HYDROLOGIC EVALUATION AND WATER-SUPPLY CONSIDERATIONS FOR FIVE PAIUTE INDIAN LAND PARCELS, MILLARD, SEVIER, AND IRON COUNTIES, SOUTHWESTERN UTAH

By Don Price, Doyle W. Stephens, and Loretta S. Conroy

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Contents

Illustrations

Illustrations

Tables

CONVERSION OF INCH-POUND UNITS TO

INTERNATIONAL SYSTEM OF UNITS (SI)

For readers who prefer to use metric (International System) units, conversion factors for terms used in this report are listed below:

Multiply inch-pound unit	By	To obtain metric unit
Acre	0.4047	Hectare
	4,047	Square meter (m^2)
Acre-foot (acre-ft)	0.001233	Cubic hectometer (hm^3)
	1,233	Cubic meter (m^3)
Cubic foot per second (ft^3/s)	0.028317	Cubic meter per second (m^3/s)
Foot (ft)	0.3048	Meter (m)
Gallon per minute (gal/min)	0.06308	Liter per second (L/s)
Inch (in)	25.4	Millimeter (mm)
	0.0254	Meter (m)
Mile (mi)	1.609	Kilometer (km)
Square mile (mi^2)	2.590	Square kilometer (km^2)

Chemical concentration and water temperature are given only in metric units. Chemical concentration is given in milligrams per liter (mg/L) or micrograms per liter (μg/L). Milligrams per liter is a unit expressing the solute per unit volume (liter) of water. One thousand micrograms per liter is equivalent to 1 milligram per liter. For concentrations less than 7,000 milligrams per liter, the numerical value is about the same as for concentrations in parts per million. Specific conductance is given in microsiemens per centimeter (μS/cm) at 25 degrees Celsius.

Water temperature is given in degrees Celsius (°C), which can be converted to degrees Fahrenheit (°F) by the following equation:

$$°F = 1.8\,(°C) + 32.$$

National Geodetic Vertical Datum of 1929 (NGVD of 1929)—a geodetic datum derived from a general adjustment of the first-order level nets of both the United States and Canada, formerly called "Sea Level Datum of 1929." Datum of gage above National Geodetic Vertical Datum (NGVD) is the elevation of the "zero" reading of the gage.

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FOR FIVE PAIUTE INDIAN LAND PARCELS, MILLARD, SEVIER,

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ABSTRACT

The hydrologic resources in the general area of five parcels of land held in trust for the Paiute Indian Tribe of Utah were evaluated. The land, located in southwestern Utah, is generally arid and has had only limited use for grazing. The parcels are located near the towns of Cove Fort, Joseph, Koosharem, and Kanarraville. On the basis of available geohydrologic and hydrologic data, water of suitable quality is locally available in the areas of the parcels for domestic, stock, recreation, and limited irrigation use. Developing this water for use on the parcels, however, would potentially require obtaining water rights, drilling wells, and constructing diversion structures. Surface water apparently is the most favorable source of supply available for the Joseph parcel, and ground water apparently is the most favorable source of supply available for the other parcels.

INTRODUCTION

Pursuant to the Paiute Indian Tribe of Utah Restoration Act of 1980 (Public Law 96-227), five parcels of land in southwestern Utah were selected to establish a reservation for four bands of the tribe (fig. 1). All five parcels were selected from national resource lands, and used mostly for grazing and administered by the U.S. Bureau of Land Management. The numbers and names of the parcels as used in this report, their approximate sizes, and the Indian bands for which those parcels were selected are as follows:

Parcel Number (fig. 1)	Name	Approximate size (acres)	Paiute Indian Band
1	Cove Fort	500	Kanosh
2	Cove Fort interchange	560	Do.
3	Joseph	520	Koosharem
4	Koosharem Reservoir	715	Do.
5	Kanarraville	2,475	Cedar City and Indian Peaks

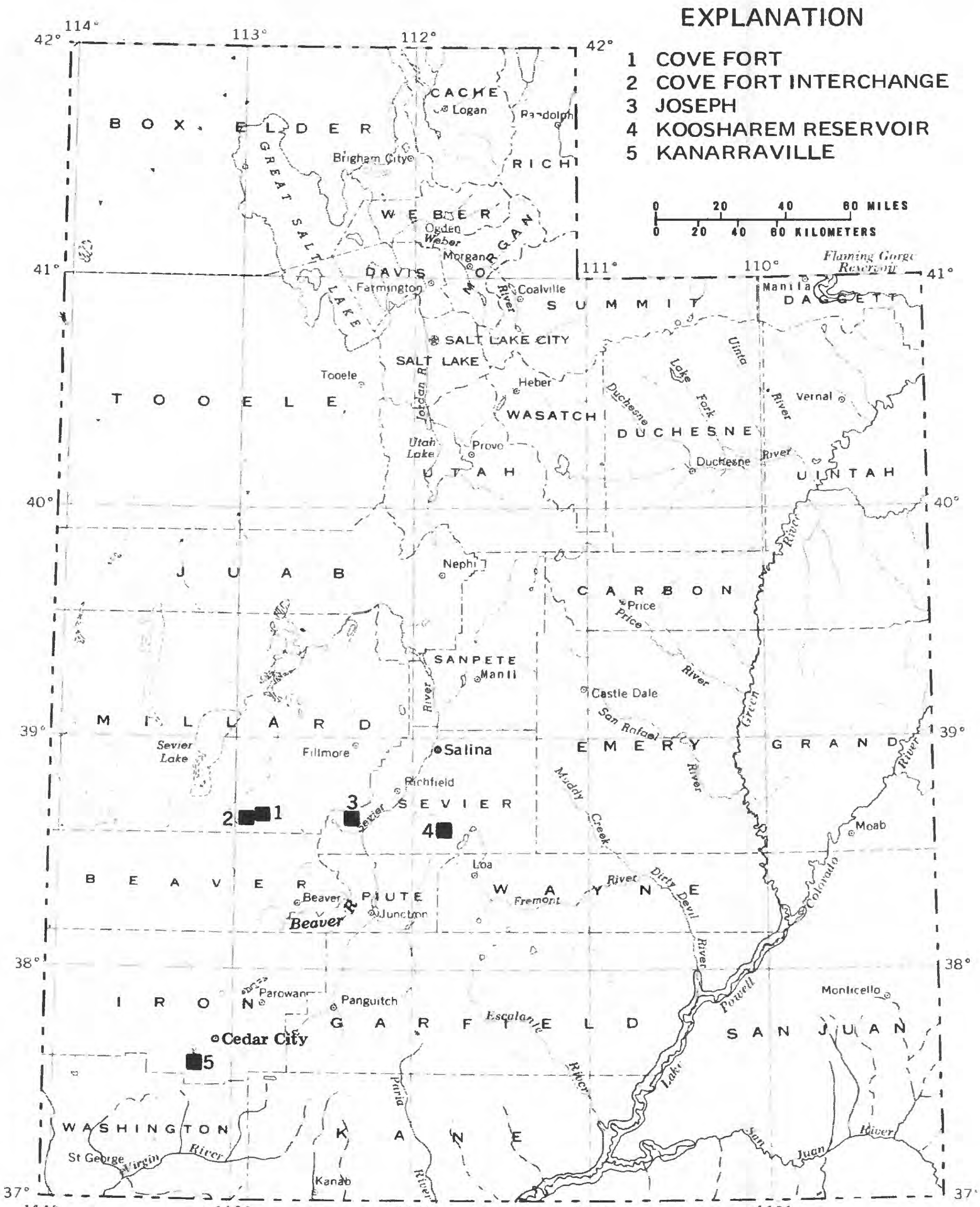


Figure 1.--Location of the five parcels in southwestern Utah.

Aside from highway crossings, limited grazing, and local extraction of sand and gravel, there has been no economic development of the parcels. Dependable water supplies are needed for development of the five parcels, and obtaining dependable water supplies for use on the parcels requires an understanding of surface- and ground-water conditions in and near the parcels. This report presents the results of a study initiated to: (1) evaluate the surface- and ground-water resources potentially available for use on the five parcels and (2) determine various alternative water sources from which it would be potentially feasible to divert water for use on each parcel. Evaluation of the legal, economic, and environmental constraints related to water development alternatives was beyond the scope of the study.

The study was carried out from April 1986 to March 1987 and was funded by Congress through the U.S. Geological Survey as part of a program to assess the water resources of Indian lands. The U.S. Bureau of Indian Affairs provided information and access to the newly-acquired lands. Results of the study as presented in this report are based mainly on geohydrologic information from previously published maps and books and on hydrologic data in the files of the U.S. Geological Survey, Salt Lake City, Utah. Two brief reconnaissance trips were made to the parcels to examine local geologic conditions and to collect additional hydrologic data. Data used in the study are summarized in tables 1 to 3 (at the end of this report).

Location and General Description of Parcels

The five parcels are in Millard, Sevier, and Iron Counties (fig. 1). They are traversed in part by Federal or State highways that connect the larger communities of central and southern Utah. Topography and cultural features in the areas of the parcels are shown in figures 2 to 5. Most of the following information about each parcel is from a report of the U.S. Bureau of Indian Affairs (1982).

Parcel 1, Cove Fort, extends northeast from the small settlement of Cove Fort (fig. 2) in Millard County. It includes about 500 acres in section 30, T. 25 S., R. 6 W., Salt Lake base line and meridian. Most of the parcel is on the lower, southern slopes of the Pahvant Range, between 6,100 and 6,500 feet above sea level. U.S. Highway 91 and State Highway 13 intersect at Cove Fort, and a segment of State Highway 13 crosses the southern part of the parcel (fig. 2).

Parcel 2, the Cove Fort interchange parcel, also in Millard County, extends northwestward from a point about 1.5 miles northwest of Cove Fort (fig. 2). It is about 1.2 miles west-northwest of parcel 1 and includes about 560 acres in parts of sections 22, 23, and 27, T. 25 S., R. 7 W., Salt Lake base line and meridian. This parcel is at the base of the Pahvant Range at an altitude of generally less than 6,000 feet above sea level. U.S. Interstate Highway 15, U.S. Highway 91, and the unpaved Black Rock Road all intersect on the parcel (fig. 2).

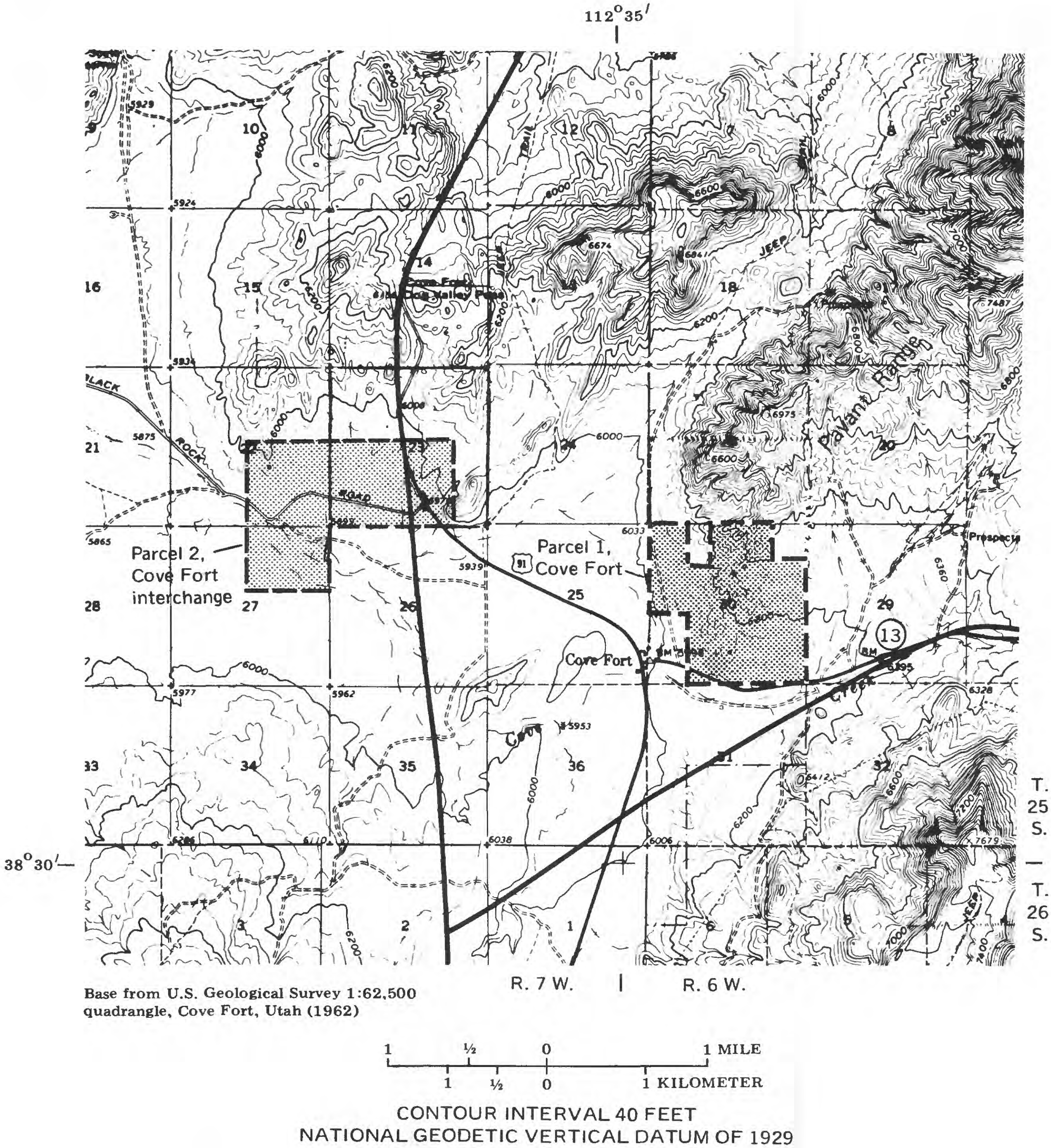
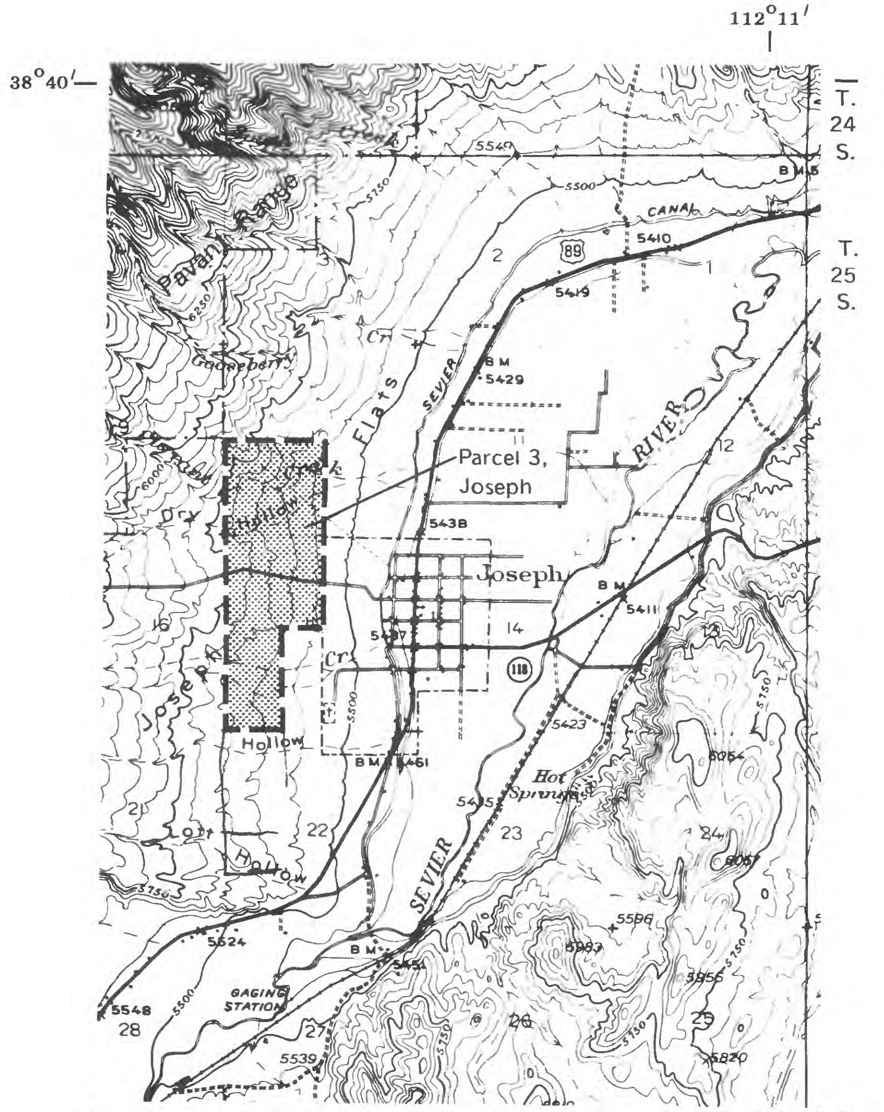


Figure 2.--Topography and cultural features in area of Cove Fort and Cove Fort interchange parcels (from U.S. Bureau of Indian Affairs, 1982).



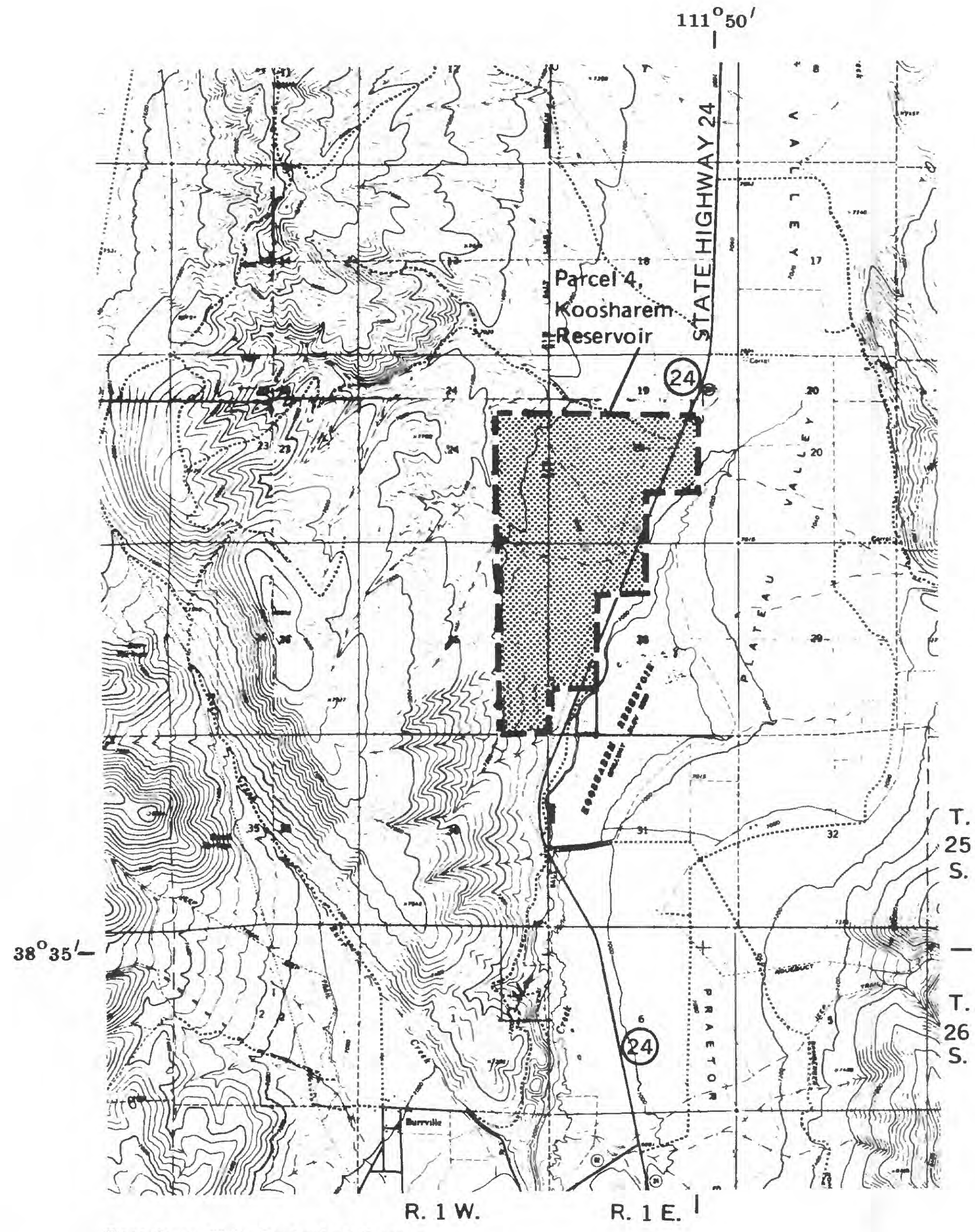
Base from U.S. Geological Survey
1:62,500 quadrangles, Monroe, 1940
and Sevier, 1932 and 1:24,000 quadrangles,
Elsinore, 1980 and Antelope Range, 1980, Utah

1 ½ 0 1 MILE

1 ½ 0 1 KILOMETER

CONTOUR INTERVAL 40 FEET
NATIONAL GEODETIC VERTICAL DATUM OF 1929

Figure 3.--Topography and cultural features in area of Joseph parcel (from U.S. Bureau of Indian Affairs, 1982).



Base from U.S. Geological Survey
1:24,000 quadrangles, Water Creek Canyon,
1968, and Koosharem, 1968, Utah

CONTOUR INTERVAL 40 FEET
NATIONAL GEODETIC VERTICAL DATUM OF 1929

Figure 4.--Topography and cultural features in area of Koosharem Reservoir parcel (from U.S. Bureau of Indian Affairs, 1982).

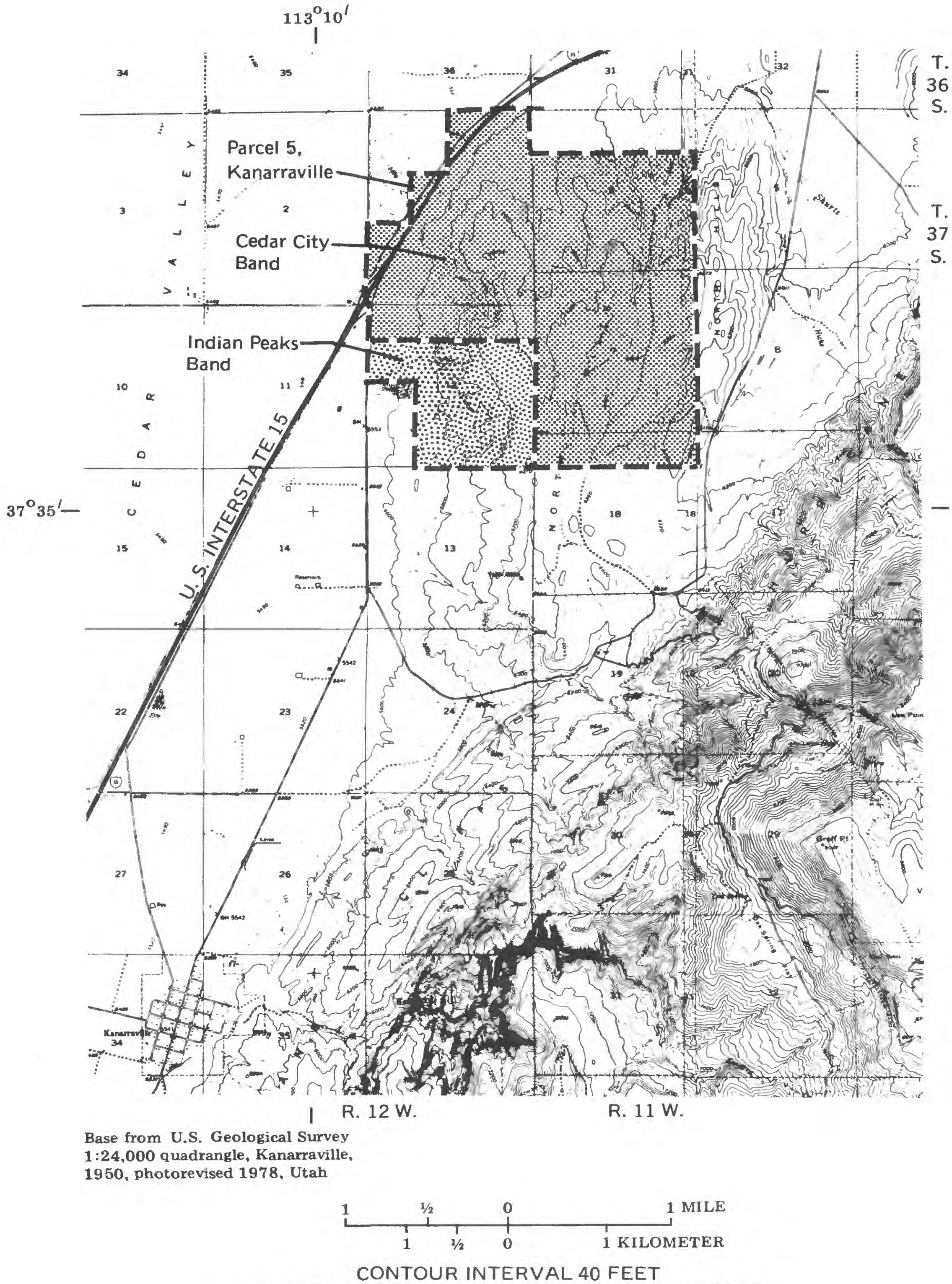


Figure 5.--Topography and cultural features in area of Kanarraville parcel (from U.S. Bureau of Indian Affairs, 1982).

Parcel 3, Joseph, is in Sevier County, alongside the western edge of the community of Joseph (fig. 3). It includes about 520 acres in parts of sections 10, 15, and 22, T. 25 S., R. 4 W., Salt Lake base line and meridian. Most of the parcel is on the lower southeastern slopes of the Pahvant Range, between 5,550 and 5,900 feet above sea level. U.S. Interstate Highway 70 from Salina (fig. 1) to Cove Fort will cross this parcel, with a proposed interchange on the parcel (U.S. Bureau of Indian Affairs, 1982, p. 8).

Parcel 4, Koosharem Reservoir, is also in Sevier County. It is adjacent to the western shore of Koosharem Reservoir (fig. 4). This parcel includes about 715 acres (including the historic burial place of the Koosharem Band) in parts of sections 19 and 30, T. 25 S., R. 1 E., and sections 24 and 25, T. 25 S., R. 1 W., Salt Lake base line and meridian. This is a high-valley area in which land-surface altitudes range from about 7,000 to 7,200 feet above NGVD of 1929. State Highway 24, which connects the communities of Salina and Loa (fig. 1), crosses several segments of this parcel.

Parcel 5, the Kanarraville parcel, is in Iron County about 3 miles northeast of the community of Kanarraville (fig. 5), and about 6 miles southwest of Cedar City. This parcel includes 2,475 acres in all or parts of sections 6, 7, and 18, T. 37 S., R. 11 W., and sections 1 and 12, T. 37 S., R. 12 W., Salt Lake base line and meridian. The land has been designated for the Cedar City and Indian Peaks Bands as shown in figure 5. Most of the parcel is on the North Hills at the base of Cedar Mountain and the Hurricane Cliffs. Land-surface altitudes on the parcel range from about 5,520 to more than 6,300 feet above sea level. U.S. Interstate Highway 15 crosses northwestern segments of the parcel at the eastern edge of Cedar Valley (also known as Cedar City Valley).

Previous Hydrologic Studies

The U.S. Geological Survey, in cooperation with the State of Utah and other Federal agencies, has periodically studied the water resources of areas that include parcels 1 to 5 since the early 1900's. A complete listing of reports resulting from these studies are included in Dragos and Conroy (1987). Several of these reports contain hydrologic data and interpretive geohydrologic information that was used for this study. The reports containing hydrologic data include Carpenter and Young (1963); Sandberg (1963); Carpenter and others (1964); Hahl and Cabell (1965); and Bjorklund and others (1977). The reports containing interpretive geohydrologic information are Meinzer (1911); Thomas and Taylor (1946); Young and Carpenter (1965); Sandberg (1966); Carpenter and others (1967); Hahl and Mundorff (1968); and Bjorklund and others (1978).

The U.S. Geological Survey also compiled a series of regional maps that show the general availability and chemical quality of ground and surface water in the general area of the parcels. Series maps that were used in compiling this report are those of Price (1972a; 1972b; 1980; 1981a; 1981b; 1982).

Data-Site Numbering System

The system of numbering wells and other hydrologic-data sites in Utah is based on the cadastral land-survey system of the U.S. Government. The number, in addition to designating the well or other data site, describes its position on the land net. Using the land-survey system, the State is divided into four quadrants by the Salt Lake base line and meridian, and these quadrants are designated by the uppercase letters, A, B, C, and D, indicating the northeast, northwest, southwest, and southeast quadrants, respectively. Numbers designating the township and range (in that order) follow the quadrant letter, and all three are enclosed in parentheses. The number after the parentheses indicates the section and is followed by three letters indicating the quarter section, the quarter-quarter section, and the quarter-quarter-quarter section--generally 10 acres[1]; the letters a, b, c, and d indicate, respectively, the northeast, northwest, southwest, and southeast quarters of each subdivision. For wells, the number after the letters is the serial number of the well within the 10-acre tract. If the location of a well has not been confirmed by a field survey, only the quarter-section letter designation is used with a serial number. Thus, well (C-25-4)11cac-1 is the first well field-checked and inventoried in the SW¼,NE¼,SW¼ of sec. 11, T. 25 S., R. 4 W., and well (C-25-6)30c-1 is a well (not field-checked) in the SW¼ of sec. 30, T. 25 S., R. 6 W. The numbering system is illustrated in figure 6. Sites for monitoring the quantity and quality of streamflow are designated in the same manner, but without serial numbers. Identification numbers used only in this report are W1 through W34 for wells and S1 through S5 for streamflow-gaging sites.

METHOD USED TO ESTIMATE STREAMFLOW CHARACTERISTICS

Most of the streams in and near parcels 1 to 5 have only intermittent or ephemeral flows; consequently, streamflow data generally are not available. However, estimates of selected streamflow characteristics were made using regression equations developed by Christensen and others (1986) for streams in the Colorado River basin in Utah. The regression equations allow prediction of streamflow characteristics for ungaged streams as well as streams with gaged sites.

The following equations, developed for mountainous regions and southwestern plateaus (Christensen and others, 1986), were used to estimate streamflow characteristics for each of the Indian parcels:

Mountainous Regions

(1) Average discharge $Q = 1.39 \times 10^{-5} A^{1.06} E^{4.67}$

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[1]Although the basic land unit, the section, is theoretically 1 square mile, many sections are irregular. Such sections are divided into 10-acre tracts, generally beginning at the southeast corner, and the surplus or shortage is taken up in the tracts along the north and west sides of the section.

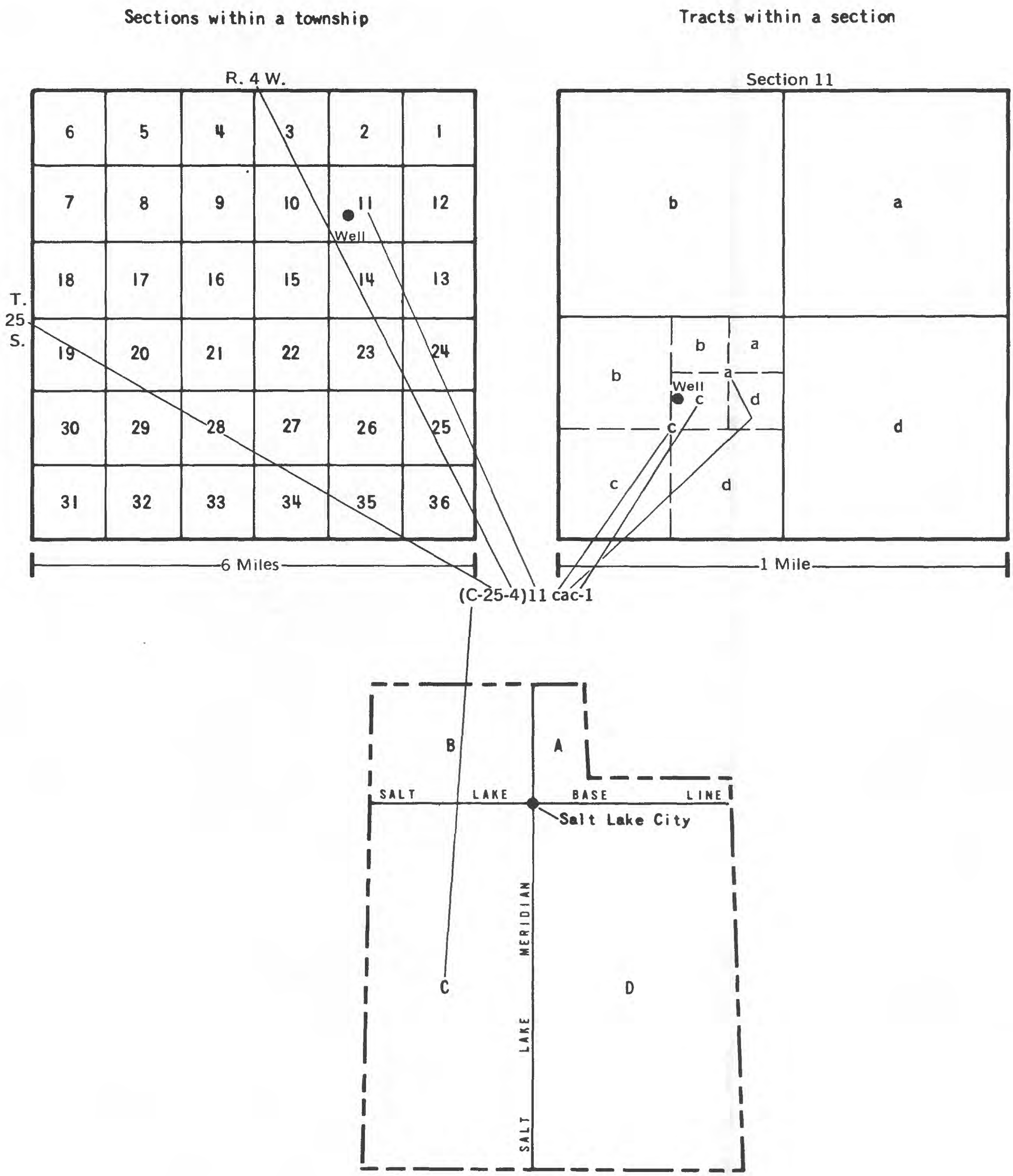


Figure 6.--Data-site numbering system.

(2) Annual maximum 15-day mean discharge for 10-year recurrence interval

$$Q = 0.00205\ A^{0.937}\ E^{3.70}$$

Southwestern Plateaus

(3) Average discharge $Q = 3.54 + 0.294\ A$

(4) Annual maximum 15-day mean discharge for 10-year recurrence interval

$$Q = 56.8 + 2.62\ A$$

where Q is the discharge, in cubic feet per second; A is contributing drainage area, in square miles; and E is mean basin elevation, in thousands of feet.

The standard errors of estimate for these equations are about 40 percent. The streamflow characteristics are: average flow, which is the arithmetic mean of all yearly flows from a gaging-station record; annual maximum 15-day mean flow, which is the annual maximum mean value from daily discharges for a 15-day consecutive period with a recurrence interval of 10 years. It is emphasized that these represent estimates derived from predictive equations, not actually measured streamflows. It was also noted by Thomas and Lindskov (1983) that streamflow equations developed for the Colorado River Basin in Utah tend to overestimate flows when applied to the desert streams of the Great Basin.

HYDROLOGIC EVALUATIONS

Parcels 1 to 5 are in the Great Basin section of the Basin and Range physiographic province (Fenneman, 1946). This region, except for the higher mountain ranges, is typically arid. Normal annual precipitation on the parcels is generally less than 12 inches, and is less than 6 inches on parts of parcels 1, 2, and 3 (U.S. Weather Bureau, 1963). Precipitation is marginally adequate to meet the soil-moisture requirements of the desert vegetation on parcels used for grazing. According to the 1:250,000 scale work maps compiled to estimate water yields in Utah (Bagley and others, 1964), mean annual runoff from the parcels is less than 1 inch (less than 0.08 acre-foot per acre). Except during brief summer thunderstorms, virtually no overland runoff occurs in the region; the few small ephemeral streams and drainageways on the parcels seldom have flow and are usually dry. Ground-water occurs at some depth in most of the rock units that underlie the parcels. Generally, however, the rock units are the type (consolidated or loosely cemented) that yield water very slowly to wells.

It is apparent that investigation of possible sources of water for economic development needs to be extended beyond parcel boundaries. To this end, both surface- and ground-water sources in close proximity to parcels 1 to 5 were investigated as discussed in the following hydrologic evaluations.

Parcels 1 and 2, Cove Fort and Cove Fort Interchange

Surface Water

Parcels 1 and 2 are in the drainage basin of Cove Creek (fig. 2), an ephemeral tributary of the Beaver River in the Sevier Lake basin (fig. 1). A reach of Cove Creek upstream from Cove Fort has flow only during some storms and periods of snowmelt in the basin, but there is seldom flow in the reach adjacent to parcels 1 and 2. During 1962-68, the U.S. Geological Survey operated a partial-record streamflow-gaging station on Cove Creek about 3 miles downstream from parcel 2 (S1, fig. 7) to monitor annual peak flows in the creek. At that station, a peak flow of 6.0 cubic feet per second was recorded on September 24, 1967, and another peak flow of 1.7 cubic feet per second was recorded on August 18, 1965. However, there was no indication of any flow at the gaging station during the intervening years. The small natural drainageways that lead from parcels 1 and 2 to Cove Creek are dry except during intense rainstorms and periods of rapid snowmelt. Several small earthfilled dams on Cove Creek impound and store the ephemeral streamflow, presumably for flood control and livestock water. Much of the water apparently is lost to evaporation. It is likely that these impoundments reduce streamflow in Cove Creek.

In addition to the data from the partial-record gage on Cove Creek, estimates of streamflow characteristics for Cove Creek were made using equations (3) and (4) for the southwestern plateau region of the Colorado River basin in Utah (Christensen and others, 1986). On the basis of equations using the contributing drainage area, average flow for the ephemeral stream on the Cove Fort parcel is 9 cubic feet per second, and the annual maximum 15-day flow (10-year recurrence interval) is 108 cubic feet per second. The estimated values for ephemeral streams on the Cove Fort interchange parcel are 28 and 276 cubic feet per second, respectively. These values are considerably larger than values obtained from the partial-record gage. This demonstrates the limitations of equations developed for the Colorado River basin in Utah when applied outside of that area. The equations for average discharge and annual maximum 15-day discharge were developed for southwestern plateaus, and are based only on drainage area to estimate streamflow for areas generally underlain by rock or low permeability. Most likely, the alluvial areas near Cove Fort are more receptive to surface-water recharge than the southwestern plateaus and would yield less streamflow.

On the basis of the investigations of Hahl and Mundorff (1968, pl. 1), overland runoff to Cove Creek generally contains less than 500 milligrams per liter of dissolved solids and is considered freshwater. The water is chemically suitable for most common uses. Where water is stored behind the small dams in Cove Creek, however, the dissolved-solids concentration could be increased substantially by evaporation. No chemical analyses of the ephemeral flows in Cove Creek or any of its tributaries were available for this evaluation.

Ground Water

Parcel 1, located mostly on the lower southern slopes of the Pahvant Range, is underlain primarily by consolidated rocks that form part of the mountain range. They include extrusive igneous rocks of Tertiary age and

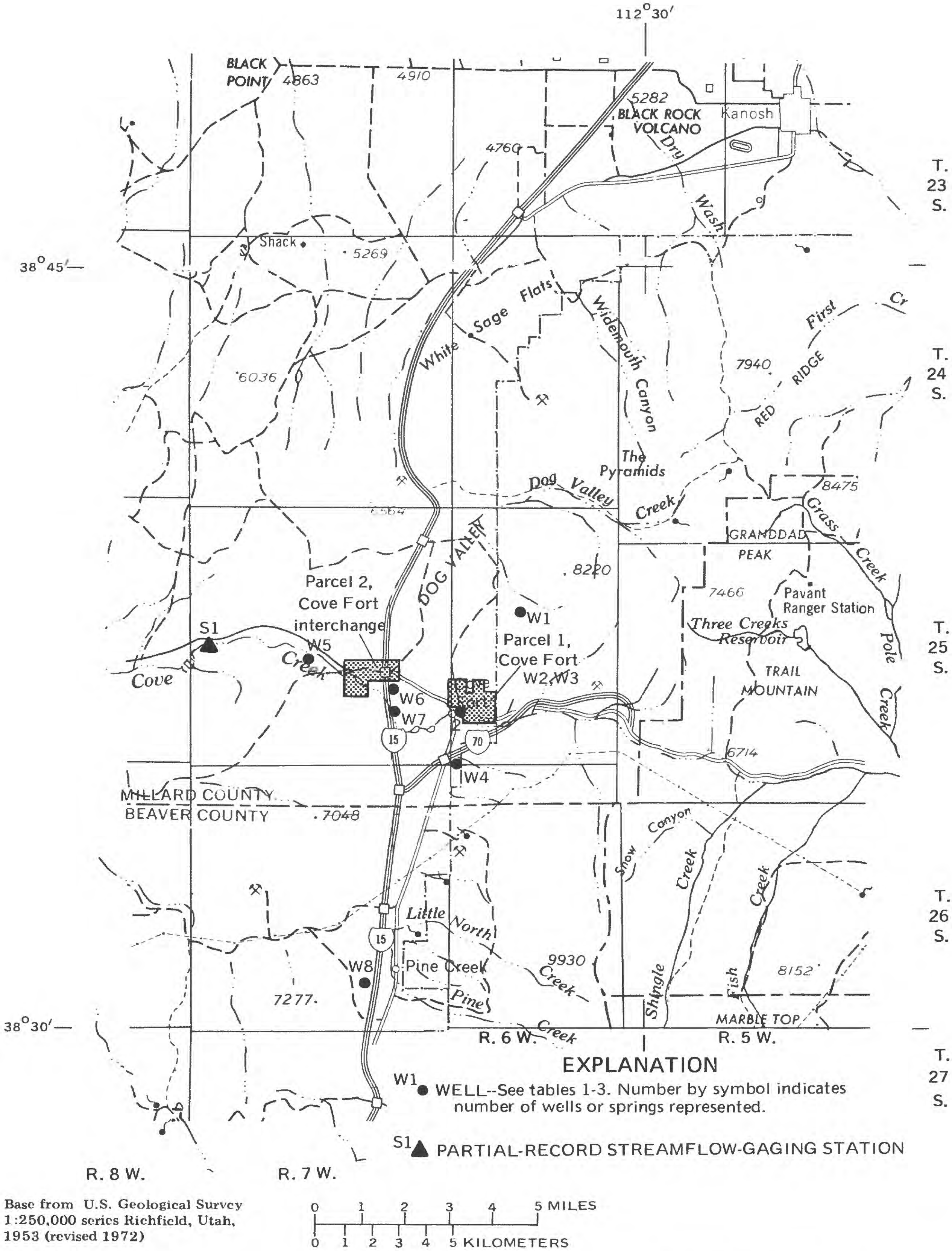


Figure 7.--Location of selected wells and a partial-record streamflow-gaging station in the general area of the Cove Fort and Cove Fort interchange parcels.

older sedimentary rocks. These rocks probably become saturated at depth, but driller's logs indicate that they probably would yield water slowly to wells. Well (C-25-6)17d-1 (table 2), which taps the igneous rocks about 2 miles north of parcel 1 (fig. 7), reportedly encountered water in lava rock between 140 and 165 feet below land surface; however, there is no indication on the driller's log (filed with the Utah Division of Water Rights, Salt Lake City) that the well yielded water nor is there any indication of the static water level in the well.

The southern part of parcel 1 apparently is underlain by unconsolidated basin-fill deposits of Tertiary and Quaternary age. On the basis of records of wells (C-25-6)30c-1 and 30c-2, maximum thickness of the basin-fill deposits beneath the southern part of parcel 1 is at least 300 feet. These deposits generally are reported in drillers' logs as either clay, sand, gravel, or boulders. Basin-fill deposits generally include some permeable water-bearing sand and gravel. Thick saturated sections of the deposits probably would yield water readily to properly constructed wells. Well (C-25-6)30c-2, which apparently taps the basin fill near Cove Fort (fig. 7, table 1), reportedly was pumped for 16 hours at a rate of 63.5 gallons per minute with no water-level drawdown. Well (C-25-6)30c-1 (fig. 7, table 1) taps gravel in the basin-fill deposits near Cove Fort. That well reportedly was pumped at a rate of 90 gallons per minute, but the pumping period and water-level drawdown were not reported. Depth to water in well (C-25-6)30c-1 was reported to be 125 feet sometime in 1958, but depth to water along the southern edge of parcel 1 is unknown.

Thermal water is found in the consolidated rocks beneath parcels 1 and 2 (Price and Arnow, 1986, p. 36). Some exploratory drilling on parcel 1 indicated that there might be some warm-water geothermal potential for the parcel. Also, a spring in the mountains overlooking Cove Fort reportedly provided water for that settlement. Therefore, thermal water beneath parcels 1 and 2 and springs in the nearby mountains are ground-water sources with potential for use on the parcels.

The northeastern and northwestern parts of parcel 2 appear to be underlain by consolidated rocks similar to those that underlie most of parcel 1. These rocks probably would yield water slowly to wells. Most of parcel 2, however, is underlain by the more permeable basin-fill deposits that locally yield water to wells. Well (C-25-7)26b-1 taps these deposits near the parcel (fig. 7, table 1). This well reportedly was pumped for 6 hours at a rate of 250 gallons per minute with 110 feet of water-level drawdown. The static water level in the well was reported to be 130 feet on completion of the well (April 20, 1966). On the basis of drillers' logs of this and several other nearby wells (tables 1 and 2; fig. 7), maximum thickness of the basin-fill deposits beneath parcel 2 is at least 400 feet.

The basin-fill deposits that extend beneath parcels 1 and 2 are part of a large basin ground-water aquifer most recently studied and described by Mower and Cordova (1974). The gradient of the potentiometric surface (ground-water level contours) in that aquifer (Mower and Cordova, 1974, pl. 4) indicate that water in the basin-fill deposits moves generally southwestward in the direction of Cove Creek. Seepage from ephemeral flows in Cove Creek may help recharge this ground-water aquifer.

According to Price (1981a), water (within about 1,000 feet of the land surface) in both the consolidated rocks and basin-fill deposits in the area of parcels 1 and 2 is fresh, with dissolved-solids concentrations ranging from about 500 to 1,000 milligrams per liter. During 1977-84, the U.S. Geological Survey monitored the chemical quality of water from well (C-26-7)26cac-1, which penetrates basin-fill deposits about 6 miles south of Cove Fort (fig. 7). The mean dissolved-solids concentration in five water samples collected from the well during the monitoring period was 402 milligrams per liter (Price and Arnow, 1986, table 12). A water sample collected from the well on August 9, 1983, had a dissolved-solids concentration of only 370 milligrams per liter (table 3). No other chemical analyses of ground water in the immediate area of parcels 1 and 2 were available; however, water from well (C-25-6)30c-1 is reported on the well record to be soft and to have "good taste." According to Price and Arnow (1986, p. 36), thermal water occurs in the consolidated rocks beneath the basin-fill deposits, and that water probably is very saline.

Parcel 3, Joseph

Surface Water

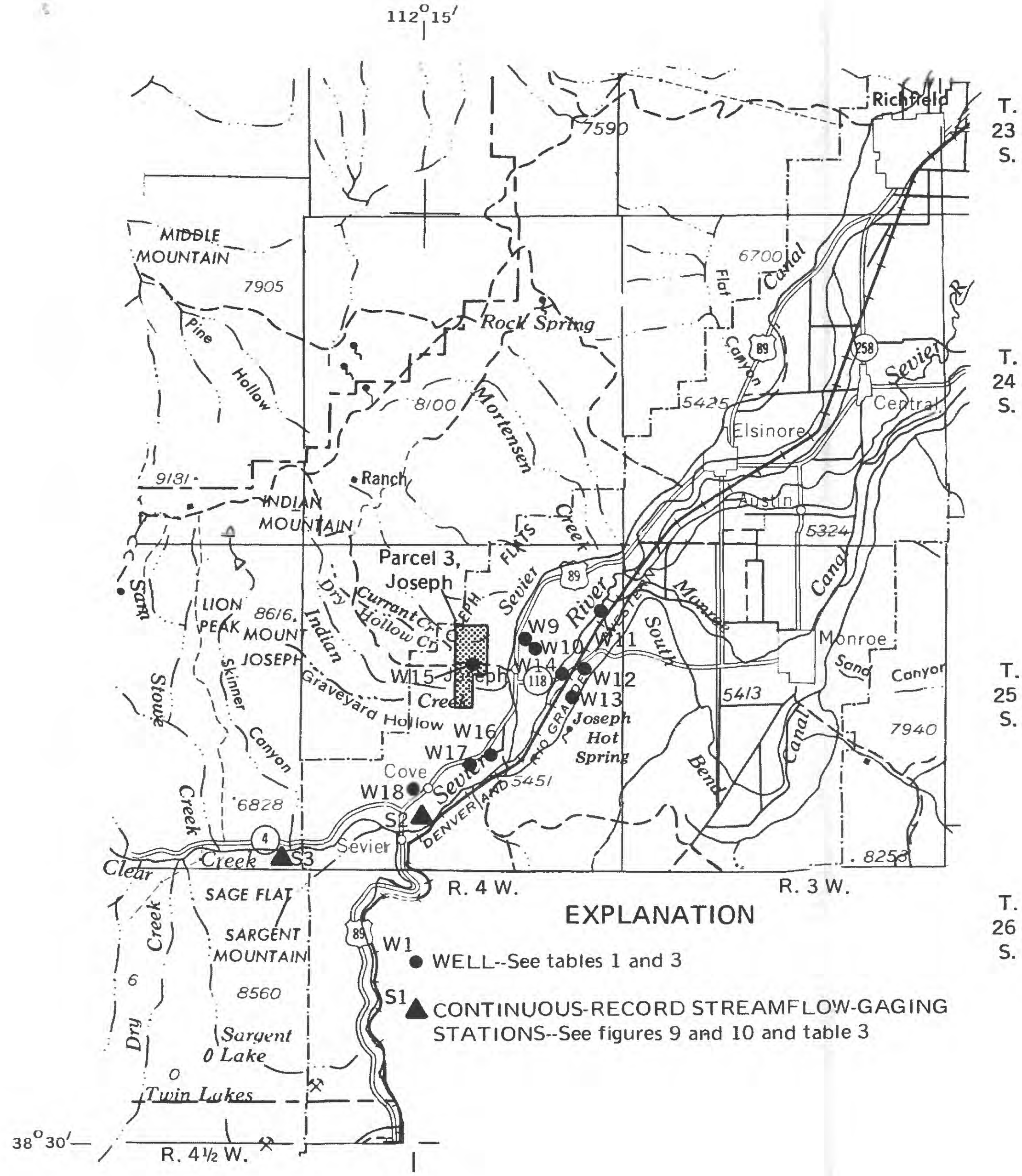
Parcel 3 is in the central Sevier River valley. The main channel of the Sevier River is within a mile of the southeast boundary of the parcel, and Clear Creek, with perennial flow, joins the Sevier River about 1 mile from the southwest corner of the parcel. Several smaller tributaries of the Sevier River, which have only ephemeral flows, cross the parcel. Those tributaries are, from north to south, Currant Creek, Dry Hollow Creek, and Indian Creek. The Sevier Canal skirts the west side of the Sevier River valley near the east boundary of the Joseph parcel.

Flow in the Sevier River in the Joseph area is variable. Prior to the irrigation season, much of the flow is stored in upstream reservoirs; during the irrigation season, much of the flow is diverted upstream from Joseph to irrigation canals, including the Sevier Canal.

The U.S. Geological Survey gages the flow of the Sevier River at S2 about 2 miles upstream from the southern boundary of parcel 3 (fig. 8). During 35 years of record (between 1944 and 1985) at the gaging station, flows ranged from 2.3 to 2,500 cubic feet per second, and averaged 248 cubic feet per second. The U.S. Geological Survey also gages the flow of Clear Creek at S3 near the creek's confluence with the Sevier River (fig. 8). During 28 years of record (between 1957 and 1985) at the Clear Creek gaging station, flows ranged from 1.5 to 769 cubic feet per second, and averaged 38 cubic feet per second. Maximum, average, and minimum daily mean flows of the Sevier River and Clear Creek at the gaging sites are shown in figures 9 and 10.

The ephemeral streams that cross the Joseph parcel are not gaged. The reports of Woolley (1946) and Butler and Marsell (1972), however, indicate that those streams have been, and continue to be, subject to cloudburst flooding.

Estimates of streamflow characteristics for the three ephemeral streams which cross parcel 3 were made using the equations (1) and (2) developed by Christensen and others (1986). Because the mean basin altitudes for these streams were near or greater than 7,000 feet above sea level, equations



Base from U.S. Geological Survey
1:250,000 series Richfield, Utah,
1953 (revised 1972)

Figure 8.--Location of selected wells and two continuous-record streamflow-gaging stations in the general area of the Joseph parcel.

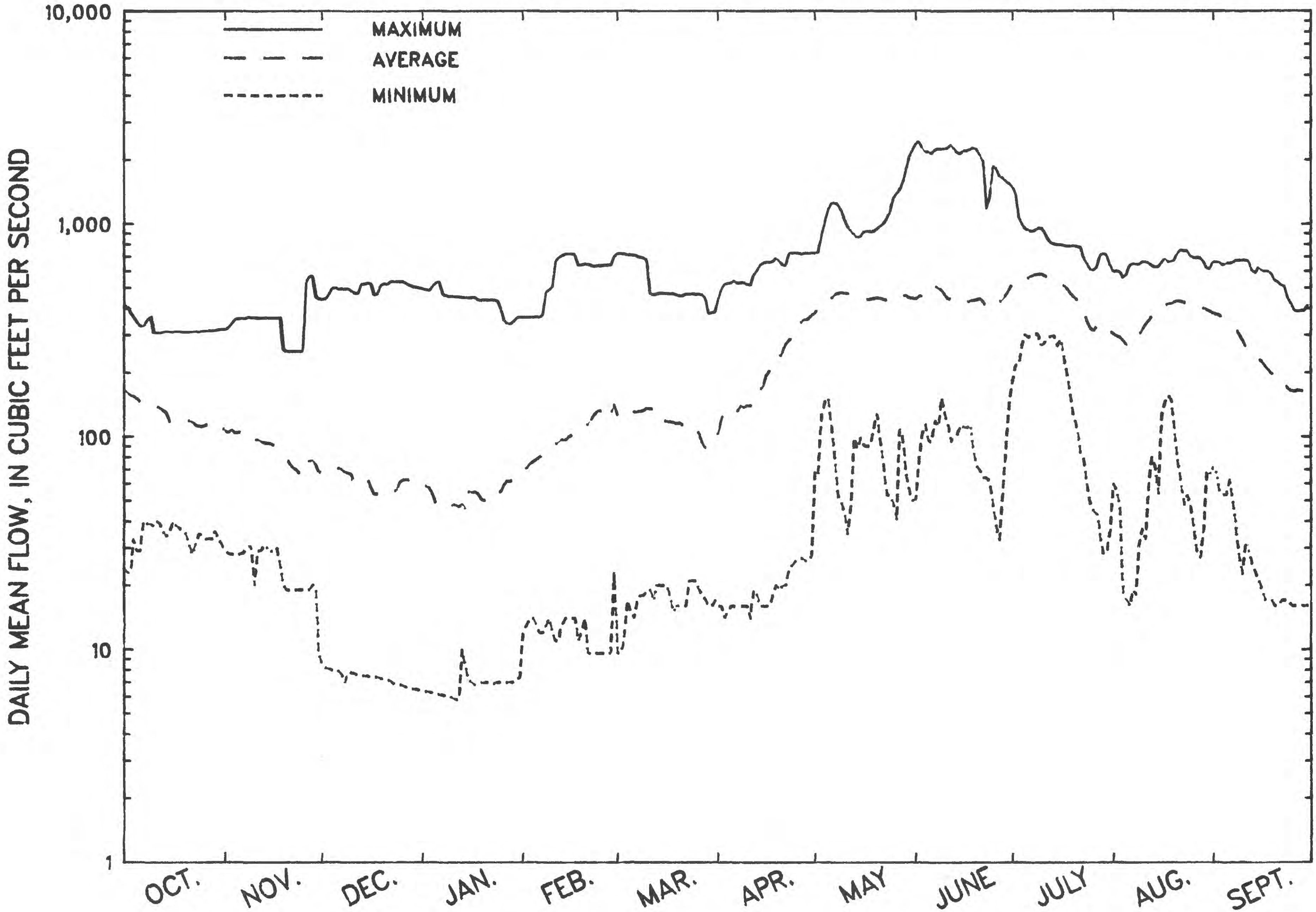


Figure 9.—Maximum, average, and minimum daily mean flow in Sevier River at S2 for water years 1944–55, 1961–86.

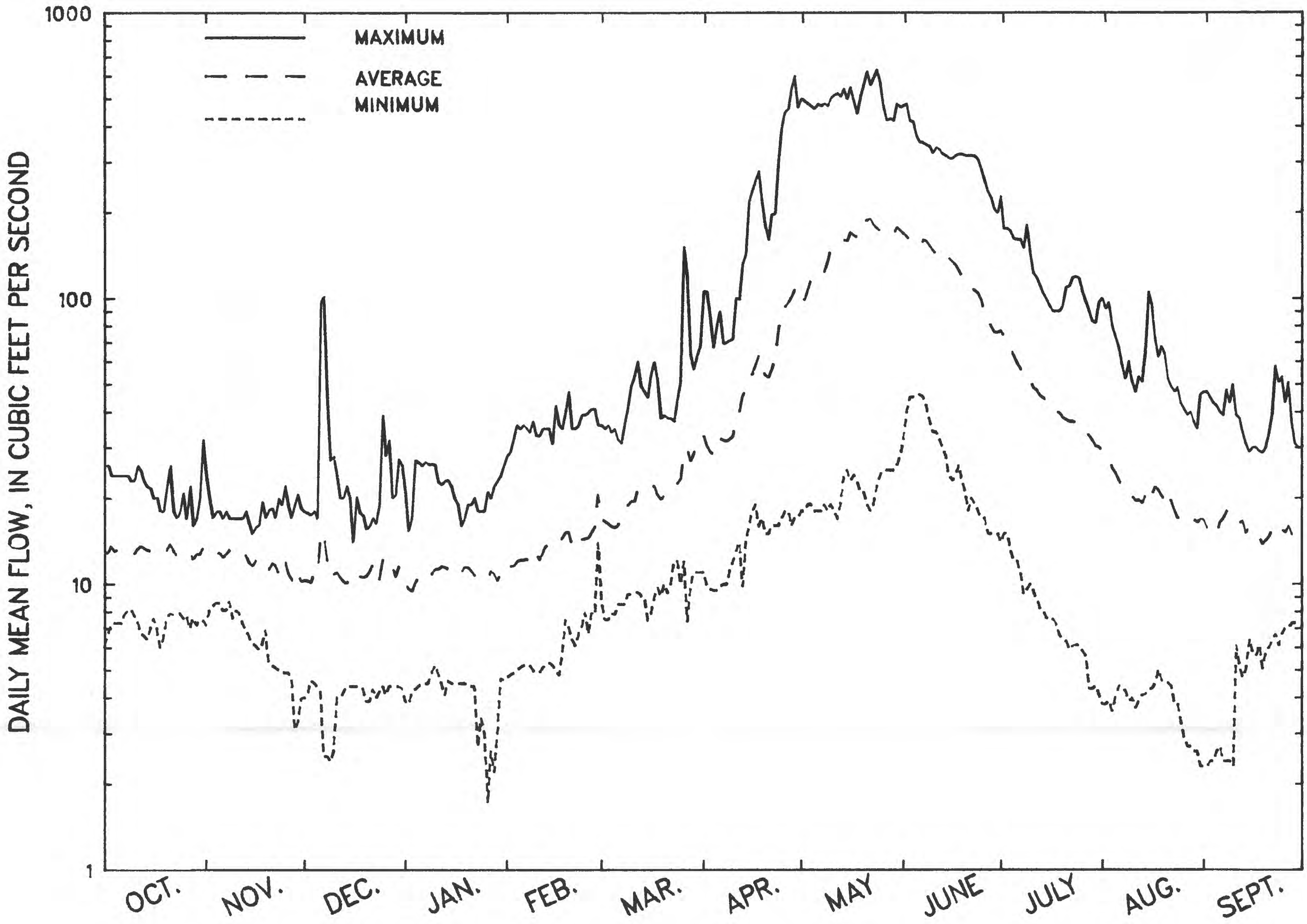


Figure 10.—Maximum, average, and minimum daily mean flow in Clear Creek at S3 for water years 1957–86.

developed for mountainous regions were used. The combined estimated average flow and annual maximum 15-day mean flow (recurrence interval of 10 years) for these three streams are 2 and 34 cubic feet per second, respectively. These estimates assume that there are no impoundments or upstream diversions. As these are ephemeral streams, it is unlikely that they would provide a dependable water supply.

The volume of water conveyed past the Joseph parcel in the Sevier Canal apparently varies considerably from year to year and during any one irrigation season. Annual reports of the Sevier River Commissioners indicate that the Sevier Canal, which passes near the eastern boundary of parcel 3, conveys from 10 to 200 cubic feet per second during the irrigation season.

According to Hahl and Mundorff (1968, pl. 1), overland runoff from the area of the Joseph parcel is fresh water, with dissolved-solids concentrations less than 500 milligrams per liter. Dissolved-solids concentration in samples collected seasonally during 1964 from the Sevier River at gaging site S2 (fig. 8) ranged from 280 to 322 milligrams per liter; dissolved-solids concentration in samples collected during the same period from Clear Creek about 2 miles downstream from gaging site S3 (fig. 8) ranged from 134 to 242 milligrams per liter (Hahl and Cabell, 1965, table 1). Selected chemical analyses of water from Sevier River and Clear Creek are presented in table 3. Chemical analyses of water are not available for the small ephemeral tributaries that cross the Joseph parcel, or for the Sevier Canal. The canal water, however, probably is similar in chemical quality to the Sevier River from where it is derived.

Ground Water

The Joseph parcel, located mostly on the lower southeastern slopes of the Pahvant Range, is underlain primarily by rocks of volcanic origin (Young and Carpenter, 1965, pl. 1). According to Young and Carpenter (1965, table 1), these rocks generally transmit water slowly. However, they do contain interbedded lava flows that locally transmit water readily. No wells are known to tap the volcanic rocks in the general area of parcel 3. Consequently, potential yields of wells in these rocks are not known.

The lower eastern and southern margins of the Joseph parcel extends almost to the floor of the central Sevier River valley. These parts of parcel 3 are underlain by unconsolidated or loosely-cemented terrace gravel, which may be mantled locally by unconsolidated stream-valley alluvium, and are underlain by the loosely cemented Sevier River Formation of Tertiary and Quaternary age. This section is nearly 1,000 feet thick near the eastern boundary of the parcel (Young and Carpenter, 1965, pl. 1, sec. B-B') and probably is saturated below the level of the Sevier River. According to Young and Carpenter (1965, table 1), the stream-valley alluvium can transmit water readily. Most of the wells shown in figure 8 apparently tap the stream-valley alluvium. They are mostly small-diameter domestic and stock wells that produce as much as 25 gallons per minute (table 1). Near the valley margin where parcel 3 is located, the alluvium and the terrace gravels may be unsaturated, especially at a level that is above the Sevier Canal. The Sevier River Formation, which probably is saturated beneath the parcel, has poor to moderate permeability (Young and Carpenter, 1965, table 1), and probably transmits water slowly to wells. According to Young and Carpenter (1965, p. 20), the formation yields small to moderate quantities of water to domestic and stock wells in other parts of the central Sevier River valley, but locally it is nearly impermeable.

According to Price (1981a) ground water in the area of the Joseph parcel generally contains dissolved-solids concentrations ranging from 500 to 1,000 milligrams per liter. The only known source of saline ground water in the area is Joseph Hot Spring (fig. 8), a fault-related spring area on the east side of the Sevier River valley (about 2 miles east of the parcel). A water sample from well (C-25-4)12abd-1, which reportedly taps stream-valley alluvium about 2 miles east of the northeast corner of the Joseph parcel (fig. 8), had a dissolved-solids concentration of 763 milligrams per liter (table 3), and a sample from well (C-25-4)15bbd-1, which apparently taps the Sevier River Formation in the parcel about 1 mile east of Joseph had a dissolved-solids concentration of 356 milligrams per liter (table 3). The town of Joseph obtains its water from two groups of springs that discharge at an altitude of about 7,000 feet above sea level in the mountains 3.5 miles west of parcel 3. These springs typically yield about 100 gallons per minute and have quality of water that is suitable for most uses; dissolved-solids concentration generally is less than 200 milligrams per liter (Utah Division of Environmental Health, Bureau of Public Water Supply, written commun., 1987). The spring water is piped to underground tanks located at the northern edge of the Joseph parcel. No chemical analyses of water from the terrace gravel or from the igneous rocks were available.

Parcel 4, Koosharem Reservoir

Surface Water

Parcel 4 is in the upper Sevier River valley. The parcel is drained by Otter Creek, a major tributary of the Sevier River, and by two small ephemeral drainageways that empty into Koosharem Reservoir (fig. 11). Koosharem Reservoir, adjacent to the eastern boundary of the parcel, is formed by an earthfill dam across Otter Creek. It stores water mostly for irrigation and has a maximum storage capacity of 7,470 acre-feet.

The U.S. Geological Survey gaged the flow of Otter Creek at S4 near Koosharem Reservoir (fig. 11) during 1964-82. During the 18 years of record, the gaged flow ranged from 3.6 to 117 cubic feet per second, and averaged 12.1 cubic feet per second. Maximum, minimum, and average daily mean flows during that period are shown in figure 12.

The 1:250,000 scale work maps compiled to estimate water yields in Utah (Bagley and others, 1964) indicate that mean annual runoff from the Koosharem Reservoir parcel is about 1 inch, or only about 60 acre-feet. The small ephemeral drainageways or streams that cross the parcel have flows only during storms and periods of snowmelt even though they originate in areas that are at higher altitudes and receive more precipitation than parcel 4.

Estimates of streamflow characteristics for the two unnamed ephemeral streams that are west of parcel 4 were made by using equations (1) and (2) developed by Christensen and others (1986). As the mean basin altitudes for these streams were greater than 7,500 feet above sea level, equations developed for mountainous regions were used. The average flow and annual maximum 15-day mean flow (recurrence interval of 10 years) are estimated to be

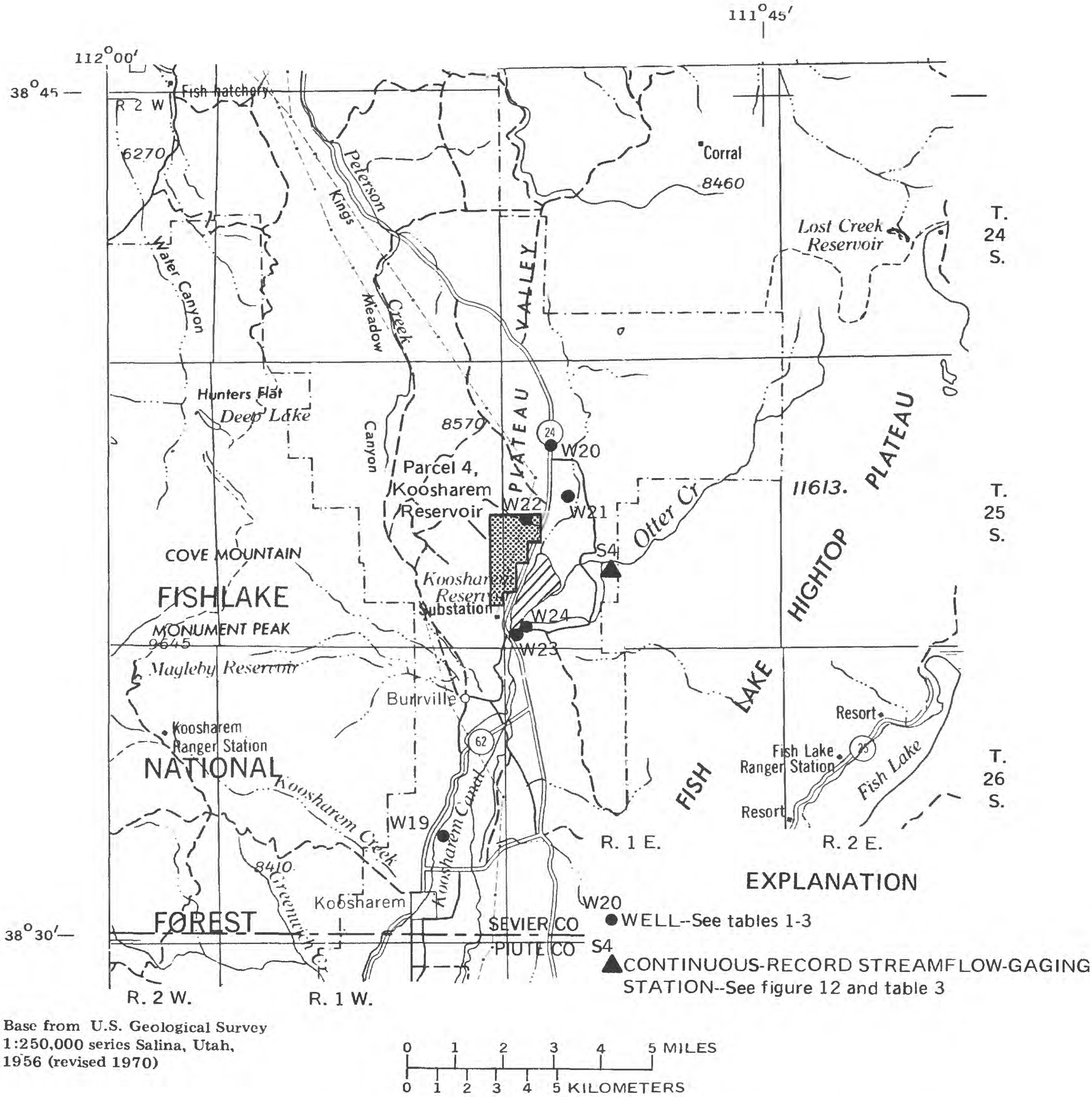


Figure 11.--Location of selected wells and a continuous-record streamflow-gaging station in the general area of the Koosharem Reservoir parcel.

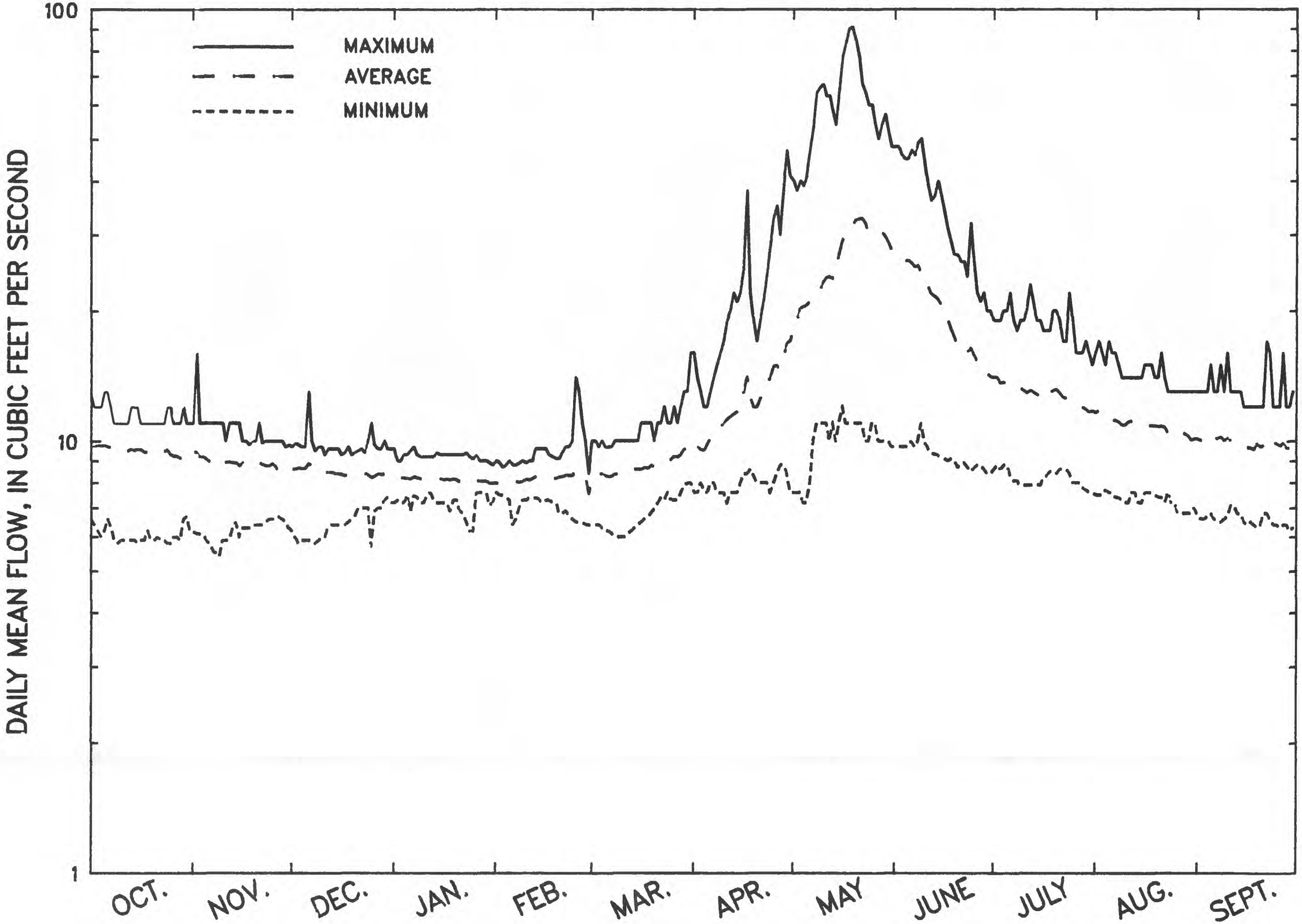


Figure 12.—Maximum, average, and minimum daily mean flow in Otter Creek at S4 for water years 1964–82.

0.1 and 2 cubic feet per second, respectively. The combined estimated average flow for these streams of 0.1 cubic foot per second makes these streams unsuitable for any significant type of development.

Surface water in the general area of the Koosharem Reservoir parcel contains dissolved-solids concentrations of less than 500 milligrams per liter (Hahl and Mundorff, 1968, pl. 1). For the period 1964-82, the dissolved-solids concentration of Otter Creek at site S4 ranged from 70 to 100 milligrams per liter based on measured values for specific conductance. Dissolved-solids concentrations of water in Otter Creek downstream at the streamflow-gaging site (C-29-2)25c, located 28 miles south of the parcel, ranged from 208 to 285 milligrams per liter (Hahl and Cabell, 1965, table 1). The ephemeral flows in the two small drainageways that cross the parcel probably have dissolved-solids concentrations of less than 300 milligrams per liter. This is also true of the water stored in Koosharem Reservoir, except during periods of low flow when concentrations probably increase because of evaporation from the reservoir. Koosharem Reservoir was inventoried under the Clean Lakes program by the Utah Division of Environmental Health in 1981 (Isham and Reichert, 1982). The water has a hardness concentration of 123 milligrams per liter as calcium carbonate, a specific conductance of 270 microsiemens per centimeter at 25 degrees Celsius, and concentrations of trace metals within State standards. However, Koosharem was classed as a eutrophic reservoir because of total phosphorus concentrations of 0.07 milligram per liter. The inventory concluded that recreation was slightly impaired by excessive nutrient concentrations. It is likely that any development near the reservoir will need to consider the control of nutrient entry into the water that could further stimulate eutrophication.

Ground Water

The western part of parcel 4 is underlain by volcanic rocks similar to those that underlie the western part of parcel 3; the eastern part of parcel 4 is underlain by stream-valley alluvium, which in turn is underlain by volcanic rocks (Carpenter and others, 1967, pl. 1, sec. E-E'). As shown in the cited section, the stream-valley alluvium is about 500 feet thick east of parcel 4; maximum thickness of the volcanic rock in that area probably exceeds 500 feet. The stream-valley alluvium forms the principal aquifer in the upper Sevier River valley, yielding small to moderate quantities of water to wells. According to Carpenter and others (1967, table 1), the volcanic rocks generally transmit water slowly, but yield water to several wells and many springs in other parts of the upper Sevier River valley. Price (1972a) indicated that potential yields to individual wells in the area of the Koosharem Reservoir parcel range from 5 to 50 gallons per minute. Well (D-25-1)19add-1, which taps stream-valley alluvium near the northeast corner of the Koosharem Reservoir parcel (fig. 11), reportedly flows at a rate of 20 gallons per minute (table 1).

According to Price (1972b), ground water in the area of the Koosharem Reservoir parcel is generally considered freshwater, with dissolved-solids concentrations of 250 to 1,000 milligrams per liter. A water sample from well (D-25-1)17ddc-1, which taps the stream-valley alluvium about 1 mile northeast of the parcel (fig. 11), had a dissolved-solids concentration of 129 milligrams per liter (table 3).

Parcel 5, Kanarraville

Surface Water

Most of the overland runoff from parcel 5 drains into Cedar Valley, a topographically-closed basin in the Great Basin which is also known as Cedar City Valley. There appears to be no well-established stream or drainageway on the parcel. Shurtz Creek is less than 1 mile from the parcel's northeastern corner, and Murie Creek is about 1 mile south of the parcel (fig. 13).

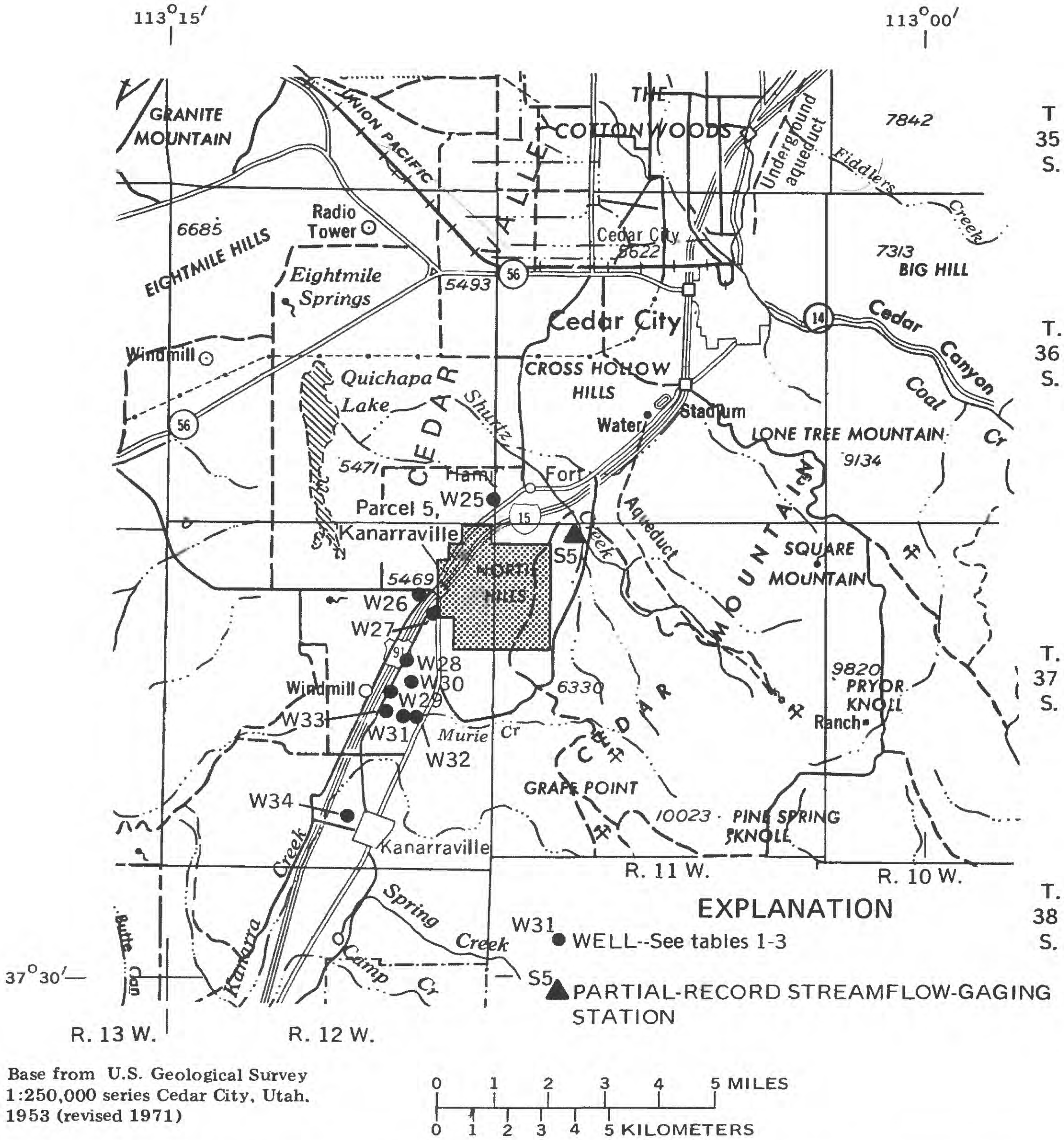
According to a 1:250,000-scale work map used to estimate annual water yields in Utah (Bagley and others, 1964), mean annual runoff from parcel 5 is less than 1 inch or less than about 200 acre-feet. As with parcels 1 to 4, the natural drainageways on the Kanarraville parcel are ephemeral and are usually dry. Estimates of selected streamflow characteristics for these streams were made using equations (3) and (4) for the southwestern plateau region in Utah developed by Christensen and others (1986). The combined estimated average flow is 11 cubic feet per second, and the annual maximum 15-day mean flow (recurrence interval of 10 years) is 177 cubic feet per second. It is likely that these are overestimates as was noted in a previous discussion of the Cove Fort and Cove Fort interchange parcels. Shurtz and Murie Creeks near parcel 5 are also ephemeral, and flow only during storm and snowmelt periods. They are both subject to considerable cloudburst flooding.

During 1959-74, the U.S. Geological Survey operated a partial-record gaging station on Shurtz Creek at S5 near the Kanarraville parcel (fig. 13) to monitor annual peak flows in the stream. The recorded peak flows exceeded 100 cubic feet per second during most of the period of record, and the largest recorded flow was 1,070 cubic feet per second on August 4, 1964. Statistical analyses of the data from the partial-record station indicate that there is about a 10-percent probability that the maximum recorded flow (1,070 cubic feet per second) would be equaled or exceeded in any 1 year at the site of the gaging station. There is also about a 90-percent probability that a peak flow of 100 cubic feet per second will be equaled or exceeded in any 1 year at the station. Annual flows in Murie Creek have not been gaged. A small reservoir on the stream (fig. 13) apparently is used for flood control and sustains flow in the reach just downstream from the reservoir.

Little is known of the chemical quality of surface water in the area of the Kanarraville parcel. Price (1980) indicates that the water contains dissolved-solids concentrations less than 500 milligrams per liter. However, there were no chemical analyses of surface water in the immediate area of the parcel.

Ground Water

The Kanarraville parcel is underlain primarily by volcanic rocks of mostly Tertiary age that are mantled for the most part by fanglomerate of Quaternary age (Thomas and Taylor, 1946, pl. 3). In most places, the volcanic rocks are felsic in composition; they probably are only slightly permeable and transmit water slowly. In the south-central part of the parcel, however, the volcanic rocks include younger (Quaternary) basalt flows, which Thomas and Taylor (1946) suggest may be very permeable. The basalt, if saturated, may



Base from U.S. Geological Survey 1:250,000 series Cedar City, Utah, 1953 (revised 1971)

Figure 13.--Location of selected wells and a partial-record streamflow-gaging station in the general area of the Kanarraville parcel.

transmit water readily. The fanglomerate, which consists largely of boulders and gravel, probably is permeable and capable of transmitting water readily. The igneous rocks and the fanglomerate are not known to have been tested by wells for saturation, or actual water-bearing properties.

The northern and western fringes of parcel 5 are underlain by unconsolidated basin-fill deposits. These deposits are part of the Cedar City Valley ground-water reservoir of Thomas and Taylor (1946), Sandberg (1966), and Bjorklund and others (1978). Basin-fill deposits contain permeable sand and gravel that yield water readily to wells. Well (C-37-12)11add-1, for example, reportedly yielded 925 gallons per minute, and well (C-37-12)14abc-1 reportedly yields 600 gallons per minute (table 1).

Few data are available regarding the chemical quality of ground water in the area of the Kanarraville parcel. Price (1981b) indicates that the ground water contains dissolved-solids concentrations generally less than 1,000 milligrams per liter. As noted by Bjorklund and others (1978, p. 49), however, the basin fill in Cedar Valley locally contains sediments eroded from rock formations that contain gypsum and other easily dissolved minerals. Consequently, water in the basin-fill deposits is locally saline. A water sample collected from well (C-37-12)11aab-1 had a dissolved-solids concentration of only 403 milligrams per liter, but a sample collected from well (C-37-12)23bbd-1 had a dissolved-solids concentration of 3,750 milligrams per liter (table 3).

SELECTED WATER-SUPPLY CONSIDERATIONS

The following discussion deals only with the physical availability of surface or ground water that might be used on the parcels. It was not in the scope of this study to address the legal and environmental constraints to developing ground water or diversion of water for use on the parcels, nor was it in the scope of this study to evaluate the various engineering options for diverting the water from its place of occurrence, storing it, and delivering it to its place of use. Surface- and ground-water sources on and near the parcels are discussed below, and any plan to develop those sources, needs to take into consideration existing water rights, costs, off-parcel land ownership, and possible effects on the environment.

Parcels 1 and 2, Cove Fort and Cove Fort Interchange

Cove Creek probably is the most feasible source of surface water for use on both parcels 1 and 2. Although the creek flows only during storm and snowmelt periods, it has provided, and can continue to provide, water for livestock. Delivery of water to either parcel 1 or parcel 2 would require upstream impoundment with diversion and conveyance facilities. There are insufficient data from which to evaluate the quality or dependability of this possible source of supply. The data do indicate that small impoundments, like those existing on the creek, would not provide a perennial water supply. When first impounded, the water probably would be fresh, but it would become increasingly more saline as the dissolved solids are concentrated by evaporation. Any plan to use this water source for domestic supply needs to include testing (and possible treatment, if necessary) for any organic contamination or toxic trace elements.

The most feasible source of ground water for use on parcels 1 and 2 probably is the saturated basin-fill deposits. Records of wells in the general area of the parcels (table 1) indicate that the fill is saturated within about 200 feet of the land surface and that the water is chemically suitable for most common uses. It seems likely, therefore, that properly constructed and equipped wells tapping the basin-fill deposits beneath the parcels 1 and 2 could yield sufficient water of suitable chemical quality for domestic, stock, or limited irrigation supply. Considering depth to water (which determines depth and cost of drilling and pumping lifts) and saturated thickness of the fill (which determines dependability of the ground-water supply), the southwestern parts of parcels 1 and 2 seem to contain the most favorable sites for a well. Assuming that a well need not be restricted to either parcels 1 or 2, a more favorable area for wells may be midway between the parcels near U.S. Highway 91. Additional study, with possible test drilling, would be required to determine the suitability of well-site alternatives.

Parcel 3, Joseph

Clear Creek may be the most favorable source of surface water for use on the Joseph parcel. Even during periods of low flow, the stream could yield sufficient water for domestic, stock, recreation, and some irrigation use. Assuming the required water rights were obtained, the water could be diverted from the creek at an upstream site and moved by gravity for use on parcel 3. Water from Clear Creek is chemically suitable for most common uses (table 3). Being subject to pollution in the open channel, however, the water would require treatment if used for domestic uses.

The Sevier River and Sevier Canal are also possible sources of surface water for use on the Joseph parcel, provided a water right can be obtained; however, water from both sources would need to be lifted against gravity for use on the parcel. Also, the canal water can be expected to be available only during the irrigation season. The ephemeral streams that cross the parcel may provide temporary water supplies during storm and snowmelt periods. Perhaps the most favorable site to construct storage facilities on the ephemeral streams is in the upper reaches where snowmelt most likely provides the more predictable and dependable flows.

The most favorable source of ground water for use on the Joseph parcel may be the saturated stream-valley alluvium in the area. Wells that tap this alluvium yield as much as 25 gallons per minute, and it is possible that a properly located and constructed well in the alluvium near parcel 3 could yield sufficient water of suitable chemical quality for domestic, stock, and limited irrigation use. Unfortunately, the saturated stream-valley alluvium is absent within the parcel boundaries or is too thin to be a dependable source of water. It is possible, however, that the lower part of the terrace gravels that underlie most of parcel 3 may yield sufficient water to a well for limited domestic or stock use. The most favorable site on the parcel for such a well would be adjacent to the eastern boundary where Indian Creek or one of the other ephemeral streams on the parcel cross that boundary. There probably is some older saturated stream-valley alluvium in the lower reaches of the canyons of those streams, and the water in that alluvium is replenished by seepage from the ephemeral flows in those streams. Also, a well could penetrate the Sevier River Formation, which may also be saturated and capable of yielding water to a well. The volcanic rocks that underly the terrace gravels probably would yield sufficient water to a well for limited domestic and stock use. It would, however, be extremely difficult to successfully locate a well in those rocks because the depth and occurrence of water in them is not well known.

Parcel 4, Koosharem Reservoir

The Koosharem Reservoir parcel, adjacent to Koosharem Reservoir and the main highway to Fish Lake, may be ideally located to benefit from the local tourist industry. The recreational value of Koosharem Reservoir is evident, but dependable domestic-water supplies would be needed to support tourism in the area of parcel 4.

Koosharem Reservoir is the most favorable source of water for domestic and other possible uses on the parcel (including stock watering and irrigation of crops adaptable to the 7,000-foot altitude). The water would need to be lifted to places of use on the parcel and would require treatment for domestic use. Small impoundments on ephemeral drainages that cross parcel 4 could store some storm and snowmelt runoff for short-term livestock use, but the supply would not be assured or dependable.

As with parcel 3, stream-valley alluvium may be the most favorable source of ground water for the Koosharem Reservoir parcel. East of the Koosharem Reservoir parcel, the stream-valley alluvium is about 500 feet thick (Carpenter and others, 1967), but within the parcel boundaries it is much thinner or is absent. A well in the northern one-half of the parcel, just inside the parcel's eastern boundary, might tap saturated stream-valley alluvium within about 100 feet of the land surface. The well, if properly located and constructed, could yield sufficient water of suitable chemical quality for domestic use. A well completed in the volcanic rocks that underly the stream-valley alluvium probably would also yield water of suitable chemical quality for domestic use; however, such a well would be more difficult to locate on the basis of available data and probably would need to be several hundred feet deep.

Parcel 5, Kanarraville

There is virtually no surface water available for development on the Kanarraville parcel. The nearest sources of surface water that might be considered for diversion to parcel 5 are Shurtz and Murie Creeks. A recently constructed stock-water trough near the southern boundary of the parcel receives water piped 1 mile from the Hurricane Cliffs area near Shurtz Creek. The small reservoir near the headwaters of Murie Creek might provide a small perennial water supply for use on the parcel if a water right could be obtained and delivery of the water to the parcel is feasible. This would also be true of an upstream impoundment, should one be constructed, on Shurtz Creek. The water from upstream impoundments on Murie and Shurtz Creeks should be chemically suitable for most common uses but would require treatment for domestic use.

Ground water probably is the most favorable source of water for use on the Kanarraville parcel. As previously noted, the basin-fill deposits that extend beneath the northern and western fringes of parcel 5 are extensions of a major valley ground-water reservoir that yields water readily to wells in most places. Available data indicate that a properly located and constructed well just inside the northern or western boundary of the parcel could produce sufficient water of suitable chemical quality for domestic, stock, and limited irrigation use. The felsic igneous rocks that underly most of the Kanarraville parcel probably would yield water too slowly to wells for beneficial use, but the terrace gravels and basalt lava flow that cap the felsic igneous rocks may contain perched water and may yield it readily enough to a well for limited domestic or stock supply. The actual existence and dependability of this probable perched water would need to be investigated.

CONCLUSIONS AND NEED FOR ADDITIONAL STUDY

Based on the available geohydrologic and hydrologic data and the results of previous hydrologic interpretation by the U.S. Geological Survey, water of suitable chemical quality is available in the areas of all the Paiute Indian land parcels for domestic, stock, recreation, and limited irrigation use. Surface water apparently is the most favorable source of supply available for the Joseph parcel and ground water apparently is the most favorable source of supply available for the other parcels. Available information may be adequate to evaluate the legal and physical feasibility of diverting the water from one of the surface- or ground-water sources to the parcels. Additional studies are needed, however, to more precisely evaluate ground-water conditions in the immediate area of each of the parcels. These site-specific studies need to include additional onsite geologic evaluations to determine the best possible location for wells for the efficient and cost-effective development of the ground water. Test drilling needs to be considered for designated well sites to determine (1) depths to water, (2) water-yielding properties of the water-bearing rock, and (3) the chemical quality of the local ground water.

Additional study also is needed to evaluate possible water sources other than those discussed in this report. For example, a detailed spring search and inventory is needed in the mountain areas adjacent to the parcels. A spring in the upper Cove Creek area reportedly once provided water (through a pipeline?) to Cove Fort. Apparently springs are present in the higher altitudes near all of the parcels, especially near the Joseph, Koosharem Reservoir, and Kanarraville parcels, that could provide water by gravity flow. For example, it has been, and continues to be, a common practice throughout the generally arid Great Basin to convey water by pipeline from springs in the higher wetter mountains several miles to lower drier areas for livestock and other uses. The spring inventory also might include an inventory of favorable headwater stream sites for impoundment of snowmelt and storm runoff for downstream use on the parcels. This is especially true for Cove Creek and the ephemeral streams that cross the Joseph parcel.

Additional study also is needed to evaluate ground water beneath the Cove Fort and Cove Fort interchange parcels as a possible source of geothermal energy. Data collected at a geothermal test well on the Cove Fort parcel indicate the water produced by the well was not hot enough (no steam) to generate electrical energy. However, water in the consolidated rock beneath these two parcels may be hot enough for space heating (including vegetable hot houses) and heated swimming pools.

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page 34 follows

[Location: See text for explanation of numbering system for data sites.
Owner or user: Refers to latest known owner or user.
Use of water: I, irrigation; H, household or domestic; S, stock; U, unused; O, observation well; P, public supply.
Character of material: G, gravel; Cg, conglomerate; S, sand.
Occurrence: U, unconfined (water table).
Altitude of land surface: Altitudes interpolated from U.S. Geological Survey topographic maps given in feet, above
Water level: Measured depths to water are given in feet and decimal fractions; reported and estimated depths are given
Remarks and other data available: L, drillers' log (table 2); C, water-quality data (table 3); Dd, drawdown, difference

Location	Identification number in this report	Owner or user	Year completed	Use of water	Depth of well (feet)	Diameter of well (inches)
		PARCELS 1 AND 2 - COVE FORT AND COVE FORT INTERCHANGE				
(C-25- 6)17d -1	W1	Laval Bradshaw	1978	I	525	14
30c -1	W2	Otto Kesler	1949	I	300	12
30c -2	W3	Utah Dept. Transportation	1977	H,I	350	8
31ccc-1	W4	Otto Kesler	1949	I	--	12
(C-25- 7)21d -1	W5	Bureau of Land Management	1983	S	600	7
26b -1	W6	Utah Dept. Transportation	1966	H	400	8
26d -1	W7	Bill Manhard	1964	H,S	426	8
(C-26- 7)26cac-1	W8	C.W. Anderson	1934	U	250	--
		PARCEL 3 - JOSEPH				
(C-25- 4)11cac-1	W9	R.G. Bradbury	--	O	39	3
11cdd-1	W10	do.	1932	O	151	6
12abd-1	W11	Ivan Mills	--	H,S	25	36
13bdb-1	W12	Walter Wayland	1936	H,S	70	5
13cbc-1	W13	Edna Meacham	1936	H,S,O	73	5
14add-1	W14	Leon Taylor	1936	U	65	5
15bbd-1	W15	Joseph City	1973	P	217	8
22dca-1	W16	Aumery Hansen	--	H,S	93.1	5
27bab-1	W17	Philip Gilard	1936	O	89	5
28bcd-1	W18	J.L. Levi	1937	S	144.6	6
		PARCEL 4 - KOOSHAREM RESERVOIR				
(C-26- 1)23ddb-1	W19	A.E. Delange	1898	O,S	200	2
(D-25- 1) 8ccd-1	W20	King Brothers, Inc.	1949	O,S	310	6
17ddc-1	W21	Cecil King	1920	H,S	52	1
19add-1	W22	Don McMilan	1898	I,O	12	2
31cbd-1	W23	Charles Burr	--	O,S	38	2
31dbb-1	W24	Nellie Dastrup	1960	S	112	2
		PARCEL 5 - KANARRAVILLE				
(C-36-12)36daa-1	W25	R. and K. Middleton	--	I	--	16
(C-37-12)11aab-1	W26	G. Vandenburghe	1953	I,O	365	14
11add-1	W27	A.L. Graff	--	I	--	14
14abc-1	W28	do.	1950	I,O	264	14
14cdb-1	W29	do.	--	I	--	14
14dbd-1	W30	do.	--	I	--	14
23aca-1	W31	J.S. Prestwich	--	I	276	16
23acb-1	W32	do.	1940	I	300	16
23bbd-1	W33	do.	--	U	--	6
34abb-1	W34	Kanarraville Irrigation Co.	1934	I,O	190	12

NGVD.
in feet.
in feet between static and pumping water level; B, bailed.]

Principal aquifer: Character of material	Principal aquifer: Depth to top (feet)	Principal aquifer: Thickness (feet)	Occurence	Altitude of land surface (feet)	Water level: Above (+) or below (-) land surface (feet)	Water level: Date of measurement	Water temperature (degrees Celsius)	Yield (gallons per minute)	Remarks and other data available
PARCELS 1 AND 2 - COVE FORT AND COVE FORT INTERCHANGE									
--	--	--	--	6,880	--	--	--	--	L
G	--	--	--	--	-125.0	1958	--	--	--
--	--	--	--	--	--	--	--	63.5	--
--	--	--	--	--	-100.0	08-05-49	--	90.0	--
--	--	--	--	5,840	-360.0	10-22-83	--	10.0	L
--	--	--	--	5,960	-130.0	04-20-66	--	250	L
--	--	--	--	5,940	-125.0	03-01-64	--	150	L
--	--	--	--	6,130	--	--	--	--	C
PARCEL 3 - JOSEPH									
--	--	--	U	5,412	-29.3	09-17-56	--	--	
Cg	--	--	U	5,412	-28.3	03-06-58	--	--	
--	--	--	--	--	--	--	12.0	--	C
S,G	40	30	U	5,444	-49.5	07-25-56	16.0	5	Dd 0 feet
S,G	33	40	U	5,426	-41.2	07-23-56	20.0	5	Dd 3 feet
S,G	18	47	U	--	+18	1936	19.5	5	Dd 2 feet
G,S	--	--	U	5,720	-62	--	--	--	Perforated below 105 feet, C
--	--	--	U	5,463	-81.6	02-12-57	--	--	
S,G	36	53	U	5,478	-63.0	09-19-56	14.5	--	B
Cg	81	15	U	--	-79.9	02-08-57	11.5	25	Dd 20 feet
PARCEL 4 - KOOSHAREM RESERVOIR									
S,G	--	--	--	6,870	+12.4	03-11-58	12.5	3	C
S,G	35	12	--	7,030	-15.4	08-18-61	12.0	50	L
S,G	--	--	--	--	--	--	14.5	.5	C
S,G	--	--	--	7,012	+4.6	08-18-61	10.5	20	One of 2 wells
S,G	--	--	--	--	+3.2	03-11-58	10.5	1	
G	11	101	--	7,075	+5.3	07-16-60	11.5	.5	L
PARCEL 5 - KANARRAVILLE									
--	--	--	--	5,605	--	--	--	--	L
--	--	--	--	5,490	-33.1	03-20-62	21.0	--	C
--	--	--	--	--	-40.0	10-10-62			
--	--	--	--	5,522	--	--	--	925	
--	--	--	--	5,488	-25.0	04-19-62	18.0	600	
--	--	--	--	5,492	--	--	--	250	
--	--	--	--	5,498	--	--	--	--	
--	--	--	--	5,525	--	--	--	--	L
--	--	--	--	5,511	--	--	14.0	--	C
--	--	--	--	5,495	--	--	12.0	--	C
--	--	--	--	5,507	-54.3	10-17-62	11.5	664	C, L

page 37 follows

Table 2.--Drillers' logs of selected wells in the general areas of parcels 1, 2, 4, and 5

[See text for explanation of numbering system. Altitude (Alt.) is land-surface altitude in feet above sea level. Thickness and depth are given in feet.]

Material	Thickness	Depth
PARCEL 1--COVE FORT		
(C-25-6)17d-1. W1. Log by B and B Drilling Co. Alt. 6,880.		
Silt	30	30
Clay and sand	50	80
Clay and gravel	22	102
"Cinders"	38	140
"Lava rocks" with water	25	165
Gravel	35	200
Clay and gravel	75	275
"Lava rocks"	79	354
Sand and gravel	66	420
Clay	80	500
Clay	25	525
PARCEL 2--COVE FORT INTERCHANGE		
(C-25-7)21d-1. W5. Log by by Clair A. Stephenson. Alt. 5,840.		
Topsoil	4	4
Clay and "cinders"	6	10
Clay and boulders	20	30
Lava rocks	18	48
Clay and "cinders"	272	320
Granite, grey	110	430
Granite, pink	22	452
Granite, grey, fractured, water-bearing	148	600
(C-25-7)26b-1. W6. Log by Clair A. Stephenson. Alt. 5,960.		
Topsoil	3	3
"Lava"	127	130
"Lava"	20	150
"Lava" (lenses)	250	400
(C-25-7)26d-1. W7. Log by by Clair A. Stephenson. Alt. 5,940.		
Topsoil	13	13
"Cinders", lava boulders, and clay	144	157
"Cinders" and clay with "sandstone" lenses	43	200
Lava gravel and clay (lenses) water-bearing	225	425
PARCEL 4--KOOSHAREM RESERVOIR		
(D-25-1)8ccd-1. W20. Log by B.B. Gardner. Alt. 7,030.		
Holocene and Pleistocene deposits:		
Loam, sandy	10	10
Clay, sandy	25	35
Sand and gravel, water	12	47
Clay	61	108
Sand, water	48	156
Clay, sandy	84	240
Hardpan	40	280
Gravel, water	30	310
(D-25-1)31dbb-1. W24. Log by Rodney Cowley. Alt. 7,075.		
Holocene and Pleistocene deposits:		
Clay	11	11
Gravel	101	112
PARCEL 5--KANARRAVILLE		
(C-36-12)36daa-1. W25. Log by H. Stonehill. Alt. 5,605.		
Soil	24	24
Gravel; dry	2	26
Gravel and clay	39	65
Clay; some water	43	108
Gravel; some water	5	113
Clay	17	130
Gravel, traces of clay, some water	20	150
Clay	40	190
Gravel	6	196
Clay	8	204
Gravel	2	206
Clay, sticky	12	218
Gravel, some clay; good water	17	235
Clay, yellow, hard	23	258
Gravel and sand, poor water	24	282
Clay	26	308
(C-37-12)23aca-1. W31. Log by P. Bradshaw. Alt. 5,525.		
Clay, sandy	32	32
Gravel and rocks	8	40
Clay	8	48
Clay and gravel	12	60
Sand and clay	23	83
Gravel, water	3	86
Sand and clay	50	136
Gravel	20	156
Sand and clay	19	175
Gravel	2	177
Clay and gravel	6	183
Tight gravel	11	194
Clay	2	196
Tight gravel	10	206
Clay, sandy	24	230
Clay and gravel	26	256
Clay	11	267
Clay and gravel	9	276
(C-37-12)34abb-1. W34. Alt. 5,507.		
Soil	18	18
Sand and clay	30	48
Gravel, dry	4	52
Clay	12	64
Gravel, water	26	90
Clay	6	96
Gravel, water	58	154
Clay	2	156
Gravel, coarse, water	34	190

Table 3.--Selected chemical analyses of water from wells

[ft³/s, cubic feet per second; ° C, degrees Celsius; µS/cm, microsiemens per centimeter

Location	Identification number in the report	Date of sample (month-day-year)	Discharge (ft³/s)	Specific conductance (µS/cm)	pH (standard units)	Water temperature (°C)	Hardness, (mg/L as $CaCO_3$)	Calcium, dissolved (mg/L as Ca)	Magnesium, dissolved (mg/L as Mg)	Sodium (mg/L as Na)	Potassium (mg/L as K)	Na + K
					Parcels 1 and 2--Cove Fort and Cove Fort Interchange							
(C-26- 7)26cac-1	W8	08-09-83	--	590	7.8	15.0	260	80	15	24	25	
					Parcel 3--Joseph							
(C-25- 4)12abd-1	W11	07-31-57	--	1,160	8.4	15.5	505	120	50	65	3.9	
(C-25- 4)15bbd-1	W15	07-08-80	--	570	8.6	--	236	70	15	32	3.0	
SEVIER RIVER ABOVE CLEAR CREEK (C-26-4)5aba	S2	03-09-64	38	515	7.9	0	222	60	18	32	2.2	
		05-18-64	359	405	7.9	16.0	178	40	19	26	3.1	
		07-27-64	88	415	8.0	21.0	180	40	19	22	4.4	
		09-21-64	40	440	8.2	10.0	193	46	19	28	4.0	
CLEAR CREEK AT SEVIER (C-25-4)32a	S3	03-09-64	12	305	8.0	4.5	108	37	4.0	15	1.8	
		05-18-64	170	170	7.6	13.0	66	23	2.0	8	1.8	
		07-27-64	3.4	305	8.4	19.0	120	40	5.0	21	3.0	
		09-21-64	2.0	340	8.0	12.0	126	42	5.0	26	3.2	
					Parcel 4--Koosharem Reservoir							
(C-26- 1)23ddb-1	W19	05-13-59	--	180	7.4	11.5	72	24	3.2			10
		05-11-60	--	189	7.8	12.0	76	24	3.9			14
		05-23-61	--	188	7.5	11.5	76	26	2.9	10	2.4	
		08-10-83	--	245	7.6	12.0	73	23	3.9	10	2.8	
(D-25- 1)17ddc-1	W21	09-04-57	--	183	8.4	14.5	63	19	3.8			3.7
OTTER CREEK ABOVE RESERVOIR NEAR ANTIMONY (C-29-2)25c	[1]	03-10-64	6.0	306	7.9	0	122	31	11			22
		05-19-64	.1	432	8.0	17.0	154	37	15			42
					Parcel 5--Kanarraville							
(C-37-12)11aab-1	W26	07-13-59	--	586	7.7	21.0	234	47	28			34
23acb-1	W32	08-16-60	--	538	7.7	14.0	218	51	22	33	2.0	
		08-31-84	--	760	7.7	14.5	340	75	36	37	2.3	
23bbd-1	W33	04-22-59	--	5,690	8.2	12.0	2,180	473	243			463
34abb-1	W34	09-05-61	--	689	7.8	11.5	53	88	33			26
		08-31-84	--	810	7.6	11.0	460	120	39	16	2.5	

[1]This site is located 28 miles south of the parcel, and is not shown on figure 11.

and streams in the general areas of parcels 1 to 5

at 25 degrees Celsius; mg/L, milligrams per liter; µg/L, micrograms per liter]

Bicarbonate (mg/L)	Carbonate (mg/L)	Sulfate, dissolved (mg/L as SO_4)	Chloride, dissolved (mg/L as Cl)	Fluoride, dissolved (mg/L as F)	Silica, dissolved (mg/L as SiO_2)	Dissolved, solids, sum of constituents, (mg/L)	Nitrate, dissolved (mg/L as NO_3)	Phosphorus, dissolved (mg/L as P)	Boron, dissolved (µg/L as B)	Iron, dissolved (µg/L as Fe)	Manganese, dissolved (µg/L as Mn)
					Parcels 1 and 2--Cove Fort and Cove Fort Interchange						
--	--	25	82	.3	43	370	--	—	30	6	3
					Parcel 3--Joseph						
--	--	118	57	1.1	51	763	55	—	—	20	0
256	6	42	32	.4	31	356	--	0.02	175	<30	11
249	1	49	20	.3	26	322	.4	.18	80	240	0
224	1	30	14	.4	22	280	.5	0	130	4,000	10
204	1	38	17	.3	20	280	0	.06	0	320	10
209	2	51	20	.4	24	306	.7	.28	0	210	10
132	1	22	20	.8	31	216	.2	.22	80	240	0
55	0	15	10	.8	20	134	1.0	0	120	6,200	0
154	2	13	18	.8	34	208	.6	.03	0	70	20
175	1	14	21	.7	38	242	.5	.30	0	20	30
					Parcel 4--Koosharem Reservoir						
100	0	1.9	7.0	—	46	142	.4	—	—	--	--
100	0	9.9	9.0	—	46	156	.6	—	—	--	--
100	0	11	6.0	.2	41	140	1.0	—	—	--	--
--	--	4.0	8.7	.3	31	140	--	.4	30	< 3	<1
79	2	3.4	11	.3	40	129	2.5	—	—	.03	.00
172	0	10	13	—	38	208	.6	—	—	--	--
240	0	16	23	—	38	285	.6	—	—	--	--
					Parcel 5--Kanarraville						
176	--	137	12	—	54	403	3.0	—	—	.02	--
162	--	135	18	.0	16	358	1.0	—	1.4	.01	--
--	--	200	49	< .1	2	500	--	< .01	90	5	<1
166	--	1,010	1,380	—	28	3,750	66	—	—	.01	--
268	--	154	13	—	16	477	15	—	—	.07	--
--	--	150	9.2	.2	18	560	--	<.01	90	3	1