APPENDICES

APPENDIX A

INTERAGENCY MEMORANDUM OF UNDERSTANDING AND SCOPE OF WORK FOR AREA-WIDE WATER STUDY FOR SALT LAKE COUNTY, PHASE II

SALT LAKE COUNTY WATER CONSERVANCY DISTRICT

MEMORANDUM OF UNDERSTANDING

TO: MANAGERS OF PARTICIPATING AGENCIES AND CONSULTING ENGINEERS FOR THE AREA-WIDE WATER STUDY

FROM: ROBERT B. HILBERT

DATE: JULY 27, 1981

SUBJECT: DISCUSSIONS WITH PRINCIPALS OF ENGINEERING FIRMS REGARDING THE AREA-WIDE WATER STUDY FOR SALT LAKE COUNTY

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On Tuesday, July 7, 1981, a meeting was held at the Salt Lake County Water Conservancy District to discuss the organization and procedures of the Area-Wide Water Study for Salt Lake County. Those attending the meeting were:

Consulting Engineers
Charles King, Coon, King & Knowlton (CK&K)
Rod Preator, Eckhoff, Watson & Preator (EW&P)
David Griffith, Horrocks & Carrollo (H&C)
Gil Horrocks, Horrocks & Carrollo (H&C)
Lou Wangsgard, Nielsen, Maxwell & Wangsgard (NM&W)

Salt Lake City Public Utilities Department (SLC)
LeRoy Hooton
Wendell Evensen

Metropolitan Water District of Salt Lake City (MWD)
Vaughn Wonnacott

Salt Lake County Water Conservancy District (SLCWCD)
Robert Hilbert
David Ovard
Matthew Marshall

The details of the meeting are summarized as follows:

1. Study Background: SLC, MWD, and SLCWCD have joined together to conduct an Area-Wide Water Study to identify available water resources in Salt Lake County to meet the needs of an expanding population in the face of continuing delays in the construction of the Central Utah Project. Because of funding limitations, a number of engineering firms were asked to participate in the study by providing selected personnel for an engineering team on a direct salary basis, in order to maximize the amount of information that could be developed for the $60,000 available to the sponsoring agencies.

2. Team Organization: John Johnson, H&C, has been selected as the team leader. He will be relocated by H&C to Salt Lake City for the duration of the study. Other team members will be drawn from CK&K, EW&P, and NM&W as needed, according to their availability as summarized on the revised Engineering Team Personnel Sheet (attached).

3. Facilities: The engineering team will be housed at the office of the SLCWCD. Office space, furniture, supplies, telephones, copy machine, secretarial help and other services will be made available by the SLCWCD. Identifiable office expenses will be shared equally by the three participating agencies. Transportation for study activities will be made available as needed by the agencies.

4. Billing Procedures: The participating agencies will reimburse the engineering firms for the direct salary of involved employees based on the annual salary for such individual divided by 2080 hours times the number of hours of involvement. Bonuses will not be included in the direct salary determination. Fringe benefits, payroll taxes, and other expenses other than direct salaries will be borne by the engineering firms. H&C will bear the entire cost of relocating and maintaining John Johnson in Salt Lake during the term of the study. Each engineering firm will bill the SLCWCD monthly for the direct salary reimbursement of involved employees. The District will verify time and involvements and pay the direct salaries as billed. The District will bill SLC and MWD for their share of the direct salaries and office expenses.

5. Starting Date: John Johnson will arrive in Salt Lake, July 13 or 14, to begin work.

6. Initial Task: The team leader will review the preliminary scope of the study, make recommendation for scope refinement, and develop a flow chart of events and a budget and schedule for utilization of support members from the other engineering firms. This information will be mailed to the principals of the engineering firms and provided to the participating agency managers by July 27, 1981. The next meeting of agency representatives and consulting engineers was suggested for the week of August 3, 1981.

7. Coordination of Study: As each task is completed or whenever review of the progress on any specific task is required, the team leader will mail a summary of the task-related activities and conclusions to the principals of each firm. Upon the request of any of the principals, a meeting of the principals will be called to review the task or study progress. Overall management of the study will proceed under control of the agency representatives in consultation with the principals of the engineering firms. An advisory panel comprised of representatives from a variety of local interests will review the progress of the study and make recommendations to the agency representatives as appropriate.

8. Other Services: Services provided by SLC or MWD will be submitted to SLCWCD for consideration in sharing the costs of the study.

Salt Lake County Water Conservancy District

Robert B. Hilbert, General Manager — Date: July 27 81

Salt Lake City Public Utilities Department

LeRoy Hooton, Director — Date: July 27, 1981

Metropolitan Water District

Vaughn Wonnacott, General Manager — Date: July 27, 1981

SCOPE OF WORK

TASK 1: POPULATION & WATER USES

A. Population:

1) Present -- Total County (Agencies to Furnish Basic Data)

2) Future Population Factors -- MX, Syn. Fuel, Intermountain Power Project

3) Projections -- 1990 & 2000 -- Total County (Agencies to Furnish Basic Data)

B. Water Uses:

1) Present -- Annual & Peak Demands for Municipal & Industrial for County, Irrigation Water, Evaporation by Lake or Streams and Discharge to Great Salt Lake

2) Present and Future Water Conservation Measures -- Individual Home Inside and Outside Uses, Recycle and/or Reuse Potentials

3) Future -- Annual & Peak Demands for Municipal & Industrial for County, Irrigation Water, Evaporation by Lake or Streams and Discharge to Great Salt Lake

TASK 2: IDENTIFY EXISTING WATER RESOURCES

A. Mountain Streams:

1) Determine Dependable Yield of each Stream -- Establish Annual and Monthly Variations in Flows, Determine Excess Flows (Assistance from City Hydrologist)

2) Determine Present Quality Ranges

3) Identify Existing Treatment & Storage Capacities

4) Identify Present Water Use & Exchange Agreements

B. Imported Water:

1) Determine Available Quantity -- Establish Annual and Monthly Variations in Flows, Determine Excess Flows

2) Determine Present Quality Ranges

3) Identify Existing Treatment & Storage Capacities

4) Identify Present Water Use & Exchange Agreements

C. Utah Lake & Jordan River:

1) Identify Canal Systems

2) Determine Dependable Yield -- Establish Annual and Monthly Variations in Flows, Determine Excess Flows

3) Identify Present Quality Ranges

4) Identify Present Water Use & Exchange Agreements

D. Great Salt Lake:

1) Determine Water Surface Fluctuations

2) Determine Present Quality Ranges

E. Groundwater:

1) Identify Well Fields

2) Review Available Data -- Establish Annual and Monthly Variations in Groundwater Levels. Determine Flows (Use Ranges -- More Exact Information to come from Current USGS Study)

3) Determine Present Quality Ranges (Use Ranges -- More Exact Information to come from Current USGS Study)

4) Identify Present Water Use & Exchange Agreements

5) Subsurface Drainage Systems

F. Springs:

1) Identify Spring Locations

2) Determine Dependable Yield -- Establish Annual and Monthly Variations in Flows, Determine Excess Flows

3) Identify Present Quality Ranges

4) Identify Present Water Use & Exchange Agreements

G. Wastewater Effluent:

1) Determine Effluent Quantities -- Establish Annual and Monthly Variations in Flows, Determine Excess Flows

2) Identify Present Quality Ranges

3) Identify Existing and Proposed Treatment Facilities

4) Identify Present Water Use & Use Agreements

TASK 3: DEVELOPABLE WATER RESOURCES

A. Mountain Streams:

1) Determine which Streams have Sufficient Water to Merit Storage Reservoirs and/or Treatment, either Singularly or Collectively

2) Investigate New Storage Sites and/or Expansion of Existing Storage Sites on Streams Selected in Item 1

3) Investigate Possible Expansion and/or New Treatment Possibilities on Streams Selected in Item 1 in Combination with or without Storage

4) Investigate Groundwater Recharge Potential

5) Investigate Canyon Groundwater Recovery

6) Investigate Power Potential

7) Estimate Cost of Viable Projects

B. Utah Lake & Jordan River:

1) Analyze Existing Data for Projection of Future Water Quality

2) Investigate Treatment & Storage Possibilities

3) Investigate Power Potential

4) Estimate Cost of Viable Facilities

C. Great Salt Lake:

Investigate & Cost Treatment Facilities

D. Groundwater:

Subject to Current USGS Study

E. Springs:

Investigate & Cost Collection, Treatment & Storage Facilities

F. Wastewater Effluent:

Investigate & Cost Advance Treatment Facilities

G. Valley Storage:

Investigate & Cost Storage Sites & Associated Treatment Facilities

H. Special Projects:

1) Investigate & Cost Dual Water Systems

2) Investigate New Water Exchange Possibilities

TASK 4: MEETINGS

A. Advisory Meetings:

Four Briefings -- One on Scope, One after Task 2, One after Task 3, and One after Review of Draft Report

B. Agencies' Briefings:

1) Monthly Formal Briefings

2) Informal Individual Briefings as Required

TASK 5: PREPARATION OF REPORT

A. Draft:

Complete Corresponding Chapter after Each Scope Task

B. Final:

APPENDIX B

WATER SUPPLY AND DEMAND STUDY FOR SALT LAKE COUNTY, PHASE I

AND

PROPOSAL FOR GROUND-WATER STUDY FOR SALT LAKE VALLEY, PHASE III

WATER SUPPLY AND DEMAND STUDY

FOR SALT LAKE COUNTY

PHASE I

JANUARY 27, 1982

PREPARED BY

METROPOLITAN WATER DISTRICT OF SALT LAKE CITY

SALT LAKE COUNTY WATER CONSERVANCY DISTRICT

SALT LAKE CITY DEPARTMENT OF PUBLIC UTILITIES

SALT LAKE COUNTY WATER RESOURCES AND WATER DEMAND STUDY THROUGH THE YEAR 2000

CONTRACTING AGENCIES

There are three agencies interested in contracting for this proposed Water Resources and Water Demand Study. They are the Metropolitan Water District of Salt Lake City, Salt Lake County Water Conservancy District, and Salt Lake City Corporation.

These three agencies through their Boards of Directors for the first two and the Advisory Board for the latter represent nearly all of the County's water and governmental agencies. For all practical purposes all of the additional M & I water needed within Salt Lake County by the year 2000 will be furnished by these three agencies.

PURPOSE OF STUDY

A preliminary study of water supply and water demand in Salt Lake County indicates that in the event of another drought such as occurred in 1934 in this area there will be insufficient water to meet the M & I needs of the County. For example, the total water demand during 1979 was 174,000 AF. Under 1934 stream flow conditions available developed water resources would only be 165,000 AF, including the full Deer Creek Reservoir storage.

Obviously, the block of water secured through the Deer Creek project of the early 1940's has reached its limit. Another block of M & I water must be secure to meet present needs as well as those of an expanding economy.

Salt Lake County has experienced a 31 percent increase in growth during the past decade. Long term projections made in the 1980 report of the Salt Lake County Division of Water Quality and Water Pollution Control indicate that the County's population will increase from its present level of approximately 600,000 to over 900,000 people by the turn of the century. Factors which may accelerate the County's population growth which were not included in the above stated population forecast are:

1) Accelerated development of Utah's energy resources
2) MX Missile project and other national defense programs
3) Continued high birth rate for local residents
4) Central location in the West making Salt Lake County a natural hub of economic expansion
5) An environmental setting offering an unexcelled variety of recreational opportunities
6) A life style ranked by a number of national organizations as the best in the United States

This high growth rate must be supplied by additional water resources and this study will provide the information necessary to identify additional water supplies available to the Salt Lake Valley.

NEED FOR STUDY

In recent years strains have been placed upon existing water resources and water facilities within the County by the rapidly expanding population and economy. Water agencies in the County have been looking forward to the completion of key facilities in the Bonneville unit of the Central Utah Project to alleviate their water supply problems. Water deliveries from this necessary water development project were originally anticipated in 1974. Funding delays and environmental and safety concerns associated with the Jordanelle Dam, the project's chief water storage facility for Salt Lake County, have pushed back the anticipated delivery date of the block of water from this project to at least 1989.

This study will identify water resources that can be developed to insure adequate water supplies for droughts or water-short years until the proposed block of M & I water is made available through the Central Utah Project.

SCOPE OF STUDY

This study will identify water resources available to Salt Lake County, including local surface and subsurface resources, existing and potential raw water storage within the basin, and surface imports to supplement local resources, and will develop cost effective alternatives on how these water resources may be most effectively utilized.

SPECIFIC TASKS

I. Identify water resources and evaluate feasibility of use based upon availability, water rights, and cost effectiveness.

1) Local canyon streams
2) Groundwater/springs
3) Imported water
4) Raw water storage
5) Conversion or exchange or irrigation water for domestic use
6) Uses of low quality Jordan River and Utah Lake water
7) Uses of low quality underground water
8) Desalination of the Great Salt Lake
9) Wastewater effluent reuse
10) Dual irrigation systems
11) Conservation
12) Other concepts

With emphasis on developing new M & I quality water resources.

II. Determine water demand based on population growth and economic development, and draw conclusions on how water resources can be effectively utilized throughout the County.

TABLE 1

EXISTING MUNICIPAL WATER SUPPLY IN SALT LAKE COUNTY UNDER AVERAGE PRECIPITATION CONDITIONS

SOURCE	SUPPLY IN ACRE-FEET
Groundwater (wells & springs)	68,600
Local Streamflow[a]	54,700
Deer Creek Reservoir[b]	61,700
Total Supply	185,000

[a]Computed as mean value from all years of operation for treatment plants on City Creek, Parleys Canyon, Big Cottonwood Canyon and Little Cottonwood Canyon.

[b]Assumes full annual allotment

TABLE II

1979 MUNICIPAL WATER USE IN SALT LAKE COUNTY (in AF)

AREA	TOTAL	SURFACE WATER	GROUNDWATER
Salt Lake City Service Area	97,153	83,629 (86%)	13,524 (14%)
Salt Lake County Outside Salt Lake City Service Area	77,562	25,719 (33%)	51,843 (67%)
Total	174,715	109,348 (63%)	65,367 (37%)

TABLE III

PROJECTED WATER BUDGET FOR SALT LAKE COUNTY WITH EXISTING SUPPLIES

YEAR	POPULATION[c]	DEMAND (AF)[d]	SUPPLY (AF)	DEFICIT (AF)
1980	621,000	174,700	185,000	--
1985	707,000	199,000	185,000	14,000
1990	793,000	223,000	185,000	38,000
1995	848,000	239,000	185,000	54,000
2000	904,000	254,000	185,000	69,000

[c]Summarized from Salt Lake County Water Quality & Pollution Control Report, July 1, 1980 Economic Demographic Futures: 1980-2000. Odd years are straight-line interpolation.

[d]Assumes demand per capita remains constant at 1980 level.

PROPOSAL FOR GROUND-WATER STUDY FOR SALT LAKE VALLEY

PHASE III

Proposal

Ground-water conditions in the Jordan Valley, Utah, with analysis by flow and solute-transport models

INTRODUCTION

The Jordan Valley (also known as the Salt Lake Valley) increased in population from 459,000 in 1970 to 618,000 in 1980, the latter being 42 percent of the population of Utah. The valley includes Salt Lake City, and it is one of the fastest growing areas in the State. Future demand for water is a concern of local and State managers and planners, especially because delivery of water from the Central Utah Project will be delayed until the late 1980's. Many water managers believe that ground-water use will have to increase greatly in the next 10 years, and they are uncertain about what the specific effects of such increased use will be.

Problems that possibly might occur include large declines in water levels in heavily-pumped areas, migration of poor-quality ground water from the west side and northern end of the valley into areas of better quality water in the valley's central part and eastern side, and land subsidence. Water managers need an analysis of the current state of the Jordan Valley's ground-water reservoir, and they also need up-to-date models to predict effects of future development on ground-water levels and quality.

The drainage basin of the Jordan Valley within Salt Lake County includes about 800 square miles on the eastern edge of the Great Basin in northern Utah (fig. 1). The valley itself includes about 500 square miles, and it is bounded on the east by the Wasatch Range, on the west by the Oquirrh Mountains, on the south by the Traverse Mountains, and on the northwest by Great Salt Lake. Elevations range from 4,200 feet at the shore of Great Salt Lake to over 11,300 feet in the Wasatch Range and over 9,300 feet in the Oquirrhs. The study will focus on ground water in the unconsolidated basin fill that underlies the valley, although study of other aspects of the hydrology of the valley and its drainage basin will be included if it adds to understanding of ground water in the basin fill.

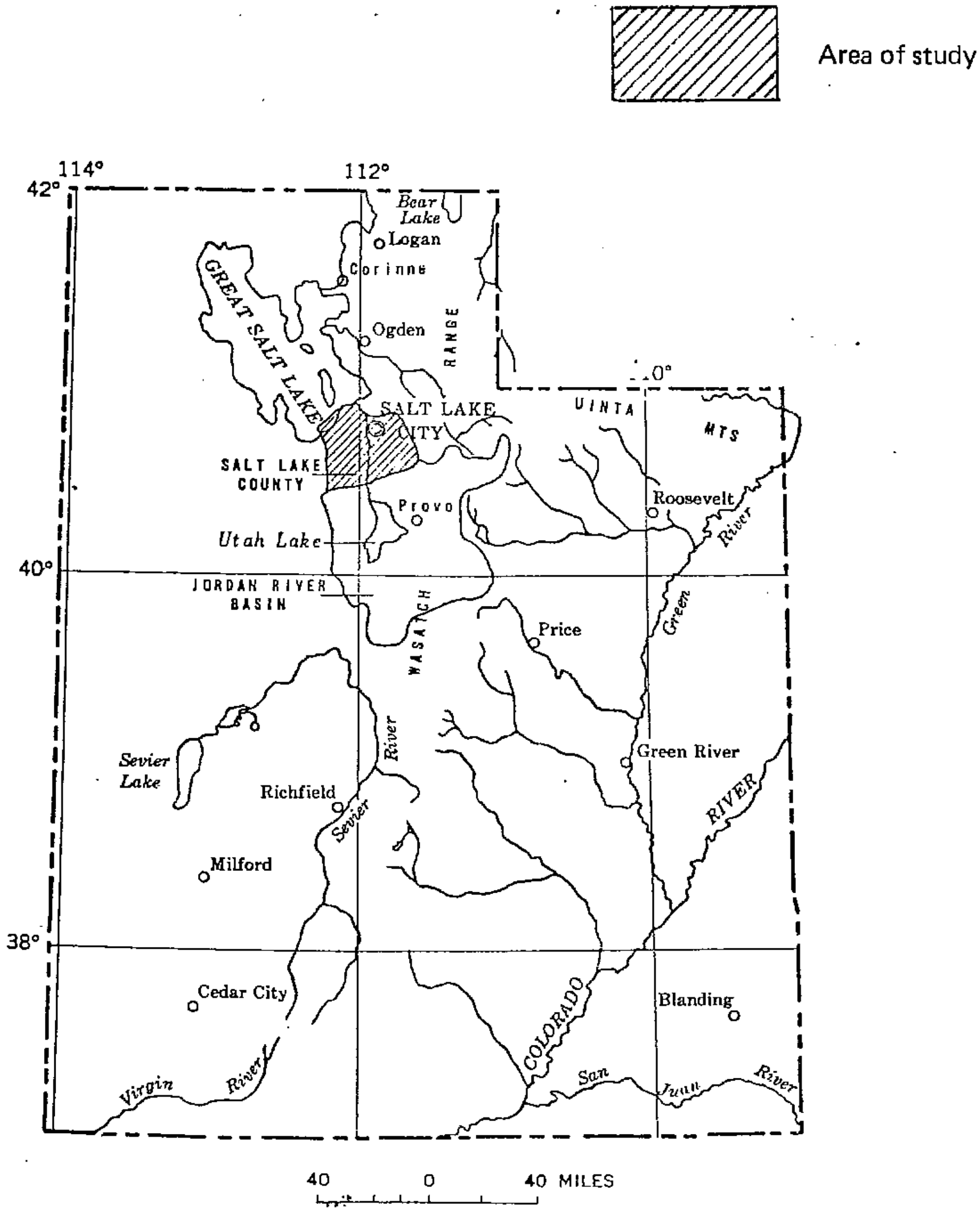

Figure 1.—Map of the study area

PURPOSE

The first objective of the study will be to determine the current state of the ground-water system in the valley in terms of water levels, recharge, movement, discharge, water in storage, and water quality. The second objective will be to design and construct digital-computer models of the ground-water reservoir which will enable managers to simulate future ground-water development and its effects on water levels, natural recharge and discharge, and water quality. A third but lesser objective will be to estimate the potential of land subsidence as related to water-level declines.

The study will meet the principal needs of the cooperators, and it will provide information on effects of water-level declines on water quality and migration of water of poor quality. Such information is sparse for ground-water systems in the Great Basin of Nevada and western Utah. In addition, this study will be integrated with and provide information for the U.S. Geological Survey's Great Basin Regional Aquifer Systems Analysis (RASA), which will be done during the period October 1980-October 1984.

APPROACH

Information available

A considerable amount of data is available on ground water in the Jordan Valley. Studies by Richardson (1906), Taylor and Leggette (1949), Marine and Price (1964), and Hely, Mower, and Harr (1971) have been reported on by the Geological Survey, and much basic data were collected during these studies and published. Water levels have been measured in observation wells since 1931, and since 1964 pumpage has been compiled annually and water-level-change maps prepared annually.

The previous studies have provided a good summary of the hydrogeology of the valley, and the potentiometric surface and variations in ground-water quality are well-defined relative to other areas of the Great Basin. The 1963-69 study (Hely, Mower, and Harr, 1971) was comprehensive and determined the valley's water budget and included construction of a two-layer electric-analog model of the ground-water reservoir. The model, which no longer exists, was used to predict water-level changes from 1932 to 1980, 2000, and 2020. The predictions for 1932-80 have been fairly well matched by actual measured water-level changes.

Related studies, which will be made during all or part of the period of this study, include the Salt Lake County Urban-Runoff Study (Sept. 1979-Oct. 1982) and the Jordan River Quality Study (Dec. 1979-Sept. 1981). These studies will provide flow and water-quality data on the Jordan River and its tributaries, and they may provide data on ground-water inflow and quality to the Jordan River. A continuing study of water losses in canals in Utah probably will be moved to Salt Lake County during FY 82-84 and will provide data on recharge from selected canals. The Great Basin RASA study will provide techniques that can be used to analyze basins in the Great Basin, and much of the information generated in the Jordan Valley study will be incorporated into the RASA study.

Hydrologic system

The Jordan Valley's hydrologic system is dominated by the ground-water reservoir in the basin fill and the Jordan River. The Jordan River flows into the valley from Utah Lake through the Traverse Mountains and then flows along the axis of the valley to Great Salt Lake. Several perennial streams from the Wasatch Range are tributary to the Jordan River. The average annual discharge of the Jordan River just above the Jordan Valley, most of which enters the valley, is about 270,000 acre-feet. During the 1964-68 water years, about 284,000 acre-feet per year of surface water entered the Jordan Valley in the river and in canals and aqueducts; and streamflow originating in the valley's drainage basin was 179,000 acre-feet per year, for a total of more than 460,000 acre-feet per year.

The Jordan River is almost entirely diverted into canals, just below where it enters the valley, during the irrigation season. Most of the river's flow below the diversions during the irrigation season consists of ground-water inflow, and the average annual gain in flow attributed to ground-water inflow is about 170,000 acre-feet.

The main source of ground water in the Jordan Valley is unconsolidated basin fill. Much of the ground water in the northern part of the valley and along its axis is under artesian conditions. Along the margins of the valley, ground water occurs under water-table condtions in coarse-grained basin fill deposited in alluvial fans or lakeshore or delta features.

Ground water has been used in the Jordan Valley since the 1850's, but estimates of discharge are available only since 1931. More than 12,000 wells had been constructed in the valley by 1980, mostly small-diameter domestic and stock wells. During 1931-79, annual discharge from wells increased from about 39,000 to 136,000 acre-feet. Almost half of the withdrawals in 1979 were for municipal use; the rest was almost evenly divided between industrial and domestic/stock uses. Less than 3 percent of the ground-water withdrawals were used for irrigation.

Although water levels have declined in areas where withdrawals for municipal and industrial use have been large, there was no long-term basin-wide decline in water levels during 1931-80. In some locations, water levels rose from 1931-80 because of recharge to the ground-water reservoir resulting from irrigation of lawns and cultivated fields with surface water.

The average annual precipitation over Salt Lake County ranges from less than 12 inches in the south-central part of the Jordan Valley to more than 60 inches along the southern boundary of the county in the Wasatch Range. Annual recharge to the ground-water reservoir in the valley is estimated to be about 367,000 acre-feet, about 40 percent of which is from urban and agricultural irrigation, and another 37 percent of which is seepage from the consolidated rock of the bounding mountain ranges into the basin fill.

Ground-water discharge also was about 367,000 acre-feet per year in 1964-68 and may have been as much as 400,000 acre-feet in 1979. Seepage to streams, drains, and Great Salt Lake and discharge by springs is about 200,000 acre-feet per year, and evapotranspiration (mostly in phreatophyte areas) is about 60,000 acre-feet per year. About 60 million acre-feet of water, much of which is fresh, is stored in the unconsolidated basin fill of the valley, and about one-third of that is theoretically recoverable by wells.

The valley's natural flow system consists of recharge along the margins of the valley from direct seepage from consolidated rock to the basin fill, seepage from streams as they leave the mountains, and from precipitation on the valley margins. Ground water moves toward the axis of the valley and northward, where it becomes confined under lenses of silt and clay deposited in Pleistocene lakes. The water discharges by upward leakage to the shallow water-table zone from which it seeps to the Jordan River, seeps from springs, is discharged by evapotranspiration in areas of phreatophytes, or seeps into Great Salt Lake.

Superimposed on the natural flow system is recharge from canals, irrigated fields, lawns, and gardens, and from man-made ponds, including the tailings pond near the Kennecott Minerals Co. smelter in the northwestern part of the valley. Much of this recharge is to the shallow water-table zone over the confined aquifer, and it discharges to the river, by evapotranspiration, or to Great Salt Lake. Discharge superimposed on the natural flow system is from wells and drains.

Plan of study

The first phase of the study will consist of updating the files of ground-water data. Wells drilled since 1968-69 will be tabulated, and industrial, municipal, major irrigation, and selected domestic wells will be inventoried in the field. Pumpage data will be checked and supplemented, if necessary, for the period since 1968. Chemical analyses made by the Geological Survey and other agencies will be tabulated and evaluated. Data from aquifer tests made by local organizations, if any, will be obtained and evaluated. Streamflow data related to the water budget for the period since 1968 will be compiled, if available.

The second phase will consist of collecting additional data necessary for the study. Data to supplement the 1963-69 study will be collected, if necessary, on recharge from streams, canals, and irrigation of farms and residential areas; and on discharge to the Jordan River and drains, by evapotranspiration, and by springs.

The observation-well network will be evaluated and wells added or deleted if necessary. A series of shallow wells (10-50 feet deep) will be augered and cased with plastic casing in the central and northern part of the valley to provide observation wells in the shallow water-table zone. Water-level data from these wells will be used to compute vertical hydraulic gradients between the artesian and water-table zones which in turn will be used in model calibration.

Aquifer tests will be run if suitable wells are available. If additional funds are available, a comprehensive aquifer test will be run to obtain data on the vertical hydraulic conductivity at one point. This would involve using an existing well as the pumped well (or possibly drilling a well to use as the pumped well) and drilling and instrumenting several observation wells. At least one of these observation wells would be completed so as to be able to provide head data in the confining bed to aid in computation of vertical hydraulic conductivities. Cores will also be collected from the confining bed and tested to obtain estimates of hydraulic conductivity.

Additional data will be collected on quality of ground water so that the areal and vertical sample coverage provides enough information to construct a solute-transport model(s) (a three-dimensional model or two-dimensional cross-section models).

The potential for land subsidence resulting from declines in water levels will be estimated by analyzing cores of silt and clay to obtain preconsolidation stresses. The cores will be obtained from local wells drilled during the period of the study or from foundation borings. Experts from other offices in the Geological Survey will be consulted on this aspect of the study.

The volumes of recoverable ground water of various qualities stored in the basin fill will be estimated using data from well logs and analyses of samples from various depths.

The third phase of the study will be to construct flow and solute-transport models of the ground-water reservoir in the valley. First, a three-dimensional flow model will be constructed, which will have at least two layers—the principal artesian aquifer and the shallow water-table zone. Additional layers may be added to represent a confining zone and the material below the principal aquifer. When this model is calibrated it will be used to construct a three-dimensional solute-transport model, if a suitable model is available at the time, or more likely, as the basis for several two-dimensional cross-section solute-transport models. At least three section models will be made—a northwest-southeast section from Great Salt Lake to the southeastern part of the valley, and two east-west sections across the valley, one from the Kennecott Minerals Co. leaching area near Copperton and another about 6 miles to the north. Experts from other offices in the Geological Survey will be consulted during the transport-modeling phase of the study.

The models will be used to determine the water-level changes resulting from various possible future programs and patterns of withdrawals from wells and to predict any migration of poor-quality water from the western and northwestern parts of the valley toward the good-quality water on the eastern side. The models will also be used for the RASA study to evaluate various generalized patterns of development to determine effects on the Jordan River and natural evapotranspiration and to study possible conjunctive use of ground and surface water.

REPORTS

A planning document, which will be prepared during the first 3 months of the study, will include a more detailed discussion of the plan of study and the current view of how the hydrologic system works, and it will also include a work plan in timetable form and an annotated outline of the final report.

A basic-data report that will be completed at the end of the third year of the study will include all data collected during the study. An open-file report documenting the flow model will be completed by the end of the third year; and a report documenting the solute-transport model(s) will be completed in the fourth year.

A final interpretive report summarizing all findings and modeling results will be prepared during the fourth and final year of the project.

PERSONNEL

The project will be staffed by 2 to 2½ persons:

Project Chief, GS-12/13, possibly available in District.

Hydrologist, GS-7/9/11, available in District.

Technician or WAE, GS/5 to 9, ½ time, not available in District.

COST ESTIMATES

Item	FY 82	FY 83	FY 84	FY 85
Salaries and benefits	$ 61,000	$ 68,000	$ 74,000	$ 76,000
Transportation	2,500	5,000	6,000	3,000
Travel	1,000	1,200	1,200	1,400
Supplies and equipment	2,000	2,500	2,000	500
Contracts	14,720	8,725	5,660	13,260
Computer use	500	1,000	3,000	4,000
Chemical analyses	500	1,500	1,000	500
Training	1,000	1,500	1,500	1,000
Reports processing	0	0	2,000	4,000
District overhead	20,520	22,050	23,760	25,560
WOTSC	10,260	11,025	11,880	12,780
	$114,000	$122,500*	$132,000*	$142,000*

*(includes 7.5 percent "cost-of-living" increases)

REFERENCES

Hely, A. G., Mower, R. W., and Harr, C. A., 1971, Water resources of Salt Lake County, Utah: Utah Department Natural Resources Technical Publication 31, 224 p.

Marine, I. W., and Price, Don, 1964, Geology and ground-water resources of the Jordan Valley: Utah Geological and Mineral Survey Bulletin 7, 68 p.

Richardson, G. B., 1906, Underground water in the valleys of Utah Lake and Jordan River, Utah: U.S. Geological Survey Water-Supply Paper 157, 81 p.

Taylor, G. H., and Leggette, R. M., 1949, Ground water in the Jordan Valley, Utah: U.S. Geological Survey Water-Supply Paper 1029, 357 p. 14 pl.

APPENDIX C

STREAM YIELD ANALYSIS PROCEDURES

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APPENDIX C

STREAM YIELD ANALYSIS PROCEDURES

GENERAL BACKGROUND:

This appendix explains the detailed procedures used during this study to analyze stream yields. An attempt has been made in this study to describe the "dependable yields" of streams in Salt Lake County by use of the results from stream flow analyses.

Stream flow records have been very useful in analyzing Salt Lake County streams. The seven major county streams along the Wasatch Range are currently gaged continuously by the Salt Lake City Water Department, and have long periods of record at the canyon mouths. Table C-1 lists the streams and their full-year periods of record used in stream flow analyses.

TABLE C-1

PERIODS OF STREAM FLOW RECORDS FOR GAGED SALT LAKE COUNTY STREAMS

STREAM	PERIOD OF RECORD USED FOR ANALYSIS*	NO. OF YEARS
City Creek	1899-1980	82
Red Butte Creek	1943-1980	38
Emigration Creek	1901-1980	80
Parleys Creek	1910-1980	71
Mill Creek	1899-1980	82
Big Cottonwood Creek	1899-1980	82
Little Cottonwood Creek	1910-1980	71

*Periods of full-year, continuously gaged records.

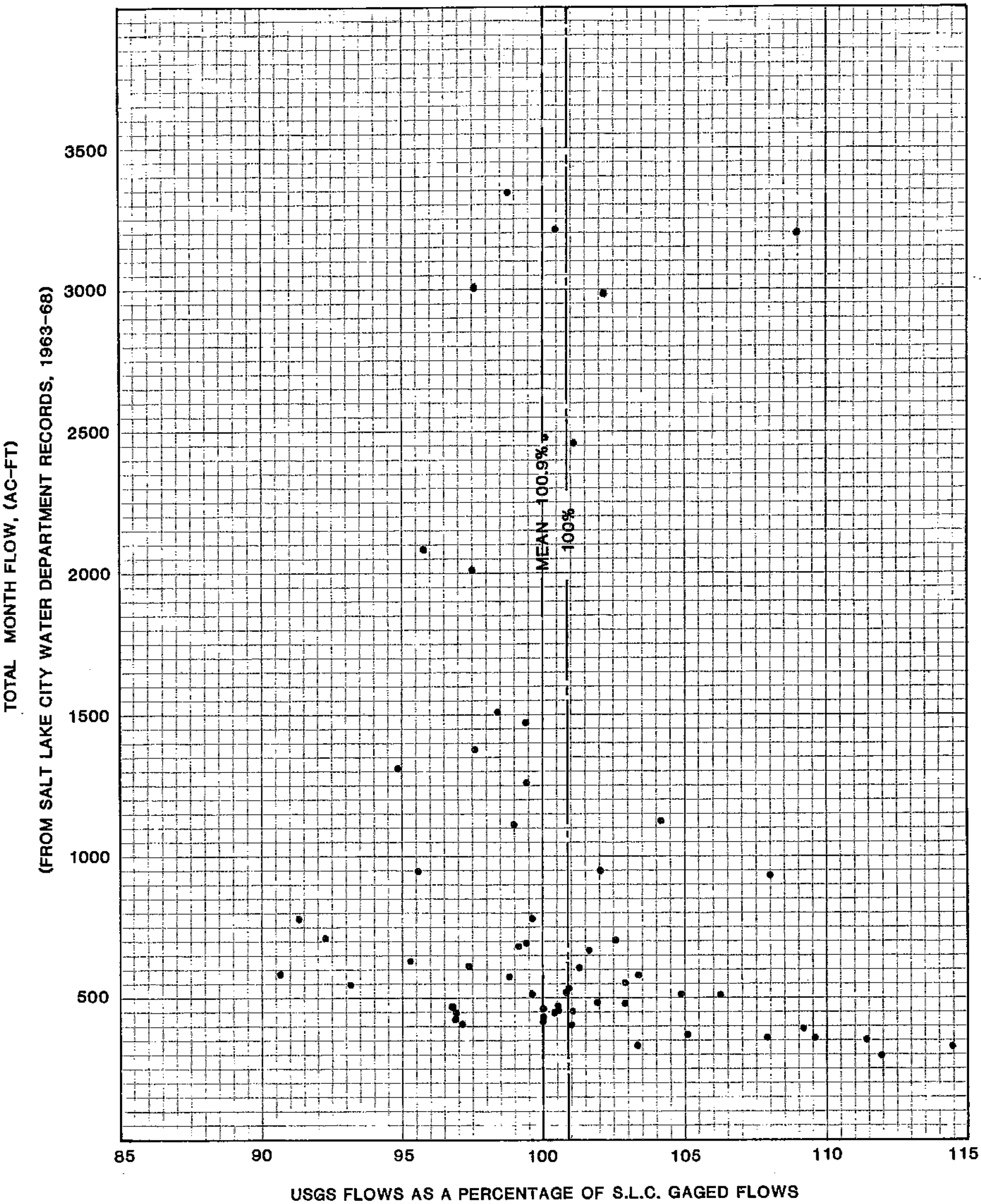
GAGED STREAM FREQUENCY ANALYSES:

Stream flow records were analyzed by conventional frequency analysis procedures. Both annual yields and monthly yields were analyzed to determine dependable yields at several different probabilities, or recurrence intervals. The following sections describe the procedures used, with examples from the City Creek analysis.

CONCURRENT PERIOD OF RECORD: For the six major streams which have been gaged by the Salt Lake City Water Department (City Creek, Emigration Creek, Parleys Creek, Mill Creek, Big Cottonwood Creek and Little Cottonwood Creek), a concurrent period of record (1963-1968) is published by the U.S. Geological Survey (USGS). The gaging for both records was performed at identical locations on each stream. During the 1963 to 1968 period the USGS obtained the gage-height charts from Salt Lake City at the City's normal gaging points, and compiled the stream flow records based on their own (USGS) rating curves.

Because of possible differences in techniques used by the USGS and Salt Lake City Water Department in rating streams and compiling records, an analysis of the two concurrent published records was performed. This was done to determine if any substantial relationship exists between the two sets of records which could be used to adjust or extend either record.

Frequent differences in published flows for identical periods of time were encountered in the two records. The USGS-published flows for each stream during the 1963-1968 period were plotted as percentages of the corresponding flows compiled by Salt Lake City. The plot prepared for City Creek is shown in Figure C-2 as an example, and is typical of the results from the other streams. As can be seen from Figure C-2, the differences in recorded flows appear to be random. No marked relationship was found in the concurrent records of any of the other streams. However, in each case a wider range of divergence was found in the lower flows than in the higher ones. Due to the randomness of the recorded flow differences and the longer term of record, the Salt Lake City Water Department flow records were used in the subsequent frequency analyses without any adjustments.



SALT LAKE COUNTY AREA-WIDE WATER STUDY

RELATIONSHIP BETWEEN USGS AND SLC RECORDED FLOWS ON CITY CREEK FOR 1963-68 CONCURRENT PERIOD OF RECORD

FIGURE C-2

STATISTICAL BACKGROUND: Hydrologists have found that random stream flows on a given stream may be described statistically, just as many other random occurrences in nature. Several types of statistical distributions have been developed to document and predict the frequency of stream flow occurrences. During this study, four distributions were used to estimate frequencies for each stream. These distributions are listed below:

(1) Log Normal Distribution (Normal Distribution with a logarithmic transformation)
(2) Log Pearson Type III Distribution
(3) Gumbels Extreme Value Distribution
(4) Log Student's t-Distribution

In addition, a ranked distribution of actual flows for each stream was calculated and tabulated. The results of these analyses for City Creek annual yields are shown on pages C-5 to C-11, in the form of computer printouts, as an example. For each stream, a separate frequency analysis was performed for each month of the year, as well as an analysis of stream yields on an annual basis.

CITY CREEK ANNUAL (82 YEARS)

FREQUENCY ANALYSIS
RESULTS FROM LOG NORMAL DISTRIBUTION

INPUT DATA

14200.0	12400.0	18600.0	13000.0	11000.0
9560.0	14600.0	4920.0	9080.0	11750.0
13740.0	7240.0	6550.0	12008.0	15296.0
17313.0	9439.0	7690.0	9220.0	14100.0
9490.0	12500.0	10700.0	8470.0	9610.0
9550.0	9790.0	13980.0	7460.0	7960.0
14357.0	13155.0	19273.0	11315.0	9130.0
13600.0	9030.0	12900.0	19900.0	10700.0
6300.0	14240.0	11990.0	9940.0	11630.0
8550.0	5120.0	17600.0	16568.0	11568.0
9020.0	20800.0	12100.0	16700.0	17800.0
13300.0	11400.0	12450.0	15270.0	10930.0
18560.0	10560.0	10530.0	10496.0	14025.0
6355.0	9060.0	14700.0	9870.0	10400.0
15100.0	13200.0	10300.0	12330.0	11540.0
12020.0	12920.0	11950.0	7515.0	12917.0
13703.0	16716.0			

FREQUENCY ANALYSIS
RESULTS FROM LOG NORMAL DISTRIBUTION
STATISTICS FOR LOGX: MEAN= 4.06009
STD DEV= .13027
SKEW= -.45803

RETURN PERIOD	STREAMFLOW
1.001 YEARS	4,545.2
1.010 YEARS	5,715.9
1.111 YEARS	7,817.9
1.250 YEARS	8,920.9
1.333 YEARS	9,382.0
2.000 YEARS	11,484.1
5.000 YEARS	14,783.8
10.000 YEARS	16,869.7
25.000 YEARS	19,418.0
50.000 YEARS	21,265.6
100.000 YEARS	23,073.4
200.000 YEARS	24,870.2
500.000 YEARS	27,228.3
1,000.000 YEARS	29,016.1
10,000.000 YEARS	35,051.8

CITY CREEK ANNUAL (82 YEARS)

FREQUENCY ANALYSIS
RESULTS FROM USING LOG PEARSON TYPE III DISTRIBUTION

INPUT DATA

14200.0	12400.0	18600.0	13000.0	11000.0
9560.0	14600.0	4920.0	9080.0	11750.0
13740.0	7240.0	6550.0	12008.0	15296.0
17313.0	9439.0	7690.0	9220.0	14100.0
9490.0	12500.0	10700.0	8470.0	9610.0
9550.0	9790.0	13980.0	7460.0	7960.0
14357.0	13155.0	19273.0	11315.0	9130.0
13600.0	9030.0	12900.0	19900.0	10700.0
6300.0	14240.0	11990.0	9940.0	11630.0
8550.0	5120.0	17600.0	16568.0	11568.0
9020.0	20800.0	12100.0	16700.0	17800.0
13300.0	11400.0	12450.0	15270.0	10930.0
18560.0	10560.0	10530.0	10496.0	14025.0
6355.0	9060.0	14700.0	9870.0	10400.0
15100.0	13200.0	10300.0	12330.0	11540.0
12020.0	12920.0	11950.0	7515.0	12917.0
13703.0	16716.0			

FREQUENCY ANALYSIS
RESULTS FROM USING LOG PEARSON TYPE III DISTRIBUTION
STATISTICS FOR LOGX: MEAN= 4.06009
STD DEV= .13027
SKEW= -.45803

RETURN PERIOD	STREAMFLOW
1.001 YEARS	3,728.7
1.010 YEARS	5,176.9
1.111 YEARS	7,728.1
1.250 YEARS	9,003.3
1.333 YEARS	9,484.9
2.000 YEARS	11,748.5
5.000 YEARS	14,844.2
10.000 YEARS	16,570.2
25.000 YEARS	18,465.7
50.000 YEARS	19,710.9
100.000 YEARS	20,836.5
200.000 YEARS	21,867.3
500.000 YEARS	23,112.7
1,000.000 YEARS	23,985.4
10,000.000 YEARS	26,504.3

CITY CREEK ANNUAL (82 YEARS)

FREQLENCY ANALYSIS
RESULTS FROM RANKING

RANKED DATA	PROBABILITIY (%)
20800.0	1.204
19900.0	2.409
19273.0	3.614
18600.0	4.819
18560.0	6.024
17800.0	7.228
17600.0	8.433
17313.0	9.638
16716.0	10.843
16700.0	12.048
16568.0	13.253
15296.0	14.457
15270.0	15.662
15100.0	16.867
14700.0	18.072
14600.0	19.277
14357.0	20.481
14240.0	21.686
14200.0	22.891
14100.0	24.096
14025.0	25.301
13980.0	26.506
13740.0	27.710
13703.0	28.915
13600.0	30.120
13300.0	31.325
13200.0	32.530
13155.0	33.734
13000.0	34.939
12920.0	36.144
12917.0	37.349
12900.0	38.554
12500.0	39.759
12450.0	40.963
12400.0	42.168
12330.0	43.373
12100.0	44.578
12020.0	45.783
12008.0	46.987
11990.0	48.192
11950.0	49.397
11750.0	50.602
11630.0	51.807
11568.0	53.012
11540.0	54.216

CITY CREEK ANNUAL (82 YEARS)

FREQUENCY ANALYSIS
RESULTS FROM RANKING

RANKED DATA	PROBABILITIY (%)
11400.0	55.421
11315.0	56.626
11000.0	57.831
10930.0	59.036
10700.0	60.240
10700.0	61.445
10560.0	62.650
10530.0	63.855
10496.0	65.060
10400.0	66.265
10300.0	67.469
9940.0	68.674
9870.0	69.879
9790.0	71.084
9610.0	72.289
9560.0	73.493
9550.0	74.698
9490.0	75.903
9439.0	77.108
9220.0	78.313
9130.0	79.518
9080.0	80.722
9060.0	81.927
9030.0	83.132
9020.0	84.337
8550.0	85.542
8470.0	86.746
7960.0	87.951
7690.0	89.156
7515.0	90.361
7460.0	91.566
7240.0	92.771
6550.0	93.975
6355.0	95.180
6300.0	96.385
5120.0	97.590
4920.0	98.795

CITY CREEK ANNUAL (82 YEARS)

FREQUENCY ANALYSIS
RESULTS FROM RANKING

INPUT DATA

14200.0	12400.0	18600.0	13000.0	11000.0
9560.0	14600.0	4920.0	9080.0	11750.0
13740.0	7240.0	6550.0	12008.0	15296.0
17313.0	9439.0	7690.0	9220.0	14100.0
9490.0	12500.0	10700.0	8470.0	9610.0
9550.0	9790.0	13980.0	7460.0	7960.0
14357.0	13155.0	19273.0	11315.0	9130.0
13600.0	9030.0	12900.0	19900.0	10700.0
6300.0	14240.0	11990.0	9940.0	11630.0
8550.0	5120.0	17600.0	16568.0	11568.0
9020.0	20800.0	12100.0	16700.0	17800.0
13300.0	11400.0	12450.0	15270.0	10930.0
18560.0	10560.0	10530.0	10496.0	14025.0
6355.0	9060.0	14700.0	9870.0	10400.0
15100.0	13200.0	10300.0	12330.0	11540.0
12020.0	12920.0	11950.0	7515.0	12917.0
13703.0	16716.0			

FREQUENCY ANALYSIS
RESULTS FROM RANKING
STATISTICS

MEAN=	11983.15853
STD DEV=	3435.61167
SKEW=	.37901

RETURN PERIOD	STREAMFLOW
1.001 YEARS	4,736.6
1.010 YEARS	4,885.9
1.111 YEARS	7,567.4
1.250 YEARS	9,109.9
1.333 YEARS	9,534.9
2.000 YEARS	11,850.0
5.000 YEARS	14,454.2
10.000 YEARS	17,133.9
25.000 YEARS	19,057.6
50.000 YEARS	20,206.0
100.000 YEARS	20,953.0
200.000 YEARS	21,326.5
500.000 YEARS	21,550.6
1,000.000 YEARS	21,625.3
10,000.000 YEARS	21,692.5

CITY CREEK ANNUAL (82 YEARS)

FREQUENCY ANALYSIS
RESULTS FROM GUMBELS EXTREME VALUE THEOREM

INPUT DATA

14200.0	12400.0	18600.0	13000.0	11000.0
9560.0	14600.0	4920.0	9080.0	11750.0
13740.0	7240.0	6550.0	12008.0	15296.0
17313.0	9439.0	7690.0	9220.0	14100.0
9490.0	12500.0	10700.0	8470.0	9610.0
9550.0	9790.0	13980.0	7460.0	7960.0
14357.0	13155.0	19273.0	11315.0	9130.0
13600.0	9030.0	12900.0	19900.0	10700.0
6300.0	14240.0	11990.0	9940.0	11630.0
8550.0	5120.0	17600.0	16568.0	11568.0
9020.0	20800.0	12100.0	16700.0	17800.0
13300.0	11400.0	12450.0	15270.0	10930.0
18560.0	10560.0	10530.0	10496.0	14025.0
6355.0	9060.0	14700.0	9870.0	10400.0
15100.0	13200.0	10300.0	12330.0	11540.0
12020.0	12920.0	11950.0	7515.0	12917.0
13703.0	16716.0			

FREQUENCY ANALYSIS
RESULTS FROM GUMBELS EXTREME VALUE THEOREM
STATISTICS MEAN= 11983.15853
STD DEV= 3435.61167
SKEW= .37901

RETURN PERIOD	STREAMFLOW
1.001 YEARS	5,259.1
1.010 YEARS	6,344.0
1.111 YEARS	8,203.0
1.250 YEARS	9,162.0
1.333 YEARS	9,561.1
2.000 YEARS	11,420.2
5.000 YEARS	14,455.2
10.000 YEARS	16,464.3
25.000 YEARS	19,006.4
50.000 YEARS	20,889.6
100.000 YEARS	22,759.3
200.000 YEARS	24,623.7
500.000 YEARS	27,082.8
1,000.000 YEARS	28,939.2
10,000.000 YEARS	35,108.3

CITY CREEK ANNUAL (82 YEARS)

FREQUENCY ANALYSIS
RESULTS FROM LOG 'T' DISTRIBUTION

INPUT DATA

14200.0	12400.0	18600.0	13000.0	11000.0
9560.0	14600.0	4920.0	9080.0	11750.0
13740.0	7240.0	6550.0	12008.0	15296.0
17313.0	9439.0	7690.0	9220.0	14100.0
9490.0	12500.0	10700.0	8470.0	9610.0
9550.0	9790.0	13980.0	7460.0	7960.0
14357.0	13155.0	19273.0	11315.0	9130.0
13600.0	9030.0	12900.0	19900.0	10700.0
6300.0	14240.0	11990.0	9940.0	11630.0
8550.0	5120.0	17600.0	16568.0	11568.0
9020.0	20800.0	12100.0	16700.0	17800.0
13300.0	11400.0	12450.0	15270.0	10930.0
18560.0	10560.0	10530.0	10496.0	14025.0
6355.0	9060.0	14700.0	9870.0	10400.0
15100.0	13200.0	10300.0	12330.0	11540.0
12020.0	12920.0	11950.0	7515.0	12917.0
13703.0	16716.0			

FREQUENCY ANALYSIS
RESULTS FROM LOG 'T' DISTRIBUTION

STATISTICS FOR LOGX:	
MEAN=	4.06009
STD DEV=	.13027
SKEW=	-.45803

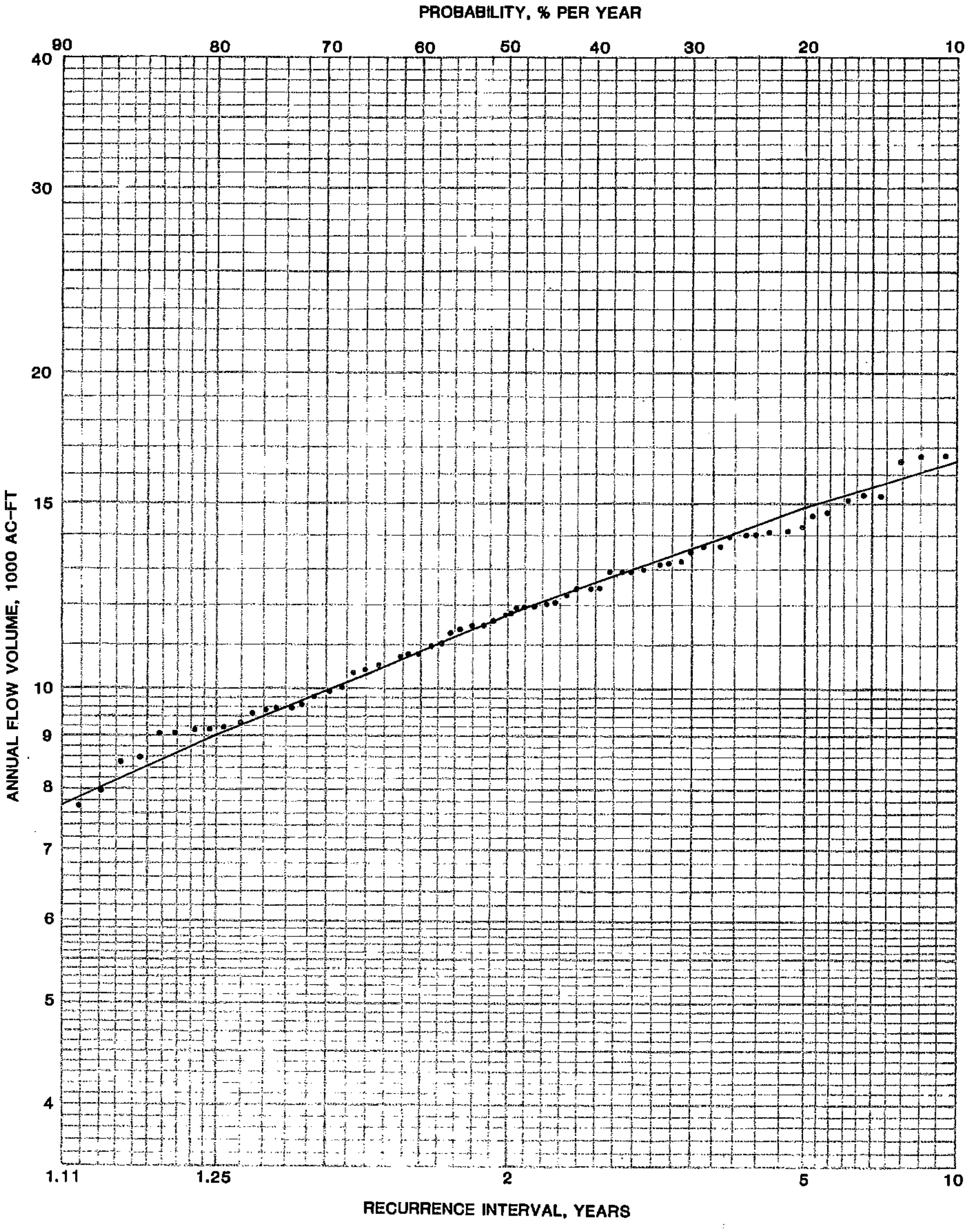
RETURN PERIOD	STREAMFLOW
1.001 YEARS	4,381.9
1.010 YEARS	5,626.1
1.111 YEARS	7,790.8
1.250 YEARS	8,904.1
1.333 YEARS	9,369.9
2.000 YEARS	11,484.1
5.000 YEARS	14,811.8
10.000 YEARS	16,928.2
25.000 YEARS	19,567.1
50.000 YEARS	21,538.4
100.000 YEARS	23,441.7
200.000 YEARS	25,389.9
500.000 YEARS	28,011.2
1,000.000 YEARS	30,097.6
10,000.000 YEARS	37,230.1

The results of the frequency analyses are estimated stream yields, in acre-feet, for different probabilities and recurrence intervals. The probability of any given stream yield indicates how often one can expect that yield to be equaled or exceeded. For example, a 90-percent probability flow can be expected to occur, on the average, nine years out of ten. The recurrence interval, or the frequency of occurrence of a given yield, is expressed as the reciprocal of the probability, in years. A 90-percent probability yield has a recurrence interval of 1.11 years, and a 50-percent probability has a recurrence interval of two years.

STATISTICAL TEST: A review of the four different distribution results was made for each of the gaged streams. It was found that the Gumbels Distribution varied more from the actual data points, or the ranked distribution, than did any other distribution. The student's t-Distribution also varied somewhat more than the remaining two distributions. For this reason, both distributions were rejected from further analysis. This is felt to be appropriate since both distributions are designed to allow for extreme values. Stream yields are, by nature, relatively uniform; therefore, an analysis of extreme values becomes unimportant.

The remaining two distributions, the Log Normal and the Log Pearson Type III, were tested to determine which distribution fit the actual data points, or ranked distribution, most closely. A modified Chi-Square test was used. This is a statistical "goodness-of-fit" test which compares the theoretical values to the actual values, and selects the distribution with the least sum of differences. Only the higher probability yields (which occur often, on the average) were tested, since these stream flow yields constitute the range of flows most likely to be used for municipal water planning purposes. A separate test was performed for each month, as well as for annual yield estimates. Table C-4 shows the December and annual test results for City Creek.

RESULTS: The results from each set of frequency analyses and statistical tests may be used to plot a frequency curve. Figure C-5 shows the annual frequency curve for City Creek, with the actual data points plotted beside the curve for comparison. Although sufficient data were also available for plotting a frequency curve for every mouth, only an annual frequency curve was prepared for each stream to avoid the voluminous graphics of plotting a curve for each month.



SALT LAKE COUNTY AREA-WIDE WATER STUDY

ANNUAL FREQUENCY CURVE
CITY CREEK

FIGURE C-5

TABLE C-4

MODIFIED CHI-SQUARE TESTS FOR RESULTS
OF CITY CREEK FREQUENCY ANALYSES

Yield Probability (%)	Ranked Yield r_i (Ac-Ft)	Theoretical Yield t_i (Ac-Ft)		$\frac{(r_i-t_i)^2}{t_i}$	
		Log Normal	Log Pearson Type III	Log Normal	Log Pearson Type III
December:					
90	367	376	376	0.22	0.22
80	399	406	406	0.12	0.12
50	482	471	472	0.257	0.212
Total				0.59	0.55*
Annual:					
90	7560	7819	7728	8.58	3.65
80	9108	8922	9002	3.88	1.25
50	11,850	11,484	11,749	11.67	0.87
Total				24.12	5.77*

*Use this Distribution because of best fit.

The decision was made to prepare calculations for 90-percent, 80-percent and 50-percent probability yields only. This is because these represent the range of probabilities most likely to be used in municipal water planning. The 90-percent, 80-percent, and 50-percent probability yield estimates for City Creek are tabultated in Table C-6, and are shown graphically in the form of an annual hydrograph in Figure C-7.

It was found that the sum of the monthly yield estimates, called the annual sum, does not equal the annual yield estimate for any probability. The percent of deviation between these two values is shown in the last row of Table C-6. In each case the annual yield estimate is higher than the sum of the monthly yield estimates. This occurs because a lower estimate is automatically made by the statistical methods for any month with a high variance, which is the case during the spring months for each stream. The annual estimates indicate that there is more water yielded annually by a given stream than is predicted by the sum of monthly estimates, but there are not enough data to justify which of, or to what extent, the monthly estimates should be adjusted. Both estimates are significant, however, and are included in the table of flow estimates for each stream. The annual yield estimate becomes useful when planning any facility with a detention time of several months or greater, such as a large reservoir. On the other hand, the individual monthly yield estimates are most useful for planning and design of facilities with little or no detention time, such as culinary water treatment plants.

CONFIDENCE LIMITS: The degree of accuracy of the results tabulated in Table C-6 has been described by calculating confidence limits. Confidence limits reflect the degree of confidence that can be placed upon a frequency curve by enclosing band of probable error or variation. Ninety-percent confidence limits have been chosen for this study. This means that nine of ten actual data points, on the average, should fall within the confidence limits.

An approximate method of calculating confidence limits, or error limits, has been used during this study. The method is based on the standard deviation of each data set, and is described in Table C-8. The City Creek frequency curve with 90-percent confidence limits is displayed in Figure C-9. The 90-percent confidence limits for the City Creek monthly and annual yield estimates are tabulated in Table C-10.

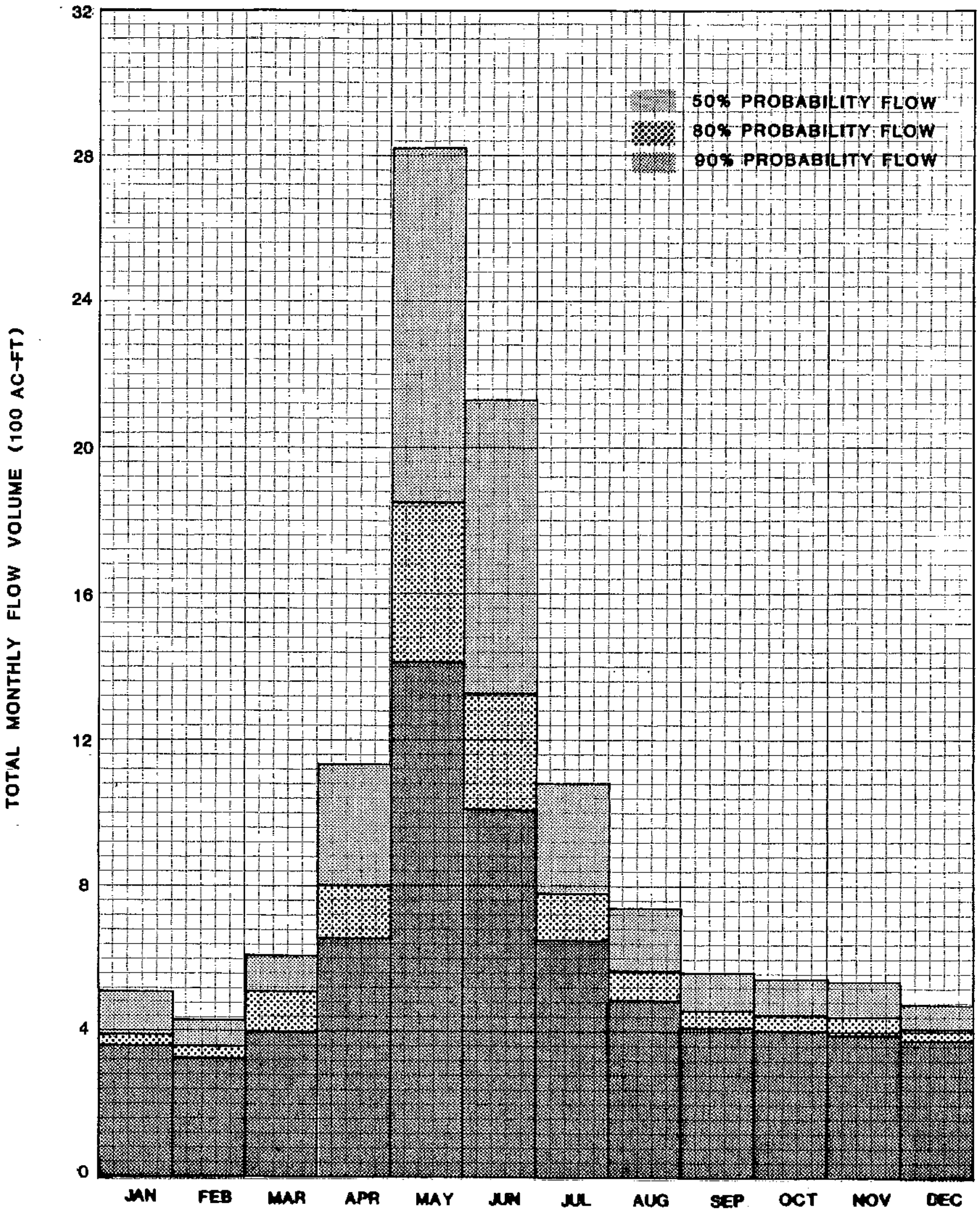
TABLE C-6

CITY CREEK FLOW ESTIMATES*

Period	Expected Total Flow Volumes at Prescribed Probabilities (Ac-Ft)		
	90% Probability	80% Probability	50% Probability
January	357	388	452
February	327	354	421
March	394	456	602
April	659	797	1,133
May	1,042	1,844	2,812
June	1,002	1,322	2,125
July	649	772	1,076
August	488	567	740
September	411	458	564
October	405	449	544
November	395	440	534
December	376	406	472
Annual Sum	6,865	8,253	11,475
Annual Yield Estimate	7,728	9,002	11,749
Deviation**	11.2%	8.3%	2.3%

*From frequency analyses of the 1988-1980 period of flow record at gaging station No. 1725 near the canyon mouth.

**Assuming the annual yield estimate to be the most correct.



SALT LAKE COUNTY AREA-WIDE WATER STUDY

ANNUAL HYDROGRAPH

CITY CREEK

FIGURE C-7

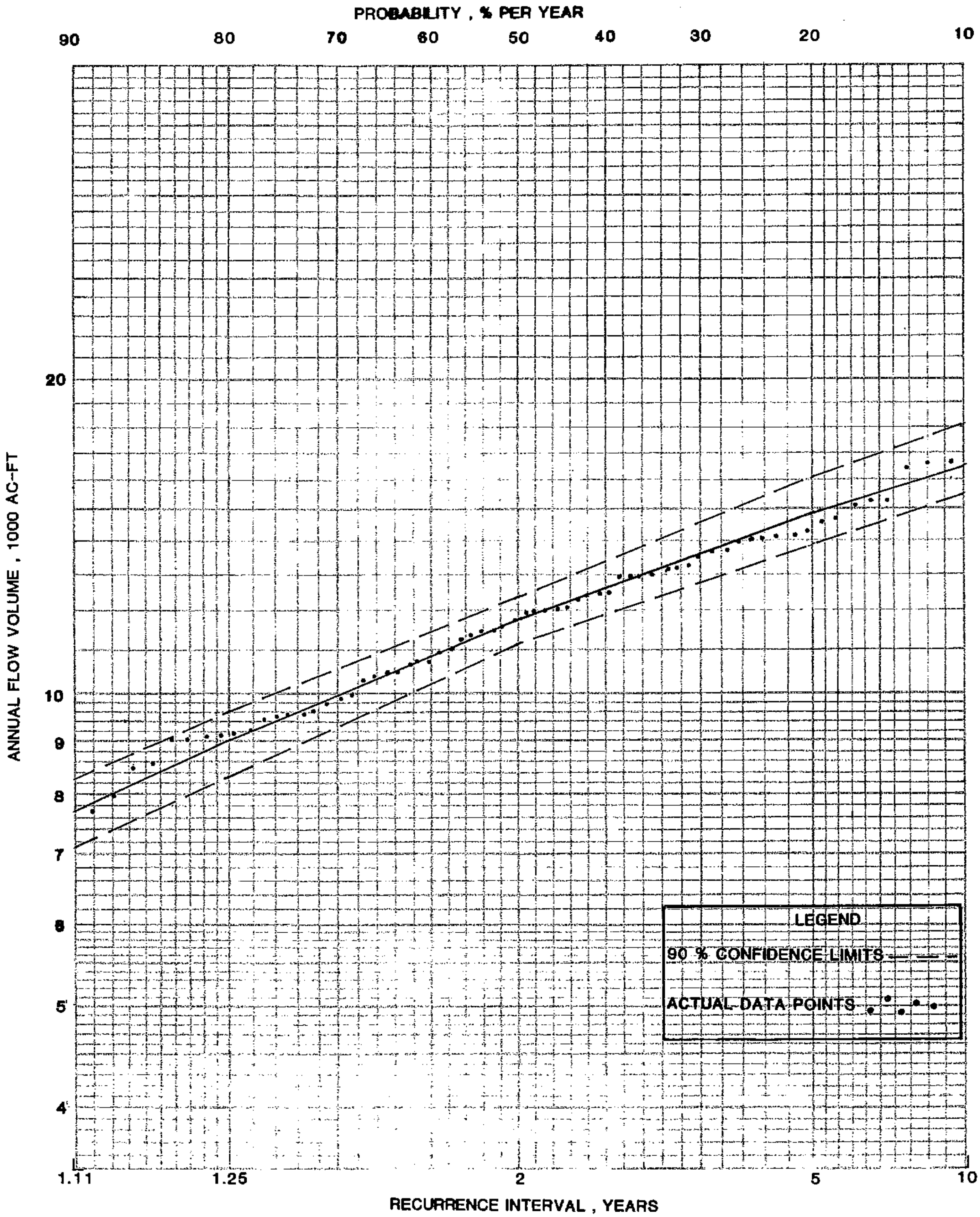
TABLE C-8

90% ERROR LIMITS FOR FLOOD FREQUENCY CURVES*

Years of Record (n)	Exceedence Frequency (%, at 5% level)						
	99.9	99	90	50	10	1	0.1
5	1.22	1.00	0.76	0.95	2.12	3.41	4.41
10	0.94	0.76	0.57	0.58	1.07	1.65	2.11
15	0.80	0.65	0.48	0.46	0.79	1.19	1.52
20	0.71	0.58	0.42	0.39	0.64	0.97	1.23
30	0.60	0.49	0.35	0.31	0.50	0.74	0.93
40	0.53	0.43	0.31	0.27	0.42	0.61	0.77
50	0.49	0.39	0.28	0.24	0.36	0.54	0.67
70	0.42	0.34	0.24	0.20	0.30	0.44	0.55
100	0.37	0.29	0.21	0.17	0.25	0.36	0.45
	0.1	1	10	50	90	99	99.9
	Exceedence Frequency (%, at 95% level)						

Note: Tabular values are multiples of the standard deviation of the variate. Five percent error limits are added to the flood value from the fitted curve at the same exceedence frequency and the sum plotted. Ninety-five percent limits are substracted from the flood value at the same exceedence frequency. Log values are added or subtracted before antilogging and plotting.

*Source: Beard, L.R., "Statistical Methods in Hydrology," Civil Works Investigations, U.S. Army Corps of Engineers, Sacramento District, 1962.



SALT LAKE COUNTY AREA-WIDE WATER STUDY

ANNUAL FREQUENCY CURVE

CITY CREEK

FIGURE C-9

TABLE C-10

CITY CREEK FLOW ESTIMATES*

Period	Expected Total Flow Volumes at Prescribed Probabilities (Ac-Ft)					
	90% Probability	90% Confidence Limits	80% Probability	90% Confidence Limits	50% Probability	90% Confidence Limits
January	357	339 - 372	388	370 - 404	452	437 - 468
February	327	307 - 345	354	334 - 372	421	403 - 440
March	394	359 - 425	456	418 - 490	602	565 - 641
April	659	588 - 724	797	716 - 872	1,133	1,048 - 1,225
May	1,042	1,234 - 1,557	1,844	1,638 - 2,038	2,812	2,579 - 3,066
June	1,002	864 - 1,132	1,322	1,152 - 1,485	2,215	1,922 - 2,350
July	649	581 - 711	772	697 - 842	1,076	998 - 1,160
August	488	448 - 523	567	524 - 606	740	699 - 784
September	411	383 - 435	458	429 - 484	564	538 - 591
October	405	381 - 426	449	424 - 471	544	522 - 567
November	395	371 - 416	440	415 - 462	534	512 - 557
December	376	358 - 391	406	388 - 422	472	457 - 488
Annual Sum	6,865		8,253		11,475	
Annual Yield Estimate	7,728	7,105 - 8,280	9,002	8,327 - 9,616	11,749	11,098 - 12,438
Deviation**	11.2%		8.3%		2.3%	

*From frequency analyses of the 1899-1980 period of flow record at gaging station No. 1725 near the canyon mouth.
**Assuming the annual yield estimate to be the most correct.

FLOW-DURATION VALUES: A further breakdown of past flows has been made which is useful for planning facilities with small detention times, such as one day. This additional breakdown is a table of past "flow-duration" values for each stream. The flow-duration table for any given month (or year) shows the amount of flow rate fluctuation experienced during that month, with the monthly estimate representing the average flow rate for the month. These flow-duration values have been calculated by the U.S. Geological Survey. Unfortunately, they are generally based on only six years of record, rather than the entire period record. They should not be used for direct comparison with the frequency analysis results without correlation. The City Creek monthly flow-duration values are tabulated in Table C-11.

UNGAGED WATERSHED ANALYSIS PROCEDURES:

ANNUAL YIELDS: A correlation method has been used during this study to estimate the mean annual yield from major ungaged watersheds in Salt Lake County. This method, known as the area-altitude method, compares an ungaged watershed to a similar, nearby gaged watershed by means of three major relationships. These are: (1) a comparison of the area of each watershed, (2) a precipitation-elevation relationship, and (3) a precipitation-runoff relationship.

The correlation of watersheds is made by comparing separate bands of elevation in the gaged watershed with the corresponding elevation bands in the ungaged watershed. During this study, 1000-foot elevation bands were used. First, the areas from each watershed within specified elevation bands were measured and tabulated. Next, a relationship between elevation and average annual precipitation was derived from a state-wide isohyetal map prepared by the State Engineer.[83] Finally, a relationship between average annual precipitation and average annual runoff was obtained from the Hydrologic Atlas of Utah.[88] The result of this method is a computed unit runoff for each elevation band, and a computed average annual yield from the ungaged watershed.

TABLE C-11

CITY CREEK
FLOW - DURATION VALUES*
(Flows Exceeded 'P' Percent of the Time)

JANUARY

'P'	Flow (cfs)
95	1.5
90	1.7
75	5.9
70	6.1
50	6.7
25	7.9
10	8.7

FEBRUARY

'P'	Flow (cfs)
95	1.7
90	2.3
75	5.8
70	5.9
50	6.4
25	8.1
10	9.1

MARCH

'P'	Flow (cfs)
95	2.8
90	3.0
75	6.2
70	6.5
50	7.8
25	9.7
10	12

APRIL

'P'	Flow (cfs)
95	3.2
90	4.0
75	9.5
70	10
50	13
25	18
10	23

MAY

'P'	Flow (cfs)
95	17
90	19
75	26
70	28
50	34
25	51
10	70

JUNE

'P'	Flow (cfs)
95	12
90	15
75	25
70	31
50	41
25	54
10	68

JULY

'P'	Flow (cfs)
95	0.8
90	1.1
75	13
70	14
50	19
25	24
10	28

AUGUST

'P'	Flow (cfs)
95	0.6
90	0.7
75	8.7
70	9.7
50	13
25	16
10	17

SEPTEMBER

'P'	Flow (cfs)
95	0.8
90	0.8
75	7.7
70	8.2
50	10
25	12
10	13

OCTOBER

'P'	Flow (cfs)
95	0.9
90	1.2
75	6.5
70	6.8
50	7.8
25	8.9
10	11

NOVEMBER

'P'	Flow (cfs)
95	1.5
90	1.6
75	6.7
70	6.8
50	7.6
25	8.7
10	10

DECEMBER

'P'	Flow (cfs)
95	1.3
90	1.5
75	6.0
70	6.3
50	7.0
25	8.0
10	9.9

*Source: USGS results from compilation of mean daily flows for 1964-1968 and 1980 period of record near the canyon mouth.

WASATCH RANGE UNGAGED WATERSHEDS: All of the ungaged Wasatch Range watersheds considered during this study, except Corner Canyon, were correlated with Little Cottonwood Canyon. Little Cottonwood Canyon appeared to be the best gaged watershed for use in correlation due to its proximity to the ungaged watersheds, east-west configuration, elevation range and similar geology. The result of an area-altitude correlation of Bells Canyon with Little Cottonwood Canyon, in the form of a computer printout, is shown in Table C-12 as an example.

BURR FORK AND ELBOW FORK: Since Little Cottonwood Canyon is so much larger than the ungaged watersheds being considered, a search was made to locate a nearby small gaged watershed which could be used for correlation. Two smaller canyons in the Salt Lake County portion of the Wasatch Range were considered. The first, Burr Fork Canyon in the upper portion of Emigration Canyon, has a drainage area of 5.9 square miles. It was rejected, however, because of its limited elevation range, typical limestone geology, and limited period of available continuous record (five years). The second small gaged watershed considered for correlation use is Elbow Fork Canyon in upper Mill Creek Canyon. Elbow Fork Canyon is fairly small, with a drainage area of 7.7 square miles. However, it was also rejected because of its limited period of record (five years). No other small gaged watersheds were found along the Salt Lake County portion of the Wasatch Range which could be used for comparison. Little Cottonwood Canyon therefore appeared to be the best alternative.

CORNER CANYON: Corner Canyon differs from the other Wasatch Range ungaged watersheds in Salt Lake County due to its large southerly slope. It was therefore compared with Fort Creek Canyon, which is located directly south and adjacent to Corner Canyon, but drains south into Utah County. Fort Creek Canyon is the nearest watershed with similar characteristics, such as large southerly exposure, similar vegetation and elevation range, and a record of stream flows. The eight-year record of stream flows for Fort Creek was correlated with the Little Cottonwood Creek record to improve its accuracy.

OQUIRRH MOUNTAIN UNGAGED WATERSHEDS: None of the Oquirrh Mountain streams draining into Salt Lake County are continuously gaged. Some infrequent USGS instantaneous flow measurements at the canyon mouth are

TABLE C-12

AREA-ALTITUDE-PRECIPITATION PROGRAM RESULTS
BASED ON LITTLE COTTONWOOD CANYON (AT MOUTH) RUNOFF = 45884

ELEVATION	AREA ~~(MI^2)~~ ACRES	PRECIP (INCHES)	RUNOFF (INCHES)	RUNOFF FACTOR	EQUIV AREA	UNIT RUNOFF (AC FT/~~MI^2~~ Ac.)	RUNOFF (AC FT)
11000	852.00	62.51	42.04	1.0000	852.00	4.43	3777.3
10000	5245.00	54.16	32.31	.7686	4031.54	3.40	17873.7
9000	6689.00	46.21	24.15	.5746	3843.82	2.54	17041.4
8000	2494.00	38.71	17.45	.4151	1035.33	1.84	4590.1
7000	1323.00	31.66	12.07	.2871	379.87	1.27	1684.1
6000	891.00	25.10	7.88	.1876	167.16	.83	741.1
5250	306.00	20.53	5.45	.1297	39.70	.57	176.0
TOTAL	###.##				###.##		45884.0

PRECIP-ELEV CURVE A= 5.173E-05 B= 1.504E+00 R= .99215
RUNOFF-PRECIP CURVE A= 2.133E-02 B= 1.834E+00 R= .99633

RESULTS FROM AREA-ALTITUDE-PRECIPITATION PROGRAM

RUNOFF FOR UNGAGED AREA BELLS CANYON
USING UNIT RUNOFF VALUES FROM LITTLE COTTONWOOD CANYON (AT MOUTH)

ELEVATION	AREA ~~(MI^2)~~ (AC)	UNIT RUNOFF (AC FT/~~MI^2~~ AC)	RUNOFF (AC FT)	
11000	190.00	4.43	~~835.0~~	841.7
10000	862.00	3.40	~~2930.8~~	2930.8
9000	526.00	2.54	~~1315.0~~	1336.0
8000	344.00	1.84	~~619.2~~	633.0
7000	220.00	1.27	~~283.9~~	279.4
6000	216.00	.83	~~172.8~~	179.3
5250	154.00	.57	~~77.0~~	87.8
TOTAL	2512.00		~~6214.7~~	6288.0 Ac-ft

available for all six of the major Oquirrh Mountain streams. These few measurements, although helpful in estimating the range of typical flow magnitudes, are useless from a statistical approach. The area-altitude method has therefore been used to estimate the average annual yield from the six Oquirrh Mountain watersheds.

Two similar gaged watersheds, which appeared to exhibit the characteristics of the leeward side of the Oquirrh Mountains were identified for possible use in the area-altitude method. These two watersheds are West Canyon in Cedar Valley and South Willow Canyon in the Stansbury Mountains west of Tooele Valley. Both are on east-facing slopes and have been continuously gaged for at least ten years.

Upon closer examination, however, it was found that South Willow Canyon is more comparable to the Wasatch Range canyons than to the Oquirrh Mountain watersheds. South Willow Canyon yields about twice the annual amount of water yielded from West Canyon, even though West Canyon is six times the size of the Stansbury watershed. South Willow Canyon's large stream yields and dense vegetation are apparently caused by a local climatological condition that is not typical of the leeward Oquirrh Mountain slopes.

West Canyon was found to be much more similar to the Salt Lake County Oquirrh Mountain slopes in terms of geology, vegetation, elevation range and runoff, and has therefore been selected for use in the area-altitude computations. A frequency analysis of the gaged West Canyon flows was performed. Unfortunately, only a ten-year period of record is available. However, no other suitable watershed with flow records has been found. Therefore, all six Oquirrh Mountain watersheds considered during this study were correlated with West Canyon.

FURTHER EXTRAPOLATIONS:

The result of the area-altitude computations for each ungaged watershed is a single number, the estimated average (or 50-percent probability) annual yield, in acre-feet. This value for each canyon creek has been extrapolated to 80-percent and 90-percent probability annual yields, based on the pattern of the gaged watershed used for correlation in each case. A further extrapolation has been made for each ungaged canyon creek to estimate monthly yields, also based on the gaged watershed pattern in each case. The 90-percent, 80-percent and 50-percent probability annual yields were distributed into monthly yield estimates. For ungaged streams which are not perennial, certain monthly yield estimates were deleted following the monthly distribution step, based on the average months of flow. Table C-13 shows the results of area-altitude computations and further extrapolations for Bells Canyon Creek, a perennial stream. Table C-14 shows similar results for Barneys Creek, an ephemeral stream.

It will be noted that the annual sum and the annual yield estimate are included in each table. The 50-percent probability annual yield estimate is the result of an area-altitude correlation. The 80-pecent and 90-pecent probability annual yield estimates were then extrapolated, as well as the monthly yield estimates. The annual sum is the sum of the monthly yield estimates. The annual sum is much lower than the annual yield estimate in the case of an intermittent or ephemeral stream, for which several extrapolated monthly yield estimates are deleted.

LIMITATIONS: These extrapolations and estimates, including the average annual yield estimates resulting from area-altitude correlations, are useful for preliminary planning purposes. However, they should not be regarded as accurate, and should be used with caution. The higher probability annual yields and the extrapolated monthly patterns have questionable accuracy for several reasons: (1) the extrapolation of monthly yields from the gaged watershed pattern does not allow for shifting of the seasonal peak flow date of watersheds with much lower elevations, even though this actually occurs; (2) extrapolations from the area-altitude method predict perennial flows for all of the ungaged streams at the canyon mouths, which is not the case; (3) in the case of the Oquirrh Mountain streams, there is no gaged Oquirrh stream in Salt Lake County that can be used to check the accuracy of the area-altitude method; and (4) the estimating methods do not take into account man-made changes in watershed characteristics, such as those due to mining activities. It is recommended that a program of continuous gaging be initiated for any stream upon which detailed plans will rely.

TABLE C-13

BELLS CANYON FLOW ESTIMATES*

Period	Expected Total Flow Volumes at Prescribed Probabilities (Ac-Ft)		
	90% Probability	80% Probability	50% Probability
January	89	97	116
February	76	84	104
March	106	113	134
April	185	226	331
May	973	1129	1456
June	1133	1481	2158
July	386	533	897
August	192	229	316
September	131	150	194
October	120	134	170
November	104	115	141
December	97	107	128
Annual Sum	3592	4398	6145
Annual Yield Estimate	4485	5100	6288

*Extrapolated from the result of an "area altitude" correlation with Little Cottonwood Canyon based on the Little Cottonwood Creek pattern.

TABLE C-14

BARNEYS CREEK FLOW ESTIMATES*

Period	Expected Total Flow Volumes at Prescribed Probabilities (Ac-Ft)		
	90% Probability	80% Probability	50% Probability
January	--	--	--
February	--	--	--
March	--	--	--
April	3.7	7.2	23
May	45	54	85
June	43	56	90
July	15	20	36
August	--	--	--
September	--	--	--
October	--	--	--
November	--	--	--
December	--	--	--
Annual Sum	107	137	234
Annual Yield Estimate	176	219	333

*Extrapolated from the result of an "area-altitude" correlation with West Canyon, based on the West Canyon Creek pattern. Several monthly yield estimates have been deleted in order to reflect the ephemeral nature of the stream.

APPENDIX D

DAM AND RESERVOIR PRELIMINARY PLANNING PROCEDURES

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APPENDIX D

DAM AND RESERVOIR PRELIMINARY PLANNING PROCEDURES

The purpose of this appendix is to describe the procedures used for dam and reservoir site selection, calculation of sizes and capacities, and making cost estimates for this report.

SITE SELECTION:

Topography was the primary criterion in the damsite selection process. The topographical features deemed most desirable were those which would allow a maximum storage capacity with as small a dam structure as possible. Each canyon's topographical features were surveyed by the use of USGS quadrangle, 7.5 minute series, 1:24000 scale maps. During the reconnaissance of the canyons considered in this study, it was found that there were some which had no suitable sites available and some which had more than one practical site. For the canyons which had more than one suitable potential reservoir site, the sites were considered on an independent basis and were considered to be mutually exclusive. No master planning of reservoir systems or multi-dam scenarios was done for this report. An example of this reconnaissance work is shown in Figure VI-10, in which a proposed dam and reservoir in Emigration Canyon are shown. Other criteria such as geology, environmental considerations, availability of borrow material, etc., were not considered unless developed in a previous study.

From the literature review, there are several potential damsites located and studied in previous reports. In many cases these reports analyze potential reservoirs as multi-purpose facilities. If the same reservoir site was deemed feasible for the present study, it was analyzed by the procedures described in this appendix, as a single-purpose municipal water supply reservoir. This was done to assure that these proposed reservoirs would be comparable with the other potential reservoirs studied in this report that were developed strictly as municipal and industrial supply facilities.

DAMSITE AND RESERVOIR CALCULATIONS:

Once a damsite had been selected, three preliminary capacities were calculated as follows: 1) the stream mean annual yield; 2) the mean annual yield, less the average constant base stream flow, referred to in this report as the "spring runoff volume"; and 3) an arbitrary capacity smaller than both 1) and 2).

Using these capacities, three dam elevations and sizes were determined from the USGS quad map by means of a planimeter. Example calculations for Burr Fork in Emigration Canyon are shown in Table D-1. From this information, various dam and reservoir characteristics were tabulated. These include the topography along the dam axis, dam dimensions, various reservoir characteristics and costs, relocations, and in some cases, the characteristics of an existing dam that could be raised. In most cases, an earth fill dam was assumed. The simplified dam cross-section shown in Figure D-2, with variable dimensions, was used to specify the individual dam characteristics.

The next step was to use a computer program developed by the U.S. Bureau of Reclamation to estimate dam and reservoir costs, based on Bureau of Reclamation unit prices. The initial data necessary for this program consisted of the dimensions of the simplified dam configuration shown in Figure D-2. An example of how that initial information was tabulated for the Burr Fork site is shown in Table D-3.

TABLE D-1

PRELIMINARY RESERVOIR CAPACITY CALCULATIONS

PROPOSED RESERVOIR NEAR BURR FORK

Elevation	Area (Acres)	Depth (Ft)	Volume (Ac-Ft)	Cum. Volume (Ac-Ft)
5860	0			
		20	28	28
5880	2.8			
		40	166	194
5920	5.5			
		40	532	726
5960	21.1			
		40	1230	1956
6000	40.4			
		40	2094	4050
6040	64.3			

Drainage Area = 6.0 sq. mi.

1. Mean Annual Yield = 2205 ac-ft (from Corps of Engineers)

   Dam Height = $\left(\frac{2205-1956}{4050-1956}\right)$ (40ft) + 140 ft + 10 ft* = 165 ft.

   Reservoir Area = $\left(\frac{2205-1956}{4050-1956}\right)$ (24.3 acres) + 40.4 acres = 43.3 acres

   Dam Area = 4 acres

   Total Area = $\left(\frac{4}{2} + 43.3\right)(1.15)$ = 52 acres

2. Spring Runoff Volume = (3240 ac-ft) $\left(\frac{2205}{4439}\right)$ = 1609 ac-ft

   Dam Height = $\left(\frac{1609-726}{1956-726}\right)$ (40) + 100 ft + 9 ft* = 138 ft.

   Reservoir Area = $\left(\frac{1609-726}{1956-726}\right)$ 19.3 acres + 21.1 acres = 35 acres

   Dam Area = 3.6 acres

   Total Area = $\left(\frac{3.6}{2} + 35\right)(1.15)$ = 42 acres

3. Capacity = 1000 ac-ft

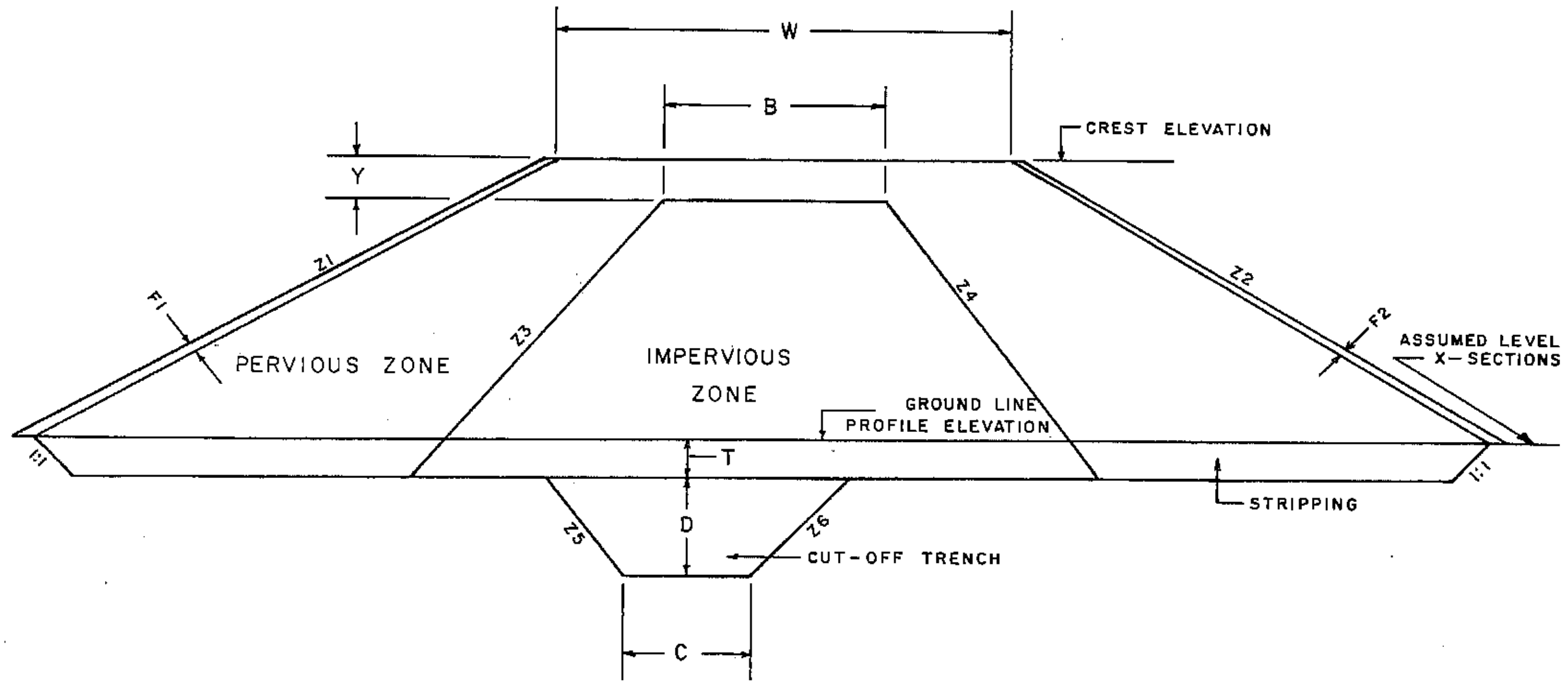
   Dam Height = $\left(\frac{1000-726}{1956-726}\right)$ (40) + 100 ft + 8 ft* = 127 ft.

   Reservoir Area = $\left(\frac{1000-726}{1956-726}\right)$ 19.3 acres + 21.1 acres = 25 acres

   Dam Area = 3.2 acres

   Total Area = $\left(\frac{3.2}{2} + 25\right)(1.15)$ = 31 acres

*Freeboard



SALT LAKE COUNTY AREA-WIDE WATER STUDY

SIMPLIFIED DAM CONFIGURATION

FIGURE D-2

TABLE D-3

TABULATION OF DAM DIMENSIONS

EMIGRATION CREEK AT BURR FORK

Z1	Z2	W	SF1	
3	2.5	30	1.05	

Z3	Z4	B	Y	SF2
0.5	0.5	20	5	1.05

Z5	Z6	C
1	1	20

T
3

F1	F2
3	2

Beginning Station	CREST ELEVATION	Depth of Cut-off
0	5987	0

Intermediate Stations	Profile Elevations	Depth of Cut-off
20	5960	6
80	5920	14
210	5880	22
220	5860	26
290	5880	22
310	5920	14
380	5960	6
400	5987	0
Last Station	CREST ELEVATION	Depth of Cut-off

The information shown includes the dam configuration as well as crest elevation, slopes and dam axis topography.

The second set of data which was necessary for the Bureau of Reclamation's computer program included reservoir areas, land costs, road, utility and other relocations, haul distances, environmental costs, spillway capacity and outlet capacity. An example of this input data, as tabulated for the Emigration Creek (Burr Fork) proposed dam site is shown on Table D-4. This procedure was performed for each of the three preliminary capacities for each proposed reservoir site.

The resulting information from the computer program execution was a dam structure cost and a total dam and reservoir capital cost. These costs were altered slightly because of built-in contingencies in the program which were considered too high. A 0.5 percent annual operation and maintenance cost based on the total capital cost, was added to an annual capital cost, which was calculated by amortizing the total cost over 20 years at 10 percent interest. All of these costs for each potential damsite and size are summarized in the Executive Summary section in Table II-4.

Given the three capacities per damsite and their respective total annual cost, a unit storage cost was developed by calculating an annual cost per acre foot for each potential reservoir capacity. These costs are graphically displayed as unit storage costs for each potential damsite in Chapter VI. An example of the graph for the Emigration Creek (Burr Fork) damsite is shown in Figure D-5. A curve was fit to the three plotted unit storage costs, as shown in Figure D-5. This allows for later interpolation between the points when the final reservoir design capacities are chosen, based on the reservoir-sizing criteria adopted and explained in the next section.

TABLE D-4

PRELIMINARY RESERVOIR AND DAM INPUT DATA
BURR FORK RESERVOIR SITE
1000 AC-FT CAPACITY

Zone 1 haul = 30 miles

Zone 2 haul = 30 miles

Riprap haul = 30 miles

Division max flood = 150 cfs

Spillway head = 3 feet, capacity = 150 cfs

Outlet works head = 132 feet, capacity = 15 cfs

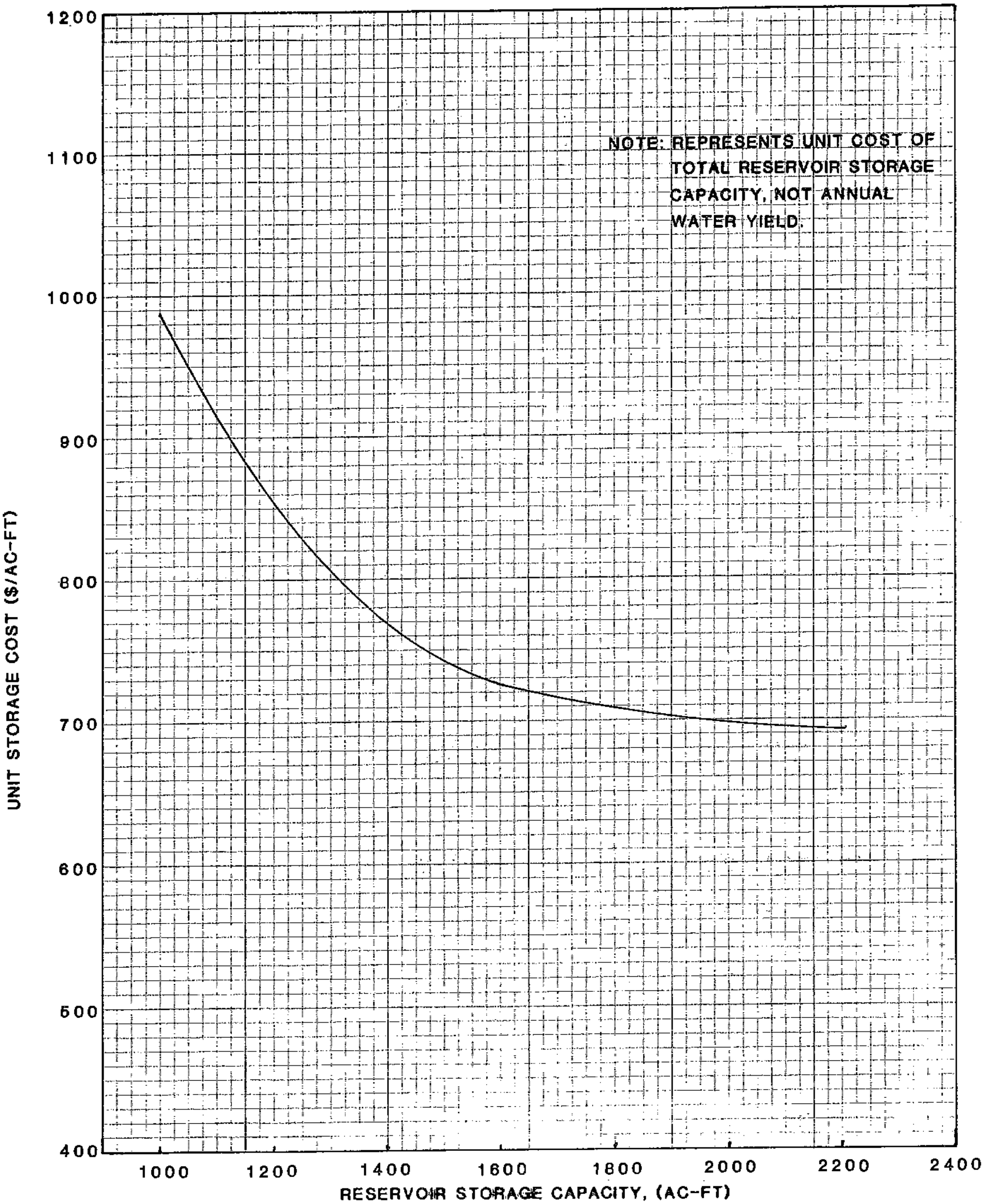
Reservoir area = 31 acres, land cost = $25,000/acre

Clearing area = 3.2 acres, unit cost = $10,000/acre

Relocations	Cost/Mile	Miles
Telephone	$13,000	4.3
Power	13,000	4.3
Pipeline	50,000	0.5

Road Rebuilding	Cost/Mile	Miles
Light duty roads	$70,000	7.8

Other Features	Cost/Unit	Units
Environmental Assessment	$200,000	1
Homes Inundated	100,000	11



SALT LAKE COUNTY AREA-WIDE WATER STUDY

UNIT STORAGE COSTS

EMIGRATION CREEK, RESERVOIR SITE B

FIGURE D-5

RESERVOIR SIZING CRITERIA:

After plotting the three unit storage costs for each reservoir site, calculations were made to determine the most probable dam and reservoir capacity that would actually be chosen by a water agency. To do this, certain assumptions were made. Two scenarios were assumed when sizing the most probable reservoir size and the amount of water yielded, as explained below:

Scenario 1: The reservoir is used as an equalizing facility. Reservoir storage is used such that the entire mean (50 percent probability) annual stream yield is delivered in a typical annual community demand pattern as calculated from records of the Salt Lake County Water Conservancy District and the Salt Lake City Water Department. The resulting typical demand patterns are shown in Table D-6.

The storage calculations for an equalizing facility at the Emigration Creek (Burr Fork) damsite are shown in Table D-7 as an example.

TABLE D-6

TYPICAL DEMAND DISTRIBUTION FROM 1978-1980 RECORDS
OF THE SALT LAKE COUNTY WATER CONSERVANCY DISTRICT AND
THE SALT LAKE CITY WATER DEPARTMENT

Month	SLC Water Department Demand Distribution (%)			Average Distrib. (%)
	1978	1979	1980	
January	4.4	4.3	4.6	4.4
February	4.0	3.6	4.4	4.0
March	4.7	4.1	4.6	4.5
April	4.7	5.0	6.4	5.4
May	7.7	10.3	6.7	8.2
June	14.6	14.4	14.3	14.4
July	17.8	16.3	16.5	16.9
August	15.2	13.2	15.6	14.7
September	9.5	12.4	10.2	10.7
October	7.8	7.9	7.4	7.7
November	4.9	4.3	4.8	4.7
December	4.7	4.2	4.7	4.5

Month	SLCWCD Demand Distribution (%)			Average Distrib. (%)	Total Average Distrib. (%)
	1978	1979	1980		
January	4.2	3.8	3.6	3.9	4.1
February	3.5	3.4	3.4	3.4	3.7
March	4.3	4.2	3.9	4.1	4.3
April	3.9	4.9	5.4	4.7	5.1
May	7.4	9.5	6.4	7.8	8.0
June	14.3	15.5	15.7	15.2	14.8
July	19.3	17.7	18.8	18.6	17.8
August	16.7	13.5	18.4	16.2	15.5
September	8.4	11.4	9.7	9.8	10.3
October	8.0	8.2	7.3	7.8	7.7
November	4.7	4.4	4.0	4.4	4.4
December	5.2	3.7	3.4	4.1	4.3

TABLE D-7

STORAGE CALCULATIONS
BURR FORK RESERVOIR SITE
EQUALIZING RESERVOIR

Month	(1) Stream Yield (Ac-Ft)	(2) Demand (Ac-Ft)	(3) Month-end Cumulative Storage (Ac-Ft)
January	30	59	19
February	34	53	0
March	103	62	41
April	381	73	349
May	419	115	653
June	202	213	642
July	89	256	475
August	43	223	295
September	32	148	179
October	37	111	105
November	36	63	78
December	32	62	48

Column (1) in Table D-7 was derived from Chapter V, Table V-5, and adjusted for the damsite location in the upper portion of the drainage area. Two adjustments were made, one based on the percentage of drainage area above the damsite versus the total drainage area, and the second based on the fact that greater precipitation occurs in the upper watershed elevations. Column (2) in Table D-7 is the monthly typical demand pattern applied to the annual yield for a 50-percent probability. Column (3) in Table D-7 is the cumulative month-end storage in the proposed reservoir.

Scenario 2: The reservoir is used as a peak supply facility. The stream flow occurring from November through June of a 50-percent probability year is completely stored, and then completely released during July through October in a typical demand pattern. Table D-8 shows the tabulated storage calculations for the Burr Fork reservoir site, based on scenario 2.

TABLE D-8

STORAGE CALCULATIONS
BURR FORK RESERVOIR SITE
PEAK SUPPLY RESERVOIR

Month	(1) Stream Yield (Ac-Ft)	(2) Demand (Ac-Ft)	(3) Month-end Cumulative Storage (Ac-Ft)
January	30	0	98
February	34	0	132
March	103	0	235
April	381	0	616
May	419	0	1035
June	202	0	1237
July	89	499	827
August	42	435	435
September	32	289	178
October	37	216	0
November	36	0	36
December	32	0	68

For streams which supply existing treatment plants, the criteria have been changed slightly, but are similar. This is because the plant (or conduit) capacity at present is known, and becomes a maximum treated water supply rate. The two scenarios are:

Scenario 1: The water treatment plant processes 100 percent of the stream flow up to the plant capacity during the winter and spring. When the plant capacity is reached, all additional stream flow in excess of plant capacity is stored in the reservoir. Water is then withdrawn from the reservoir at a rate such that the plant is operated at capacity constantly through the summer for as long as the storage lasts.

Scenario 2: The water treatment plant processes 110 percent of the amount of water it processed during 1980, up to the plant capacity. During November through June, all stream flow in excess of the plant capacity is stored in the reservoir. Beginning in July, the plant is operated at capacity, drawing upon storage from the reservoir for as long as the storage lasts.

For presently undeveloped streams with no treatment plants existing, a third scenario was developed.

Scenario 3: No storage is provided, and treatment and conveyance costs are estimated for facilities which could process nearly all the unregulated stream flows during a 50-percent probability runoff year.

CARRY-OVER CAPACITY: In order to allow for continued water supply from each reservoir at the typical rates calculated even during "dry" years, a carry-over storage capacity was calculated. This carry-over storage, combined with the average year maximum required storage already calculated, results in the total reservoir storage capacity at each reservoir site.

The carry-over storage was calculated as the difference between the 50-percent probability and the 90-percent probability annual stream yields at each reservoir site. This allows for the average (50 percent probability) annual yield to be released from the reservoir during a subsequent "dry" (90 percent probability) year.

TOTAL COSTS: The resulting total reservoir storage capacities were then used to extract the unit cost to construct the dam and reservoir from the unit storage graphs, as shown already in Figure D-5 for Burr Fork. The unit cost of water developed from the reservoir was then calculated based on the annual water yield, not on the reservoir capacity. The unit cost of water treatment and conveyance facilities was then added, to arrive at a total unit cost of developed and treated municipal water. An example of these reservoir capacities and unit costs for the Burr Fork reservoir site is shown in Table D-9.

TABLE D-9

ESTIMATED COSTS FOR DEVELOPED AND TREATED WATER FROM EMIGRATION CREEK AT BURR FORK (Reservoir Site B)

Item	Unit	Scenario 1. Equalizing Facility	Scenario 2. Peaking Facility	Scenario 3. No Storage[m] Facility
Reservoir Capacity[a]	Ac-Ft	1312[n]	1896[n]	0
Carry-over Capacity[b]	Ac-Ft	659	659	0
Existing Annual Water Yield[c]	Ac-Ft	0	0	0
Developable Annual Water Yield[d]	Ac-Ft	3928	3928	3928
Total Annual Water Yield[e]	Ac-Ft	3928	3928	3928
Unit Storage Cost[f]	$/Ac-Ft	780	700	0
Unit Water Yield Cost for Reservoir[g]	$/Ac-Ft	260	338	0
Water Treatment Plant Capacity	mgd	10.7[h]	10.7[h]	14.9[l]
Annual Treatment & Conveyance Cost[i]	$1000	1100	1040	1233
Unit Water Yield Cost for Treatment & Conveyance[j]	$/Ac-Ft	280	265	314
Total Unit Water Yield Cost[k]	$/Ac-Ft	540	603	314

(a) Includes storage and carry-over capacity.
(b) Calculated as the difference between 50% and 90% probability yields. See annual sums, Table V-5.
(c) No municipal water presently developed.
(d) Additional water developed in excess of existing annual water yield.
(e) Sum of existing and developable annual water yields.
(f) From Figure VI-12.
(g) Total annual reservoir cost (unit storage cost multiplied by reservoir capacity) divided by developable annual water yield.
(h) Based on average flow during peak month demand.
(i) From Figure VI-14.
(j) Annual treatment & conveyance cost divided by the developable annual water yield.
(k) Sum of unit water yield costs for reservoir and treatment & conveyance.
(l) Plant capacity equals the sum of: (1) the average flow during the peak month flow released from the resevoir, and (2) 120% of the corresponding month regulated stream flow at the canyon mouth from the intervening drainage area.
(m) This represents natural unregulated stream flow pattern.
(n) The 50% probability annual yield at the resevoir site is redistributed according to the scenario distribution, and released to Emigration Creek.

APPENDIX E

MONTHLY STREAM FLOW RECORDS AND FLOW-DURATION TABLES FOR GAGED WASATCH RANGE STREAMS

TABLE OF CONTENTS

ANNUAL FLOW - DURATION VALUES
FOR WASATCH GAGED STREAMS
NEAR CANYON MOUTHS*
(Flows Exceeded 'P' Percent of the Time)

CITY CREEK

'P'	Flow (cfs)
95	1.3
90	2.2
75	6.7
70	7.1
50	9.0
25	16
10	34

Time Period: 1964-68, 1980

RED BUTTE CREEK

'P'	Flow (cfs)
95	1.1
90	1.4
75	1.8
70	2.0
50	2.5
25	4.2
10	9.6

Time Period: 1964-80

EMIGRATION CREEK

'P'	Flow (cfs)
95	0.6
90	0.2
75	1.3
70	1.5
50	3.0
25	7.0
10	16

Time Period: 1964-68,1980

PARLEYS CREEK

'P'	Flow (cfs)
95	7.4
90	9.5
75	13
70	14
50	16
25	30
10	81

Time Period: 1913

MILL CREEK

'P'	Flow (cfs)
95	4.4
90	5.4
75	6.9
70	7.5
50	9.0
25	14
10	28

Time Period: 1964-68,1980

BIG COTTONWOOD CREEK

'P'	Flow (cfs)
95	15
90	18
75	23
70	24
50	30
25	67
10	180

Time Period: 1931-68,1980

LITTLE COTTONWOOD CREEK

'P'	Flow (cfs)
95	1.5
90	3.1
75	15
70	16
50	21
25	61
10	220

Time Period: 1964-68, 1980

*Source: USGS results from compilation of mean daily flows for the time periods shown for each stream.

CITY CREEK
FLOW - DURATION VALUES*
(FLows Exceeded 'P' Percent of the Time)

JANUARY

'P'	Flow (cfs)
95	1.5
90	1.7
75	5.9
70	6.1
50	6.7
25	7.9
10	8.7

FEBRUARY

'P'	Flow (cfs)
95	1.7
90	2.3
75	5.8
70	5.9
50	6.4
25	8.1
10	9.1

MARCH

'P'	Flow (cfs)
95	2.8
90	3.0
75	6.2
70	6.5
50	7.8
25	9.7
10	12

APRIL

'P'	Flow (cfs)
95	3.2
90	4.0
75	9.5
70	10
50	13
25	18
10	23

MAY

'P'	Flow (cfs)
95	17
90	19
75	26
70	28
50	34
25	51
10	70

JUNE

'P'	Flow (cfs)
95	12
90	15
75	25
70	31
50	41
25	54
10	68

JULY

'P'	Flow (cfs)
95	0.8
90	1.1
75	13
70	14
50	19
25	24
10	28

AUGUST

'P'	Flow (cfs)
95	0.6
90	0.7
75	8.7
70	9.7
50	13
25	16
10	17

September

'P'	Flow (cfs)
95	0.8
90	0.8
75	7.7
70	8.2
50	10
25	12
10	13

OCTOBER

'P'	Flow (cfs)
95	0.9
90	1.2
75	6.5
70	6.8
50	7.8
25	8.9
10	11

NOVEMBER

'P'	Flow (cfs)
95	1.5
90	1.6
75	6.7
70	6.8
50	7.6
25	8.7
10	10

DECEMBER

'P'	Flow (cfs)
95	1.3
90	1.5
75	6.0
70	6.3
50	7.0
25	8.0
10	9.9

*Source: USGS results from compilation of mean daily flows for 1964-1968 and 1980 period of record near the canyon mouth.

RED BUTTE CREEK
FLOW - DURATION VALUES*
(Flows Exceeded 'P' Percent of the Time)

JANUARY

'P'	Flow (cfs)
95	1.0
90	1.4
75	1.6
70	1.6
50	1.9
25	2.4
10	2.8

FEBRUARY

'P'	Flow (cfs)
95	1.2
90	1.4
75	1.7
70	1.8
50	2.2
25	2.6
10	3.7

MARCH

'P'	Flow (cfs)
95	1.4
90	1.8
75	2.5
70	2.6
50	3.2
25	4.1
10	8.5

APRIL

'P'	Flow (cfs)
95	3.0
90	3.3
75	4.1
70	4.5
50	6.8
25	13
10	18

MAY

'P'	Flow (cfs)
95	3.4
90	4.3
75	6.6
70	7.5
50	11
25	15
10	20

JUNE

'P'	Flow (cfs)
95	2.3
90	2.9
75	4.1
70	4.4
50	5.7
25	7.9
10	11

JULY

'P'	Flow (cfs)
95	1.4
90	1.6
75	2.3
70	2.5
50	3.2
25	4.0
10	5.0

AUGUST

'P'	Flow (cfs)
95	1.0
90	1.2
75	1.6
70	1.9
50	2.2
25	2.6
10	3.1

SEPTEMBER

'P'	Flow (cfs)
95	0.9
90	1.0
75	1.3
70	1.4
50	1.9
25	2.3
10	2.7

OCTOBER

'P'	Flow (cfs)
95	0.9
90	1.2
75	1.5
70	1.6
50	2.0
25	2.4
10	2.8

NOVEMBER

'P'	Flow (cfs)
95	1.2
90	1.4
75	1.6
70	1.7
50	2.1
25	2.5
10	2.8

DECEMBER

'P'	Flow (cfs)
95	1.0
90	1.3
75	1.6
70	1.6
50	1.9
25	2.3
10	2.6

*Source: USGS results from compilation of mean daily flows for 1964-1981 period of record near the canyon mouth.

EMIGRATION CREEK
FLOW - DURATION VALUES*
(Flows Exceeded 'P' Percent of the Time)

JANUARY

'P'	Flows (cfs)
95	0.5
90	0.6
75	0.9
70	1.0
50	1.3
25	2.0
10	3.3

FEBRUARY

'P'	Flows (cfs)
95	0.5
90	0.6
75	1.0
70	1.1
50	1.8
25	3.2
10	7.0

MARCH

'P'	Flows (cfs)
95	0.6
90	0.7
75	2.2
70	2.4
50	4.1
25	6.3
10	9.8

APRIL

'P	Flow (cfs)
95	3.8
90	4.3
75	5.9
70	6.2
50	9.3
25	18
10	36

MAY

'P'	Flow (cfs)
95	4.2
90	6.7
75	9.6
70	11
50	17
25	28
10	39

JUNE

'P'	Flow (cfs)
95	2.2
90	4.8
75	6.1
70	6.6
50	8.8
25	15
10	18

JULY

'P'	Flow (cfs)
95	2.4
90	2.9
75	3.5
70	3.7
50	4.8
25	6.4
10	7.9

AUGUST

'P'	Flow (cfs)
95	1.2
90	1.3
75	1.8
70	1.9
50	2.8
25	3.6
10	4.7

SEPTEMBER

'P'	Flow (cfs)
95	1.0
90	1.1
75	1.3
70	1.4
50	1.7
25	2.3
10	3.4

OCTOBER

'P'	Flow (cfs)
95	0.4
90	0.5
75	0.8
70	0.9
50	1.3
25	2.6
10	2.9

NOVEMBER

'P'	Flow (cfs)
95	0.6
90	0.7
75	0.9
70	1.2
50	1.8
25	2.5
10	3.2

DECEMBER

'P'	Flow (cfs)
95	0.6
90	0.6
75	0.9
70	1.0
50	1.3
25	1.8
10	2.1

*Source: USGS results from compilation of mean daily flows for 1964-1968 and 1980 period of record at the canyon mouth.

PARLEYS CREEK
FLOW - DURATION VALUES*
(Flows Exceeded 'P' Percent of the Time)

JANUARY

'P'	Flow (cfs)
95	4.9
90	6.6
75	8.7
70	9.2
50	12
25	17
10	20

FEBRUARY

'P'	Flow (cfs)
95	5.1
90	6.9
75	8.6
70	8.9
50	11
25	16
10	18

MARCH

'P'	Flow (cfs)
95	8.5
90	9.0
75	11
70	12
50	15
25	62
10	83

APRIL

'P'	Flow (cfs)
95	21
90	42
75	50
70	52
50	61
25	100
10	120

MAY

'P'	Flow (cfs)
95	58
90	63
75	74
70	77
50	98
25	150
10	170

JUNE

'P'	Flow (cfs)
95	26
90	28
75	32
70	33
50	39
25	74
10	160

JULY

'P'	Flow (cfs)
95	14
90	15
75	19
70	20
50	23
25	33
10	42

AUGUST

'P'	Flow (cfs)
95	8.7
90	9.0
75	11
70	13
50	18
25	21
10	26

SEPTEMBER

'P'	Flow (cfs)
95	7.5
90	7.7
75	8.3
70	9.1
50	15
25	17
10	18

OCTOBER

'P'	Flow (cfs)
95	8.6
90	9.0
75	12
70	13
50	15
25	16
10	18

NOVEMBER

'P'	Flow (cfs)
95	6.1
90	7.0
75	9.5
70	10
50	13
25	14
10	17

DECEMBER

'P'	Flow (cfs)
95	5.7
90	6.3
75	8.3
70	8.7
50	11
25	12
10	13

*Source: USGS results from compilation of mean daily flows for 1910, 1912 and 1913 period of record at the canyon mouth.

MILL CREEK
FLOW - DURATION VALUES*
(Flows Exceeded 'P' Percent of the Time)

JANUARY

'P'	Flow (cfs)
95	2.8
90	3.1
75	4.7
70	5.2
50	6.6
25	8.3
10	9.0

FEBRUARY

'P'	Flow (cfs)
95	4.7
90	5.2
75	5.9
70	6.1
50	7.1
25	9.3
10	11

MARCH

'P'	Flow (cfs)
95	5.4
90	5.6
75	6.2
70	6.4
50	7.8
25	9.4
10	9.9

APRIL

'P'	Flow (cfs)
95	6.4
90	6.8
75	8.1
70	8.4
50	10
25	13
10	17

MAY

'P'	Flow (cfs)
95	11
90	13
75	21
70	21
50	27
25	37
10	44

JUNE

'P'	Flow (cfs)
95	5.9
90	6.6
75	9.5
70	9.8
50	12
25	14
10	15

JULY

'P'	Flow (cfs)
95	6.2
90	6.5
75	8.5
70	8.6
50	9.1
25	12
10	13

AUGUST

'P'	Flow (cfs)
95	4.6
90	5.0
75	6.3
70	6.6
50	7.7
25	8.3
10	10

SEPTEMBER

'P'	Flow (cfs)
95	3.7
90	4.5
75	5.6
70	5.9
50	7.5
25	8.1
10	9.5

OCTOBER

'P'	Flow (cfs)
95	2.5
90	3.0
75	4.8
70	5.2
50	6.3
25	8.1
10	9.0

NOVEMBER

'P'	Flow (cfs)
95	4.9
90	6.6
75	8.7
70	9.2
50	12
25	17
10	20

DECEMBER

'P'	Flow (cfs)
95	2.5
90	3.0
75	4.8
70	5.2
50	6.3
25	8.1
10	9.0

*Source: USGS results from compilation of mean daily flows for 1964-1968 and 1980 period of record at the canyon mouth.

BIG COTTONWOOD CREEK
FLOW - DURATION VALUES*
(Flows Exceeded 'P' Percent of the Time)

JANAURY

'P'	Flow (cfs)
95	13
90	15
75	17
70	18
50	21
25	24
10	28

FEBRUARY

'P'	Flow (cfs)
95	14
90	15
75	18
70	19
50	22
25	25
10	28

MARCH

'P'	Flow (cfs)
95	16
90	19
75	23
70	24
50	27
25	31
10	39

APRIL

'P'	Flow (cfs)
95	28
90	33
75	44
70	47
50	62
25	90
10	130

MAY

'P'	Flow (cfs)
95	76
90	89
75	130
70	140
50	180
25	250
10	330

JUNE

'P'	Flow (cfs)
95	61
90	92
75	150
70	170
50	210
25	270
10	350

JULY

'P'	Flow (cfs)
95	24
90	33
75	49
70	53
50	71
25	100
10	150

AUGUST

'P'	Flow (cfs)
95	17
90	21
75	28
70	30
50	36
25	47
10	57

SEPTEMBER

'P'	Flow (cfs)
95	16
90	19
75	23
70	24
50	28
25	34
10	45

OCTOBER

'P'	Flow (cfs)
95	14
90	18
75	22
70	23
50	27
25	32
10	37

NOVEMBER

'P'	Flow (cfs)
95	15
90	17
75	21
70	22
50	25
25	29
10	33

DECEMBER

'P'	Flow (cfs)
95	13
90	15
75	19
70	20
50	23
25	27
10	31

*Source: USGS results from compilation of mean daily flows for 1931-1968 and 1980 period of record at canyon mouth.

LITTLE COTTONWOOD CREEK
FLOW - DURATION VALUES*
(Flows Exceeded 'P' Percent of the Time)

JANUARY

'P'	Flow (cfs)
95	1.0
90	1.1
75	12
70	13
50	14
25	16
10	17

FEBRUARY

'P'	Flow (cfs)
95	1.1
90	1.3
75	12
70	13
50	14
25	16
10	17

MARCH

'P'	Flow (cfs)
95	1.4
90	1.6
75	13
70	14
50	16
26	19
10	21

APRIL

'P'	Flow (cfs)
95	1.6
90	5.7
75	17
70	18
50	24
25	42
10	57

MAY

'P'	Flow (cfs)
95	28
90	39
75	73
70	85
50	130
25	210
10	300

JUNE

'P'	Flow (cfs)
95	130
90	160
75	220
70	240
50	300
25	380
10	420

JULY

'P'	Flow (cfs)
95	39
90	47
75	72
70	81
50	120
25	210
10	280

AUGUST

'P'	Flow (cfs)
95	4.7
90	11
75	24
70	26
50	46
25	63
10	70

SEPTEMBER

'P'	Flow (cfs)
95	2.3
90	2.6
75	18
70	21
50	28
25	36
10	45

OCTOBER

P'	Flow (cfs)
95	1.4
90	1.6
75	16
70	17
50	19
25	22
10	31

NOVEMBER

'P'	Flow (cfs)
95	1.5
90	1.7
75	15
70	16
50	17
25	20
10	22

DECEMBER

'P'	Flow (cfs)
95	1.1
90	1.2
75	12
70	13
50	15
25	18
10	20

*Source: USGS results from compilation of mean daily flows for 1964-1968 and 1980 period of record at gaging station near canyon mouth.

CITY CREEK NEAR SALT LAKE CITY UTAH 10172500

YEAR	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	ANN
1899	523.	446.	418.	322.	288.	408.	1350.	2540.	4670.	1770.	809.	671.	14215.
1900	623.	547.	512.	493.	413.	571.	652.	1470.	956.	605.	462.	386.	7690.
1901	400.	383.	352.	330.	310.	419.	655.	3140.	1380.	777.	565.	415.	9126.
1902	450.	413.	392.	358.	305.	354.	795.	2380.	1750.	834.	567.	423.	9021.
1903	414.	314.	363.	373.	341.	403.	605.	1620.	2380.	992.	714.	545.	9064.
1904	580.	408.	419.	384.	381.	518.	1280.	3420.	2330.	1210.	821.	618.	12429.
1905	559.	504.	494.	470.	418.	488.	746.	1850.	1590.	900.	654.	543.	9216.
1906	516.	467.	481.	478.	435.	654.	1340.	3110.	2940.	1480.	941.	721.	13563.
1907	654.	605.	579.	550.	849.	1240.	2390.	4320.	4790.	2530.	1370.	932.	20809.
1908	754.	614.	624.	585.	532.	639.	912.	2290.	3830.	1920.	1170.	872.	14742.
1909	814.	594.	545.	652.	539.	836.	1870.	4410.	4460.	1840.	1230.	724.	18514.
1910	799.	655.	553.	523.	528.	1230.	2380.	3260.	2080.	922.	615.	536.	14081.
1911	553.	476.	430.	492.	500.	615.	1190.	1750.	1300.	769.	537.	418.	9030.
1912	395.	353.	333.	323.	303.	363.	815.	2780.	3680.	1340.	836.	593.	12114.
1913	520.	450.	412.	368.	333.	426.	1410.	2560.	1400.	879.	621.	488.	9867.
1914	453.	406.	381.	384.	345.	750.	1610.	3860.	2240.	1190.	769.	567.	12955.
1915	519.	442.	407.	378.	444.	523.	1240.	1730.	1620.	996.	652.	536.	9487.
1916	517.	464.	473.	437.	471.	1130.	1770.	3070.	2060.	1130.	799.	574.	12895.
1917	615.	527.	446.	419.	363.	470.	1370.	3760.	4750.	2040.	1120.	785.	16665.
1918	676.	544.	530.	497.	423.	762.	1110.	2300.	1530.	904.	633.	524.	10433.
1919	505.	465.	445.	402.	357.	532.	1350.	2970.	1700.	1060.	676.	571.	11033.
1920	595.	561.	375.	404.	441.	473.	1200.	3150.	2570.	1250.	849.	637.	12505.
1921	577.	530.	537.	526.	594.	1440.	2110.	5980.	3870.	1860.	1100.	774.	19898.
1922	695.	619.	587.	538.	447.	689.	1770.	5070.	4190.	1590.	996.	649.	17840.
1923	600.	579.	521.	496.	444.	540.	1520.	4290.	2870.	1430.	1000.	762.	15052.
1924	713.	637.	610.	576.	541.	592.	1120.	2020.	1060.	726.	528.	437.	9560.
1925	443.	458.	432.	427.	458.	683.	1440.	2700.	1590.	922.	646.	526.	10725.
1926	483.	433.	434.	415.	380.	646.	1840.	2630.	1330.	879.	646.	555.	10671.
1927	596.	558.	529.	447.	405.	611.	1140.	3040.	2780.	1370.	1000.	839.	13315.
1928	775.	572.	525.	513.	483.	818.	1250.	4330.	1740.	959.	701.	546.	13212.
1929	534.	492.	490.	464.	405.	652.	1310.	3900.	2960.	1510.	1090.	827.	14634.
1930	805.	720.	527.	493.	451.	535.	833.	1380.	964.	670.	560.	535.	8473.
1931	493.	432.	417.	416.	369.	405.	586.	1080.	732.	545.	441.	387.	6303.
1932	392.	362.	364.	352.	358.	495.	1210.	3310.	2300.	1080.	683.	506.	11412.
1933	486.	456.	449.	443.	385.	507.	744.	1780.	2830.	1000.	689.	546.	10315.
1934	516.	483.	492.	461.	385.	451.	458.	453.	362.	303.	277.	280.	4921.
1935	308.	323.	358.	337.	353.	444.	821.	2280.	2330.	959.	612.	485.	9610.
1936	470.	472.	445.	437.	417.	812.	2090.	4320.	2370.	1140.	719.	551.	14243.
1937	526.	490.	475.	423.	419.	676.	1120.	3710.	2150.	1180.	726.	558.	12453.
1938	549.	481.	482.	450.	395.	627.	1630.	3300.	2080.	1050.	726.	559.	12329.
1939	545.	527.	519.	490.	423.	701.	1140.	1990.	1010.	701.	555.	475.	9076.
1940	461.	427.	431.	445.	433.	719.	1320.	2310.	1170.	769.	580.	483.	9548.
1941	505.	493.	469.	440.	474.	701.	1140.	3030.	2060.	1220.	805.	649.	11986.
1942	615.	556.	539.	539.	495.	701.	2170.	3130.	3150.	1600.	1010.	762.	15267.
1943	726.	631.	658.	646.	589.	762.	1610.	1860.	1670.	1030.	769.	589.	11540.
1944	499.	497.	488.	443.	418.	499.	916.	2840.	2460.	1250.	824.	619.	11753.
1945	621.	415.	512.	469.	421.	481.	619.	1790.	1960.	1090.	799.	613.	9790.
1946	562.	505.	468.	450.	390.	627.	1470.	1980.	1490.	879.	621.	497.	9939.
1947	497.	476.	494.	462.	505.	707.	1070.	2820.	1560.	1040.	750.	553.	10934.
1948	547.	534.	509.	446.	338.	553.	1270.	3280.	2140.	1030.	732.	637.	12016.

CITY CREEK NEAR SALT LAKE CITY UTAH 10172500

YEAR	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	ANN
1949	563.	537.	495.	438.	393.	670.	1670.	3490.	2720.	1320.	836.	613.	13745.
1950	670.	564.	483.	497.	540.	696.	1410.	3260.	2900.	1410.	876.	671.	13977.
1951	650.	590.	543.	519.	494.	596.	1060.	2760.	1930.	1070.	848.	573.	11633.
1952	512.	480.	505.	517.	502.	646.	2350.	6070.	3680.	1600.	985.	713.	18560.
1953	648.	594.	569.	567.	489.	596.	1030.	2130.	3440.	1310.	912.	634.	12919.
1954	610.	579.	549.	536.	487.	588.	756.	1110.	722.	532.	426.	348.	7243.
1955	335.	333.	353.	341.	292.	280.	634.	1910.	1370.	720.	508.	388.	7464.
1956	375.	360.	511.	413.	325.	536.	874.	2140.	1340.	738.	532.	408.	8552.
1957	420.	383.	390.	341.	348.	443.	749.	2430.	2580.	1200.	740.	533.	10557.
1958	521.	429.	386.	414.	483.	510.	978.	3610.	2390.	1020.	685.	525.	11951.
1959	510.	466.	473.	466.	270.	428.	547.	991.	892.	607.	484.	412.	6546.
1960	408.	363.	350.	375.	354.	507.	1080.	1930.	1070.	636.	459.	429.	7961.
1961	410.	429.	388.	344.	327.	404.	484.	723.	546.	391.	351.	320.	5117.
1962	330.	326.	332.	321.	385.	511.	1530.	2750.	1930.	1050.	616.	449.	10530.
1963	460.	435.	424.	375.	345.	410.	567.	1800.	1180.	647.	475.	397.	7515.
1964	370.	364.	350.	325.	299.	356.	612.	2983.	3012.	1504.	808.	583.	11566.
1965	510.	481.	510.	479.	545.	608.	1123.	3339.	3196.	1479.	927.	780.	13977.
1966	665.	632.	577.	528.	448.	694.	1307.	2001.	1111.	718.	511.	454.	9646.
1967	454.	411.	405.	370.	337.	465.	711.	2077.	2477.	1257.	784.	556.	10304.
1968	527.	469.	447.	429.	423.	586.	946.	2463.	3217.	1371.	951.	682.	12511.
1969	683.	618.	548.	576.	505.	696.	1891.	3956.	2222.	1540.	1101.	870.	15206.
1970	659.	634.	618.	542.	546.	559.	623.	2912.	3289.	1479.	815.	656.	13332.
1971	579.	573.	582.	607.	725.	937.	2103.	3524.	3165.	1798.	1001.	757.	16351.
1972	718.	657.	667.	592.	592.	1384.	1772.	3592.	1653.	1222.	823.	646.	14318.
1973	617.	571.	535.	514.	477.	647.	1018.	3595.	2743.	1340.	861.	704.	13622.
1974	644.	582.	578.	570.	527.	1063.	1782.	4871.	3198.	1661.	952.	721.	17149.
1975	699.	620.	622.	616.	500.	701.	877.	3097.	5879.	3018.	1418.	915.	18962.
1976	832.	707.	685.	645.	611.	711.	1133.	2990.	1608.	1013.	719.	573.	12227.
1977	559.	526.	481.	458.	412.	475.	647.	843.	919.	605.	471.	396.	6792.
1978	383.	366.	381.	381.	878.	1795.	1795.	4148.	4159.	1689.	977.	702.	17654.
1979	588.	518.	499.	457.	388.	521.	890.	2500.	1599.	836.	605.	455.	9856.
1980	422.	385.	380.	411.	444.	533.	968.	2710.	2503.	1161.	729.	538.	11184.
MEAN	552.	498.	480.	459.	441.	639.	1216.	2818.	2291.	1159.	758.	581.	11893.
SD	119.	95.	84.	83.	109.	254.	486.	1095.	1113.	455.	223.	141.	3375.
CV	0.22	0.19	0.17	0.18	0.25	0.40	0.40	0.39	0.49	0.39	0.29	0.24	0.28

RED BUTTE CREEK AT FORT DOUGLAS NEAR SALT LAKE CITY UTAH 10172200

YEAR	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	ANN
1943	92.	109.	119.	118.	131.	221.	368.	236.	195.	109.	78.	59.	1835.
1944	86.	101.	100.	100.	93.	139.	420.	768.	554.	245.	130.	92.	2828.
1945	104.	123.	111.	107.	102.	140.	232.	302.	308.	156.	111.	80.	1876.
1946	93.	104.	113.	106.	99.	218.	588.	385.	223.	127.	86.	73.	2215.
1947	106.	126.	140.	119.	136.	262.	509.	512.	327.	160.	111.	89.	2597.
1948	108.	126.	135.	119.	117.	157.	643.	719.	337.	162.	116.	79.	2818.
1949	115.	115.	125.	101.	94.	222.	857.	726.	450.	211.	127.	107.	3250.
1950	151.	127.	112.	117.	149.	253.	601.	910.	459.	218.	131.	114.	3342.
1951	127.	175.	226.	149.	168.	210.	415.	593.	266.	150.	130.	84.	2693.
1952	127.	175.	119.	140.	142.	204.	1490.	1590.	535.	243.	199.	137.	5101.
1953	137.	143.	144.	175.	158.	229.	572.	695.	497.	226.	130.	91.	3197.
1954	95.	123.	131.	135.	119.	156.	225.	149.	99.	69.	48.	48.	1397.
1955	61.	76.	81.	71.	67.	93.	255.	311.	166.	81.	60.	46.	1368.
1956	52.	76.	111.	126.	87.	165.	261.	240.	131.	71.	45.	31.	1396.
1957	53.	82.	82.	74.	133.	143.	317.	781.	533.	235.	129.	90.	2652.
1958	89.	95.	109.	99.	111.	170.	625.	1050.	348.	189.	116.	93.	3094.
1959	98.	109.	121.	120.	112.	137.	172.	187.	104.	78.	65.	75.	1378.
1960	82.	61.	60.	66.	66.	160.	377.	263.	134.	58.	31.	25.	1383.
1961	46.	61.	65.	61.	59.	79.	102.	100.	46.	42.	11.	16.	688.
1962	26.	56.	58.	59.	76.	85.	452.	539.	245.	104.	46.	39.	1785.
1963	47.	64.	80.	64.	74.	79.	163.	385.	174.	81.	53.	50.	1314.
1964	43.	59.	56.	51.	57.	65.	259.	971.	478.	243.	126.	88.	2496.
1965	99.	105.	163.	157.	190.	219.	686.	996.	458.	248.	171.	142.	3634.
1966	134.	140.	129.	111.	87.	192.	295.	266.	160.	98.	74.	65.	1751.
1967	87.	95.	93.	89.	8C.	156.	203.	384.	235.	138.	80.	67.	1707.
1968	84.	90.	93.	92.	125.	217.	412.	580.	416.	183.	137.	99.	2528.
1969	112.	111.	107.	135.	133.	179.	838.	594.	293.	179.	111.	75.	2867.
1970	104.	104.	105.	123.	131.	153.	223.	743.	453.	252.	139.	127.	2657.
1971	133.	147.	152.	213.	242.	396.	1020.	904.	457.	254.	169.	145.	4232.
1972	166.	163.	170.	171.	172.	610.	742.	660.	344.	199.	133.	120.	3650.
1973	147.	143.	129.	126.	118.	192.	452.	873.	405.	234.	143.	149.	3111.
1974	135.	136.	133.	132.	141.	492.	1100.	1410.	518.	268.	168.	122.	4755.
1975	165.	155.	142.	149.	129.	245.	388.	1950.	1080.	442.	239.	170.	5254.
1976	184.	171.	165.	143.	148.	196.	447.	472.	235.	158.	128.	107.	2554.
1977	121.	116.	99.	101.	91.	113.	186.	197.	146.	79.	64.	63.	1376.
1978	8C.	85.	92.	90.	103.	414.	978.	950.	451.	229.	156.	142.	3770.
1979	135.	131.	121.	112.	103.	183.	412.	390.	177.	102.	77.	58.	2001.
1980	8C.	87.	83.	88.	117.	167.	438.	603.	335.	196.	125.	108.	2427.
C	C.	0.	0.	0.	C.	0.	0.	0.	0.	0.	0.	0.	0.
MEAN	100.	109.	112.	110.	114.	198.	480.	625.	327.	167.	108.	86.	2538.
SD	4C.	38.	39.	39.	42.	114.	308.	412.	196.	85.	51.	39.	1156.
CV	0.40	0.34	0.35	0.35	0.37	0.58	C.64	0.66	0.60	0.51	C.47	0.46	0.46

EMIGRATION CREEK NEAR SALT LAKE CITY UTAH 10172000

YEAR	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	ANN
1901	42.	77.	54.	41.	93.	229.	492.	765.	290.	113.	70.	49.	2315.
1902	62.	71.	58.	37.	48.	90.	577.	610.	290.	126.	48.	31.	2048.
1903	42.	66.	58.	66.	36.	188.	478.	583.	513.	172.	60.	49.	2311.
1904	76.	77.	42.	53.	99.	419.	1070.	1600.	595.	332.	109.	69.	4541.
1905	95.	85.	50.	57.	62.	121.	305.	567.	270.	81.	26.	26.	1745.
1906	33.	39.	39.	39.	36.	261.	894.	892.	630.	277.	141.	111.	3392.
1907	89.	94.	114.	98.	355.	1230.	1670.	676.	449.	341.	416.	417.	5949.
1908	314.	127.	167.	98.	87.	183.	340.	541.	452.	393.	379.	292.	3373.
1909	354.	332.	224.	84.	107.	140.	3630.	1780.	2200.	861.	615.	357.	10684.
1910	609.	101.	73.	104.	516.	2580.	5950.	3070.	345.	84.	51.	59.	13542.
1911	93.	53.	49.	154.	126.	258.	421.	265.	173.	89.	39.	26.	1746.
1912	37.	33.	31.	23.	29.	71.	345.	2030.	916.	425.	299.	252.	4491.
1913	222.	221.	175.	60.	147.	323.	1860.	1130.	666.	455.	237.	240.	5736.
1914	183.	161.	114.	135.	144.	867.	1000.	1190.	732.	282.	170.	129.	5107.
1915	174.	93.	109.	77.	120.	237.	530.	362.	335.	165.	67.	71.	2340.
1916	74.	82.	77.	96.	148.	565.	791.	1020.	589.	220.	125.	121.	3908.
1917	107.	91.	89.	92.	69.	48.	1190.	2280.	1420.	615.	347.	259.	6607.
1918	177.	156.	145.	118.	112.	608.	875.	621.	344.	232.	127.	137.	3652.
1919	137.	122.	111.	86.	73.	275.	976.	646.	297.	161.	69.	101.	3054.
1920	158.	97.	82.	80.	108.	239.	1580.	2570.	643.	368.	242.	183.	6350.
1921	152.	121.	112.	98.	265.	2040.	2730.	3170.	1930.	750.	621.	346.	12335.
1922	307.	286.	308.	247.	138.	415.	2460.	4570.	1580.	713.	298.	166.	11488.
1923	125.	121.	146.	132.	89.	306.	1610.	1970.	750.	338.	202.	229.	6018.
1924	200.	127.	95.	101.	116.	138.	607.	499.	249.	96.	37.	32.	2297.
1925	61.	76.	69.	80.	92.	427.	762.	639.	368.	216.	122.	95.	3007.
1926	108.	107.	105.	90.	83.	342.	1360.	769.	309.	186.	92.	68.	3619.
1927	85.	95.	91.	61.	65.	386.	1040.	1320.	702.	314.	205.	159.	4523.
1928	149.	184.	177.	76.	75.	738.	1150.	1160.	578.	269.	125.	87.	4768.
1929	110.	108.	85.	68.	64.	388.	1610.	1890.	803.	399.	285.	280.	6090.
1930	216.	160.	218.	131.	142.	162.	315.	227.	124.	68.	61.	93.	1937.
1931	132.	120.	87.	74.	72.	97.	189.	196.	107.	39.	43.	33.	1189.
1932	37.	47.	42.	41.	43.	170.	1300.	1130.	422.	170.	87.	67.	3556.
1933	69.	73.	52.	41.	42.	111.	726.	1330.	601.	200.	77.	51.	3373.
1934	66.	67.	69.	52.	61.	84.	76.	50.	51.	39.	36.	30.	681.
1935	31.	37.	46.	44.	31.	40.	246.	585.	397.	141.	56.	45.	1699.
1936	44.	40.	55.	71.	55.	531.	2910.	1530.	541.	286.	157.	89.	6309.
1937	108.	105.	90.	80.	75.	401.	1270.	1420.	518.	300.	145.	87.	4599.
1938	120.	108.	106.	92.	98.	424.	1320.	1090.	543.	268.	140.	87.	4396.
1939	101.	114.	103.	109.	92.	579.	869.	457.	242.	118.	84.	73.	2941.
1940	106.	102.	101.	99.	132.	432.	797.	503.	223.	87.	39.	42.	2663.
1941	60.	67.	68.	68.	119.	397.	904.	941.	468.	312.	156.	103.	3663.
1942	131.	152.	116.	116.	123.	418.	1980.	1350.	946.	464.	239.	159.	6194.
1943	146.	143.	147.	115.	106.	430.	875.	534.	404.	177.	97.	71.	3245.
1944	91.	107.	100.	99.	100.	130.	708.	1050.	922.	435.	220.	120.	4082.
1945	108.	127.	122.	85.	92.	143.	341.	676.	571.	195.	93.	92.	2645.
1946	85.	77.	80.	80.	72.	80.	500.	607.	367.	220.	111.	82.	2361.
1947	157.	104.	121.	63.	96.	472.	934.	910.	560.	265.	156.	113.	3951.
1948	151.	130.	106.	108.	114.	203.	1530.	1410.	586.	269.	81.	36.	4724.
1949	121.	128.	94.	80.	50.	403.	1950.	1310.	762.	326.	173.	59.	5456.
1950	88.	93.	63.	45.	173.	487.	1600.	1990.	972.	450.	190.	107.	6258.

EMIGRATION CREEK NEAR SALT LAKE CITY UTAH 10172000

YEAR	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	ANN
1951	113.	150.	178.	123.	296.	436.	1100.	1360.	588.	288.	175.	72.	4879.
1952	120.	115.	77.	100.	130.	227.	4240.	3650.	1340.	642.	421.	186.	11248.
1953	130.	139.	114.	178.	149.	426.	1270.	1400.	1110.	518.	299.	184.	5917.
1954	187.	171.	140.	136.	138.	186.	387.	209.	120.	37.	16.	15.	1742.
1955	19.	19.	22.	22.	29.	74.	415.	583.	302.	131.	56.	30.	1702.
1956	27.	26.	25.	100.	29.	398.	570.	525.	391.	128.	32.	38.	2289.
1957	24.	24.	25.	23.	49.	198.	646.	1670.	903.	361.	178.	124.	4225.
1958	129.	112.	126.	199.	225.	341.	1670.	2370.	765.	342.	157.	106.	6542.
1959	102.	126.	123.	148.	145.	216.	363.	390.	175.	63.	28.	28.	1907.
1960	26.	30.	44.	47.	47.	278.	897.	444.	218.	25.	25.	24.	2105.
1961	25.	24.	25.	25.	23.	22.	18.	20.	21.	15.	15.	12.	245.
1962	16.	18.	30.	21.	26.	131.	1199.	680.	324.	149.	28.	18.	2640.
1963	27.	35.	37.	37.	33.	37.	380.	805.	384.	75.	26.	18.	1894.
1964	27.	36.	34.	30.	30.	36.	574.	2621.	966.	489.	205.	85.	5133.
1965	85.	127.	127.	227.	459.	670.	2077.	2035.	960.	417.	308.	272.	7764.
1966	236.	266.	181.	145.	145.	399.	694.	537.	356.	254.	103.	103.	3419.
1967	266.	314.	217.	216.	208.	382.	529.	796.	451.	261.	121.	67.	3828.
1968	83.	75.	67.	63.	125.	316.	948.	1342.	959.	366.	241.	152.	4737.
1969	135.	125.	130.	212.	182.	283.	2317.	1422.	778.	400.	255.	172.	6411.
1970	218.	135.	88.	105.	167.	249.	460.	1629.	715.	267.	130.	115.	4278.
1971	140.	162.	131.	277.	451.	929.	2301.	1736.	889.	370.	202.	154.	7742.
1972	166.	170.	192.	168.	273.	1835.	1913.	1564.	489.	279.	133.	129.	7311.
1973	149.	143.	111.	110.	110.	244.	1189.	2045.	746.	317.	156.	170.	5490.
1974	140.	144.	133.	147.	139.	1146.	2942.	3051.	1139.	501.	228.	115.	9825.
1975	127.	139.	119.	127.	117.	337.	968.	5140.	2744.	978.	442.	238.	11476.
1976	218.	166.	152.	133.	168.	309.	1057.	988.	390.	162.	93.	63.	3899.
1977	79.	73.	51.	44.	40.	59.	143.	184.	127.	51.	38.	36.	925.
1978	34.	36.	34.	32.	40.	756.	2200.	2255.	929.	299.	135.	123.	6873.
1979	91.	95.	69.	50.	67.	248.	1055.	826.	315.	125.	69.	38.	3048.
1980	50.	48.	46.	69.	192.	281.	1548.	1459.	539.	226.	103.	87.	4648.
0	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
MEAN	120.	108.	97.	93.	119.	392.	1182.	1262.	616.	277.	154.	112.	4532.
SD	90.	64.	55.	54.	96.	425.	978.	974.	465.	192.	127.	87.	2810.
CV	0.75	0.59	0.57	0.58	0.81	1.08	0.83	0.77	0.75	0.69	0.82	0.77	0.62

PARLEY'S CREEK NEAR SALT LAKE CITY UTAH 10171500

YEAR	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	ANN
1910	1140.	1250.	1080.	1140.	855.	4420.	7440.	6890.	1960.	1400.	965.	726.	29266.
1911	842.	684.	599.	670.	600.	1010.	1620.	2020.	1340.	1000.	596.	477.	11458.
1912	621.	469.	516.	508.	507.	719.	2950.	8550.	7200.	2350.	1420.	1040.	26850.
1913	972.	904.	621.	646.	555.	812.	5670.	5080.	2150.	1510.	1080.	845.	20845.
1914	922.	738.	658.	744.	700.	1920.	4620.	6150.	3530.	1660.	1080.	833.	23555.
1915	916.	702.	633.	646.	594.	910.	2650.	1940.	1880.	1040.	738.	732.	13381.
1916	646.	607.	552.	564.	644.	2440.	4110.	5080.	2700.	1370.	972.	708.	20393.
1917	793.	643.	558.	525.	548.	683.	3620.	9220.	7680.	2290.	1310.	934.	28804.
1918	836.	643.	689.	683.	633.	1480.	2680.	2660.	1620.	1130.	701.	720.	14475.
1919	701.	601.	558.	338.	336.	787.	2890.	2350.	1590.	1060.	892.	774.	12877.
1920	528.	573.	787.	585.	610.	990.	3950.	10600.	4970.	1790.	1350.	1040.	27773.
1921	1010.	964.	867.	867.	1070.	4210.	6310.	12500.	6900.	2420.	1560.	1150.	39828.
1922	1030.	922.	941.	793.	739.	1380.	5190.	14400.	6250.	2280.	1490.	1040.	36455.
1923	1080.	881.	849.	867.	672.	1060.	4060.	9410.	4090.	1620.	1180.	851.	26620.
1924	861.	660.	614.	530.	615.	633.	1940.	1990.	881.	627.	457.	391.	10199.
1925	462.	469.	514.	483.	494.	1280.	2340.	3250.	1960.	1050.	799.	508.	13609.
1926	566.	492.	449.	379.	434.	953.	3130.	2700.	1140.	812.	478.	502.	12035.
1927	516.	523.	446.	469.	472.	1060.	3350.	5580.	3080.	1480.	965.	785.	18726.
1928	799.	756.	646.	627.	587.	1820.	3520.	5710.	1730.	1240.	750.	643.	18828.
1929	689.	568.	555.	495.	434.	1180.	4430.	7380.	3380.	1590.	1140.	1050.	22891.
1930	953.	649.	560.	520.	561.	775.	1680.	1390.	833.	750.	639.	601.	9911.
1931	566.	458.	407.	426.	402.	545.	976.	1380.	666.	516.	357.	298.	6997.
1932	346.	312.	372.	336.	369.	744.	3610.	6130.	2600.	1110.	781.	631.	17341.
1933	639.	537.	429.	298.	363.	695.	1870.	4870.	3350.	1070.	613.	562.	15296.
1934	488.	447.	469.	402.	440.	536.	461.	323.	245.	249.	196.	180.	4436.
1935	256.	254.	394.	306.	337.	494.	1390.	3140.	2150.	959.	572.	401.	10653.
1936	412.	422.	416.	452.	452.	1230.	6660.	7130.	2630.	1160.	756.	601.	22321.
1937	552.	561.	499.	513.	566.	984.	3500.	6760.	2420.	1250.	738.	672.	19015.
1938	689.	619.	652.	507.	519.	1220.	4750.	4870.	2450.	1230.	676.	702.	18884.
1939	584.	571.	536.	494.	459.	1160.	2730.	2000.	994.	577.	468.	527.	11100.
1940	522.	379.	442.	576.	587.	1060.	2330.	2200.	922.	528.	359.	414.	10319.
1941	433.	508.	486.	495.	572.	1050.	2650.	4850.	2150.	1210.	818.	672.	15894.
1942	726.	655.	867.	713.	794.	1080.	5840.	5160.	3540.	1590.	978.	762.	22705.
1943	775.	750.	732.	719.	711.	1550.	3870.	2810.	2150.	1170.	787.	678.	16702.
1944	744.	613.	676.	633.	604.	695.	2140.	5640.	4120.	1620.	928.	708.	19121.
1945	744.	655.	639.	639.	683.	713.	1240.	1990.	1490.	984.	719.	708.	11204.
1946	604.	738.	676.	670.	532.	1220.	5310.	4000.	1860.	1000.	707.	539.	17856.
1947	602.	672.	639.	639.	683.	1290.	3220.	4930.	2530.	1300.	879.	887.	18271.
1948	824.	738.	793.	769.	679.	818.	5100.	7190.	3170.	1440.	1150.	649.	23320.
1949	738.	887.	726.	646.	502.	1120.	4810.	6030.	3010.	1460.	941.	690.	21560.
1950	775.	744.	769.	789.	806.	1430.	5170.	8500.	4690.	2040.	1160.	912.	27785.
1951	911.	930.	890.	739.	959.	1330.	3880.	6130.	2940.	1490.	1100.	793.	22092.
1952	797.	788.	806.	817.	784.	996.	9940.	13680.	5600.	2170.	1290.	897.	38565.
1953	796.	751.	775.	874.	608.	1100.	3100.	5070.	4640.	1570.	1010.	743.	21037.
1954	778.	733.	630.	580.	557.	720.	1410.	1130.	702.	452.	362.	358.	8412.
1955	433.	505.	461.	468.	446.	587.	1430.	2980.	1390.	748.	496.	431.	10375.
1956	466.	523.	651.	705.	291.	1540.	2210.	2940.	1440.	820.	488.	508.	12582.
1957	542.	415.	485.	437.	362.	932.	2130.	6200.	4700.	1370.	792.	612.	18977.
1958	554.	474.	557.	508.	576.	879.	3130.	6880.	1900.	1140.	532.	591.	17721.
1959	421.	497.	500.	322.	537.	631.	1030.	1450.	841.	511.	371.	386.	7497.

PARLEY'S CREEK NEAR SALT LAKE CITY UTAH 10171500

YEAR	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	ANN
1960	369.	317.	322.	429.	361.	994.	2340.	1860.	1010.	566.	483.	311.	9362.
1961	338.	346.	358.	263.	384.	417.	607.	606.	313.	186.	220.	209.	4247.
1962	298.	326.	363.	368.	490.	667.	3914.	3619.	1942.	1188.	722.	546.	14443.
1963	512.	417.	358.	342.	407.	380.	1003.	3509.	1176.	615.	377.	360.	9456.
1964	400.	375.	314.	288.	322.	350.	1480.	7750.	3325.	1901.	1062.	647.	18214.
1965	586.	471.	958.	896.	1238.	1298.	4837.	7965.	2718.	1709.	1159.	858.	24693.
1966	864.	719.	652.	634.	616.	1262.	2736.	3122.	1558.	972.	598.	682.	14415.
1967	652.	592.	537.	511.	552.	984.	1612.	5310.	3690.	1857.	887.	659.	17843.
1968	824.	695.	638.	568.	732.	1364.	2413.	5426.	4424.	1951.	1186.	911.	21132.
1969	996.	712.	671.	836.	986.	1287.	6229.	6859.	2962.	1634.	962.	665.	24799.
1970	820.	911.	608.	674.	717.	822.	1445.	6325.	3792.	1733.	989.	840.	19676.
1971	823.	808.	769.	1283.	1281.	2168.	5926.	7088.	4445.	1925.	1422.	1119.	29057.
1972	986.	944.	1006.	1030.	1046.	4105.	6170.	7734.	4047.	2503.	1103.	1077.	31751.
1973	998.	845.	700.	690.	542.	1077.	3066.	7703.	3386.	1563.	1022.	851.	22443.
1974	687.	660.	676.	665.	590.	2513.	5627.	10047.	4384.	1734.	1220.	760.	29583.
1975	929.	624.	693.	717.	727.	1022.	2283.	14387.	11126.	3813.	2011.	1439.	39771.
1976	1600.	1140.	867.	731.	792.	1140.	4273.	5516.	2453.	1731.	960.	966.	22169.
1977	1140.	675.	537.	527.	457.	497.	800.	1226.	901.	525.	414.	505.	8204.
1978	580.	408.	527.	546.	634.	2658.	7498.	9530.	4776.	1756.	942.	843.	30698.
1979	729.	693.	707.	616.	556.	925.	3289.	4225.	1772.	1022.	705.	568.	15807.
1980	533.	424.	548.	618.	824.	954.	4516.	6595.	3130.	1364.	770.	576.	20852.
MEAN	708.	633.	618.	603.	607.	1208.	3466.	5459.	2894.	1344.	856.	694.	19091.
SD	238.	197.	170.	196.	202.	794.	1890.	3225.	1921.	614.	346.	236.	8209.
CV	0.34	0.31	0.27	0.32	0.33	0.66	0.55	0.59	0.66	0.46	0.40	0.34	0.43

MILL CREEK NEAR SALT LAKE CITY UTAH 1017000

YEAR	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	ANN
1899	922.	770.	640.	716.	570.	751.	1250.	2140.	3000.	1580.	1100.	933.	14372.
1900	898.	804.	703.	741.	577.	728.	750.	1330.	963.	643.	583.	509.	9229.
1901	526.	520.	438.	441.	450.	515.	591.	1810.	1180.	932.	770.	689.	8862.
1902	715.	676.	627.	574.	493.	594.	760.	1450.	1290.	844.	676.	555.	9254.
1903	594.	508.	428.	482.	360.	520.	607.	1080.	1540.	932.	790.	689.	8530.
1904	697.	656.	558.	606.	568.	689.	1130.	2550.	2430.	1580.	916.	890.	13270.
1905	840.	736.	531.	545.	437.	629.	730.	1420.	1560.	945.	778.	706.	9877.
1906	714.	603.	441.	534.	524.	585.	906.	1920.	2200.	1170.	955.	833.	11385.
1907	802.	679.	720.	684.	786.	1180.	1940.	2930.	3450.	2110.	1580.	1350.	18211.
1908	1150.	988.	920.	795.	741.	838.	910.	1820.	2750.	1890.	1410.	1160.	15372.
1909	1050.	948.	798.	904.	922.	1190.	1750.	3120.	4830.	2250.	1730.	1480.	20972.
1910	1280.	1160.	1000.	947.	839.	1320.	1960.	2360.	1840.	1360.	1130.	964.	16160.
1911	928.	904.	935.	676.	528.	609.	714.	1720.	1310.	922.	676.	565.	10487.
1912	553.	637.	615.	676.	551.	670.	1420.	2740.	3530.	1500.	1270.	1020.	15182.
1913	1220.	1030.	959.	812.	705.	855.	2650.	4240.	2330.	1390.	1030.	863.	18084.
1914	855.	785.	793.	781.	678.	1050.	1740.	3360.	2440.	1520.	1190.	1090.	16282.
1915	879.	785.	726.	553.	502.	600.	964.	1520.	1480.	1070.	830.	750.	10659.
1916	676.	613.	615.	537.	541.	849.	1170.	2160.	1900.	1170.	959.	768.	11958.
1917	744.	595.	563.	477.	449.	359.	904.	2160.	2680.	1610.	1200.	904.	12645.
1918	750.	655.	633.	526.	482.	793.	857.	1580.	1590.	1000.	762.	690.	10318.
1919	609.	494.	516.	391.	329.	392.	904.	2310.	1340.	916.	756.	660.	9617.
1920	639.	530.	437.	329.	372.	425.	904.	2590.	1980.	1400.	1080.	791.	11477.
1921	689.	619.	479.	423.	449.	1140.	1390.	3720.	4080.	1790.	1400.	1110.	17289.
1922	892.	726.	701.	559.	525.	676.	1230.	4080.	3560.	1680.	1320.	1100.	17049.
1923	836.	744.	867.	732.	572.	633.	1040.	3200.	2740.	1530.	1250.	1090.	15234.
1924	799.	575.	537.	489.	514.	521.	595.	1510.	970.	701.	553.	528.	8292.
1925	524.	455.	431.	390.	364.	509.	726.	1740.	1610.	959.	689.	568.	8965.
1926	546.	471.	414.	367.	325.	398.	607.	1740.	1010.	610.	477.	423.	7388.
1927	446.	396.	308.	274.	317.	450.	928.	2350.	2730.	1620.	1130.	833.	11782.
1928	812.	821.	564.	522.	488.	652.	875.	2950.	1690.	1170.	947.	768.	12259.
1929	750.	702.	515.	464.	334.	532.	940.	2680.	2570.	1480.	1020.	869.	12856.
1930	599.	584.	607.	408.	395.	615.	845.	1170.	940.	652.	627.	607.	8049.
1931	683.	568.	554.	590.	540.	600.	720.	947.	590.	553.	438.	397.	7180.
1932	413.	327.	301.	296.	288.	446.	904.	2240.	1620.	1030.	756.	625.	9246.
1933	559.	507.	445.	448.	394.	454.	619.	1250.	2180.	1040.	775.	601.	9272.
1934	548.	489.	514.	467.	415.	443.	471.	472.	389.	344.	296.	259.	5107.
1935	311.	334.	323.	317.	275.	291.	453.	1180.	1530.	713.	514.	386.	6627.
1936	284.	241.	227.	250.	248.	347.	1150.	2590.	1510.	1010.	713.	554.	9124.
1937	491.	433.	328.	228.	269.	228.	696.	2240.	1400.	978.	612.	475.	8378.
1938	540.	437.	413.	331.	280.	505.	1170.	2590.	1890.	1060.	738.	581.	10535.
1939	452.	394.	311.	306.	256.	386.	774.	1430.	922.	555.	465.	353.	6604.
1940	371.	299.	330.	299.	263.	415.	863.	1510.	756.	615.	485.	453.	6659.
1941	441.	334.	305.	303.	298.	390.	684.	2220.	1640.	1020.	849.	672.	9156.
1942	593.	553.	539.	510.	454.	427.	1320.	2530.	2620.	1300.	996.	708.	12550.
1943	587.	518.	502.	424.	480.	556.	940.	1460.	1480.	1090.	812.	560.	9409.
1944	501.	477.	452.	339.	396.	441.	631.	1880.	2530.	1380.	1380.	702.	11109.
1945	639.	666.	562.	455.	302.	343.	521.	1150.	1370.	1050.	799.	534.	8391.
1946	499.	408.	352.	509.	473.	536.	1320.	2270.	1430.	1010.	762.	562.	10131.
1947	556.	422.	462.	430.	444.	554.	952.	2440.	1620.	1070.	836.	643.	10429.
1949	535.	563.	537.	473.	347.	379.	1070.	3230.	2240.	1090.	842.	556.	11862.

MILL CREEK NEAR SALT LAKE CITY UTAH 1017000

YEAR	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	ANN
1949	360.	376.	440.	408.	355.	407.	1110.	3480.	1980.	1180.	892.	750.	11738.
1950	756.	660.	615.	500.	575.	731.	1330.	2840.	2860.	1370.	967.	849.	14053.
1951	759.	724.	700.	610.	574.	684.	933.	2240.	1800.	1020.	823.	659.	11526.
1952	642.	562.	508.	521.	550.	592.	2030.	4680.	3810.	1640.	1190.	889.	17614.
1953	773.	645.	663.	697.	568.	636.	857.	1500.	2850.	1290.	953.	718.	12150.
1954	639.	594.	552.	616.	499.	534.	622.	1040.	685.	552.	441.	398.	7172.
1955	409.	415.	311.	371.	310.	457.	593.	1470.	1180.	800.	607.	508.	7431.
1956	473.	451.	516.	460.	340.	588.	853.	1770.	1210.	753.	641.	522.	8577.
1957	496.	319.	485.	418.	442.	539.	734.	1980.	2860.	1290.	857.	676.	11096.
1958	616.	563.	552.	505.	480.	551.	953.	2710.	1930.	1230.	754.	625.	11469.
1959	570.	535.	559.	513.	480.	540.	642.	941.	1030.	618.	532.	503.	7463.
1960	471.	394.	440.	379.	417.	519.	689.	1190.	818.	580.	485.	410.	6792.
1961	319.	279.	331.	364.	340.	386.	391.	563.	503.	380.	341.	328.	4525.
1962	263.	272.	264.	286.	287.	356.	746.	1404.	1282.	789.	595.	485.	7029.
1963	381.	346.	379.	339.	354.	383.	359.	1028.	927.	584.	464.	393.	5937.
1964	311.	281.	293.	331.	339.	339.	535.	1989.	2810.	1277.	610.	600.	9915.
1965	522.	451.	528.	571.	528.	644.	1045.	2449.	3511.	1378.	988.	808.	13423.
1966	675.	642.	552.	516.	557.	663.	903.	1872.	1093.	737.	583.	552.	9345.
1967	540.	505.	430.	408.	434.	521.	564.	1835.	2697.	1293.	857.	661.	10745.
1968	661.	624.	695.	595.	615.	654.	855.	1806.	3018.	1315.	997.	752.	12587.
1969	679.	628.	598.	601.	588.	612.	1523.	3372.	1907.	1228.	954.	719.	13409.
1970	719.	635.	653.	691.	617.	655.	760.	2332.	2819.	1344.	973.	821.	13019.
1971	748.	724.	629.	679.	649.	851.	1572.	2685.	2837.	1386.	1038.	883.	14681.
1972	816.	774.	756.	610.	598.	1093.	1331.	2990.	2269.	978.	838.	772.	13825.
1973	715.	679.	562.	550.	581.	614.	757.	2541.	2155.	1077.	811.	718.	11760.
1974	656.	613.	594.	541.	531.	792.	1350.	3483.	2382.	1190.	887.	741.	13760.
1975	707.	655.	608.	603.	550.	614.	655.	2346.	4598.	2166.	1139.	891.	15532.
1976	822.	739.	743.	713.	640.	707.	946.	2283.	1404.	935.	772.	703.	11407.
1977	647.	562.	612.	550.	459.	493.	541.	675.	733.	566.	489.	471.	6798.
1978	449.	426.	434.	428.	384.	586.	1255.	2558.	3119.	1111.	792.	719.	12261.
1979	636.	602.	562.	550.	477.	535.	713.	1533.	1130.	847.	748.	649.	8982.
1980	651.	539.	537.	576.	576.	632.	881.	1800.	2134.	1085.	788.	685.	10884.
MEAN	644.	577.	544.	510.	473.	597.	963.	2128.	1995.	1120.	849.	698.	11098.
SD	200.	180.	165.	152.	138.	211.	407.	847.	952.	398.	281.	225.	3342.
CV	0.31	0.31	0.30	0.30	0.29	0.35	0.42	0.40	0.48	0.36	0.33	0.32	0.30

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1899	2280.	1970.	1510.	1480.	1350.	1980.	5650.	11100.	22600.	9970.	3750.	3030.	66670.
1900	2280.	2020.	1660.	1480.	1560.	1970.	4050.	9220.	10100.	3570.	2070.	1510.	41490.
1901	1680.	1730.	1540.	1360.	1320.	1800.	4140.	16600.	10200.	4420.	2400.	1770.	48960.
1902	1790.	1650.	1670.	1420.	1350.	1510.	4190.	12900.	11600.	3820.	2030.	1660.	45590.
1903	1620.	1480.	1400.	1310.	1080.	1480.	3430.	9840.	13400.	3500.	1450.	544.	40534.
1904	1910.	1790.	1600.	1480.	1550.	1910.	5240.	15600.	18400.	13300.	2950.	2800.	68530.
1905	2270.	1890.	1570.	1580.	1390.	1790.	3580.	8500.	11200.	3920.	2210.	1890.	41790.
1906	1970.	1680.	1620.	1590.	1490.	1940.	4370.	12600.	11900.	8880.	4590.	3420.	56050.
1907	2650.	2350.	3000.	2920.	2390.	3360.	5060.	12800.	25700.	24100.	6000.	3450.	93780.
1908	3170.	2650.	2280.	2020.	1790.	2090.	5030.	11900.	17400.	10100.	3910.	3210.	65550.
1909	3520.	2790.	2230.	2490.	2130.	2640.	5870.	15700.	31500.	14400.	6270.	5400.	94940.
1910	4290.	3960.	3860.	3450.	2650.	5700.	10800.	17500.	14000.	5420.	3870.	3050.	78550.
1911	3260.	2660.	2590.	2470.	2360.	2910.	4160.	10400.	16800.	6210.	3040.	2170.	59030.
1912	2360.	1740.	1540.	1520.	1380.	1680.	3760.	13500.	24900.	7560.	4260.	3040.	67240.
1913	3110.	2520.	1930.	1700.	1580.	2000.	6490.	13900.	11400.	5660.	2800.	2380.	55470.
1914	2660.	1810.	1680.	1580.	1270.	2800.	6370.	18100.	16400.	7990.	3410.	2550.	66620.
1915	2740.	2150.	1600.	1410.	1340.	2000.	6600.	8790.	11300.	4710.	2490.	2170.	47300.
1916	1970.	1810.	1630.	1620.	1690.	3740.	6370.	12000.	14900.	6520.	3580.	2930.	58760.
1917	3420.	2050.	1820.	1860.	1590.	1810.	4520.	12700.	22300.	11200.	4510.	3450.	71230.
1918	2850.	2140.	1970.	1800.	1660.	3030.	4810.	11500.	15400.	4590.	2630.	2270.	54650.
1919	2530.	2020.	1740.	1590.	1380.	2100.	6130.	15400.	7740.	3390.	2670.	2400.	49090.
1920	2710.	2520.	1930.	1820.	1600.	2130.	3970.	19800.	19100.	6520.	3420.	2730.	68250.
1921	2790.	2600.	2120.	2130.	2190.	4270.	5430.	19900.	28800.	11200.	4770.	3260.	89460.
1922	2760.	2310.	2370.	2040.	1690.	2330.	4530.	18700.	24200.	7930.	4180.	2760.	75800.
1923	2320.	2180.	2050.	2020.	1720.	2310.	4830.	17500.	18200.	9840.	3700.	2840.	69510.
1924	2990.	2180.	1920.	1700.	1610.	1770.	4270.	12400.	6900.	3140.	1860.	1630.	42370.
1925	1640.	1620.	1300.	1560.	1720.	2850.	5670.	14600.	10900.	5470.	2760.	2520.	52610.
1926	2150.	1730.	1600.	1420.	1360.	2310.	6310.	13900.	8030.	3100.	2260.	1650.	45820.
1927	1960.	1710.	1800.	1570.	1400.	2160.	4740.	14400.	18400.	6830.	3040.	2550.	60560.
1928	2480.	2550.	2130.	2000.	1750.	2900.	4490.	17460.	9460.	4030.	2340.	1880.	53470.
1929	1870.	1770.	1590.	1480.	1300.	2110.	4300.	13900.	16200.	7010.	3150.	2820.	57500.
1930	2260.	1680.	1600.	1400.	1340.	1800.	6010.	8610.	8270.	2760.	2200.	2090.	40020.
1931	2580.	1650.	1480.	1350.	1230.	1510.	3840.	8300.	4160.	1640.	1300.	1210.	30250.
1932	1260.	1160.	1150.	1040.	1110.	1650.	4470.	15200.	13700.	5130.	2280.	1870.	50020.
1933	1700.	1480.	1260.	1270.	1040.	1720.	3340.	8610.	18600.	4250.	1990.	1510.	46770.
1934	1410.	1200.	1080.	1030.	977.	1800.	3870.	4900.	1570.	867.	836.	690.	20230.
1935	750.	922.	1060.	922.	1000.	1200.	2960.	8490.	15530.	4240.	1540.	1000.	39614.
1936	941.	904.	769.	793.	794.	1480.	6660.	16540.	10180.	3780.	2100.	1350.	46291.
1937	1190.	1140.	990.	805.	900.	1550.	3310.	14200.	8930.	3470.	1450.	1310.	39245.
1938	1780.	1370.	1520.	1060.	972.	1840.	5940.	13710.	13570.	4060.	2020.	1420.	49262.
1939	1460.	1420.	1310.	1090.	950.	2170.	5440.	10330.	6720.	2580.	1240.	1180.	35890.
1940	1410.	988.	873.	947.	972.	2000.	4470.	11810.	4770.	1570.	941.	1050.	31801.
1941	1170.	1160.	947.	947.	1020.	1710.	3110.	14510.	13510.	5050.	2530.	1760.	47424.
1942	2180.	1980.	1780.	1590.	1460.	2120.	6720.	11810.	15290.	5770.	2140.	1590.	54430.
1943	1430.	1410.	1400.	1250.	1290.	1780.	5750.	9720.	11540.	5160.	2130.	1470.	44330.
1944	1740.	1620.	1380.	1250.	1170.	1420.	3010.	12300.	16130.	5720.	2140.	1690.	49570.
1945	1600.	1600.	1380.	1290.	1170.	1480.	2660.	11620.	12380.	7190.	2980.	1760.	47110.
1946	1830.	1840.	1570.	1540.	1270.	2210.	8510.	12300.	10120.	3750.	1950.	1550.	48440.
1947	2050.	2040.	1840.	1460.	1410.	2240.	4260.	15620.	12140.	6270.	2670.	1960.	54160.
1948	1970.	2140.	1950.	1670.	1390.	1570.	4360.	16230.	14400.	4860.	2420.	1840.	54800.

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1949	1830.	1700.	1670.	1460.	1340.	1950.	5130.	13160.	13270.	5580.	2280.	1640.	51010.
1950	1950.	1640.	1440.	1410.	1300.	1630.	4240.	11470.	14810.	6580.	2530.	1930.	50930.
1951	1790.	1950.	1810.	1540.	1510.	1630.	4050.	12540.	14760.	5810.	3400.	1810.	52600.
1952	2160.	1630.	1570.	1450.	1480.	1630.	6540.	18330.	20100.	8350.	3900.	2270.	69410.
1953	1900.	1630.	2040.	1580.	1340.	2030.	4060.	7930.	19100.	7380.	3150.	1910.	54050.
1954	1860.	1690.	1510.	1440.	1320.	1740.	3840.	9410.	6030.	2950.	1580.	1290.	34660.
1955	1320.	1350.	1240.	1170.	1040.	1280.	2690.	12310.	11770.	3920.	1960.	1270.	41320.
1956	1210.	1320.	1730.	1750.	1180.	1760.	3820.	11640.	11890.	3880.	2020.	1600.	43800.
1957	1560.	1390.	1370.	1280.	1210.	1830.	3170.	12970.	19650.	8710.	3290.	2210.	58640.
1958	1910.	1680.	1570.	1460.	1390.	1790.	4130.	20350.	16370.	4780.	2530.	1840.	59800.
1959	1600.	1380.	1410.	1230.	1170.	1470.	3380.	8280.	12710.	3410.	1800.	1800.	39640.
1960	2050.	1450.	1230.	1170.	1140.	2200.	5510.	11820.	9910.	2520.	1580.	1350.	41930.
1961	1320.	1270.	1180.	1010.	900.	1220.	2300.	6620.	5120.	1420.	1140.	1110.	24610.
1962	1220.	1160.	998.	973.	1500.	1550.	5870.	11950.	16520.	7040.	2130.	1490.	52401.
1963	1440.	1220.	1090.	1030.	1040.	1190.	2320.	10480.	13250.	3830.	1640.	1630.	40160.
1964	1320.	1350.	1170.	1075.	924.	1063.	2760.	12893.	14995.	7374.	2621.	1975.	49520.
1965	1608.	1527.	1903.	1824.	1945.	1709.	4215.	10496.	17718.	8763.	3750.	3279.	58737.
1966	2367.	1981.	1733.	1467.	1389.	2277.	4523.	10272.	7120.	2712.	1715.	1546.	39102.
1967	1602.	1414.	1356.	1251.	1236.	1863.	1845.	12029.	17405.	8953.	2257.	1183.	52394.
1968	1603.	1503.	1290.	1204.	1340.	1948.	3442.	10322.	19012.	6295.	3721.	2256.	53936.
1969	2084.	1935.	1732.	1738.	1503.	1784.	5580.	19646.	13856.	6780.	2849.	1881.	61368.
1970	1871.	1717.	1550.	1570.	1609.	1786.	2391.	13050.	15986.	6083.	2842.	3122.	53577.
1971	2486.	2177.	2045.	2222.	1964.	2439.	5445.	12704.	18206.	6572.	3016.	2592.	61868.
1972	2437.	2263.	2053.	1764.	1719.	3564.	4784.	15111.	15773.	4459.	2426.	2089.	58442.
1973	2307.	2004.	1709.	1641.	1381.	1786.	3052.	16012.	15297.	4997.	2719.	2477.	55382.
1974	2241.	2103.	1920.	1885.	1647.	2956.	4825.	18135.	16020.	5071.	2594.	1944.	61341.
1975	1929.	1790.	1645.	1592.	1404.	1859.	2109.	10074.	22550.	15109.	3871.	2431.	66363.
1976	2483.	2099.	1946.	1715.	1744.	2022.	3905.	13428.	9716.	4061.	1980.	1802.	46901.
1977	1637.	1366.	1279.	1177.	1044.	1261.	3560.	5470.	7713.	1999.	1499.	1428.	29433.
1978	1518.	1246.	1216.	1140.	1214.	2596.	5405.	11211.	19283.	7178.	3330.	2671.	58008.
1979	2208.	1782.	1657.	1481.	1259.	1768.	3493.	12314.	10751.	4013.	2212.	1487.	44425.
1980	1697.	1382.	1303.	1372.	1393.	1690.	4471.	11312.	15960.	7160.	2492.	2018.	52250.
MEAN	2039.	1778.	1634.	1520.	1411.	2048.	4570.	12825.	14311.	5978.	2686.	2065.	52864.
SD	628.	490.	460.	437.	349.	708.	1452.	3357.	5506.	3464.	1030.	770.	13745.
CV	0.31	0.28	0.28	0.29	0.25	0.35	0.32	0.26	0.38	0.58	0.38	0.37	0.26

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1910	3430.	1310.	1400.	1330.	955.	3050.	8640.	14000.	11200.	4340.	3100.	994.	53749.
1911	1220.	982.	738.	836.	1430.	1270.	3330.	8320.	13400.	4970.	2430.	1740.	40666.
1912	1890.	1390.	1230.	818.	719.	836.	1650.	8670.	25100.	8420.	3580.	1740.	56043.
1913	1600.	1600.	1080.	873.	789.	867.	3250.	11700.	12100.	8480.	1900.	1520.	45759.
1914	1620.	1340.	984.	799.	783.	1460.	4000.	13500.	17600.	12000.	2070.	1630.	57786.
1915	1380.	857.	793.	689.	622.	812.	3700.	9100.	13900.	5550.	1420.	1290.	40113.
1916	922.	714.	732.	701.	644.	1750.	4720.	10000.	15800.	10200.	2890.	1420.	50493.
1917	3660.	1350.	1080.	830.	800.	947.	1820.	9780.	14900.	9410.	2650.	1170.	48397.
1918	1210.	887.	892.	879.	761.	1140.	2730.	10700.	16700.	4740.	1640.	1370.	43649.
1919	1620.	1050.	898.	695.	628.	775.	2710.	12800.	9700.	2450.	1310.	1240.	35876.
1920	1480.	1210.	1250.	1060.	863.	941.	1400.	8550.	14600.	6330.	2690.	1460.	41834.
1921	1600.	1360.	1330.	1250.	1070.	1670.	2400.	9650.	29200.	12400.	3950.	2180.	68060.
1922	1160.	1030.	1240.	978.	855.	1080.	1810.	7070.	25100.	7380.	3420.	1640.	52763.
1923	1190.	1170.	1000.	928.	822.	1350.	2450.	11400.	16100.	9650.	2760.	1380.	50200.
1924	1230.	887.	726.	775.	759.	799.	1260.	10800.	6660.	2360.	1280.	958.	28494.
1925	867.	780.	769.	898.	811.	1210.	3480.	11600.	11100.	6640.	2730.	2250.	43135.
1926	2270.	1250.	1070.	984.	1050.	1570.	4380.	11700.	9340.	3300.	1890.	916.	39720.
1927	1060.	744.	769.	750.	766.	947.	2680.	12200.	24300.	10600.	2410.	1370.	58596.
1928	1330.	1240.	1160.	1090.	1000.	1210.	1790.	18400.	12700.	4550.	1590.	839.	46899.
1929	719.	684.	627.	561.	400.	726.	1580.	10300.	19300.	9280.	2760.	1850.	48787.
1930	1410.	821.	593.	604.	611.	812.	4610.	8180.	10400.	2860.	1640.	1170.	33711.
1931	1720.	869.	922.	621.	572.	824.	2090.	9650.	5740.	1520.	1040.	570.	26138.
1932	536.	506.	612.	676.	696.	885.	2360.	12700.	17300.	8050.	2320.	1200.	47841.
1933	965.	928.	935.	855.	766.	787.	1630.	6210.	14700.	4170.	1880.	1030.	34856.
1934	879.	815.	707.	482.	555.	984.	3440.	8180.	2190.	947.	799.	655.	20633.
1935	732.	744.	732.	732.	816.	965.	1850.	7870.	16070.	6760.	1890.	1040.	40201.
1936	910.	750.	627.	676.	615.	836.	3760.	14700.	12970.	4560.	1810.	1200.	43414.
1937	910.	762.	744.	799.	672.	978.	2120.	12790.	12080.	5960.	1600.	1150.	40565.
1938	1190.	1090.	1110.	978.	833.	1010.	4330.	15490.	19160.	7130.	2090.	1110.	55521.
1939	1160.	1040.	1010.	861.	750.	1350.	4990.	14630.	11900.	4290.	1780.	1330.	45091.
1940	1320.	899.	756.	683.	702.	1140.	3930.	16480.	8150.	2050.	1200.	910.	38220.
1941	1000.	881.	812.	775.	789.	1210.	2060.	14200.	13510.	8850.	2850.	1570.	48507.
1942	1560.	1440.	1300.	1130.	955.	928.	5120.	9720.	15110.	7870.	1810.	1140.	48083.
1943	1000.	875.	842.	805.	761.	953.	2950.	10020.	11310.	6640.	1920.	1270.	39346.
1944	1300.	1150.	1060.	941.	811.	818.	1630.	10640.	15530.	8790.	1730.	1160.	45560.
1945	1140.	1070.	812.	719.	761.	892.	1340.	10880.	14520.	9720.	4300.	1610.	47764.
1946	1500.	1240.	1010.	916.	805.	1260.	4440.	6150.	8330.	4540.	1800.	1120.	33111.
1947	1430.	1370.	1150.	935.	900.	1370.	2990.	10450.	8990.	6270.	3130.	1580.	40565.
1948	1420.	1280.	1180.	1050.	984.	1010.	1980.	11070.	16900.	6700.	2210.	1330.	47114.
1949	1230.	875.	818.	695.	509.	1000.	3640.	13280.	16540.	6390.	2320.	1460.	48757.
1950	1190.	1180.	996.	844.	713.	1000.	3150.	10260.	17470.	8050.	2370.	1540.	48763.
1951	1120.	1020.	1040.	840.	730.	882.	2560.	10780.	14730.	6000.	3270.	1570.	44542.
1952	1250.	938.	849.	768.	781.	829.	3200.	16370.	21820.	10480.	3460.	1820.	62565.
1953	1230.	937.	874.	888.	735.	1010.	1940.	6460.	21050.	8120.	2420.	1440.	47104.
1954	1110.	1060.	970.	906.	884.	1170.	2660.	11320.	8260.	3950.	1950.	1190.	35430.
1955	1010.	945.	864.	765.	734.	847.	1270.	10180.	15280.	3970.	2290.	1290.	39445.
1956	971.	842.	980.	1100.	908.	952.	2100.	11930.	15050.	4420.	2330.	1240.	42823.
1957	916.	790.	739.	661.	638.	818.	1420.	6570.	17660.	8450.	2720.	1600.	42982.
1958	1050.	774.	726.	612.	736.	820.	1610.	14240.	17220.	4900.	2280.	1420.	46388.
1959	1050.	846.	845.	774.	618.	758.	1750.	5970.	14140.	3390.	1530.	1400.	33071.

LITTLE COTTONWOOD CREEK NEAR SALT LAKE CITY UTAH 10167500

YEAR	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	ANN
1960	1520.	1120.	926.	802.	726.	1280.	3260.	10170.	12090.	8260.	1630.	1010.	42794.
1961	930.	830.	800.	647.	540.	716.	1340.	9960.	6450.	1510.	1110.	1260.	26093.
1962	1130.	1070.	948.	876.	804.	1060.	4050.	9300.	17220.	8960.	2760.	1270.	49448.
1963	1060.	995.	762.	703.	690.	787.	1120.	9210.	14660.	7470.	1960.	1320.	40737.
1964	1200.	1080.	923.	814.	708.	819.	1072.	11040.	17327.	8154.	1836.	1483.	46456.
1965	1743.	1192.	1183.	1004.	886.	1071.	1673.	8843.	20719.	14550.	5138.	2209.	60211.
1966	1743.	1192.	1183.	979.	796.	1088.	3155.	11462.	8551.	2953.	1479.	1035.	35616.
1967	987.	888.	771.	764.	732.	980.	1321.	9125.	20754.	12697.	3117.	1849.	53985.
1968	1308.	996.	829.	746.	773.	1862.	1759.	8515.	21143.	7730.	3853.	2364.	51878.
1969	1647.	1634.	1270.	1218.	1004.	1174.	4455.	19617.	16575.	9983.	3415.	1942.	63934.
1970	1338.	1111.	983.	910.	902.	1031.	1362.	9992.	17951.	7452.	2518.	2304.	47854.
1971	1521.	1470.	1421.	1365.	1229.	1368.	3585.	10049.	19458.	8249.	2916.	2235.	54866.
1972	1533.	1450.	1331.	1145.	949.	1671.	2765.	12113.	16024.	4283.	3621.	1606.	48491.
1973	2178.	1529.	1263.	1025.	893.	1105.	1666.	14064.	19888.	8329.	3199.	2257.	57396.
1974	1881.	1812.	1377.	1184.	971.	1448.	2123.	14802.	17546.	5360.	2524.	1473.	52501.
1975	1237.	1032.	914.	1052.	882.	918.	1056.	5515.	20758.	21671.	4957.	2564.	62556.
1976	1683.	1428.	1144.	989.	949.	1115.	2139.	12764.	11804.	5064.	2228.	1694.	43001.
1977	1302.	998.	928.	664.	675.	751.	2509.	4164.	10302.	2782.	1878.	1776.	28729.
1978	1574.	1113.	1073.	943.	858.	1362.	3364.	8763.	23190.	12998.	4146.	2818.	62202.
1979	1880.	1187.	1273.	1067.	665.	703.	1784.	11953.	15263.	5995.	2921.	1770.	46461.
1980	1226.	982.	904.	933.	767.	968.	2607.	10087.	21361.	14225.	3546.	2602.	60208.
MEAN	1356.	1066.	966.	868.	792.	1081.	2688.	10833.	15238.	7007.	2450.	1492.	45839.
SD	502.	257.	212.	183.	161.	354.	1298.	2952.	5046.	3559.	903.	461.	9632.
CV	0.37	0.24	0.22	0.21	0.20	0.33	0.48	0.27	0.33	0.51	0.37	0.31	0.21