53%	0%	0%	15%	67
BLACK FORREST	3.90											
SC 213	0.89	0%	100%	0%	0%	74%	0%	0%	26%	0%	15%	67
215	1.03	0%	100%	0%	0%	100%	0%	0%	0%	0%	2%	62
217	0.83	0%	100%	0%	0%	100%	0%	0%	0%	0%	2%	62
219	0.51	0%	89%	11%	0%	0%	100%	0%	0%	0%	9%	66
221	0.95	0%	100%	0%	0%	12%	88%	0%	0%	0%	8%	64
223	0.88	0%	100%	0%	0%	61%	39%	0%	0%	0%	5%	63
225	0.37	0%	100%	0%	0%	100%	0%	0%	0%	0%	2%	62
SMITH CREEK	5.46											
MB 225	0.95	0%	100%	0%	0%	100%	0%	0%	0%	0%	2%	62
227	0.43	0%	100%	0%	0%	100%	0%	0%	0%	0%	2%	62
228	0.24	0%	100%	0%	0%	100%	0%	0%	0%	0%	2%	62
229	0.44	0%	100%	0%	0%	100%	0%	0%	0%	0%	2%	62
230	0.45	0%	100%	0%	0%	100%	0%	0%	0%	0%	2%	62
231	1.07	0%	100%	0%	0%	100%	0%	0%	0%	0%	2%	62
232	0.26	0%	100%	0%	0%	100%	0%	0%	0%	0%	2%	62
MONUMENT BRANCH	3.84											
MT 233	1.47	0%	100%	0%	0%	100%	0%	0%	0%	0%	2%	62
MIDDLE TRIBUTARY	1.47											
JV 183	1.15	0%	87%	0%	13%	100%	0%	0%	0%	0%	2%	64
185	0.71	0%	100%	0%	0%	100%	0%	0%	0%	0%	2%	62
187	1.09	0%	100%	0%	0%	100%	0%	0%	0%	0%	2%	62
189	1.10	5%	95%	0%	0%	100%	0%	0%	0%	0%	2%	61
DM 201	1.16	0%	5%	0%	94%	100%	0%	0%	0%	0%	2%	79
203	0.77	0%	50%	0%	50%	100%	0%	0%	0%	0%	2%	71

EXISTING CURVE NUMBERS

BASIN NAMES		AREA SQ MILES	SOILS DISTRIBUTION IN PERCENT				EXISTING LAND USE DISTRIBUTION IN PERCENT					WEIGHTED % IMPERV	CURVE NUMBER
			GROUP A	GROUP B	GROUP C	GROUP D	TYPE 1	TYPE 2	TYPE 3	TYPE 4	TYPE 5		
			PERV CN:	PERV CN:	PERV CN:	PERV CN:	IMPERV:	IMPERV:	IMPERV:	IMPERV:	IMPERV:		
			39	61	74	80	2	9	27	54	84		
	121	1.11	0%	0%	0%	100%	100%	0%	0%	0%	0%	2%	80
	123	0.91	0%	0%	0%	100%	100%	0%	0%	0%	0%	2%	80
	125	0.47	0%	0%	0%	100%	100%	0%	0%	0%	0%	2%	80
	127	0.69	0%	0%	0%	100%	100%	0%	0%	0%	0%	2%	80
	129	0.85	0%	0%	0%	100%	100%	0%	0%	0%	0%	2%	80
	131	0.69	0%	0%	0%	100%	100%	0%	0%	0%	0%	2%	80
	133	0.72	0%	0%	0%	100%	100%	0%	0%	0%	0%	2%	80
	135	0.85	0%	0%	0%	100%	100%	0%	0%	0%	0%	2%	80
	137	1.03	0%	0%	0%	100%	100%	0%	0%	0%	0%	2%	80
	139	1.24	0%	0%	0%	100%	100%	0%	0%	0%	0%	2%	80
	141	0.91	0%	0%	0%	100%	100%	0%	0%	0%	0%	2%	80
	143	1.25	19%	16%	0%	65%	100%	0%	0%	0%	0%	2%	70
HLC	145	0.58	0%	8%	0%	100%	100%	0%	0%	0%	0%	2%	85
NBC	147	1.29	0%	0%	0%	100%	100%	0%	0%	0%	0%	2%	80
	149	0.62	0%	0%	0%	100%	100%	0%	0%	0%	0%	2%	80
	151	0.77	0%	0%	0%	100%	100%	0%	0%	0%	0%	2%	80
	153	1.04	6%	41%	0%	52%	100%	0%	0%	0%	0%	2%	70
BC	155	1.03	0%	97%	3%	0%	100%	0%	0%	0%	0%	2%	62
HYC	157	0.72	0%	0%	0%	100%	100%	0%	0%	0%	0%	2%	80
	159	0.64	0%	0%	0%	100%	100%	0%	0%	0%	0%	2%	80
	161	0.73	0%	34%	0%	66%	100%	0%	0%	0%	0%	2%	74
	163	0.73	0%	100%	0%	0%	100%	0%	0%	0%	0%	2%	62
	165	0.44	0%	100%	0%	0%	100%	0%	0%	0%	0%	2%	62
	167	0.60	0%	100%	0%	0%	100%	0%	0%	0%	0%	2%	62
BC	169	0.77	0%	92%	7%	0%	100%	0%	0%	0%	0%	2%	63
	171	0.39	4%	96%	0%	0%	100%	0%	0%	0%	0%	2%	61
BEAVER CREEK		27.19											
JC	173	1.01	0%	85%	15%	0%	100%	0%	0%	0%	0%	2%	64
	175	1.16	0%	79%	20%	0%	100%	0%	0%	0%	0%	2%	64
	177	1.40	0%	100%	0%	0%	100%	0%	0%	0%	0%	2%	62
	179	0.73	0%	100%	0%	0%	100%	0%	0%	0%	0%	2%	62
	180	0.65	0%	100%	0%	0%	100%	0%	0%	0%	0%	2%	62
	181	0.16	0%	100%	0%	0%	100%	0%	0%	0%	0%	2%	62
	182	0.24	0%	100%	0%	0%	100%	0%	0%	0%	0%	2%	62
JACKSON CREEK		5.35											

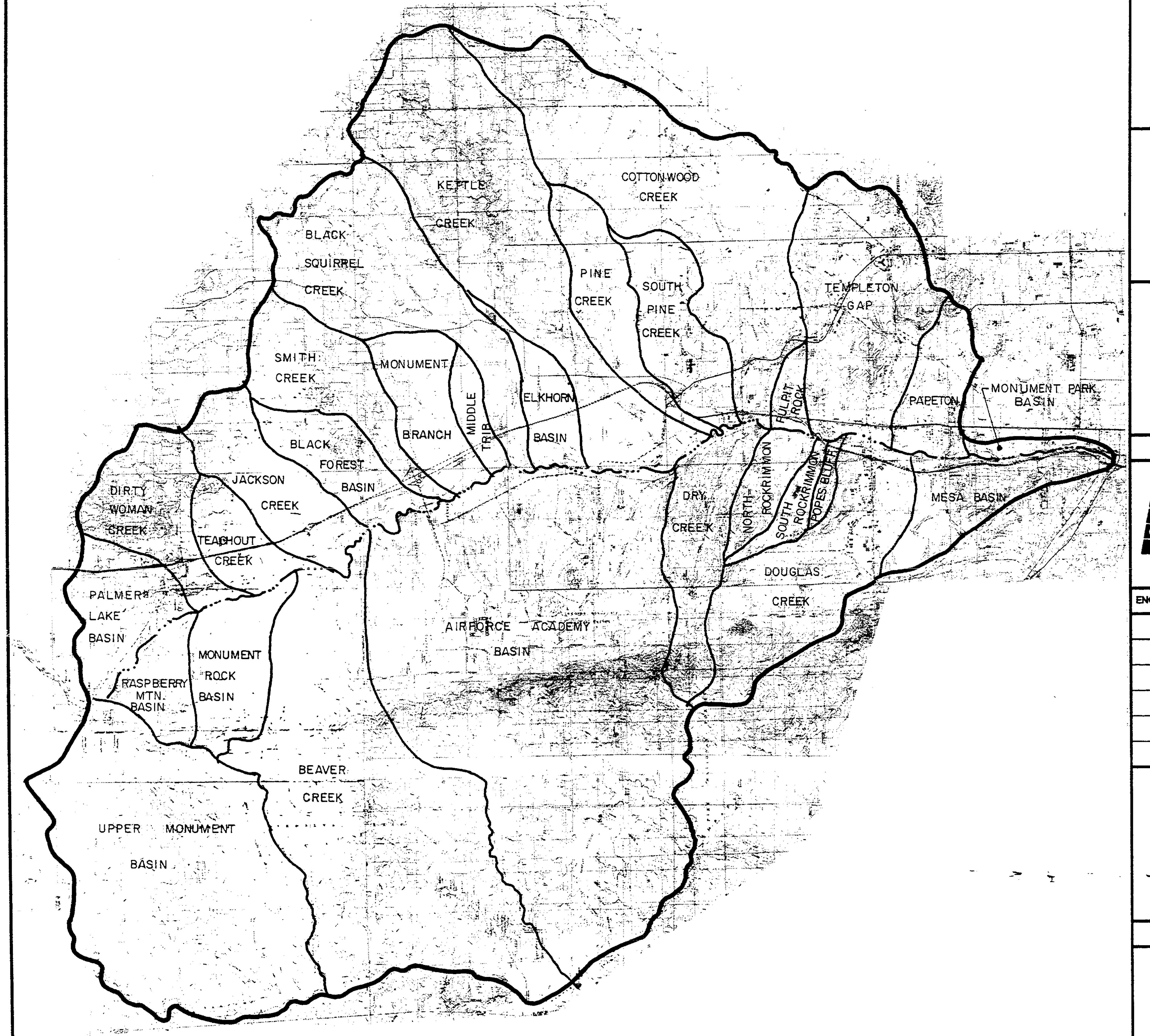
EXISTING CURVE NUMBERS

BASIN NAMES		AREA SQ MILES	SOILS DISTRIBUTION IN PERCENT				EXISTING LAND USE DISTRIBUTION IN PERCENT					WEIGHTED % IMPERV	CURVE NUMBER
			GROUP A	GROUP B	GROUP C	GROUP D	TYPE 1	TYPE 2	TYPE 3	TYPE 4	TYPE 5		
			PERV CN:	PERV CN:	PERV CN:	PERV CN:	IMPERV:	IMPERV:	IMPERV:	IMPERV:	IMPERV:		
			39	61	74	80	2	9	27	54	84		
PALMER LAKE		4.64											
MR	65	0.78	0%	73%	0%	27%	100%	0%	0%	0%	0%	2%	67
	67	0.72	0%	49%	13%	37%	76%	24%	0%	0%	0%	4%	71
	69	0.72	0%	70%	0%	29%	100%	0%	0%	0%	0%	2%	67
	71	0.96	0%	91%	0%	8%	100%	0%	0%	0%	0%	2%	63
	73	0.53	0%	94%	5%	0%	100%	0%	0%	0%	0%	2%	62
	75	0.32	0%	100%	0%	0%	100%	0%	0%	0%	0%	2%	62
	77	0.24	0%	100%	0%	0%	100%	0%	0%	0%	0%	2%	62
MONUMENT ROCK		4.27											
DWC	79	0.50	0%	87%	13%	0%	0%	100%	0%	0%	0%	9%	66
	81	0.66	0%	91%	9%	0%	0%	100%	0%	0%	0%	9%	65
	83	0.61	0%	96%	4%	0%	0%	100%	0%	0%	0%	9%	65
	85	0.36	0%	92%	8%	0%	69%	32%	0%	0%	0%	4%	64
	87	0.66	0%	91%	9%	0%	83%	17%	0%	0%	0%	3%	63
	89	0.45	0%	96%	4%	0%	74%	26%	0%	0%	0%	4%	63
	91	0.78	0%	90%	10%	0%	15%	63%	22%	0%	0%	12%	67
	93	0.52	0%	94%	7%	0%	78%	0%	22%	0%	0%	8%	65
	95	0.66	0%	100%	0%	0%	39%	0%	0%	61%	0%	34%	73
	97	0.25	0%	64%	37%	0%	32%	69%	0%	0%	0%	7%	69
DIRTY WOMAN CREEK		5.45											
TC	99	0.47	0%	100%	0%	0%	63%	0%	37%	0%	0%	11%	65
	101	0.74	0%	100%	0%	0%	85%	0%	16%	0%	0%	6%	63
	103	0.21	0%	101%	0%	0%	74%	0%	27%	0%	0%	9%	65
	105	0.83	0%	86%	14%	0%	73%	0%	28%	0%	0%	9%	66
	107	0.44	0%	100%	0%	0%	100%	0%	0%	0%	0%	2%	62
TEACHOUT CREEK		2.69											
EG	109	1.24	0%	0%	0%	100%	100%	0%	0%	0%	0%	2%	80
	111	0.75	0%	0%	0%	100%	100%	0%	0%	0%	0%	2%	80
	113	0.98	0%	0%	0%	100%	100%	0%	0%	0%	0%	2%	80
	115	0.85	0%	0%	0%	100%	100%	0%	0%	0%	0%	2%	80
	117	0.47	0%	0%	0%	100%	100%	0%	0%	0%	0%	2%	80
SBC	119	1.83	0%	37%	0%	63%	100%	0%	0%	0%	0%	2%	73

EXISTING CURVE NUMBERS

BASIN NAMES		AREA SQ MILES	SOILS DISTRIBUTION IN PERCENT				EXISTING LAND USE DISTRIBUTION IN PERCENT					WEIGHTED % IMPERV	CURVE NUMBER
			GROUP A	GROUP B	GROUP C	GROUP D	TYPE 1	TYPE 2	TYPE 3	TYPE 4	TYPE 5		
			PERV CN:	PERV CN:	PERV CN:	PERV CN:	IMPERV:	IMPERV:	IMPERV:	IMPERV:	IMPERV:		
			39	61	74	80	2	9	27	54	84		
ICC	01	0.87	0%	0%	0%	100%	100%	0%	0%	0%	0%	2%	80
	03	1.12	0%	4%	0%	96%	100%	0%	0%	0%	0%	2%	80
	05	1.07	0%	0%	0%	100%	100%	0%	0%	0%	0%	2%	80
	07	1.17	0%	0%	0%	100%	100%	0%	0%	0%	0%	2%	80
	09	1.05	0%	0%	0%	100%	100%	0%	0%	0%	0%	2%	80
	11	1.19	0%	0%	0%	100%	100%	0%	0%	0%	0%	2%	80
NMC	13	0.87	0%	0%	0%	100%	100%	0%	0%	0%	0%	2%	80
	15	0.84	0%	0%	0%	100%	100%	0%	0%	0%	0%	2%	80
	17	1.21	0%	0%	0%	100%	100%	0%	0%	0%	0%	2%	80
	19	0.88	0%	14%	0%	85%	100%	0%	0%	0%	0%	2%	78
	21	0.85	0%	0%	0%	100%	100%	0%	0%	0%	0%	2%	80
	23	1.28	0%	0%	0%	100%	100%	0%	0%	0%	0%	2%	80
	25	0.99	0%	0%	0%	100%	100%	0%	0%	0%	0%	2%	80
	27	1.24	0%	0%	0%	100%	100%	0%	0%	0%	0%	2%	80
	29	0.59	0%	0%	0%	100%	100%	0%	0%	0%	0%	2%	80
	31	0.69	0%	0%	0%	100%	75%	0%	0%	25%	0%	15%	83
MC	33	1.40	0%	0%	0%	100%	100%	0%	0%	0%	0%	2%	80
	35	0.46	0%	0%	0%	100%	100%	0%	0%	0%	0%	2%	80
	37	1.04	0%	0%	0%	100%	100%	0%	0%	0%	0%	2%	80
	39	0.41	0%	0%	0%	100%	100%	0%	0%	0%	0%	2%	80
	41	1.08	0%	0%	0%	100%	100%	0%	0%	0%	0%	2%	80
	43	1.38	0%	0%	0%	100%	100%	0%	0%	0%	0%	2%	80
	45	0.86	0%	2%	0%	98%	100%	0%	0%	0%	0%	2%	80
	47	0.68	0%	97%	0%	3%	66%	0%	0%	34%	0%	20%	68
UPPER MONUMENT		23.22											
RM	51	0.98	0%	93%	0%	8%	88%	0%	12%	0%	0%	5%	64
	55	1.07	0%	95%	0%	5%	84%	0%	16%	0%	0%	6%	64
	59	0.37	0%	99%	0%	0%	99%	0%	0%	0%	0%	2%	61
RASBERRY MOUNTAIN		2.42											
PL	49	0.31	0%	100%	0%	0%	100%	0%	0%	0%	0%	2%	62
	53	0.95	0%	100%	0%	0%	100%	0%	0%	0%	0%	2%	62
	57	1.48	0%	92%	9%	0%	77%	12%	0%	0%	12%	12%	67
	61	0.91	0%	88%	12%	0%	100%	0%	0%	0%	0%	2%	63
	63	0.99	0%	98%	2%	0%	42%	17%	0%	41%	0%	24%	70

Table 7



MONUMENT CREEK DRAINAGE BASIN PLANNING STUDY

CITY OF COLORADO SPRINGS
PLANNING AND DEVELOPMENT DEPARTMENT
ENGINEERING DIVISION

CH2M HILL
KIOWA ENGINEERING INC.
THOMAS & THOMAS
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REGIONAL SUB-BASINS

SEPT., 1991

FIGURE 5

02-12-91 MONDBS.DGN

Table 2 Monument Creek Sub-basins

Sub-Basin	Area (sq.mi.)	Type
Upper Monument Creek	23.2	---
Raspberry Mountain	2.4	Right Bank
Palmer Lake	4.6	Left Bank
Monument Rock	4.2	Right Bank
Dirty Woman Creek	5.4	Left Bank
Teachout Creek	2.6	Left Bank
Beaver Creek	27.1	Right Bank
Jackson Creek	5.3	Left Bank
Black Forest	3.9	Left Bank
Smith Creek	5.4	Left Bank
Monument Branch	3.8	Left Bank
Middle Tributary	1.4	Left Bank
Air Force Academy	44.6	Right Bank
Black Squirrel Creek	11.1	Left Bank
Elkhorn	2.7	Left Bank
Kettle Creek	19.6	Left Bank
Dry Creek	5.6	Right Bank
South Pine Creek	4.9	Left Bank
Cottonwood Creek	20.4	Left Bank
Pine Creek	4.7	Left Bank
Pulpit Rock	2.2	Left Bank
North Rockrimmon	2.2	Right Bank
South Rockrimmon	1.2	Right Bank
Popes Bluff	0.6	Right Bank
Douglas Creek	10.2	Right Bank
Templeton Gap	11.0	Left Bank
Roswell	1.1	Left Bank
Papeton	2.4	Left Bank
Mesa	4.2	Right Bank
Monument Valley	0.7	Left Bank
TOTAL	238.7	

are common during the summer months, and are typified by quick-moving low pressure cells which draw moisture from the Gulf of Mexico into the region. Average temperatures range from about 30°F in the winter to 75°F in the summer. The relative humidity ranges from about 25 percent in the summer to 45 percent in the winter.

Winter precipitation is in the form of snow. The moisture source in the winter is generally the Pacific Ocean. Winter storms typically track from west to east and the majority of the snowfall occurs in the higher mountains to the west. The winter months are typically the driest portion of the year. Snow pack in the basin is generally light and, therefore, springtime runoff is generally light.

Flood History

Colorado Springs has endured a long history of flooding along Monument Creek. Early reports are mainly eyewitness accounts documented in newspaper articles. These articles describe floods as "walls of water" and "torrents", and precipitation as "...came down, not in drops, but in floods". Many floods were described as "...highest known up to that time". Damage reports and loss of life statistics sometimes contradict each other from paper to paper.

Stream gage data was non-existent prior to the installation of gages in 1938. Gage data records exist for Monument Creek at Pikeview from 1939 to 1949 and from 1976 to the present. However, no significant flood event occurred during this period of record. Therefore, records of eyewitness accounts provide the only information available to document historic floods.

In general, flood reports describe storms of short duration and of great intensity usually preceded by a period of widespread precipitation. Flood producing rainfall has been reported as high as 14 to 18 inches. Snowfall and snowmelt has not been reported to be a factor in flooding. In short, flood events have been caused by cloudburst activity over previously saturated ground.

Perhaps the best flood documentation exists in the Department of Water Resources *28th Biennial Report of the State Engineer to the Governor of Colorado.* The City Engineer of Colorado Springs made a slope-area determination of the peak discharge of the May 30, 1935, flood and the following report:

> *"Colorado Springs Flood -- the flood at Colorado Springs on the Monument Creek, a tributary of the Fountain River, originated 2 mi. northwest of Colorado Springs about 10:30 a.m., May 30 1935, and lasted from 2 to 2-1/2 hr. The creek reached flood stage about 12:30 p.m., crest elevation about 2 p.m., and had receded somewhat by 3:30 p.m. The peak discharge, as determined by F.O. Ray, city engineer of Colorado Springs, was 50,000 sec.-ft. This flood on Monument Creek is the greatest of which there is any record, and created damages to property in Colorado Springs estimated at $750,000 and the loss of three lives."*

Presented on Table 3 is a summary of the known flood events and selected characteristics of each storm recorded. The information recorded on Table 3 has been compiled from newspaper accounts along with other articles.

Soils and Geology

Soils within the Monument Creek basin vary between soils types A through D, as identified by the U.S. Department of Agriculture, Soil Conservation Service. Type D soils are predominate in the forested areas west of Monument Creek. These soils are generally associated with the Pikes Peak Granite found in the region. Figure 3 depicts the hydrologic soil types distributed throughout the Monument Creek basin.

Soils are classified in hydrologic groups A, B, C, and D according to their infiltration capacity. Group A soils consist chiefly of well-drained sands and gravels and have a low runoff potential. A work map was prepared showing the distribution of the four soils groups throughout the Monument Creek watershed. The percentage of each soil group within individual sub-basins was estimated by using a planimeter to measure soil group areas.

Impervious Area

In general, total runoff from a watershed is a function of the type of soils and the extent of impervious area within the basin. Runoff curve numbers, which are based on soil types and impervious area, were determined for each sub-basin in the Monument Creek watershed for both existing and future development conditions. Curve numbers were calculated based on the procedures identified in the City/County Drainage Criteria Manual. Tables 5-4 and 5-5 of the criteria manual was referred to when selecting representative curve numbers.

The extent of impervious area within each sub-basin was estimated for existing development conditions based on aerial photography of the watershed dated November, 1989. Various land uses shown in the aerial photography were categorized according to the information shown in Table 4. A work map was prepared indicating the location of each land use zone relative to drainage basin boundaries. Areas of the categorized land uses within each sub-basin were measured using a planimeter.

Sub-basin imperviousness for future development conditions was based on information prepared by the City of Colorado Springs, El Paso County, and Pikes Peak Area Council of Governments for a recent planning study entitled *Socioeconomic Forecasts for Transportation Planning Beyond the Year 2010*. In order to develop the plan, the ultimate holding capacity (in terms of population and residential and business density) was estimated for a number of transportation planning zones. These estimates, developed to ensure that growth would not be

TABLE 3
SUMMARY OF KNOWN FLOOD EVENTS
MONUMENT CREEK

Storm Date	Precip Amount	Discharge at Fountain Crk. Confluence (cfs)	Discharge at Templeton Gap (cfs)	Type of Storm	Destruction	Loss of Life	Depth	Remarks
June 10 1864		40,000 (est)		5 hrs long radius of 3-4 miles	crops totally destroyed	13	20-30'	Rain came down not in drops but in floods
May 21-22 1876	2.62"							chiefly snow no serious flood
May 20 1878				Cloudburst near Palmer Lake				
July 25 1885			6,120	Severe cloudburst over northern part of City				Sharp flood on Mon. Crk. ..highest known up to that time.
August 2 1886		40,000		Intense rainfall in Mon. Crk. & T-Gap Drainage Area				
May 26-28 1902	3.02" Total			Cloudburst				
June 3-4 1921		10,000			No bridge loss			Stream within banks.
July 29-30 1932	3.54" Total		9,700	Cloudburst				Cloudburst in Black Forest Flooded Papeton
May 30 1935	4-18"	50,000		Heavy rains from multiple storm cells of short duration after a period of general precip.	$750,000, all bridges except one & dozens of homes	4		Caused by intense rainfall in headwaters
June 17 1965	2-14"			Major cell over Palmer Lake	Monument Dam nearly broke			

Table 4 Existing Land Use Categories

Type	Typical Land Use	Range of Imperviousness	Average Imperviousness
1	Agricultural/Forest/Open Space	0 to 4%	2%
2	Residential (0.1 to 0.4 DU/ac)/Park	5 to 14%	9%
3	Residential (0.4 to 4 DU/ac)	15 to 39%	27%
4	Residential (4 to 8 DU/ac)/ Multifamily/Neighborhood Business Areas	40 to 69%	54%
5	Commercial/Industrial	70 to 99%	84%

over-allocated in any zone, provide the information necessary to calculate imperviousness percentages for each transportation zone for the ultimate build-out condition.

Several different growth distribution scenarios were analyzed in the plan in order to forecast urban expansion over the next several decades (a shorter time frame than it would take to achieve an ultimate build-out condition). The scenarios included a most likely condition, a set of directional scenarios (northern growth, eastern growth, and southern growth) and a build-out condition of existing zoning and approved plans. The continuation of current growth trends and the directional growth scenarios were forecasted to a planning horizon defined as the time frame at which the population in the study area reaches one million. This planning horizon, which, according to the plan, is expected to represent the year 2030 or beyond, was assumed to be appropriate for the purpose of estimating quantities of stormwater runoff for future development conditions in the Monument Creek watershed.

Estimates of imperviousness for the ultimate build-out condition of the transportation zones were adjusted so that they would be representative of the one million population planning horizon. The adjustment was comprised of multiplying the area of residential and business development projected for ultimate build-out by the ratio of forecasted population (for the one million planning horizon) to the ultimate population. Transportation planning zones were superimposed on a drainage basin map and measured using a planimeter to estimate a weighted average percent imperviousness for each sub-basin for future development conditions.

After soils types and percent imperviousness for existing and future development conditions were identified, runoff curve numbers were calculated. A weighted average curve number was calculated for each sub-basin for both existing and future development conditions. The results of these calculations are presented in Section IV of this report.

SECTION IV
HYDROLOGIC ANALYSIS

Previous Studies

Two previous hydrologic studies have been prepared for Monument Creek. These studies are *Flood Plain Information Monument Creek, Colorado Springs, Colorado* prepared by the U.S. Army Corps of Engineers (COE) in May 1971 and the *F.E.M.A. Flood Insurance Study* revised in 1989. The *F.E.M.A. Flood Insurance Study* appears to have used the hydrology from the COE study in their report.

The COE study used a regional gage analysis to determine the peak discharge for Monument Creek because the limited stream flow records available for Monument Creek were judged inadequate to develop reliable peak frequency curves. The regional gage analysis used a procedure developed during the study of the Arkansas River and its tributaries above John Martin Dam. The procedure utilizes the relationship between drainage area to the ratio of peak discharge for a given flood and the peak of the unit hydrograph for the basin. Using the information developed in the John Martin Dam study, frequency curves were developed for Monument Creek at various locations. Intermediate Regional Flood and Standard Project Flood discharges were developed for the basin. The Standard Project Flood discharge at the confluence with Fountain Creek was determined to be 63,400 cubic feet per second (cfs). The Intermediate Regional Flood discharge was determined to be 32,000 cfs at the confluence. The Intermediate Regional flood is defined as having an average frequency of occurrence of once in 100 years, which is also known as the 100-year discharge.

Gage Station Analysis

The flow in Monument Creek has been monitored by the U.S. Geological Survey (USGS) at Pikeview, Colorado, for the periods between October 1938 and September 1949 and between January 1976 and the current year. The discharge gage, identified as hydrologic unit 11020003, is located approximately 0.7 miles downstream from Dry Creek and 1,200 feet upstream from the Interstate 25 Bridge between the Rockrimmon and Nevada Avenue exits. The watershed drainage area at the gage is 204 square miles. A flood flow frequency analysis for the Monument Creek basin was conducted so runoff model results could be compared to the analysis.

The annual peak discharges at the Pikeview gage were documented in *Magnitude and Frequency of Floods in the U.S.* reports (DOI, 1939-1949), and in *U.S. Geological Survey Water Resources Data for Colorado* reports (DOI, 1976-1989). In addition, the peak discharge of the

1935 Monument Creek flood was documented in the *Twenty-Eighth Biennial Report of the State Engineer to the Governor of Colorado* (State Engineer, 1939). The peak discharge of the flood just above the mouth of the Fountain Creek confluence (approximately 7.5 miles downstream of Pikeview) was estimated at 50,000 cfs in the report.

The flood flow frequency analysis was conducted based on the recorded peak discharge data at Pikeview. A program developed by the COE called HEC WRC (COE 1985) was used to conduct the analysis. To incorporate the 1935 flood into the flood flow frequency analysis at Pikeview, the peak discharge was adjusted according to the ratio of the respective drainage areas (204 sq.mi. / 238 sq.mi X 50,000 cfs). This resulted in an approximate peak flow of 42,860 cfs at Pikeview. To determine the effects of including the 1935 flood discharge in the flood flow frequency analysis, three options were examined:

1. Use of recorded peak discharge data from 1939-1949 and 1976-1989 without the 1935 flood.

2. Use of recorded peak discharge data from 1939-1949, 1976-1989, and inputting the 1935 flood as an annual peak discharge.

3. Use of recorded peak discharge data from 1939-1949, 1976-1989, and inputting the 1935 flood as an historic event.

The results of the analysis are presented in Table 5. Computed and expected probability flows for various exceedance probabilities are shown for each of the three options.

The program determined computed discharges and confidence intervals from the basic flood frequency curve. The expected probability flows were determined by adjusting the basic flood frequency curve to incorporate the effects of uncertainty in application of the curve. The authors of the *Guidelines for Determining Flood Flow Frequency* (DOI, 1982) indicate that the expected probability flows may be more valid than the computed flows for analysis based on small data sets. **Since the analysis of the Pikeview gage consists of only 25 or 26 years of record, it is recommended that the expected probability flows be used for comparing the Pikeview gage data with results of the rainfall/runoff model.**

From the review of the data presented on Table 5, it appears that the magnitude of predicted discharges is extremely sensitive to the manner in which the 1935 flood is incorporated into the gage record. Option 1 (not including the 1935 flood) results in an under-estimation of discharges. Option 2 (inputting the 1935 flood as an annual peak discharge) results in an over estimation of extreme event peak flows. Option 3 (inputting the 1935 flood as an historic event) is identified in *Guidelines for Determining Flood Flow Frequency* (DOI, 1982) as the approach most appropriate for estimating extreme event discharges.

Table 5 Estimated Discharges in Monument Creek at Pikeview, Colorado (all discharges in cfs)

	Option 1		Option 2		Option 3	
Exceedance Probability (Return Period)	Computed Discharge	Expected Probability Discharge	Computed Discharge	Expected Probability Discharge	Computed Discharge	Expected Probability Discharge
0.002 (500 yr)	10,300	14,200	164,000	454,000	49,200	104,000
0.005 (200 yr)	7,880	10,100	73,500	149,000	27,700	46,900
0.010 (100 yr)	6,320	7,640	39,500	66,000	17,600	26,000
0.020 (50 yr)	4,970	5,730	21,000	30,000	11,100	14,600
0.040 (25 yr)	3,810	4,210	11,000	13,800	6,800	8,140
0.100 (10 yr)	2,520	2,660	4,490	5,030	3,410	3,730
0.200 (5 yr)	1,710	1,760	2,190	2,300	1,910	1,990
0.500 (2 yr)	815	815	743	743	753	753
0.800	388	377	358	352	368	360
0.900	263	249	276	268	273	264
0.950	191	175	234	226	222	210
0.990	105	87	190	183	162	150

Runoff Model

The runoff model used to determine the peak flows and volumes within the study area is the HEC-1 computer program developed by the COE Hydrologic Engineering Center. The use of this hydrological model is in conformance with the City of Colorado Springs/El Paso County Drainage Criteria Manual. HEC-1 hydrologic modeling was specified by the City of Colorado Springs for use in this Drainage Basin Planning Study.

Basin Characteristics

The area of study for this hydrologic evaluation is the Monument Creek basin, as shown on Figure 2. The Monument Creek Drainage Basin has been divided into 30 regional basins. These regional basins are listed in Table 2 and shown on Figure 5. Most of these 30 basins have

FLOOD FREQUENCY ANALYSIS
Monument Creek at Fountain Ck. Confluence

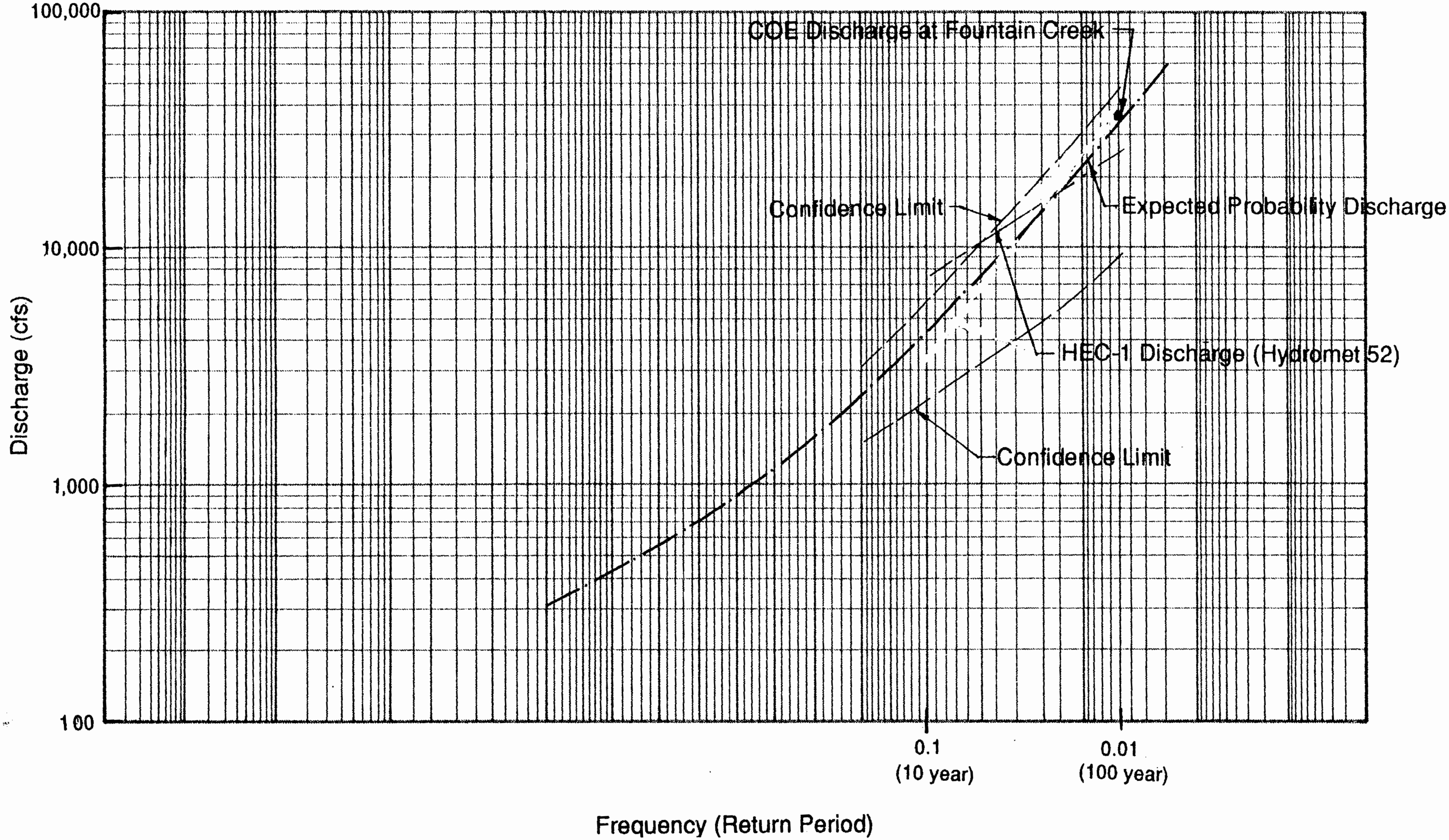
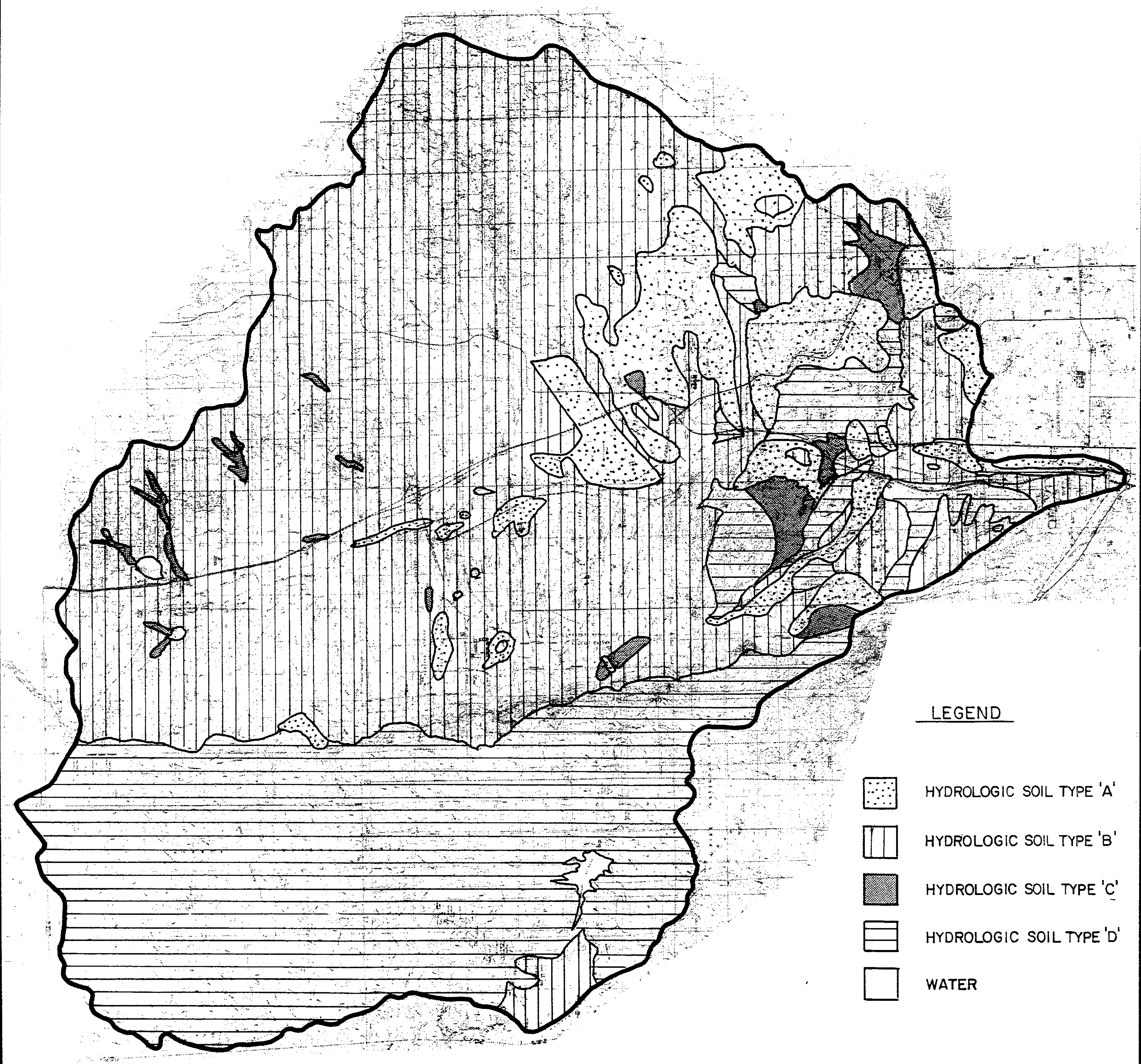


Figure 4



MONUMENT CREEK DRAINAGE BASIN PLANNING STUDY

CITY OF COLORADO SPRINGS
PLANNING AND DEVELOPMENT DEPARTMENT
ENGINEERING DIVISION

KIOWA ENGINEERING INC.
THOMAS & THOMAS
URBAN EDGES INC.

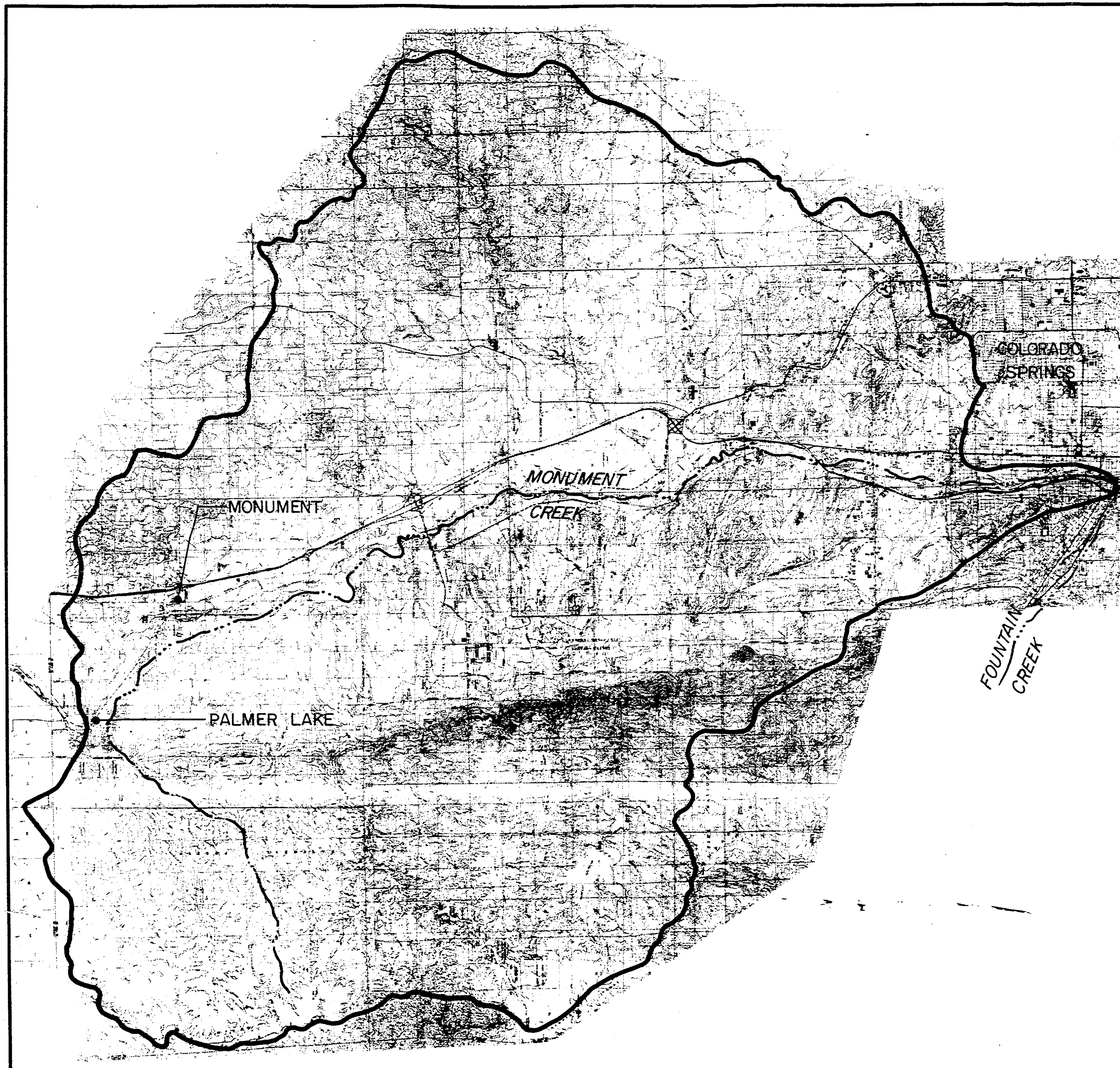
ENGR	DRAFT EAK	CHECK

REVISION	DATE	BY

HYDROLOGIC SOILS MAP

SEPT, 1991

FIGURE 3



MONUMENT CREEK DRAINAGE BASIN PLANNING STUDY

CITY OF COLORADO SPRINGS
PLANNING AND DEVELOPMENT DEPARTMENT
ENGINEERING DIVISION

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BASIN MAP

SEPT., 1991

FIGURE 2

PROJECTED CURVE NUMBERS

BASIN NAMES		AREA SQ MILES	SOILS DISTRIBUTION IN PERCENT GROUP A PERV CN: 39	GROUP B PERV CN: 61	GROUP C PERV CN: 74	GROUP D PERV CN: 80	PROJECTED LAND USE DISTRIBUTION IN PERCENT ZONE 1	% AREA	IMPERV %	ZONE 2	% AREA	IMPERV %	ZONE 3	% AREA	IMPERV %	ZONE 4	% AREA	IMPERV %	WEIGH % IMPERV	CURVE NUMBER
	441	1.70	0%	100%	0%	0%	226	78%	14%	224	22%	2%							12%	65
	443	1.47	22%	78%	0%	0%	224	67%	2%	171	23%	10%							4%	58
	445	1.26	0%	100%	0%	0%	225	48%	14%	171	52%	10%							12%	65
	447	0.96	0%	100%	0%	0%	226	5%	14%	225	10%	14%	224	15%	2%	171	70%	10%	9%	64
	449	1.10	21%	79%	0%	0%	171	100%	10%										10%	60
	451	0.70	0%	100%	0%	0%	225	8%	14%	171	92%	10%							10%	65
	453	1.24	0%	100%	0%	0%	171	100%	10%										10%	65
	455	0.99	50%	50%	0%	0%	171	57%	10%	170	43%	41%							23%	61
	457	0.84	61%	38%	0%	0%	171	100%	10%										10%	52
	459	0.97	59%	41%	0%	0%	240	17%	4%	171	83%	10%							9%	52
	461	1.07	54%	46%	0%	0%	240	10%	4%	172	60%	21%	171	7%	10%	152	23%	75%	31%	64
	463	1.04	61%	39%	0%	0%	172	18%	21%	171	82%	10%							12%	53
	465	1.70	30%	51%	0%	19%	172	44%	21%	171	24%	10%	TYPE 4	31%	77%				35%	72
	467	1.21	19%	62%	0%	19%	TYPE 4	100%	77%										77%	89
	469	0.90	70%	30%	0%	0%	TYPE 4	100%	77%										77%	86
	471	0.73	76%	24%	0%	0%	TYPE 4	100%	77%										77%	86
	473	0.47	85%	15%	0%	0%	TYPE 4	100%	77%										77%	85
	475	0.24	48%	29%	0%	25%	TYPE 4	100%	77%										77%	88
	477	0.16	72%	29%	0%	0%	TYPE 4	100%	77%										77%	86
COTTON WOOD CREEK		20.43																		
PR	479	1.15	20%	15%	15%	50%	6	100%	38%										38%	79
PULPIT ROCK																				
PC	413	0.82	7%	86%	0%	7%	171	100%	10%										10%	65
	415	0.78	0%	100%	0%	0%	171	100%	10%										10%	65
	417	0.87	34%	66%	0%	0%	171	100%	10%										10%	58

PROJECTED CURVE NUMBERS

BASIN NAMES	AREA SQ MILES	SOILS DISTRIBUTION IN PERCENT				PROJECTED LAND USE DISTRIBUTION IN PERCENT												WEIGH % IMPERV	CURVE NUMBER
		GROUP A	GROUP B	GROUP C	GROUP D														
		PERV CN:	PERV CN:	PERV CN:	PERV CN:	ZONE 1	% AREA	IMPERV %	ZONE 2	% AREA	IMPERV %	ZONE 3	% AREA	IMPERV %	ZONE 4	% AREA	IMPERV %		
		39	61	74	80														
419	0.54	100%	0%	0%	0%	171	78%	10%	170	22%	41%							17%	49
421	1.32	87%	0%	13%	0%	170	100%	41%										41%	66
423	0.38	30%	69%	0%	0%	212	100%	12%										12%	60
PINE CREEK	4.71																		
NR 375	1.14	15%	20%	25%	40%	165	33%	24%	163	57%	30%	162	10%	33%				28%	77
376	1.06	32%	11%	49%	8%	165	10%	24%	163	78%	30%	161	12%	16%				28%	72
NORTH ROCK RIMMON	2.20																		
377	0.90	0%	0%	36%	63%	163	100%	30%										30%	84
378	0.35	33%	0%	18%	49%	163	92%	30%	25	8%	81%							34%	76
SOUTH ROCK RIMMON	1.25																		
379	0.67	0%	15%	0%	85%	163	94%	30%	25	6%	81%							33%	84
POPES BLUFF	0.67																		
381	1.05	7%	44%	0%	49%	402	67%	2%	164	33%	30%							11%	72
383	0.88	36%	29%	0%	34%	402	38%	2%	164	62%	30%							19%	66
385	1.33	4%	15%	0%	87%	164	100%	30%										30%	86
387	1.00	34%	29%	8%	29%	164	100%	30%										30%	71
389	0.58	30%	31%	0%	40%	164	69%	30%	163	31%	30%							30%	73
391	1.07	21%	62%	0%	16%	164	29%	30%	163	29%	30%	TYPE 4	41%	77%				49%	78
393	1.21	38%	47%	0%	14%	163	28%	30%	TYPE 4	72%	77%							64%	82
395	1.57	22%	25%	27%	37%	402	17%	2%	164	82%	30%							25%	79
397	0.51	0%	51%	0%	49%	52	100%	62%										62%	87
399	1.05	33%	29%	0%	38%	52	100%	62%										62%	84
DOUGLASS CREEK	10.25																		

PROJECTED CURVE NUMBERS

BASIN NAMES	AREA SQ MILES	SOILS DISTRIBUTION IN PERCENT				PROJECTED LAND USE DISTRIBUTION IN PERCENT												WEIGH % IMPERV	CURVE NUMBER
		GROUP A PERV CN: 39	GROUP B PERV CN: 61	GROUP C PERV CN: 74	GROUP D PERV CN: 80	ZONE 1	% AREA	IMPERV %	ZONE 2	% AREA	IMPERV %	ZONE 3	% AREA	IMPERV %	ZONE 4	% AREA	IMPERV %		
481	0.99	0%	77%	23%	0%	152	78%	75%	TYPE 4	22%	77%							75%	90
483	1.40	18%	41%	41%	0%	TYPE 4	100%	77%										77%	90
485	1.12	82%	0%	0%	18%	1	18%	86%	TYPE 4	82%	77%							79%	87
487	0.70	8%	92%	0%	0%	TYPE 4	100%	77%										77%	89
489	1.38	33%	12%	46%	8%	TYPE 4	100%	77%										77%	90
491	1.10	78%	0%	0%	22%	TYPE 4	100%	77%										77%	87
493	0.75	0%	39%	0%	61%	13	62%	66%	10	24%	11%	TYPE 4	14%	77%				54%	87
495	0.99	13%	41%	0%	46%	1	86%	86%	TYPE 4	14%	77%							85%	93
497	0.89	0%	64%	0%	35%	TYPE 4	100%	77%										77%	91
499	0.35	33%	33%	0%	34%	14	100%	58%										58%	82
501	0.34	32%	0%	0%	68%	14	27%	58%	6	73%	38%							43%	80
503	0.98	1%	0%	12%	88%	6	100%	38%										38%	86
TEMPLETON GAP	10.99																		
505	0.41	15%	28%	28%	28%	TYPE 4	100%	77%										77%	91
507	0.72	44%	56%	0%	0%	TYPE 4	100%	77%										77%	87
ROSWELL	1.13																		
509	1.29	69%	31%	0%	0%	TYPE 4	100%	77%										77%	86
511	1.17	22%	78%	0%	0%	TYPE 4	100%	77%										77%	88
PAPTON	2.46																		
401	0.60	0%	24%	0%	77%	52	57%	62%	TYPE 4	43%	77%							68%	91
403	0.56	0%	50%	0%	50%	55	22%	44%	54	11%	46%	TYPE 4	67%	77%				66%	89
405	0.82	0%	44%	0%	56%	55	82%	44%	53	18%	71%							49%	85
407	0.88	0%	46%	0%	54%	55	16%	44%	55	23%	44%	52	30%	62%	53	31%	71%	58%	87

PROJECTED CURVE NUMBERS

BASIN NAMES	AREA SQ MILES	SOILS DISTRIBUTION IN PERCENT				PROJECTED LAND USE DISTRIBUTION IN PERCENT												WEIGH % IMPERV	CURVE NUMBER
		GROUP A	GROUP B	GROUP C	GROUP D														
		PERV CN:	PERV CN:	PERV CN:	PERV CN:	ZONE 1	% AREA	IMPERV %	ZONE 2	% AREA	IMPERV %	ZONE 3	% AREA	IMPERV %	ZONE 4	% AREA	IMPERV %		
		39	61	74	80														
409	0.52	0%	12%	0%	88%	55	0.38	44%	55	0.35	44%	TYPE 4	0.27	77%				53%	88
411	0.84	0%	38%	0%	62%	TYPE 4	100%	77%										77%	92
	4.22																		
MESA																			
513	0.27	36%	21%	0%	43%	TYPE 4	100%	77%										77%	90
515	0.48	47%	29%	0%	24%	TYPE 4	100%	77%										77%	88
MONUMENT VALLEY	0.75																		

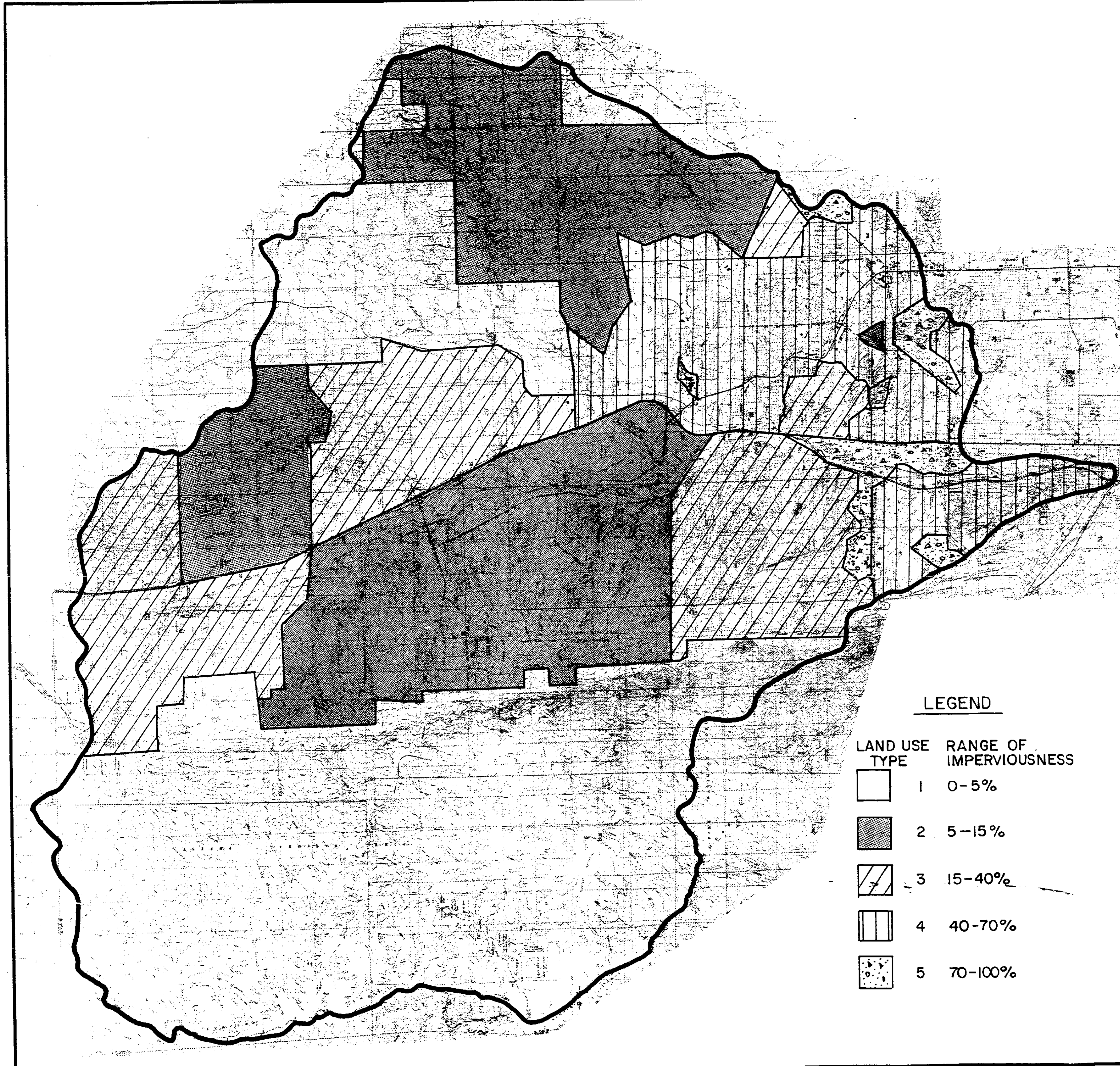
This reduction factor varies with watershed area. The resulting areally adjusted rainfall depth (2.07 inches for the 10-year storm and 3.02 inches for the 100-year storm) was applied uniformly over the Monument Creek basin. The areal reduction factor published in HMR 51 was selected instead of an alternate reduction factor identified in NOAA Atlas 2 because the HMR 51 factor compares more favorably with recent extreme storm events in the region.

The second approach used to adjust point rainfall depths in the large Monument Creek basin area consists of the development of an elliptical rainfall pattern. This approach, which is documented in Hydrometeorological Report No. 52 (HMR 52), attempts to represent an elliptical storm cell with maximum rainfall depths in a central core and decreasing depths in locations further removed from the core. Areal adjustments factors published in HMR 51 were multiplied by the point (core area) rainfall depths to represent reductions in storm depth in progressively larger ellipses located further away from the core.

Suggested orientations for the axis of the elliptical distribution are given for different parts of the United States within HMR 52. The orientation for this region of the United States is a range of azimuths from approximately 180^{o} to 260^{o}. Using the range of suggested orientations and the areas for each isohyetal, the rainfall distribution was placed over the basin in such a manner that as many complete isohyetals as possible are contained within the basin. This position would produce the greatest amount of rainfall over the basin. Figure 7A shows the location of the isohyetal lines used for the precipitation distribution for the HMR 52 with HMR 51 rainfall values approach.

The third approach to adjust point rainfall depths in the basin consists of the development of an elliptical rainfall pattern as in the previous approach. This approach follows the procedure for developing rainfall depths associated with each isohyetal developed in HMR 52. This approach by necessity has been modified to in order to apply the published method which is for Probable Maximum Precipitation amounts to the 100-year storm event. This approach is the same method that is currently being used in the development of the hydrology for the Fountain Creek Drainage Basin Planning Study. The method is being evaluated with the hope of providing consistency between both the Monument Creek and Fountain Creek studies. This is necessary because the Fountain Creek study will need to incorporate the results of the Monument Creek study to develop flows below the confluence of the two creeks.

The orientation of the axis of the elliptical distribution for this third approach was calculated such that the maximum amount of rainfall falls onto the basin. The orientation developed has an azimuth of 311 degrees. Figure 7B shows the location of the isohyetal lines used for the precipitation distribution for this HMR 52 approach.



MONUMENT CREEK DRAINAGE BASIN PLANNING STUDY

CITY OF COLORADO SPRINGS
PLANNING AND DEVELOPMENT DEPARTMENT
ENGINEERING DIVISION

0 1 2 3 4
MILES

KIOWA ENGINEERING INC.
THOMAS & THOMAS
URBAN EDGES INC.

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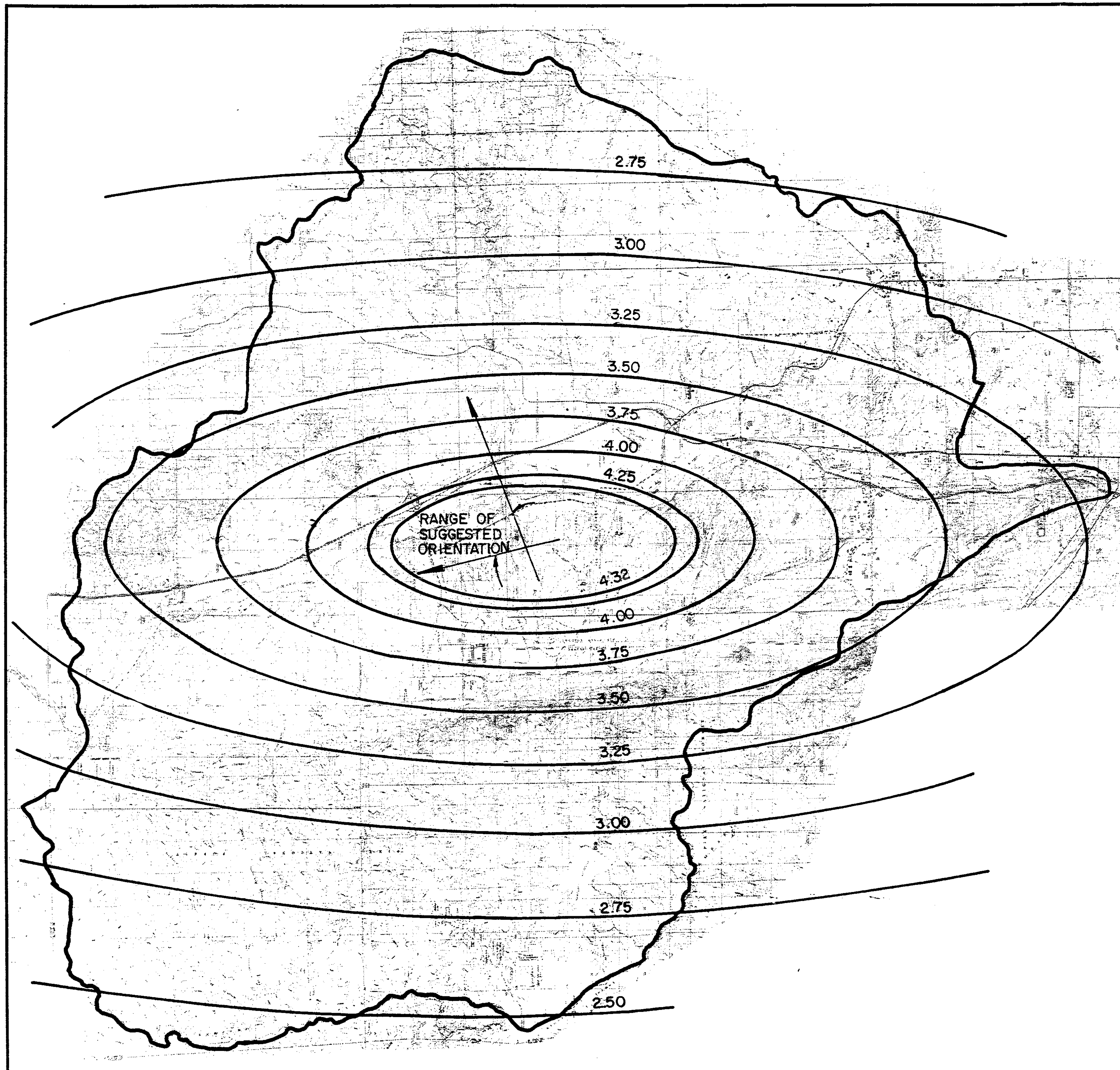
PROPOSED LAND USE

SEPT, 1991

FIGURE 6

07-17-91 mcrkbdr2.DGN



MONUMENT CREEK DRAINAGE BASIN PLANNING STUDY

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DEPARTMENT
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ISOHYETAL MAP

HMR 52 USING HMR ADJUSTED RAINFALL VALUES

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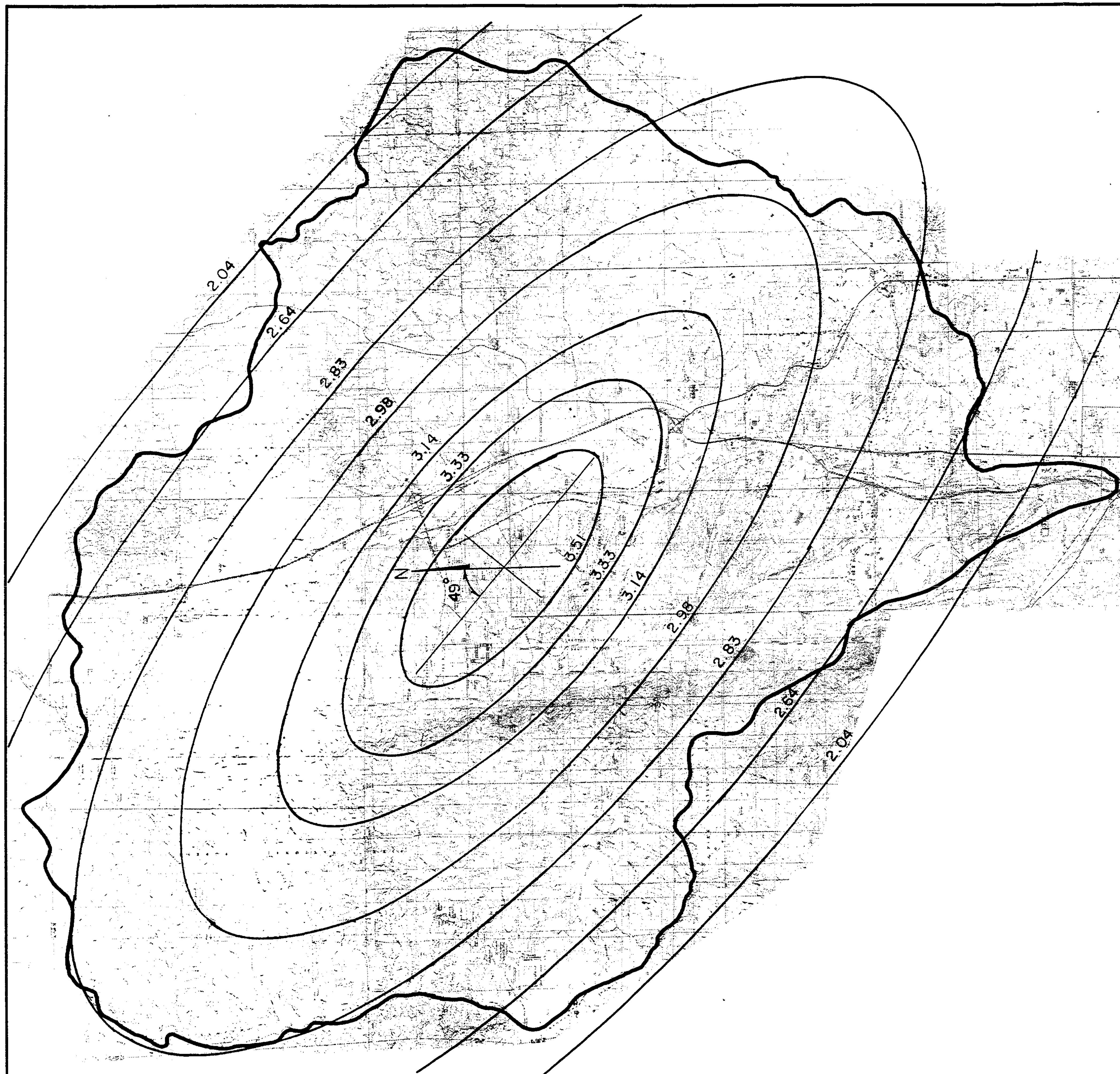
FIGURE 7A



MONUMENT CREEK DRAINAGE BASIN PLANNING STUDY

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PLANNING AND DEVELOPMENT DEPARTMENT
ENGINEERING DIVISION

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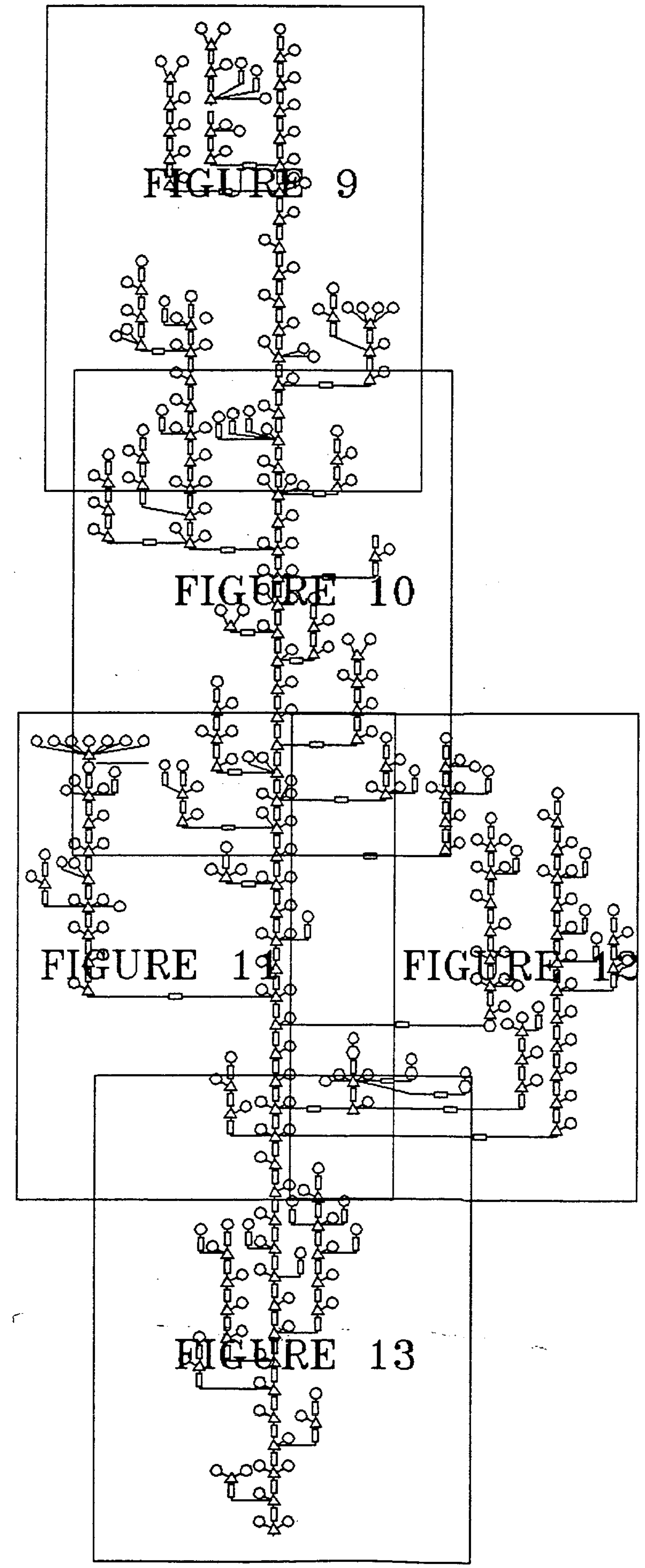
ISOHYETAL MAP

HMR 52 USING MODIFIED PMP PROCEDURE

MAY, 1992

FIGURE 7B



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HYDROLOGIC FLOW CHART

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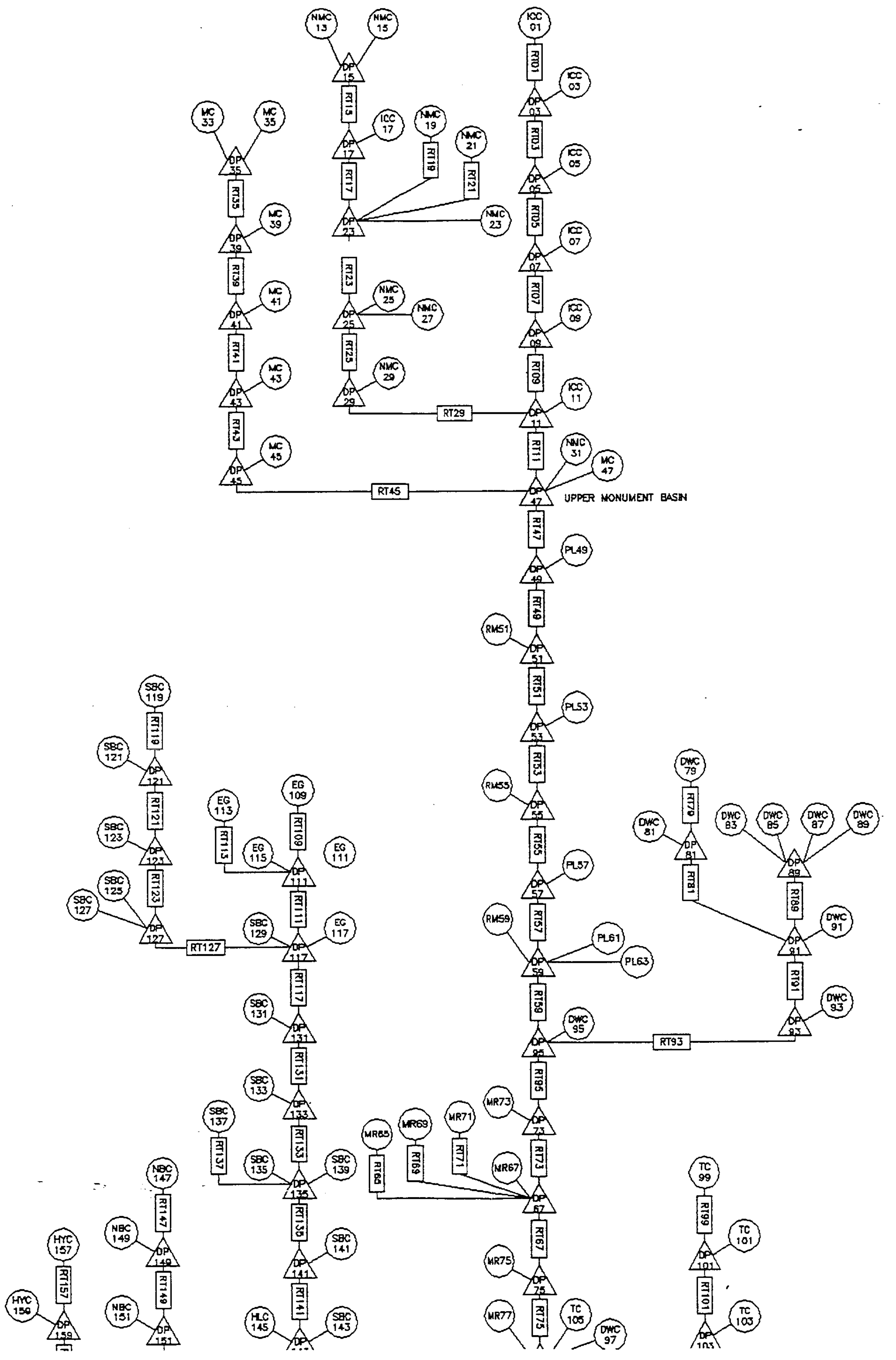
Figure 8



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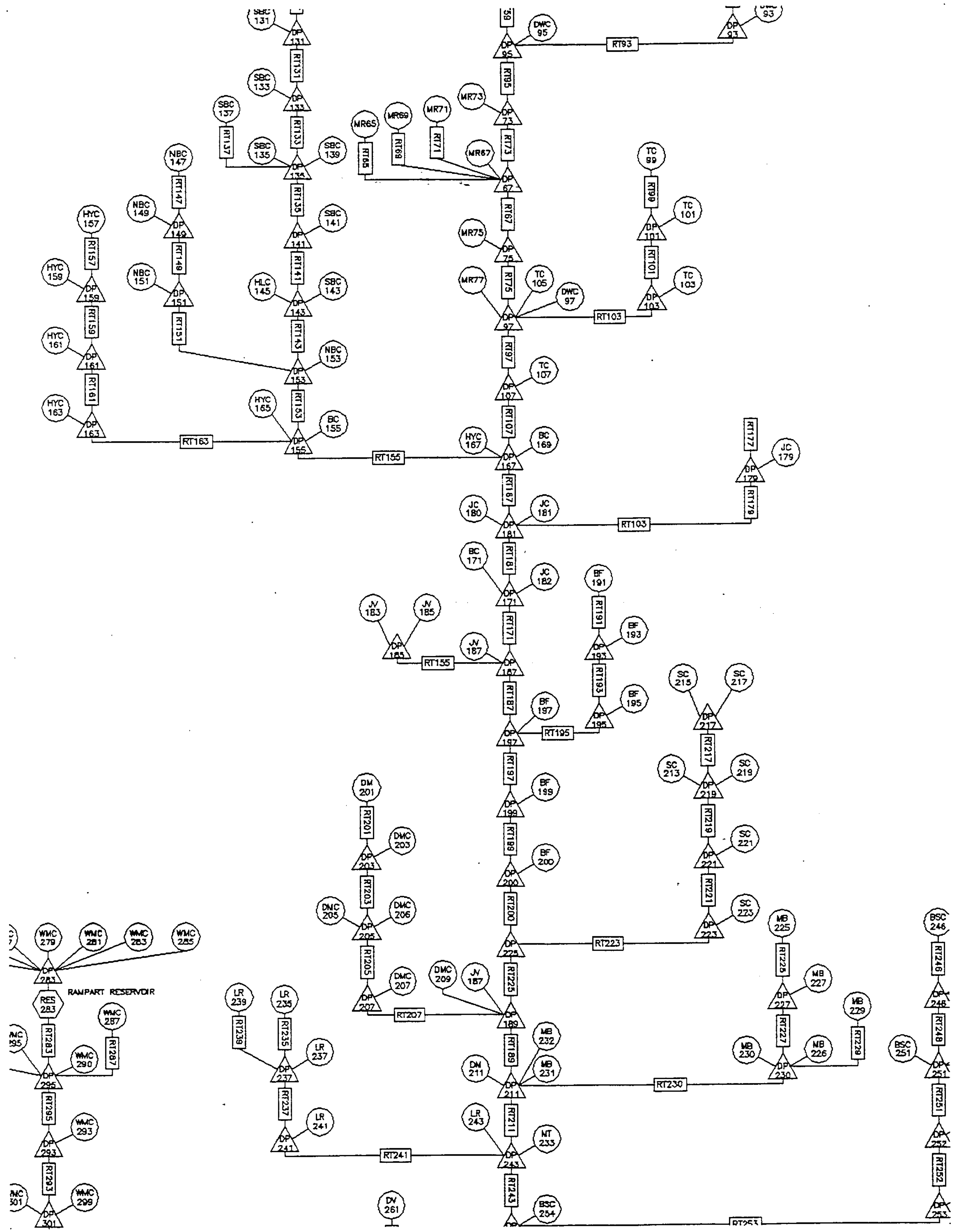
HYDROLOGIC FLOW CHART DETAIL

SEPT., 1991

Figure 9



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HYDROLOGIC FLOW CHART DETAIL

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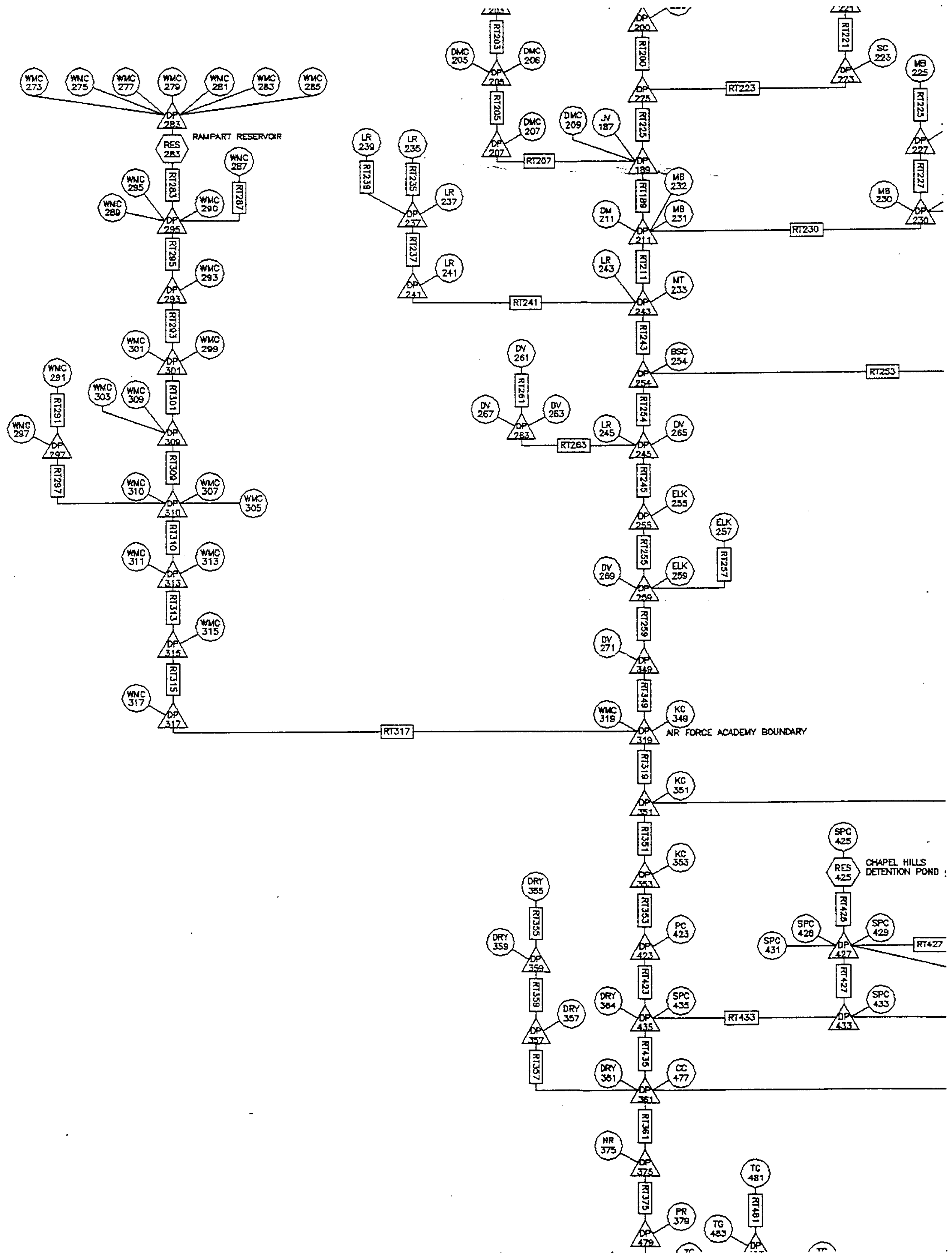
Figure 10



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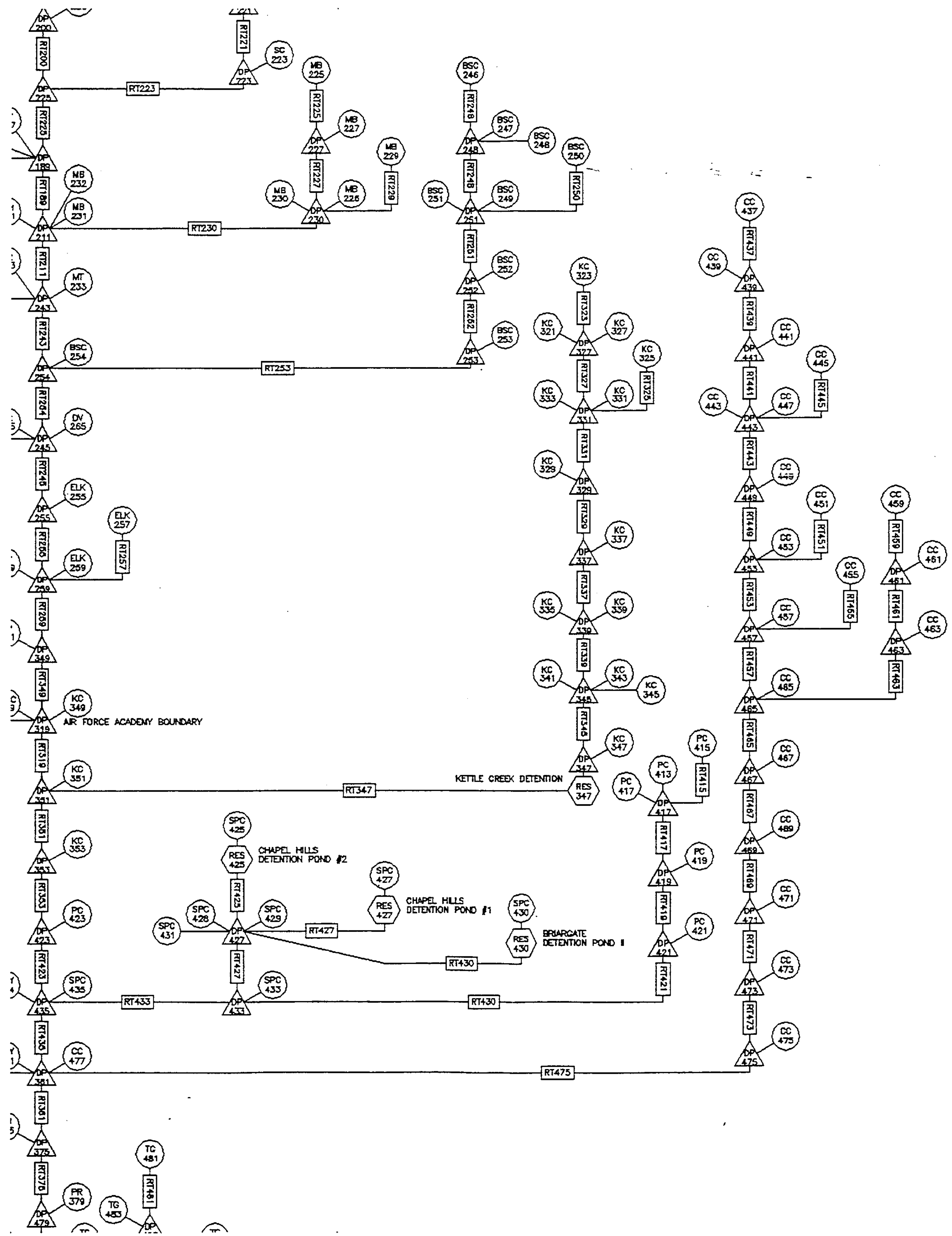
HYDROLOGIC FLOW CHART DETAIL

SEPT., 1991

Figure 11



MONUMENT CREEK DRAINAGE BASIN PLANNING STUDY

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HYDROLOGIC FLOW CHART DETAIL

SEPT., 1991

Figure 12

Hydrologic Modeling

The hydrologic model consists of 259 sub-basins, ranging in size from 80 acres to 200 acres, linked by drainageways or "reaches". Hydrographs are accumulated at design points along the major drainages. A hydrologic flow chart was developed and is shown in Figures 8 through 13. Both the existing and future development condition hydrologic models are based on the current configuration of Monument Creek and the tributary drainage channels. During the alternative evaluation process, the hydrologic model will be modified to reflect proposed changed channel conditions and possibly some detention storage.

The hydrologic model for the basin is based upon the USGS topographic quadrangles for the basin supplemented with the Facility Inventory Management System (FIMS) topographic mapping provided by the City of Colorado Springs Department of Utilities. Basin areas, lengths, slopes, and flow patterns were determined from these maps.

Table 10 summarizes the conditions modelled in the detailed hydrologic analysis. Both the 10- and 100-year storms were analyzed for existing and future development conditions. Two rainfall patterns based on HMR 51 and HMR 52 were modelled.

Table 10 Hydrologic Conditions Modelled

Conditions Type of Rainfall Pattern	Existing Development Conditions 10-Year	 100-Year	Future Development 10-Year	 100-Year
Uniform areally adjusted rainfall (HMR 51)	X	X	X	X
Elliptical storm cell pattern (HMR 52 using HMR 51 adjusted rainfall values)	X	X	X	X
Elliptical storm cell pattern (HMR 52 using modified PMP procedure)	X	X	X	X

Results

The results of the hydrologic analysis have been presented in several formats. A basin hydrologic map which contains the basin boundary, regional basins, channel routing scheme, sub-basin locations, and design points is shown on Exhibit 1 which is contained in a map pocket attached to this report. Flood discharge profiles for the various storm types analyzed are shown on Figures 14 through 21.

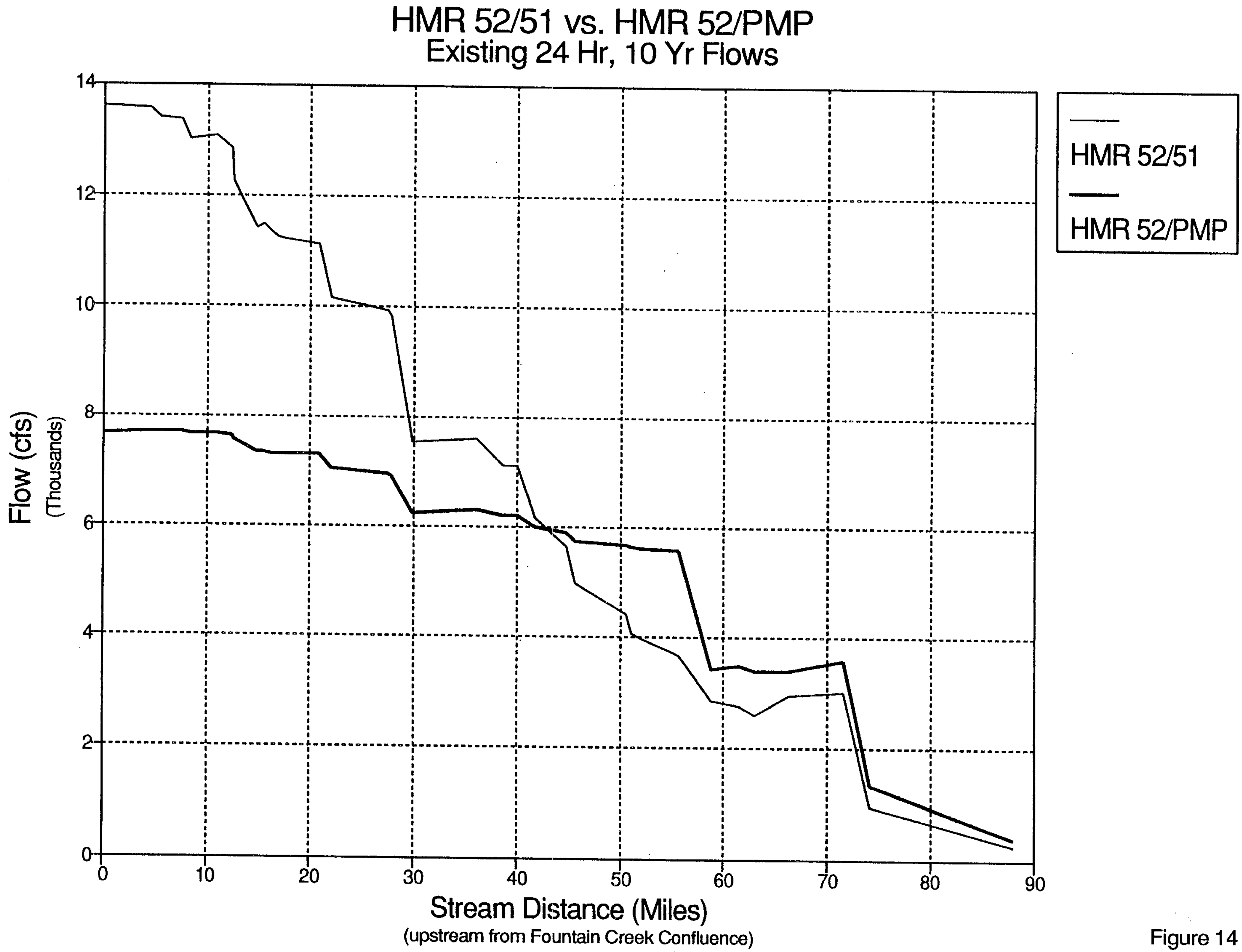

HMR 52/51 vs. HMR 52/PMP
Existing 24 Hr, 10 Yr Flows
Flow (cfs)
(Thousands)
0
2
4
6
8
10
12
14
0
10
20
30
40
50
60
70
80
90
Stream Distance (Miles)
(upstream from Fountain Creek Confluence)
HMR 52/51
HMR 52/PMP

Figure 14

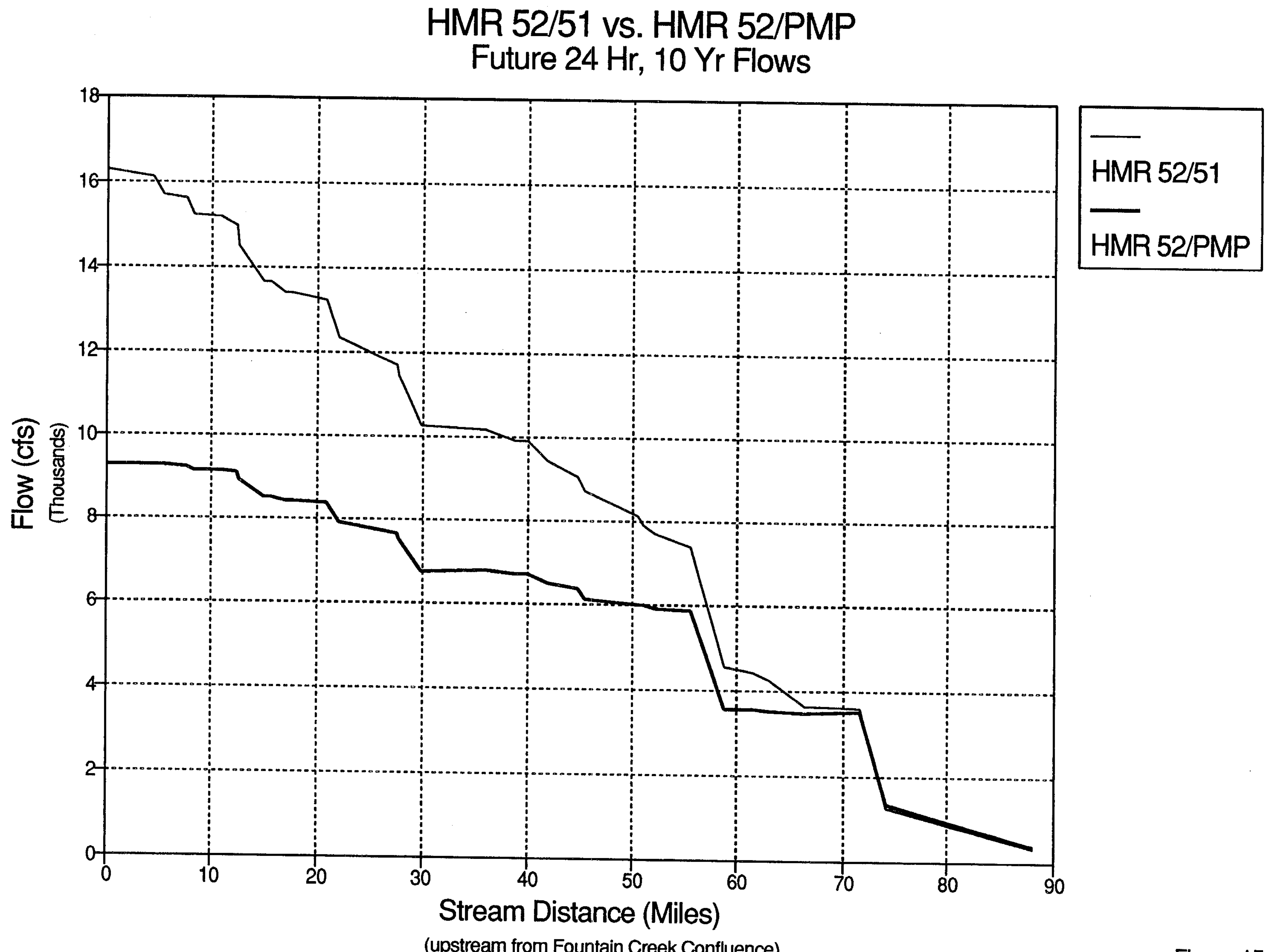

HMR 52/51 vs. HMR 52/PMP
Future 24 Hr, 10 Yr Flows
Flow (cfs)
(Thousands)
0
2
4
6
8
10
12
14
16
18
0
10
20
30
40
50
60
70
80
90
Stream Distance (Miles)
(upstream from Fountain Creek Confluence)
HMR 52/51
HMR 52/PMP

Figure 15

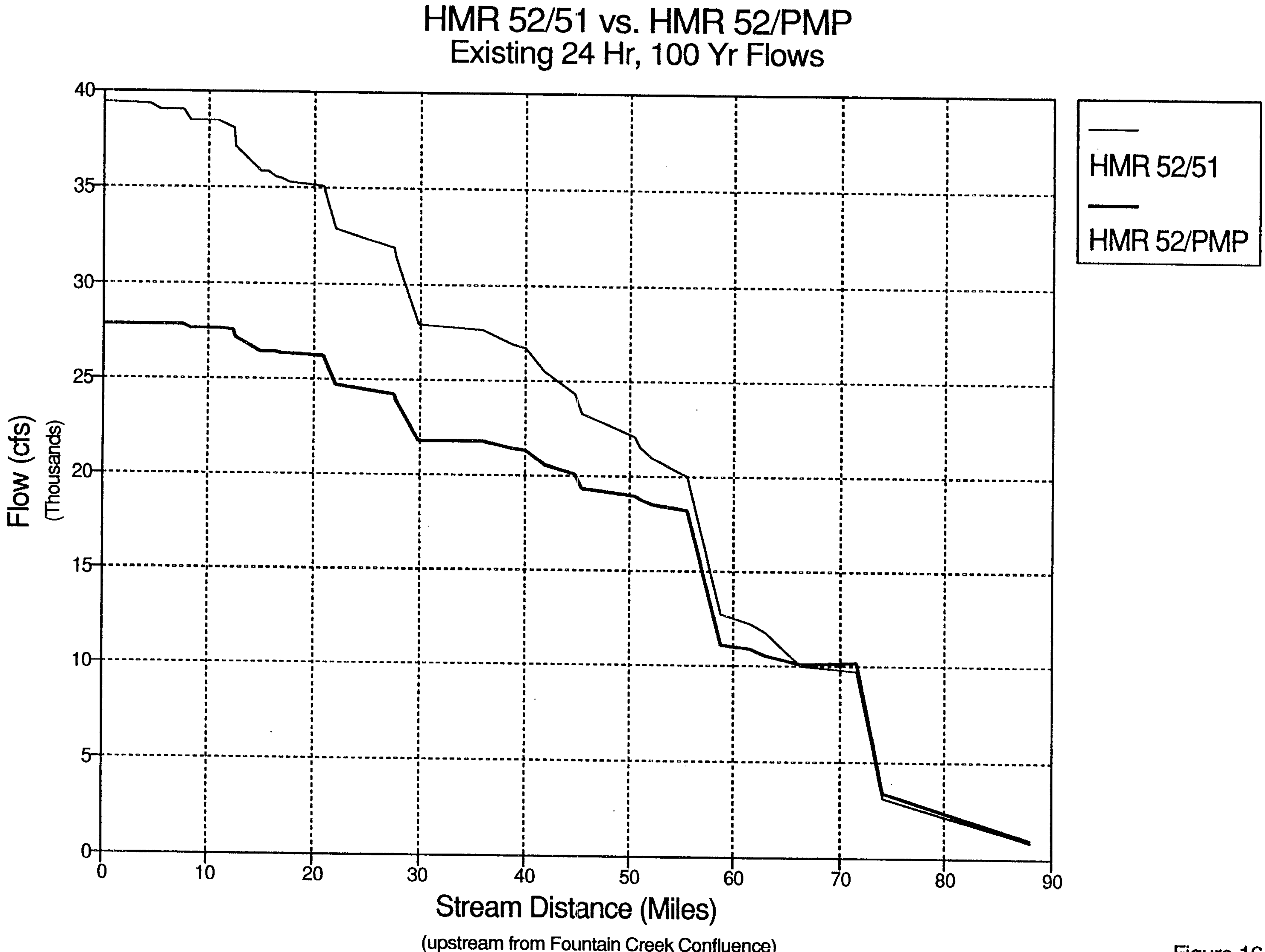
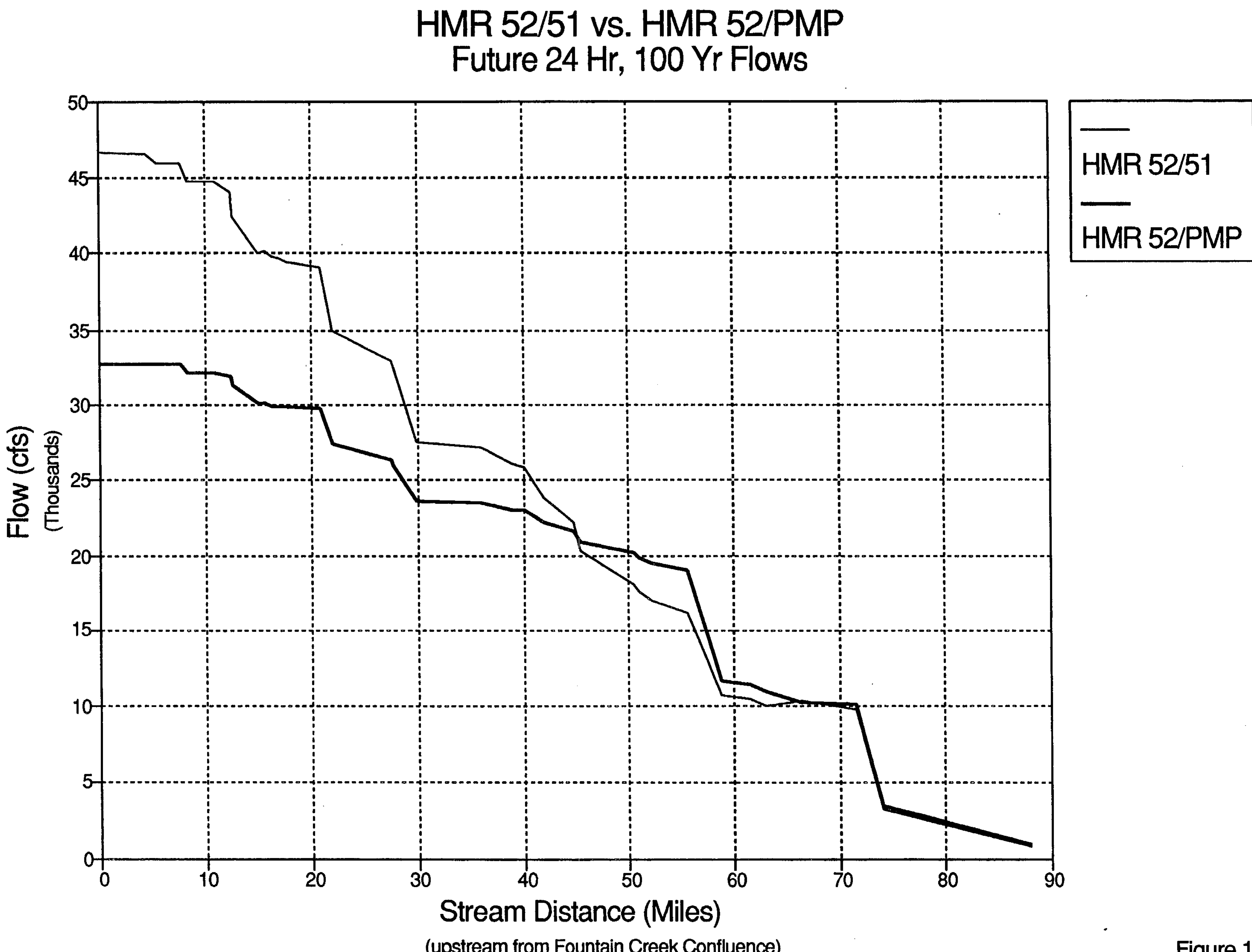

HMR 52/51 vs. HMR 52/PMP
Existing 24 Hr, 100 Yr Flows
Flow (cfs)
(Thousands)
40
35
30
25
20
15
10
5
0
0
10
20
30
40
50
60
70
80
90
Stream Distance (Miles)
(upstream from Fountain Creek Confluence)
HMR 52/51
HMR 52/PMP

Figure 16



HMR 52/51 vs. HMR 52/PMP
Future 24 Hr, 100 Yr Flows
HMR 52/51
HMR 52/PMP
Flow (cfs)
(Thousands)
0
5
10
15
20
25
30
35
40
45
50
0
10
20
30
40
50
60
70
80
90
Stream Distance (Miles)
(upstream from Fountain Creek Confluence)

Figure 17

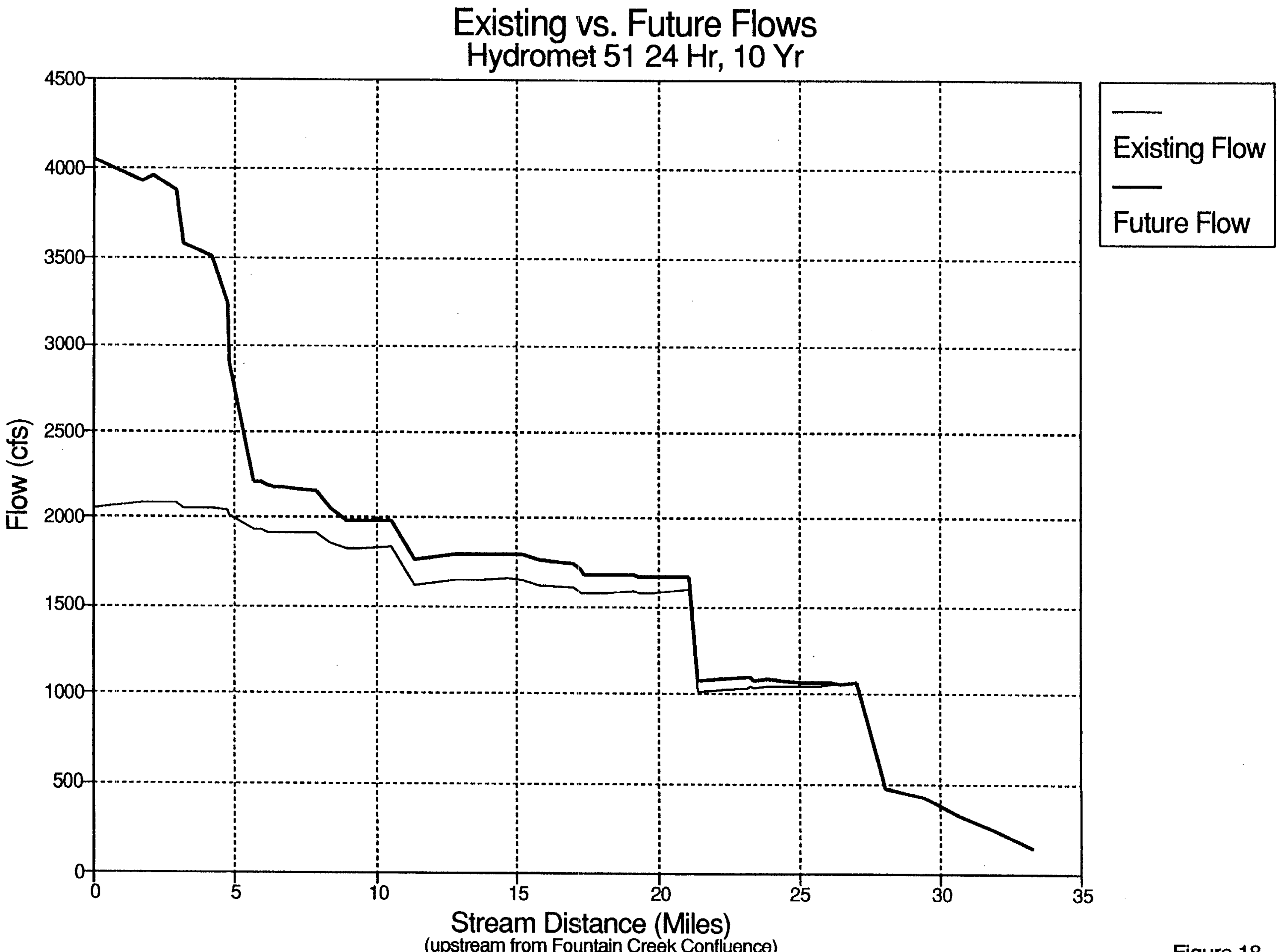

Existing vs. Future Flows
Hydromet 51 24 Hr, 10 Yr
Flow (cfs)
4500
4000
3500
3000
2500
2000
1500
1000
500
0
0
5
10
15
20
25
30
35
Stream Distance (Miles)
(upstream from Fountain Creek Confluence)
Existing Flow
Future Flow

Figure 18