C153804

FEASIBILITY STUDY FOR: LEFT HAND VALLEY RESERVOIR SPILLWAY MODIFICATIONS

Prepared for:

Left Hand Ditch Company
P.O. Box 229
Niwot, Colorado 80544

and

Colorado Water Conservation Board
1313 Sherman Street, Room 721
Denver, Colorado 80203

Prepared By:

Rocky Mountain Consultants, Inc.
700 Florida Avenue, Suite 500
Longmont, Colorado 80501

RMC Job No. 50.0132.007.02

Revised December 19, 1994

LEFT HAND DITCH COMPANY

August 31, 1994

Mr. Chuck Lile, Director
Colorado Water Conservation Board
1313 Sherman Street, Room 721
Denver, Colorado 80203

Re: Feasibility Study for Increasing the Spillway Capacity at Left Hand Valley Reservoir, Boulder County, Colorado

Dear Mr. Lile:

The Office of the State Engineer has ordered the Left Hand Ditch Company to increase the spillway capacity at Left Hand Valley Reservoir or to face a storage restriction. The attached feasibility study concludes that the most feasible way of accomplishing the increase is to construct an additional spillway of roller compacted concrete over the north dam. The Left Hand Ditch Company is seeking financial assistance from the Colorado Water Conservation Board to pay for the work required in this project. The Company will acquire additional funding through its bank for the amount not financed by the CWCB.

Transmitted herewith is a feasibility study which provides information about the project and the Left Hand Ditch Company in accordance with the CWCB guidelines. The construction cost of the project is estimated to be $490,400. A completed loan application has already been transmitted to your office requesting approval of up to $500,000 for financing of this project. If you have any questions related to this feasibility study please contact Mr. Mark McLean of Rocky Mountain Consultants, Inc. at (303) 665-6283.

Thank you for your consideration.

Sincerely,

LEFT HAND DITCH COMPANY

Charles Lippincott, Vice - President

Attachment

P.O. Box 229 • Niwot, Colorado • 80544 • (303) 530-0125 • Fax (303) 530-5252

LEFT HAND DITCH COMPANY

RESOLUTION

A RESOLUTION REQUESTING STATE CONSTRUCTION FUNDING THROUGH THE COLORADO WATER CONSERVATION BOARD FOR ENLARGEMENT OF THE SPILLWAY CAPACITY AT LEFT HAND VALLEY RESERVOIR.

Whereas, the Office of the State Engineer has ordered an increase in the capacity of the spillway at Left Hand Valley Reservoir to increase the public safety; and

Whereas, the Left Hand Ditch Company seeks to obtain the most favorable financing of the project; and

Whereas, according to Section 4 of Article VII of the By-Laws/Articles of Incorporation of the Left Hand Ditch Company the Board of Directors shall have the power "to borrow money on the credit and responsibility of the Corporation, in such sums as they may deem necessary or proper for all purposes previously authorized by the stockholders of the Corporation"; and

Whereas, at the annual meeting of the stockholders of the Left Hand Ditch Company held February 5, 1994 said stockholders approved a motion authorizing the Board of Directors to take such action as may be necessary to comply with the office of the State Engineer's order to increase the spillway capacity of the Left Hand Valley Reservoir including construction of an additional spillway of roller compacted concrete and to approve and obtain loans and/or other financing means necessary to finance the project;

NOW, THEREFORE, BE IT RESOLVED BY THE BOARD OF DIRECTORS OF THE LEFT HAND DITCH COMPANY:

1. That the total estimated construction cost for increasing the spillway capacity at Left Hand Valley Reservoir including the actual construction and construction engineering is $490,400.

2. That the Left Hand Ditch Company is applying to the Colorado Water Conservation Board for $367,800.00 in State construction loan funds to partially finance this project, said funds to be repaid over a period of 30 years.

3. That the Left Hand Ditch Company proposes to borrow the remaining $122,600.00 through a bank loan to be repaid over a period of 15 years.

P.O. Box 229 • Niwot, Colorado • 80544 • (303) 530-0125 • Fax (303) 530-5252

Introduced, Read and Adopted by the Board of Directors of the Left Hand Ditch Company at its regular meeting this 24th day of August, 1994.

Charles Lippincott, Vice-President

Attest:

Bertram Nelson, Secretary

FEASIBILITY STUDY FOR:
LEFT HAND VALLEY RESERVOIR
SPILLWAY MODIFICATIONS

Prepared for:

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P.O. Box 229
Niwot, Colorado 80544

and

Colorado Water Conservation Board
1313 Sherman Street, Room 721
Denver, Colorado 80203

Prepared By:

Rocky Mountain Consultants, Inc.
700 Florida Avenue, Suite 500
Longmont, Colorado 80501

RMC Job No. 50.0132.007.02

Revised December 19, 1994

Certification

I, Mark A. McLean, a registered professional engineer in the State of Colorado, hereby certify that the information presented in this report was prepared by me or was prepared under my direct supervision for the owners thereof.

By:_____

Mark A. McLean, P.E., #25061

Acknowledgments

Rocky Mountain Consultants, Inc. would like to thank the Board and staff of the Left Hand Ditch Company for their valuable assistance during the preparation of this report. Special thanks to Mr. Richard Behrmann, President and Ms. Sarah Rodriguez, office secretary, for their time and efforts on this project. We would also like to thank Mr. John Van Sciver and Mr. Bill Green of the Colorado Water Conservation Board for their help in understanding the requirements of this submittal.

Executive Summary

In response to an order from the State Engineer's Office the Left Hand Ditch Company is seeking to make certain modifications to the dams at Left Hand Valley Reservoir to increase the spillway capacity. The Company is seeking funding from the CWCB for a portion of the construction costs associated with the improvements. This feasibility study examines the feasibility of one non-structural and seven structural alternatives and demonstrates the technical, financial and institutional feasibility of constructing a new stepped roller compacted concrete spillway over the north dam of the reservoir.

The spillway will be constructed over the north dam forming the reservoir and will have a 95 foot crest width converging to a 70 foot stilling basin at the bottom of the 2.25:1 slope. The existing spillway will remain in place providing capacity for storms up to 1 in 100 years recurrence interval. The new spillway will have a fuse plug section constructed on its crest to be overtopped during storms of greater than 1 in 100 year recurrence intervals. In concert the two spillways will provide a total capacity of 11,025 cfs, sufficient to pass the runoff from a storm equal to 75 percent of the Probable Maximum Precipitation without overtopping the dams.

The construction cost estimate for the new spillway, including construction engineering and contingencies, is $490,400. The Company will finance 75 percent of the construction cost through a construction fund loan from the CWCB and will finance the remaining 25 percent of the construction cost through a bank loan. Assessments charged to the shareholders of the Company will provide the funds necessary to repay the loans. Assessments were increased from $5.00 per share to $7.50 per share for 1994 in anticipation of this project. Assessments will further be increased from $7.50 per share to $8.00 or more per share to fund the repayment beginning in 1995. Construction will begin in September 1995 with completion in approximately six to eight weeks.

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Chapter I - Introduction

The State of Colorado, acting through the State Engineer's Office (SEO), has determined that the spillway capacity at Left Hand Valley Reservoir, located north of Boulder, Colorado, is inadequate and will not safely pass the runoff from the 75 percent Probable Maximum Precipitation storm without overtopping of the dams. On October 3, 1991 the SEO ordered the Left Hand Ditch Company to increase the spillway capacity or be subject to a storage restriction. A copy of the order is included as Appendix A. The purpose of this feasibility study is to determine the most feasible method of increasing the spillway capacity at Left Hand Valley Reservoir.

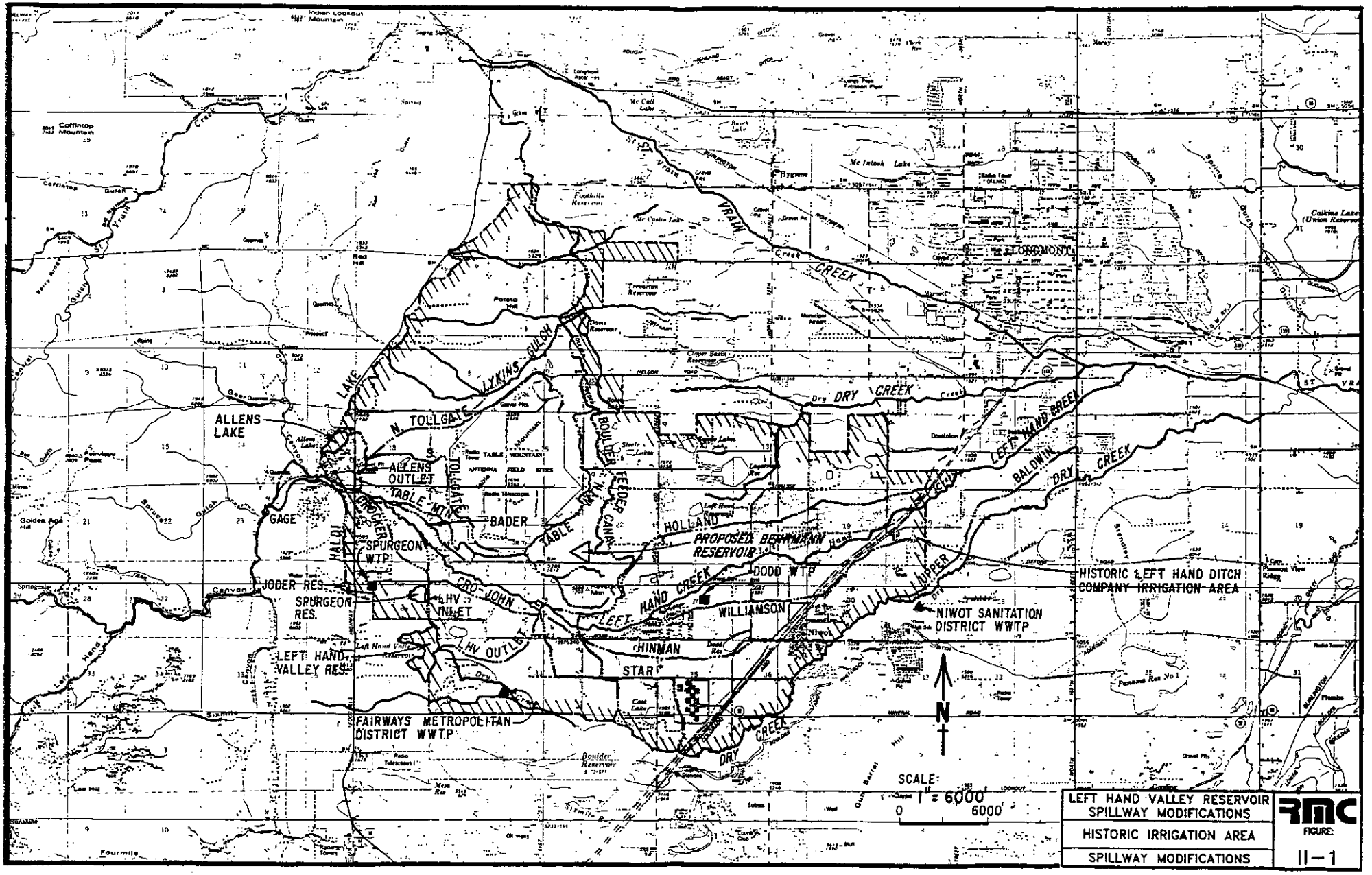
A non-structural plan and seven structural plans are examined for financial, technical and institutional feasibility. The non-structural plan is one of no action. The structural plans include widening the existing spillway, constructing a new spillway over the north dam, and providing complete overtopping protection for the north dam. For the new spillway alternatives both conventional formed concrete and roller compacted concrete are considered. Roller compacted concrete is considered exclusively for the overtopping alternatives. In order to minimize the size of the spillway, and therefore the cost of the project, various means of raising the dams are discussed. Fuse plug embankment construction is considered in order to cause the existing spillway to be utilized for more frequent floods.

The project will be financed through a loan from the Colorado Water Conservation Board and a bank loan. Repayment will be accomplished by charging increased assessments against issued share of Company stock. A financial analysis is presented showing the funding and repayment for the preferred alternative.

Chapter II - Description of Sponsoring Entity

The Left Hand Ditch Company (the Company) was formed on February 27, 1866 when the all of the owners of water rights on Left Hand Creek formed a mutual ditch company for the purpose of making a diversion from South St. Vrain Creek to the Left Hand Creek basin. The individual water rights of the various persons forming the company were transferred to the Company for distribution under a mutual ditch company system. The Company is made up of approximately 400 shareholders owning 16,647 shares of stock issued out of 16,800 shares outstanding. The Company service area is roughly located along Left Hand Creek from the foothills of the Front Range to Niwot, Colorado. A map showing the service area is attached as Figure II-1 and Figure II-2 shows a schematic diagram of the Company's ditches and reservoirs.

The Company owns the 33 most senior direct flow rights on Left Hand Creek totalling 294.58 cfs and effectively controlling the entire flow of Left Hand Creek. The Company also owns two direct flow priorities out of South St. Vrain Creek totalling 726 cfs. This was the first transbasin diversion in Colorado and led to the court case of Coffin vs. Left Hand Ditch Company, one of the most important cases in Colorado water law. Water diverted from South St. Vrain Creek represents a majority of the total supply of the Left Hand Ditch Company. To regulate its flows and to provide a supply during times of diminished streamflow the Company owns five reservoirs including Left Hand Valley Reservoir, the largest and most important in the system. Table II-1 lists the direct flow and storage assets of the Company.



LEFT HAND VALLEY RESERVOIR SPILLWAY MODIFICATIONS

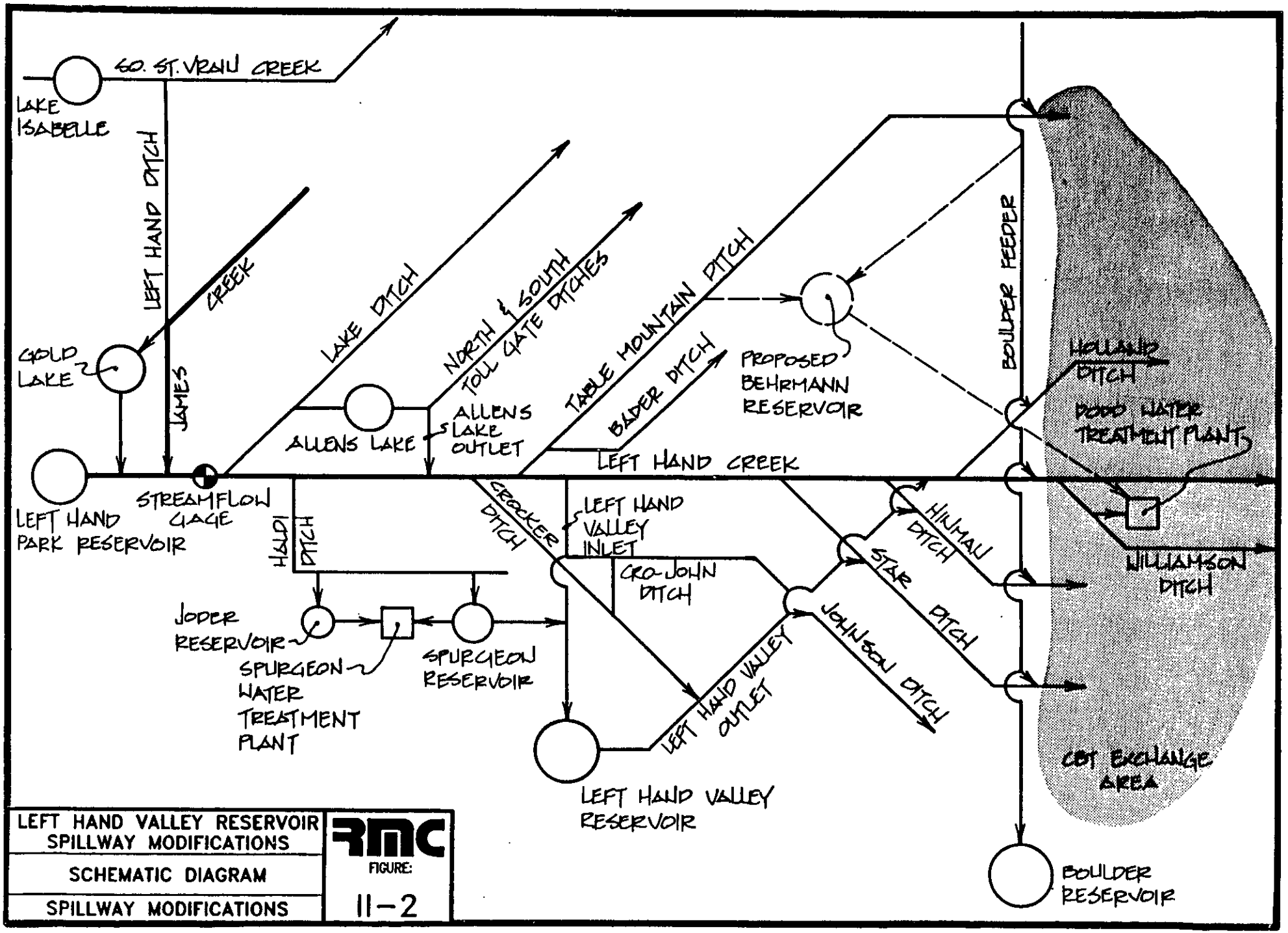
HISTORIC IRRIGATION AREA

SPILLWAY MODIFICATIONS

RMC

FIGURE:

II—1



LEFT HAND VALLEY RESERVOIR SPILLWAY MODIFICATIONS	RMC FIGURE:
SCHEMATIC DIAGRAM	11-2
SPILLWAY MODIFICATIONS	

Table II-1

Left Hand Ditch Company Water Rights

Direct Flow Rights:				
Ditch Name	**Amount**	**Adjudication**	**Appropriation**	**Source**
Cochran Ditch	.32 cfs	6/02/1882	9/01/1860	Left Hand Creek
	8.28 cfs	6/02/1882	6/15/1866	Left Hand Creek
Hornbaker Ditch	3.88 cfs	6/02/1882	5/15/1861	Left Hand Creek
	1.70 cfs	6/02/1882	7/15/1864	Left Hand Creek
	18.66 cfs	6/02/1882	6/01/1865	Left Hand Creek
Williamson - Cavey Ditch	2.68 cfs	6/02/1882	5/31/1862	Left Hand Creek
	4.50 cfs	6/02/1882	6/01/1863	Left Hand Creek
	6.80 cfs	6/02/1882	5/01/1865	Left Hand Creek
Holland Ditch	2.00 cfs	6/02/1882	5/01/1863	Left Hand Creek
	1.28 cfs	6/02/1882	5/01/1866	Left Hand Creek
	69.40 cfs	6/02/1882	10/21/1873	Left Hand Creek
Badar No.2 Ditch	1.46 cfs	6/02/1882	5/31/1863	Left Hand Creek
	6.72 cfs	6/02/1882	3/15/1870	Left Hand Creek
Farmers Ditch	1.63 cfs	6/02/1882	6/01/1863	Left Hand Creek
	2.03 cfs	6/02/1882	6/15/1865	Left Hand Creek
	11.61 cfs	6/02/1882	11/01/1870	Left Hand Creek
Baum Goyn Ditch	3.96 cfs	6/02/1882	9/26/1863	Left Hand Creek
	6.78 cfs	6/02/1882	5/01/1867	Left Hand Creek
Badar No.1 Ditch	9.16 cfs	6/02/1882	5/31/1864	Left Hand Creek
Altona Ditch	2.01 cfs	6/02/1882	5/31/1865	Left Hand Creek
	8.66 cfs	6/02/1882	4/15/1875	Left Hand Creek
Table Mountain Ditch	15.30 cfs	6/02/1882	6/25/1866	Left Hand Creek
	26.43 cfs	6/02/1882	4/15/1874	Left Hand Creek
Way Ditch	4.20 cfs	6/02/1882	5/01/1868	Left Hand Creek
Toll Gate Ditch	2.63 cfs	6/02/1882	4/01/1870	Left Hand Creek
	2.72 cfs	6/02/1882	5/01/1874	Left Hand Creek
	3.94 cfs	6/02/1882	5/03/1879	Left Hand Creek
Star Ditch	25.68 cfs	6/02/1882	4/01/1873	Left Hand Creek
Crocker Ditch	3.83 cfs	6/02/1882	5/01/1871	Left Hand Creek
	14.98 cfs	6/02/1882	5/01/1872	Left Hand Creek
Johnson Ditch	8.55 cfs	6/02/1882	4/01/1873	Left Hand Creek
Lake Ditch	8.92 cfs	6/02/1882	5/15/1874	Left Hand Creek
	3.88 cfs	6/02/1882	4/15/1879	Left Hand Creek
Left Hand Ditch	40.77 cfs	6/02/1882	6/01/1863	South St. Vrain Creek
	685.23 cfs	6/02/1882	6/01/1870	South St. Vrain Creek
Storage Rights:				
Reservoir Name	**Amount**	**Adjudication**	**Appropriation**	**Source**
Allens Lake	134.2 ac-ft	7/23/1951	12/02/1918	Left Hand Creek
Allens Lake Enlargement	569.5 ac-ft	7/23/1951	5/17/1927	Left Hand Creek
Allens Lake Refill	703.7 ac-ft	7/23/1951	12/31/1929	Left Hand Creek
Gold Lake	354.0 ac-ft	3/13/1907	9/01/1879	South St. Vrain
Gold Lake Enlargement	82.0 ac-ft	3/13/1907	5/18/1904	South St. Vrain
Gold Lake Refill (abs.)	290.66 ac-ft	7/23/1951	12/31/1929	Left Hand Creek
Gold Lake Refill (cond.)	145.34 ac-ft	7/23/1951	12/31/1929	Left Hand Creek
Isabelle Lake	809.8 ac-ft	6/11/1926	9/15/1907	South St. Vrain
Left Hand Park Reservoir	185.0 ac-ft	3/13/1907	8/05/1891	Left Hand Creek
Left Hand Park Enlargement	1,102.32 ac-ft	2/25/1971	8/01/1961	Left Hand Creek
Left Hand Valley Reservoir	10,572.6 ac-ft	7/23/1951	5/15/1945	Left Hand Creek

The Company (a mutual ditch company formed under C.R.S. 7-42-101 to 118) is a perpetual corporation formed "*to own and operate an irrigation and water system in the Niwot region of Boulder County, Colorado and in connection therewith to own, control, maintain and operate irrigation ditches, laterals, irrigation reservoirs, headgates, flumes, weirs, irrigation water rights and decrees, and other property of a complete irrigation system; to employ such secretaries, clerks, auditors, attorneys, water superintendents, ditch riders, and laborers as may be needed; to divert, store, measure and distribute water under the water rights, priorities, and decrees owned and controlled by the Left Hand Ditch Company; to provide water to its stockholders for irrigation, domestic, industrial and commercial purposes; and in general to carry on the business of providing such water to the stockholders of the Corporation.*" (By-Laws/Articles of Incorporation, Article III). The original Articles of Incorporation are nearly illegible, therefore, Appendix B includes a copy of the By-Laws/Articles of Incorporation adopted by the Company on February 5, 1974.

The powers and authorities of the Company as exercised by the Board of Directors are listed in Appendix B under Article VII, Section 4, and specifically include that *"Express power and authority are hereby conferred upon the Board to borrow money on the credit and responsibility of the Corporation, in such sums as they may deem necessary or proper for all such purposes previously authorized by the stockholders of the Corporation."* At the Company's 1993 annual meeting held in February 1994 the stockholders approved a motion "... *for the Ditch Board to pursue the option of the rolling* (sic) *compacted concrete, to negotiate the best financial deal possible, and to give the Board financing power to approve any loans needed with the maneuvering power to accept a more feasible way to complete the project if needed"* (from the minutes of the 1993 annual meeting).

The Board of Directors consists of five persons who are stockholders in the Company. The five Directors each represent a district or division of the Left Hand Ditch Company irrigation system. The districts are listed in the By-Laws/Articles of Incorporation, Article VI. The officers of the Company, consisting of a President, Vice-President, Secretary and Treasurer are members of the Board of Directors and are chosen annually by the Board. The duties of Board of Directors

are listed in Article VIII of the By-Laws/Articles of Incorporation. The current Directors of the Company and their offices are as follows:

President	Richard Behrmann	Director, District 1
Vice-President	Charles Lippincott	Director, District 3
Secretary	Bertram Nelson	Director, District 5
Treasurer	Morley Fentress	Director, District 2
	Frank Gould	Director, District 4

Revenues are derived principally from assessments charged on shares of stock owned by the stockholders. A small amount of revenue comes from the lease of surface rights at Left Hand Valley Reservoir and from interest on money in the bank. Appendix C contains financial statements prepared by the Company's accountants for 1992 and 1993.

Chapter III - Background Information

A. Study Area Description

Left Hand Valley Reservoir is the largest and most important reservoir in the Left Hand Ditch Company system. The reservoir serves as a source for direct releases of storage water, as an exchange vessel, and as a regulating reservoir for smoothing out diversions by the twelve lateral ditches served by the Company. Five of the twelve ditches can be served directly by the reservoir through its outlet ditch. The seven upper ditches in the system benefit by diverting water from Left Hand Creek in exchange for reservoir releases made to the lower ditches.

Left Hand Valley Reservoir is an off channel reservoir located in the upper drainage basin of Dry Creek, a tributary of St. Vrain Creek, just east of the first foothills of the Front Range. The reservoir is located in Sections 29, 30, 31 and 32 of Township 3 North, Range 70 West of the 6th P.M., Boulder County, Colorado as shown in Figure III-1. Water to fill Left Hand Valley is diverted from Left Hand Creek and carried through a canal to the reservoir. The reservoir is formed by two dams each approximately 45 feet high and 450 feet long, has a normal full capacity of 1,624 acre-feet, and a surface area at the normal high water line of 113 acres. The existing spillway is located in a cut in the south abutment of the north dam and is trapezoidal in cross section with a 30-40 foot bottom width and 2:1 side slopes. The spillway flowline crest elevation is approximately 5,351 feet and the tops of the dams are at approximately 5,358 feet. The existing spillway has a capacity of 2,200 cfs for a reservoir water surface elevation of 5,358 feet.

Left Hand Valley Reservoir is located approximately 3 miles north of the City of Boulder, Colorado and approximately 1.5 miles west of Boulder Reservoir. Just south and east of the reservoir is a residential county development of approximately 157 homes and a golf course. These facilities cause the dams to be classified as Class 1, high hazard dams. Because of the height of the dams and the capacity of the reservoir, the dams are classified as intermediate in size.

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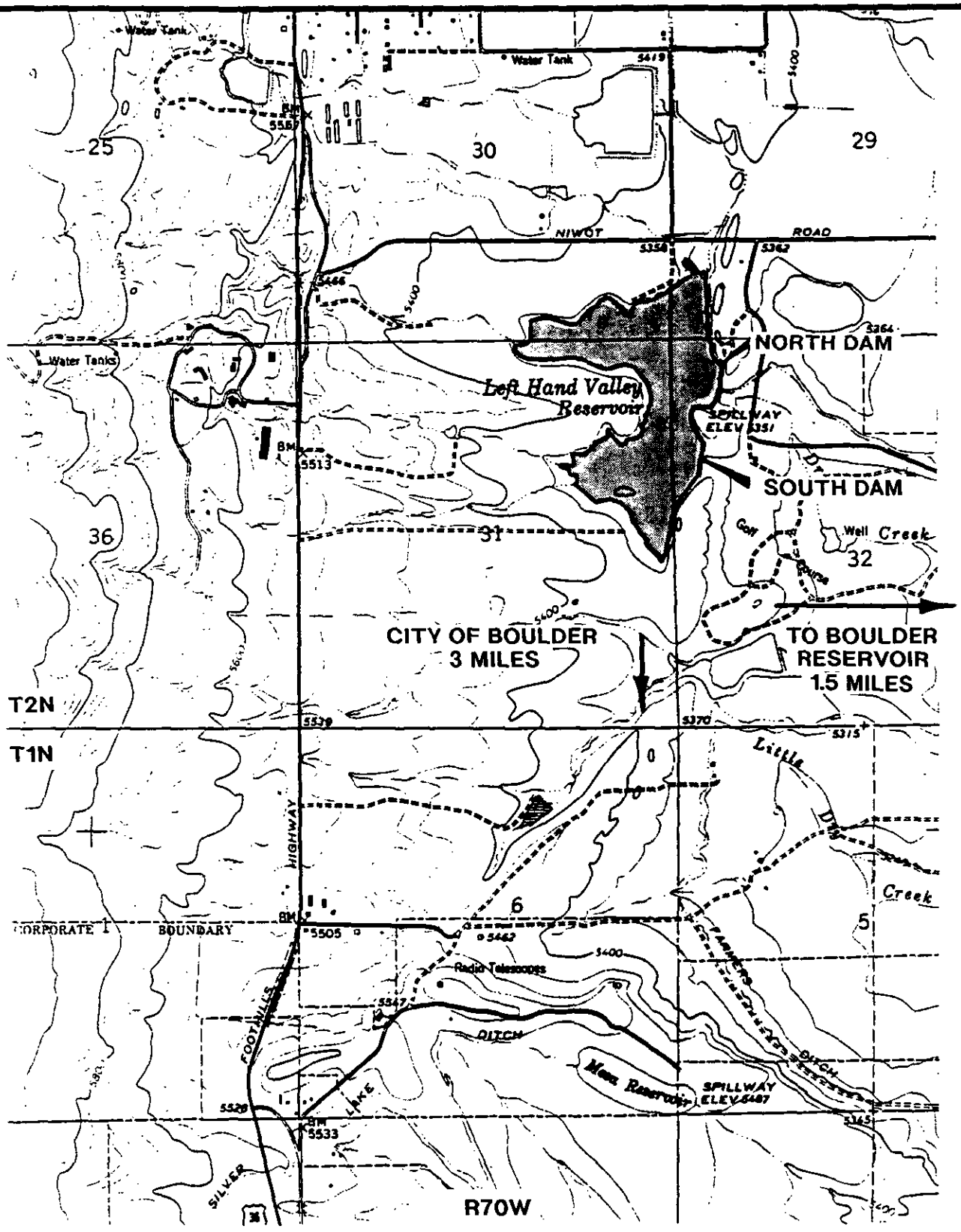


BASE MAP: TOPOGRAPHIC MAP, BOULDER QUADRANGLE
7.5 MINUTE SERIES

N

0 1000' 2000'

SCALE: 1"=2000'

LEFT HAND VALLEY RESERVOIR SPILLWAY MODIFICATIONS	RMC
LEFT HAND VALLEY RESERVOIR LOCATION	FIGURE:
LEFT HAND DITCH COMPANY	III–1

According to the rules and regulations of the Office of the State Engineer, Class 1 - Intermediate dams must be able to pass the runoff from a design storm of 75 percent of the Probable Maximum Precipitation without overtopping. Hydrologic analysis (Rocky Mountain Consultants, Inc. 1993, included as Appendix D) concluded that without improvements the design flood would overtop the existing dams by approximately 2.92 feet. The purpose of this study is to determine the most feasible manner in which to provide sufficient increased spillway capacity to safely pass the design flood. Figure III-2 shows the area in the vicinity of the north dam of the reservoir, including the dam, the existing spillway, the outlet works, and the extent of the Company's property.

B. Water Demands

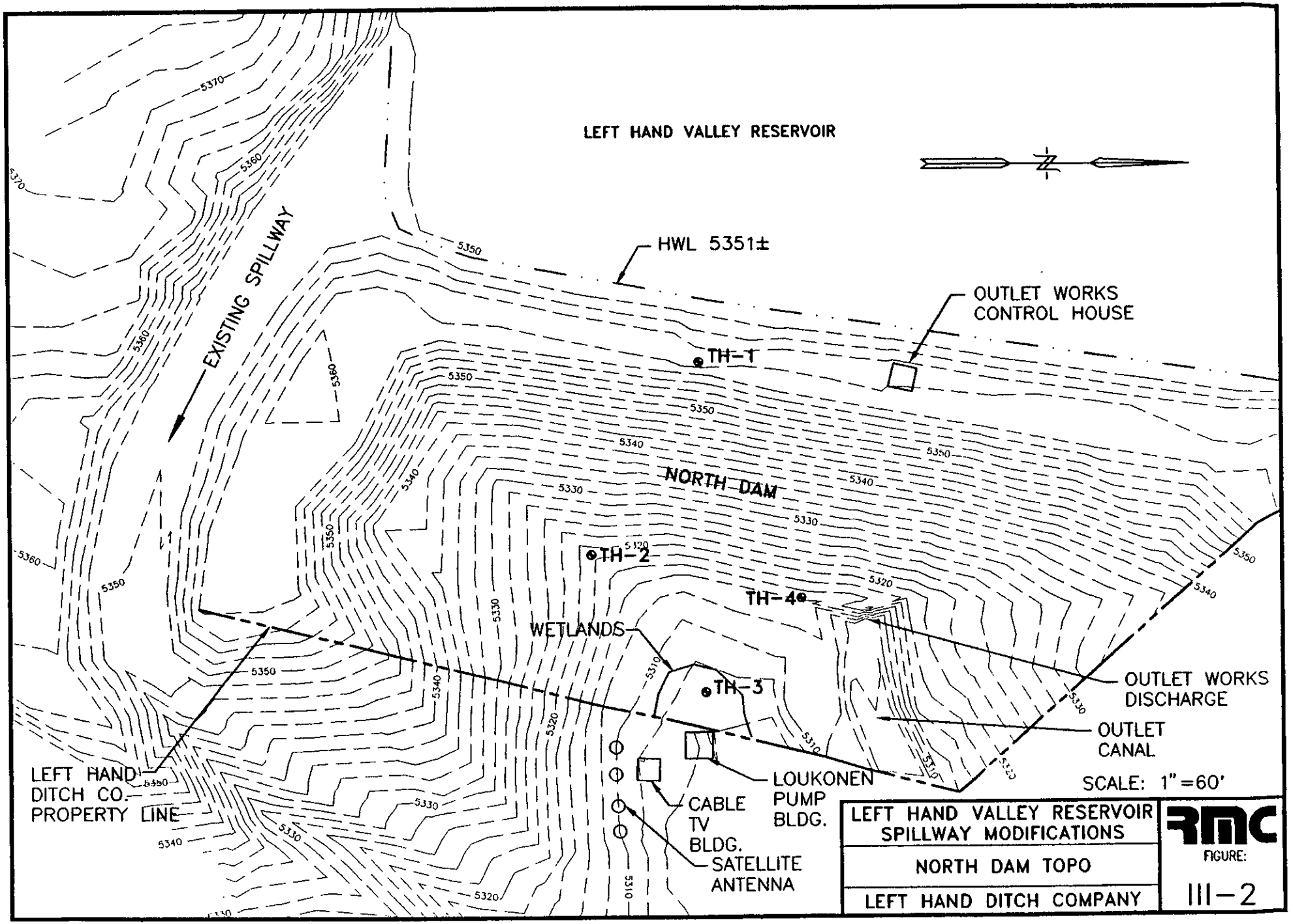
The purpose of this project is strictly limited in scope to providing additional spillway capacity at Left Hand Valley Reservoir. No additional water supplies will be developed in connection with this project. No new or increased diversions will be made from Left Hand Creek and no additional storage capacity is to be created at the reservoir.

C. Project Lands

The uses of water from Left Hand Valley Reservoir are not changing as a result of this project. This project will not broaden the Company service area and will not provide for the irrigation of any new lands.

D. Hydrology and Water Rights

The water rights of the Company are briefly described in Chapter II. This project will not provide any additional water rights or water supplies for the Company. The hydrology of importance to this project is the determination of inflow and routed outflow from 75 percent of the PMP as described in detail in Appendix D. The peak inflow to the reservoir from the design storm is 17,938 cfs.


LEFT HAND VALLEY RESERVOIR
HWL 5351±
EXISTING SPILLWAY
OUTLET WORKS CONTROL HOUSE
TH-1
NORTH DAM
TH-2
TH-4
WETLANDS
TH-3
OUTLET WORKS DISCHARGE
OUTLET CANAL
LOUKONEN PUMP BLDG.
CABLE TV BLDG.
SATELLITE ANTENNA
LEFT HAND DITCH CO. PROPERTY LINE
SCALE: 1" = 60'
LEFT HAND VALLEY RESERVOIR SPILLWAY MODIFICATIONS
NORTH DAM TOPO
LEFT HAND DITCH COMPANY
RMC
FIGURE:
III-2

E. Water Quality

There will be no water quality impacts as a result of this project, nor will there be any new water supplies developed as a part of this project for which water quality would need to be addressed. Construction dewatering will be performed in accordance with all appropriate permits.

F. Field Investigations

Field investigations to date include site inspections by the author, topographic surveys of the north dam, its environs, and the south dam crest, and a geotechnical investigation of the north dam. A copy of the topographic map prepared from the survey is included as Figure III-2. A copy of the Preliminary Geotechnical Studies report (Rocky Mountain Consultants, Inc., 1994) is included as Appendix E. The topographic survey and geotechnical investigation were conducted in order to provide a basis for design of the spillway improvements. Photographs of the Left Hand Valley Reservoir area are included in Appendix F.

Chapter IV - Formulation of Alternatives

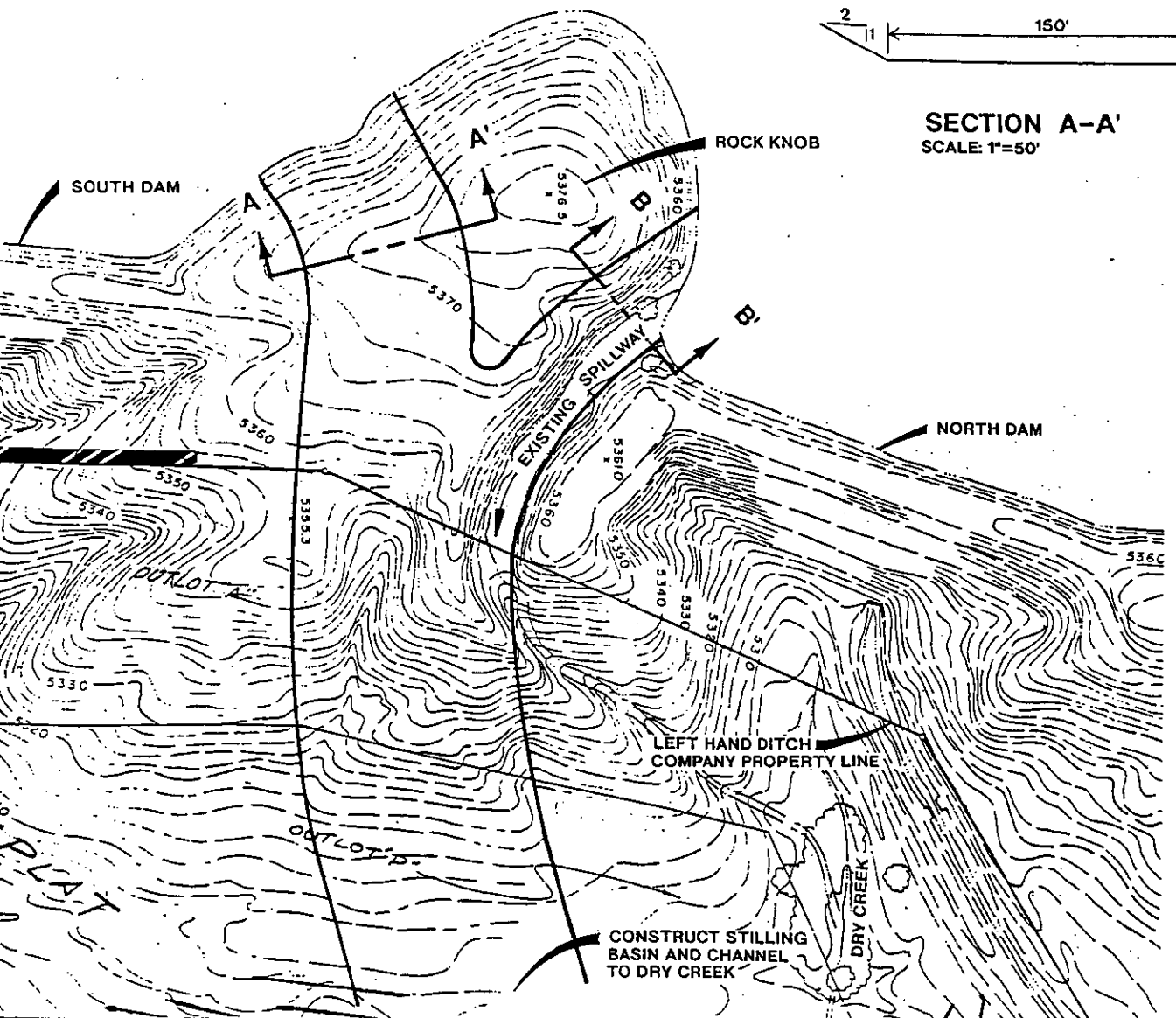
There are three basic structural alternatives (with several variations each) and one nonstructural alternative to providing the required additional spillway capacity at Left Hand Valley Reservoir. The first structural alternative is to widen the existing spillway sufficiently to pass the design flood. The second structural alternative is to construct an additional spillway which in concert with the existing spillway would provide a total capacity sufficient to pass the design flood. The third structural alternative is to lower the top of the north dam and make it overtoppable. The nonstructural alternative is essentially a "do nothing" alternative leaving the existing spillway in place and not providing any additional spillway capacity. Each plan is described in detail in the following sections.

A. Plan A - No Action

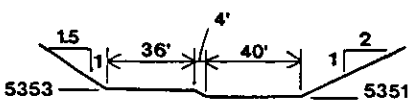
A non-structural alternative to providing additional spillway capacity is to do nothing. If ordered improvements to the spillway capacity are not completed the SEO would impose a storage restriction on the reservoir. Because of the magnitude of the design storm the storage restriction could effectively require the complete breach of the dam and loss of the storage reservoir.

B. Plan B - Widening the Existing Spillway

The existing spillway is located in a cut through the south abutment of the north dam forming Left Hand Valley Reservoir. It is trapezoidal in shape with a bottom width of approximately 30-40 feet and side slopes of 2:1 horizontal to vertical. The south abutment of the north dam, which is also the north abutment of the south dam is a bedrock knob approximately 450 feet across from one dam to the other. The knob has an elevation at the top of 5,376 feet, or 18 feet above the tops of the dams and 25 feet above the spillway crest. Figure IV-1 shows the two dams and the knob between them.



SECTION A–A'
SCALE: 1"=50'



SECTION B–B'
SCALE: 1"=50'

0 50' 100'
SCALE: 1"=100'

LEFT HAND VALLEY RESERVOIR SPILLWAY MODIFICATIONS	RMC
WIDENING OF THE EXISTING SPILLWAY	FIGURE:
LEFT HAND DITCH COMPANY	IV–1

Plan B would require an excavation through the knob to provide a total spillway crest width of 230 feet (see Appendix D, Results). Because of the height of the knob and the resulting depth of cut it would be most economical to divide the excavation into two channels, one on each side of the knob, leaving the highest prominence of the knob intact and reducing the volume of excavation. Figure IV-1 shows the configuration of the two channels which combined provide a total width of 230 feet. The two channels would join at the east side of the knob and a concrete crest wall would be constructed to define the spillway crest. Below the crest a chute would be excavated down the east slope of the knob terminating at an excavated stilling basin. A channel would be excavated to convey the flow from the basin northeast away from the residential subdivision and toward the natural drainage of Dry Creek. The side slopes of the chute, the stilling basin and the outflow channel would be protected from erosion by placement of riprap. The floor of the chute would be excavated to bedrock which is anticipated to be near the ground surface and would not be anticipated to require erosion protection.

C. Plan C - Constructing a New Spillway

The primary element of this plan is the construction of a new spillway sized to provide enough additional capacity such that the total spillway capacity (the combined capacities of the existing and new spillways) would be sufficient to safely pass the design flood. The spillway would be constructed over the north dam of the reservoir to convey the additional discharge from the reservoir to the natural drainage located directly below the dam. Since the spillway would be constructed over the dam embankment it will have to be erosion resistant, which on the 2.25:1 embankment face slope will require concrete construction. The concrete can be a traditional formed concrete chute and stilling basin or a roller compacted concrete chute and stilling basin. For reasons explained in Chapter V, Section C.2 a formed spillway is not technically feasible for this site.

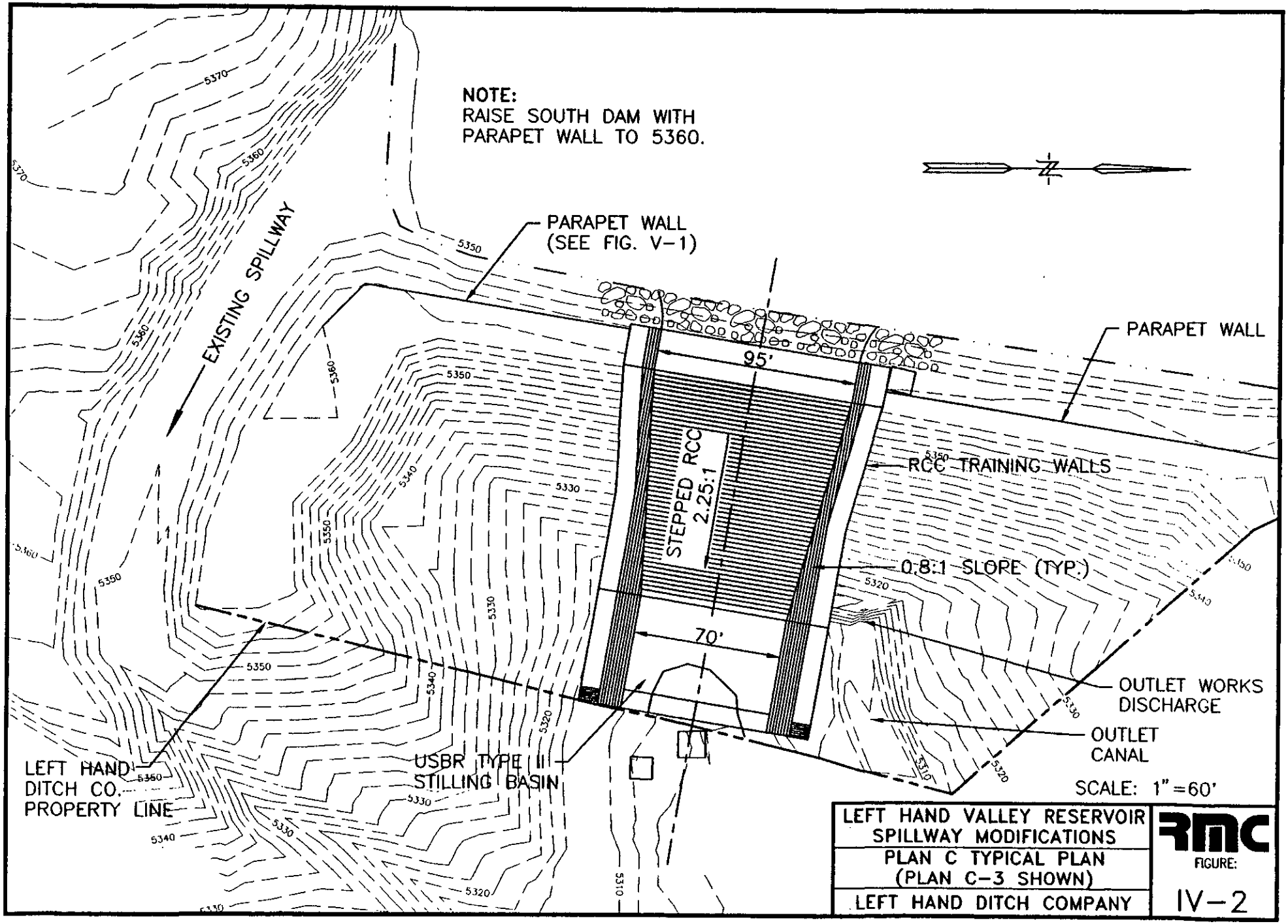
The flowline crest width of the new spillway depends on the elevation of the crest and the head of the water stored in surcharge storage in the reservoir. A small increase in head can cause a significant decrease in the spillway width required to pass the same flow rate. In order to increase the head and decrease the spillway width the dams would have to be raised. This can be

accomplished by placement of additional fill material on the dams or by construction of parapet walls along the upstream crests of the dams. Fill material will have to meet embankment specifications and will be subject to the SEO rules regarding crest width which will be narrowed by placing additional fill. The parapet wall can be a simple conventional concrete retaining wall which will provide additional surcharge storage without narrowing the dam crests. A detailed discussion of these elements is included in subsequent sections. For reasons explained in Chapter V, Section C.3, placement of fill for raising the dams is not a feasible option at this site. The parapet wall concept is considered in the new spillway alternatives.

The most significant narrowing of the new spillway occurs when the flowline crest is constructed at an elevation lower than the existing spillway and a fuse plug embankment is constructed across the new spillway. The fuse plug will cause the existing spillway to be used initially. When the surcharge storage is great enough the fuse plug would overtop, erode away, and open up the full capacity of the new spillway. With the fuse plug eroded out of the spillway channel the capacity can be very large because of the greatly increased head. For reasons explained in Chapter V, Section C.4, a fuse plug spillway constructed on an RCC spillway floor located below the normal high water line of the reservoir is not feasible and is not included for further consideration for this project.

Based on the preceding discussions, Plan C is reduced to the consideration of the required size of an RCC spillway to be constructed over the north dam of Left Hand Valley Reservoir. The following is a brief list of the major components of the preliminary design of an Plan C spillway as shown in Figures IV-2 and IV-3.

- An upstream crest section at elevation 5,351 will be constructed of two layers of roller compacted concrete each one foot thick to form the floor of the spillway. A cutoff wall consisting of three layers of RCC, nine feet wide and one foot thick will be placed in an excavated trench at the upstream end of the RCC floor. The layers of RCC used to form



LEFT HAND VALLEY RESERVOIR SPILLWAY MODIFICATIONS	RMC
PLAN C TYPICAL PLAN (PLAN C-3 SHOWN)	FIGURE:
LEFT HAND DITCH COMPANY	IV-2

the floor will probably be bonded to resist sliding due to the drag force exerted by the flow of water. Side walls of RCC sloping back at 0.8:1 slopes will be formed by the successive placement of layers of RCC up to the top of the dam, or parapet wall if used. Riprap on a granular bedding would be placed to protect the approach section of the spillway excavation from erosion. Grading and riprap/bedding of the upstream face of the dam would be performed to create satisfactory hydraulic approach conditions. A fuse plug/maintenance road will be constructed on the spillway crest to cause floods of less than one in one hundred year recurrence to be carried in the existing spillway..

- A roller compacted concrete chute section will be constructed in an excavation on the face of the dam. The stepped chute will be formed by placement of horizontal layers of RCC in eight to nine foot widths, one foot thick. Each layer will be set 2'-3" back from the previous layer to form a 2.25:1 stepped spillway. Training walls of RCC approximately six to eight feet in height, measured normal to the slope, and sloped at 0.8:1 will be formed integrally with the chute by placement of successive layers of RCC. A graded gravel filter drain with collection pipes underneath the concrete chute will be installed to provide positive drainage. Backfill may be placed in the new RCC chute section to provide a maintenance road for access to the dam crest. During a large discharge over the spillway the backfill material will be eroded out of the channel

- A roller compacted concrete stilling basin will be provided at the bottom of the RCC chute and will be constructed integrally with the chute and training walls. A cutoff wall will be constructed at the downstream end of the stilling basin to prevent undercutting of the basin under design flows. The cutoff wall would be necessary because downstream improvements to prevent channel erosion, such as riprap, would have be constructed on property owned by others. It is anticipated that the cutoff wall will be constructed of drilled concrete caissons or driven piles, taken down to sound bedrock, to prevent damage from local scour downstream of the stilling basin.

- A conventional concrete parapet wall of varying height (depending on the specific plan alternative) will be constructed along the upstream crests of both dams, to each abutment and to the training walls of the new RCC spillway section. The parapet wall can increase the head available by one to three feet, reducing the required width of the spillway.

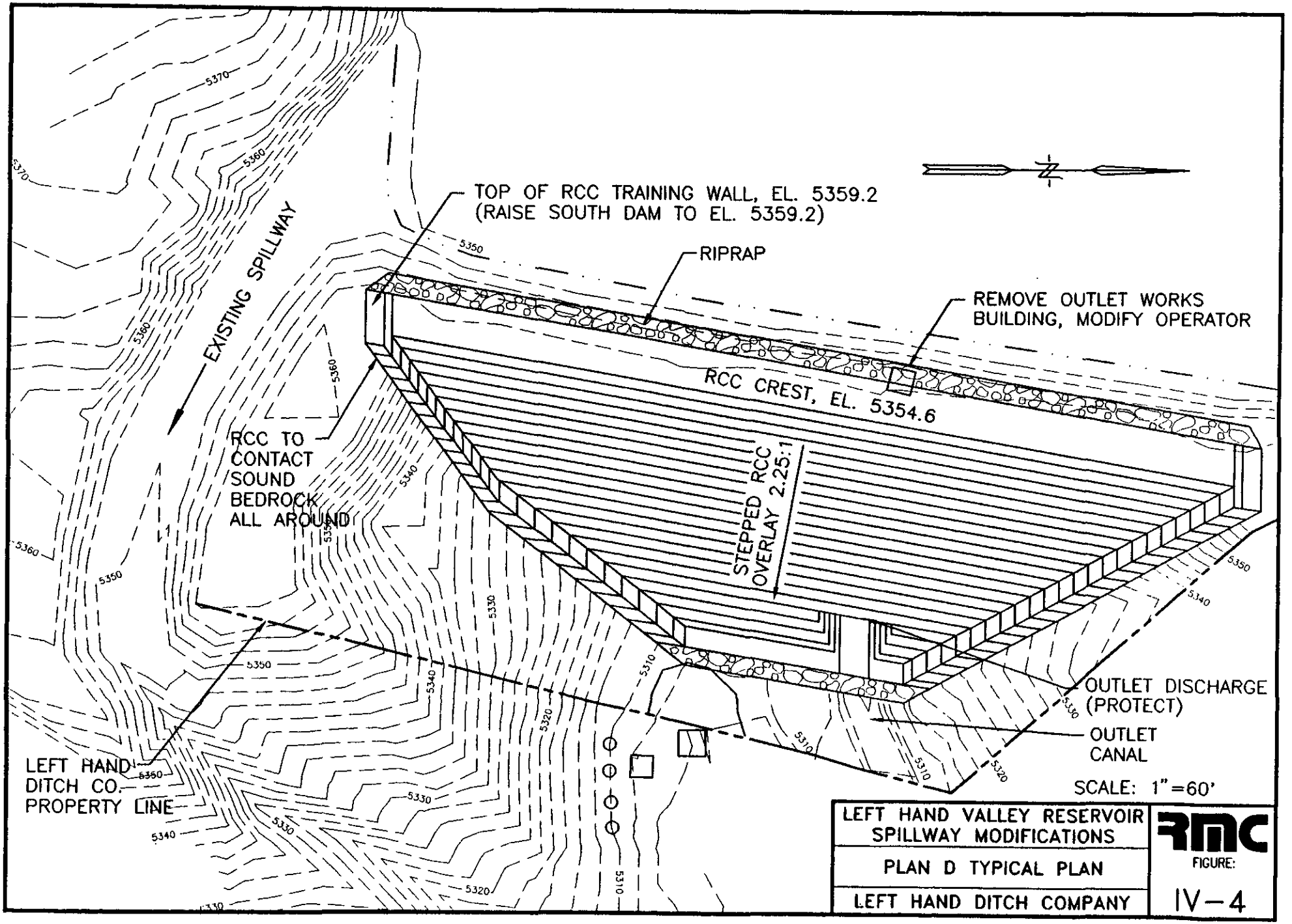
The following sizing alternatives for Plan C are evaluated in Chapter V:

Plan	Spillway Width (feet)	Maximum Discharge (cfs)	Parapet Height (feet)	Max. Water Surface Elevation
C-1	200	10,988	0	5,358
C-2	140	9,409	1	5,359
C-3	95	7,625	2	5,360
C-4	65	6,053	3	5,361

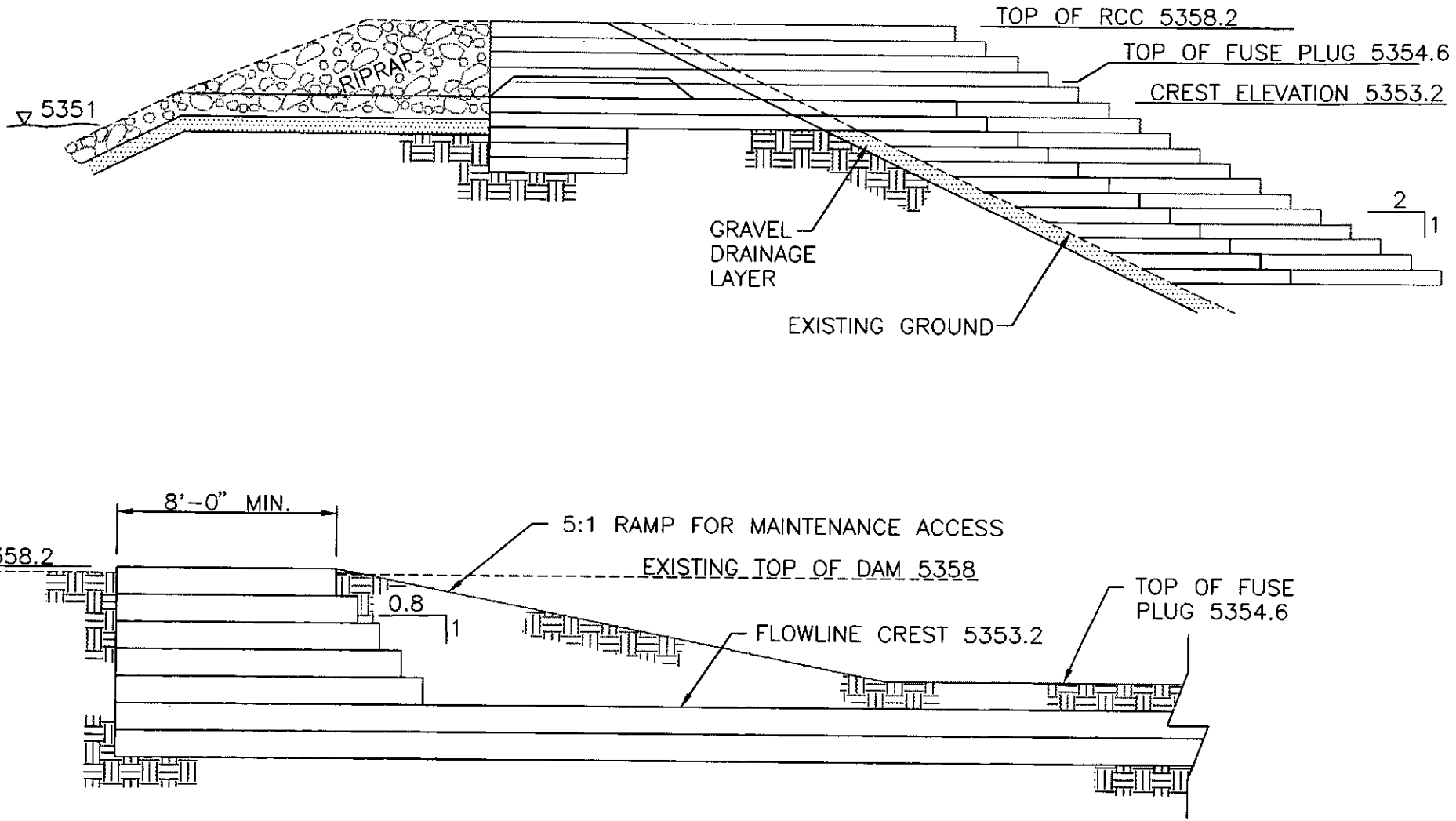
D. Plan D - Overtopping Protection for the North Dam

Plan D alternatives generally consist of constructing a nonerodable facing for the north dam of the reservoir as shown in Figures IV-4, IV-5 and IV-6. A stepped RCC facing would allow the entire dam to be overtopped during an extreme hydrologic event without damage. By utilizing the entire dam width the overtoppable dam crest could be situated at an elevation above the existing spillway, or a fuse plug could be constructed, causing more frequent spillway flows to proceed out of the existing spillway. Plan D-1 has the spillway crest placed at the 100-year flood level of the reservoir assuming the existing spillway is to function alone up to the 100-year flood. In Plan D-2 the spillway crest is 1.4 feet lower than the 100-year flood level and a fuse plug would be constructed on the spillway crest to a height equal to the 100-year flood level.

Hydrologic analysis of Plan D-1 shows that the top of the north dam can be reduced to elevation 5,354.6 without the design flood overtopping the south dam if the south dam is raised



LEFT HAND VALLEY RESERVOIR SPILLWAY MODIFICATIONS	RMC
PLAN D TYPICAL PLAN	FIGURE:
LEFT HAND DITCH COMPANY	IV–4



SCALE: 1"=10'

CREST SECTION
NOT TO SCALE

LEFT HAND VALLEY RESERVOIR SPILLWAY MODIFICATIONS	RMC
PLAN D-2 CROSS SECTION	FIGURE:
LEFT HAND DITCH COMPANY	IV-6

to elevation 5,359.2. All flood flows up to the one in 100 year flood would be carried by the existing spillway exclusively. The north dam/spillway would be overtopped only for storms with recurrence intervals greater than one in one hundred years.

Providing the same protection, without raising the south dam, is accomplished in Plan D-2 which will have the RCC overtopping section on the north dam constructed to an elevation of 5,353.2 feet. A fuse plug with a crest elevation of 5,354.6 will be constructed on the RCC spillway floor. The RCC section will be low enough so that the head available between the RCC floor and the top of the south dam at elevation 5,358 will be sufficient to pass the design flood through the reservoir without overtopping the south dam.

The RCC overlay for both plans will be constructed to sound rock at the abutments and along the toe of the north dam, thus protecting the overlay from undercutting. The cutoff to the bedrock at the toe of the dam can be constructed from RCC unless the excavation is too deep in which case a concrete curtain wall will be constructed underneath the first RCC layer. Because of the protection afforded by the RCC contact with the bedrock around the perimeter of the dam there will be no need for a traditional stilling basin. A certain amount of riprap protection will be provided at the toe to reduce nuisance erosion from small overflow events and rain falling on the face of the dam.

Chapter V - Evaluation of Alternatives

A. Plan A - No Action

Inquiry was made to the State Engineer's Office to determine what action would be taken if the Company did nothing to increase the spillway capacity at Left Hand Valley Reservoir. The Dam Safety Branch responded that storage would have to be restricted to the level at which the reservoir could store and pass the 75 percent PMP design flood through the existing spillway without overtopping the dams. Analyses using HEC-1 were made with various starting reservoir contents to find the storage level at which the flood could be safely routed through the reservoir. The analyses showed that even if the reservoir was at the dead storage level at the start of the flood, the dams would be overtopped by about one foot. Therefore, the SEO could order that the north dam be breached, causing complete loss of the reservoir as a storage facility. A complete breach would involve the removal of approximately 32,000 cubic yards of material at a cost of approximately $64,000-$96,000. The loss of the value of the storage facility (assuming a replacement value of $4,000 per acre-foot) would be about $6,400,000. Because of the possible complete loss of the reservoir Plan A is not considered to be feasible.

B. Plan B - Widening the Existing Spillway

As mentioned previously, the existing spillway is an excavation through the rock knob which forms the south abutment of the north dam. Because it is located between the two dams the knob also forms the north abutment of the south dam. The knob is located immediately west of the main road into the nearby residential subdivision and golf course and features very prominently in the local vistas. Excavation through the knob would drastically affect the view, replacing the natural contours with a dramatic cut at the crest of the spillway and the artificial contours of the chute down the side of the hill. When contacted, the Lake Valley Homeowners Association officers confirmed their concern over the appearance the spillway enlargement project.

The Company's property skirts the knob just below the level of the tops of the two dams. Therefore, to widen the existing spillway would require the purchase of a relatively large tract of land now owned in common by the Homeowners Association. The Association officers reported that any sale of commonly owned property would have to be approved by 75 percent of the mortgage holders or title holders of the 157± lots within the subdivision. This approval, if it could be obtained at all, would likely be time consuming and could be expensive because of meetings, paying the Association's expenses for a right-of-way agent and their attorney, preparing exhibits, etc. It is our opinion that the typical homeowner in the subdivision would not react favorably to locating the spillway by excavating through the rock knob and therefore would not support the sale of property to the Company.

The financial feasibility appears to be no better, and could be much worse, than the Plan C and Plan D alternatives discussed in subsequent sections of this report. The construction estimate for Plan C-3b (the cheapest alternative) is approximately $384,000 (Table V-2). In order for the excavated spillway to be more feasible it must cost less. Preliminary estimates indicate Plan B would require approximately 60,000 to 70,000 cubic yards of excavation, $100,000 worth of riprap for the stilling basin and for the berm guiding the flow away from the developed area to the natural drainage in the northeast, and an allowance of $50,000 for construction of the concrete spillway crest, revegetation and other miscellaneous construction expenses. Plan B also has an associated unknown condition, the possible existence of hard rock excavation required when cutting through the knob and down the chute. The cost of excavation of the 60,000 to 70,000 cubic yards of material could vary dramatically depending on the nature of the material to be removed, especially if blasting is required. Subtracting the estimated $150,000 for riprap, concrete and miscellaneous expenses from a maximum of $384,000 (to be no more expensive than Plan C-3b) leaves $234,000 for all earthwork - including excavation, placement of excavated material as fill, and disposal of excess material or about $3.35 to $3.90 per cubic yard.

We believe that the cheapest at which excavation alone could be accomplished would be assuming that 70 percent of the material to be removed could be easily handled with standard

equipment (at a cost of $2.00 per cubic yard), that 30 percent would require ripping with a single tooth dozer (at a cost of $3.00 per cubic yard), and that no blasting would be required. The cost of this type of excavation alone would be approximately $2.30 per cubic yard leaving at most $1.05 to $1.60 per cubic yard for placement of compacted fill in the berm, hauling the excess material to waste and any other earthwork expenses. If blasting is required (at a typical cost in excess of $8.00 per cubic yard) the excavation costs could increase tremendously beyond those estimated above. Therefore, we believe that widening the existing spillway would be at least as costly as the Plan C alternatives and could potentially be much more expensive. We believe that the social and financial aspects of this alternative are each sufficient to make it infeasible and when combined are sufficient to make this alternative not worthy of further consideration.

C. Plan C - Constructing a New Spillway

C.1 General

For the following reasons, the best location for a new spillway is over the north dam of the reservoir.

- It can be located entirely on Company property,
- It is as far removed as possible from the residential subdivision,
- It is located as far back from the main road as possible,
- It is somewhat screened by trees, and
- It is located in the natural drainage where flood flows would proceed if there were no dam.

The new spillway can be built of formed concrete or roller compacted concrete. To reduce the spillway crest width, and minimize the cost of the structure, the head on the spillway should be maximized. This can be accomplished by raising the dams through the placement of additional fill, construction of a parapet wall, or a combination of both. The spillway width can be minimized by utilizing a fuse plug constructed on the concrete spillway floor. The lower the spillway floor elevation the greater the head available and the narrower the required crest width.

The following three subsections of this report describe three options available when considering the construction of a new spillway: 1) the construction material, 2) the effect of raising the dams (and therefore the maximum flood storage level) on the spillway width required, and 3) the possible inclusion of a fuse plug in the new spillway.

C.2 Formed Concrete vs. Roller Compacted Concrete

The dimensions of Plan C-3 are used for a basis of comparison between a formed concrete spillway (Plan C-3a) and a stepped RCC spillway (Plan C-3b). Hydraulic calculations show that velocities on a 2.25:1 formed concrete chute, using n=0.008 (Design of Small Dams, pg. 384), would be approximately 52.6 feet per second, for a discharge of 7,625 cfs and width of 95 feet converging to 70 feet (Plan C-3a). The depth of flow entering the stilling basin would be approximately 1.9 feet and the Froude number would be approximately 6.7 The conjugate depth for determining the depth of the stilling basin would be 17.2 feet and the stilling basin (assuming USBR Type II Basin) would be 72 feet in length. The longest basin which will fit within the property is about 55 feet. The physical restriction imposed by the Company's property on the size of the stilling basin makes the use of formed concrete less desirable. Dam safety could still be adequately provided with the shorter stilling basin, but downstream hydraulics would not be optimal. Before dismissing this option because of the stilling basin length requirement a cost estimate was made. If the cost is favorable compared to other alternatives a formed concrete spillway could be feasible. Table V-1 shows that Plan C-3a using formed concrete would require a budget of approximately $594,500.

For the same flow on a stepped RCC spillway the velocity (using n=0.033 per the USBR McClure Dam modeling results) would be 42.5 feet per second, the depth entering the stilling basin would be 2.4 feet, the Froude number would be 4.88, the conjugate depth would be 15 feet, and the Type II stilling basin length would be 58.5 feet, much closer to the space available. The hydraulic characteristics of the RCC spillway make it more technically feasible for this site than the formed concrete spillway. As will be discussed in a later section the cost of Plan C-3b using roller compacted concrete is also less than the same configuration constructed of conventional formed concrete. For these reasons roller compacted concrete construction is more feasible than conventional formed concrete construction for this alternative.

Table V-1

Construction Cost Estimate
Left Hand Valley Reservoir Spillway Modifications

Plan C-3a
95 ft Formed Concrete Spillway with Dam Raise to 5,360

Item	Description	Unit	Quantity	Unit Cost	Total Cost
1.	Mobilization	L.S.			$25,000
2.	Site Preparation	L.S.			$2,500
3.	Excavation	C.Y.	3952	$2.00	$7,904
4.	Gravel Drain	Tons	382	$15.00	$5,730
5.	Formed Concrete	C.Y.	1078	$300.00	$323,400
6.	Concrete Parapet Wall	C.Y.	216	$350.00	$75,600
7.	Fuse Plug	C.Y.	196	$10.00	$1,960
8.	Class 6 Roadbase on Fuse Plug	Tons	26	$10.00	$260
9.	Riprap and Bedding	Tons	240	$15.00	$3,600
10.	Revegetation	Acres	3	$2,500.00	$7,500
11.	24" Caisson Toe Wall	FT	680	$25.00	$17,000
	Subtotal Construction Cost				$470,454
12.	Construction Engineering	L.S.			$25,000
	Subtotal Construction and Engineering				$495,454
13.	Contingencies @ 20%				$99,091
	Total Budget Estimate				**$594,545**

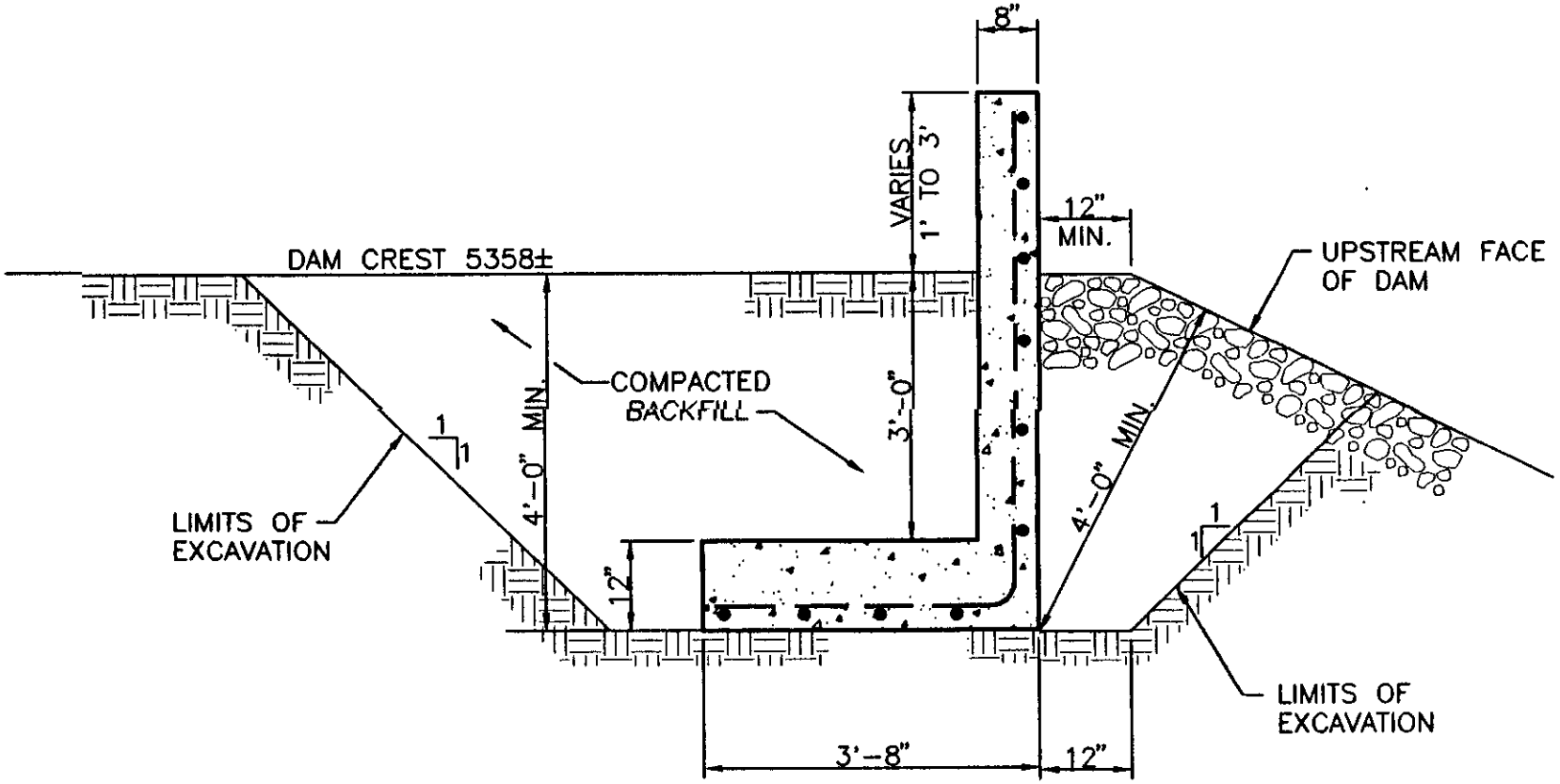
C.3 Raising the Dams

Raising the dams, which increases the head on the spillway and increases the surcharge storage in the reservoir, has a dramatic effect on the required width of the spillway. Hydraulic analysis using HEC-1 shows the following relationship between maximum reservoir level (head) and the required spillway width for Left Hand Valley Reservoir.

Maximum Reservoir Water Surface Elevation	Required Width of New Spillway (feet)
5,358 (Existing Top of Dams)	200
5,359	140
5,360	95
5,361	65

The crests of the dams at Left Hand Valley Reservoir average approximately 18 feet in width. The minimum crest width for dams according to the SEO rules and regulations is 10 feet plus the vertical height of the dam divided by 5. For the dams at Left Hand Valley, which have a vertical height of approximately 45 feet, the minimum crest width is 19 feet. The SEO has indicated that they will allow some latitude regarding width, but that the crests should not be narrower than 15 feet in any case. However, placement of even one foot of fill with 3:1 side slopes on an 18 foot wide crest would reduce the top width to 12 feet, three feet less than the State's indicated minimum and seven feet less than the regulation requires.

Additional dam height can be achieved without narrowing the dam crests below the SEO minimum by constructing a vertical parapet wall near the upstream crest. The parapet wall will be constructed of formed reinforced concrete. The estimated cost of this type of wall would be approximately $350 per cubic yard. The cost of the parapet wall must be compared to the corresponding reduction in cost of the spillway to determine the best combination of wall height and crest width. A typical parapet wall is shown in Figure V-1.



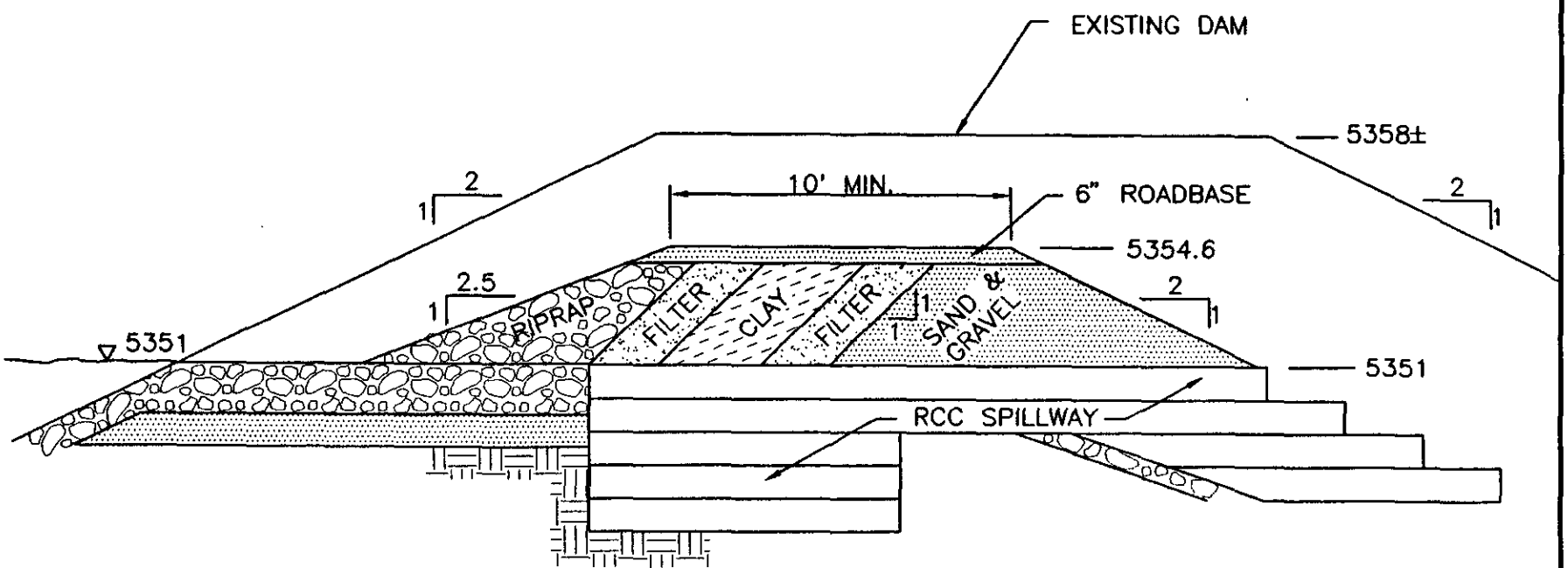
SCALE: 1/2" = 1'

LEFT HAND VALLEY RESERVOIR SPILLWAY MODIFICATIONS	RMC
PARAPET WALL DETAIL	FIGURE:
LEFT HAND DITCH COMPANY	V-1

C.4 Fuse Plug Spillway

A fuse plug spillway has the advantage of having the shortest crest width for any type of spillway which can be constructed. As discussed previously, this is due to the greatly increased head available after the fuse plug is eroded from the spillway section. If the spillway crest is located below the normal reservoir level (to have a greater head and smaller width) the fuse plug itself must function as a dam, preventing leakage out of the reservoir. Once it is overtopped in a large flood it must erode away to open up the full spillway cross section. However, if excess leakage through the fuse plug develops with a full reservoir a piping failure of the plug could occur. Thus, the uppermost contents of the reservoir could be released at a very high rate through the spillway without the occurrence of a severe hydrologic event. If the fuse plug does not function as required and erode properly the dams could be overtopped during a severe hydrologic event. These uncertainties and risks are sufficient to make any fuse plug alternative with the spillway crest below the normal high water line unacceptable.

A fuse plug may still be used effectively for causing more frequent runoff to be discharged through the existing spillway. If the new spillway flowline crest is set at elevation 5,351 (the same as the existing spillway) the fuse plug would have to be 3.6 feet high to cause the existing spillway to be used for all floods up to the 100-year storm. Only greater storms would overtop the fuse plug and flow out of both the existing and new spillways. Because this type of fuse plug would not be required to function as a dam holding back the reservoir, except for short durations during storm events, prevention of leakage would not be as critical a design parameter. The design could focus more on assuring that the fuse plug would fail when overtopped and required to do so. A typical fuse plug cross section is shown in Figure V-2.



SCALE: 1"=5'

LEFT HAND VALLEY RESERVOIR SPILLWAY MODIFICATIONS	RMC
FUSE PLUG DETAIL	FIGURE:
LEFT HAND DITCH COMPANY	V-2

C.5 Plan C-1, 200 ft RCC Spillway

A new spillway would have to have a 200 foot crest width to pass a peak flow of 10,988 cfs if constructed with a 5,351 crest elevation and with no raise of the dams. The width available below the dam for locating the stilling basin is not greater than about 80-90 feet which would necessitate too great a convergence (in excess of 6-12 degrees) of the training walls for reasonable performance of the chute and stilling basin. The maximum convergence based on the hydraulic characteristics of the chute is approximately 5-15 feet per side or 10-30 feet total. Therefore, this alternative is not considered to be technically feasible.

C.6 Plan C-2, 140 ft RCC Spillway

If a parapet wall is used to raise the maximum reservoir level to elevation 5,359 feet, increasing the spillway capacity and enhancing the flood routing capacity of the reservoir, the crest width can be reduced to 140 feet. The required stilling basin width based on reasonable convergence for this spillway is also greater than the space available. Therefore, this alternative is also considered to be technically infeasible.

C.7 Plan C-3b, 95 ft RCC Spillway

Raising the dams two feet with a parapet wall to elevation 5,360 improves the spillway capacity and reservoir routing capacity such that a 95 foot crest width is sufficient to safely pass the runoff from the design storm. Converging the chute to 70 feet wide at the stilling basin will allow the basin to be located in the available space without compromising the performance of the chute or stilling basin. As shown in Table V-2 this alternative will require 3,532 cubic yards of RCC in the crest, chute and stilling basin. The parapet wall will contain 209 cubic yards of conventional concrete and would be approximately 805 feet in length across the crests of both dams. The total estimated construction cost of Plan C-3b is $383,637. Construction engineering fees estimated at $25,000 and contingencies at 20 percent raise the estimated budget required for construction to $490,400.

Table V-2

Construction Cost Estimate
Left Hand Valley Reservoir Spillway Modifications

Plan C-3b
95 ft RCC Spillway with Dam Raise to 5,360

Item	Description	Unit	Quantity	Unit Cost	Total Cost
1.	Mobilization	L.S.			$25,000
2.	Site Preparation	L.S.			$2,500
3.	Excavation	C.Y.	7718	$2.00	$15,436
4.	Gravel Drain	Tons	905	$15.00	$13,575
5.	Roller Compacted Concrete	C.Y.	3532	$60.00	$211,920
6.	Backfill RCC Chute 12"	C.Y.	902	$3.00	$2,706
7.	Concrete Parapet Wall	C.Y.	209	$350.00	$73,150
8.	Fuse Plug	C.Y.	196	$10.00	$1,960
9.	Class 6 Roadbase on Fuse Plug	Tons	26	$10.00	$260
10.	Riprap and Bedding	Tons	417	$15.00	$6,255
11.	Revegetation	Acres	3	$2,500.00	$7,500
12.	24" Caisson Toe Wall	FT	935	$25.00	$23,375
	Subtotal Construction Cost				$383,637
13.	Construction Engineering	L.S.			$25,000
	Subtotal Construction and Engineering				$408,637
14.	Contingencies @ 20%				$81,727
	Total Budget Estimate				**$490,364**

Construction of this alternative will require the loss of a very small (0.049 acres) wetlands area located where the stilling basin will be constructed. The Company is seeking the Corps of Engineers agreement that this alternative is within the scope of repairs to facilities and therefore does not need a 404 permit. We anticipate that a permit can be obtained should the Corps disagree with the request and require that a permit be issued for the construction.

C.8 Plan C-4, 65 ft RCC Spillway

An additional one foot of parapet wall, increasing the maximum reservoir water surface elevation to 5,361, further reduces the required spillway width to 65 feet. This reduces the RCC quantity but increases the size and cost of the parapet wall. The stilling basin will be the same width as the chute since the length increases as the width decreases. As shown in Table V-3 this alternative will require 3,275 cubic yards of RCC in the crest, chute and stilling basin. The parapet wall will contain 286 cubic yards of conventional concrete and will be approximately 1,000 feet in length across the crests of both dams and along the existing spillway. The total estimated construction cost of Plan C-4 is $384,992 and the estimated budget including construction engineering and contingencies is $492,000. This alternative has the same wetlands issue as Plan C-3.

D. Plan D - Overtopping Protection for the North Dam

D.1 Plan D-1, 400 ft RCC Overtopping Section with Raise of the South Dam

Providing erosion protection so that the dam remains intact during overtopping requires a much greater quantity of RCC than the RCC spillway alternatives evaluated in Section C. The RCC forms an overlay on the crest and entire downstream face of the dam. However, the required raise of the South Dam is smaller and costs less than constructing the parapet walls to be built with the Plan C alternatives. Table V-4 provides details of the cost estimate of Plan D-1 which totals $596,400 with construction engineering and contingencies. Because the overlay is located on the face of the dam and there is no stilling basin it might be possible that this plan will not disturb the wetlands adjacent to the Company's property line. However, protecting the wetland area may reduce the site access and equipment maneuvering room enough to impact the cost of the alternative.

Table V-3

Construction Cost Estimate
Left Hand Valley Reservoir Spillway Modifications

Plan C-4
65 ft RCC Spillway with Dam Raise to 5,361

Item	Description	Unit	Quantity	Unit Cost	Total Cost
1.	Mobilization	L.S.			$25,000
2.	Site Preparation	L.S.			$2,500
3.	Excavation	C.Y.	6090	$2.00	$12,180
4.	Gravel Drain	Tons	747	$15.00	$11,205
5.	Roller Compacted Concrete	C.Y.	3275	$60.00	$196,500
6.	Backfill RCC Chute 12"	C.Y.	769	$3.00	$2,307
7.	Concrete Parapet Wall	C.Y.	286	$350.00	$100,100
8.	Fuse Plug	C.Y.	134	$10.00	$1,340
9.	Class 6 Roadbase on Fuse Plug	Tons	22	$10.00	$220
10.	Riprap and Bedding	Tons	326	$15.00	$4,890
11.	Revegetation	Acres	3	$2,500.00	$7,500
12.	24" Caisson Toe Wall	FT	850	$25.00	$21,250
	Subtotal Construction Cost				$384,992
13.	Construction Engineering	L.S.			$25,000
	Subtotal Construction and Engineering				$409,992
14.	Contingencies @ 20%				$81,998
	Total Budget Estimate				**$491,990**

Table V-4

Construction Cost Estimate
Left Hand Valley Reservoir Spillway Modifications

Plan D-1
400 ft RCC Overtopping Protection with Dam Raise to 5,359.2

Item	Description	Unit	Quantity	Unit Cost	Total Cost
1.	Mobilization	L.S.			$25,000
2.	Site Preparation	L.S.			$2,500
3.	Excavation	C.Y.	4337	$2.00	$8,674
4.	Gravel Drain	Tons	2049	$15.00	$30,735
5.	Roller Compacted Concrete	C.Y.	5925	$60.00	$355,500
6.	Fill on South Dam	C.Y.	333	$3.00	$999
7.	Riprap and Bedding	Tons	908	$15.00	$13,620
8.	Revegetation	Acres	2	$2,500.00	$5,000
9.	24" Caisson Toe Wall	FT	1200	$25.00	$30,000
	Subtotal Construction Cost				$472,028
10.	Construction Engineering	L.S.			$25,000
	Subtotal Construction and Engineering				$497,028
11.	Contingencies @ 20%				$99,406
	Total Budget Estimate				**$596,434**

D.2 Plan D-2, 400 ft RCC Overtopping Section with Fuse Plug

Plan D-2 differs from D-1 in that the RCC crest elevation is lowered from 5,354.6 to 5,353.2 and a fuse plug is constructed on the RCC crest. This construction reduces the quantity of RCC required in the overtopping section and eliminates the need for raising the south dam. It requires the additional construction of a fuse plug 1.4 feet high with a top width of 10-12 feet which would function as a service roadway across the spillway floor. Table V-5 provides details of the cost estimate of Plan D-2 which totals $594,700 including construction and contingencies. This alternative has the same wetlands issue as Plan D-1.

Table V-5

Construction Cost Estimate
Left Hand Valley Reservoir Spillway Modifications

Plan D-2
400 ft RCC Overtopping Protection with Fuse Plug to 5,354.6

Item	Description	Unit	Quantity	Unit Cost	Total Cost
1.	Mobilization	L.S.			$25,000
2.	Site Preparation	L.S.			$2,500
3.	Excavation	C.Y.	5068	$2.00	$10,136
4.	Gravel Drain	Tons	2006	$15.00	$30,090
5.	Roller Compacted Concrete	C.Y.	5805	$60.00	$348,300
6.	Fuse Plug	C.Y.	251	$10.00	$2,510
7.	Class 6 Roadbase on Fuse Plug	Tons	133	$10.00	$1,330
8.	Riprap and Bedding	Tons	1050	$15.00	$15,750
9.	Revegetation	Acres	2	$2,500.00	$5,000
10.	24" Caisson Toe Wall	FT	1200	$25.00	$30,000
	Subtotal Construction Cost				$470,616
11.	Construction Engineering	L.S.			$25,000
	Subtotal Construction and Engineering				$495,616
12.	Contingencies @ 20%				$99,123
	Total Budget Estimate				**$594,739**

Chapter VI - Selection of Alternative

A. Narrative Description

Table VI-1 shows a summary of the plan alternatives examined for improving the spillway capacity at Left Hand Valley Reservoir and lists their major advantages and disadvantages. Based on the financial, institutional and social impacts Plan C-3b (a 95 foot wide roller compacted concrete spillway over the north dam, with a parapet wall raise of both dams to elevation 5,360) is selected as the preferred alternative. Plan C-3b was selected based on its structural appropriateness for the site, its cost compared to the other alternatives (the same as Plan C-4 and approximately $100,000 less than the estimated costs of Plan C-3a, Plan D-1 or Plan D-2), its reduced social impact and lack of real estate purchase requirement as compared to the Plan B alternative, and its provision for the continued use of the asset (as compared to loss of the use of the reservoir with Plan A). If the costs of the Plan D alternatives were not 20 percent greater than the Plan C alternatives they would be the favored alternatives due mainly to their simplicity.

Under Plan C-3b the new spillway will be constructed of stepped, roller compacted concrete over the north dam with a fuse plug embankment section (see Figures IV-2, IV-3 and V-2) so that only the existing spillway will be used for runoff from storms with up to one in one hundred year recurrence intervals. For storms greater than the one in one hundred year storm the fuse plug will overtop and both the existing and new spillway will discharge the flood waters. To achieve the 95 foot crest width of the new Plan C-3b spillway, a concrete parapet wall will be constructed on both dams raising the maximum water surface in the reservoir to 5,360 for short durations during extreme floods.

B. Hydraulic, Hydrologic and Structural Design Criteria

Hydraulic design criteria for roller compacted concrete is primarily limited to the consideration of roughness for use in determining flow velocity, depth and hydraulic jump depth and length. Based on the Bureau of Reclamation report, "Hydraulic Model Study of McClure

Table VI-1

Comparison of Plan Alternatives

Plan	Description	Approx. Cost	Advantages	Disadvantages
A	No Action	$96,000	Lowest construction cost.	Loss of valuable storage asset. Loss of irrigation and municipal water supply.
B	Widening of the Existing Spillway	$490,000+	Basic earthwork construction methods.	High cost if rock encountered. Possible blasting in a residential area. Possible blasting on dam abutments. Flows not easily discharged to natural drainage. Requires land acquisition. Land acquisition requires HOA approval. Impairs local vistas.
C-3a	New 95-70 ft Formed Concrete Spillway with Dam Raise to 5,360 and Fuse Plug	$595,000	Proven method. Discharges flows to the natural drainage.	Highest Cost. Requires longest stilling basin. Highest quality control required. Requires fuse plug and dam raise. Highest maintenance expected.
C-3b	New 95-70 ft RCC Spillway with Dam Raise to 5,360 and Fuse Plug	$490,000	Cost. Fast construction. Energy dissipation on steps. Uses earthwork methods. Fits the available land. Discharges flows to the natural drainage.	Requires fuse plug and dam raise. Narrow width is less efficient for RCC placement.
C-4	New 65 ft RCC Spillway with Dam Raise to 5,361 and Fuse Plug	$492,000	Cost. Fast construction. Energy dissipation on steps. Uses earthwork methods. Fits the available land. Discharges flows to the natural drainage.	Requires fuse plug and dam raise. Requires highest dam raise. Stilling basin is longer than available space. Narrow width is less efficient for RCC placement.
D-1	400 ft Overtopping Protection for North Dam with Dam Raise to 5,359.2	$596,000	No fuse plug. Simple fast construction using earthwork methods. Energy dissipation on steps. Fits the available land. Does not impact wetlands. Discharges flows to the natural drainage.	Highest cost. Requires slight dam raise.
D-2	400 ft Overtopping Protection for North Dam with Fuse Plug	$595,000	No dam raise. Simple fast construction using earthwork methods. Energy dissipation on steps. Fits the available land. Does not impact wetlands. Discharges flows to the natural drainage.	Highest cost. Requires fuse plug.

Dam Existing and Proposed RCC Stepped Spillways" published in February 1990, the roughness factor used for the stepped spillway will be n=0.033 for design based on velocity, including the stilling basin length and height. The design of the chute wall height will be based on a factor of n=0.039 for a conservative determination of flow depth. Flow depth will be approximately three feet and the chute walls will allow for approximately three feet of freeboard. To contain the hydraulic jump the stilling basin will be approximately 14 feet deep. The control section of the spillway will be the point at which the floor stops and the chute begins, where the slope suddenly changes to 2.25:1. The broad crested weir equation with a coefficient of 3.0 is adequate to describe the hydraulic characteristics of the control section.

Structural design criteria include the strength of the RCC material, and the stability of the dam and RCC section. The RCC as anticipated will have a 28 day compressive strength of 2,000 psi and a maximum aggregate size of 1.5 inches. The material will be placed using standard earthmoving equipment and standard compacted soils construction techniques. Stability analysis will be performed on the dam including the RCC section, however, no difficulties are expected due to the history of this type of construction. The gravel drainage layer to be provided underneath the RCC section will relieve any uplift pressures which might otherwise develop and will substantially improve the stability of the structure.

Hydrologic design characteristics are the flood inflows and the reservoir routing characteristics as described in Appendix D . With the proposed parapet wall, the maximum outflow from the design storm will be 11,025 cfs. Approximately 30 percent of this total, or 3,400 cfs, will discharge through the existing spillway. The remaining 7,625 cfs will discharge through the new spillway after the fuse plug is eroded away. The fuse plug will be designed so that it begins to erode at less than one foot of overtopping and erodes completely away in a short period of time, on the order of 15 minutes.

C. Land and Right-of-Way Requirements

The Left Hand Ditch Company owns the site on which the project facilities will be constructed. During construction the Company will acquire a temporary easement from the neighboring Lake Valley Homeowners Association. The temporary easement will provide an area of approximately one acre for stockpiling construction materials, RCC batching and equipment storage. A temporary roadway easement will also be acquired to provide access to the dams from the one acre site.

D. Project Implementation Schedule

The following schedule is anticipated for implementation of this project:

Date	Action
November 1994	Approval of funding request by CWCB
Winter 1994-1995	Completion of construction plans, specifications and design reports, negotiate easement acquisitions
February 1995	Approval of stockholders at annual meeting for final contract with CWCB
Spring 1995	CWCB and SEO review of plans and specifications
May 1995	Contract with CWCB
Summer 1995	Complete plans and specifications with CWCB and SEO changes
mid-July 1995	Advertise and Bid
September 1995	Begin construction
mid-October 1995	Complete construction
November 1995	Produce as-built drawings

E. Cost Estimates

Table V-2 presented an estimate of the construction and construction engineering costs associated with the selected alternative for this project. Land acquisition, which will be limited to temporary easements for construction, is not expected to cost more than about $2,000. The design of the project, for which the Company has already contracted with Rocky Mountain Consultants, Inc. is budgeted at $59,380 which includes a 10 percent contingency factor. The cost of this feasibility study is approximately $8,500. Operation, maintenance, replacement, insurance and administration costs associated with this project are expected to be quite small because of the simple scope and type of construction. These costs are believed to be conservatively estimated at one percent per year. An inflation factor of four percent is used for these annual expenses. The following table summarizes the costs estimated for this project.

Description	Estimated Cost
Construction	$460,400 (including 20% contingency)
Construction Engineering	$30,000 (including 20% contingency)
Total Construction Costs	**$490,400**
Design Engineering (1)	$59,380 (including 10% contingency)
Feasibility Study (1)	$8,500
Land Acquisition (1)	$2,000
Total Capital Expenses	**$560,280**

(1) Project expenses not financed by CWCB Construction Fund Loan and Bank Loan

F. Financial Program

The total construction budget estimated for this project is $490,400. In order to build the project the Company is seeking funding from the CWCB for 75 percent of this total or $367,800. The remaining 25 percent, or $122,600 will be financed through a bank loan. At the present time

a commercial loan, secured with real estate, from First National Bank in Longmont is available to the Company with a 10.5 percent interest rate and a term of 15 years. More favorable terms may be obtained if a FHA guaranteed loan can be obtained. The financial program shown in this report assumes the commercial loan rate and term. The term and rate for the CWCB loan are assumed to be 30 years and 4.375 percent (based on agricultural share ownership of 63 percent and municipal/industrial share ownership of 37 percent with a four percent interest rate for agricultural ownership and a five percent interest rate for municipal/industrial ownership). At these rates and terms the combined annual payment on the two loans will be $38,830. The annual revenue and expenses for this project are shown in Table VI-2.

Repayment of the loans will be made by increasing assessments against the shares of Company stock issued and outstanding. The analysis in Table VI-2 shows the per share annual costs for repayment of the loans and for annual operating expenses for the 16,647 shares issued and outstanding. The present value of share assessments required to operate the Company and service the loan debt ranges from $5.65 per share (year 30) to $8.20 per share (year 1). In 1994 the Company raised its assessments from $5.00 per share to $7.50 per share in anticipation of the financial obligations of this project. Additional assessment increases will be made as needed to cover the expenditures of the project.

G. Institutional Considerations

The following table shows permits and agreements which may be required for the construction of this project. These are standard for this type of construction and little difficulty is foreseen in obtaining all required permits, agreements or approvals.

Assumptions	
Total Construction Cost	$490,400
Annual Operating Expenses	$94,000
Revenue from Assessments	100%
Number of Shares in Company	16,647
Inflation	4%
Interest on Reserves	6%

Financing					
Source	Share	Principal	Interest	Years	Payment
CWCB Loan	75%	$367,800.00	4.375%	30	$22,249
Bank Loan	25%	$122,600.00	10.50%	15	$16,581

Table VI-2, Schedule of Revenue and Expenditures
Left Hand Valley Reservoir Spillway Modifications

	Annual Revenues			Annual Expenditures						
Year of Operation	Total Assessments Required	Assessments Per Share Required	Present Value of Future Assessments	Annual Operating Expenses	Loan Reserve Fund Annual	Loan Reserve Fund Accum.	Payments on CWCB Loan	Payments on Bank Loan	Interest on Reserve Funds	Total Expenditures
1	$136,480	$8.20	$8.20	$94,000	$3,883	$3,883	$22,249	$16,581	$233	$136,480
2	$140,007	$8.41	$8.09	$97,760	$3,883	$7,766	$22,249	$16,581	$466	$140,007
3	$143,685	$8.63	$7.98	$101,670	$3,883	$11,649	$22,249	$16,581	$699	$143,685
4	$147,519	$8.86	$7.88	$105,737	$3,883	$15,532	$22,249	$16,581	$932	$147,519
5	$151,515	$9.10	$7.78	$109,967	$3,883	$19,415	$22,249	$16,581	$1,165	$151,515
6	$155,681	$9.35	$7.69	$114,365	$3,883	$23,298	$22,249	$16,581	$1,398	$155,681
7	$160,022	$9.61	$7.60	$118,940	$3,883	$27,181	$22,249	$16,581	$1,631	$160,022
8	$164,547	$9.88	$7.51	$123,698	$3,883	$31,064	$22,249	$16,581	$1,864	$164,547
9	$169,262	$10.17	$7.43	$128,645	$3,883	$34,947	$22,249	$16,581	$2,097	$169,262
10	$174,175	$10.46	$7.35	$133,791	$3,883	$38,830	$22,249	$16,581	$2,330	$174,175
11	$175,643	$10.55	$7.13	$139,143		$38,830	$22,249	$16,581	$2,330	$175,643
12	$181,209	$10.89	$7.07	$144,709		$38,830	$22,249	$16,581	$2,330	$181,209
13	$186,997	$11.23	$7.02	$150,497		$38,830	$22,249	$16,581	$2,330	$186,997
14	$193,017	$11.59	$6.96	$156,517		$38,830	$22,249	$16,581	$2,330	$193,017
15	$183,692	$11.03	$6.37	$162,778	($16,581)	$22,249	$22,249	$16,581	$1,335	$183,692
16	$190,203	$11.43	$6.34	$169,289		$22,249	$22,249	$0	$1,335	$190,203
17	$196,974	$11.83	$6.32	$176,060		$22,249	$22,249	$0	$1,335	$196,974
18	$204,017	$12.26	$6.29	$183,103		$22,249	$22,249	$0	$1,335	$204,017
19	$211,341	$12.70	$6.27	$190,427		$22,249	$22,249	$0	$1,335	$211,341
20	$218,958	$13.15	$6.24	$198,044		$22,249	$22,249	$0	$1,335	$218,958
21	$226,880	$13.63	$6.22	$205,966		$22,249	$22,249	$0	$1,335	$226,880
22	$235,118	$14.12	$6.20	$214,204		$22,249	$22,249	$0	$1,335	$235,118
23	$243,686	$14.64	$6.18	$222,772		$22,249	$22,249	$0	$1,335	$243,686
24	$252,597	$15.17	$6.16	$231,683		$22,249	$22,249	$0	$1,335	$252,597
25	$261,865	$15.73	$6.14	$240,951		$22,249	$22,249	$0	$1,335	$261,865
26	$271,503	$16.31	$6.12	$250,589		$22,249	$22,249	$0	$1,335	$271,503
27	$281,526	$16.91	$6.10	$260,612		$22,249	$22,249	$0	$1,335	$281,526
28	$291,951	$17.54	$6.08	$271,037		$22,249	$22,249	$0	$1,335	$291,951
29	$302,792	$18.19	$6.07	$281,878		$22,249	$22,249	$0	$1,335	$302,792
30	$293,153	$17.61	$5.65	$293,153	($22,249)	$0	$22,249	$0	$0	$293,153
Totals	$6,146,014			$5,271,984	$0		$667,466	$248,721	$42,157	$6,146,014

Permitting Authority	Permit , Approval or Agreement Required
U.S. Army Corps of Engineers	Agreement that work is excluded from 404 -or- 404 Permit
Boulder County	Grading Permit
Division of Water Resources	Approval of design
Water Quality Control Division	Construction Dewatering Permit
Air Pollution Control Division	Fugitive Dust Permit
Lake Valley Homeowners Association	Easement Agreement

H. Benefits

According to the Company there are approximately 400 shareholders in the Left Hand Ditch Company who own a total of 16,647 shares of stock. Shareholders include the Left Hand Water District, the largest shareholder, Boulder County, IBM and many individuals. Approximately 63 percent of the shares are owned by agricultural entities. Many of the municipal/industrial owned shares are also used for irrigation. The Company operates Left Hand Valley Reservoir in such a manner that it benefits all the shareholders, not just those on the ditches which can be served directly from the reservoir. If this project is not built and the reservoir asset is lost due to a severe storage restriction being imposed by the State Engineer the loss would be borne by all the shareholders. At a replacement value of $4,000 per acre-foot, for 1,624 acre-feet of storage capacity, the value lost would be nearly $6,500,000. Additional losses could be incurred if the storage asset were lost due to the reduced ability to efficiently manage the water supply available from Left Hand Creek and therefore a reduction in the water supply available to the shareholders for agricultural irrigation and other uses. The total estimated cost of this project at $560,280 is equal to approximately $345 per acre-foot of capacity.

APPENDIX A

LETTER FROM THE STATE ENGINEER'S OFFICE DATED OCTOBER 3, 1991

ROY ROMER
Governor

JERIS A. DANIELSON
State Engineer

OFFICE OF THE STATE ENGINEER
DIVISION OF WATER RESOURCES

1313 Sherman Street-Room 818
Denver, Colorado 80203
(303) 866-3581
FAX [303] 866-3589

October 3, 1991

Mr. Jesse Parrish
Left Hand Ditch Company
P.O. Box 229
Niwot, Colorado 80544

CERTIFIED NO.: P 175 900 200

When replying, please refer to:
LEFTHAND VALLEY DAM
W. Div. 1, DAMID: 050210

DUE DATE: August 1, 1994

Dear Mr. Parrish:

On August 15, 1991, Mr. Mark Haynes performed a dam safety inspection on the above referenced structure in accordance with Section 37-87-107, C.R.S. (1990 Repl. Vol.), which assigns the responsibility for the determination of the safe storage level for the reservoirs within Colorado to the State Engineer. The enclosed inspection report summarizes Mr. Haynes' opinion of the conditions observed during the inspection, and identifies actions required to improve the condition and safety of the dam and to extend the useful life of the structure. Please read the inspection report and implement the recommendations listed in the "Items Requiring Action By Owner to Improve the Safety of the Dam" section on page 2 of the report. Also, please retain the yellow copy for your files and future reference.

A hydrologic evaluation performed by our office indicates that the existing spillway at this site can accommodate approximately 30 percent of the flood produced by the Probable Maximum Precipitation (PMP) before overtopping of the dam will occur. This structure is currently classified as a Class I dam. The rules and regulations require that existing Class I dams be able to safely accommodate 75 percent of the PMP. Therefore, the spillway at the Lefthand Valley Dam is considered to be inadequate, and additional spillway capacity is needed at the site. A professional engineer licensed in the state of Colorado and experienced in the design and construction of earth dams should be employed to perform the necessary studies to determine required spillway size and to prepare the plans and specifications for the construction of the spillway. The plans and specifications shall be submitted to this office for my review and approval prior to commencement of construction. A completion date of August 1, 1994, has been assigned to the final construction of the additional spillway capacity. If the spillway is not completed by this date, a storage level restriction on the order of 9 feet below the dam crest could be imposed on the reservoir.

Our files show that surface monuments were installed on the dam in 1989, and that we have not received any survey data for these monuments. The rules and regulations require that surface monuments be surveyed once every year for the first five years after the monuments have been installed and once every five years thereafter. A copy of the survey data should be submitted to our office on an annual basis. Please have the surface monuments surveyed this year and the resulting data transmitted to this office.

You are reminded that the Left Hand Ditch Company, as owner of this dam, is liable for the safety of this structure and for any damages caused by a failure of the dam. As such, it is in the best interest of the owner to operate and maintain the existing facility in a manner such that the safety of the dam and the general public is not jeopardized.

If you have any questions concerning this matter or any other dam safety related item, please feel free to contact Mr. Mark Haynes at (303) 866-3581.

Sincerely,

Jeris A. Danielson
State Engineer

JAD/MRH:rjb/050210.mrh

cc: Alan Berryman, Division Engineer (2 Copies)

Enclosure (a/s)

APPENDIX B

LEFT HAND DITCH COMPANY
BY-LAWS/ARTICLES
OF INCORPORATION

The Left Hand Ditch Company

P.O. Box 229
Niwot, Colorado 80544

BY-LAWS/ARTICLES OF INCORPORATION

ADOPTED: February 5, 1974
AMENDED: February 1984
AMENDED: February 1986
AMENDED: February 1988
AMENDED: February 1989

BY-LAWS/ARTICLES OF INCORPORATION

LEFT HAND DITCH COMPANY
Adopted February 5, 1974

ARTICLE I: NAME AND DURATION

The name of the Corporation shall be the LEFT HAND DITCH COMPANY and its period of duration shall be perpetual.

ARTICLE II: PLACE OF BUSINESS

The place of business of the Left Hand Ditch Company shall be the valley of Left Hand Creek and its tributaries and the area occupied and served by its reservoirs and ditches, in Boulder County, Colorado. The Service Area of the Left Hand Ditch Company shall be identified and delineated on an official map adopted by the Board of Directors.

ARTICLE III: OBJECTS

Section 1.

The objects and purposes of the Left Hand Ditch Company for which the Corporation is formed and incorporated shall be as follows: to own and operate an irrigation and water system in the Niwot region of Boulder County, Colorado, and in connection therewith to own, control, maintain and operate irrigation ditches, laterals, irrigation reservoirs, headgates, flumes, weirs, irrigation water rights and decrees, and other property of a complete irrigation system; to employ such secretaries, clerks, auditors, attorneys, water superintendents, ditch riders and laborers as may be needed; to divert, store, measure and distribute water under the water rights, priorities, and decrees owned and controlled by the Left Hand Ditch Company; to provide water to its stockholders for irrigation, domestic, industrial and commercial purposes; and in general to carry on the business of providing such water to the stockholders of the Corporation.

ARTICLE IV: CAPITAL STOCK

Section 1.

The authorized Capital stock of the Corporation shall be 16,800 shares of a par value of .3125 dollars each, and of equal standing and of only one class.

Section 2.

All transfers of stock shall be made upon the books of the Corporation upon surrender of the certificates covering the same, in person by the holder of the shares or by his legal representative. Transfers shall be made only when the stockholder is free from indebtedness to the Corporation. Shares may be transferable to the Corporation itself.

In case of loss of a stock certificate the Secretary of the Corporation shall require proof of loss before issuing a new certificate and may demand an idemnity bond with corporate surety in such amount as may be fixed by the Board of Directors before the issuance of a new certificate.

New stock certificates may also be issued in accordance with the procedure and provisions set forth in C.R.S.§7-42-114 to §7-42-117 (1973), which provides,

in general, that if more than three years have elapsed since the Corporation was notified that a certificate has been lost or destroyed the owner of the lost or destroyed certificate may file a statement under oath with the Secretary of the Corporation that the stock has been lost, mislaid or destroyed and request the issuance of a new stock certificate. Upon receipt of such request, the Secretary of the Corporation will publish notice that a demand has been filed in accordance with the terms of the statute. If no claim of interest or ownership other than that made by the person filing such notice is filed with the Secretary of the Corporation, the Corporation will issue a duplicate certificate. The costs of following the statutory proceedings will be paid by the person requesting the new certificate. No bond will be required when the statutory proceeding is followed.

Section 3.
No stockholder shall have any right to transfer or remove Left Hand Ditch Company water outside the service area of the Left Hand Ditch Company.

ARTICLE V: STOCKHOLDERS MEETING

Section 1.
The regular annual meetings of the stockholders of this Corporation shall be held in or near the town of Niwot, Boulder County, Colorado, at a time, date and place, designated by the Board of Directors each year.

Section 2.
Special meetings of the stockholders of this Corporation may be called at any time by a resolution of the Board of Directors, at which meetings no business shall be transacted except such as shall be mentioned in the notice of the special meeting.

Section 3.
Whenever the stockholders of one-third (1/3) in amount of the capital stock of the Corporation shall request the President of the Corporation, in writing, to call a special meeting of the stockholders, giving the reasons for the special meeting; the President shall without delay call a meeting of the Board of Directors and present the request; and thereupon the Board of Directors shall call a special meeting of the stockholders to be held within thirty (30) days.

Section 4.
At all stockholders' meetings a majority of all the stock of the Corporation must be represented in person or by proxy to constitute a quorum for the transaction of any business.

Section 5.
Notice of all meetings of stockholders shall be mailed to each stockholder of record at least thirty (30) days before such meeting, stating the time and place of said meeting, and in the case of a special meeting, stating the object and purpose of said meeting.

Section 6.
Stockholders of Record of the previous December 31, shall be entitled to vote at each annual meeting. The record date for a special meeting of stockholders shall be the date on which the notice of the meeting is sent.

Section 7.
At all meetings of stockholders, a stockholder may vote by proxy executed in writing by the stockholder or his duly authorized attorney in fact. Such proxy shall be filed with the secretary of the Corporation before or at the time of the meeting. No proxy shall be valid after eleven (11) months from the date of its execution, unless otherwise provided in the proxy. In the case where a stock is held in the name of two or more persons, such as joint tenancy, tenancy in common, or other common ownership, any one of the owners listed on the stock book of the Corporation shall be deemed to have authority to sign the proxy on behalf of all owners, unless and until such authority is proven to the contrary to the satisfaction of the Board of Directors.

Section 8.

Each outstanding share of stock shall be entitled to one vote on all matters properly placed before the stockholders. Any shares held in the name of two or more persons, such as joint tenancy, tenancy in common, or other common ownership, may be voted by one of the record owners unless and until such authority is proven to the contrary to the satisfaction of the Board of Directors. Any shares standing in the name of a corporation may be voted by such officer or agent, or by proxy, as the by-laws or other authority of such corporation may prescribe. Shares held by an administrator, executor, guardian or conservator may be voted by such person in his representative capacity, either in person or by proxy, but no trustee shall be entitled to vote shares held by him without a transfer of such shares into his name.

Section 9.
A stockholder whose shares are pledged shall be entitled to vote such shares until the shares have been transferred into the name of the pledgee, and thereafter the pledgee shall be entitled to vote the shares so transferred. In the case where shares of stock are shown on the corporate books to be owned by equity owners with other persons or parties shown as holding a security interest only, these shares shall be voted by the equity owner or owners.

ARTICLE VI: DIRECTORS & OFFICERS

Section 1.
The Board of Directors of the Corporation shall consist of five persons who shall be stockholders in the Company. One director to be elected from each of the five districts or divisions of the Left Hand Ditch Company irrigation system which are described in the By-Laws of the Corporation.

District 1: to be comprised of the territory irrigated from the Haldi Ditch, the Lake Ditch, the North and South Toll Gate Ditches, the Crocker Ditch and the Table Mountain Ditch.

District 2: to be comprised of the territory irrigated from the Cro-John Ditch, Bader Ditch, the Johnson Ditch, the Star Ditch and the Hinman Ditch.

District 3: to be comprised of the territory irrigated from the Holland Ditch and the Williamson Ditch.

District 4: to be comprised of the area above the Boulder Supply Canal.

District 5: to be comprised of the area below the Boulder Supply Canal.

One or two directors shall be elected each year to fill the vacancy left by the director or directors whose term of office expires that year. Those nominated must be stockholders in the district which they are to represent and may only be nominated by stockholders from that district. Those so nominated shall be voted on by all the stockholders as a body and the one receiving the highest number of votes in each district shall be declared elected for a term of three years.

Section 2.

All elections shall be by ballot of the stockholders for the persons nominated. Each stockholder shall have the right to vote in person or by proxy the number of shares owned by him and standing in his name on the books of the Corporation; and the person or persons receiving the highest number of votes shall be declared to be elected to the Board of Directors.

Section 3.

Directors shall serve until their successors are duly elected and have qualified. Vacancies on the Board of Directors caused by death, resignation, or inability to act, of any member of the Board of Directors shall be filled by the remaining members of the Board to serve until the next regular or special meeting of the stockholders.

Section 4.

The officers of the Corporation shall consist of a president, a vice-president, a secretary and a treasurer, who shall be members of the Board of Directors, and who shall be chosen annually by the Board of Directors. The Board of Directors may, in addition, appoint as an officer of the Corporation a vice- president for water operations and an assistant secretary. The Vice-President for Water Operations will have such duties and responsibilities as the Board of Directors may from time to time establish. The Assistant Secretary may be an individual or a corporation and shall have such practical and ministerial functions as the Board of Directors may from time to time determine. Vacancies occurring in any office shall be filled by the Board of Directors.

ARTICLE VII: DUTIES OF DIRECTORS

Section 1.

Regular meetings of the Board of Directors shall be held once a month with time and place to be determined by the President with the consent of the Directors.

Section 2.

Special meetings of the Board of Directors may be held upon the call of the president, the time and place to be fixed by the president, provided twenty-four hours notice is given each director of such special meeting. Special meetings of the Board shall be called by the President at any time or upon the request of two or more Directors.

Section 3.

At the meeting of the Board of Directors, three members shall constitute a quorum for the transaction of business.

Section 4.
All corporate powers shall be exercised by the Board of Directors, who shall have full control and authority over the Corporation, and shall have the power;

1st; To make all rules and regulations for the guidance of the officers and the management of the affairs of the Corporation.

2nd: To collect assessments on the capital stock of the Corporation as levied by action of the stockholders.

3rd: Express power and authority are hereby conferred upon the Board to borrow money on the credit and responsibility of the Corporation, in such sums as they may deem necessary or proper for all purposes previously authorized by the stockholders of the Corporation.

4th: They shall cause to be kept a complete record of all their meetings and acts, also the proceedings of all stockholders' meetings.

5th: They shall cause to be issued to those lawfully entitled thereto, under the articles of incorporation, certificates for the paid up shares of stock, which shall never exceed in the aggregate the capital stock of the Corporation.

6th: To act upon all bills and accounts.

7th: To fill all vacancies in their own board, and elect all its officers and appoint its superintendent, ditch riders and all other clerks, servants and employees of the Corporati

8th: To do and perform every act necessary to be done to fully manage the affairs of the Corporation.

9th: To cause to be brought such actions in law or equity as they may deem necessary to protect the interests of the Corporation, and to carry into effect its objects and purposes.

ARTICLE VIII: DUTIES OF OFFICERS

Section 1.
The President of the Corporation shall preside at the meetings of the stockholders and the Board of Directors.

Section 2.
The Vice-President shall preside at meetings in the absence of the President.

Section 3.
The Secretary shall attend the meetings of the Board of Directors and shall prepare and put into permanent form accurate and complete minutes of the same. The Secretary shall act as directed by the Board of Directors in connection with all official transactions and financial business of the Corporation, including transfers and records of stock, and shall make accurate and complete reports of all transactions.

Section 4.
The Treasurer or, in his absence, such other person as may be designated by the Board of Directors, shall countersign all checks of the Corporation, as directed by the Board.

Section 5.
The Board of Directors may assign such additional duties and responsibilities to each of the officers as may be deemed necessary.

Section 6.
The Board of Directors shall have general management of the irrigation system of the Left Hand Ditch Company and of all irrigation water flowing therein or impounded therefor, and of the proper division of the water into the ditches and reservoirs of the Corporation, and of the proper division and distribution of the said water to the stockholders. All ditch riders, water superintendents and assistants shall be under the supervision of the Board of Directors.

Section 7.
All notes, leases, deeds, contracts, and other documents including new certificates of stock, shall be approved by the Board of Directors, signed by the President or Vice-President, and attested to by the Secretary with seal affixed.

ARTICLE IX: SALARIES AND COMPENSATION

The members of the Board of Directors shall each receive $60.00 per month during his term of office. In addition, each member of the Board of Directors shall be entitled to be reimbursed for all expenses actually incurred in the performance of his duties as a member of the Board of Directors.

ARTICLE X: ASSESSMENTS

Section 1.
At the regular annual meeting of this Corporation, or at special meetings called for that purpose, the stockholders shall by a majority vote of the stock represented at the meeting, levy an assessment on the capital stock of the Corporation for the purpose of providing funds for operating the affairs of the Company, defraying its expenses, paying its officers and employees, keeping the ditches and reservoirs and other property in good repair, and for the payment of claims against the Corporation.

Section 2.
When such assessment shall have been made, it shall become due on June 1, of each year; and the secretary shall at least ten (10) days before the said date notify each stockholder by written or printed notice hereof, and mail the same to each stockholder, or serve the said notice personally on such stockholders as he may decide. The record date for assessment of stockholders shall be March 31, of each year.

Section 3.
Such assessment, if not paid when due, shall draw interest from June 1 of the year in which it is levied, at the rate of one (1) per cent until paid, and if not paid within two (2) years after the same became due and payable, it shall be the duty of the secretary to advertise for sale and to sell such stock so delinquent, in the manner following:
The Secretary shall give written notice to the owner or to the legal representative of the owner of the stock on which the assessment is delinquent, by mailing such notice, properly sealed in an envelope, and addressed directly to the last known address of the said owner or his representative, at least (30) thirty days before the time set for said sale, which time shall be set by the Board of Directors and which information shall be included in the said notice, notifying the said owner or his representative that the said stock will be sold at public auction on the said date unless prior to that time payment is made to the secretary of all assessments made against the stock, together with the interest on unpaid assessments, and together with all costs of the procedure to sell stock;

and a like notice shall be sent in the same manner to any person claiming or holding a lien on the said stock, as shown by the records of the Corporation or by the records at the office of the County Clerk and Recorder of Boulder County, Colorado. The Secretary shall also publish a like notice in a newspaper published in Boulder County, Colorado, once each week for four successive weeks or for five issues of said newspaper, preceding the date of the said sale. Upon the date set for the sale of the said stock, the stock on which the assessment is delinquent and unpaid shall be sold at public auction to the highest bidder, for cash. At such sale the Corporation may become the purchaser of the stock, and the transfer shall be made to the purchaser as in other cases. Out of the proceeds of the sale shall be paid all costs of the sale and other expenses incident thereto, and the amount of all assessments against the stock, together with interest, and the balance shall then be paid to the person legally entitled to the money. The old certificate outstanding shall thereupon become absolutely void.

Section 4.
The stockholders may set a minimum assessment applicable to all stockholders.

ARTICLE XI: AMENDMENTS

The Articles of Incorporation may be amended at any regular annual meeting of the stockholders of this Corporation, by a two-thirds vote of the stock represented at the meeting, provided a quorum is present and provided further that the notice to each stockholder for said meeting shall have contained specific information concerning the proposed amendment or amendments.

Amendments may be proposed by the Board of Directors, a committee appointed by the Board of Directors for this purpose, or a group of stockholders representing at least 10 percent of the Capital Stock of the Corporation.

The Articles of Incorporation may also be amended at any special meeting of the stockholders of this Corporation by a two-thirds vote of the stock represented at the meeting, provided a quorum is present, and provided further that the notice for the special meeting contained specific information concerning the proposed amendment or amendments.

ARTICLE XII: LIABILITY OF DIRECTORS

A Director of the Corporation shall not be personally liable to the Corporation or its stockholders for monetary damages for breach of fiduciary duty as a director, except for liability arising from (1) any breach of the directors's duty of loyalty to the Corporation or its stockholders, (2) acts or omissions not in good faith or which involve intentional misconduct or a knowing violation of law, (3) any transaction from which the director derived any improper personal benefit or (4) any other act expressly proscribed or for which directors are otherwise liable under the Colorado Corporation Codes or statutory law. If Colorado statutory law is subsequently amended to authorize corporate action further limiting or eliminating the personal liability of directors, then the liability of a director of the Corporation shall be limited or eliminated to the fullest extent permitted by Colorado statute as so amended.

APPENDIX C

LEFT HAND DITCH COMPANY
FINANCIAL STATEMENTS
DECEMBER 31, 1993 AND 1992

ROCKY MOUNTAIN CONSULTANTS, INC.

LEFT HAND DITCH COMPANY

(a Colorado corporation)

FINANCIAL STATEMENTS

December 31, 1993 and 1992

LEFT HAND DITCH COMPANY

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Lambert, Jensen,
Burcham & Stelmack, LLC
Certified Public Accountants and Consultants
717 5th Avenue, Longmont, Colorado 80501-5420
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Merlyn J. Lambert, CPA
Lawrence M. Jensen, CPA
John P. Burcham, CPA
Richard A. Stelmack, CPA

ACCOUNTANTS' REVIEW REPORT

To the Board of Directors
Left Hand Ditch Company
Niwot, Colorado

We have reviewed the accompanying balance sheets of Left Hand Ditch Company (a Colorado corporation) as of December 31, 1993 and 1992, and the related statements of income and retained earnings, and cash flows for the years then ended, in accordance with Statements on Standards for Accounting and Review Services issued by the American Institute of Certified Public Accountants. All information included in these financial statements is the representation of the management of Left Hand Ditch Company.

A review consists principally of inquiries of Company personnel and analytical procedures applied to financial data. It is substantially less in scope than an audit in accordance with generally accepted auditing standards, the objective of which is the expression of an opinion regarding the financial statements taken as a whole. Accordingly, we do not express such an opinion.

Based on our review, we are not aware of any material modifications that should be made to the accompanying financial statements in order for them to be in conformity with generally accepted accounting principles.

Lambert, Jensen, Burcham & Stelmack, LLC
Certified Public Accountants

February 3, 1994

LEFT HAND DITCH COMPANY

EXHIBIT A

BALANCE SHEETS
(Note 1)

	December 31, 1993	December 31, 1992
ASSETS		
CURRENT ASSETS		
Cash in bank	$ 50,470	$ 47,854
Certificate of deposit	78,946	76,166
Assessments and interest receivable	1,950	5,094
Rent receivable	1,000	2,000
Prepaid expense	5,883	5,738
Income tax refund receivable	-	1,775
Total current assets	138,249	138,627
PROPERTY AND EQUIPMENT		
Irrigation facilities	443,335	433,272
Machinery and equipment	9,440	8,914
	452,775	442,186
Less accumulated depreciation	293,325	282,840
	159,450	159,346
Construction in progress	11,839	5,215
Net property and equipment	171,289	164,561
	$ 309,538	$ 303,188
LIABILITIES AND STOCKHOLDERS' EQUITY		
CURRENT LIABILITIES		
Accounts payable	$ 3,111	$ 283
Accrued expenses	441	437
Customer deposits	2,000	2,000
Income taxes payable	-	240
Total current liabilities	5,552	2,960
COMMITMENTS AND CONTINGENCIES (Note 6)		
STOCKHOLDERS' EQUITY		
Common stock - 16,800 $.3125 par value shares authorized, 16,647 issued and outstanding	5,202	5,202
Paid in capital	204,675	204,675
Retained earnings (Exhibit B)	94,109	90,351
Total stockholders' equity	303,986	300,228
	$ 309,538	$ 303,188

See accompanying notes and accountants' review report

LEFT HAND DITCH COMPANY

EXHIBIT B

STATEMENTS OF INCOME AND RETAINED EARNINGS
(Note 1)

	Years ended December 31, 1993	1992
REVENUE (net of water costs of $2,874 in 1993 and $2,758 in 1992)	$ 86,473	$ 87,678
OPERATING EXPENSES		
Salaries and wages	31,583	30,697
Payroll taxes	2,540	2,511
	34,123	33,208
Legal and accounting	10,227	16,892
Insurance expense	10,124	10,247
Depreciation expense	10,485	9,366
Repairs and maintenance	9,912	6,983
Contracted services	5,000	5,000
Vehicle expense	3,501	3,700
Directors' fees	3,600	3,300
Telephone expense	2,128	1,836
Office supplies and expense	1,723	1,562
Computer expense	910	375
Dues and assessments	112	200
Engineering costs	-	-
Other sundry expenses	1,571	999
Total operating expenses	93,416	93,668
OPERATING LOSS	(6,943)	(5,990)
OTHER INCOME AND EXPENSE		
Lease income	7,000	8,000
Interest income	4,447	5,126
Transfer fees	680	530
Miscellaneous income	59	126
Miscellaneous expense	(1,485)	-
Total other income and expense	10,701	13,782
INCOME (LOSS) BEFORE INCOME TAXES AND EXTRAORDINARY ITEM	3,758	7,792
Provision for income taxes	-	(1,558)
INCOME (LOSS) BEFORE EXTRAORDINARY ITEM	3,758	6,234
EXTRAORDINARY ITEM		
Reduction of income taxes due to utilization of net operating loss - lossforwards	-	1,318
NET INCOME (LOSS) FOR YEAR	3,758	7,552
RETAINED EARNINGS, Beginning of year	90,351	82,799
RETAINED EARNINGS, End of year (Exhibit A)	$ 94,109	$ 90,351

See accompanying notes and accountants' review report

LEFT HAND DITCH COMPANY

EXHIBIT C

STATEMENTS OF CASH FLOWS
(Note 1)

	Years ended December 31, 1993	1992
CASH FLOWS FROM OPERATING ACTIVITIES		
Net income (loss) for year (Exhibit B)	$ 3,758	$ 7,552
Adjustments to reconcile net income to net cash provided (used) by operations -		
Depreciation	10,485	9,366
(Increase) decrease in -		
Accounts receivables	4,144	(3,130)
Prepaid expense	(145)	61
Income tax receivables	1,775	-
Increase (decrease) in -		
Accounts payable	2,828	137
Accrued expenses	4	(2)
Income taxes payable	(240)	240
Net cash provided (used) by operating activities	22,609	14,224
CASH FLOWS FROM INVESTING ACTIVITIES		
(Increase) decrease in certificate of deposit	(2,780)	21,741
Dam and road improvements	(10,589)	-
Payments made for construction-in-progress	(6,624)	(5,215)
Net cash provided (used) by investing activities	(19,993)	16,526
NET INCREASE (DECREASE) IN CASH AND CASH EQUIVALENTS	2,616	30,750
CASH AND CASH EQUIVALENTS AT BEGINNING OF YEAR	47,854	17,104
CASH AND CASH EQUIVALENTS AT END OF YEAR (EXHIBIT A)	$ 50,470	$ 47,854

See accompanying notes and accountants' review report

LEFT HAND DITCH COMPANY

NOTES TO FINANCIAL STATEMENTS
December 31, 1993 and 1992

NOTE 1 - SUMMARY OF SIGNIFICANT ACCOUNTING POLICIES

Nature of Business. The Company owns and operates irrigation water systems in Boulder County, Colorado. The Company grants credit to all of its Boulder County customers for annual assessments.

Cash and Cash Equivalents. The Company presents its cash flow statements using the indirect method. For purposes of cash flow presentation, the Company considers cash on hand and demand deposits with financial institutions to be cash equivalents.

Property and Equipment. Property and equipment are stated at cost except for adjudicated water rights which are carried at a nominal value of $1. Substantially all depreciation expense has been determined using the straight line method. The cost of maintenance and repairs has been charged against income as incurred; significant renewals, betterments and improvements are capitalized.

Allowance for doubtful accounts. No allowance for doubtful accounts has been provided for in the Company's financial statements pursuant to the Company's policy of selling individual shares when assessments and related interest become more than 3 years in arrears. For the year ending December 31, 1993, three shares were sold at auction. Sale proceeds in excess of the amounts due in arrears to the Company were paid to the original owners.

NOTE 2 - PROPERTY AND EQUIPMENT

Depreciation has been determined based upon estimated useful lives as follows:

Roads, dams, reservoirs, and equipment, etc.	15 - 67 years
Office equipment	5 - 10 years

Depreciation expense totalled $10,485 and $9,366 for the years 1993 and 1992, respectively.

NOTE 3 - OPERATING LEASE

The Company leases certain water surface rights at Left Hand Valley Reservoir to James Geidel for recreational purposes. It is a three year lease which expires in December, 1995. The cost of the surface water rights is not determinable.

NOTE 4 - RELATED PARTY TRANSACTIONS

The Company has an agreement with the Left Hand Water District to transfer and exchange Northern Colorado Water Conservancy District (Big "T") water and Left Hand Ditch Company water pursuant to certain restrictive terms and conditions. This agreement expires November 13, 2000.

Pursuant to a contract for secretarial and bookkeeping services, the Ditch Company paid the Left Hand Water District amounts totalling $5,000 during 1993 and $5,000 during 1992.

As of December 31, 1993 the Left Hand Water District owns approximately 17.1% of Left Hand Ditch Company stock.

NOTE 5 - INCOME TAXES

The provision for federal and Colorado income taxes consists of the following amounts:

	1993	1992
Taxes on current year's taxable income	$ -	$ 1,558
Reduction of income taxes due to net operating loss carryforward	-	1,318
Provision for federal and Colorado taxes	$ -	$ 240

For the year ended December 31, 1993, the Company believes that it is not subject to income taxes under I.R.C. Section 501(c)(12) covering mutual ditch companies wherein member assessment income exceeds 85% of its total income, and no unrelated business income in excess of the allowed annual exclusion amount has been collected that would be subject to income taxes.

The following is a schedule of net operating loss deduction carryforwards and their related expiration dates:

	Colorado	Federal
December 31, 2006	$ 5,234	$ -
December 31, 2007	4,996	-
	$ 10,230	$ -

NOTE 5 - INCOME TAXES - continued

Income tax expense differed from income taxes currently payable at December 31, 1992 because of the effect of federal and Colorado net operating loss carryforwards which offset the net income for the year then ended for federal and state income tax purposes by $6,360 and $7,960, respectively.

NOTE 6 - COMMITMENTS AND CONTINGENCIES

The Company has been notified by the State of Colorado, Office of the State Engineer that in accordance with the Colorado "Rules and Regulations for Dam Safety and Dam Construction", certain modifications to the Left Hand Valley Reservoir and spillway system are required to be made, or at least be substantially in progress by August, 1994, to the make the system capable of accommodating the flood generated by 75% of the "Probable Maximum Precipitation" (PMP).

The Company's engineering consultant has recommended a total budget of $600,000 to cover construction and engineering costs of $463,685 and $136,315 for contingencies. The Board has directed the engineering firm to investigate other viable alternatives. It is anticipated that the resultant cost to complete the project, including interest on borrowed funds, will be funded with debt proceeds to be repaid through increased assessments to the shareholder members.

APPENDIX D

REVISED FLOOD HYDROLOGY REPORT
FOR
LEFT HAND VALLEY
RESERVOIR DAM, 1993

ROCKY MOUNTAIN CONSULTANTS, INC.

REVISED
FLOOD HYDROLOGY REPORT

FOR

LEFT HAND VALLEY RESERVOIR DAM
BOULDER COUNTY, COLORADO

WATER DIVISION 1
WATER DISTRICT 5

DAMID: 050210

Prepared for:

LEFT HAND DITCH COMPANY
P.O. Box 229
Niwot, Colorado 80544

Prepared by:

ROCKY MOUNTAIN CONSULTANTS, INC.
Premiere Building
700 Florida Avenue, Suite 500
Longmont, Colorado 80501

August, 1993

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Appendix A HEC-1 Computer Output

I. INTRODUCTION

Left Hand Valley Reservoir, owned by the Left Hand Ditch Company, is located on Dry Creek approximately three miles north of the City of Boulder, Colorado in Sections 29, 30, 31 and 32, T2N, R70W of the 6th PM. The reservoir is formed by two earth dams each approximately 45 feet high and 450 feet in crest length. The purpose of this report is to determine flood inflows to Left Hand Valley Reservoir and to assess spillway adequacy based on the current Rules and Regulations for Dam Safety and Dam Construction.

II. DAM HAZARD EVALUATION

Left Hand Valley Reservoir is rated by the Colorado State Engineer's Office (SEO) as a Class I, Intermediate Dam. By definition, failure of a Class I dam could result in significant property damage and loss of human life. Significant damage is defined as damage to structures where people live, work or recreate. There are a number of homes and businesses below the dam which could be damaged in the event of failure of the dam. Flood flows are tributary to Boulder Reservoir approximately two miles below Left Hand Valley Reservoir on Dry Creek.

III. DRAINAGE BASIN DESCRIPTION

The drainage basin above Left Hand Valley Reservoir is approximately 3.91 square miles, including the reservoir surface of approximately 0.18 square miles, ranging in elevation from 5351 feet at the spillway to approximately 6680 feet at the western edge of the drainage. Three sub-basins are included in the total drainage area and range in length from 8,400 feet to 14,200 feet. A topographic map of the drainage area is included as Figure 1. The soils of the basin generally consist of poorly drained soils classified as Hydrologic Soils Types C and D. Approximately 45 percent of the drainage basin consists of Type C soils and the remaining 55 percent consists of Type D soils. Ground cover consists predominantly of unirrigated pasture or range land in fair condition.

IV. DESIGN PRECIPITATION

The SEO Rules and Regulations require that the inflow design flood for existing Class I, Intermediate Dams consider three-quarters of the Probable Maximum Precipitation (PMP). Hydrometeorological Report No. 55A (HMR-55A) published by the U.S. Departments of Commerce, Army, and Interior, June 1988, was used to determine the Probable Maximum Precipitation for the drainage basin above Left Hand Valley Reservoir. The drainage basin was located on isohyetal maps to determine the general storm 1-hour, 6-hour, 24-hour and 72-hour 10-square mile index PMP values. Local storm values were checked and the general storm was found to control. This is consistent with HMR-55A which states "The general storm also controls most of the first upslopes (classified as 'orographic' regions)", HMR-55A, page 209.

The drainage basin is located within the C orographic subunit as shown on Figure 11.2 in HMR-55A. Because the drainage basin is less than 10 square miles in area no areal reduction factors are applied to reduce the 10-square mile index PMP values. The index values were reduced by 25 percent resulting in the 75 percent PMP values shown in Table 1.

A regression analysis using the 75% PMP values was performed resulting in two equations describing the rainfall depth-duration relationship. The equation $Y=9.46351(X)^{0.381978}$, where X equals time in hours and Y equals rainfall depth in inches, was derived from a regression using the 1, 3, 6 and 24 hour values in Table 1. This equation has a correlation coefficient of 0.99878 and was used to calculate rainfall depths for 5-minute intervals from 0000 hours to 0230 hours. The second equation, $Y=6.020812\ln(X)+7.906$ with a correlation coefficient of 0.999598, was derived from a regression using the 3, 6, 24 and 72 hour values in Table 1. This equation was used to calculate rainfall depths at 5-minute intervals from 0235 hours to 7200 hours. The 5-minute interval rainfall depths determined using the regression equations are shown on Table 2 for the first 8 hours of rainfall.

The 5-minute incremental rainfall amounts were arranged by placing the largest increment at 8 hours from the beginning of the rainfall, or at the one-third point of the 24-hour storm. The largest increment was then preceded by the second largest and followed by the third and fourth largest increments. This pattern was repeated until all the incremental precipitation amounts were arranged into a 24-hour storm.

V. INFILTRATION

The amount of rainfall contributing to runoff is the difference between the amount of rain falling in a period of time and the amount which is intercepted, retained or which infiltrates into the ground. Using a minimum loss rate of 0.15 inches per hour for Type C soils and 0.05 inches per hour for Type D soils, and considering the relative percentages of each soil type, a weighted average loss rate of 0.10 inches per hour was obtained.

VI. RAINFALL-RUNOFF RELATIONSHIP

The Bureau of Reclamation general storm dimensionless unit hydrograph for the Great Plains region, Design of Small Dams 3rd Ed. (DSD) Table 3-7, was used to describe the relationship between rainfall excess and runoff. The Great Plains dimensionless unit hydrograph was transformed into a dimensionless unit hydrograph for each of the sub-basins above Left Hand Valley Reservoir by using the basin length and slope characteristics to compute basin lag and unit duration. The basin lags were computed using the following equation:

$$Lag = C[(LL_c)/(S_{ave}^{0.5})]^{0.33}$$

Each sub-basin was divided into three reaches consisting of varying slopes. The slopes in the three reaches were averaged using a technique described in the Boulder County Storm Drainage Criteria Manual. The reaches of each sub-basin used in the lag computations are described in Table 4. The resulting total lag times are 1.04 hours for Sub-basin A, 0.62 hours for Sub-basin B and 0.65 hours for Sub-basin C.

The theoretical unit durations are calculated to be Lag/5.5 or 0.19 hours for Sub-basin A, 0.11 hours for Sub-basin B and 0.12 hours for Sub-basin C. A 5-minute time increment was chosen for the unit duration to assure that the peak of the hydrograph would be adequately represented. For each 5 minute time increment the percent of the lag time plus semi-duration was calculated and a

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*                                       *
*   FLOOD HYDROGRAPH PACKAGE  (HEC-1)   *
*            SEPTEMBER 1990             *
*             VERSION 4.0               *
*                                       *
*  RUN DATE  08/09/1993  TIME  13:23:38 *
*                                       *
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*                                       *
*    U.S. ARMY CORPS OF ENGINEERS       *
*    HYDROLOGIC ENGINEERING CENTER      *
*          609 SECOND STREET            *
*       DAVIS, CALIFORNIA 95616         *
*           (916) 756-1104              *
*                                       *
*****************************************
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LEFT HAND VALLEY DAM HYDROLOGY - EXISTING CONDITION
75% of PROBABLE MAXIMUM PRECIP
24-HOUR GENERAL STORM, BUREC GREAT PLAINS UNIT HYDROGRAPH
ANALYSIS OF THREE CONTRIBUTING SUB-BASINS PLUS LAKE SURFACE

6 IO OUTPUT CONTROL VARIABLES

IPRNT	0	PRINT CONTROL
IPLOT	0	PLOT CONTROL
QSCAL	0.	HYDROGRAPH PLOT SCALE

IT HYDROGRAPH TIME DATA

NMIN		5	MINUTES IN COMPUTATION INTERVAL
IDATE	1	0	STARTING DATE
ITIME		0000	STARTING TIME
NQ		300	NUMBER OF HYDROGRAPH ORDINATES
NDDATE	2	0	ENDING DATE
NDTIME		0055	ENDING TIME
ICENT		19	CENTURY MARK

COMPUTATION INTERVAL .08 HOURS
TOTAL TIME BASE 24.92 HOURS

ENGLISH UNITS

DRAINAGE AREA	SQUARE MILES
PRECIPITATION DEPTH	INCHES
LENGTH, ELEVATION	FEET
FLOW	CUBIC FEET PER SECOND
STORAGE VOLUME	ACRE-FEET
SURFACE AREA	ACRES
TEMPERATURE	DEGREES FAHRENHEIT

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***************
*             *
7 KK    *   SUB-A   *
*             *
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CALCULATE THE RUNOFF FROM SUBBASIN A

SUBBASIN RUNOFF DATA

9 BA SUBBASIN CHARACTERISTICS

TAREA 2.37 SUBBASIN AREA

PRECIPITATION DATA

10 PB STORM 26.72 BASIN TOTAL PRECIPITATION

11 PI INCREMENTAL PRECIPITATION PATTERN

.02	.02	.02	.02	.02	.02	.02	.02	.02	.02
.02	.02	.02	.02	.02	.03	.03	.03	.03	.03
.03	.03	.03	.03	.03	.03	.03	.03	.03	.03
.03	.03	.03	.03	.03	.03	.03	.03	.04	.04
.04	.04	.04	.04	.04	.04	.04	.04	.04	.04
.05	.05	.05	.05	.05	.05	.05	.05	.05	.06
.06	.06	.06	.06	.07	.07	.07	.07	.08	.08
.08	.09	.09	.09	.10	.10	.11	.11	.12	.13
.14	.15	.16	.17	.18	.19	.19	.20	.22	.25
.28	.33	.40	.55	1.11	3.58	.80	.65	.49	.44
.37	.35	.31	.29	.27	.26	.24	.23	.22	.21
.20	.20	.19	.19	.18	.18	.18	.17	.17	.16
.16	.15	.15	.14	.14	.13	.13	.12	.12	.12
.11	.11	.11	.10	.10	.10	.10	.09	.09	.09
.09	.09	.08	.08	.08	.08	.08	.08	.07	.07
.07	.07	.07	.07	.07	.07	.07	.06	.06	.06
.06	.06	.06	.06	.06	.06	.06	.06	.05	.05
.05	.05	.05	.05	.05	.05	.05	.05	.05	.05
.05	.05	.04	.04	.04	.04	.04	.04	.04	.04
.04	.04	.04	.04	.04	.04	.04	.04	.04	.04
.04	.04	.04	.04	.04	.04	.04	.04	.04	.04
.03	.03	.03	.03	.03	.03	.03	.03	.03	.03
.03	.03	.03	.03	.03	.03	.03	.03	.03	.03
.03	.03	.03	.03	.03	.03	.03	.03	.03	.03
.03	.03	.03	.03	.03	.03	.03	.03	.03	.03
.03	.03	.03	.03	.03	.03	.02	.02	.02	.02
.02	.02	.02	.02	.02	.02	.02	.02	.02	.02
.02	.02	.02	.02	.02	.02	.02	.02	.02	.02

39 LU UNIFORM LOSS RATE

STRTL .00 INITIAL LOSS

CNSTL .10 UNIFORM LOSS RATE

RTIMP .00 PERCENT IMPERVIOUS AREA

39 UI INPUT UNITGRAPH, 94 ORDINATES, VOLUME = 1.00

8.0	44.0	130.0	262.0	440.0	606.0	827.0	993.0	1153.0	1265.0
1339.0	1201.0	1021.0	882.0	757.0	670.0	590.0	520.0	466.0	411.0
361.0	324.0	288.0	257.0	232.0	209.0	192.0	177.0	160.0	149.0
138.0	130.0	123.0	117.0	110.0	104.0	99.0	94.0	88.0	84.0
79.0	75.0	71.0	67.0	64.0	60.0	57.0	54.0	51.0	48.0
45.0	43.0	41.0	39.0	37.0	34.0	33.0	31.0	29.0	28.0
26.0	25.0	23.0	22.0	21.0	20.0	19.0	18.0	17.0	16.0
15.0	15.0	14.0	14.0	13.0	12.0	11.0	11.0	10.0	10.0
9.0	8.0	8.0	7.0	6.0	6.0	5.0	4.0	4.0	3.0
3.0	2.0	1.0	1.0						

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value interpolated from DSD Table 3-9 (a regression on the falling limb of the DSD unit hydrograph was used to estimate values for lag plus semi-durations greater than 600 percent). This value was then multiplied by the sub-basin area and the constant 26.89 to determine the unit hydrograph for each sub-basin. The resulting unit hydrographs are presented in Tables 5, 6 and 7 and Figures 3, 4 and 5. Values in the tables are shown at 5-minute intervals for the first 12 hours.

VII. RESERVOIR AND SPILLWAY CHARACTERISTICS

Left Hand Valley Reservoir has a storage capacity of approximately 1,624 acre-feet and an area of approximately 113 acres at the spillway crest elevation of 5351 feet. Each dam has a crest length of approximately 450 feet and the crests are generally at an elevation of 5358 feet although the low point of the top of the dams is at an elevation of approximately 5356.5 feet. Table 8, Figure 6 and Figure 7 show the elevation-capacity and elevation-area relationships for the reservoir. Surface area and storage capacity information were taken from aerial photography provided by the Left Hand Ditch Company dated January 6, 1993.

The existing trapezoidal spillway has a flowline crest length of 40 feet with side slopes of 2:1 and is located in a cut in the south abutment of the north dam. The flowline crest of the spillway is at an elevation of 5351 feet corresponding to the normal high water line of the reservoir. Flows entering the spillway channel are conducted approximately 250 feet to a natural drainage channel which is tributary to Dry Creek below the north dam. At the point where the spillway joins the natural channel the bed slope increases from 0.5 percent to 20 percent and the bottom width reduces to approximately 25 feet. Side slopes are maintained at approximately 2:1. At the change from mild slope to steep slope spillway flows pass through critical depth. This is the hydraulic control point for the spillway. The spillway capacity curve was determined by calculating the backwater effects at the spillway inlet for various flows at the control point. Figure 8 shows the spillway inlet configuration and Table 8 and Figure 9 show the elevation-discharge relationship for the spillway.

VIII. RESULTS

The Army Corps of Engineers HEC-1 program was used to compute inflow hydrographs and routed outflow hydrographs for Left Hand Valley Reservoir. Basic inputs for the determination of overland runoff and the inflow hydrograph were the rainfall depth duration curve described in Table 3, infiltration described in Section V, the unit hydrographs described in Tables 5, 6 and 7 and the sub-basin areas. Lag time and loss rate were assumed to be zero for precipitation on the reservoir surface. Data used to calculate the outflow hydrograph consisted of the reservoir elevation-capacity curve described in Table 8 and Figure 6, the spillway elevation-discharge curve described in Table 8 and Figure 9 and the characteristics of the dams.

The initial water surface was assumed to be at the spillway flowline crest, elevation 5351, for a full reservoir condition. It is assumed that the base flow into the reservoir is 0 cfs as Dry Creek is an ephemeral stream with a very small contributing area. At times the Ditch Company diverts water from Left Hand Creek and passes it through the reservoir for downstream ditches. All such inflows to

the reservoir were assumed to be passing through the outlet works which has a capacity (according to the original construction plans) of 163 cfs at pool elevation 5351. These conditions are modeled in HEC-1 as no inflow and no outlet works discharge. This is slightly conservative since, under normal conditions, discharges through the outlet works would increase a small amount due to the increased head caused by the rising reservoir water surface elevation as the flood hydrograph was routed through the reservoir.

Three conditions were analyzed to determine the maximum reservoir water surface as the inflow design flood routes through the reservoir, Condition 1 - the existing spillway and existing dams with a low point elevation of 5356.5 feet, Condition 2 - the existing spillway with the dams regraded to their original design elevation of 5358 eliminating the low points and Condition 3 - the dams regraded to 5358 feet and an enlarged rectangular spillway of 230 feet crest length.

For Condition 1 with the existing dams and spillway, the runoff flood hydrograph from the design storm routes through the reservoir with 2.92 feet of overtopping of the dams. With the dams regraded to elevation 5358, Condition 2, the flood routes through with 2.59 feet of overtopping of the dams. To prevent overtopping a rectangular spillway with a crest length of 230 feet, assuming a weir coefficient of 3.10, is required to prevent overtopping, as modeled in Condition 3. For the 230 foot spillway the flood routes through the reservoir with 0.03 feet of residual freeboard.

The following table summarizes the results of the analyses for the three conditions. Figure 10 shows the combined inflow flood hydrograph, resulting from runoff from the watershed and rainfall on the lake, and the routed outflow hydrograph for existing dam and spillway, Condition 1. The detailed HEC-1 output for Condition 1 is included as Appendix A.

Left Hand Valley Reservoir
Summary of HEC-1 Results

	Condition	Peak Inflow (cfs)	Peak Outflow (cfs)	Maximum Water Surface Elevation (feet)	Residual Freeboard (-) or Overtopping (+) (feet)
1)	Existing 40 foot Spillway, Existing Dams	17,938	15,565	5359.42	+2.92
2)	Existing 40 foot Spillway, Regraded Dams (elev. 5358)	17,938	14,309	5360.59	+2.59
3)	Regraded Dams 230 foot Spillway	17,938	13,114	5357.97	-0.03

TABLES

Table 1
Left Hand Valley Reservoir
PMP Precipitation Development

Basin Average 10-square mile Index PMP Values

Duration	Rainfall Depth (inches)
1-hour	12.50
6-hour	24.50
24-hour	36.00
72-hour	45.00

3.67-square mile 75 Percent PMP Values

Duration	Rainfall Depth (inches)
1-hour	9.38
6-hour	18.38
24-hour	27.00
72-hour	33.75

Table 2

Left Hand Valley Reservoir
Incremental Rainfall Depths, Determined from Regression Equations

Time (hh mm)	Cumulative Rainfall Depth (inches)	Incremental Rainfall Depth (inches)	Time (hh mm)	Cumulative Rainfall Depth (inches)	Incremental Rainfall Depth (inches)
00 00	0.00		04 00	16.26	0.13
00 05	3.58	3.58	04 05	16.39	0.12
00 10	4.77	1.11	04 10	16.51	0.12
00 15	5.57	0.80	04 15	16.63	0.12
00 20	6.22	0.65	04 20	16.74	0.12
00 25	6.77	0.55	04 25	16.86	0.11
00 30	7.26	0.49	04 30	16.97	0.11
00 35	7.70	0.44	04 35	17.08	0.11
00 40	8.11	0.40	04 40	17.19	0.11
00 45	8.48	0.37	04 45	17.30	0.11
00 50	8.83	0.35	04 50	17.40	0.10
00 55	9.15	0.33	04 55	17.51	0.10
01 00	9.46	0.31	05 00	17.61	0.10
01 05	9.76	0.29	05 05	17.71	0.10
01 10	10.04	0.28	05 10	17.80	0.10
01 15	10.31	0.27	05 15	17.90	0.10
01 20	10.56	0.26	05 20	17.99	0.09
01 25	10.81	0.25	05 25	18.09	0.09
01 30	11.05	0.24	05 30	18.18	0.09
01 35	11.28	0.23	05 35	18.27	0.09
01 40	11.50	0.22	05 40	18.36	0.09
01 45	11.72	0.22	05 45	18.45	0.09
01 50	11.93	0.21	05 50	18.53	0.09
01 55	12.13	0.20	05 55	18.62	0.09
02 00	12.33	0.20	06 00	18.70	0.08
02 05	12.53	0.19	06 05	18.79	0.08
02 10	12.72	0.19	06 10	18.87	0.08
02 15	12.90	0.18	06 15	18.95	0.08
02 20	13.08	0.18	06 20	19.03	0.08
02 25	13.26	0.18	06 25	19.11	0.08
02 30	13.43	0.17	06 30	19.19	0.08
02 35	13.63	0.20	06 35	19.26	0.08
02 40	13.82	0.19	06 40	19.34	0.08
02 45	14.01	0.19	06 45	19.41	0.07
02 50	14.19	0.18	06 50	19.49	0.07
02 55	14.36	0.17	06 55	19.56	0.07
03 00	14.53	0.17	07 00	19.63	0.07
03 05	14.70	0.16	07 05	19.70	0.07
03 10	14.86	0.16	07 10	19.77	0.07
03 15	15.01	0.16	07 15	19.84	0.07
03 20	15.17	0.15	07 20	19.91	0.07
03 25	15.31	0.15	07 25	19.98	0.07
03 30	15.46	0.15	07 30	20.05	0.07
03 35	15.60	0.14	07 35	20.11	0.07
03 40	15.74	0.14	07 40	20.18	0.07
03 45	15.87	0.14	07 45	20.24	0.07
03 50	16.01	0.13	07 50	20.31	0.06
03 55	16.14	0.13	07 55	20.37	0.06

Table 3

Left Hand Valley Reservoir
Arranged Incremental Rainfall Depths

Time (hh mm)	Cumulative Rainfall Depth (inches)	Incremental Rainfall Depth (inches)	Time (hh mm)	Cumulative Rainfall Depth (inches)	Incremental Rainfall Depth (inches)
00 05	0.02	0.02	04 05	1.46	0.04
00 10	0.04	0.02	04 10	1.50	0.04
00 15	0.06	0.02	04 15	1.54	0.05
00 20	0.09	0.02	04 20	1.59	0.05
00 25	0.11	0.02	04 25	1.64	0.05
00 30	0.13	0.02	04 30	1.69	0.05
00 35	0.15	0.02	04 35	1.74	0.05
00 40	0.18	0.02	04 40	1.79	0.05
00 45	0.20	0.02	04 45	1.84	0.05
00 50	0.22	0.02	04 50	1.89	0.05
00 55	0.25	0.02	04 55	1.95	0.05
01 00	0.27	0.02	05 00	2.00	0.06
01 05	0.30	0.02	05 05	2.06	0.06
01 10	0.32	0.02	05 10	2.12	0.06
01 15	0.34	0.02	05 15	2.18	0.06
01 20	0.37	0.03	05 20	2.25	0.06
01 25	0.40	0.03	05 25	2.31	0.07
01 30	0.42	0.03	05 30	2.38	0.07
01 35	0.45	0.03	05 35	2.45	0.07
01 40	0.47	0.03	05 40	2.52	0.07
01 45	0.50	0.03	05 45	2.60	0.08
01 50	0.53	0.03	05 50	2.68	0.08
01 55	0.56	0.03	05 55	2.76	0.08
02 00	0.58	0.03	05 00	2.85	0.09
02 05	0.61	0.03	06 05	2.94	0.09
02 10	0.64	0.03	06 10	3.03	0.09
02 15	0.67	0.03	06 15	3.13	0.10
02 20	0.70	0.03	06 20	3.23	0.10
02 25	0.73	0.03	06 25	3.34	0.11
02 30	0.76	0.03	06 30	3.45	0.11
02 35	0.79	0.03	06 35	3.57	0.12
02 40	0.82	0.03	06 40	3.70	0.13
02 45	0.86	0.03	06 45	3.84	0.14
02 50	0.89	0.03	06 50	3.99	0.15
02 55	0.92	0.03	06 55	4.15	0.16
03 00	0.96	0.03	06 00	4.32	0.17
03 05	0.99	0.03	07 05	4.50	0.18
03 10	1.03	0.03	07 10	4.69	0.19
03 15	1.06	0.04	07 15	4.88	0.19
03 20	1.10	0.04	07 20	5.09	0.20
03 25	1.13	0.04	07 25	5.31	0.22
03 30	1.17	0.04	07 30	5.56	0.25
03 35	1.21	0.04	07 35	5.84	0.28
03 40	1.25	0.04	07 40	6.16	0.33
03 45	1.29	0.04	07 45	6.57	0.40
03 50	1.33	0.04	07 50	7.12	0.55
03 55	1.37	0.04	07 55	8.23	1.11
04 00	1.41	0.04	08 00	11.81	3.58

Table 3 (Continued)

Time (hh mm)	Cumulative Rainfall Depth (inches)	Incremental Rainfall Depth (inches)	Time (hh mm)	Cumulative Rainfall Depth (inches)	Incremental Rainfall Depth (inches)
08 05	12.61	0.80	12 05	21.54	0.08
08 10	13.26	0.65	12 10	21.62	0.08
08 15	13.75	0.49	12 15	21.69	0.08
08 20	14.19	0.44	12 20	21.77	0.08
08 25	14.56	0.37	12 25	21.85	0.07
08 30	14.91	0.35	12 30	21.92	0.07
08 35	15.22	0.31	12 35	21.99	0.07
08 40	15.51	0.29	12 40	22.06	0.07
08 45	15.78	0.27	12 45	22.13	0.07
08 50	16.04	0.26	12 50	22.20	0.07
08 55	16.27	0.24	12 55	22.27	0.07
09 00	16.50	0.23	13 00	22.33	0.07
09 05	16.72	0.22	13 05	22.40	0.07
09 10	16.93	0.21	13 10	22.46	0.06
09 15	17.13	0.20	13 15	22.53	0.06
09 20	17.33	0.20	13 20	22.59	0.06
09 25	17.52	0.19	13 25	22.65	0.06
09 30	17.71	0.19	13 30	22.71	0.06
09 35	17.89	0.18	13 35	22.77	0.06
09 40	18.07	0.18	13 40	22.83	0.06
09 45	18.25	0.18	13 45	22.89	0.06
09 50	18.42	0.17	13 50	22.94	0.06
09 55	18.59	0.17	13 55	23.00	0.06
10 00	18.75	0.16	14 00	23.06	0.06
10 05	18.91	0.16	14 05	23.11	0.05
10 10	19.06	0.15	14 10	23.16	0.05
10 15	19.21	0.15	14 15	23.22	0.05
10 20	19.35	0.14	14 20	23.27	0.05
10 25	19.49	0.14	14 25	23.32	0.05
10 30	19.62	0.13	14 30	23.37	0.05
10 35	19.74	0.13	14 35	23.42	0.05
10 40	19.87	0.12	14 40	23.47	0.05
10 45	19.99	0.12	14 45	23.52	0.05
10 50	20.10	0.12	14 50	23.57	0.05
10 55	20.22	0.11	14 55	23.62	0.05
11 00	20.33	0.11	15 00	23.67	0.05
11 05	20.43	0.11	15 05	23.71	0.05
11 10	20.54	0.10	15 10	23.76	0.05
11 15	20.64	0.10	15 15	23.81	0.05
11 20	20.74	0.10	15 20	23.85	0.05
11 25	20.84	0.10	15 25	23.90	0.04
11 30	20.93	0.09	15 30	23.94	0.04
11 35	21.02	0.09	15 35	23.98	0.04
11 40	21.11	0.09	15 40	24.03	0.04
11 45	21.20	0.09	15 45	24.07	0.04
11 50	21.29	0.09	15 50	24.11	0.04
11 55	21.37	0.08	15 55	24.15	0.04
12 00	21.46	0.08	16 00	24.20	0.04

Table 4
Left Hand Valley Reservoir
Hydrologic Characteristics of Sub-basins A, B and C

Sub-basin	Reach	L_a (miles)		S (feet/mile)	Lag (hours)
A	Above 5800 feet	0.455		1,012	
	5600 feet to 5800 feet	0.492		406	
	Below 5600 feet	1.742		143	
		L = 2.689	L_c = 1.614	S_{ave} = 259	1.04
B	Above 5720 feet	0.530		1,094	
	5440 to 5720 feet	0.492		569	
	Below 5440 feet	0.568		157	
		L = 1.590	L_c =0.795	S_{ave} = 482	0.62
C	Above 5720 feet	0.568		1,549	
	5520 to 5720 feet	0.379		528	
	Below 5520 feet	0.795		212	
		L = 1.742	L_c =0.871	S_{ave} = 541	0.65

Note: $S_{ave} = [(L_1S_1^{0.24} + L_2S_2^{0.24} + L_3S_3^{0.24})/(L_1 + L_2 + L_3)]^{4.17}$

Boulder County Storm Drainage Criteria Manual Equation 619, p. 615.

Lag = $1.6[(L)(L_c)/(S_{ave})^{1/2}]^{0.33}$

Table 5

Left Hand Valley Reservoir
Sub-Basin A Unit Hydrograph

Time (hh mm)	Unitgraph Ordinate (cfs)	Time (hh mm)	Unitgraph Ordinate (cfs)
00 00	0	04 00	54
00 05	8	04 05	51
00 10	44	04 10	48
00 15	130	04 15	45
00 20	262	04 20	43
00 25	440	04 25	41
00 30	606	04 30	39
00 35	827	04 35	37
00 40	993	04 40	34
00 45	1153	04 45	33
00 50	1265	04 50	31
00 55	1339	04 55	29
01 00	1201	05 00	28
01 05	1021	05 05	26
01 10	882	05 10	25
01 15	757	05 15	23
01 20	670	05 20	22
01 25	590	05 25	21
01 30	520	05 30	20
01 35	466	05 35	19
01 40	411	05 40	18
01 45	361	05 45	17
01 50	324	05 50	16
01 55	288	05 55	15
02 00	257	06 00	15
02 05	232	06 05	14
02 10	209	06 10	14
02 15	192	06 15	13
02 20	177	06 20	12
02 25	160	06 25	11
02 30	149	06 30	11
02 35	138	06 35	10
02 40	130	06 40	10
02 45	123	06 45	9
02 50	117	06 50	8
02 55	110	06 55	8
03 00	104	07 00	7
03 05	99	07 05	6
03 10	94	07 10	6
03 15	88	07 15	5
03 20	84	07 20	4
03 25	79	07 25	4
03 30	75	07 30	3
03 35	71	07 35	3
03 40	67	07 40	2
03 45	64	07 45	1
03 50	60	07 50	1
03 55	57	07 55	0

Table 6

Left Hand Valley Reservoir
Sub-Basin B Unit Hydrograph

Time (hh mm)	Unitgraph Ordinate (cfs)	Time (hh mm)	Unitgraph Ordinate (cfs)
00 00	0	03 45	5
00 05	11	03 50	5
00 10	72	03 55	4
00 15	182	04 00	4
00 20	313	04 05	4
00 25	433	04 10	3
00 30	523	04 15	3
00 35	524	04 20	2
00 40	405	04 25	2
00 45	314	04 30	1
00 50	255	04 35	1
00 55	208	04 40	0
01 00	171		
01 05	140		
01 10	115		
01 15	96		
01 20	82		
01 25	71		
01 30	62		
01 35	55		
01 40	50		
01 45	46		
01 50	42		
01 55	38		
02 00	35		
02 05	32		
02 10	29		
02 15	26		
02 20	24		
02 25	22		
02 30	20		
02 35	18		
02 40	17		
02 45	15		
02 50	14		
02 55	13		
03 00	12		
03 05	10		
03 10	10		
03 15	9		
03 20	8		
03 25	7		
03 30	7		
03 35	6		
03 40	6		

Table 7

Left Hand Valley Reservoir
Sub-Basin C Unit Hydrograph

Time (hh mm)	Unitgraph Ordinate (cfs)	Time (hh mm)	Unitgraph Ordinate (cfs)
00 00	0	03 45	8
00 05	12	03 50	7
00 10	81	03 55	7
00 15	209	04 00	6
00 20	359	04 05	5
00 25	515	04 10	5
00 30	629	04 15	5
00 35	685	04 20	4
00 40	549	04 25	3
00 45	432	04 30	3
00 50	349	04 35	2
00 55	284	04 40	2
01 00	237	04 45	1
01 05	193	04 50	1
01 10	160	04 55	0
01 15	134		
01 20	113		
01 25	99		
01 30	85		
01 35	75		
01 40	68		
01 45	62		
01 50	57		
01 55	52		
02 00	48		
02 05	44		
02 10	40		
02 15	37		
02 20	34		
02 25	31		
02 30	28		
02 35	26		
02 40	23		
02 45	21		
02 50	20		
02 55	18		
03 00	17		
03 05	15		
03 10	14		
03 15	13		
03 20	12		
03 25	11		
03 30	10		
03 35	9		
03 40	8		

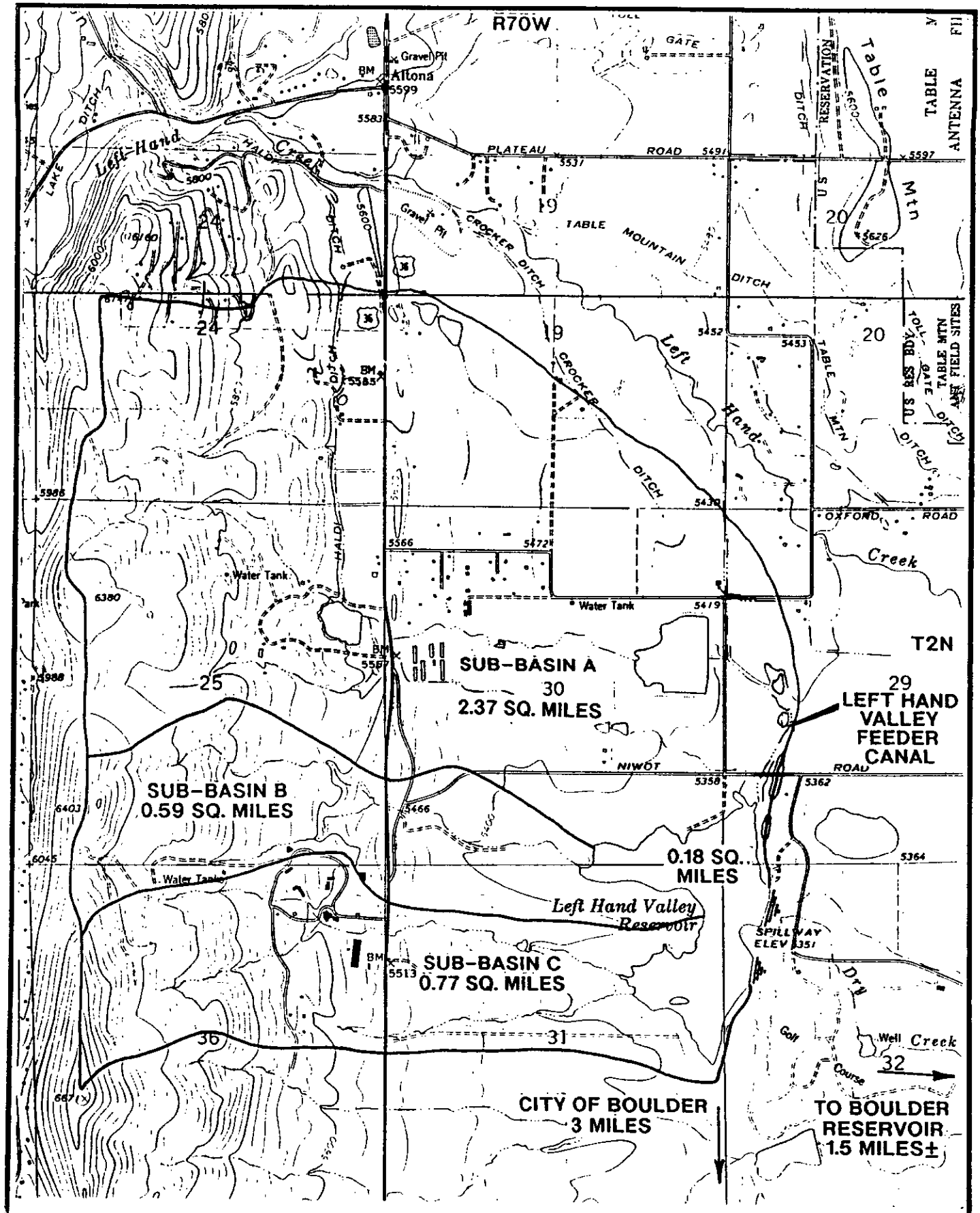
Table 8

Left Hand Valley Reservoir
Reservoir and Spillway Characteristics

Elevation	Surface Area (acres)	Storage Capacity (acre-feet)	Elevation	Spillway Capacity (cfs)
5324	17	100 est.	5351	0
5325	19	118	5352	105
5327	22	159	5353	300
5329	26	207	5354	550
5331	32	265	5355	870
5333	35	332	5356	1,250
5335	43	410	5357	1,690
5337	48	501	5358	2,200
5339	59	608		
5341	65	732		
5343	76	873		
5345	84	1,033		
5347	94	1,211		
5349	103	1,408		
5351	113	1,624		
5353	125	1,863		
5355	137	2,125		
5357	151	2,413		
5359	164	2,728		
5361	179	3,072		

FIGURES

144130



LEFT HAND VALLEY RESERVOIR VICINITY

RMC

FIGURE: 1

Figure 2

75% PMP 10-Square Mile Precipitation

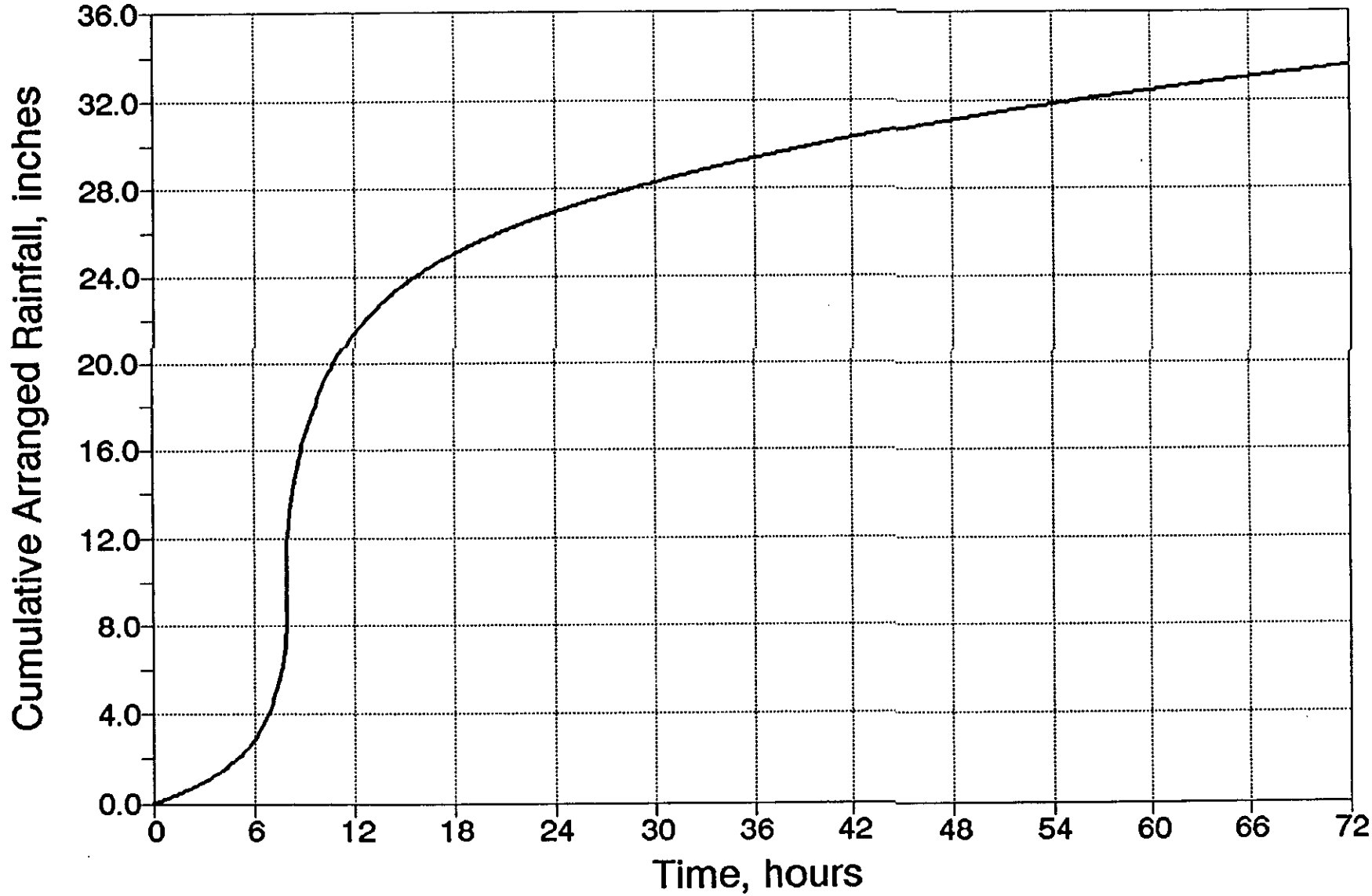


Figure 3

Runoff Unit Hydrograph, Sub-basin A

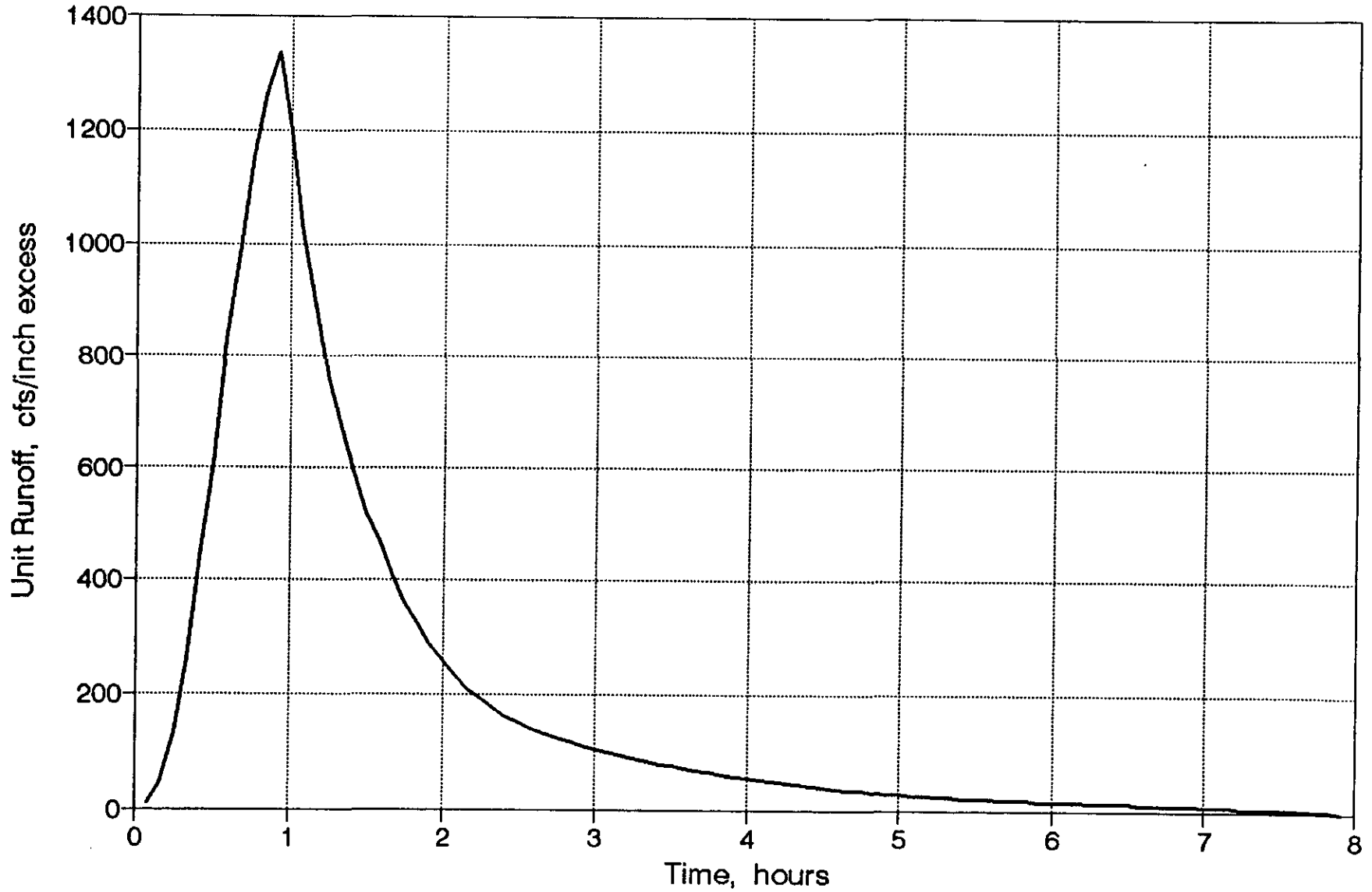


Figure 4

Runoff Unit Hydrograph, Sub-basin B

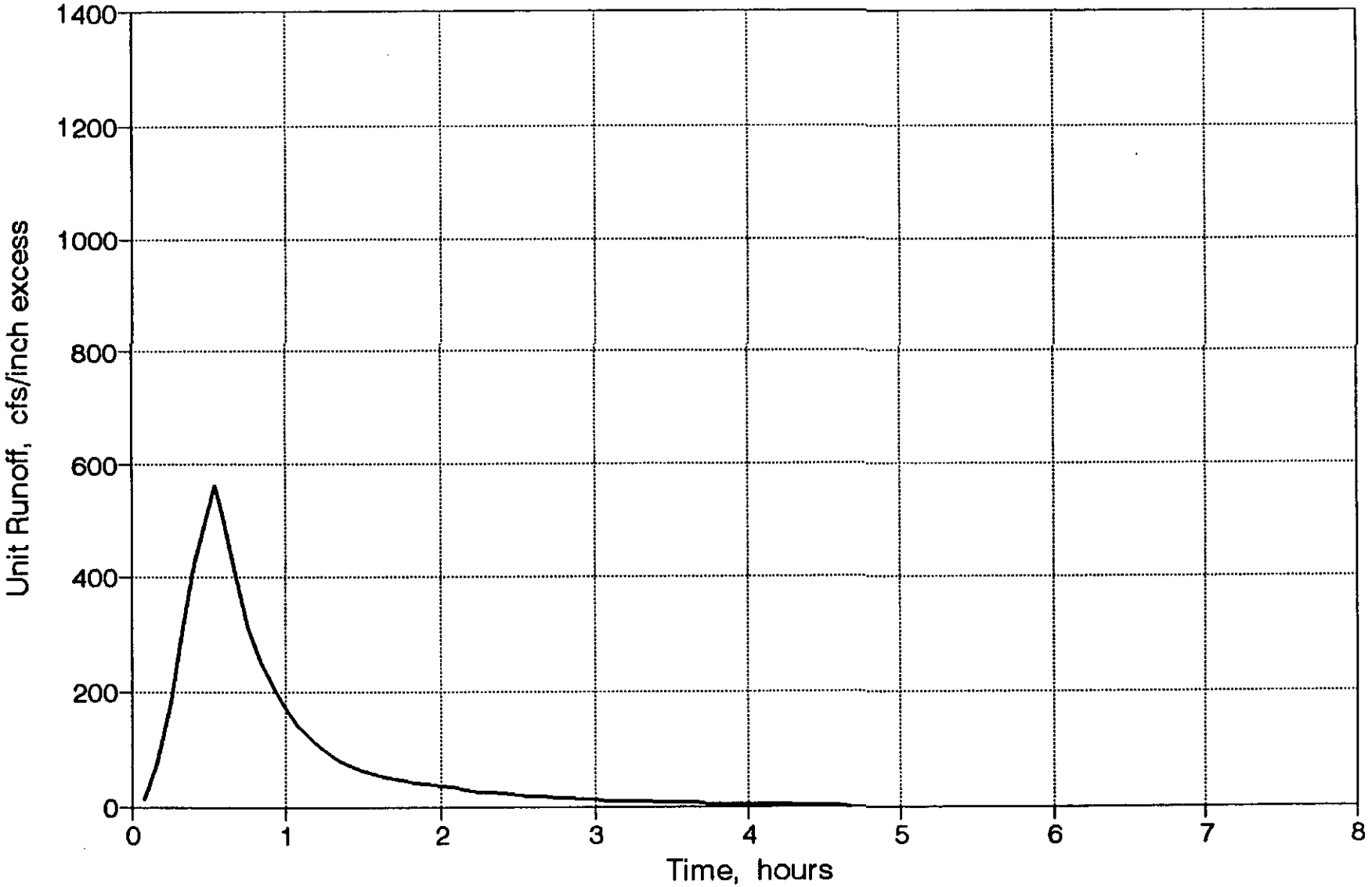


Figure 5

Runoff Unit Hydrograph, Sub-basin C

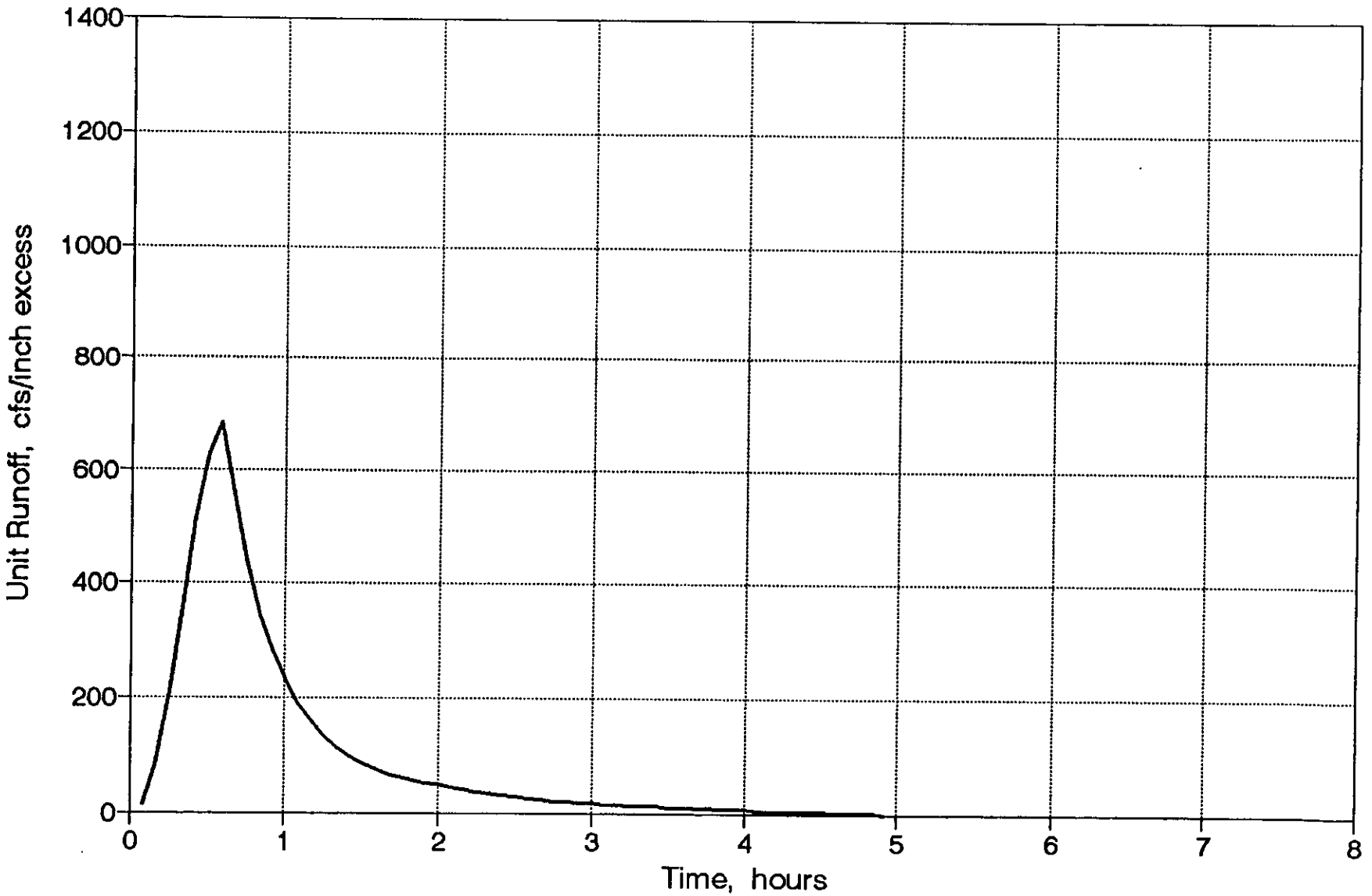


Figure 6

Elevation-Capacity Curve

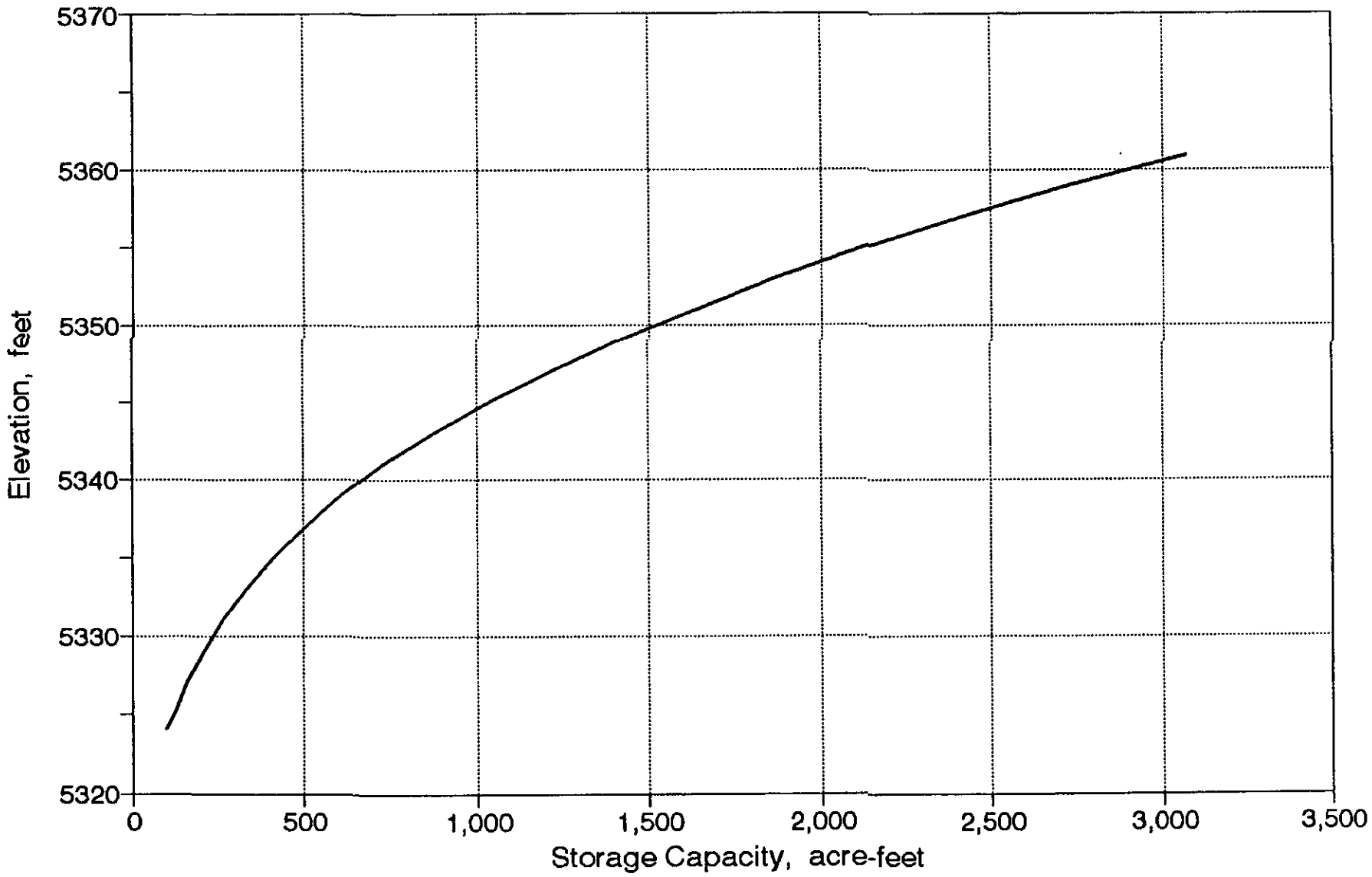


Figure 7

Elevation-Area Curve

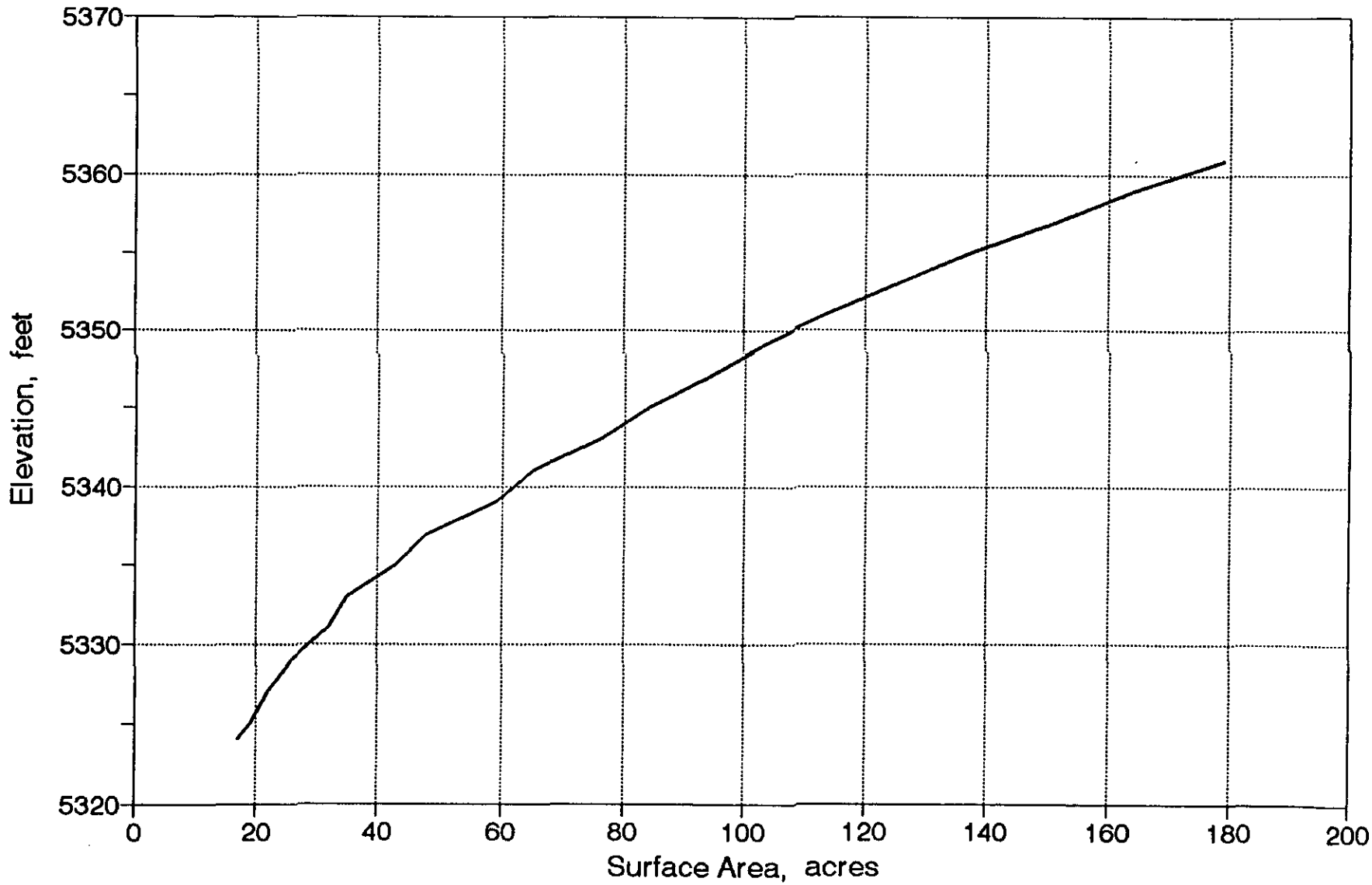


Figure 8

Spillway Flowline Cross Section

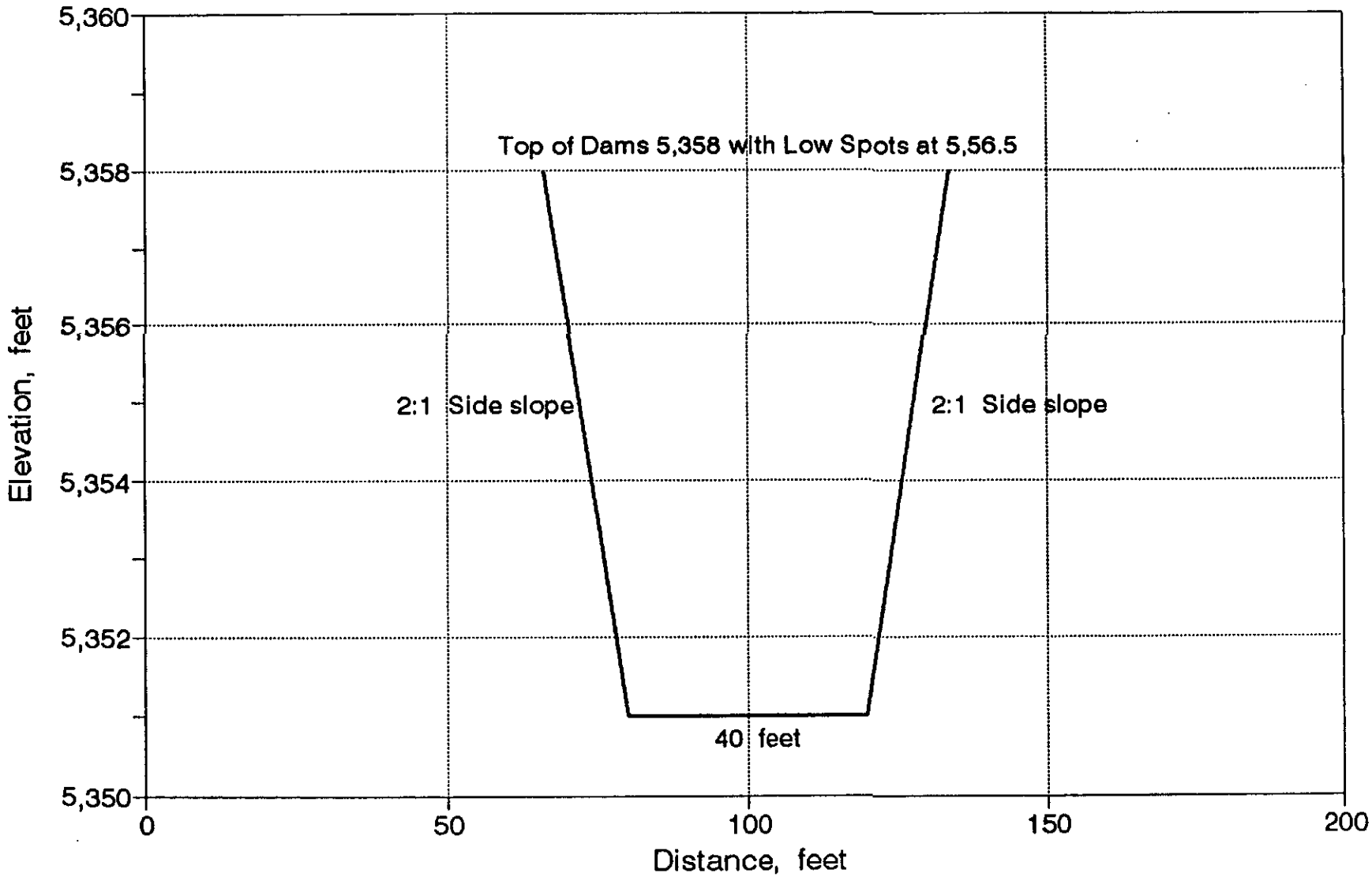


Figure 9

Spillway Elevation-Discharge Curve

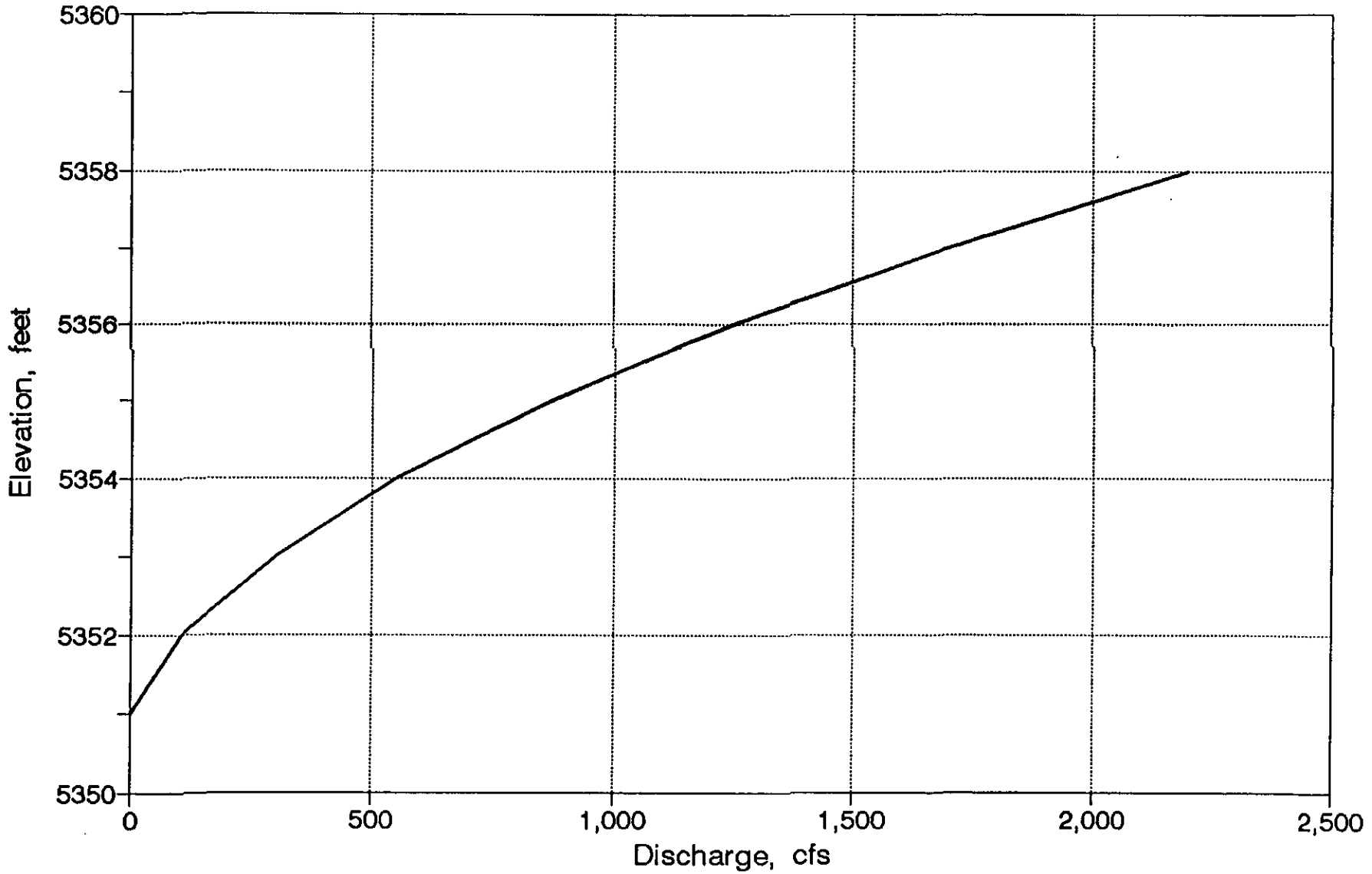
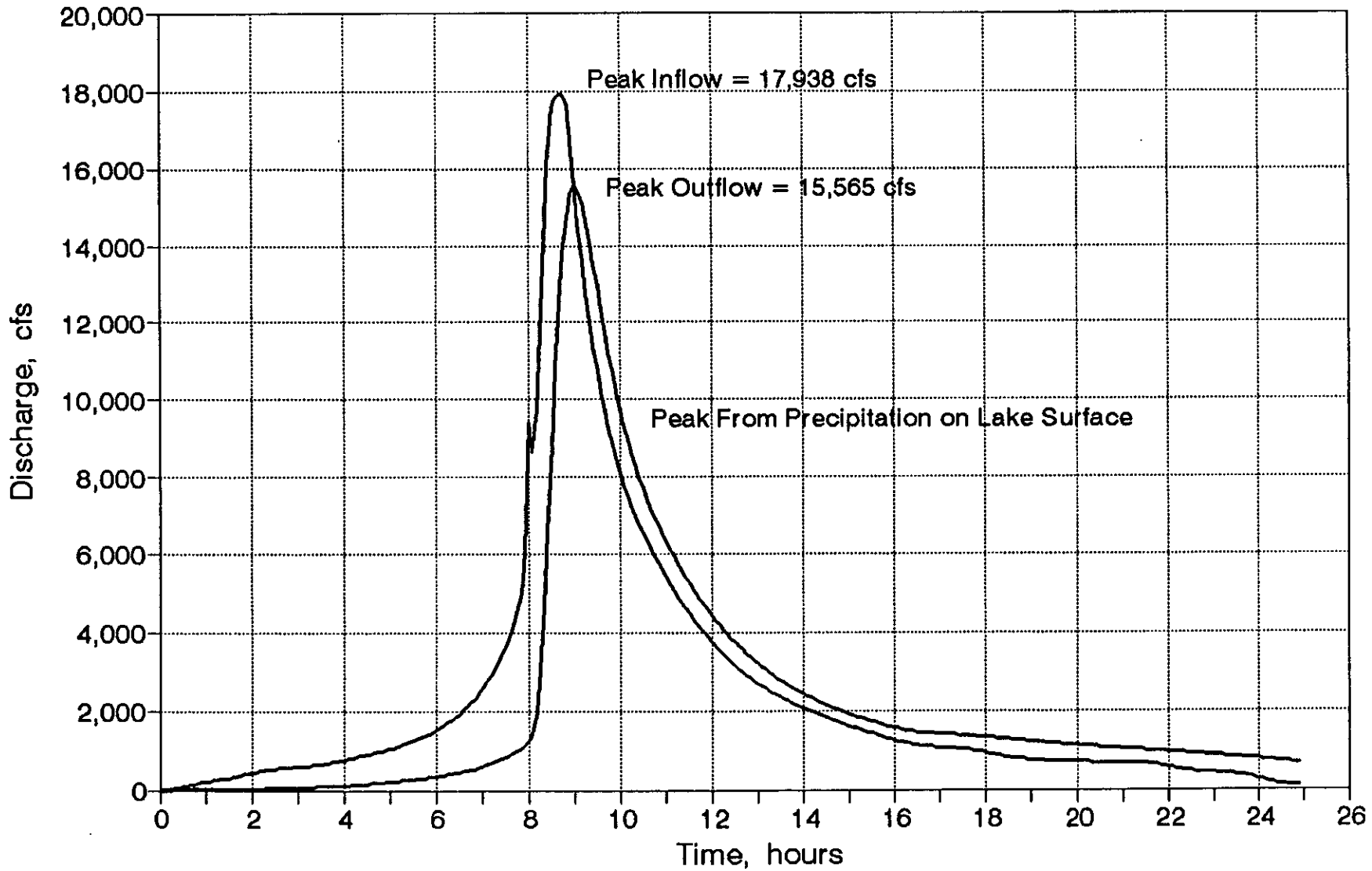


Figure 10

Inflow and Outflow Hydrographs



APPENDIX A

HEC-1 RESULTS, CONDITION 1

```
*****************************************
*                                       *
*   FLOOD HYDROGRAPH PACKAGE  (HEC-1)   *
*           SEPTEMBER 1990              *
*            VERSION 4.0                *
*                                       *
*  RUN DATE  08/09/1993  TIME  13:23:38 *
*                                       *
*****************************************
```


```
*****************************************
*                                       *
*    U.S. ARMY CORPS OF ENGINEERS       *
*    HYDROLOGIC ENGINEERING CENTER      *
*         609 SECOND STREET             *
*       DAVIS, CALIFORNIA 95616         *
*         (916) 756-1104                *
*                                       *
*****************************************
```


```
X     X  XXXXXXX   XXXXX          X
X     X  X        X     X        XX
X     X  X        X              X
XXXXXXX  XXXX     X       XXXXX  X
X     X  X        X              X
X     X  X        X     X        X
X     X  XXXXXXX   XXXXX         XXX
```

```
::::::::::::::::::::::::::::::::::::::::::::
::::::::::::::::::::::::::::::::::::::::::::
:::                                      :::
:::  Full Microcomputer Implementation   :::
:::                 by                   :::
:::         Haestad Methods, Inc.        :::
:::                                      :::
::::::::::::::::::::::::::::::::::::::::::::
::::::::::::::::::::::::::::::::::::::::::::
```

37 Brookside Road * Waterbury, Connecticut 06708 * (203) 755-1666

THIS PROGRAM REPLACES ALL PREVIOUS VERSIONS OF HEC-1 KNOWN AS HEC1 (JAN 73), HEC1GS, HEC1DB, AND HEC1KW.

THE DEFINITIONS OF VARIABLES -RTIMP- AND -RTIOR- HAVE CHANGED FROM THOSE USED WITH THE 1973-STYLE INPUT STRUCTURE.
THE DEFINITION OF -AMSKK- ON RM-CARD WAS CHANGED WITH REVISIONS DATED 28 SEP 81. THIS IS THE FORTRAN77 VERSION
NEW OPTIONS: DAMBREAK OUTFLOW SUBMERGENCE , SINGLE EVENT DAMAGE CALCULATION, DSS:WRITE STAGE FREQUENCY,
DSS:READ TIME SERIES AT DESIRED CALCULATION INTERVAL LOSS RATE:GREEN AND AMPT INFILTRATION
KINEMATIC WAVE: NEW FINITE DIFFERENCE ALGORITHM

```
         LINE          ID.....1.....2.....3.....4.....5.....6.....7.....8.....9.....10

            1          ID   LEFT HAND VALLEY DAM HYDROLOGY - EXISTING CONDITION
            2          ID   75% of PROBABLE MAXIMUM PRECIP
            3          ID   24-HOUR GENERAL STORM, BUREC GREAT PLAINS UNIT HYDROGRAPH
            4          ID   ANALYSIS OF THREE CONTRIBUTING SUB-BASINS PLUS LAKE SURFACE
*** FREE ***
            5          IT     5       0       0     300
            6          IO     0

            7          KK   SUB-A
            8          KM   CALCULATE THE RUNOFF FROM SUBBASIN A
            9          BA    2.37
           10          PB       0
           11          PI     .02     .02     .02     .02     .02     .02     .02     .02     .02     .02
           12          PI     .02     .02     .02     .02     .02     .03     .03     .03     .03     .03
           13          PI     .03     .03     .03     .03     .03     .03     .03     .03     .03     .03
           14          PI     .03     .03     .03     .03     .03     .03     .03     .03     .04     .04
           15          PI     .04     .04     .04     .04     .04     .04     .04     .04     .04     .04
           16          PI     .05     .05     .05     .05     .05     .05     .05     .05     .05     .06
           17          PI     .06     .06     .06     .06     .07     .07     .07     .07     .08     .08
           18          PI     .08     .09     .09     .09     .10     .10     .11     .11     .12     .13
           19          PI     .14     .15     .16     .17     .18     .19     .19     .20     .22     .25
           20          PI     .28     .33     .40     .55    1.11    3.58     .80     .65     .49     .44
           21          PI     .37     .35     .31     .29     .27     .26     .24     .23     .22     .21
           22          PI     .20     .20     .19     .19     .18     .18     .18     .17     .17     .16
           23          PI     .16     .15     .15     .14     .14     .13     .13     .12     .12     .12
           24          PI     .11     .11     .11     .10     .10     .10     .10     .09     .09     .09
           25          PI     .09     .09     .08     .08     .08     .08     .08     .08     .07     .07
           26          PI     .07     .07     .07     .07     .07     .07     .07     .06     .06     .06
           27          PI     .06     .06     .06     .06     .06     .06     .06     .06     .05     .05
           28          PI     .05     .05     .05     .05     .05     .05     .05     .05     .05     .05
           29          PI     .05     .05     .04     .04     .04     .04     .04     .04     .04     .04
           30          PI     .04     .04     .04     .04     .04     .04     .04     .04     .04     .04
           31          PI     .04     .04     .04     .04     .04     .04     .04     .04     .04     .04
           32          PI     .03     .03     .03     .03     .03     .03     .03     .03     .03     .03
           33          PI     .03     .03     .03     .03     .03     .03     .03     .03     .03     .03
           34          PI     .03     .03     .03     .03     .03     .03     .03     .03     .03     .03
           35          PI     .03     .03     .03     .03     .03     .03     .03     .03     .03     .03
           36          PI     .03     .03     .03     .03     .03     .03     .02     .02     .02     .02
           37          PI     .02     .02     .02     .02     .02     .02     .02     .02     .02     .02
           38          PI     .02     .02     .02     .02     .02     .02     .02     .02     .02     .02
           39          LU       0     0.1
           40          UI       8      44     130     262     440     606     827     993    1153    1265
           41          UI    1339    1201    1021     882     757     670     590     520     466     411
           42          UI     361     324     288     257     232     209     192     177     160     149
           43          UI     138     130     123     117     110     104      99      94      88      84
           44          UI      79      75      71      67      64      60      57      54      51      48
           45          UI      45      43      41      39      37      34      33      31      29      28
           46          UI      26      25      23      22      21      20      19      18      17      16
           47          UI      15      15      14      14      13      12      11      11      10      10
           48          UI       9       8       8       7       6       6       5       4       4       3
           49          UI       3       2       1       1       0
```

```
LINE      ID.....1.....2.....3.....4.....5.....6.....7.....8.....9.....10

  50      KK  SUB-B
  51      KM  CALCULATE THE RUNOFF FROM SUBBASIN B
  52      BA   0.59
  53      LU     0     0.1
  54      UI    11      72     182     313     433     523     524     405     314     255
  55      UI   208     171     140     115      96      82      71      62      55      50
  56      UI    46      42      38      35      32      29      26      24      22      20
  57      UI    18      17      15      14      13      12      10      10       9       8
  58      UI     7       7       6       6       5       5       4       4       4       3
  59      UI     3       2       2       1       1       0

  60      KK  SUB-C
  61      KM  CALCULATE THE RUNOFF FROM SUBBASIN C
  62      BA   0.77
  63      LU     0     0.1
  64      UI    12      81     209     359     515     629     685     549     432     349
  65      UI   284     237     193     160     134     113      99      85      75      68
  66      UI    62      57      52      48      44      40      37      34      31      28
  67      UI    26      23      21      20      18      17      15      14      13      12
  68      UI    11      10       9       8       8       7       7       6       5       5
  69      UI     5       4       3       3       2       2       1       1       0

  70      KK   COMB
  71      KM  COMBINE ROUTED HYDROGRAPHS FROM SUBBASINS A,B AND C
  72      HC     3

  73      KK   LAKE
  74      KM  CALCULATE THE RUNOFF FROM THE LAKE
  75      BA  0.176
  76      LU   0.0     0.0
  77      UD     0.

  78      KK   COMB
  79      KM  COMBINE HYDROGRAPH FROM DRAINAGE WITH LAKE SURFACE HYDROGRAPH
  80      HC     2

  81      KK    DAM
  82      KM  ROUTE THE FLOOD HYDROGRAPH THROUGH LEFT HAND VALLEY RESERVOIR
  83      RS     1    ELEV    5351
  84      SV  1624    1863    2125    2413    2728    3072
  85      SE  5351    5353    5355    5357    5359    5361
  86      SQ     0     105     300     550     870    1250    1690    2200    2750    3400
  87      SE  5351    5352    5353    5354    5355    5356    5357    5358    5359    5360
  88      ST 5356.50   900     2.8     1.5
  89      ZZ
```

HYDROGRAPH AT STATION SUB-A

DA	MON	HRMN	ORD	RAIN	LOSS	EXCESS	COMP Q	DA	MON	HRMN	ORD	RAIN	LOSS	EXCESS	COMP Q
1		0000	1	.00	.00	.00	0.	1		1230	151	.07	.01	.06	2140.
1		0005	2	.02	.01	.01	0.	1		1235	152	.07	.01	.06	2081.
1		0010	3	.02	.01	.01	1.	1		1240	153	.07	.01	.06	2029.
1		0015	4	.02	.01	.01	2.	1		1245	154	.07	.01	.06	1974.
1		0020	5	.02	.01	.01	5.	1		1250	155	.07	.01	.06	1922.
1		0025	6	.02	.01	.01	10.	1		1255	156	.07	.01	.06	1874.
1		0030	7	.02	.01	.01	17.	1		1300	157	.07	.01	.06	1826.
1		0035	8	.02	.01	.01	27.	1		1305	158	.07	.01	.06	1781.
1		0040	9	.02	.01	.01	39.	1		1310	159	.06	.01	.05	1735.
1		0045	10	.02	.01	.01	52.	1		1315	160	.06	.01	.05	1693.
1		0050	11	.02	.01	.01	67.	1		1320	161	.06	.01	.05	1654.
1		0055	12	.02	.01	.01	82.	1		1325	162	.06	.01	.05	1617.
1		0100	13	.02	.01	.01	96.	1		1330	163	.06	.01	.05	1582.
1		0105	14	.02	.01	.01	108.	1		1335	164	.06	.01	.05	1547.
1		0110	15	.02	.01	.01	119.	1		1340	165	.06	.01	.05	1512.
1		0115	16	.02	.01	.01	127.	1		1345	166	.06	.01	.05	1477.
1		0120	17	.03	.01	.02	135.	1		1350	167	.06	.01	.05	1444.
1		0125	18	.03	.01	.02	143.	1		1355	168	.06	.01	.05	1412.
1		0130	19	.03	.01	.02	150.	1		1400	169	.06	.01	.05	1380.
1		0135	20	.03	.01	.02	158.	1		1405	170	.05	.01	.04	1352.
1		0140	21	.03	.01	.02	167.	1		1410	171	.05	.01	.04	1323.
1		0145	22	.03	.01	.02	178.	1		1415	172	.05	.01	.04	1296.
1		0150	23	.03	.01	.02	190.	1		1420	173	.05	.01	.04	1270.
1		0155	24	.03	.01	.02	203.	1		1425	174	.05	.01	.04	1246.
1		0200	25	.03	.01	.02	217.	1		1430	175	.05	.01	.04	1220.
1		0205	26	.03	.01	.02	233.	1		1435	176	.05	.01	.04	1195.
1		0210	27	.03	.01	.02	249.	1		1440	177	.05	.01	.04	1166.
1		0215	28	.03	.01	.02	263.	1		1445	178	.05	.01	.04	1138.
1		0220	29	.03	.01	.02	275.	1		1450	179	.05	.01	.04	1111.
1		0225	30	.03	.01	.02	286.	1		1455	180	.05	.01	.04	1082.
1		0230	31	.03	.01	.02	295.	1		1500	181	.05	.01	.04	1055.
1		0235	32	.03	.01	.02	303.	1		1505	182	.05	.01	.04	1034.
1		0240	33	.03	.01	.02	311.	1		1510	183	.05	.01	.04	1011.
1		0245	34	.03	.01	.02	318.	1		1515	184	.04	.01	.03	990.
1		0250	35	.03	.01	.02	324.	1		1520	185	.04	.01	.03	973.
1		0255	36	.03	.01	.02	329.	1		1525	186	.04	.01	.03	954.
1		0300	37	.03	.01	.02	334.	1		1530	187	.04	.01	.03	937.
1		0305	38	.03	.01	.02	338.	1		1535	188	.04	.01	.03	917.
1		0310	39	.03	.01	.02	342.	1		1540	189	.04	.01	.03	896.
1		0315	40	.04	.01	.03	346.	1		1545	190	.04	.01	.03	876.
1		0320	41	.04	.01	.03	350.	1		1550	191	.04	.01	.03	854.
1		0325	42	.04	.01	.03	354.	1		1555	192	.04	.01	.03	833.
1		0330	43	.04	.01	.03	359.	1		1600	193	.04	.01	.03	812.
1		0335	44	.04	.01	.03	366.	1		1605	194	.04	.01	.03	792.
1		0340	45	.04	.01	.03	375.	1		1610	195	.04	.01	.03	773.
1		0345	46	.04	.01	.03	385.	1		1615	196	.04	.01	.03	757.
1		0350	47	.04	.01	.03	397.	1		1620	197	.04	.01	.03	742.
1		0355	48	.04	.01	.03	411.	1		1625	198	.04	.01	.03	730.
1		0400	49	.04	.01	.03	425.	1		1630	199	.04	.01	.03	718.
1		0405	50	.04	.01	.03	440.	1		1635	200	.04	.01	.03	708.
1		0410	51	.04	.01	.03	454.	1		1640	201	.04	.01	.03	698.
1		0415	52	.05	.01	.04	466.	1		1645	202	.04	.01	.03	690.
1		0420	53	.05	.01	.04	477.	1		1650	203	.04	.01	.03	682.
1		0425	54	.05	.01	.04	487.	1		1655	204	.04	.01	.03	675.

1	0430	55	.05	.01	.04	498.	*	1	1700	205	.04	.01	.03	668.
1	0435	56	.05	.01	.04	509.	*	1	1705	206	.04	.01	.03	662.
1	0440	57	.05	.01	.04	522.	*	1	1710	207	.04	.01	.03	657.
1	0445	58	.05	.01	.04	536.	*	1	1715	208	.04	.01	.03	652.
1	0450	59	.05	.01	.04	551.	*	1	1720	209	.04	.01	.03	647.
1	0455	60	.05	.01	.04	567.	*	1	1725	210	.04	.01	.03	643.
1	0500	61	.06	.01	.05	584.	*	1	1730	211	.04	.01	.03	639.
1	0505	62	.06	.01	.05	602.	*	1	1735	212	.03	.01	.02	635.
1	0510	63	.06	.01	.05	618.	*	1	1740	213	.03	.01	.02	632.
1	0515	64	.06	.01	.05	634.	*	1	1745	214	.03	.01	.02	627.
1	0520	65	.06	.01	.05	650.	*	1	1750	215	.03	.01	.02	622.
1	0525	66	.07	.01	.06	667.	*	1	1755	216	.03	.01	.02	614.
1	0530	67	.07	.01	.06	685.	*	1	1800	217	.03	.01	.02	606.
1	0535	68	.07	.01	.06	704.	*	1	1805	218	.03	.01	.02	595.
1	0540	69	.07	.01	.06	725.	*	1	1810	219	.03	.01	.02	583.
1	0545	70	.08	.01	.07	749.	*	1	1815	220	.03	.01	.02	569.
1	0550	71	.08	.01	.07	775.	*	1	1820	221	.03	.01	.02	554.
1	0555	72	.08	.01	.07	802.	*	1	1825	222	.03	.01	.02	539.
1	0600	73	.09	.01	.08	830.	*	1	1830	223	.03	.01	.02	525.
1	0605	74	.09	.01	.08	859.	*	1	1835	224	.03	.01	.02	513.
1	0610	75	.09	.01	.08	891.	*	1	1840	225	.03	.01	.02	503.
1	0615	76	.10	.01	.09	926.	*	1	1845	226	.03	.01	.02	494.
1	0620	77	.10	.01	.09	962.	*	1	1850	227	.03	.01	.02	486.
1	0625	78	.11	.01	.10	999.	*	1	1855	228	.03	.01	.02	479.
1	0630	79	.11	.01	.10	1040.	*	1	1900	229	.03	.01	.02	472.
1	0635	80	.12	.01	.11	1083.	*	1	1905	230	.03	.01	.02	466.
1	0640	81	.13	.01	.12	1129.	*	1	1910	231	.03	.01	.02	461.
1	0645	82	.14	.01	.13	1178.	*	1	1915	232	.03	.01	.02	457.
1	0650	83	.15	.01	.14	1231.	*	1	1920	233	.03	.01	.02	452.
1	0655	84	.16	.01	.15	1288.	*	1	1925	234	.03	.01	.02	449.
1	0700	85	.17	.01	.16	1351.	*	1	1930	235	.03	.01	.02	445.
1	0705	86	.18	.01	.17	1422.	*	1	1935	236	.03	.01	.02	442.
1	0710	87	.19	.01	.18	1499.	*	1	1940	237	.03	.01	.02	439.
1	0715	88	.19	.01	.18	1585.	*	1	1945	238	.03	.01	.02	437.
1	0720	89	.20	.01	.19	1678.	*	1	1950	239	.03	.01	.02	434.
1	0725	90	.22	.01	.21	1780.	*	1	1955	240	.03	.01	.02	432.
1	0730	91	.25	.01	.24	1889.	*	1	2000	241	.03	.01	.02	430.
1	0735	92	.28	.01	.27	2005.	*	1	2005	242	.03	.01	.02	428.
1	0740	93	.33	.01	.32	2129.	*	1	2010	243	.03	.01	.02	426.
1	0745	94	.40	.01	.39	2265.	*	1	2015	244	.03	.01	.02	425.
1	0750	95	.55	.01	.54	2418.	*	1	2020	245	.03	.01	.02	423.
1	0755	96	1.11	.01	1.10	2602.	*	1	2025	246	.03	.01	.02	422.
1	0800	97	3.58	.01	3.57	2866.	*	1	2030	247	.03	.01	.02	420.
1	0805	98	.80	.01	.79	3290.	*	1	2035	248	.03	.01	.02	419.
1	0810	99	.65	.01	.64	3952.	*	1	2040	249	.03	.01	.02	418.
1	0815	100	.49	.01	.48	4844.	*	1	2045	250	.03	.01	.02	417.
1	0820	101	.44	.01	.43	5930.	*	1	2050	251	.03	.01	.02	415.
1	0825	102	.37	.01	.36	7048.	*	1	2055	252	.03	.01	.02	414.
1	0830	103	.35	.01	.34	8305.	*	1	2100	253	.03	.01	.02	413.
1	0835	104	.31	.01	.30	9379.	*	1	2105	254	.03	.01	.02	412.
1	0840	105	.29	.01	.28	10347.	*	1	2110	255	.03	.01	.02	412.
1	0845	106	.27	.01	.26	11047.	*	1	2115	256	.03	.01	.02	411.
1	0850	107	.26	.01	.25	11405.	*	1	2120	257	.03	.01	.02	410.
1	0855	108	.24	.01	.23	10991.	*	1	2125	258	.02	.01	.01	409.
1	0900	109	.23	.01	.22	10334.	*	1	2130	259	.02	.01	.01	408.
1	0905	110	.22	.01	.21	9706.	*	1	2135	260	.02	.01	.01	406.
1	0910	111	.21	.01	.20	9095.	*	1	2140	261	.02	.01	.01	403.
1	0915	112	.20	.01	.19	8577.	*	1	2145	262	.02	.01	.01	398.
1	0920	113	.20	.01	.19	8083.	*	1	2150	263	.02	.01	.01	391.
1	0925	114	.19	.01	.18	7626.	*	1	2155	264	.02	.01	.01	383.

1	0930	115	.19	.01	.18	7219.	*	1	2200	265	.02	.01	.01	372.
1	0935	116	.18	.01	.17	6821.	*	1	2205	266	.02	.01	.01	360.
1	0940	117	.18	.01	.17	6453.	*	1	2210	267	.02	.01	.01	347.
1	0945	118	.18	.01	.17	6132.	*	1	2215	268	.02	.01	.01	333.
1	0950	119	.17	.01	.16	5830.	*	1	2220	269	.02	.01	.01	321.
1	0955	120	.17	.01	.16	5558.	*	1	2225	270	.02	.01	.01	310.
1	1000	121	.16	.01	.15	5318.	*	1	2230	271	.02	.01	.01	301.
1	1005	122	.16	.01	.15	5099.	*	1	2235	272	.02	.01	.01	293.
1	1010	123	.15	.01	.14	4910.	*	1	2240	273	.02	.01	.01	286.
1	1015	124	.15	.01	.14	4737.	*	1	2245	274	.02	.01	.01	280.
1	1020	125	.14	.01	.13	4569.	*	1	2250	275	.02	.01	.01	275.
1	1025	126	.14	.01	.13	4425.	*	1	2255	276	.02	.01	.01	270.
1	1030	127	.13	.01	.12	4288.	*	1	2300	277	.02	.01	.01	266.
1	1035	128	.13	.01	.12	4166.	*	1	2305	278	.02	.01	.01	262.
1	1040	129	.12	.01	.11	4049.	*	1	2310	279	.02	.01	.01	258.
1	1045	130	.12	.01	.11	3937.	*	1	2315	280	.02	.01	.01	255.
1	1050	131	.12	.01	.11	3824.	*	1	2320	281	.02	.01	.01	253.
1	1055	132	.11	.01	.10	3715.	*	1	2325	282	.00	.00	.00	250.
1	1100	133	.11	.01	.10	3610.	*	1	2330	283	.00	.00	.00	247.
1	1105	134	.11	.01	.10	3506.	*	1	2335	284	.00	.00	.00	244.
1	1110	135	.10	.01	.09	3400.	*	1	2340	285	.00	.00	.00	239.
1	1115	136	.10	.01	.09	3302.	*	1	2345	286	.00	.00	.00	232.
1	1120	137	.10	.01	.09	3203.	*	1	2350	287	.00	.00	.00	223.
1	1125	138	.10	.01	.09	3109.	*	1	2355	288	.00	.00	.00	212.
1	1130	139	.09	.01	.08	3017.	*	2	0000	289	.00	.00	.00	199.
1	1135	140	.09	.01	.08	2928.	*	2	0005	290	.00	.00	.00	184.
1	1140	141	.09	.01	.08	2844.	*	2	0010	291	.00	.00	.00	168.
1	1145	142	.09	.01	.08	2759.	*	2	0015	292	.00	.00	.00	151.
1	1150	143	.09	.01	.08	2680.	*	2	0020	293	.00	.00	.00	136.
1	1155	144	.08	.01	.07	2603.	*	2	0025	294	.00	.00	.00	123.
1	1200	145	.08	.01	.07	2528.	*	2	0030	295	.00	.00	.00	112.
1	1205	146	.08	.01	.07	2456.	*	2	0035	296	.00	.00	.00	102.
1	1210	147	.08	.01	.07	2386.	*	2	0040	297	.00	.00	.00	94.
1	1215	148	.08	.01	.07	2322.	*	2	0045	298	.00	.00	.00	86.
1	1220	149	.08	.01	.07	2259.	*	2	0050	299	.00	.00	.00	79.
1	1225	150	.07	.01	.06	2198.	*	2	0055	300	.00	.00	.00	73.
							*							

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TOTAL RAINFALL = 26.72, TOTAL LOSS = 2.33, TOTAL EXCESS = 24.39

PEAK FLOW	TIME		MAXIMUM AVERAGE FLOW			
(CFS)	(HR)		6-HR	24-HR	72-HR	24.92-HR
11405.	8.83	(CFS)	4455.	1554.	1498.	1498.
		(INCHES)	17.478	24.383	24.398	24.398
		(AC-FT)	2209.	3082.	3084.	3084.

CUMULATIVE AREA = 2.37 SQ MI

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50 KK

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* *
* SUB-B *
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CALCULATE THE RUNOFF FROM SUBBASIN B

SUBBASIN RUNOFF DATA

52 BA SUBBASIN CHARACTERISTICS

TAREA .59 SUBBASIN AREA

PRECIPITATION DATA

10 PB STORM 26.72 BASIN TOTAL PRECIPITATION

11 PI INCREMENTAL PRECIPITATION PATTERN

.02	.02	.02	.02	.02	.02	.02	.02	.02	.02
.02	.02	.02	.02	.02	.03	.03	.03	.03	.03
.03	.03	.03	.03	.03	.03	.03	.03	.03	.03
.03	.03	.03	.03	.03	.03	.03	.03	.04	.04
.04	.04	.04	.04	.04	.04	.04	.04	.04	.04
.05	.05	.05	.05	.05	.05	.05	.05	.05	.06
.06	.06	.06	.06	.07	.07	.07	.07	.08	.08
.08	.09	.09	.09	.10	.10	.11	.11	.12	.13
.14	.15	.16	.17	.18	.19	.19	.20	.22	.25
.28	.33	.40	.55	1.11	3.58	.80	.65	.49	.44
.37	.35	.31	.29	.27	.26	.24	.23	.22	.21
.20	.20	.19	.19	.18	.18	.18	.17	.17	.16
.16	.15	.15	.14	.14	.13	.13	.12	.12	.12
.11	.11	.11	.10	.10	.10	.10	.09	.09	.09
.09	.09	.08	.08	.08	.08	.08	.08	.07	.07
.07	.07	.07	.07	.07	.07	.07	.06	.06	.06
.06	.06	.06	.06	.06	.06	.06	.06	.05	.05
.05	.05	.05	.05	.05	.05	.05	.05	.05	.05
.05	.05	.04	.04	.04	.04	.04	.04	.04	.04
.04	.04	.04	.04	.04	.04	.04	.04	.04	.04
.04	.04	.04	.04	.04	.04	.04	.04	.04	.04
.03	.03	.03	.03	.03	.03	.03	.03	.03	.03
.03	.03	.03	.03	.03	.03	.03	.03	.03	.03
.03	.03	.03	.03	.03	.03	.03	.03	.03	.03
.03	.03	.03	.03	.03	.03	.03	.03	.03	.03
.03	.03	.03	.03	.03	.03	.02	.02	.02	.02
.02	.02	.02	.02	.02	.02	.02	.02	.02	.02
.02	.02	.02	.02	.02	.02	.02	.02	.02	.02

53 LU UNIFORM LOSS RATE

STRTL .00 INITIAL LOSS

CNSTL .10 UNIFORM LOSS RATE

RTIMP .00 PERCENT IMPERVIOUS AREA

51 UI INPUT UNITGRAPH, 55 ORDINATES, VOLUME = 1.00

11.0	72.0	182.0	313.0	433.0	523.0	524.0	405.0	314.0	255.0
208.0	171.0	140.0	115.0	96.0	82.0	71.0	62.0	55.0	50.0
46.0	42.0	38.0	35.0	32.0	29.0	26.0	24.0	22.0	20.0
18.0	17.0	15.0	14.0	13.0	12.0	10.0	10.0	9.0	8.0
7.0	7.0	6.0	6.0	5.0	5.0	4.0	4.0	4.0	3.0
3.0	2.0	2.0	1.0	1.0					

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HYDROGRAPH AT STATION SUB-B

DA	MON	HRMN	ORD	RAIN	LOSS	EXCESS	COMP Q	DA	MON	HRMN	ORD	RAIN	LOSS	EXCESS	COMP Q
1		0000	1	.00	.00	.00	0.	1		1230	151	.07	.01	.06	396.
1		0005	2	.02	.01	.01	0.	1		1235	152	.07	.01	.06	383.
1		0010	3	.02	.01	.01	1.	1		1240	153	.07	.01	.06	373.
1		0015	4	.02	.01	.01	3.	1		1245	154	.07	.01	.06	362.
1		0020	5	.02	.01	.01	7.	1		1250	155	.07	.01	.06	352.
1		0025	6	.02	.01	.01	12.	1		1255	156	.07	.01	.06	342.
1		0030	7	.02	.01	.01	18.	1		1300	157	.07	.01	.06	335.
1		0035	8	.02	.01	.01	24.	1		1305	158	.07	.01	.06	328.
1		0040	9	.02	.01	.01	29.	1		1310	159	.06	.01	.05	323.
1		0045	10	.02	.01	.01	32.	1		1315	160	.06	.01	.05	317.
1		0050	11	.02	.01	.01	35.	1		1320	161	.06	.01	.05	311.
1		0055	12	.02	.01	.01	38.	1		1325	162	.06	.01	.05	305.
1		0100	13	.02	.01	.01	40.	1		1330	163	.06	.01	.05	297.
1		0105	14	.02	.01	.01	41.	1		1335	164	.06	.01	.05	290.
1		0110	15	.02	.01	.01	43.	1		1340	165	.06	.01	.05	282.
1		0115	16	.02	.01	.01	44.	1		1345	166	.06	.01	.05	276.
1		0120	17	.03	.01	.02	45.	1		1350	167	.06	.01	.05	271.
1		0125	18	.03	.01	.02	47.	1		1355	168	.06	.01	.05	267.
1		0130	19	.03	.01	.02	49.	1		1400	169	.06	.01	.05	263.
1		0135	20	.03	.01	.02	53.	1		1405	170	.05	.01	.04	260.
1		0140	21	.03	.01	.02	58.	1		1410	171	.05	.01	.04	257.
1		0145	22	.03	.01	.02	64.	1		1415	172	.05	.01	.04	252.
1		0150	23	.03	.01	.02	69.	1		1420	173	.05	.01	.04	247.
1		0155	24	.03	.01	.02	74.	1		1425	174	.05	.01	.04	241.
1		0200	25	.03	.01	.02	77.	1		1430	175	.05	.01	.04	234.
1		0205	26	.03	.01	.02	80.	1		1435	176	.05	.01	.04	228.
1		0210	27	.03	.01	.02	83.	1		1440	177	.05	.01	.04	223.
1		0215	28	.03	.01	.02	85.	1		1445	178	.05	.01	.04	218.
1		0220	29	.03	.01	.02	86.	1		1450	179	.05	.01	.04	215.
1		0225	30	.03	.01	.02	88.	1		1455	180	.05	.01	.04	212.
1		0230	31	.03	.01	.02	89.	1		1500	181	.05	.01	.04	209.
1		0235	32	.03	.01	.02	90.	1		1505	182	.05	.01	.04	207.
1		0240	33	.03	.01	.02	91.	1		1510	183	.05	.01	.04	205.
1		0245	34	.03	.01	.02	92.	1		1515	184	.04	.01	.03	204.
1		0250	35	.03	.01	.02	92.	1		1520	185	.04	.01	.03	202.
1		0255	36	.03	.01	.02	93.	1		1525	186	.04	.01	.03	199.
1		0300	37	.03	.01	.02	94.	1		1530	187	.04	.01	.03	194.
1		0305	38	.03	.01	.02	94.	1		1535	188	.04	.01	.03	189.
1		0310	39	.03	.01	.02	95.	1		1540	189	.04	.01	.03	183.
1		0315	40	.04	.01	.03	95.	1		1545	190	.04	.01	.03	177.
1		0320	41	.04	.01	.03	96.	1		1550	191	.04	.01	.03	172.
1		0325	42	.04	.01	.03	99.	1		1555	192	.04	.01	.03	169.
1		0330	43	.04	.01	.03	102.	1		1600	193	.04	.01	.03	166.
1		0335	44	.04	.01	.03	107.	1		1605	194	.04	.01	.03	163.
1		0340	45	.04	.01	.03	112.	1		1610	195	.04	.01	.03	161.
1		0345	46	.04	.01	.03	118.	1		1615	196	.04	.01	.03	159.
1		0350	47	.04	.01	.03	122.	1		1620	197	.04	.01	.03	157.
1		0355	48	.04	.01	.03	125.	1		1625	198	.04	.01	.03	156.
1		0400	49	.04	.01	.03	128.	1		1630	199	.04	.01	.03	155.
1		0405	50	.04	.01	.03	130.	1		1635	200	.04	.01	.03	154.
1		0410	51	.04	.01	.03	132.	1		1640	201	.04	.01	.03	153.
1		0415	52	.05	.01	.04	134.	1		1645	202	.04	.01	.03	152.
1		0420	53	.05	.01	.04	136.	1		1650	203	.04	.01	.03	152.
1		0425	54	.05	.01	.04	139.	1		1655	204	.04	.01	.03	151.
1		0430	55	.05	.01	.04	143.	1		1700	205	.04	.01	.03	150.
1		0435	56	.05	.01	.04	148.	1		1705	206	.04	.01	.03	150.

1	0440	57	.05	.01	.04	154.	*	1	1710	207	.04	.01	.03	149.
1	0445	58	.05	.01	.04	160.	*	1	1715	208	.04	.01	.03	149.
1	0450	59	.05	.01	.04	164.	*	1	1720	209	.04	.01	.03	149.
1	0455	60	.05	.01	.04	168.	*	1	1725	210	.04	.01	.03	148.
1	0500	61	.06	.01	.05	171.	*	1	1730	211	.04	.01	.03	148.
1	0505	62	.06	.01	.05	174.	*	1	1735	212	.03	.01	.02	147.
1	0510	63	.06	.01	.05	178.	*	1	1740	213	.03	.01	.02	146.
1	0515	64	.06	.01	.05	183.	*	1	1745	214	.03	.01	.02	144.
1	0520	65	.06	.01	.05	189.	*	1	1750	215	.03	.01	.02	141.
1	0525	66	.07	.01	.06	196.	*	1	1755	216	.03	.01	.02	137.
1	0530	67	.07	.01	.06	203.	*	1	1800	217	.03	.01	.02	131.
1	0535	68	.07	.01	.06	209.	*	1	1805	218	.03	.01	.02	126.
1	0540	69	.07	.01	.06	217.	*	1	1810	219	.03	.01	.02	122.
1	0545	70	.08	.01	.07	224.	*	1	1815	220	.03	.01	.02	118.
1	0550	71	.08	.01	.07	233.	*	1	1820	221	.03	.01	.02	116.
1	0555	72	.08	.01	.07	242.	*	1	1825	222	.03	.01	.02	113.
1	0600	73	.09	.01	.08	252.	*	1	1830	223	.03	.01	.02	112.
1	0605	74	.09	.01	.08	261.	*	1	1835	224	.03	.01	.02	110.
1	0610	75	.09	.01	.08	272.	*	1	1840	225	.03	.01	.02	109.
1	0615	76	.10	.01	.09	284.	*	1	1845	226	.03	.01	.02	108.
1	0620	77	.10	.01	.09	296.	*	1	1850	227	.03	.01	.02	107.
1	0625	78	.11	.01	.10	309.	*	1	1855	228	.03	.01	.02	106.
1	0630	79	.11	.01	.10	323.	*	1	1900	229	.03	.01	.02	106.
1	0635	80	.12	.01	.11	337.	*	1	1905	230	.03	.01	.02	105.
1	0640	81	.13	.01	.12	352.	*	1	1910	231	.03	.01	.02	104.
1	0645	82	.14	.01	.13	370.	*	1	1915	232	.03	.01	.02	104.
1	0650	83	.15	.01	.14	389.	*	1	1920	233	.03	.01	.02	103.
1	0655	84	.16	.01	.15	412.	*	1	1925	234	.03	.01	.02	103.
1	0700	85	.17	.01	.16	437.	*	1	1930	235	.03	.01	.02	103.
1	0705	86	.18	.01	.17	465.	*	1	1935	236	.03	.01	.02	102.
1	0710	87	.19	.01	.18	497.	*	1	1940	237	.03	.01	.02	102.
1	0715	88	.19	.01	.18	530.	*	1	1945	238	.03	.01	.02	102.
1	0720	89	.20	.01	.19	564.	*	1	1950	239	.03	.01	.02	102.
1	0725	90	.22	.01	.21	599.	*	1	1955	240	.03	.01	.02	101.
1	0730	91	.25	.01	.24	634.	*	1	2000	241	.03	.01	.02	101.
1	0735	92	.28	.01	.27	672.	*	1	2005	242	.03	.01	.02	101.
1	0740	93	.33	.01	.32	715.	*	1	2010	243	.03	.01	.02	101.
1	0745	94	.40	.01	.39	768.	*	1	2015	244	.03	.01	.02	101.
1	0750	95	.55	.01	.54	837.	*	1	2020	245	.03	.01	.02	100.
1	0755	96	1.11	.01	1.10	939.	*	1	2025	246	.03	.01	.02	100.
1	0800	97	3.58	.01	3.57	1132.	*	1	2030	247	.03	.01	.02	100.
1	0805	98	.80	.01	.79	1530.	*	1	2035	248	.03	.01	.02	100.
1	0810	99	.65	.01	.64	2118.	*	1	2040	249	.03	.01	.02	100.
1	0815	100	.49	.01	.48	2781.	*	1	2045	250	.03	.01	.02	100.
1	0820	101	.44	.01	.43	3381.	*	1	2050	251	.03	.01	.02	100.
1	0825	102	.37	.01	.36	3799.	*	1	2055	252	.03	.01	.02	100.
1	0830	103	.35	.01	.34	3829.	*	1	2100	253	.03	.01	.02	100.
1	0835	104	.31	.01	.30	3447.	*	1	2105	254	.03	.01	.02	100.
1	0840	105	.29	.01	.28	3090.	*	1	2110	255	.03	.01	.02	100.
1	0845	106	.27	.01	.26	2800.	*	1	2115	256	.03	.01	.02	100.
1	0850	107	.26	.01	.25	2543.	*	1	2120	257	.03	.01	.02	100.
1	0855	108	.24	.01	.23	2318.	*	1	2125	258	.02	.01	.01	99.
1	0900	109	.23	.01	.22	2119.	*	1	2130	259	.02	.01	.01	99.
1	0905	110	.22	.01	.21	1945.	*	1	2135	260	.02	.01	.01	97.
1	0910	111	.21	.01	.20	1800.	*	1	2140	261	.02	.01	.01	94.
1	0915	112	.20	.01	.19	1678.	*	1	2145	262	.02	.01	.01	89.
1	0920	113	.20	.01	.19	1573.	*	1	2150	263	.02	.01	.01	84.
1	0925	114	.19	.01	.18	1482.	*	1	2155	264	.02	.01	.01	79.
1	0930	115	.19	.01	.18	1404.	*	1	2200	265	.02	.01	.01	75.
1	0935	116	.18	.01	.17	1339.	*	1	2205	266	.02	.01	.01	72.

1	0940	117	.18	.01	.17	1282.	*	1	2210	267	.02	.01	.01	69.
1	0945	118	.18	.01	.17	1229.	*	1	2215	268	.02	.01	.01	67.
1	0950	119	.17	.01	.16	1181.	*	1	2220	269	.02	.01	.01	65.
1	0955	120	.17	.01	.16	1138.	*	1	2225	270	.02	.01	.01	64.
1	1000	121	.16	.01	.15	1099.	*	1	2230	271	.02	.01	.01	63.
1	1005	122	.16	.01	.15	1061.	*	1	2235	272	.02	.01	.01	62.
1	1010	123	.15	.01	.14	1024.	*	1	2240	273	.02	.01	.01	61.
1	1015	124	.15	.01	.14	991.	*	1	2245	274	.02	.01	.01	60.
1	1020	125	.14	.01	.13	958.	*	1	2250	275	.02	.01	.01	60.
1	1025	126	.14	.01	.13	926.	*	1	2255	276	.02	.01	.01	59.
1	1030	127	.13	.01	.12	894.	*	1	2300	277	.02	.01	.01	58.
1	1035	128	.13	.01	.12	865.	*	1	2305	278	.02	.01	.01	58.
1	1040	129	.12	.01	.11	833.	*	1	2310	279	.02	.01	.01	58.
1	1045	130	.12	.01	.11	804.	*	1	2315	280	.02	.01	.01	57.
1	1050	131	.12	.01	.11	776.	*	1	2320	281	.02	.01	.01	57.
1	1055	132	.11	.01	.10	748.	*	1	2325	282	.00	.00	.00	56.
1	1100	133	.11	.01	.10	718.	*	1	2330	283	.00	.00	.00	55.
1	1105	134	.11	.01	.10	695.	*	1	2335	284	.00	.00	.00	53.
1	1110	135	.10	.01	.09	670.	*	1	2340	285	.00	.00	.00	49.
1	1115	136	.10	.01	.09	646.	*	1	2345	286	.00	.00	.00	44.
1	1120	137	.10	.01	.09	623.	*	1	2350	287	.00	.00	.00	37.
1	1125	138	.10	.01	.09	603.	*	1	2355	288	.00	.00	.00	31.
1	1130	139	.09	.01	.08	582.	*	2	0000	289	.00	.00	.00	26.
1	1135	140	.09	.01	.08	564.	*	2	0005	290	.00	.00	.00	22.
1	1140	141	.09	.01	.08	545.	*	2	0010	291	.00	.00	.00	19.
1	1145	142	.09	.01	.08	528.	*	2	0015	292	.00	.00	.00	17.
1	1150	143	.09	.01	.08	510.	*	2	0020	293	.00	.00	.00	15.
1	1155	144	.08	.01	.07	496.	*	2	0025	294	.00	.00	.00	13.
1	1200	145	.08	.01	.07	481.	*	2	0030	295	.00	.00	.00	11.
1	1205	146	.08	.01	.07	465.	*	2	0035	296	.00	.00	.00	10.
1	1210	147	.08	.01	.07	452.	*	2	0040	297	.00	.00	.00	9.
1	1215	148	.08	.01	.07	436.	*	2	0045	298	.00	.00	.00	8.
1	1220	149	.08	.01	.07	423.	*	2	0050	299	.00	.00	.00	8.
1	1225	150	.07	.01	.06	408.	*	2	0055	300	.00	.00	.00	7.
							*							

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TOTAL RAINFALL = 26.72, TOTAL LOSS = 2.33, TOTAL EXCESS = 24.39

PEAK FLOW	TIME		MAXIMUM AVERAGE FLOW			
(CFS)	(HR)		6-HR	24-HR	72-HR	24.92-HR
3829.	8.50	(CFS)	1135.	388.	374.	374.
		(INCHES)	17.890	24.427	24.443	24.443
		(AC-FT)	563.	769.	769.	769.

CUMULATIVE AREA = .59 SQ MI

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          *            *
60 KK     *     SUB-C  *
          *            *
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CALCULATE THE RUNOFF FROM SUBBASIN C

SUBBASIN RUNOFF DATA

62 BA SUBBASIN CHARACTERISTICS

TAREA .77 SUBBASIN AREA

PRECIPITATION DATA

10 PB STORM 26.72 BASIN TOTAL PRECIPITATION

11 PI INCREMENTAL PRECIPITATION PATTERN

.02	.02	.02	.02	.02	.02	.02	.02	.02	.02
.02	.02	.02	.02	.02	.03	.03	.03	.03	.03
.03	.03	.03	.03	.03	.03	.03	.03	.03	.03
.03	.03	.03	.03	.03	.03	.03	.03	.04	.04
.04	.04	.04	.04	.04	.04	.04	.04	.04	.04
.05	.05	.05	.05	.05	.05	.05	.05	.05	.06
.06	.06	.06	.06	.07	.07	.07	.07	.08	.08
.08	.09	.09	.09	.10	.10	.11	.11	.12	.13
.14	.15	.16	.17	.18	.19	.19	.20	.22	.25
.28	.33	.40	.55	1.11	3.58	.80	.65	.49	.44
.37	.35	.31	.29	.27	.26	.24	.23	.22	.21
.20	.20	.19	.19	.18	.18	.18	.17	.17	.16
.16	.15	.15	.14	.14	.13	.13	.12	.12	.12
.11	.11	.11	.10	.10	.10	.10	.09	.09	.09
.09	.09	.08	.08	.08	.08	.08	.08	.07	.07
.07	.07	.07	.07	.07	.07	.07	.06	.06	.06
.06	.06	.06	.06	.06	.06	.06	.06	.05	.05
.05	.05	.05	.05	.05	.05	.05	.05	.05	.05
.05	.05	.04	.04	.04	.04	.04	.04	.04	.04
.04	.04	.04	.04	.04	.04	.04	.04	.04	.04
.04	.04	.04	.04	.04	.04	.04	.04	.04	.04
.03	.03	.03	.03	.03	.03	.03	.03	.03	.03
.03	.03	.03	.03	.03	.03	.03	.03	.03	.03
.03	.03	.03	.03	.03	.03	.03	.03	.03	.03
.03	.03	.03	.03	.03	.03	.03	.03	.03	.03
.03	.03	.03	.03	.03	.03	.02	.02	.02	.02
.02	.02	.02	.02	.02	.02	.02	.02	.02	.02
.02	.02	.02	.02	.02	.02	.02	.02	.02	.02

63 LU UNIFORM LOSS RATE

STRTL .00 INITIAL LOSS

CNSTL .10 UNIFORM LOSS RATE

RTIMP .00 PERCENT IMPERVIOUS AREA

61 UI INPUT UNITGRAPH, 58 ORDINATES, VOLUME = 1.00

12.0	81.0	209.0	359.0	515.0	629.0	685.0	549.0	432.0	349.0
284.0	237.0	193.0	160.0	134.0	113.0	99.0	85.0	75.0	68.0
62.0	57.0	52.0	48.0	44.0	40.0	37.0	34.0	31.0	28.0
26.0	23.0	21.0	20.0	18.0	17.0	15.0	14.0	13.0	12.0
11.0	10.0	9.0	8.0	8.0	7.0	7.0	6.0	5.0	5.0
5.0	4.0	3.0	3.0	2.0	2.0	1.0	1.0		

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HYDROGRAPH AT STATION SUB-C

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DA	MON	HRMN	ORD	RAIN	LOSS	EXCESS	COMP Q	*	DA	MON	HRMN	ORD	RAIN	LOSS	EXCESS	COMP Q
								*								
1		0000	1	.00	.00	.00	0.	*	1		1230	151	.07	.01	.06	531.
1		0005	2	.02	.01	.01	0.	*	1		1235	152	.07	.01	.06	517.
1		0010	3	.02	.01	.01	1.	*	1		1240	153	.07	.01	.06	500.
1		0015	4	.02	.01	.01	4.	*	1		1245	154	.07	.01	.06	486.
1		0020	5	.02	.01	.01	8.	*	1		1250	155	.07	.01	.06	469.
1		0025	6	.02	.01	.01	14.	*	1		1255	156	.07	.01	.06	455.
1		0030	7	.02	.01	.01	21.	*	1		1300	157	.07	.01	.06	444.
1		0035	8	.02	.01	.01	29.	*	1		1305	158	.07	.01	.06	435.
1		0040	9	.02	.01	.01	35.	*	1		1310	159	.06	.01	.05	427.
1		0045	10	.02	.01	.01	40.	*	1		1315	160	.06	.01	.05	419.
1		0050	11	.02	.01	.01	45.	*	1		1320	161	.06	.01	.05	412.
1		0055	12	.02	.01	.01	48.	*	1		1325	162	.06	.01	.05	403.
1		0100	13	.02	.01	.01	51.	*	1		1330	163	.06	.01	.05	394.
1		0105	14	.02	.01	.01	53.	*	1		1335	164	.06	.01	.05	384.
1		0110	15	.02	.01	.01	55.	*	1		1340	165	.06	.01	.05	373.
1		0115	16	.02	.01	.01	56.	*	1		1345	166	.06	.01	.05	365.
1		0120	17	.03	.01	.02	58.	*	1		1350	167	.06	.01	.05	358.
1		0125	18	.03	.01	.02	60.	*	1		1355	168	.06	.01	.05	352.
1		0130	19	.03	.01	.02	63.	*	1		1400	169	.06	.01	.05	347.
1		0135	20	.03	.01	.02	67.	*	1		1405	170	.05	.01	.04	343.
1		0140	21	.03	.01	.02	73.	*	1		1410	171	.05	.01	.04	338.
1		0145	22	.03	.01	.02	80.	*	1		1415	172	.05	.01	.04	333.
1		0150	23	.03	.01	.02	88.	*	1		1420	173	.05	.01	.04	326.
1		0155	24	.03	.01	.02	94.	*	1		1425	174	.05	.01	.04	319.
1		0200	25	.03	.01	.02	99.	*	1		1430	175	.05	.01	.04	310.
1		0205	26	.03	.01	.02	103.	*	1		1435	176	.05	.01	.04	301.
1		0210	27	.03	.01	.02	106.	*	1		1440	177	.05	.01	.04	294.
1		0215	28	.03	.01	.02	109.	*	1		1445	178	.05	.01	.04	288.
1		0220	29	.03	.01	.02	111.	*	1		1450	179	.05	.01	.04	283.
1		0225	30	.03	.01	.02	113.	*	1		1455	180	.05	.01	.04	279.
1		0230	31	.03	.01	.02	115.	*	1		1500	181	.05	.01	.04	276.
1		0235	32	.03	.01	.02	116.	*	1		1505	182	.05	.01	.04	273.
1		0240	33	.03	.01	.02	117.	*	1		1510	183	.05	.01	.04	270.
1		0245	34	.03	.01	.02	119.	*	1		1515	184	.04	.01	.03	268.
1		0250	35	.03	.01	.02	120.	*	1		1520	185	.04	.01	.03	265.
1		0255	36	.03	.01	.02	120.	*	1		1525	186	.04	.01	.03	261.
1		0300	37	.03	.01	.02	121.	*	1		1530	187	.04	.01	.03	256.
1		0305	38	.03	.01	.02	122.	*	1		1535	188	.04	.01	.03	250.
1		0310	39	.03	.01	.02	123.	*	1		1540	189	.04	.01	.03	242.
1		0315	40	.04	.01	.03	123.	*	1		1545	190	.04	.01	.03	234.
1		0320	41	.04	.01	.03	125.	*	1		1550	191	.04	.01	.03	228.
1		0325	42	.04	.01	.03	127.	*	1		1555	192	.04	.01	.03	223.
1		0330	43	.04	.01	.03	132.	*	1		1600	193	.04	.01	.03	218.
1		0335	44	.04	.01	.03	137.	*	1		1605	194	.04	.01	.03	215.
1		0340	45	.04	.01	.03	144.	*	1		1610	195	.04	.01	.03	212.
1		0345	46	.04	.01	.03	151.	*	1		1615	196	.04	.01	.03	209.
1		0350	47	.04	.01	.03	157.	*	1		1620	197	.04	.01	.03	207.
1		0355	48	.04	.01	.03	162.	*	1		1625	198	.04	.01	.03	205.
1		0400	49	.04	.01	.03	165.	*	1		1630	199	.04	.01	.03	203.
1		0405	50	.04	.01	.03	168.	*	1		1635	200	.04	.01	.03	202.
1		0410	51	.04	.01	.03	171.	*	1		1640	201	.04	.01	.03	201.
1		0415	52	.05	.01	.04	173.	*	1		1645	202	.04	.01	.03	200.
1		0420	53	.05	.01	.04	176.	*	1		1650	203	.04	.01	.03	199.
1		0425	54	.05	.01	.04	179.	*	1		1655	204	.04	.01	.03	198.
1		0430	55	.05	.01	.04	184.	*	1		1700	205	.04	.01	.03	197.
1		0435	56	.05	.01	.04	191.	*	1		1705	206	.04	.01	.03	196.
1		0440	57	.05	.01	.04	198.	*	1		1710	207	.04	.01	.03	196.
1		0445	58	.05	.01	.04	206.	*	1		1715	208	.04	.01	.03	195.

1	0450	59	.05	.01	.04	212.	*	1	1720	209	.04	.01	.03	194.
1	0455	60	.05	.01	.04	217.	*	1	1725	210	.04	.01	.03	194.
1	0500	61	.06	.01	.05	221.	*	1	1730	211	.04	.01	.03	193.
1	0505	62	.06	.01	.05	225.	*	1	1735	212	.03	.01	.02	193.
1	0510	63	.06	.01	.05	230.	*	1	1740	213	.03	.01	.02	192.
1	0515	64	.06	.01	.05	236.	*	1	1745	214	.03	.01	.02	189.
1	0520	65	.06	.01	.05	244.	*	1	1750	215	.03	.01	.02	185.
1	0525	66	.07	.01	.06	252.	*	1	1755	216	.03	.01	.02	180.
1	0530	67	.07	.01	.06	261.	*	1	1800	217	.03	.01	.02	173.
1	0535	68	.07	.01	.06	270.	*	1	1805	218	.03	.01	.02	166.
1	0540	69	.07	.01	.06	279.	*	1	1810	219	.03	.01	.02	161.
1	0545	70	.08	.01	.07	289.	*	1	1815	220	.03	.01	.02	156.
1	0550	71	.08	.01	.07	300.	*	1	1820	221	.03	.01	.02	152.
1	0555	72	.08	.01	.07	312.	*	1	1825	222	.03	.01	.02	149.
1	0600	73	.09	.01	.08	324.	*	1	1830	223	.03	.01	.02	147.
1	0605	74	.09	.01	.08	336.	*	1	1835	224	.03	.01	.02	145.
1	0610	75	.09	.01	.08	350.	*	1	1840	225	.03	.01	.02	143.
1	0615	76	.10	.01	.09	365.	*	1	1845	226	.03	.01	.02	142.
1	0620	77	.10	.01	.09	381.	*	1	1850	227	.03	.01	.02	140.
1	0625	78	.11	.01	.10	397.	*	1	1855	228	.03	.01	.02	139.
1	0630	79	.11	.01	.10	414.	*	1	1900	229	.03	.01	.02	138.
1	0635	80	.12	.01	.11	432.	*	1	1905	230	.03	.01	.02	138.
1	0640	81	.13	.01	.12	452.	*	1	1910	231	.03	.01	.02	137.
1	0645	82	.14	.01	.13	474.	*	1	1915	232	.03	.01	.02	136.
1	0650	83	.15	.01	.14	499.	*	1	1920	233	.03	.01	.02	136.
1	0655	84	.16	.01	.15	527.	*	1	1925	234	.03	.01	.02	135.
1	0700	85	.17	.01	.16	559.	*	1	1930	235	.03	.01	.02	135.
1	0705	86	.18	.01	.17	594.	*	1	1935	236	.03	.01	.02	134.
1	0710	87	.19	.01	.18	634.	*	1	1940	237	.03	.01	.02	134.
1	0715	88	.19	.01	.18	676.	*	1	1945	238	.03	.01	.02	133.
1	0720	89	.20	.01	.19	720.	*	1	1950	239	.03	.01	.02	133.
1	0725	90	.22	.01	.21	765.	*	1	1955	240	.03	.01	.02	133.
1	0730	91	.25	.01	.24	811.	*	1	2000	241	.03	.01	.02	132.
1	0735	92	.28	.01	.27	859.	*	1	2005	242	.03	.01	.02	132.
1	0740	93	.33	.01	.32	914.	*	1	2010	243	.03	.01	.02	132.
1	0745	94	.40	.01	.39	979.	*	1	2015	244	.03	.01	.02	132.
1	0750	95	.55	.01	.54	1064.	*	1	2020	245	.03	.01	.02	131.
1	0755	96	1.11	.01	1.10	1188.	*	1	2025	246	.03	.01	.02	131.
1	0800	97	3.58	.01	3.57	1415.	*	1	2030	247	.03	.01	.02	131.
1	0805	98	.80	.01	.79	1883.	*	1	2035	248	.03	.01	.02	131.
1	0810	99	.65	.01	.64	2579.	*	1	2040	249	.03	.01	.02	131.
1	0815	100	.49	.01	.48	3370.	*	1	2045	250	.03	.01	.02	131.
1	0820	101	.44	.01	.43	4149.	*	1	2050	251	.03	.01	.02	130.
1	0825	102	.37	.01	.36	4721.	*	1	2055	252	.03	.01	.02	130.
1	0830	103	.35	.01	.34	4949.	*	1	2100	253	.03	.01	.02	130.
1	0835	104	.31	.01	.30	4535.	*	1	2105	254	.03	.01	.02	130.
1	0840	105	.29	.01	.28	4096.	*	1	2110	255	.03	.01	.02	130.
1	0845	106	.27	.01	.26	3712.	*	1	2115	256	.03	.01	.02	130.
1	0850	107	.26	.01	.25	3375.	*	1	2120	257	.03	.01	.02	130.
1	0855	108	.24	.01	.23	3088.	*	1	2125	258	.02	.01	.01	130.
1	0900	109	.23	.01	.22	2820.	*	1	2130	259	.02	.01	.01	129.
1	0905	110	.22	.01	.21	2593.	*	1	2135	260	.02	.01	.01	127.
1	0910	111	.21	.01	.20	2398.	*	1	2140	261	.02	.01	.01	123.
1	0915	112	.20	.01	.19	2231.	*	1	2145	262	.02	.01	.01	118.
1	0920	113	.20	.01	.19	2093.	*	1	2150	263	.02	.01	.01	112.
1	0925	114	.19	.01	.18	1966.	*	1	2155	264	.02	.01	.01	105.
1	0930	115	.19	.01	.18	1861.	*	1	2200	265	.02	.01	.01	99.
1	0935	116	.18	.01	.17	1772.	*	1	2205	266	.02	.01	.01	95.
1	0940	117	.18	.01	.17	1694.	*	1	2210	267	.02	.01	.01	91.
1	0945	118	.18	.01	.17	1625.	*	1	2215	268	.02	.01	.01	88.

1	0950	119	.17	.01	.16	1563.	*	1	2220	269	.02	.01	.01	86.
1	0955	120	.17	.01	.16	1507.	*	1	2225	270	.02	.01	.01	84.
1	1000	121	.16	.01	.15	1454.	*	1	2230	271	.02	.01	.01	83.
1	1005	122	.16	.01	.15	1405.	*	1	2235	272	.02	.01	.01	81.
1	1010	123	.15	.01	.14	1360.	*	1	2240	273	.02	.01	.01	80.
1	1015	124	.15	.01	.14	1316.	*	1	2245	274	.02	.01	.01	79.
1	1020	125	.14	.01	.13	1272.	*	1	2250	275	.02	.01	.01	78.
1	1025	126	.14	.01	.13	1229.	*	1	2255	276	.02	.01	.01	78.
1	1030	127	.13	.01	.12	1188.	*	1	2300	277	.02	.01	.01	77.
1	1035	128	.13	.01	.12	1145.	*	1	2305	278	.02	.01	.01	76.
1	1040	129	.12	.01	.11	1106.	*	1	2310	279	.02	.01	.01	76.
1	1045	130	.12	.01	.11	1069.	*	1	2315	280	.02	.01	.01	75.
1	1050	131	.12	.01	.11	1030.	*	1	2320	281	.02	.01	.01	75.
1	1055	132	.11	.01	.10	995.	*	1	2325	282	.00	.00	.00	74.
1	1100	133	.11	.01	.10	958.	*	1	2330	283	.00	.00	.00	73.
1	1105	134	.11	.01	.10	925.	*	1	2335	284	.00	.00	.00	70.
1	1110	135	.10	.01	.09	893.	*	1	2340	285	.00	.00	.00	65.
1	1115	136	.10	.01	.09	863.	*	1	2345	286	.00	.00	.00	59.
1	1120	137	.10	.01	.09	833.	*	1	2350	287	.00	.00	.00	51.
1	1125	138	.10	.01	.09	804.	*	1	2355	288	.00	.00	.00	43.
1	1130	139	.09	.01	.08	777.	*	2	0000	289	.00	.00	.00	37.
1	1135	140	.09	.01	.08	751.	*	2	0005	290	.00	.00	.00	31.
1	1140	141	.09	.01	.08	728.	*	2	0010	291	.00	.00	.00	27.
1	1145	142	.09	.01	.08	704.	*	2	0015	292	.00	.00	.00	24.
1	1150	143	.09	.01	.08	683.	*	2	0020	293	.00	.00	.00	21.
1	1155	144	.08	.01	.07	661.	*	2	0025	294	.00	.00	.00	18.
1	1200	145	.08	.01	.07	639.	*	2	0030	295	.00	.00	.00	16.
1	1205	146	.08	.01	.07	622.	*	2	0035	296	.00	.00	.00	14.
1	1210	147	.08	.01	.07	604.	*	2	0040	297	.00	.00	.00	13.
1	1215	148	.08	.01	.07	584.	*	2	0045	298	.00	.00	.00	12.
1	1220	149	.08	.01	.07	565.	*	2	0050	299	.00	.00	.00	11.
1	1225	150	.07	.01	.06	548.	*	2	0055	300	.00	.00	.00	10.
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TOTAL RAINFALL = 26.72, TOTAL LOSS = 2.33, TOTAL EXCESS = 24.39

PEAK FLOW (CFS)	TIME (HR)		MAXIMUM AVERAGE FLOW 6-HR	24-HR	72-HR	24.92-HR
4949.	8.50	(CFS)	1479.	505.	487.	487.
		(INCHES)	17.865	24.412	24.429	24.429
		(AC-FT)	734.	1003.	1003.	1003.

CUMULATIVE AREA = .77 SQ MI

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          *            *
70 KK     *      COMB  *
          *            *
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COMBINE ROUTED HYDROGRAPHS FROM SUBBASINS A,B AND C

72 HC HYDROGRAPH COMBINATION

ICOMP 3 NUMBER OF HYDROGRAPHS TO COMBINE

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HYDROGRAPH AT STATION COMB
SUM OF 3 HYDROGRAPHS

DA	MON	HRMN	ORD	FLOW	DA	MON	HRMN	ORD	FLOW	DA	MON	HRMN	ORD	FLOW	DA	MON	HRMN	ORD	FLOW
1		0000	1	0.	1		0615	76	1575.	1		1230	151	3067.	1		1845	226	743.
1		0005	2	0.	1		0620	77	1639.	1		1235	152	2981.	1		1850	227	733.
1		0010	3	3.	1		0625	78	1705.	1		1240	153	2902.	1		1855	228	724.
1		0015	4	9.	1		0630	79	1777.	1		1245	154	2822.	1		1900	229	716.
1		0020	5	20.	1		0635	80	1852.	1		1250	155	2743.	1		1905	230	709.
1		0025	6	36.	1		0640	81	1933.	1		1255	156	2672.	1		1910	231	703.
1		0030	7	56.	1		0645	82	2022.	1		1300	157	2604.	1		1915	232	697.
1		0035	8	80.	1		0650	83	2119.	1		1305	158	2544.	1		1920	233	692.
1		0040	9	103.	1		0655	84	2227.	1		1310	159	2484.	1		1925	234	687.
1		0045	10	125.	1		0700	85	2347.	1		1315	160	2430.	1		1930	235	683.
1		0050	11	147.	1		0705	86	2481.	1		1320	161	2377.	1		1935	236	679.
1		0055	12	168.	1		0710	87	2630.	1		1325	162	2325.	1		1940	237	675.
1		0100	13	187.	1		0715	88	2791.	1		1330	163	2273.	1		1945	238	672.
1		0105	14	203.	1		0720	89	2963.	1		1335	164	2220.	1		1950	239	669.
1		0110	15	216.	1		0725	90	3144.	1		1340	165	2167.	1		1955	240	666.
1		0115	16	228.	1		0730	91	3334.	1		1345	166	2118.	1		2000	241	664.
1		0120	17	238.	1		0735	92	3536.	1		1350	167	2072.	1		2005	242	661.
1		0125	18	249.	1		0740	93	3758.	1		1355	168	2031.	1		2010	243	659.
1		0130	19	262.	1		0745	94	4011.	1		1400	169	1990.	1		2015	244	657.
1		0135	20	278.	1		0750	95	4320.	1		1405	170	1954.	1		2020	245	655.
1		0140	21	298.	1		0755	96	4730.	1		1410	171	1918.	1		2025	246	653.
1		0145	22	321.	1		0800	97	5412.	1		1415	172	1881.	1		2030	247	652.
1		0150	23	347.	1		0805	98	6703.	1		1420	173	1843.	1		2035	248	650.
1		0155	24	371.	1		0810	99	8650.	1		1425	174	1806.	1		2040	249	648.
1		0200	25	393.	1		0815	100	10995.	1		1430	175	1764.	1		2045	250	647.
1		0205	26	416.	1		0820	101	13460.	1		1435	176	1724.	1		2050	251	646.
1		0210	27	437.	1		0825	102	15567.	1		1440	177	1683.	1		2055	252	645.
1		0215	28	456.	1		0830	103	17083.	1		1445	178	1644.	1		2100	253	643.
1		0220	29	473.	1		0835	104	17362.	1		1450	179	1610.	1		2105	254	642.
1		0225	30	487.	1		0840	105	17533.	1		1455	180	1573.	1		2110	255	641.
1		0230	31	499.	1		0845	106	17559.	1		1500	181	1540.	1		2115	256	640.
1		0235	32	510.	1		0850	107	17322.	1		1505	182	1513.	1		2120	257	639.
1		0240	33	519.	1		0855	108	16396.	1		1510	183	1486.	1		2125	258	638.
1		0245	34	528.	1		0900	109	15273.	1		1515	184	1462.	1		2130	259	636.
1		0250	35	535.	1		0905	110	14244.	1		1520	185	1440.	1		2135	260	630.
1		0255	36	542.	1		0910	111	13293.	1		1525	186	1414.	1		2140	261	620.
1		0300	37	549.	1		0915	112	12486.	1		1530	187	1388.	1		2145	262	605.
1		0305	38	554.	1		0920	113	11750.	1		1535	188	1356.	1		2150	263	587.
1		0310	39	559.	1		0925	114	11074.	1		1540	189	1321.	1		2155	264	566.
1		0315	40	564.	1		0930	115	10484.	1		1545	190	1288.	1		2200	265	546.
1		0320	41	571.	1		0935	116	9932.	1		1550	191	1254.	1		2205	266	526.
1		0325	42	580.	1		0940	117	9428.	1		1555	192	1224.	1		2210	267	507.
1		0330	43	593.	1		0945	118	8986.	1		1600	193	1196.	1		2215	268	489.
1		0335	44	610.	1		0950	119	8574.	1		1605	194	1169.	1		2220	269	472.
1		0340	45	631.	1		0955	120	8203.	1		1610	195	1146.	1		2225	270	458.
1		0345	46	654.	1		1000	121	7871.	1		1615	196	1125.	1		2230	271	446.
1		0350	47	676.	1		1005	122	7564.	1		1620	197	1107.	1		2235	272	436.
1		0355	48	698.	1		1010	123	7295.	1		1625	198	1091.	1		2240	273	427.

1	0400	49	719.	*	1	1015	124	7044.	*	1	1630	199	1077.	*	1	2245	274	419.
1	0405	50	739.	*	1	1020	125	6799.	*	1	1635	200	1064.	*	1	2250	275	413.
1	0410	51	757.	*	1	1025	126	6580.	*	1	1640	201	1052.	*	1	2255	276	406.
1	0415	52	773.	*	1	1030	127	6370.	*	1	1645	202	1042.	*	1	2300	277	401.
1	0420	53	788.	*	1	1035	128	6176.	*	1	1650	203	1032.	*	1	2305	278	396.
1	0425	54	805.	*	1	1040	129	5987.	*	1	1655	204	1024.	*	1	2310	279	392.
1	0430	55	825.	*	1	1045	130	5811.	*	1	1700	205	1016.	*	1	2315	280	388.
1	0435	56	848.	*	1	1050	131	5630.	*	1	1705	206	1009.	*	1	2320	281	384.
1	0440	57	873.	*	1	1055	132	5458.	*	1	1710	207	1002.	*	1	2325	282	380.
1	0445	58	901.	*	1	1100	133	5285.	*	1	1715	208	996.	*	1	2330	283	375.
1	0450	59	927.	*	1	1105	134	5125.	*	1	1720	209	990.	*	1	2335	284	366.
1	0455	60	952.	*	1	1110	135	4963.	*	1	1725	210	985.	*	1	2340	285	353.
1	0500	61	976.	*	1	1115	136	4811.	*	1	1730	211	981.	*	1	2345	286	335.
1	0505	62	1001.	*	1	1120	137	4659.	*	1	1735	212	976.	*	1	2350	287	312.
1	0510	63	1027.	*	1	1125	138	4516.	*	1	1740	213	970.	*	1	2355	288	286.
1	0515	64	1054.	*	1	1130	139	4375.	*	1	1745	214	961.	*	2	0000	289	262.
1	0520	65	1083.	*	1	1135	140	4243.	*	1	1750	215	948.	*	2	0005	290	238.
1	0525	66	1114.	*	1	1140	141	4116.	*	1	1755	216	931.	*	2	0010	291	215.
1	0530	67	1148.	*	1	1145	142	3991.	*	1	1800	217	910.	*	2	0015	292	192.
1	0535	68	1183.	*	1	1150	143	3873.	*	1	1805	218	887.	*	2	0020	293	172.
1	0540	69	1221.	*	1	1155	144	3759.	*	1	1810	219	865.	*	2	0025	294	154.
1	0545	70	1262.	*	1	1200	145	3648.	*	1	1815	220	843.	*	2	0030	295	140.
1	0550	71	1308.	*	1	1205	146	3542.	*	1	1820	221	822.	*	2	0035	296	127.
1	0555	72	1356.	*	1	1210	147	3442.	*	1	1825	222	802.	*	2	0040	297	116.
1	0600	73	1405.	*	1	1215	148	3342.	*	1	1830	223	784.	*	2	0045	298	106.
1	0605	74	1457.	*	1	1220	149	3246.	*	1	1835	224	768.	*	2	0050	299	97.
1	0610	75	1514.	*	1	1225	150	3154.	*	1	1840	225	755.	*	2	0055	300	89.
				*					*					*				

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PEAK FLOW	TIME			MAXIMUM AVERAGE FLOW		
(CFS)	(HR)		6-HR	24-HR	72-HR	24.92-HR
17559.	8.75	(CFS)	7055.	2446.	2358.	2358.
		(INCHES)	17.586	24.392	24.411	24.411
		(AC-FT)	3498.	4852.	4856.	4856.

CUMULATIVE AREA = 3.73 SQ MI

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          *             *
 73 KK    *     LAKE    *
          *             *
          ***************
                    CALCULATE THE RUNOFF FROM THE LAKE

             SUBBASIN RUNOFF DATA

 75 BA         SUBBASIN CHARACTERISTICS
                     TAREA          .18  SUBBASIN AREA

               PRECIPITATION DATA

 10 PB               STORM        26.72  BASIN TOTAL PRECIPITATION
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11 PI INCREMENTAL PRECIPITATION PATTERN

.02	.02	.02	.02	.02	.02	.02	.02	.02	.02
.02	.02	.02	.02	.02	.03	.03	.03	.03	.03
.03	.03	.03	.03	.03	.03	.03	.03	.03	.03
.03	.03	.03	.03	.03	.03	.03	.03	.04	.04
.04	.04	.04	.04	.04	.04	.04	.04	.04	.04
.05	.05	.05	.05	.05	.05	.05	.05	.05	.06
.06	.06	.06	.06	.07	.07	.07	.07	.08	.08
.08	.09	.09	.09	.10	.10	.11	.11	.12	.13
.14	.15	.16	.17	.18	.19	.19	.20	.22	.25
.28	.33	.40	.55	1.11	3.58	.80	.65	.49	.44
.37	.35	.31	.29	.27	.26	.24	.23	.22	.21
.20	.20	.19	.19	.18	.18	.18	.17	.17	.16
.16	.15	.15	.14	.14	.13	.13	.12	.12	.12
.11	.11	.11	.10	.10	.10	.10	.09	.09	.09
.09	.09	.08	.08	.08	.08	.08	.08	.07	.07
.07	.07	.07	.07	.07	.07	.07	.06	.06	.06
.06	.06	.06	.06	.06	.06	.06	.06	.05	.05
.05	.05	.05	.05	.05	.05	.05	.05	.05	.05
.05	.05	.04	.04	.04	.04	.04	.04	.04	.04
.04	.04	.04	.04	.04	.04	.04	.04	.04	.04
.04	.04	.04	.04	.04	.04	.04	.04	.04	.04
.03	.03	.03	.03	.03	.03	.03	.03	.03	.03
.03	.03	.03	.03	.03	.03	.03	.03	.03	.03
.03	.03	.03	.03	.03	.03	.03	.03	.03	.03
.03	.03	.03	.03	.03	.03	.03	.03	.03	.03
.03	.03	.03	.03	.03	.03	.02	.02	.02	.02
.02	.02	.02	.02	.02	.02	.02	.02	.02	.02
.02	.02	.02	.02	.02	.02	.02	.02	.02	.02

76 LU UNIFORM LOSS RATE

STRTL	.00	INITIAL LOSS
CNSTL	.00	UNIFORM LOSS RATE
RTIMP	.00	PERCENT IMPERVIOUS AREA

77 UD SCS DIMENSIONLESS UNITGRAPH

TLAG	.00	LAG

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WARNING *** TIME INTERVAL IS GREATER THAN .29*LAG

UNIT HYDROGRAPH
5 END-OF-PERIOD ORDINATES

1013. 284. 56. 11. 0.

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HYDROGRAPH AT STATION LAKE

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DA	MON	HRMN	ORD	RAIN	LOSS	EXCESS	COMP Q	DA	MON	HRMN	ORD	RAIN	LOSS	EXCESS	COMP Q
1		0000	1	.00	.00	.00	0.	1		1230	151	.07	.00	.07	96.
1		0005	2	.02	.00	.02	20.	1		1235	152	.07	.00	.07	96.
1		0010	3	.02	.00	.02	26.	1		1240	153	.07	.00	.07	95.
1		0015	4	.02	.00	.02	27.	1		1245	154	.07	.00	.07	95.
1		0020	5	.02	.00	.02	27.	1		1250	155	.07	.00	.07	95.
1		0025	6	.02	.00	.02	27.	1		1255	156	.07	.00	.07	95.

1	0030	7	.02	.00	.02	27.	*	1	1300	157	.07	.00	.07	95.
1	0035	8	.02	.00	.02	27.	*	1	1305	158	.07	.00	.07	95.
1	0040	9	.02	.00	.02	27.	*	1	1310	159	.06	.00	.06	85.
1	0045	10	.02	.00	.02	27.	*	1	1315	160	.06	.00	.06	82.
1	0050	11	.02	.00	.02	27.	*	1	1320	161	.06	.00	.06	82.
1	0055	12	.02	.00	.02	27.	*	1	1325	162	.06	.00	.06	82.
1	0100	13	.02	.00	.02	27.	*	1	1330	163	.06	.00	.06	82.
1	0105	14	.02	.00	.02	27.	*	1	1335	164	.06	.00	.06	82.
1	0110	15	.02	.00	.02	27.	*	1	1340	165	.06	.00	.06	82.
1	0115	16	.02	.00	.02	27.	*	1	1345	166	.06	.00	.06	82.
1	0120	17	.03	.00	.03	37.	*	1	1350	167	.06	.00	.06	82.
1	0125	18	.03	.00	.03	40.	*	1	1355	168	.06	.00	.06	82.
1	0130	19	.03	.00	.03	41.	*	1	1400	169	.06	.00	.06	82.
1	0135	20	.03	.00	.03	41.	*	1	1405	170	.05	.00	.05	72.
1	0140	21	.03	.00	.03	41.	*	1	1410	171	.05	.00	.05	69.
1	0145	22	.03	.00	.03	41.	*	1	1415	172	.05	.00	.05	68.
1	0150	23	.03	.00	.03	41.	*	1	1420	173	.05	.00	.05	68.
1	0155	24	.03	.00	.03	41.	*	1	1425	174	.05	.00	.05	68.
1	0200	25	.03	.00	.03	41.	*	1	1430	175	.05	.00	.05	68.
1	0205	26	.03	.00	.03	41.	*	1	1435	176	.05	.00	.05	68.
1	0210	27	.03	.00	.03	41.	*	1	1440	177	.05	.00	.05	68.
1	0215	28	.03	.00	.03	41.	*	1	1445	178	.05	.00	.05	68.
1	0220	29	.03	.00	.03	41.	*	1	1450	179	.05	.00	.05	68.
1	0225	30	.03	.00	.03	41.	*	1	1455	180	.05	.00	.05	68.
1	0230	31	.03	.00	.03	41.	*	1	1500	181	.05	.00	.05	68.
1	0235	32	.03	.00	.03	41.	*	1	1505	182	.05	.00	.05	68.
1	0240	33	.03	.00	.03	41.	*	1	1510	183	.05	.00	.05	68.
1	0245	34	.03	.00	.03	41.	*	1	1515	184	.04	.00	.04	58.
1	0250	35	.03	.00	.03	41.	*	1	1520	185	.04	.00	.04	55.
1	0255	36	.03	.00	.03	41.	*	1	1525	186	.04	.00	.04	55.
1	0300	37	.03	.00	.03	41.	*	1	1530	187	.04	.00	.04	55.
1	0305	38	.03	.00	.03	41.	*	1	1535	188	.04	.00	.04	55.
1	0310	39	.03	.00	.03	41.	*	1	1540	189	.04	.00	.04	55.
1	0315	40	.04	.00	.04	51.	*	1	1545	190	.04	.00	.04	55.
1	0320	41	.04	.00	.04	54.	*	1	1550	191	.04	.00	.04	55.
1	0325	42	.04	.00	.04	54.	*	1	1555	192	.04	.00	.04	55.
1	0330	43	.04	.00	.04	55.	*	1	1600	193	.04	.00	.04	55.
1	0335	44	.04	.00	.04	55.	*	1	1605	194	.04	.00	.04	55.
1	0340	45	.04	.00	.04	55.	*	1	1610	195	.04	.00	.04	55.
1	0345	46	.04	.00	.04	55.	*	1	1615	196	.04	.00	.04	55.
1	0350	47	.04	.00	.04	55.	*	1	1620	197	.04	.00	.04	55.
1	0355	48	.04	.00	.04	55.	*	1	1625	198	.04	.00	.04	55.
1	0400	49	.04	.00	.04	55.	*	1	1630	199	.04	.00	.04	55.
1	0405	50	.04	.00	.04	55.	*	1	1635	200	.04	.00	.04	55.
1	0410	51	.04	.00	.04	55.	*	1	1640	201	.04	.00	.04	55.
1	0415	52	.05	.00	.05	65.	*	1	1645	202	.04	.00	.04	55.
1	0420	53	.05	.00	.05	67.	*	1	1650	203	.04	.00	.04	55.
1	0425	54	.05	.00	.05	68.	*	1	1655	204	.04	.00	.04	55.
1	0430	55	.05	.00	.05	68.	*	1	1700	205	.04	.00	.04	55.
1	0435	56	.05	.00	.05	68.	*	1	1705	206	.04	.00	.04	55.
1	0440	57	.05	.00	.05	68.	*	1	1710	207	.04	.00	.04	55.
1	0445	58	.05	.00	.05	68.	*	1	1715	208	.04	.00	.04	55.
1	0450	59	.05	.00	.05	68.	*	1	1720	209	.04	.00	.04	55.
1	0455	60	.05	.00	.05	68.	*	1	1725	210	.04	.00	.04	55.
1	0500	61	.06	.00	.06	78.	*	1	1730	211	.04	.00	.04	55.
1	0505	62	.06	.00	.06	81.	*	1	1735	212	.03	.00	.03	44.
1	0510	63	.06	.00	.06	82.	*	1	1740	213	.03	.00	.03	42.
1	0515	64	.06	.00	.06	82.	*	1	1745	214	.03	.00	.03	41.
1	0520	65	.06	.00	.06	82.	*	1	1750	215	.03	.00	.03	41.
1	0525	66	.07	.00	.07	92.	*	1	1755	216	.03	.00	.03	41.

1	0530	67	.07	.00	.07	95.	*	1	1800	217	.03	.00	.03	41.
1	0535	68	.07	.00	.07	95.	*	1	1805	218	.03	.00	.03	41.
1	0540	69	.07	.00	.07	95.	*	1	1810	219	.03	.00	.03	41.
1	0545	70	.08	.00	.08	106.	*	1	1815	220	.03	.00	.03	41.
1	0550	71	.08	.00	.08	108.	*	1	1820	221	.03	.00	.03	41.
1	0555	72	.08	.00	.08	109.	*	1	1825	222	.03	.00	.03	41.
1	0600	73	.09	.00	.09	119.	*	1	1830	223	.03	.00	.03	41.
1	0605	74	.09	.00	.09	122.	*	1	1835	224	.03	.00	.03	41.
1	0610	75	.09	.00	.09	123.	*	1	1840	225	.03	.00	.03	41.
1	0615	76	.10	.00	.10	133.	*	1	1845	226	.03	.00	.03	41.
1	0620	77	.10	.00	.10	136.	*	1	1850	227	.03	.00	.03	41.
1	0625	78	.11	.00	.11	146.	*	1	1855	228	.03	.00	.03	41.
1	0630	79	.11	.00	.11	149.	*	1	1900	229	.03	.00	.03	41.
1	0635	80	.12	.00	.12	160.	*	1	1905	230	.03	.00	.03	41.
1	0640	81	.13	.00	.13	173.	*	1	1910	231	.03	.00	.03	41.
1	0645	82	.14	.00	.14	187.	*	1	1915	232	.03	.00	.03	41.
1	0650	83	.15	.00	.15	200.	*	1	1920	233	.03	.00	.03	41.
1	0655	84	.16	.00	.16	214.	*	1	1925	234	.03	.00	.03	41.
1	0700	85	.17	.00	.17	227.	*	1	1930	235	.03	.00	.03	41.
1	0705	86	.18	.00	.18	241.	*	1	1935	236	.03	.00	.03	41.
1	0710	87	.19	.00	.19	255.	*	1	1940	237	.03	.00	.03	41.
1	0715	88	.19	.00	.19	258.	*	1	1945	238	.03	.00	.03	41.
1	0720	89	.20	.00	.20	269.	*	1	1950	239	.03	.00	.03	41.
1	0725	90	.22	.00	.22	292.	*	1	1955	240	.03	.00	.03	41.
1	0730	91	.25	.00	.25	329.	*	1	2000	241	.03	.00	.03	41.
1	0735	92	.28	.00	.28	369.	*	1	2005	242	.03	.00	.03	41.
1	0740	93	.33	.00	.33	430.	*	1	2010	243	.03	.00	.03	41.
1	0745	94	.40	.00	.40	517.	*	1	2015	244	.03	.00	.03	41.
1	0750	95	.55	.00	.55	692.	*	1	2020	245	.03	.00	.03	41.
1	0755	96	1.11	.00	1.11	1306.	*	1	2025	246	.03	.00	.03	41.
1	0800	97	3.58	.00	3.58	3975.	*	1	2030	247	.03	.00	.03	41.
1	0805	98	.80	.00	.80	1893.	*	1	2035	248	.03	.00	.03	41.
1	0810	99	.65	.00	.65	1097.	*	1	2040	249	.03	.00	.03	41.
1	0815	100	.49	.00	.49	765.	*	1	2045	250	.03	.00	.03	41.
1	0820	101	.44	.00	.44	630.	*	1	2050	251	.03	.00	.03	41.
1	0825	102	.37	.00	.37	534.	*	1	2055	252	.03	.00	.03	41.
1	0830	103	.35	.00	.35	489.	*	1	2100	253	.03	.00	.03	41.
1	0835	104	.31	.00	.31	439.	*	1	2105	254	.03	.00	.03	41.
1	0840	105	.29	.00	.29	405.	*	1	2110	255	.03	.00	.03	41.
1	0845	106	.27	.00	.27	377.	*	1	2115	256	.03	.00	.03	41.
1	0850	107	.26	.00	.26	359.	*	1	2120	257	.03	.00	.03	41.
1	0855	108	.24	.00	.24	335.	*	1	2125	258	.02	.00	.02	31.
1	0900	109	.23	.00	.23	318.	*	1	2130	259	.02	.00	.02	28.
1	0905	110	.22	.00	.22	304.	*	1	2135	260	.02	.00	.02	27.
1	0910	111	.21	.00	.21	291.	*	1	2140	261	.02	.00	.02	27.
1	0915	112	.20	.00	.20	277.	*	1	2145	262	.02	.00	.02	27.
1	0920	113	.20	.00	.20	273.	*	1	2150	263	.02	.00	.02	27.
1	0925	114	.19	.00	.19	263.	*	1	2155	264	.02	.00	.02	27.
1	0930	115	.19	.00	.19	260.	*	1	2200	265	.02	.00	.02	27.
1	0935	116	.18	.00	.18	249.	*	1	2205	266	.02	.00	.02	27.
1	0940	117	.18	.00	.18	246.	*	1	2210	267	.02	.00	.02	27.
1	0945	118	.18	.00	.18	245.	*	1	2215	268	.02	.00	.02	27.
1	0950	119	.17	.00	.17	235.	*	1	2220	269	.02	.00	.02	27.
1	0955	120	.17	.00	.17	232.	*	1	2225	270	.02	.00	.02	27.
1	1000	121	.16	.00	.16	222.	*	1	2230	271	.02	.00	.02	27.
1	1005	122	.16	.00	.16	219.	*	1	2235	272	.02	.00	.02	27.
1	1010	123	.15	.00	.15	208.	*	1	2240	273	.02	.00	.02	27.
1	1015	124	.15	.00	.15	205.	*	1	2245	274	.02	.00	.02	27.
1	1020	125	.14	.00	.14	194.	*	1	2250	275	.02	.00	.02	27.
1	1025	126	.14	.00	.14	191.	*	1	2255	276	.02	.00	.02	27.

1	1030	127	.13	.00	.13	181.	*	1	2300	277	.02	.00	.02	27.
1	1035	128	.13	.00	.13	178.	*	1	2305	278	.02	.00	.02	27.
1	1040	129	.12	.00	.12	167.	*	1	2310	279	.02	.00	.02	27.
1	1045	130	.12	.00	.12	164.	*	1	2315	280	.02	.00	.02	27.
1	1050	131	.12	.00	.12	164.	*	1	2320	281	.02	.00	.02	27.
1	1055	132	.11	.00	.11	153.	*	1	2325	282	.00	.00	.00	7.
1	1100	133	.11	.00	.11	151.	*	1	2330	283	.00	.00	.00	1.
1	1105	134	.11	.00	.11	150.	*	1	2335	284	.00	.00	.00	0.
1	1110	135	.10	.00	.10	140.	*	1	2340	285	.00	.00	.00	0.
1	1115	136	.10	.00	.10	137.	*	1	2345	286	.00	.00	.00	0.
1	1120	137	.10	.00	.10	136.	*	1	2350	287	.00	.00	.00	0.
1	1125	138	.10	.00	.10	136.	*	1	2355	288	.00	.00	.00	0.
1	1130	139	.09	.00	.09	126.	*	2	0000	289	.00	.00	.00	0.
1	1135	140	.09	.00	.09	123.	*	2	0005	290	.00	.00	.00	0.
1	1140	141	.09	.00	.09	123.	*	2	0010	291	.00	.00	.00	0.
1	1145	142	.09	.00	.09	123.	*	2	0015	292	.00	.00	.00	0.
1	1150	143	.09	.00	.09	123.	*	2	0020	293	.00	.00	.00	0.
1	1155	144	.08	.00	.08	113.	*	2	0025	294	.00	.00	.00	0.
1	1200	145	.08	.00	.08	110.	*	2	0030	295	.00	.00	.00	0.
1	1205	146	.08	.00	.08	109.	*	2	0035	296	.00	.00	.00	0.
1	1210	147	.08	.00	.08	109.	*	2	0040	297	.00	.00	.00	0.
1	1215	148	.08	.00	.08	109.	*	2	0045	298	.00	.00	.00	0.
1	1220	149	.08	.00	.08	109.	*	2	0050	299	.00	.00	.00	0.
1	1225	150	.07	.00	.07	99.	*	2	0055	300	.00	.00	.00	0.
							*							

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TOTAL RAINFALL = 26.72, TOTAL LOSS = .00, TOTAL EXCESS = 26.72

PEAK FLOW	TIME		MAXIMUM AVERAGE FLOW			
(CFS)	(HR)		6-HR	24-HR	72-HR	24.92-HR
3975.	8.00	(CFS)	352.	126.	122.	122.
		(INCHES)	18.608	26.720	26.720	26.720
		(AC-FT)	175.	251.	251.	251.

CUMULATIVE AREA = .18 SQ MI

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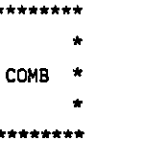
78 KK



COMBINE HYDROGRAPH FROM DRAINAGE WITH LAKE SURFACE HYDROGRAPH

80 HC HYDROGRAPH COMBINATION

ICOMP 2 NUMBER OF HYDROGRAPHS TO COMBINE

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HYDROGRAPH AT STATION COMB

SUM OF 2 HYDROGRAPHS

DA	MON	HRMN	ORD	FLOW	DA	MON	HRMN	ORD	FLOW	DA	MON	HRMN	ORD	FLOW	DA	MON	HRMN	ORD	FLOW
1		0000	1	0.	1		0615	76	1708.	1		1230	151	3163.	1		1845	226	784.
1		0005	2	21.	1		0620	77	1774.	1		1235	152	3077.	1		1850	227	774.
1		0010	3	29.	1		0625	78	1851.	1		1240	153	2997.	1		1855	228	765.
1		0015	4	36.	1		0630	79	1926.	1		1245	154	2917.	1		1900	229	757.
1		0020	5	47.	1		0635	80	2012.	1		1250	155	2838.	1		1905	230	750.
1		0025	6	63.	1		0640	81	2106.	1		1255	156	2767.	1		1910	231	743.
1		0030	7	84.	1		0645	82	2209.	1		1300	157	2699.	1		1915	232	738.
1		0035	8	107.	1		0650	83	2319.	1		1305	158	2639.	1		1920	233	732.
1		0040	9	130.	1		0655	84	2441.	1		1310	159	2570.	1		1925	234	728.
1		0045	10	152.	1		0700	85	2574.	1		1315	160	2512.	1		1930	235	723.
1		0050	11	174.	1		0705	86	2723.	1		1320	161	2459.	1		1935	236	720.
1		0055	12	195.	1		0710	87	2885.	1		1325	162	2407.	1		1940	237	716.
1		0100	13	214.	1		0715	88	3050.	1		1330	163	2354.	1		1945	238	713.
1		0105	14	230.	1		0720	89	3232.	1		1335	164	2302.	1		1950	239	710.
1		0110	15	243.	1		0725	90	3436.	1		1340	165	2249.	1		1955	240	707.
1		0115	16	255.	1		0730	91	3663.	1		1345	166	2200.	1		2000	241	704.
1		0120	17	275.	1		0735	92	3905.	1		1350	167	2154.	1		2005	242	702.
1		0125	18	289.	1		0740	93	4188.	1		1355	168	2113.	1		2010	243	700.
1		0130	19	303.	1		0745	94	4528.	1		1400	169	2071.	1		2015	244	698.
1		0135	20	319.	1		0750	95	5012.	1		1405	170	2026.	1		2020	245	696.
1		0140	21	339.	1		0755	96	6035.	1		1410	171	1986.	1		2025	246	694.
1		0145	22	362.	1		0800	97	9387.	1		1415	172	1949.	1		2030	247	692.
1		0150	23	388.	1		0805	98	8596.	1		1420	173	1912.	1		2035	248	691.
1		0155	24	411.	1		0810	99	9747.	1		1425	174	1874.	1		2040	249	689.
1		0200	25	434.	1		0815	100	11760.	1		1430	175	1833.	1		2045	250	688.
1		0205	26	457.	1		0820	101	14089.	1		1435	176	1792.	1		2050	251	687.
1		0210	27	478.	1		0825	102	16101.	1		1440	177	1751.	1		2055	252	685.
1		0215	28	497.	1		0830	103	17573.	1		1445	178	1713.	1		2100	253	684.
1		0220	29	514.	1		0835	104	17800.	1		1450	179	1678.	1		2105	254	683.
1		0225	30	528.	1		0840	105	17938.	1		1455	180	1641.	1		2110	255	682.
1		0230	31	540.	1		0845	106	17936.	1		1500	181	1609.	1		2115	256	681.
1		0235	32	551.	1		0850	107	17682.	1		1505	182	1582.	1		2120	257	680.
1		0240	33	560.	1		0855	108	16731.	1		1510	183	1555.	1		2125	258	669.
1		0245	34	569.	1		0900	109	15591.	1		1515	184	1520.	1		2130	259	663.
1		0250	35	576.	1		0905	110	14548.	1		1520	185	1495.	1		2135	260	657.
1		0255	36	583.	1		0910	111	13583.	1		1525	186	1469.	1		2140	261	647.
1		0300	37	590.	1		0915	112	12763.	1		1530	187	1442.	1		2145	262	632.
1		0305	38	595.	1		0920	113	12023.	1		1535	188	1410.	1		2150	263	614.
1		0310	39	600.	1		0925	114	11337.	1		1540	189	1376.	1		2155	264	593.
1		0315	40	615.	1		0930	115	10744.	1		1545	190	1342.	1		2200	265	573.
1		0320	41	625.	1		0935	116	10181.	1		1550	191	1308.	1		2205	266	554.
1		0325	42	634.	1		0940	117	9674.	1		1555	192	1279.	1		2210	267	535.
1		0330	43	647.	1		0945	118	9232.	1		1600	193	1251.	1		2215	268	516.
1		0335	44	665.	1		0950	119	8809.	1		1605	194	1224.	1		2220	269	499.
1		0340	45	685.	1		0955	120	8436.	1		1610	195	1200.	1		2225	270	486.
1		0345	46	708.	1		1000	121	8092.	1		1615	196	1179.	1		2230	271	474.
1		0350	47	731.	1		1005	122	7783.	1		1620	197	1161.	1		2235	272	464.
1		0355	48	752.	1		1010	123	7503.	1		1625	198	1145.	1		2240	273	455.
1		0400	49	773.	1		1015	124	7249.	1		1630	199	1131.	1		2245	274	447.
1		0405	50	794.	1		1020	125	6994.	1		1635	200	1118.	1		2250	275	440.
1		0410	51	812.	1		1025	126	6771.	1		1640	201	1107.	1		2255	276	434.
1		0415	52	838.	1		1030	127	6551.	1		1645	202	1096.	1		2300	277	428.
1		0420	53	856.	1		1035	128	6354.	1		1650	203	1087.	1		2305	278	423.
1		0425	54	873.	1		1040	129	6155.	1		1655	204	1078.	1		2310	279	419.
1		0430	55	893.	1		1045	130	5975.	1		1700	205	1070.	1		2315	280	415.
1		0435	56	916.	1		1050	131	5793.	1		1705	206	1063.	1		2320	281	411.

1	0440	57	942.	*	1	1055	132	5611.	*	1	1710	207	1057.	*	1	2325	282	387.
1	0445	58	969.	*	1	1100	133	5436.	*	1	1715	208	1051.	*	1	2330	283	377.
1	0450	59	995.	*	1	1105	134	5275.	*	1	1720	209	1045.	*	1	2335	284	367.
1	0455	60	1020.	*	1	1110	135	5103.	*	1	1725	210	1040.	*	1	2340	285	353.
1	0500	61	1054.	*	1	1115	136	4948.	*	1	1730	211	1035.	*	1	2345	286	335.
1	0505	62	1082.	*	1	1120	137	4795.	*	1	1735	212	1020.	*	1	2350	287	312.
1	0510	63	1109.	*	1	1125	138	4652.	*	1	1740	213	1011.	*	1	2355	288	286.
1	0515	64	1136.	*	1	1130	139	4502.	*	1	1745	214	1002.	*	2	0000	289	262.
1	0520	65	1165.	*	1	1135	140	4366.	*	1	1750	215	989.	*	2	0005	290	238.
1	0525	66	1206.	*	1	1140	141	4239.	*	1	1755	216	972.	*	2	0010	291	215.
1	0530	67	1243.	*	1	1145	142	4114.	*	1	1800	217	951.	*	2	0015	292	192.
1	0535	68	1279.	*	1	1150	143	3996.	*	1	1805	218	928.	*	2	0020	293	172.
1	0540	69	1316.	*	1	1155	144	3872.	*	1	1810	219	906.	*	2	0025	294	154.
1	0545	70	1368.	*	1	1200	145	3758.	*	1	1815	220	884.	*	2	0030	295	140.
1	0550	71	1416.	*	1	1205	146	3651.	*	1	1820	221	863.	*	2	0035	296	127.
1	0555	72	1465.	*	1	1210	147	3551.	*	1	1825	222	843.	*	2	0040	297	116.
1	0600	73	1524.	*	1	1215	148	3451.	*	1	1830	223	825.	*	2	0045	298	106.
1	0605	74	1579.	*	1	1220	149	3355.	*	1	1835	224	809.	*	2	0050	299	97.
1	0610	75	1636.	*	1	1225	150	3253.	*	1	1840	225	796.	*	2	0055	300	89.
				*					*					*				

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PEAK FLOW	TIME		MAXIMUM AVERAGE FLOW			
(CFS)	(HR)		6-HR	24-HR	72-HR	24.92-HR
17938.	8.67	(CFS)	7396.	2572.	2480.	2480.
		(INCHES)	17.604	24.490	24.515	24.515
		(AC-FT)	3667.	5102.	5107.	5107.

CUMULATIVE AREA = 3.91 SQ MI

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          *            *
81 KK     *      DAM   *
          *            *
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ROUTE THE FLOOD HYDROGRAPH THROUGH LEFT HAND VALLEY RESERVOIR

HYDROGRAPH ROUTING DATA

83 RS STORAGE ROUTING

NSTPS	1	NUMBER OF SUBREACHES
ITYP	ELEV	TYPE OF INITIAL CONDITION
RSVRIC	5351.00	INITIAL CONDITION
X	.00	WORKING R AND D COEFFICIENT

84 SV	STORAGE	1624.0	1863.0	2125.0	2413.0	2728.0	3072.0			
85 SE	ELEVATION	5351.00	5353.00	5355.00	5357.00	5359.00	5361.00			
86 SQ	DISCHARGE	0.	105.	300.	550.	870.	1250.	1690.	2200.	2750.	3400.
87 SE	ELEVATION	5351.00	5352.00	5353.00	5354.00	5355.00	5356.00	5357.00	5358.00	5359.00	5360.00

88 ST TOP OF DAM

TOPEL	5356.50	ELEVATION AT TOP OF DAM
DAMWID	900.00	DAM WIDTH
COQD	2.80	WEIR COEFFICIENT
EXPD	1.50	EXPONENT OF HEAD

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COMPUTED STORAGE-OUTFLOW-ELEVATION DATA

(INCLUDING FLOW OVER DAM)

STORAGE	1624.00	1743.50	1863.00	1994.00	2125.00	2269.00	2413.00	2570.50	2728.00	2900.00
OUTFLOW	.00	105.00	300.00	550.00	870.00	1250.00	2580.95	6829.54	12711.17	19900.71
ELEVATION	5351.00	5352.00	5353.00	5354.00	5355.00	5356.00	5357.00	5358.00	5359.00	5360.00

STORAGE	3072.00
OUTFLOW	28105.77
ELEVATION	5361.00

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HYDROGRAPH AT STATION DAM

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DA	MON	HRMN	ORD	OUTFLOW	STORAGE	STAGE	DA	MON	HRMN	ORD	OUTFLOW	STORAGE	STAGE	DA	MON	HRMN	ORD	OUTFLOW	STORAGE	STAGE
1		0000	1	0.	1624.0	5351.0	1		0820	101	4655.	2498.7	5357.5	1		1640	201	1453.	2335.3	5356.5
1		0005	2	0.	1624.1	5351.0	1		0825	102	6610.	2563.7	5358.0	1		1645	202	1445.	2332.9	5356.4
1		0010	3	0.	1624.2	5351.0	1		0830	103	8770.	2626.6	5358.4	1		1650	203	1438.	2330.5	5356.4
1		0015	4	0.	1624.5	5351.0	1		0835	104	10812.	2680.9	5358.7	1		1655	204	1431.	2328.1	5356.4
1		0020	5	1.	1624.8	5351.0	1		0840	105	12524.	2723.5	5359.0	1		1700	205	1423.	2325.7	5356.4
1		0025	6	1.	1625.1	5351.0	1		0845	106	13804.	2756.0	5359.2	1		1705	206	1416.	2323.2	5356.4
1		0030	7	1.	1625.6	5351.0	1		0850	107	14774.	2780.2	5359.3	1		1710	207	1408.	2320.8	5356.4
1		0035	8	2.	1626.3	5351.0	1		0855	108	15371.	2794.8	5359.4	1		1715	208	1401.	2318.4	5356.3
1		0040	9	3.	1627.1	5351.0	1		0900	109	15565.	2799.5	5359.4	1		1720	209	1394.	2316.0	5356.3
1		0045	10	4.	1628.0	5351.0	1		0905	110	15444.	2796.5	5359.4	1		1725	210	1386.	2313.6	5356.3
1		0050	11	5.	1629.1	5351.0	1		0910	111	15103.	2788.2	5359.4	1		1730	211	1379.	2311.3	5356.3
1		0055	12	6.	1630.4	5351.1	1		0915	112	14632.	2776.6	5359.3	1		1735	212	1372.	2308.9	5356.3
1		0100	13	7.	1631.7	5351.1	1		0920	113	14092.	2763.2	5359.2	1		1740	213	1364.	2306.4	5356.3
1		0105	14	8.	1633.2	5351.1	1		0925	114	13516.	2748.7	5359.1	1		1745	214	1357.	2303.9	5356.2
1		0110	15	9.	1634.7	5351.1	1		0930	115	12932.	2733.7	5359.0	1		1750	215	1349.	2301.5	5356.2
1		0115	16	11.	1636.4	5351.1	1		0935	116	12331.	2718.8	5358.9	1		1755	216	1342.	2299.0	5356.2
1		0120	17	12.	1638.1	5351.1	1		0940	117	11740.	2704.2	5358.8	1		1800	217	1334.	2296.4	5356.2
1		0125	18	14.	1640.0	5351.1	1		0945	118	11187.	2690.4	5358.8	1		1805	218	1325.	2293.7	5356.2
1		0130	19	16.	1641.9	5351.1	1		0950	119	10671.	2677.2	5358.7	1		1810	219	1317.	2290.9	5356.2
1		0135	20	18.	1644.0	5351.2	1		0955	120	10191.	2664.8	5358.6	1		1815	220	1308.	2288.0	5356.1
1		0140	21	19.	1646.1	5351.2	1		1000	121	9744.	2653.0	5358.5	1		1820	221	1299.	2285.0	5356.1
1		0145	22	21.	1648.4	5351.2	1		1005	122	9336.	2642.1	5358.5	1		1825	222	1290.	2282.0	5356.1
1		0150	23	24.	1650.8	5351.2	1		1010	123	8957.	2631.8	5358.4	1		1830	223	1280.	2278.9	5356.1
1		0155	24	26.	1653.4	5351.2	1		1015	124	8609.	2622.2	5358.3	1		1835	224	1271.	2275.8	5356.0
1		0200	25	28.	1656.2	5351.3	1		1020	125	8286.	2613.1	5358.3	1		1840	225	1261.	2272.6	5356.0
1		0205	26	31.	1659.0	5351.3	1		1025	126	7985.	2604.6	5358.2	1		1845	226	1251.	2269.4	5356.0
1		0210	27	33.	1662.0	5351.3	1		1030	127	7705.	2596.5	5358.2	1		1850	227	1242.	2266.1	5356.0
1		0215	28	36.	1665.1	5351.3	1		1035	128	7442.	2588.8	5358.1	1		1855	228	1234.	2262.9	5356.0
1		0220	29	39.	1668.3	5351.4	1		1040	129	7195.	2581.5	5358.1	1		1900	229	1225.	2259.6	5355.9
1		0225	30	42.	1671.6	5351.4	1		1045	130	6964.	2574.6	5358.0	1		1905	230	1217.	2256.4	5355.9
1		0230	31	45.	1675.0	5351.4	1		1050	131	6747.	2568.0	5358.0	1		1910	231	1208.	2253.2	5355.9

1	0235	32	48.	1678.4	5351.5	*	1	1055	132	6541.	2561.6	5357.9	*	1	1915	232	1200.	2250.0	5355.9
1	0240	33	51.	1681.9	5351.5	*	1	1100	133	6342.	2555.3	5357.9	*	1	1920	233	1192.	2246.9	5355.8
1	0245	34	54.	1685.4	5351.5	*	1	1105	134	6151.	2549.3	5357.9	*	1	1925	234	1183.	2243.7	5355.8
1	0250	35	57.	1689.0	5351.5	*	1	1110	135	5967.	2543.4	5357.8	*	1	1930	235	1175.	2240.6	5355.8
1	0255	36	60.	1692.6	5351.6	*	1	1115	136	5788.	2537.5	5357.8	*	1	1935	236	1167.	2237.5	5355.8
1	0300	37	63.	1696.2	5351.6	*	1	1120	137	5615.	2531.8	5357.8	*	1	1940	237	1159.	2234.4	5355.8
1	0305	38	67.	1699.9	5351.6	*	1	1125	138	5449.	2526.3	5357.7	*	1	1945	238	1151.	2231.4	5355.7
1	0310	39	70.	1703.5	5351.7	*	1	1130	139	5290.	2520.9	5357.7	*	1	1950	239	1143.	2228.4	5355.7
1	0315	40	73.	1707.2	5351.7	*	1	1135	140	5136.	2515.6	5357.7	*	1	1955	240	1135.	2225.4	5355.7
1	0320	41	76.	1710.9	5351.7	*	1	1140	141	4987.	2510.4	5357.6	*	1	2000	241	1127.	2222.5	5355.7
1	0325	42	80.	1714.7	5351.8	*	1	1145	142	4843.	2505.4	5357.6	*	1	2005	242	1120.	2219.6	5355.7
1	0330	43	83.	1718.6	5351.8	*	1	1150	143	4705.	2500.4	5357.6	*	1	2010	243	1112.	2216.7	5355.6
1	0335	44	87.	1722.5	5351.8	*	1	1155	144	4572.	2495.7	5357.5	*	1	2015	244	1105.	2213.9	5355.6
1	0340	45	90.	1726.5	5351.9	*	1	1200	145	4444.	2491.0	5357.5	*	1	2020	245	1097.	2211.1	5355.6
1	0345	46	94.	1730.7	5351.9	*	1	1205	146	4319.	2486.4	5357.5	*	1	2025	246	1090.	2208.3	5355.6
1	0350	47	98.	1735.0	5351.9	*	1	1210	147	4201.	2481.9	5357.4	*	1	2030	247	1083.	2205.6	5355.6
1	0355	48	101.	1739.4	5352.0	*	1	1215	148	4085.	2477.5	5357.4	*	1	2035	248	1076.	2203.0	5355.5
1	0400	49	106.	1744.0	5352.0	*	1	1220	149	3974.	2473.2	5357.4	*	1	2040	249	1069.	2200.4	5355.5
1	0405	50	113.	1748.6	5352.0	*	1	1225	150	3865.	2469.0	5357.4	*	1	2045	250	1062.	2197.8	5355.5
1	0410	51	121.	1753.4	5352.1	*	1	1230	151	3760.	2464.8	5357.3	*	1	2050	251	1055.	2195.2	5355.5
1	0415	52	129.	1758.2	5352.1	*	1	1235	152	3661.	2460.8	5357.3	*	1	2055	252	1049.	2192.7	5355.5
1	0420	53	137.	1763.1	5352.2	*	1	1240	153	3564.	2456.9	5357.3	*	1	2100	253	1042.	2190.3	5355.5
1	0425	54	145.	1768.1	5352.2	*	1	1245	154	3471.	2453.1	5357.3	*	1	2105	254	1036.	2187.8	5355.4
1	0430	55	153.	1773.1	5352.2	*	1	1250	155	3381.	2449.3	5357.2	*	1	2110	255	1029.	2185.4	5355.4
1	0435	56	162.	1778.3	5352.3	*	1	1255	156	3296.	2445.7	5357.2	*	1	2115	256	1023.	2183.0	5355.4
1	0440	57	170.	1783.5	5352.3	*	1	1300	157	3213.	2442.1	5357.2	*	1	2120	257	1017.	2180.7	5355.4
1	0445	58	179.	1788.9	5352.4	*	1	1305	158	3134.	2438.7	5357.2	*	1	2125	258	1011.	2178.4	5355.4
1	0450	59	188.	1794.4	5352.4	*	1	1310	159	3057.	2435.3	5357.1	*	1	2130	259	1005.	2176.0	5355.4
1	0455	60	197.	1800.0	5352.5	*	1	1315	160	2985.	2432.1	5357.1	*	1	2135	260	999.	2173.7	5355.3
1	0500	61	207.	1805.8	5352.5	*	1	1320	161	2916.	2428.9	5357.1	*	1	2140	261	992.	2171.3	5355.3
1	0505	62	216.	1811.7	5352.6	*	1	1325	162	2849.	2425.8	5357.1	*	1	2145	262	986.	2168.9	5355.3
1	0510	63	226.	1817.7	5352.6	*	1	1330	163	2785.	2422.8	5357.1	*	1	2150	263	979.	2166.5	5355.3
1	0515	64	236.	1823.8	5352.7	*	1	1335	164	2723.	2419.9	5357.0	*	1	2155	264	973.	2164.0	5355.3
1	0520	65	246.	1830.0	5352.7	*	1	1340	165	2664.	2417.1	5357.0	*	1	2200	265	966.	2161.3	5355.3
1	0525	66	257.	1836.5	5352.8	*	1	1345	166	2607.	2414.3	5357.0	*	1	2205	266	959.	2158.5	5355.2
1	0530	67	267.	1843.0	5352.8	*	1	1350	167	2549.	2411.5	5357.0	*	1	2210	267	951.	2155.7	5355.2
1	0535	68	278.	1849.8	5352.9	*	1	1355	168	2492.	2408.9	5357.0	*	1	2215	268	943.	2152.8	5355.2
1	0540	69	290.	1856.8	5352.9	*	1	1400	169	2438.	2406.3	5357.0	*	1	2220	269	936.	2149.9	5355.2
1	0545	70	302.	1864.0	5353.0	*	1	1405	170	2386.	2403.7	5356.9	*	1	2225	270	928.	2146.9	5355.2
1	0550	71	316.	1871.4	5353.1	*	1	1410	171	2336.	2401.3	5356.9	*	1	2230	271	920.	2143.8	5355.1
1	0555	72	331.	1879.1	5353.1	*	1	1415	172	2289.	2398.9	5356.9	*	1	2235	272	912.	2140.8	5355.1
1	0600	73	346.	1887.1	5353.2	*	1	1420	173	2243.	2396.5	5356.9	*	1	2240	273	903.	2137.7	5355.1
1	0605	74	362.	1895.3	5353.2	*	1	1425	174	2200.	2394.3	5356.9	*	1	2245	274	895.	2134.6	5355.1
1	0610	75	378.	1903.8	5353.3	*	1	1430	175	2158.	2392.0	5356.9	*	1	2250	275	887.	2131.5	5355.0
1	0615	76	395.	1912.6	5353.4	*	1	1435	176	2116.	2389.8	5356.8	*	1	2255	276	879.	2128.4	5355.0
1	0620	77	412.	1921.8	5353.4	*	1	1440	177	2075.	2387.5	5356.8	*	1	2300	277	871.	2125.4	5355.0
1	0625	78	431.	1931.4	5353.5	*	1	1445	178	2035.	2385.3	5356.8	*	1	2305	278	863.	2122.3	5355.0
1	0630	79	450.	1941.4	5353.6	*	1	1450	179	1997.	2383.1	5356.8	*	1	2310	279	856.	2119.3	5355.0
1	0635	80	469.	1951.8	5353.7	*	1	1455	180	1960.	2380.9	5356.8	*	1	2315	280	849.	2116.3	5354.9
1	0640	81	490.	1962.7	5353.8	*	1	1500	181	1924.	2378.8	5356.8	*	1	2320	281	841.	2113.3	5354.9
1	0645	82	512.	1974.0	5353.8	*	1	1505	182	1889.	2376.6	5356.7	*	1	2325	282	834.	2110.3	5354.9
1	0650	83	535.	1986.0	5353.9	*	1	1510	183	1856.	2374.5	5356.7	*	1	2330	283	827.	2107.2	5354.9
1	0655	84	561.	1998.6	5354.0	*	1	1515	184	1823.	2372.4	5356.7	*	1	2335	284	819.	2104.1	5354.8
1	0700	85	594.	2011.9	5354.1	*	1	1520	185	1792.	2370.4	5356.7	*	1	2340	285	811.	2100.9	5354.8
1	0705	86	628.	2025.9	5354.2	*	1	1525	186	1762.	2368.4	5356.7	*	1	2345	286	803.	2097.8	5354.8
1	0710	87	664.	2040.8	5354.4	*	1	1530	187	1733.	2366.3	5356.7	*	1	2350	287	795.	2094.5	5354.8
1	0715	88	703.	2056.5	5354.5	*	1	1535	188	1705.	2364.3	5356.7	*	1	2355	288	787.	2091.1	5354.7
1	0720	89	743.	2073.1	5354.6	*	1	1540	189	1678.	2362.2	5356.6	*	2	0000	289	779.	2087.6	5354.7
1	0725	90	786.	2090.8	5354.7	*	1	1545	190	1650.	2360.1	5356.6	*	2	0005	290	770.	2084.0	5354.7
1	0730	91	832.	2109.6	5354.9	*	1	1550	191	1624.	2357.9	5356.6	*	2	0010	291	761.	2080.3	5354.7

1	0735	92	882.	2129.7	5355.0	*	1	1555	192	1598.	2355.8	5356.6	*	2	0015	292	751.	2076.5	5354.6
1	0740	93	939.	2151.3	5355.2	*	1	1600	193	1574.	2353.6	5356.6	*	2	0020	293	742.	2072.5	5354.6
1	0745	94	1001.	2174.6	5355.3	*	1	1605	194	1550.	2351.3	5356.6	*	2	0025	294	732.	2068.6	5354.6
1	0750	95	1069.	2200.4	5355.5	*	1	1610	195	1528.	2349.1	5356.6	*	2	0030	295	723.	2064.6	5354.5
1	0755	96	1149.	2230.8	5355.7	*	1	1615	196	1508.	2346.8	5356.5	*	2	0035	296	713.	2060.6	5354.5
1	0800	97	1270.	2275.5	5356.0	*	1	1620	197	1491.	2344.6	5356.5	*	2	0040	297	703.	2056.6	5354.5
1	0805	98	1431.	2328.1	5356.4	*	1	1625	198	1476.	2342.3	5356.5	*	2	0045	298	693.	2052.5	5354.4
1	0810	99	1939.	2379.7	5356.8	*	1	1630	199	1467.	2340.0	5356.5	*	2	0050	299	683.	2048.5	5354.4
1	0815	100	3083.	2436.5	5357.1	*	1	1635	200	1460.	2337.7	5356.5	*	2	0055	300	673.	2044.5	5354.4
						*							*						

****

PEAK OUTFLOW IS 15565. AT TIME 9.00 HOURS

PEAK FLOW	TIME		MAXIMUM AVERAGE FLOW			
(CFS)	(HR)		6-HR	24-HR	72-HR	24.92-HR
15565.	9.00	(CFS)	6877.	2363.	2276.	2276.
		(INCHES)	16.369	22.501	22.501	22.501
		(AC-FT)	3410.	4687.	4687.	4687.

PEAK STORAGE	TIME	MAXIMUM AVERAGE STORAGE			
(AC-FT)	(HR)	6-HR	24-HR	72-HR	24.92-HR
2799.	9.00	2558.	2193.	2173.	2173.

PEAK STAGE	TIME	MAXIMUM AVERAGE STAGE			
(FEET)	(HR)	6-HR	24-HR	72-HR	24.92-HR
5359.42	9.00	5357.92	5355.37	5355.21	5355.21

CUMULATIVE AREA = 3.91 SQ MI

RUNOFF SUMMARY
FLOW IN CUBIC FEET PER SECOND
TIME IN HOURS, AREA IN SQUARE MILES

OPERATION	STATION	PEAK FLOW	TIME OF PEAK	AVERAGE FLOW FOR MAXIMUM PERIOD 6-HOUR	24-HOUR	72-HOUR	BASIN AREA	MAXIMUM STAGE	TIME OF MAX STAGE
HYDROGRAPH AT	SUB-A	11405.	8.83	4455.	1554.	1498.	2.37		
HYDROGRAPH AT	SUB-B	3829.	8.50	1135.	388.	374.	.59		
HYDROGRAPH AT	SUB-C	4949.	8.50	1479.	505.	487.	.77		
3 COMBINED AT	COMB	17559.	8.75	7055.	2446.	2358.	3.73		
HYDROGRAPH AT	LAKE	3975.	8.00	352.	126.	122.	.18		
2 COMBINED AT	COMB	17938.	8.67	7396.	2572.	2480.	3.91		
ROUTED TO	DAM	15565.	9.00	6877.	2363.	2276.	3.91	5359.42	9.00

SUMMARY OF DAM OVERTOPPING/BREACH ANALYSIS FOR STATION DAM
(PEAKS SHOWN ARE FOR INTERNAL TIME STEP USED DURING BREACH FORMATION)

PLAN 1 .....

	INITIAL VALUE	SPILLWAY CREST	TOP OF DAM
ELEVATION	5351.00	5356.50	5356.50
STORAGE	1624.	2341.	2341.
OUTFLOW	0.	1470.	1470.

RATIO OF PMF	MAXIMUM RESERVOIR W.S.ELEV	MAXIMUM DEPTH OVER DAM	MAXIMUM STORAGE AC-FT	MAXIMUM OUTFLOW CFS	DURATION OVER TOP HOURS	TIME OF MAX OUTFLOW HOURS	TIME OF FAILURE HOURS
1.00	5359.42	2.92	2799.	15565.	8.33	9.00	.00

*** NORMAL END OF HEC-1 ***
NORMAL END OF HEC-1

APPENDIX E

PRELIMINARY
GEOTECHNICAL STUDIES

ROCKY MOUNTAIN CONSULTANTS, INC.

PRELIMINARY GEOTECHNICAL STUDIES

INTRODUCTION

This report presents the results of Rocky Mountain Consultants, Inc.'s preliminary geotechnical studies for the proposed roller compacted concrete (RCC) spillway and stilling basin to be located on the north dam of the Left Hand Valley Reservoir in Boulder County, Colorado. This report includes a description of the subsurface investigation and the subsurface conditions encountered, as well as preliminary analysis for the proposed spillway and stilling basin.

FIELD INVESTIGATION

Four test holes were drilled to investigate subsurface conditions at the site at locations shown on Figure III-2 in the Feasibility Study for Left Hand Valley Reservoir Spillway Modifications. Test hole 1 was drilled on the crest of the dam, test hole 2 was drilled in the toe of the dam near the south abutment, test hole 3 was drilled below the dam in the area of the proposed stilling basin, and test hole 4 was drilled near the toe of the dam south of the outlet works. The test holes were drilled on December 16, 1993 using four-inch O.D. continuous flight solid stem augers powered by a track-mounted CME-850 drill rig. Soil samples were obtained in five-foot intervals using split-spoon or California liner samplers. Test hole summary logs are included on Figure 1.

LABORATORY INVESTIGATION

Soil samples obtained during the drilling operations were tested for physical and engineering properties, including: moisture content, dry density, sieve analysis, Atterberg limits, Proctor density and moisture, water soluble sulfates, and direct shear strength. Laboratory results are summarized on Table 1. The direct shear test results are plotted in Attachment A.

SUBSURFACE CONDITIONS

Our interpretation of the subsurface profile across the dam is shown in cross-sectional view on Figure 2. The cross-section on Figure 2 is based upon data obtained in this investigation, as well as data documented in the original dam plans (Runyan, 1948). The cross-section indicates a maximum depth of approximately 75 feet of fill soils (including approximately 20 feet of fill soils in the cutoff key) is present under the dam crest. The dam fill, with the

exception of the easternmost toe of the dam, apparently overlies approximately eight to 12 feet of residual clay soils on top of shale bedrock. At the easternmost toe of the dam, the fill soils overlie approximately zero to eight feet of sandy clay soils and approximately six to eight feet of residual clay soils on top of shale bedrock. In the stilling basin, approximately 18 feet of sandy clay soil overlies approximately four feet of residual clay soil on top of shale bedrock.

The dam fill soils consist of medium stiff to very stiff clayey sand, sandy clay, and residual clay soils with local claystone and shale fragments. The tested fill soils have plasticity indices ranging from 12 to 14 with 34 to 54 percent fines passing the No. 200 sieve. One fill soil sample tested for strength by direct shear test had an internal friction angle of 45.2 degrees and a cohesive strength of 914 pounds per square foot (psf).

The clay soils located under the easternmost toe of the dam and in the stilling basin are soft to stiff, locally sandy, clay. In the stilling basin area the soils are wet and the water table is at the ground surface. A sample of this soil type had a plasticity index of 21 with 78 percent fines passing the No. 200 sieve.

The residual clay soils are stiff to very stiff sandy clay with relic bedrock structure. A sample of residual clay had a plasticity index of 16 with 58 percent fines passing the No. 200 sieve.

The shale bedrock is hard to very hard and locally fissile and very indurated. A sample of shale had a plasticity index of 7 with 19 percent fines passing the No. 200 sieve. The shale bedrock does not readily breakdown to its constituent particle size accounting for the low percentage of fines passing the No. 200 sieve.

PRELIMINARY ANALYSIS

Our investigations indicate a roller compacted concrete spillway and stilling basin are feasible for this site. Stability problems or excessive settlements are not anticipated provided final geotechnical recommendations are followed. Underdrains and filters should be constructed under the spillway and stilling basin. Construction dewatering will be necessary in the stilling basin area.

REFERENCES

Runyan, D., 1948, "Plans for the Left Hand Valley Reservoir," prepared for the Left Hand Ditch Company, Niwot, Colorado.

Job No. 50-0132.007.01

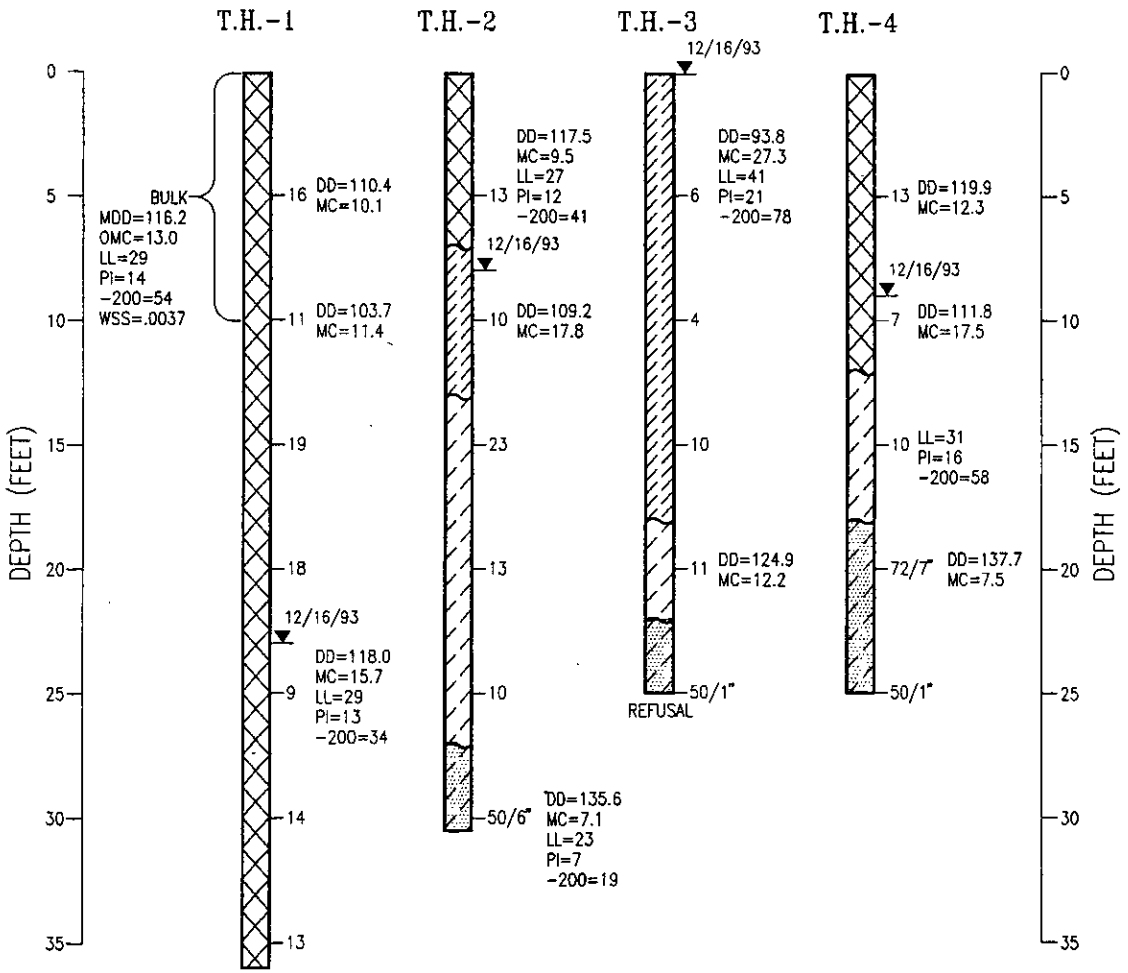
TABLE 1

SUMMARY OF LABORATORY TEST RESULTS

Sample Location		Natural Moisture Content (%)	Natural Dry Density (pcf)	Gradation		Percent Passing No. 200 Sieve	Atterberg Limits		Max. Dry Density (pcf)	Optimum Moisture Content (%)	Water Soluble Sulfate (%)	Soil Classification
Hole	Depth (feet)			Gravel (%)	Sand (%)		Liquid Limit (%)	Plasticity Index (%)				
TH-1	0 - 10			0	45.7	54.3	29	14	116.2	13.0	0.0037	Very sandy clay (CL)
TH-1	5	10.1	110.4									Sandy clay (CL)
TH-1	10	11.4	103.7									Very sandy clay (CL)
TH-1	25	15.7	118.0	0	66.5	33.5	29	13				Very clayey sand (SC)
TH-2	5	9.5	117.5	12.4	46.5	41.1	27	12				Very clayey sand (SC)
TH-2	10	17.8	109.2									Sandy clay (CL)
TH-2*	30	7.1	135.6			19.0	23	7				Shale
TH-3	5	27.3	93.8	0	22.2	77.8	41	21				Sandy clay (CL)
TH-3	20	12.2	124.9									Sandy clay (CL)
TH-4	5	12.3	119.9									Sandy clay (CL)
TH-4	10	17.5	111.8									Sandy clay (CL)
TH-4	15			0	41.8	58.2	31	16				Very sandy clay (CL)
TH-4	20	7.5	137.7									Shale

* Shale samples not completely broken down for sieve analysis.

DEPT19/50/5-0132.TAB



LEGEND:

FILL: CLAY, RESIDUAL CLAY,CLAYSTONE AND CLAYEY SAND, MEDIUM STIFF TO VERY STIFF, SILTY, LOCALLY SANDY, LOCALLY ORGANIC, LOCAL SHALE ROCK FRAGMENTS, DRY TO WET, BROWN, GREY. GENERALLY CONSISTS OF CLAY IN UPPER 15-FEET AND RESIDUAL CLAY AND CLAYSTONE BELOW 15-FEET (CL,CL-CH,CL-SC,SC)

CLAY, SOFT TO STIFF, SILTY, LOCALLY SANDY, WET, BROWN, GREY, (CL,CL-CH)

RESIDUAL CLAY, STIFF TO VERY STIFF, SILTY, VERY MOIST TO WET, BROWN-GREY, RELIC CLAYSTONE BEDROCK STRUCTURE (CL,CL-CH)

SHALE, HARD TO VERY HARD, SILTY, LOCALLY FISSLE AND VERY INDURATED, MOIST, DARK BROWN TO DARK GREY, DOES NOT BREAK DOWN

6 — CALIFORNIA LINER SAMPLE NUMBER INDICATES 6 BLOWS OF A 140 LB. HAMMER FALLING 30-INCHES WERE REQUIRED TO DRIVE THE SAMPLER 1-FOOT

BULK — BULK SAMPLE INTERVAL

12/16/93 — GROUNDWATER LEVEL AND DATE

REFUSAL — PRACTICAL AUGER DRILLING REFUSAL

NOTES:

1) TEST HOLES WERE DRILLED ON 12/16/93 USING 4-INCH O.D. CONTINUOUS FLIGHT SOLID STEM AUGER POWERED BY A TRACK-MOUNTED CME-850 DRILL RIG.

2) EXPLORATORY BORING LOCATIONS AND ELEVATIONS WERE SURVEYED. LOGS ARE DRAWN TO DEPTH.

3) LINES BETWEEN MATERIALS REPRESENT APPROXIMATE BOUNDARIES BETWEEN TYPES AND TRANSITIONS MAY BE GRADUAL.

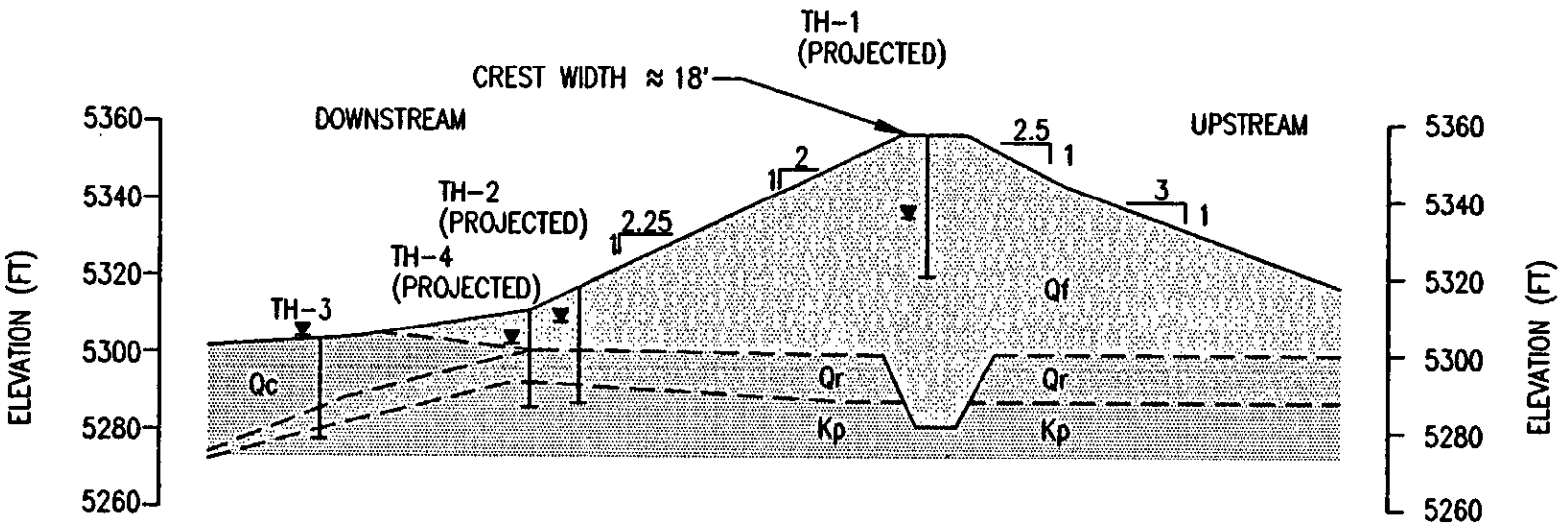
4) GROUNDWATER LEVELS WERE MEASURED AT THE TIME OF DRILLING. GROUNDWATER LEVELS WILL VARY SEASONALLY WITH THE RESERVOIR WATER LEVEL.

5) LABORATORY TESTING:
   - MC=MOISTURE CONTENT, %
   - DD=DRY DENSITY, pcf
   - -200=% PASSING THE #200 SIEVE
   - LL=LIQUID LIMIT
   - PI=PLASTICITY INDEX
   - MDD=MAXIMUM DRY DENSITY, PCF
   - OMC=OPTIMUM MOISTURE CONTENT, %
   - WSS=WATER SOLUBLE SULFATES

LEFT HAND VALLEY
RESERVOIR NORTH DAM
TEST HOLE SUMMARY LOGS

RMC

FIGURE:
1



Qf FILL

Qc CLAY

Qr RESIDUAL SOIL

Kp SHALE

0 25' 50'

VERT. SCALE: 1"=50'
HORZ. SCALE: 1"=50'

SECTION A-A
LEFT HAND VALLEY
RESERVOIR NORTH DAM

RMC

FIGURE:
2

ATTACHMENT A

DIRECT SHEAR TEST RESULTS

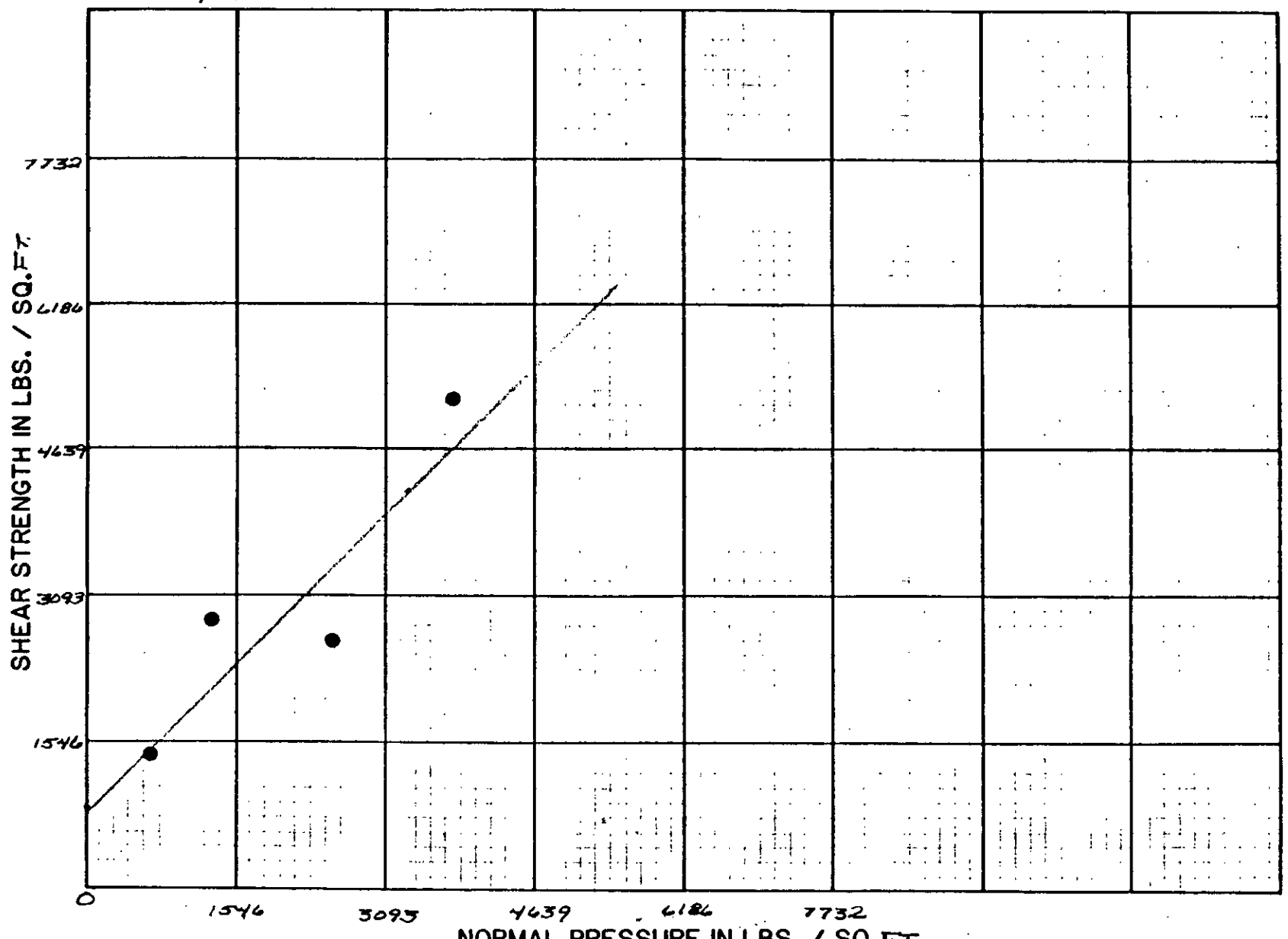
Project No. 2009-09

By: SR Date: 1-10-94

Checked by: _____ Date: _____

RMC INC.
TH-1 @ 25'
LEFT HAND

● = PEAK SHEAR STRENGTH $\phi = 45.2°$ $C = 914$ PSF



DIRECT SHEAR TEST DATA
1.938" ø SAMPLES

ADVANCED TERRA TESTING