Ground-Water Possibilities South of the Snake River Between Twin Falls and Pocatello, Idaho

By E. G. CROSTHWAITE

CONTRIBUTIONS TO HYDROLOGY

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CONTENTS

ILLUSTRATIONS

TABLES

CONTRIBUTIONS TO HYDROLOGY

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By E. G. Crosthwaite

ABSTRACT

The Snake River Plain and tributary valleys south of the Snake River between Twin Falls and Pocatello, Idaho (here called the South Side area), contain about 180,000 acres of irrigated land, of which 145,000 acres is irrigated with surface water and 35,000 is irrigated wholly or partly with ground water. The area also contains more than 200,000 acres of arable land that is idle or used only for grazing because it lacks irrigation water. Most of the surface-water supply is already used or reserved, and some land now irrigated needs supplemental water.

The climate of the area ranges from semiarid on the Snake River Plain to subhumid on higher mountains. The average annual precipitation at lowland stations ranges from about 9 to 12 inches.

The principal sources of ground water are extrusive volcanic rocks of silicic to intermediate composition, basalt, and sand and gravel. Ground water occurs commonly under artesian conditions in the silicic to intermediate volcanic rocks and in sand and gravel tongues and lenses in lake beds. Basalt and alluvium commonly contain unconfined water.

The area of this report is divided into 13 roughly defined ground-water districts, some of which are further divided into subdistricts. The known geologic and hydrologic factors of each area are summarized and a preliminary appraisal is made of the ground-water resources in relation to land resources and to the regimen of streams. The current state of development, proposed new developments, and ground-water potential of each division are discussed.

The Dry Creek district is the most intensively irrigated area in Idaho in which wells furnish the water supply. Ground water occurs under both artesian and water-table conditions. More than 53,000 acre-feet of ground water was pumped in 1954. There are large areas of undeveloped arable land in the district, but pumping in some parts of the district currently is approaching or surpasses the perennial yield of the ground-water reservoirs.

The Golden Valley district contains considerable arable land but, owing to the relatively great depth to water and the generally poor yield of wells, the prospects for extensive ground-water development are not promising.

In the Oakley district ground water is pumped from alluvium to supplement surface water and to bring new land into production. The ground water will be fully exploited within a few years if the present rate of development by individual landowners continues. The total area of nonirrigated land far exceeds the amount that could be irrigated with indigenous ground water.

Both artesian and unconfined water occur in the Burley district. Most existing wells tap unconfined water in the southern part where there are still large tracts of idle arable land. Pumping lifts are rather high.

The South Walcott district contains a considerable acreage of arable land and is underlain by excellent aquifers. The effect that heavy pumping would have on the flow of the Raft and Snake Rivers and on seepage from Lake Walcott is not well understood. Presumably substantial pumping would be feasible without direct deleterious effects.

The Raft River basin, including the Elba and Almo-Yost subbasins, is the largest district in the South Side area. Ground water occurs in both unconfined and artesian aquifers. Possibly as much as 150,000 acres of dry land is irrigable, but the ground-water supply presumably is sufficient to irrigate only a few thousand acres in addition to the approximately 40,000 now irrigated with surface and ground water. Pumping of wells at some locations would deplete the base flow of the Raft River and would be competitive with surface-water use.

The United States Bureau of Reclamation has started construction of the Michaud Flats Irrigation Project in the Western Michaud Flats district. The adopted reclamation plan is to irrigate about 10,000 acres, using surface water pumped from American Falls Reservoir and ground water pumped from wells. Ground water in part of the district is tributary to the reservoir. Withdrawals of ground water will be compensated in part by the return of waste water to the reservoir and to the Snake River.

The Eastern Michaud Flats district contains more arable land and has better aquifers than the Western Michaud Flats district, but pumping might reduce noticeably the discharge of ground water to the American Falls Reservoir. The Bureau of Indian Affairs plans to develop about 13,600 acres of Indian land with water stored in Palisades and American Falls Reservoirs.

Virtually nothing is known about ground-water conditions in the Arbon and Rockland Valleys and in several small areas such as the Basin district, the Albion basin, and along the northern border of the Sublett Range. Preliminary studies have been made in three areas, the Dry Creek, Raft River, and Western Michaud Flats districts. None has been studied comprehensively. The available data for each district are summarized in tabular form.

Further investigations in the area are needed and should include accurate hydrologic mapping. Studies are needed of the sources and amounts of ground-water recharge, of the effects of ground-water withdrawals on the total water supply, and of numerous related problems.

INTRODUCTION

PURPOSE AND SCOPE OF REPORT

In the part of the Snake River Plain and tributary valleys south of the Snake River between Twin Falls and Pocatello, Idaho, large tracts of land have been irrigated with surface water for many years, and most of the usable surface water either is already used or is reserved. Nevertheless, some irrigated lands need supplemental water. Many thousand additional acres of irrigable dry land is largely unused except for grazing. Supplemental water and water for additional irrigation seemingly will have to be obtained largely from underground sources. In this report a preliminary appraisal is made of ground-water resources in relation to land resources and to the regimen of surface streams. The current state of development is summarized, proposed new developments are outlined so far as they are known, and the unused supply of ground water is discussed.

Parts of the data contained herein were obtained from several published and open-file reports. Additional hydrologic data were obtained in the field, and a brief geologic reconnaissance was made in key areas. The available data are by no means an adequate basis for appraisal of the total ground-water resources. Indeed, for some districts practically no information is available. Thus all conclusions are highly generalized and most undoubtedly will be modified by future studies.

The investigations on which this report is based were made on behalf of the U. S. Bureau of Reclamation, with the cooperation of the Idaho Department of Reclamation. The work was done under the direct supervision of R. L. Nace, district geologist, Ground Water Branch, U. S. Geological Survey, Boise, Idaho.

LOCATION OF AREA

The area considered in this report includes the Snake River Plain and tributary valleys south of the Snake River between Twin Falls and Pocatello, Idaho, and includes much of Cassia and Power Counties (fig. 7). Small areas in the northeastern part of Twin Falls County

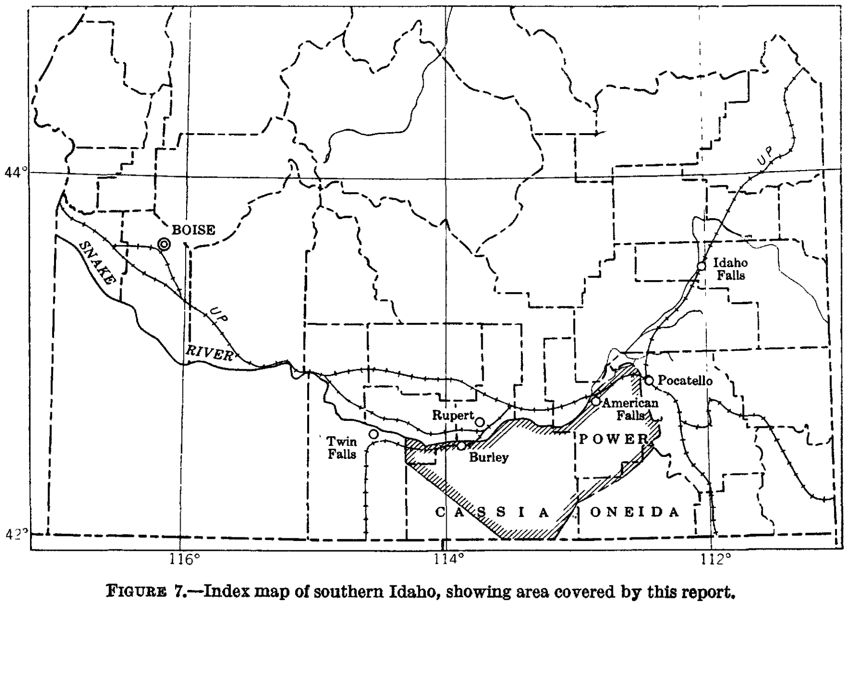

FIGURE 7.—Index map of southern Idaho, showing area covered by this report.

and northwestern part of Oneida County also are included. For convenience the entire region covered by the report is here called the South Side area. The total lowland area, including tributary valley lowlands that merge with the Snake River Plain, is about 1,500 square miles. Hills and mountain ranges that trend generally southward from the Snake River Plain separate the several tributary valleys and comprise about 2,000 additional square miles of upland.

The geologic map (pl. 5) was compiled from all available sources, published and unpublished. For the purpose of this report the South Side area is divided into ground-water districts or units, each of which is described separately. Some of the subdivisions necessarily are arbitrary.

PREVIOUS INVESTIGATIONS

Parts of the South Side area are mentioned briefly in early works by King (1878) and Eldridge (1895). I. C. Russell (1902) made the first general ground-water investigation in the Snake River Plain, including the northwestern part of the South Side area. Bowen (1913) reported on the coal and lignite resources of southwestern Cassia County, just outside the South Side area. Bowen's report contains useful geologic data. , W. B. Heroy (in Mansfield, 1920) described briefly the water resources of the Fort Hall Indian Reservation. Mansfield's report contained the earliest detailed geologic map of any part of the area. Piper (1923) made a reconnaissance study of the geology and water resources of the Goose Creek Basin, and later (1924) investigated the oil and gas possibilities of Power and Oneida Counties. Anderson (1931) reported on the geology and mineral resources of the eastern part of Cassia County. Waring (1934) briefly examined ground-water conditions in the Albion basin. The most extensive study of ground water in the Snake River Plain was by Stearns, Crandall, and Steward (1938). Streamflow records of the Snake River and tributary streams have been collected and published by the Geological Survey since 1895.

Since 1946, in response to needs created by the expansion of agriculture and increased demands for irrigation water, the Geological Survey has been systematically collecting and releasing to the public data on the ground-water resources of Idaho. Much of the work has been done in cooperation with the Idaho Department of Reclamation. Released reports on areas south of the Snake River contain basic information about the Michaud Flats Project in Power County (Stewart, Nace, and Deutsch, 1951), the Raft River basin of Cassia County (Fader, 1951), the Dry Creek area in northeastern Twin Falls and northwestern Cassia Counties (West and Fader, 1952), and the lower Goose Creek area in Cassia County (Mower, 1953). In several areas not covered by released reports wells have been inventoried, geologic studies have been made, and reports are in preparation.

The ground-water geology of the area along the foothill borders of the lower Goose Creek basin and of the Dry Creek area has been mapped, but the maps have not yet been published.

GEOGRAPHY

Part of the South Side area is in the Snake River Plain and part is in the Basin and Range province, which bounds the plain on the south. The plain is made up largely of a sequence of interlocking volcanic flow rocks, chiefly basalt. The Basin and Range province consists mostly of uplifted and partly dissected faultblock mountains separated by downfaulted basins. The climate of the uplands is semiarid to subhumid and that of the valleys and plain is arid to semiarid.

SURFACE FEATURES

In the South Side area the Snake River Plain is an elongated belt of nearly flat to gently rolling land, 1 to 12 miles wide, forming an irregular, broad arc adjacent to the Snake River. About a dozen volcanic hills are scattered over the part of the plain discussed in this report. At the north edge of the South Side area the channel of the Snake River ranges in depth from 25 feet to more than 400 feet below the plain and is cut in basalt, lake beds, and alluvium. In the northeastern part of the area, the basin of the American Falls Reservoir and the channel of the Portneuf River are mostly in lake beds that extend under adjacent terraces. Below American Falls the Snake River enters a narrow canyon 50 to 150 feet deep. Successive downstream reaches of the canyon are shallower, and from Minidoka Dam to Milner the river channel is only 25 to 30 feet below the general level of the adjacent plain. Near Milner the river enters a canyon that deepens downstream. At the northwest corner of the area the Snake River canyon is more than 400 feet deep and about 1,500 feet wide.

The principal basins or valleys in the South Side area, in order from west to east, are as follows: the lower Goose Creek, Raft River, Rockland, and Bannock Creek-Arbon. The lower Goose Creek and Raft River valleys merge on the north with the Snake River Plain, but their geologic structure and history link them to the Basin and Range province, rather than to the plain. The lower Goose Creek valley is rudely triangular in outline and its floor is a gently sloping alluvial plain, bounded by mountains on the west, south, and east, and merging with the Snake River Plain on the north. The Raft River valley, which is more than 10 miles wide and about 40 miles long, slopes gently northward. The flanks of the lowland are occupied by coalescing alluvial fans which extend from the bases of surrounding mountains. The central valley floor is largely an alluvial flood plain.

428381—57——2

The Rockland Valley is about 30 miles long and averages 5 to 6 miles in width. The valley is irregular in form and its floor is rather rough and rolling.

The Arbon Valley is an intermountain basin about 4 miles wide and 15 miles long which contains the headwaters of Bannock Creek. Downstream from Arbon Valley is the valley of Bannock Creek, a narrow, flat-bottomed valley half a mile to 2 miles wide, extending northward about 20 miles to the Michaud Flats section of the Snake River Plain.

There are several minor valleys and basins in the area. The area known as Basin, an upland basin east of Oakley, is about 5 miles long and 3 miles wide and drains to the lower Goose Creek valley through a narrow notch in the bordering hills. Albion basin, a triangular area containing about 25 square miles between the Albion Range and the Malta Range, opens onto the Snake River Plain through a narrow canyon east of Declo. The Almo and Elba basins are in the south-central part of the area and drain into the Raft River valley. All the valleys tributary to the Snake River Plain are bounded on the east and west by mountain ranges, the axes of which are nearly parallel and trend northward. The Raft River valley is bordered on the south by the Raft River Mountains, a domed uplift whose major axis trends eastward. This uplift, most of which lies in northwestern Utah, is not of direct concern in this report. In the extreme southwestern part of the South Side area, along the southwestern side of the lower Goose Creek valley, tilted mountains slope northeastward and eastward. The mountains, called the Rock Creek Hills by Russell (1902), are known locally both by that name and as the South Hills. Beyond the map area in southwestern Cassia County parts of the Rock Creek Hills attain elevations of more than 8,000 feet. The hills are largely a plateau, capped by rhyolite or latite, into which deep, narrow valleys or canyons have been cut. Benches and mesas form the interstream areas. Outside the volcanic area Paleozoic rocks form steep hills. The Rock Creek Hills slope steeply northward and terminate abruptly at the edge of the Snake River Plain. The eastern front of the hills slopes sharply toward the lower Goose Creek valley.

East of the lower Goose Creek valley is the Albion Range, a high, broad range extending from near the boundary between Utah and Idaho to the edge of the plain east of Declo. Cache Peak, in the central part of this range, is more than 10,000 feet in altitude and is the highest peak in Idaho south of the Snake River. The western and northwestern sides of the Albion Range form a steep front along the southeast side of the lower Goose Creek valley. The eastern side of the range is indented by the Albion, Elba, and Almo basins. The summit of the range has not been deeply dissected.

South of Oakley and separated from the Rock Creek Hills and the Albion Range by deep, narrow valleys is South (Middle) Mountain, a northward extension of the Goose Creek Mountains of Utah and Nevada. This mountain is a fault block having a long westward back slope and a steep eastern face. It has been but little dissected by erosion.

The Malta Range, east of the Albion Range, is separated from that range only by the small Albion, Elba, and Almo basins. The Malta Range extends from near the Utah boundary northward to a point northeast of Declo, where it slopes beneath the Snake River Plain. The bold eastern front of the range, facing the valley of the Raft River, rises more than 3,000 feet above the valley floor and more than 8,000 feet above sea level. The western front also is steep but is not as high as the east side. A prominent capping of volcanic rock protects the steep slopes of the range, but where the rock has been cut through by erosion the underlying beds of volcanic ash are removed easily by erosion.

On the east side of the Raft River valley are the deeply dissected Black Pine and Sublett Ranges. The Black Pine Range is about 17 miles long and 9 miles wide and its highest altitude is about 9,700 feet. The range occupies the southeastern corner of Cassia County and is separated from the Sublett Range on the north by a broad pass. The maximum altitude of the Sublett mountains is only about 7,500 feet. The range is long, broad, and irregular in form, having the appearance of a maturely dissected plateau; it consists largely of nearly parallel ridges separated by steep, narrow valleys. Its northern end slopes beneath the Snake River Plain just south of the Snake River.

The Deep Creek Mountains, in south-central Power County and northern Oneida County, separate Rockland Valley from the Arbon Valley and the valley of Bannock Creek. This mature range is about 12 miles wide and 45 miles long, rising abruptly above the bordering valleys and culminating in Bannock Peak at an altitude of 8,256 feet. On the north the range terminates rather sharply between American Falls and Pocatello.

The South Side area is bordered by the Bannock Range on the northeast and the Blue Springs Hills on the southeast. These ranges are similar to the Deep Creek Mountains: they are broad, are deeply dissected, and rise sharply from the valley floors.

DRAINAGE

The entire South Side area is tributary to the Snake River. The main stream in each principal valley flows northward and has several tributaries. The largest main stream is the Portneuf River, which enters the Snake near the northeast corner of the area. Only a very small part of the basin of the Portneuf River is in the report area. The discharge of some streams, such as Dry, Cottonwood, and Goose Creeks, is diverted or stored for irrigation, and water from these streams rarely reaches the Snake River. Characteristically, most streams are perennial only in their headward reaches or in large valleys and canyons. Intermittent discharge across the alluvial valley floors occurs chiefly during floods. Many streams have alternate "loss and gain" reaches, that is, water is lost by infiltration at some places and at others the flow is increased by effluent ground water.

Two streams bear the name Rock Creek, one in Twin Falls County, one in Power County. Rock Creek in Twin Falls County rises in the Rock Creek Hills and flows northward to the Snake River Plain. After leaving the uplands and flowing northward across the plain for 2 or 3 miles, the creek turns northwestward, passes through a canyon in basalt, and finally joins the Snake River northwest of Twin Falls. Most of the water in the stream is diverted near where it debouches onto the plain, but downstream return flow from irrigated lands served by the Twin Falls South Side Canal Company probably exceeds the original normal flow. Rock Creek in Power County is the principal stream in the Rockland Valley.

Dry Creek, Cottonwood Creek, and a few other small streams rise in the Rock Creek Hills and, like Rock Creek, are largely diverted for irrigation.

Most of the watershed of Goose Creek is outside the South Side area in the southern extension of the Rock Creek Hills and in the Goose Creek Mountains in Cassia County, Idaho, Elko County, Nev., and Box Elder County, Utah. The headwater area was described by Piper (1923). The Goose Creek Reservoir has filled only once since its completion in 1913. All water from the reservoir is diverted for irrigation and there is practically no natural flow in the creek below the reservoir. Two of the main tributaries of Goose Creek are Birch Creek, which rises between South Mountain and the Albion Range, and Basin Creek, which rises in the Albion Range. In the lower Goose Creek valley the channels of these streams are indistinct and rarely contain water.

Marsh Creek and its tributaries drain the northeast slopes of the Albion Range and the Albion basin. The creek flows northward through a narrow valley between the Albion and Malta Ranges, reaches the Snake River Plain, and flows westward through Declo to the Snake River. An odd feature of this drainage is that the headwaters all rise in the Albion Range. The Malta Range lies in the rain shadow of the Albion Range and contributes very little runoff to Marsh Creek.

The Raft River system occupies the largest drainage basin in the area. The Raft River rises in the Raft River Mountains in Utah, flows northward into the Almo basin of Idaho, and then passes eastward through a gap (The Narrows) in the southern end of the Malta Range. From The Narrows the river swings northeastward to the axis of the Raft River valley. About 12 miles above its mouth the river is deflected eastward around basalt flows. The principal tributaries of the Raft River are George, Clear, Cassia, and Sublett Creeks.

Fall Creek, the only perennial stream between the Raft River and Rockland Valley, rises in the hills at the north end of the Sublett Range, flows a short distance in a deep valley across the Snake River Plain, and joins the Snake River about 20 miles southwest of American Falls.

Rockland Valley is drained by Rock Creek, whose headwaters are in the east side of the Sublett Range and the west slope of the Deep Creek Mountains. Northward from Rockland village the stream flows for about 6 miles through a canyon cut in basalt and ash beds, then joins the Snake River southwest of American Falls.

Bannock Creek rises in the southern part of Arbon Valley and empties into American Falls Reservoir. The principal tributaries of Bannock Creek are Knox, Moonshine, and Starlight Creeks on the west and Rattlesnake Creek on the east.

CLIMATE

The climate of the Snake River Plain and of the basin and range area is generally semiarid. Winters are moderately to severely cold, and summers are hot and dry. The diurnal range of temperature is large and precipitation is meager. The average relative humidity is about 50 to 55 percent and is lower in summer than in winter. The average wind speed at Pocatello is about 9 miles per hour and the recorded maximum is more than 75 miles per hour. The prevailing wind is southwest.

PRECIPITATION

The average annual precipitation ranges from less than 10 inches on the Snake River Plain in the Twin Falls-Burley area to about 35 inches in the higher mountains south of the plain. There is little information about precipitation in the mountains. Precipitation and

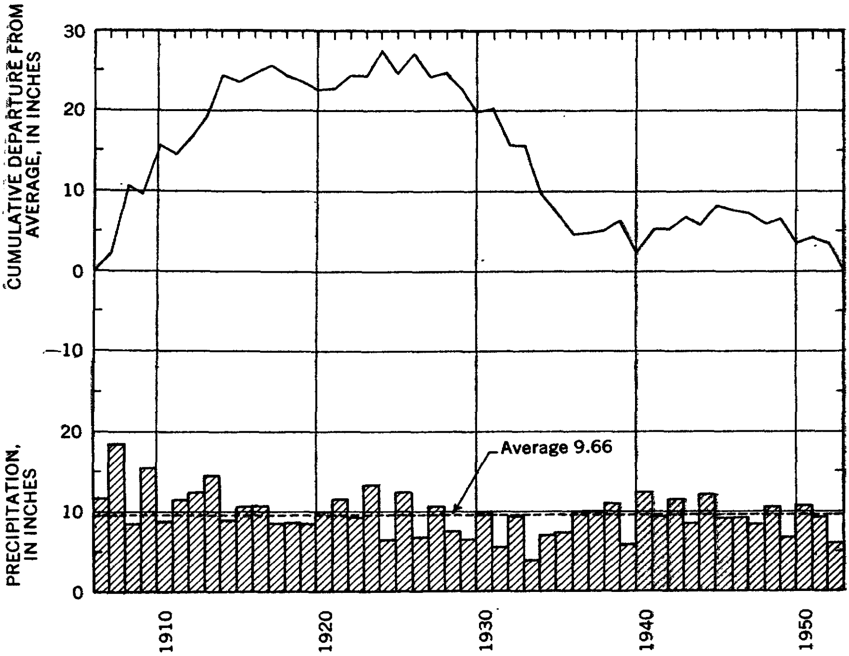

FIGURE 8.—Annual precipitation and cumulative departure from average at Twin Falls.

temperature records for the foothill and lowland areas are summarized in table 1.

In the Raft River drainage basin the annual precipitation ranges from 10–12 inches on the main valley floor to 27–35 inches at higher altitudes and is estimated to average about 13 inches in the basin as a whole (R. L. Nace, 1955, oral communication).

Precipitation is chiefly snow during December, January, and February at lower altitudes and from November to April at higher altitudes. Despite the semiarid climate, precipitation in much of the South Side area is fairly well distributed throughout the year. July and August are the driest months.

Precipitation at four representative stations (figs. 8–11) varies greatly from year to year. For example, at Oakley (fig. 10) precipitation was more than 16 inches in 1909 and less than 8 inches in 1910. Precipitation generally was high from 1906 to 1916 and low from 1931 to 1935. During the "wet" years large tracts in the South Side area were dry-farmed and the Goose Creek irrigation project was completed. During later years of average to deficient precipitation much of the dry-farmed land was abandoned. Concurrently, the Goose Creek and some other irrigation projects often were short of water.

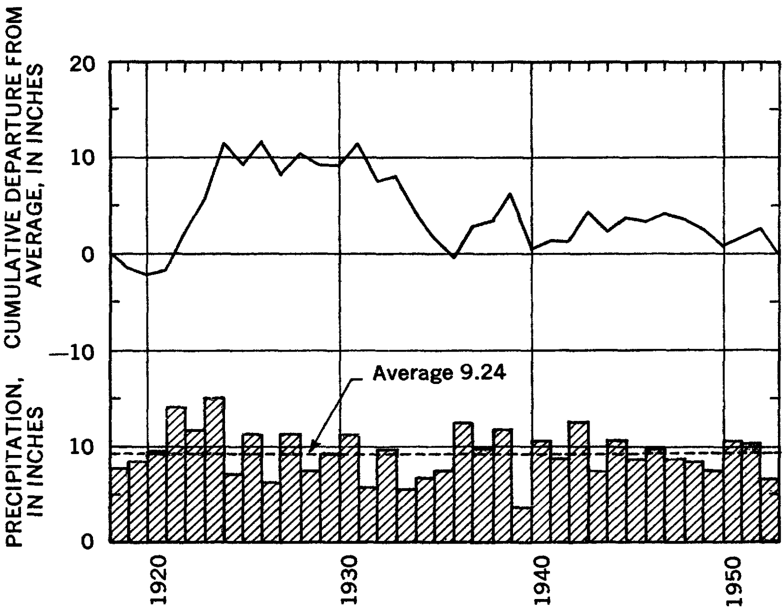

FIGURE 9.—Annual precipitation and cumulative departure from average at Burley.

TEMPERATURE

The mean annual temperature in the South Side area ranges from 42.8° F at Strevell in southern Cassia County to 49.1° F at Twin Falls in Twin Falls County (table 1). January usually is the coldest month, the mean monthly temperatures at different stations ranging from about 18° to 28° F. July is the warmest month, the mean monthly temperatures ranging from 62° to 72° F. The agricultural areas generally are free from killing frosts from late May until late September. Recorded extreme temperatures have ranged from —38° F at American Falls in January 1949 to 108° F at Oakley in July 1893.

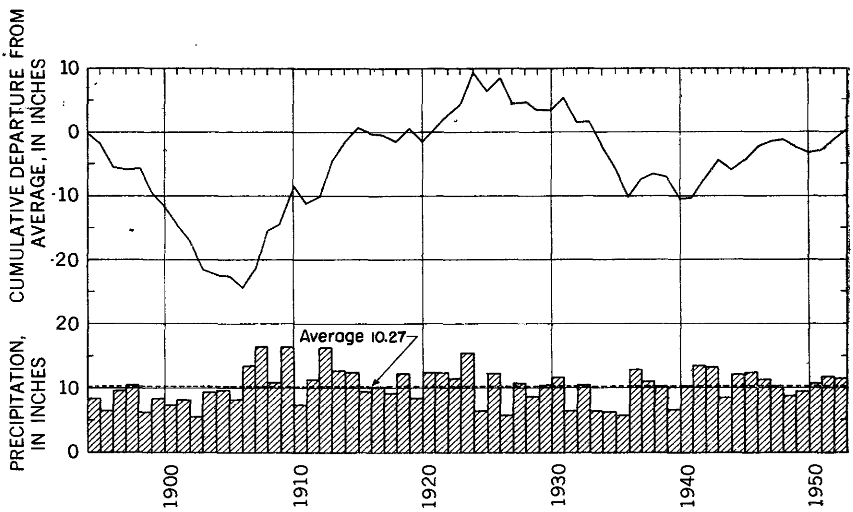

FIGURE 10.—Annual precipitation and cumulative departure from average at Oakley.

EVAPORATION

Stearns and others (1938) presented data concerning evaporation pans at Jerome, about 12 miles northwest of the area; at Sterling in Bingham County; and at Milner, American Falls, and Michaud in the South Side area. Additional data were collected by the University of Idaho and by the U. S. Weather Bureau at Minidoka Dam and by the University of Idaho at the Aberdeen Experimental Station. The average evaporation from the Weather Bureau class A land pan at Minidoka Dam, measured during the period May–September in the years 1949–54, was 53.02 inches. At other stations in or near the South Side area evaporation from class A land pans during the growing season ranges from 26 to 48 inches. In general, evaporation from ponds and reservoirs in southern Idaho probably is about 70 percent of that from land pans (Follansbee, 1934).

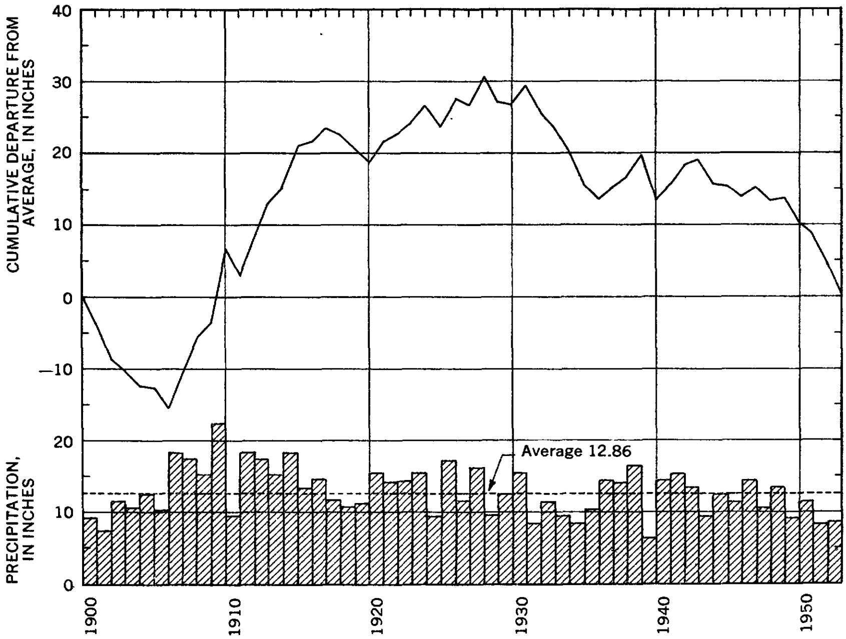

FIGURE 11.—Annual precipitation and cumulative departure from average at Pocatello.

DEVELOPMENT

POPULATION

The population of Cassia County in 1950 was 14,629; that of Power County was 3,988; and that of Twin Falls County was 40,979, of which approximately 5,000 was in the northeastern part of the county. A small part of the population of Power County is north of the Snake River. The population of the part of Oneida County within the South Side area is small. Tables 2 and 3 show respectively the population of principal urban centers and of the parts of counties that are in the South Side area.

428381—57——3

TABLE 1.—*Mean annual precipitation and temperature in the South Side area, Idaho*

[From records of the U. S. Weather Bureau]

Station	Precipitation (inches)	Temperature (° F)	Years of record	Altitude (feet)
Albion	13. 92	46. 4	23	4, 750
Almo	17. 33	--------	[1] 8	5, 500
American Falls 1 NW	12. 96	46. 2	56	4, 316
Burley	9. 39	48. 7	36	4, 180
Burley CAA AP	9. 26	47. 7	16	4, 157
Burley Factory	10. 00	47. 3	29	4, 140
Milner Dam	--------	47. 9	[1] 18	4, 135
Minidoka Dam	13. 87	47. 4	[1] 7	4, 200
Oakley	10. 20	48. 3	60	4, 600
Paul	10. 34	48. 0	19	4, 200
Pocatello	12. 44	47. 2	53	4, 444
Rupert	9. 95	47. 6	47	4, 204
Strevell	11. 56	42. 8	[1] 14	5, 280
Twin Falls 2 NE	9. 77	48. 5	48	3, 770
Twin Falls 3 SE	8. 88	49. 1	29	3, 770

[1] Includes some years of incomplete records.

TABLE 2.—*Population of principal urban centers in the South Side area*

[Based on records of the U. S. Bureau of the Census]

City	County	1940	1950	Increase (percent)
Albion	Cassia	357	610	71
American Falls	Power	1, 439	1, 874	30
Burley	Cassia	5, 329	5, 924	11
Declo	Cassia	238	219	−8
Hansen	Twin Falls	527	463	−12
Kimberly	Twin Falls	963	1, 347	40
Murtaugh	Twin Falls	272	239	−12
Oakley	Cassia	813	684	−16
Pocatello	Bannock and Power	18, 133	26, 131	44
Rockland	Power	277	277	0
Twin Falls	Twin Falls	11, 851	17, 600	48. 5

TABLE 3.—*Population of the South Side area*

[Based on records of the U. S. Bureau of the Census]

County	Area [1] (square miles)	Population 1940	Population 1950
Cassia	2, 250	14, 430	14, 629
Power	960	3, 250	3, 500
Twin Falls	200	------	5, 000
Totals	3, 410	------	23, 129

[1] Estimated. Includes only the part of each county that is in the South Side area.

AGRICULTURE

About 510,000 acres of land is farmed. The principal irrigated crops are alfalfa, potatoes, sugar beets, small grain, onions, beans, peas, and seed clover. The principal dry-farm crops are small grains, chiefly wheat. Cattle and sheep raising are important industries, and horses, swine, poultry, and dairy products provide considerable income. According to the U. S. Census of Agriculture the dollar value of crops produced in Cassia County was about $7,322,000 in 1945 and $8,311,000 in 1950. The value of livestock was about $4,278,000 in 1945 and $6,663,000 in 1950. Agricultural production in the part of Twin Falls County east of Rock Creek probably is on a comparable scale, but in Power County production is lower, owing to the small area under irrigation.

INDUSTRY AND NATURAL RESOURCES

Industries in the South Side area include cheese factories, a sugar-beet-processing plant, potato and seed warehouses, creameries, plants for fabricating construction materials, a phosphate-fertilizer plant, a chemical plant producing elemental phosphorus, and numerous other smaller industries. The principal natural resources are water and soil. Sand and gravel, building stone, and a few low-grade mineral deposits in the Albion and Black Pine Ranges are exploited.

TRANSPORTATION

The agricultural area is served by a system of Federal and State highways and improved county roads. U. S. Highway 30 (Oregon Trail Highway) crosses the northern part of the area through Twin Falls, Burley, and Pocatello. At Burley U. S. Highway 30S branches southeastward through the Raft River valley to Salt Lake City, Utah. Each of the principal basins except the Arbon Valley is joined to the Federal highway by a paved State highway. Arbon Valley is served by a graveled State road. Each basin and the western part of the southern Snake River Plain has a network of county roads. In addition, U. S. Forest Service, county, and private roads traverse the mountains.

The main line of the Union Pacific Railroad crosses the northeastern part of the area. A branch line and spurs from Minidoka serve Burley, Declo, Oakley, and Twin Falls.

United Air Lines connects Twin Falls to Boise, Idaho, and Salt Lake City, Utah. West Coast Airlines serves Twin Falls, Burley, and Pocatello. Western Airlines connects Pocatello to Idaho Falls, Idaho, and Salt Lake City.

WATER USE

IRRIGATION

About 145,000 acres of land in the South Side area is irrigated, chiefly with surface water. In 1952 about 35,000 acres was irrigated wholly or partly with ground water. The area irrigated in Cassia and Power Counties in 1944 and 1949, the latest years for which reliable figures are available, is shown in table 4. Table 5 summarizes the growth of ground-water irrigation in the Oakley area and the Raft River valley.

TABLE 4.—*Area irrigated in Cassia and Power Counties*

[From records of U. S. Bureau of the Census]

	Cassia County		*Power County* [1]	
	1944	*1949*	*1944*	*1949*
Number of irrigated farms	1, 201	1, 150	125	170
Irrigated land (acres)	91, 434	100, 391	8, 970	10, 868
Nonirrigated land (acres)	------	86, 289	------	311, 369

[1] Includes area north of the Snake River.

TABLE 5.—*Irrigation in the lower Goose Creek and Raft River valleys*

[From records of U. S. Bureau of the Census]

	Oakley area		*Raft River valley*	
	1949	*1952*	*1949*	*1954*
Irrigated land (acres)				
With surface water	14, 040	--------	20, 279	-----
With ground water	559	[1] 5, 500	1, 037	6, 000
With both surface and ground water	705	--------	6, 776	-----

[1] Estimated.

TABLE 6.—*Principal irrigation dams on southern Snake River Plain, Idaho*

Dam	*Year completed*	*Usable storage (acre-feet)*	*Acres irrigated in report area*
Milner	1905	----------	?
Minidoka	1909	95, 000	50, 000
Goose Creek	1913	74, 000	15, 000
American Falls	1927	1, 700, 000	-------
Sublette	1935	2, 300	?

The Twin Falls South Side Canal Co., which serves the earliest major irrigation development in the South Side area, was developed under the provisions of the Federal Carey Act. Irrigation water was first delivered to the district in 1905. The district (including the Murtaugh-Hansen-Kimberly area) is served chiefly by water diverted from the Snake River at Milner Dam. Milner Dam also diverts irrigation water to lands near Milner and Murtaugh (Milner Low-Lift Project) as well as to tracts north of the Snake River in Gooding, Jerome, and Lincoln Counties. Other dams in the South Side area and their completion times are Minidoka, 1907, Goose Creek, 1913, American Falls, 1927, and Sublett, 1935. Minidoka Dam diverts water for irrigation both south and north of the Snake River, to the South Side Pumping Division and North Side Gravity Division of the Minidoka Project, respectively. Goose Creek Reservoir serves the Goose Creek valley in the vicinity of Oakley, and Sublett Reservoir serves land along Sublett Creek. American Falls Reservoir is the key management facility for the entire Snake River water supply to the irrigated area in the Snake River Plain east of the Hagerman Valley. Operation of all other dams and reservoirs is supplemental to that of American Falls Reservoir.

MUNICIPAL AND DOMESTIC WATER SUPPLIES

The following list shows the sources of municipal water supplies in the South Side area.

Ground Water	*Surface Water*
Alameda	Pocatello
Albion	Twin Falls
American Falls	
Burley	
Hansen	
Kimberly	
Oakley	
Pocatello	
Rockland	

It is understood that Alameda and Pocatello soon will add to their supplies by drilling additional wells. Farm and small-village supplies are obtained from wells, except around Oakley, where water is piped to many farms from a well and a group of springs. A few ranches obtain domestic and stock water from springs.

GEOLOGY

STRATIGRAPHIC UNITS AND THEIR WATER-BEARING PROPERTIES

Thorough knowledge of the ground-water geology of the South Side area would be essential for a comprehensive evaluation of the ground-water resources because the occurrence of ground water is affected strongly by the physical character and structure of the rocks. The rocks exposed in the South Side area range in age from Precambrian(?) to Recent (table 7), but not all intervening geologic periods are represented. Very little geologic field study was done by the writer, and the data presented herein were compiled chiefly from published and open-file reports by others. Rocks of Proterozoic(?) to middle Tertiary age crop out in the hills and mountains, and the younger rocks are exposed on the Snake River Plain and in valley lowlands. A thick sequence of metamorphosed Precambrian(?) sedimentary rocks is exposed in the Albion Range and South Mountain. Rocks of Paleozoic age crop out in each mountain range except the Malta Range. Rocks of Cambrian, Ordivician, Mississippian, Pennsylvanian, and Permian ages have been identified, but they are not differentiated on the geologic map (pl. 5) because detailed representation of those units would be impracticable on the scale of the map and would have little significance for the purposes of this report. The age relation of the formations and their distribution in mountain areas are summarized in table 7.

TABLE 7.—*Age and type of rocks in mountain ranges south of the Snake River Plain*

Mountain range	*Age and type of rocks*
Rock Creek Hills	Undifferentiated limestone, shale, and quartzite of Paleozoic age; Tertiary silicic volcanic flows and pyroclastic and sedimentary rocks.
South Mountain	Precambrian(?) metamorphic rocks and Cretaceous(?) granite.
Albion Range	Precambrian(?) metamorphic rocks; Mississippian limestone and sandstone; Pennsylvanian sandstone and chert; Cretaceous(?) granite; Tertiary silicic volcanic flows and pyroclastic and sedimentary rocks.
Malta Range	Tertiary silicic volcanic flows and pyroclastic and sedimentary rocks.
Raft River Mountains (Utah)	Precambrian(?) metamorphic rocks; Cambrian quartzite, sandy shale, limestone, and dolomite.
Black Pine Range	Mississippian limestone and sandstone; Pennsylvanian sandstone and chert; Permian shale, chert, and limestone.
Sublett Range	Mississippian limestone and sandstone; Pennsylvanian sandstone and chert; Permian shale, chert, and limestone.
Deep Creek Mountains	Cambrian quartzite; Cambrian and Ordovician limestone; Carboniferous limestone, shale, and chert; Tertiary volcanic flows and pyroclastic and sedimentary rocks.
Blue Springs Hills	Cambrian quartzite; Carboniferous limestone, shale, and chert.
Bannock Range	Cambrian and Ordovician limestone; Ordovician dolomite and quartzite; Mississippian limestone; undifferentiated limestone, shale, and sandstone of Paleozoic age; Tertiary volcanic flows and pyroclastic and sedimentary rocks.

A granitic intrusive body of Cretaceous(?) age is exposed in the southern part of the Albion Range. About 5 miles west of Almo, in an area called the Cassia City of Rocks, the granitic rock has been shaped by weathering and erosion into extraordinary forms. Rocks that are thought to be apophyses of the intrusive body crop out farther north in the Albion Range and on the north and east sides of South Mountain.

Sedimentary rocks of Mesozoic age have not been identified in the South Side area. Tertiary rocks, consisting of silicic to basic igneous flows and pyroclastic rocks, and Miocene(?) to Recent sediments are distributed widely in the area. The Precambrian(?) and Paleozoic rocks are important in the hydrology of the basin because fractures, faults, and solution cavities in the rocks yield water to stock and domestic wells and to springs. The rocks also occupy much of the upland catchment area where rain and snowmelt enter the rock voids and become ground water, which is transmitted by underflow to the basins.

The chief water-bearing formations from which water can be pumped for irrigation are the silicic and basic flow rocks, pyroclastic sediments, and alluvial sand and gravel. Rhyolitic rock, latite, and associated ash beds yield small to moderate amounts of water to wells, commonly under artesian pressure. Blocky, broken, and fractured basalt and cinder beds yield water copiously to irrigation wells at many places. Alluvial flood-plain and fan materials yield small to large amounts of water, depending on their local characteristics. Table 8 summarizes the water-bearing properties of the geologic formations.

STRUCTURE

The principal structural control of the occurrence and movement of the ground water in the South Side area is that by faults. Faulting has displaced all rocks older than the Snake River basalt. Most of the Precambrian(?) and Paleozoic rocks in the mountain ranges are extensively folded and faulted. Presumably all these rocks are present at moderate to great depth beneath the valleys and the Snake River Plain. The rocks of middle to late Tertiary age are faulted and tilted. The tilting has produced the necessary structural condition for the occurrence of artesian water in the Dry Creek area (p. 121) and at other places.

Late block faulting produced the basin-and-range structures in the mountain and valley areas. Regional subsidence of the Snake River Plain formed the Snake River downwarp (Kirkham, 1931), and faulting around the borders of the plain may have accompanied the downwarping. The plain thus is a large structural basin that extends in a broad arc from the vicinity of Yellowstone Park westward through southern Idaho into eastern Oregon. Lava flows from numerous vents flooded the plain, which was built up by innumerable interlocking layers of basalt.

TABLE 8.—*Stratigraphic units and their water-bearing properties*

Era	Period or epoch		Formation	Thickness (feet)	Physical character and areal distribution	Water-bearing properties
Cenozoic	Quaternary	Recent and Pleistocene	Alluvium	0–200+	Alluvial clay, silt, sand, and gravel underlying the valley and basin floors. Includes windblown silt, sandy clay, and very fine sand, which mantle parts of the lowland areas and are mixed with alluvium; landslide and talus materials bordering steep mountain slopes; and clay, silt, sand, and clean water-worn gravel and boulders along stream channels.	Sandy and gravelly alluvium yield considerable ground water in the Dry Creek, Oakley, Burley, Raft River, and Bannock Creek areas and in the eastern part of Michaud Flats. The alluvium has not been tested adequately in other areas. Windblown deposits and landslide and talus materials are not important aquifers because at most places they are above the zone of saturation.
		Pleistocene	Burley lake beds (not exposed)	450±	Clay, silt, sand, and fine gravel, unconsolidated to well-compacted and intercalated basalt; known only from drill holes in the vicinity of Burley, Rupert, and Paul; underlie alluvium and windblown deposits. Intercalated basalt layers occur 150 to 225 feet below the surface and at the bottom of the sequence.	Sand, gravel, and basalt yield moderate amounts of water to domestic wells. Clay and silt retard vertical percolation and perch some ground water in the Burley Irrigation District; at depth they are confining beds in artesian systems.
			American Falls lake beds	150+	Buff and brown clay and sand, partly consolidated; locally fossiliferous; mantled at places by windblown deposits; exposed in bluffs along the shore of American Falls reservoir. About 60 feet below the top of the formation is a thin bed of basic tuff and at least one intercalated basalt flow. The lower part is sandy and gravelly and may grade downward into older alluvium. The upper part is coarse grained and gravelly toward Pocatello.	The fine-grained beds yield little water and are imperfect confining beds that hold water in underlying coarse-grained beds, which yield moderate amounts of water to irrigation wells. In the eastern part of the Michaud Flats the formation and intercalated or underlying coarse alluvium yield water copiously to wells.
	Tertiary and Quaternary	Recent to Pliocene	Snake River basalt	200+	Olivine basalt, gray to black, dense to vesicular, fine-grained, with irregular and columnar jointing; contains some broken basalt, cinders, and interflow sediments; crops out discontinuously in the Dry Creek, Golden Valley, Burley, and Rockland Valley areas and south of Lake Walcott. At most places the basalt is mantled by a veneer of windblown material; at some other places it is covered by alluvium. Some of the basalt flows are younger than the Burley and American Falls lake beds and some may be older than the Raft lake beds.	An important aquifer in the Dry Creek, Burley, and South Walcott areas, where it yields unconfined water copiously to wells. Receives recharge readily. Interflow sediments yield little or no water.
	Tertiary	Pliocene	Raft lake beds	200±	Partly consolidated beds of buff clay, silt, and sand; concretionary in places. Crop out south of the Snake River between the Raft River and Rock Creek, where they form a high bluff and bench along the Snake River.	Yield small amount of water to domestic wells.

Cenozoic	Tertiary		Rockland Valley basalt (not differentiated from Snake River basalt)	250±	Evenly bedded blue and black weathered basalt. Crops out on the west flank of Rockland Valley near the Snake River.	Water-bearing properties not known.
		Pliocene(?)	Massacre volcanics (not differentiated from Snake River basalt)	?	Dikes, pyroclastic debris, and basalt flows. Exposed along the Snake River near the mouth of Rock Creek in Power County.	Water-bearing properties not known. Probably not an important aquifer.
			Eagle Rock tuff (not differentiated from Snake River basalt)	35±	Welded rhyolitic tuff and pumice. Exposed along the Snake River between Rock Creek and American Falls.	Water-bearing properties not known. Probably not an important aquifer.
			Neeley lake beds	100±	Beds of partly reworked tuff and ash, flesh-colored to brown, evenly bedded. Exposed along the Snake River for a short distance downstream from American Falls.	Probably yield little ground water to wells.
			Lake beds (not differentiated on map)	?	Fine-grained beds underlying alluvium in Raft River valley. May be part of the Salt Lake formation.	Yield small to moderate amount of water to wells, commonly under artesian pressure. Water is warm and highly mineralized at some places.
		Pliocene (?) and Miocene	Tertiary volcanic rocks and associated sediments	1, 400+	Flows and welded tuff, commonly called rhyolite; consist of latite flow rocks, welded tuff, fine- to coarse-grained ash, commonly reworked by running water, and silt, sand, and gravel; include also some flows of rhyolite, andesite, and basalt; exposed widely in the highlands; scattered outcrops occur in the lowlands. In the Dry Creek area some of the beds are moderately to highly altered, forming the so-called "water talc" of drillers.	Joints and fault zones in the flows and welded tuff yield small to moderate quantities of water to wells. Coarse-grained ash beds, sand, and gravel also yield small to moderate amounts of water. Nonpermeable altered beds and some fault zones control the movement of ground water. Form an imp rtant artesian aquifer in the Dry Creek area. Have not been adequately tested in other areas.
Mesozoic	Cretaceous(?)		Granite (Cassia batholith)	------------	Even-grained to porphyritic granite and granodiorite. Exposed in the southern part of the Albion Range and in South Mountain.	Yields water to a few small springs. Joints and other fractures probably would yield small amount of ground water to wells.
Paleozoic	Permian to Cambrian		Undifferentiated rocks ranging from Cambrian to Permian in age	------------	Limestone, quartzite, sandstone, dolomite, and shale, thin- to thick-bedded. Exposed in all the mountain ranges except the Malta Range.	Yield water to several large springs, but yield little or no water to wells except where the rock is fractured. Transmit an undetermined amount of water from catchment areas to the lowlands.
Proterozoic (?)	Precambrian (?)		Undifferentiated rocks	------------	Mostly quartzite, but include marble, schist, and gneiss. Exposed in the Albion Range and in South Mountain.	Fractured zones yield small amount of water, but the rocks as a whole are nonpermeable.

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OCCURRENCE AND DEVELOPMENT OF GROUND WATER

The ultimate source of practically all ground water is precipitation. Some of the precipitation runs off the land surface in streams, some evaporates directly and some is evaporated from vegetation (transpired), and the remainder enters the ground and recharges the ground-water reservoirs. At most places the ground water has a complex history but eventually it is discharged through wells and springs and by transpiration. Porous, coarse-grained or cavernous aquifers usually yield water copiously. Examples of good aquifers are coarse-grained sand and gravel and jointed or scoriaceous basalt.

DRY CREEK AREA

The Dry Creek area, as here defined, is north of the Rock Creek Hills and south of the Snake River in Tps. 10–12 S., Rs. 18–20 E. (pl. 5). Much of the area is a nearly flat plain which rises gently southward toward the Rock Creek Hills. There are two broad, low volcanic cones a short distance south of the Snake River. Hansen Butte, the larger dome, which is southeast of Hansen, covers several square miles. The smaller dome is south of Kimberly and just north of Rock Creek.

GEOLOGY

Quaternary alluvium and windblown clay, silt, and sand cover most of the region. Sand and gravel occur along the courses of Cottonwood, Dry, and Rock Creeks. The thickness of the alluvium ranges from a few feet to more than 75 feet. The northern foot of the Rock Creek Hills is mantled with low, gently sloping alluvial fans consisting of material ranging in size from clay to large boulders.

The Snake River basalt underlies the northern three-fourths of the area at shallow to moderate depth. The basalt crops out in the two buttes mentioned above, in the canyon of the Snake River, and on the plain east of the Dry Creek area in R. 21 E. Interbedded with the basalt layers are thin to thick beds of alluvium and windblown material, and a few cinder beds.

The alluvium in the southern quarter of the region is underlain by Tertiary volcanic rocks, including consolidated flows, welded tuff, and volcanic ash. These rocks are physically continuous with similar rocks in the adjacent Rock Creek Hills. The Snake River basalt overlaps the Tertiary rocks.

HYDROLOGY

UNCONFINED GROUND WATER

Unconfined ground water occurs in alluvial sand and gravel in the central part of the Dry Creek area and in fractured basalt northward toward the Snake River. Yields from most of the present wells in the alluvium are low to moderate, ranging from 50 to 450 gpm. The water table is only 25 to 100 feet below the land surface, however, and the low pumping lift helps to make the development of ground water for irrigation economically feasible at some places. Improvement of well construction would increase yields.

The basalt and cinder beds yield large amounts of ground water. Near Murtaugh the depth to water is only 30 to 45 feet, but the depth is greater elsewhere, ranging up to 465 feet or more on the slopes of Hansen Butte.

In the western and central parts of the area ground water in the unconfined aquifers moves northwestward toward the Snake River. In the eastern part of the area it moves northeastward. Some of the water may be discharged naturally by percolation into the basalt and alluvium of the Golden Valley area to the east, but no evidence of such discharge is at hand.

A small amount of ground-water recharge is derived from local precipitation in the Dry Creek area. The principal sources of recharge and replenishment, however are underflow from the Rock Creek Hills and infiltration of water from local streams and from canals and irrigated fields. Perhaps some recharge of unconfined ground water is by upward leakage from artesian aquifers in the underlying Tertiary extrusive rocks.

ARTESIAN GROUND WATER

The Tertiary volcanic rocks underlying the southern part of the area yield small to moderate amounts of artesian water to irrigation wells. The water occurs under small to moderate artesian pressure in several aquifers, and the depth to the static water level in some wells is 5 feet or less. Several wells at Artesian City, 5 miles south of Murtaugh, and a few wells near Rock Creek flowed at one time. However, only a few wells now flow, all these being in the canyon of Rock Creek. Reported yields of the flowing wells range from 5 to 650 gpm.

Many faults complicate the movement of water and the head in the artesian aquifers. Drill cuttings show that there is jasper and opal in some of the fault zones. These minerals probably were deposited by circulating mineralized water, which also altered much of the rock to bentonitic clay. The mineral deposits and alteration products reduce the permeability of the aquifer in the fault zones and at some places restrict the lateral movement of ground water. Also, some permeable beds are offset by faults, so that they abut against impermeable rocks, thus sealing the truncated ends of some aquifers. At other places in the fault zones, however, soluble minerals seemingly have been leached out, leaving the zone more permeable than the original rock. Detailed subsurface geologic data for the Dry Creek area are not available, and the influence of structure on the occurrence of ground water is poorly understood.

DEVELOPMENT OF WATER RESOURCES

The irrigation needs of the part of the Dry Creek area near Murtaugh, and of the part south of Kimberly and Hansen and north of Rock Creek, are served amply by water from the Snake River. Small tracts along Rock and Dry Creeks above the highline canal are irrigated with creek water when it is available.

No surface water is available to irrigate the remainder of the area. Ground water has been developed rapidly during the last 6 years, and the Dry Creek area is the most intensively pumped area in Idaho, measuring intensity as the ratio of pumpage to total ground-water supply. Since 1952, when the irrigation wells were inventoried by the Geological Survey, several drilling rigs have been continuously active in the area. Some older wells have been deepened and a few new ones have been drilled. Pumpage for irrigation in 1952 was about 48,700 acre-feet and in 1954 exceeded 53,000 acre-feet. It is estimated that about 13,500 acres is irrigated solely with ground water and about 5,000 acres receives supplemental irrigation from ground water.

More than 15,000 additional acres in the Dry Creek area is suitable for irrigation. Most of that land will be under cultivation within 10 years if the recent rate of development continues. A few instances have been reported of interference between wells, resulting in declining water levels or lowered artesian pressure. Therefore, the current annual rate of ground-water pumping may approach, if it does not already exceed, the perennial yield of the aquifers, at least locally. Table 9 summarizes the ground-water development in the Dry Creek area. Well tables, well logs, and detailed pumpage data for this area are contained in an earlier report by West and Fader (1952).

TABLE 9.—*Ground-water pumpage in the Dry Creek area, Twin Falls and Cassia Counties*

Year	Number of wells drilled	Increase in pumpage (acre-feet)	Total pumpage (acre-feet)
1946	[1] 31	--------	6, 000
1947	24	7, 400	13, 400
1948	35	6, 800	20, 200
1949	29	7, 300	27, 500
1950	34	10, 800	38, 300
1951	25	8, 000	46, 300
1952	13	2, 300	48, 600
1953	9	2, 200	50, 800
1954	13	2, 700	53, 500
Total	213		

[1] Number of wells in use in 1946.

GOLDEN VALLEY DISTRICT

The Golden Valley ground-water basin is immediately east of the Dry Creek area in R. 21 E. The basin is bounded on the north by the Snake River and on the south by the Rock Creek Hills. Topographically it is related to the Dry Creek area and is a nearly flat plain sloping gently upward to the base of the Rock Creek Hills. There are several low, broad basalt cones in the northern third of the region.

The Snake River basalt crops out as far south as the northern part of T. 12 S. The basalt is covered with windblown deposits at scattered places, and the western and southern edges of the basalt are mantled with coarse alluvium. The remainder of the area is underlain by alluvium several hundred feet thick, which rests on Tertiary extrusive volcanic rocks. The Tertiary deposits probably overlie limestone and chert of Paleozoic age.

Not much is known about ground-water conditions in the Golden Valley. The depth to the main water table ranges from 150 feet beneath the valley floor to more than 340 feet on the flanks of the volcanic cones and domes. About half a mile south of the Snake River the depth to water in one well reportedly is 27 feet below the land surface. That general area contains perched ground water recharged by infiltration of irrigation water. At some places in T. 12 S. a water-bearing zone lies 50–175 feet below the land surface. Near the foot of the Rock Creek Hills ground-water occurrence seems to be erratic. Water flows from wells at some places, but at others the water table is more than 400 feet below the land surface.

Movement of the ground water in the Golden Valley undoubtedly is controlled by the lithology and the geologic structures, but little is known about these factors. Highly permeable zones probably are rare, and faults in the rocks presumably impede ground-water movement. The amount of natural local recharge probably is small. In general, conditions for the occurrence of ground water are more favorable northward, near the Snake River.

Replenishment of the main body or bodies of ground water in the Golden Valley probably is chiefly by underflow from adjacent areas. The Rock Creek Hills contribute ground water by mass percolation, and aquifers east and west of the area may contribute by underflow. Some of the ground water in T. 12 S., R. 21 E., probably is derived from infiltration from Cottonwood Creek during the spring. Additional recharge is by infiltration of irrigation water diverted from Cottonwood and Buckhorn Creeks and from the artesian irrigation wells in secs. 31 and 32, T. 12 S., R. 21 E., and sec. 6, T. 13 S., R. 21 E.

DEVELOPMENT OF WATER RESOURCES

Several hundred acres in the northwestern part of the Golden Valley, and a few hundred acres in the northeastern part are irrigated with water from the Snake River. Irrigation was attempted also on several hundred acres in T. 12 S., R. 21 E., using water from Goose Creek and other creeks, but that water supply is sufficient to irrigate only a few hundred acres regularly.

Very little ground water is pumped in the Golden Valley. The average yield of wells is small and the depth to water at many places is excessive. Well 12S–21E–27ba1, the deepest in the area, penetrated 1,050 feet of alluvium, basalt, and silicic volcanic rocks but reportedly yielded only 60 gpm with a drawdown of 115 feet during a pumping test. The depth to water before the test was about 135 feet. A small quantity of ground water might be pumped near the base of the Rock Creek Hills but available data do not suggest that large supplies could be developed.

OAKLEY DISTRICT

The Oakley ground-water district is a part of the lower Goose Creek valley between the Golden Valley and the foothills of the Albion Range. It is a nearly featureless alluvial and eolian plain sloping northward from an upland area a short distance south of Oakley. The district, as here defined, extends northward to the south boundary of T. 12 S.

The floor of the basin is underlain to a depth of several hundred feet by alluvium that was deposited by Goose, Birch, and Basin Creeks. Basalt-flow layers are intercalated in the lower part of the alluvium in the northern part of the basin. Tertiary extrusive volcanic rocks underlie the alluvium and basalt. The western face of the foothills of the Albion Range is a fault-line scarp. Another fault was traced northwestward from sec. 9, T. 13 S., R. 23 E., to sec. 20, T. 12 S., R. 22 E. The full extent of the fault is not known because parts of the fault trace are covered by alluvium (pl. 5). Concealed faults presumably are present within the district and along its south and southwest boundaries.

HYDROLOGY

Unconfined ground water occurs in alluvial sand and gravel and in basalt in the Oakley district. The underlying Tertiary rocks have not been adequately explored as a source of ground water, but a few irrigation wells obtain part of their water from those rocks. Well 13S–22E–31dc1, the deepest in the area (1,651 feet), failed to obtain a satisfactory supply of irrigation water from either the alluvium or the Tertiary rocks. The depth to water in the district ranges from less than 25 feet near Oakley to more than 275 feet at the northern edge of the basin. Part of the district is irrigated with surface water from Goose Creek Reservoir. Infiltration of unconsumed surface water contributes appreciable ground-water recharge and has built up a ground-water ridge extending northward beneath the irrigated area. Underflow from the drainage basins of Goose, Birch, and Basin Creeks also contributes to ground-water recharge.

DEVELOPMENT OF WATER RESOURCES

The supply of surface water for irrigation is not adequate for the land already under irrigation. Drilling of wells for supplemental water was begun in 1948, and by the end of 1954 more than 45 irrigation wells were in production. Reportedly, about two-fifths of the total irrigation water applied in the Oakley district is ground water. The yield of individual wells ranges from 200 to 1,100 gpm, and the average is about 615 gpm (1.4 cfs). New wells were being drilled and more land was being brought under cultivation in 1954.

The safe yield of the aquifers in the Oakley district has not been determined. The few available water-level records did not show appreciable decline of water levels as of the end of the 1952 pumping season. In early 1955, however, water levels were at their lowest levels since observations were started in 1948. Water levels probably were lower at times in the past, judging from miscellaneous measurements by Piper (1923). The currently low water levels, showing a decline in ground-water storage, probably reflect deficient precipitation since 1952. Direct recharge from precipitation has decreased, and recharge from irrigation has lessened, owing to reduced applications of irrigation water. There is very little surface runoff out of the district and almost all water (both pumped and stored) that is not consumptively used or evaporated infiltrates to the ground-water reservoir. Well records, drillers' logs, and pumpage estimates are contained in a report by Mower (1953).

GROUND-WATER RECHARGE

Piper (1923, pp. 53–54) estimated that recharge to the ground-water reservoir above the Goose Creek Reservoir is about 40,000 acre-feet yearly. Presumably, that water reaches the basin below the reservoir by underflow. The average yearly surface inflow to the Goose Creek Reservoir is about 50,300 acre-feet. During the 10-year period 1945–54 inclusive, releases of water from the Goose Creek Reservoir averaged about 45,300 acre-feet. Consumptive use of water on cropland is about 19,800 acre-feet (11,000 acres irrigated; estimated 1.8 acre-feet per acre of irrigation water consumed yearly). Thus, about 25,500 acre-feet of surface water applied for irrigation is available for ground-water recharge each year. Direct recharge from local precipitation probably is only a few thousand acre-feet yearly, and the total volume of ground-water recharge probably is less than 65,000 acre-feet yearly. A substantial part of the 40,000 acre-feet of recharge in the upper basin presumably recharges deep artesian aquifers that are not tapped by lowland wells. Moreover, a part of the surface inflow to Goose Creek Reservoir is ground water discharged by upstream artesian wells and by seepage into stream channels. Assuming that about half the ground water in the upper drainage basin reaches the lowland and replenishes water in the alluvium below Goose Creek Reservoir, the total average annual supply of unconfined ground water is about 45,000 acre-feet. Very likely, wells pumped during 4 to 5 months a year could intercept no more than about 25 percent of the supply or about 11,000 acre-feet, enough to irrigate about 5,000 to 6,000 acres.

The above estimates are extremely crude. Besides depending on several insecure assumptions, the estimates ignore such factors as evaporation from open-water surfaces, consumptive use by native vegetation, and underflow from Birch and Basin Creeks. Furthermore, some of the so-called surface water is supplemental ground water. Without belaboring the meager data available, the estimates suggest the general order of magnitude of feasible development and emphasize the importance of deep percolation of irrigation water as a source of recharge.

BASIN DISTRICT

Basin, a 15-square-mile area east of Oakley at the western foot of the Albion Range, is a bowl-shaped region bounded on the north and south by hills of Precambrian(?) metamorphic rocks and Tertiary extrusive volcanic rocks. On the west are hills of the Tertiary rocks. The basin floor is underlain by Quaternary alluvium which is more than 150 feet thick at some places. The alluvium is silty sand near the surface and sand, gravel, and boulders at shallow depth. Ground water occurs at shallow depth in much of the basin.

The Basin district receives runoff water from the surrounding highlands but chiefly from the Albion Range. Ground water migrates toward the axis of the basin and thence through alluvium into the Oakley basin through a narrow gap in the hills on the west or through a pass in the hills to the northwest.

Water from Basin Creek and its tributaries is diverted to irrigate the lower land in the basin; higher lands are dry-farmed. Two irrigation wells were in use in the basin in 1952. One was in alluvium and quartzite and reportedly yielded more than 900 gpm of water. The other, drilled through nonpermeable alluvium and Tertiary extrusive volcanic rocks, had a small yield. The amount of yearly recharge to the ground-water reservoir and the safe perennial yield of the basin are not known. The supply, however, probably is not sufficient for all irrigable land in the basin.

BURLEY GROUND-WATER DISTRICT

The Burley ground-water district is north of the Oakley district. It is bounded on the north by the Snake River and on the east by the Albion Range and an arbitrary line northwestward from the Albion Range. The western boundary was arbitrarily chosen as the west line of R. 22 E.

The surface features of the Burley district are similar to those of the Dry Creek area. It is a plain underlain largely by Quaternary alluvium. The Snake River basalt crops out in the western, southeastern, and northeastern parts (pl. 5). Alluvium and lake beds are interbedded with the basalt in parts of the basin. In the vicinity of Burley at least 150 feet of the Burley lake beds underlies the alluvium. Basalt is intercalated in the lake beds and also underlies them. Presumably, the basalt is underlain by silicic Tertiary extrusive volcanic rocks, although no wells in this district have penetrated the entire thickness of sediments and basalt.

HYDROLOGY

Ground water occurs chiefly under water-table conditions in fractured basalt and alluvial sand and gravel. Some of the Burley lake beds contain artesian water. Ground water in alluvial gravel is perched on the Burley lake beds north of the high-line canal in the Burley Irrigation District. The perched water is recharged largely by infiltration of irrigation water diverted from the Snake River. The slope of the main water table varies from west to southwest and south. The detailed configuration of the water table has not been ascertained.

Ground water in the Burley district is replenished from several sources whose relative importance is not known. Important sources of recharge to the main ground-water reservoir are thought to be percolation from the southwest end of Lake Walcott, northward underflow from the Oakley basin, and downward movement of the perched ground water at the edges of the perching beds. Locally, there seem to be ground-water mounds on the main water table beneath the area of perched ground water, owing to slow percolation through the perching beds. Some recharge occurs by infiltration of surface runoff from the Albion Range but that contribution probably is small.

The perched ground water is discharged by lateral movement to the Snake River, by downward leakage to the main ground-water reservoir, by evapotranspiration, and by pumping. It is replenished chiefly by infiltration from canals and irrigated fields, although some water may be derived from the South Walcott area and from Marsh Creek underflow.

DEVELOPMENT OF WATER RESOURCES

Few wells reach the main water table north of the south side high-line canal. The perched shallow water is adequate for domestic and stock use and local irrigation. The shallow water is tapped also by a few small industrial and commercial wells and by a low-pressure yard-water system in the city of Burley. The main city water supply is obtained from deep wells.

In recent years large areas of privately owned land south of the canal have been cleared and leveled, and several irrigation wells have been drilled. Development of that area is accelerating. About 10,000 acres of undeveloped land is State owned, and 8,000 acres is Federal. Perched water is lacking and ground water is obtained from the main zone of saturation.

Good yields are reported from the main ground-water reservoir, and pumping in 1952 did not noticeably lower the ground-water levels. Pumping lifts ranged from about 225 to more than 350 feet. Further development may be warranted for purposes for which the pumping lift is not excessive. In 1952 the city of Burley's low-pressure system used about 2,100 acre-feet of water from gravel and sand overlying the Burley lake beds. Moderate amounts are pumped at other places. About 2,000 acre-feet of shallow ground water was pumped in 1952 for irrigation north of the canal. In 1952 about 11,700 acre-feet of ground water was pumped for irrigation south of the high-line canal.

SOUTH WALCOTT DISTRICT

The South Walcott district contains about 180 square miles south of Lake Walcott. It is bounded on the west by the Snake River, on the south by the Albion and Malta Ranges, and on the east by the Raft River. The surface of the district is a gently rolling basalt plain with several low, broad basalt domes rising a few-score feet above the general level of the plain. Irrigation developments are confined to the western and southeastern parts.

GEOLOGY

The Snake River basalt crops out in much of the South Walcott district and underlies all of it. Large areas are mantled by wind-blown material and alluvium that range in thickness from almost nil to several feet. Similar sediments are intercalated between basalt layers at depth. On the east side of the district, and possibly at some places near the north and west sides, the Raft lake beds and alluvium of the Raft River are interfingered with the basalt. Adjacent to the mountain fronts on the south, Precambrian(?) schist and quartzite and Tertiary volcanic rocks underlie slopewash and basalt at shallow depth, but a short distance north of the mountains the older rocks are deeply buried and have not been found in drilling.

HYDROLOGY

Unconfined ground water occurs in fractured basalt, cinder beds, and intercalated sand and gravel. Along the south and southwest margins some of the ground water may be under artesian pressure. The depth to water ranges from less than 50 feet on the east side of the district to more than 250 feet in the south-central part adjacent to the Malta Range. In the western quarter of the region the depth to water ranges from about 100 to 180 feet.

Little information is available about the movement of ground water because wells have been drilled only around the margins of the area. According to R. L. Nace (oral communication, 1955), ground water moves toward the central part of the area from the northeast, east, and south. In the western part it moves toward the Snake River and the Declo-Burley area. The ground water is discharged largely by underflow out of the district, but virtually nothing is known of its course and destination.

Recharge of ground water directly from precipitation in the district is small. The principal source of replenishment probably is underflow from the Raft River valley. There probably is underflow also from the Snake River Plain on the east, and the downstream part of Lake Walcott loses water by infiltration. The surface of Lake Walcott along its south shore for a distance of 8 to 12 miles above Minidoka Dam is above the water table. Leakage from the lake may be a substantial contribution to the ground-water reservoir. Underflow and infiltration from Marsh Creek probably contribute a small part to recharge.

The Snake River gains water in the reach between Minidoka and Milner Dams. Stearns (1938) estimated the average yearly gain as about 300 cubic feet per second for the years 1917–27. No estimate has been made for recent years. Part of the gain is surface waste of irrigation water from Lake Walcott, but a considerable amount is discharged ground water. Much of the ground-water discharge occurs in the Burley district on the south side of the river, and in the Minidoka district on the north side. Some may occur in the western part of the South Walcott district.

DEVELOPMENT OF WATER RESOURCES

Irrigation agriculture in the South Walcott district is confined largely to the west, south, and east marginal belts. The western part is irrigated from the Minidoka South Side canal. A few irrigation wells have been installed just east of the canal about 4 or 5 miles northeast of Declo and also east of Declo. Small areas west of the Raft River and south of U. S. Highway 30N and along the southeast margin are irrigated with ground water. About 30 percent of the area, including part of the Minidoka Project along the western edge, is privately owned; 15–20 percent is State owned; and 50–55 percent is Federal land. A large part of the Federal land is within a range-reseeding project.

The South Walcott district is favorable for ground-water development. Most wells yield water copiously and the pumping lift in much of the area would be small to moderate. Locally, however, well yields might be only moderate and pumping lifts might be high. The ground-water potential of the area is relatively large, but the effects of heavy pumping on the regimens of Lake Walcott and the Snake and Raft Rivers cannot be determined at this time.

ALBION DISTRICT

The Albion district is a distinct topographic and hydrologic basin and is entirely surrounded by the Albion and Malta Ranges. It is triangular in plan, with the apex of the triangle at its lower (northern) end. The basin floor is underlain by alluvium, the thickness of which is not known. The alluvium probably overlies Tertiary volcanic rocks and Precambrian(?) quartzite and schist.

HYDROLOGY

Data from a few wells in the Albion area indicate that unconfined ground water occurs at shallow depth and artesian water occurs at moderate depth. The shallow ground water moves northward through the alluvium and leaves the basin by underflow beneath the course of Marsh Creek. Some of the ground water is discharged from springs along the lower reaches of Marsh Creek. The artesian water probably moves in the same general direction as the unconfined water.

Small streams that drain the Albion Range, and a few that drain the Malta Range, discharge across the valley floor, chiefly in the southern part of the Albion Valley. Some of the stream water sinks into the alluvium and is stored as ground water. The remainder, estimated to be about 2,000 acre-feet yearly (Stearns, 1938), is discharged through Marsh Creek to the Snake River Plain.

DEVELOPMENT OF WATER RESOURCES

Some of the water from Marsh Creek and its tributaries is diverted to irrigate land within the Albion Basin. Several hundred acres of land on the lower slopes of the Albion Range northwest of Albion is dry-farmed. Much of the downstream discharge of Marsh Creek is water from springs and seeps in the northern part of the basin and above the narrow creek valley between the northern ends of the Albion and Malta Ranges. That water has been appropriated to irrigate lands farther downstream on the margin of the Snake River Plain, a few miles east of Declo. Little or no ground water is pumped for irrigation. The effect that pumping would have on the flow of Marsh Creek is not known.

RAFT RIVER BASIN

The Raft River basin is the largest basin in the South Side area. The drainage area is about 1,700 square miles, including the Raft River valley and the Almo, Yost, and Elba subbasins in eastern Cassia County, Idaho, and northwestern Box Elder County, Utah. The principal ground-water developments are in the Raft River valley north of Strevell and south of the South Walcott district. The Raft River valley contains more than 150,000 acres of irrigable land, ownership of which is divided among the State and Federal Governments and private interests. The floors of the Raft River valley and the subbasins are underlain by alluvium. Talus deposits and coalescing alluvial fans border the lowland areas. Little is known about the subsurface geology of the Raft River basin. Lake beds occur beneath the alluvium in extensive areas, especially in the Raft River valley.

HYDROLOGY

A preliminary report on the Raft River basin (Fader, 1951) contains well logs and records of wells, ground-water withdrawals, and water-level fluctuations in wells. The hydrology of the Raft River basin has been studied by Nace, Fader, and Sisco (work in progress). A preliminary summary of their principal conclusions is given in the following paragraphs:

1. The Raft River basin consists of the Raft River valley and several tributary subbasins. The Raft River valley is the gathering ground for all the ground and surface water from the tributary areas. Water not intercepted in the main valley is discharged northward to the Snake River Plain. Some of the ground water is discharged into the upstream part of Lake Walcott but the main mass of the ground waters moves by underflow northwestward to the South Walcott area. Almost all the water discharged by the Raft River is diverted for irrigation, and only a few thousand acre-feet a year flows into Lake Walcott.

2. Ground water occurs in both unconfined and confined aquifers. The unconfined water is at shallow depth in sand and gravel in lowland areas, where the annual range of fluctuation of ground-water

levels is about 5 to 8 feet. There was little net change in water levels for the period 1948–52, but after 1953 there was a small, steady decline, partly because of increased pumping but largely because of subnormal precipitation on the recharge area. Little is known about the water in artesian aquifers.

3. About 24,000 acres of land in the Raft River basin is irrigated with water from the Raft River and its tributaries, chiefly in the Raft River valley. Ground water is used to irrigate more than 10,000 acres and to provide supplemental water to some of the land irrigated with surface water. Most wells yield more than 500 gpm.

4. Probably as much as 150,000 additional acres in the valley is amenable to irrigation. It is estimated that about 135,000 acre-feet of ground water is discharged yearly by northward underflow.

5. About 70,000 acre-feet of ground water was pumped in 1955, seemingly without material interference among wells or noticeable depletion of ground-water storage.

6. Factors which should be considered during development in the basin, other than the area of irrigable land and the water supply, are the distribution of wells and the quality of the water and the soil. Properly placed wells would not seriously deplete the local surface-water supply. Little is known about the quality of the ground water, but records indicate that some is doubtful to unsuitable for use on some types of soil.

7. Sufficient uncommitted ground water is available to irrigate additional land, but the amount of irrigable land and the water supply require further study.

AREA IN POWER COUNTY BETWEEN THE RAFT RIVER AND ROCK CREEK

The northern end of the Sublett mountains slopes down to the Snake River Plain between the Raft River basin and Rock Creek. In that reach the Snake River flows through a narrow valley which is bordered by abrupt bluffs on the south. The land surface between the Sublett Range and the river bluffs slopes gently northward. Widely separated tributary valleys in the region characteristically are steep and narrow.

Small patches of Recent alluvium crop out adjacent to the Snake River, but the Raft lake beds are exposed in most of the area north of the Sublett mountains. At some places gravel beds, probably remnants of alluvial fans, cap the lake beds. Rocks of Paleozoic age probably are present at depth in the area and remnants of Tertiary volcanic rocks may lie between the rocks of Paleozoic age and the lake beds. Several small inliers of rocks of Paleozoic age occur in the western part of the region (pl. 5).

HYDROLOGY

Ground-water conditions in the western half of the area resemble those in the northeastern part of the Raft River valley. The depth to water ranges between about 100 and 200 feet, and the water table slopes north and west toward the Raft and Snake Rivers. The best aquifers are believed to be sandy phases of the lake beds. Some water may occur in the Tertiary volcanic rocks.

The Recent alluvium along the Snake River is a good aquifer, but heavy pumping would induce recharge from the river and would be competitive with surface-water use.

Records of a few stock wells in the eastern part of the area indicate that the depth to water exceeds 250 feet. Direct information is lacking about aquifers and well yields, but general geologic information suggests that the lake beds, which probably are poor aquifers, occur below the water table in parts of the area. The underlying rocks of Paleozoic age have not been explored.

DEVELOPMENT OF WATER RESOURCES

A few small areas along the Snake River are irrigated with surface water, and some of the wide, gently sloping interstream areas are dry-farmed. Irrigation with surface water would not be practical in most of the area. Seemingly, there are no irrigation wells in the area, which is generally unfavorable for irrigation pumping because of the excessive depth to water and the poor yield of the aquifers. A few small tracts lying at low elevations close to the Snake River might be irrigated with water pumped from alluvial gravel, but the pumping would be competitive with surface-water use.

ROCKLAND VALLEY

The gently to steeply rolling Rockland Valley, with an area exceeding 200 square miles, lies south of American Falls in Power County. The Snake River basalt, capped by alluvium and lake beds, extends up the valley almost as far south as Rockland. Basalt is present also on the northeast flank of the Sublett Range, nearly a thousand feet above the valley floor.

The rest of the valley, southward from a point about 2 miles north of Rockland, contains white, gray, buff, and yellowish-brown ash beds, silt, clay, acidic tuff, and volcanic flow rocks. The tuff and flow rock cap some of the hills and form mesalike uplands. At some places the beds are faulted and tilted, the dips being as much as 30 degrees, or even more. Ribbons of alluvium lie along the narrow floors of creek valleys and soil mantles the rolling hills. Limestone of Paleozoic age crops out at a few places near the axis of the valley. The rocks of Tertiary and Quaternary age have not been mapped or studied.

HYDROLOGY

The estimated yearly discharge from Rock Creek to the Snake River is 10,000 to 15,000 acre-feet. This runoff is rather small (between 1 to 2 inches per acre) for a basin which is able to sustain a large dry-farming economy and in which the annual precipitation is probably in excess of 12 inches.

Domestic and stock wells along the creek tap ground water at a depth of a few feet, but at higher elevations near the mountain front the depth to water is more than 250 feet. Northwest of Rockland, near Table Mountain, the depth to water ranges from 250 to more than 300 feet.

Ground water in the Rockland Valley is derived from infiltration of precipitation and snowmelt on the Sublett Range and the Deep Creek Mountains. The water moves by mass underflow toward the valley and thence northward in the valley to the Snake River Plain.

DEVELOPMENT OF WATER RESOURCES

Large areas of the rolling hills and land that extends far up on the lower slopes of the mountains are dry-farmed, but only a small area is irrigated. Rock Creek is diverted to irrigate parts of the valley-bottom land. Spring water is used for irrigation at some places, and numerous springs and seeps water some pasture land. Few irrigation wells have been drilled. Attempts to develop ground water for irrigation have not been very successful, but the available data are not a sufficient basis for estimating the potential ground-water development. In an area of about 20 square miles south of Rockland about a dozen wells, mostly for stock and domestic supply, are present. There are few wells elsewhere in the valley.

WESTERN MICHAUD FLATS DISTRICT

The area north of the Deep Creek Mountains between Rock Creek and the Fort Hall Indian Reservation, centering around the city of American Falls, is here called the Western Michaud Flats district and corresponds to the Michaud Flats project of the United States Bureau of Reclamation. Topographically, it consists of (1) a narrow, low-lying area, 1 to 3 miles wide, adjacent to American Falls Reservoir and the Snake River, and (2) high, outlying lands between the lowland area and the Deep Creek Mountains. Most land in the Michaud Flats project, and some land adjacent to the project, either is dry farmed or is irrigated with ground water. The reclamation project will irrigate about 11,000 acres, of which about one-third will be supplied with water pumped from wells. Water from American Falls Reservoir will be used on two-thirds of the land. Part of the ground water is tributary to the reservoir; however, consumptive net depletion of ground water on the completed project probably will be less than unconsumed surface water that will return to the reservoir.

HYDROLOGY

Stewart, Nace, and Deutsch (1951) summarized the available information about the area as follows:

Reconnaissance of the ground-water geology of the area disclosed surface outcrops of late Cenozoic sedimentary, pyroclastic, and volcanic rocks. Well logs and test borings show that similar materials are present beneath the land surface in the zone of saturation. Ground water occurs under perched, unconfined, and confined (artesian) conditions, but the aquifers have not been adequately explored. Existing irrigation wells, 300 feet or less in depth, yield several hundred to 1,400 gallons of water a minute, with pumping drawdowns of 6 to 50 feet, and perhaps more. A few wells have been "pumped out" at rates of less than 800 gallons a minute. Scientific well-construction and development methods would lead to more efficient well performance.

A generalized water-table contour map of the area shows that the principal general direction of ground-water movement is toward the west and northwest. The southwestern part of the American Falls Reservoir, and a segment of the Snake River below the dam, may be perched above the water table. Ground water appears to move beneath this segment of the river to the Snake River Plain on the northwest side.

So far as is known, recharge to the ground-water reservoir is chiefly from local sources and from the runoff from the mountain area southeast of the project. Seepage losses from surface water spread for irrigation would contribute a substantial amount of new recharge to the ground water, but the amount of such recharge might be less than the depletion of ground water by pumping. Therefore, with ground-water irrigation of part of the project, return flow to the American Falls Reservoir might be less than it is in the existing regimen. Ground-water pumping where the ground water is not tributary to the reservoir might not deplete the reservoir appreciably, but would reduce the net supply of water available west of Neeley.

Evidence indicates that at least moderate supplies of ground water can be obtained in low-lying areas southwest and northeast of American Falls, but the safe perennial yields of the aquifers cannot now be estimated. The ground-water potential in high and outlying lands is not known. It is unlikely that this potential is sufficient to supply all high and outlying lands, but the supply may be adequate for a substantial part of these lands. Thorough investigation appears to be warranted.

EASTERN MICHAUD FLATS DISTRICT

The Eastern Michaud Flats district includes the part of the Fort Hall Indian Reservation south of American Falls Reservoir and the Portneuf River and north of the Bannock Range and the Deep Creek Mountains. Geologically and hydrologically it is an eastward extension of the Western Michaud Flats district. Geologic and hydrologic conditions in parts of the eastern district resemble those in the west, but the Eastern Michaud Flats contains a larger irrigable acreage of low land and undoubtedly has a larger ground-water potential.

In the eastern part of the area, near the Portneuf River, the water-bearing materials seem to be coarser and more permeable than those on the west. Irrigation and industrial wells produce water abundantly and there is only small drawdown during pumping. The coarse sand and gravel aquifers were deposited by the Portneuf River. An unknown but probably substantial amount of the ground water is directly tributary to American Falls Reservoir, and some is indirectly tributary. For example, a 1½-mile spring-fed stream, locally called "Wide Creek," rises on the Portneuf River flood plain and discharges more than 50 cfs to the reservoir.

The Bureau of Indian Affairs plans to irrigate about 13,600 acres of land with water from Palisades and American Falls Reservoirs, and is considering also additional irrigation with ground water. Ground-water increments from deep percolation and surface waste would be tributary to American Falls Reservoir. The quantitative balance between return flow of surface water, new recharge from deep percolation, and consumptive depletion of pumped ground water cannot be estimated without careful field study.

BANNOCK CREEK DISTRICT

The Bannock Creek district is south of Michaud Flats and American Falls Reservoir. It is bordered on the west by the Deep Creek Mountains and on the east by the Bannock Range and the Blue Springs Hills. For convenience, the basin is divided into two sections. The downstream (northern) section includes the narrow valley of Bannock Creek south of Michaud Flats on the Fort Hall Indian Reservation. The upstream (southern) section includes the headwaters area, a broad basin south of the Indian Reservation. This latter area, known as Arbon Valley, is some 20 miles long and up to 8 miles wide. Only the northern third of the Arbon Valley is shown on the geologic map (pl. 5).

GEOLOGY

On the Indian reservation the narrow, alluvial floor of the valley of Bannock Creek is flanked by hills of Tertiary extrusive and sedimentary rocks, overlain in some places by basalt. Mansfield (1920) reported that basalt is intercalated with some of the acidic extrusive rocks. Toward the southern part of the Indian reservation, rocks of Paleozoic age are exposed adjacent to Bannock Creek. Northward, near Michaud Flats, the valley floor widens and includes several hundred acres of gently rolling alluvial plain.

SUMMARY AND CONCLUSIONS

Exploitation of ground water in the South Side area was rapid during the decade 1945–55, and it has not been practicable to keep information up to date. For example, records for the Oakley area, compiled in 1952, already are outdated.

The press for new agricultural development is indicated by the amount of land for which requests for ground-water permits and licenses have been filed with the State Reclamation Engineer since 1945. In addition to those for new development on private land, many applications have also been filed for entry on vacant desert lands which prospective users propose to irrigate with ground water (table 10).

TABLE 10.—*Irrigation applications (land to be irrigated with ground water) in some areas south of the Snake River, Idaho* [1]

Area and status of land	Acres to be irrigated	
	Full supply	Supplemental supply
RAFT RIVER VALLEY		
Patented land. Water licenses and permits issued	16, 000	7, 000
Vacant public land:		
Entries allowed	12, 165	0
Entry permits pending	10, 514	2, 000
OAKLEY-BURLEY AREA		
Patented land. Water licenses and permits issued	10, 400	9, 700
Vacant public land under state license or permit:		
Entries allowed	4, 119	0
Entry permits pending	2, 468	0
DRY CREEK BASIN		
Patented land. Water licenses and permits issued	22, 800	9, 200
Vacant public land under state license or permit:		
Entries allowed	500	0
Entry permits pending	18, 700	800
Total	97, 666	28, 700

[1] Data from files of the Idaho State Department of Reclamation and United States Bureau of Land Management. Information is through 1954.

Estimates indicate that, in 1952, 44,000 acre-feet of ground water was pumped from 189 irrigations wells in the Dry Creek area, the most intensively developed area of ground-water irrigation in the State. Since the canvass of 1952, drilling rigs have been active in the area deepening old wells and drilling new ones. Pumpage in 1954 probably was in the neighborhood of 53,000 acre-feet. Competition for water is keen, and conflicts of interest seem to be developing locally.

The lower Goose Creek basin, between Oakley and Burley, reportedly contains some of the finest irrigable land in southern Idaho. A water supply for that land has been sought since the earliest reclamation development of the area. Practically all the surface-water yield of the basin has been appropriated, but in recent years private interests have done a substantial amount of exploration for ground water. The geology of the lowlands and of the tributary catchment area is rather complex and an estimate of the overall ground-water potential would require considerable detailed study. The average yearly increment to the ground-water reservoir is not known, but the present and planned developments may approach the safe yield.

The shallow aquifer in the vicinity of Burley is recharged largely by infiltration of surface water. That water could be pumped efficiently and cheaply. Consideration might be given to the pumping of exchange water, releasing surface water for use where ground-water use is not feasible. Although drainage problems seemingly are not serious around Burley, pumping irrigation wells would have drainage benefits. Pumping probably would reduce ground-water discharge to the Snake River, but the seasonal distribution of such effect is not known. The gain in streamflow between Minidoka and Milner Dams is credited administratively to the Minidoka Project, and valid water rights apply to the gained water.

South of the Minidoka South Side high-line canal there are extensive tracts of vacant land. Ground-water pumping lifts in that area range from 200 to more than 300 feet, but private development is proceeding. Pumping there will have little or no effect on the shallow ground water north of the canal or on surface flow in the Snake River above Milner Dam.

In the South Walcott area ground water occurs at depths of 75–300 feet below the land surface in aquifers which probably will yield moderate to large amounts of water. Much of the ground water reaches the area by underflow from the Raft River and Albion basins. How much water the area receives and how much could be recovered is not known. The interrelations of the ground water, the Snake River, Lake Walcott, the northeastern part of the Burley district, and the Snake River Plain are not well understood.

Substantial tracts in the Raft River valley have been irrigated for many years. The total irrigable acreage is not known, but it seems obvious that it far exceeds the area that could be served with the indigenous water supply. The estimated gross water demand for 38,679 acres of land with valid and pending permits and licenses is less than 100,000 acre-feet per season.[1] The estimated total unused perennial ground-water supply in the basin approaches 135,000 acre-feet per year. The consumptive use on the 10,000 acres now irrigated with ground water probably does not exceed 20,000 acre-feet of water per year. Thus, there seems to be latitude for additional development with ground water, though not all the unused supply could be inter-

[1] Assuming that a gross supply of 2.5 acre-feet per acre would be adequate for the types of crops grown in the growing season indicated by weather records.

cepted during the growing season. Ground-water pumping might compete to some extent with surface-water use.

The Western Michaud Flats district contains about 10,000 acres of low-lying irrigable land and a larger additional acreage of high land. Under a Bureau of Reclamation project, now under construction, part of the lowland will be irrigated with surface water from American Falls Reservoir and part with ground water pumped from wells. Ground-water withdrawals will tend to reduce the discharge of ground water to the reservoir. On the other hand, surface-irrigation will provide new ground-water recharge, and surface waste will return to the reservoir and to the Snake River below the reservoir. Nothing is known of the ground-water potential of adjacent higher land, but it is unlikely that the supply is sufficient to serve all the irrigable high land. The southwestern part of American Falls Reservoir and a downstream segment of the Snake River appear to be perched above the water table. Thus, withdrawal of ground water adjacent to that part of the reservoir and river would have no direct effect on increments to the reservoir. The effects farther downstream cannot be predicted at this time.

The Eastern Michaud Flats district contains a large amount of irrigable land and at least part of the area is underlain by good aquifers. Most of the land is in the Indian reservation, and short-term leasing by non-Indians does not encourage ground-water development. Prospective lessees fear also that pumping would raise controversies about inflow to American Falls Reservoir and about effects on surface-water rights.

The ground-water resources of two large areas, the Rockland and Arbon Valleys, are entirely unknown. A substantial part of the surface water available in those areas is utilized but the amount is sufficient for only a small fraction of the irrigable land. Each valley has a large catchment area, but only a few thousand acre-feet of water leaves as surface runoff. Nothing is known about the amount of ground water in storage or in transit in the valleys, but the water regimen may be analogous to that in the Raft River valley.

Important data about the ground-water districts are summarized in table 11. All numerical values in the table are approximations. The table shows that the Dry Creek, Oakley, Burley, South Walcott, Raft River, and Michaud Flats districts have a combination of substantial ground-water supplies, good aquifers, and a large acreage of undeveloped irrigable land. Development in the Dry Creek area with ground water probably is near the practicable limit already. Development in the Oakley district may reach such a limit within a few years.

TABLE 11.—*Summary of the occurrence and use of ground water in the South Side area*

District and area (square miles)	*Principal aquifers*	*Condition of occurrence*	*Source of recharge* [1]	*Mode of discharge* [2]	*Yield of irrigation wells* [3]	*Depth to water-bearing material (feet below land surface)*	*Status of irrigation (acres)*			*Remarks*
							Irrigated with ground water	*Irrigated with surface water*	*Irrigable but not irrigated* [4]	
Dry Creek (150)	Alluvium and basalt.	Unconfined	Irrigation water and upward leakage from underlying artesian aquifers.	Underflow to Snake River Plain; pumping.	Fair to good.	10–150 in alluvium; 150–300+ in basalt.	15,000±	40,000?	20,000±	Most intensively developed ground-water area in Idaho; competition for ground water is keen. Ground water supplements surface water for some land and is full supply for other land. Geologic structure controls movement of ground water in artesian aquifers.
	Tertiary volcanic rocks and volcanic ash.	Artesian	Underflow from Rock Creek Hills; irrigation water.	Leakage to unconfined aquifers; pumping.	Poor to good.	0–200				
Golden Valley (100)	Alluvium, basalt, and Tertiary volcanic rocks.	Unconfined, perhaps artesian also.	Underflow from Rock Creek Hills, and possibly from Dry Creek and Oakley districts.	Underflow to Snake River Plain.	Poor to fair.	300+ at north end of area.	1,000?	50?	25,000+	Little is known about ground-water conditions, except that they are quite variable. Future development probably will be relatively small.
Oakley (45)	Alluvium	Unconfined	Irrigation water; underflow from Rock Creek Hills, South Mtn., and Albion Range.	Pumping and underflow to Burley district.	Good	25–275	3,000	11,000	8,000±	Ground water supplements surface water for some land and is full supply for other land. Pumping does not affect local surface streams. Development of privately owned land probably will reach the safe yield of the basin within a few years.
Basin (15)	Alluvium and Tertiary volcanic rocks.	Unconfined	Infiltration of precipitation on Albion Range.	Underflow to Oakley basin.	------------	------------	200±	------------	5,000	Potential ground-water development small because of small catchment area.
Burley (210)	Alluvium, lake beds, and basalt.	Unconfined and artesian.	Irrigation water.	Percolation to underlying aquifers; seepage to Snake River; pumping.	Fair to good.	10–100	1,000±	48,000	----------	Includes only the area served by the Minidoka South Side high-line canal.
	Basalt	do	Irrigation water; underflow	Underflow to western Snake	Good to excellent.	200–350	5,000±	300±	30,000±	Includes the area outside the Minidoka South

			from South Walcott and Oakley districts.	River Plain; pumping.						Side project. Contains large areas of undeveloped privately owned land and State land.
Albion (25)	Alluvium	Unconfined and artesian.	Underflow from Albion and Malta Ranges.	Surface flow and underflow to South Walcott.	----	20–?	500–	6,000±?	----	Probably feasible to pump ground water on small scale; heavy pumping might interfere with surface-water rights.
South Walcott (180)	Snake River basalt.	Unconfined	Underflow from Raft River valley, Albion basin, and Snake River Plain.	Underflow to Snake River Plain and Burley district. Pumping along west side.	Fair to excellent.	75–300	1,500±	4,000±	20,000+	A little-known but promising area for ground-water development.
Raft River (850)										
Main Valley	Alluvium	do	Infiltration from streams; irrigation water; underflow from highland areas.	Seepage to Raft and Snake Rivers; underflow to South Walcott area; and pumping.	Fair to excellent.	0–350	10,000	24,000	150,000±	Estimated ground-water supply sufficient to irrigate substantial additional acreage.
	Lake beds and associated volcanic rocks.	Artesian	Underflow from highland areas.	Small percentage of total supply is pumped; underflow to Snake River Plain.	Poor to fair.	75–1,000+				Some of water is warm and is chemically of poor quality for irrigation.
Elba	Alluvium	Unconfined and possibly artesian.	Underflow from highland areas.	Underflow to main valley.	do	----	----	----	----	Local pumping may be feasible.
Almo-Yost	Alluvium	Unconfined	Underflow from highland areas and infiltration from streams.	do	do	----	----	8,000	----	Do.
	Lake beds and associated volcanic rocks.	Artesian	Underflow from highland areas.	do	----	----	----	----	----	
Raft River to Rock Creek. (50)	Alluvium and lake beds.	Unconfined and possibly artesian.	Underflow from Sublette Range.	Seepage into Snake River and underflow to Snake River Plain.	----	100–250+	----	2,000±	----	Ground-water conditions not known; possible future development probably very small. Large areas on north slope of Sublett Range are dry-farmed.

See footnotes at end of table.

TABLE 11.—*Summary of the occurrence and use of ground water in the South Side area*—Continued

District and area (square miles)	*Principal aquifers*	*Condition of occurrence*	*Source of recharge* [1]	*Mode of discharge* [2]	*Yield of irrigation wells* [3]	*Depth to water-bearing material (feet below land surface)*	*Status of irrigation (acres)*			*Remarks*
							Irrigated with ground water	*Irrigated with surface water*	*Irrigable but not irrigated* [4]	
Rockland Valley. (200)	Alluvium, Snake River basalt, and Tertiary rocks.	Unconfined and artesian.	Underflow from Sublett and Deep Creek Mountains.	Underflow to Snake River Plain; seepage into Rock Creek.	------------	5-350------	--------	4,500±	50,000±	Agriculture largely by dry-farming. Catchment area is large but surface runoff is estimated to be only 50 acre-feet per square mile per year.
Western Michaud Flats. (65)	Alluvium and lake beds; possibly volcanic rocks also.	----do--------	Underflow from Deep Creek Mountains.	Underflow to Snake River Plain; seepage into American Falls Reservoir.	Fair to good.	5-275------	1,000+	-----------	25,000±	Moderate amount of ground water available in lowland. Practically nothing is known about highland.
Eastern Michaud Flats. (50)	----do---------	----do--------	Underflow from Deep Creek Mountains, Bannock Range, Bannock valley, and Portneuf valley.	----do---------	Fair to excellent.	30-90------	--------	None(?)----	22,000±	Ground-water possibilities probably much better than the Western Michaud Flats, but development would affect ground-water discharge to American Falls Reservoir.
Bannock Valley. (12)	Alluvium and Tertiary volcanic rocks.	Unconfined and artesian(?).	Underflow from Bannock Range, Deep Creek Mountains, and Arbon Valley.	Underflow to Michaud Flats.	Fair to good.	10-70------	500±	1,600	400±	Small acreage available for development.
Arbon Valley--- (90)	Alluvium and slopewash.	Unconfined and artesian(?).	Underflow from surrounding highland.	Underflow to Bannock Creek valley.	------------	20-200-----	100±	-----------	40,000+	Agriculture largely by dry-farming. Ground-water conditions practically unknown.

[1] Sources of recharge other than direct infiltration of precipitation.
[2] Modes of discharge other than by evapotranspiration.
[3] Numerical ratings not feasible. An "excellent" means capable of yielding water copiously. "Poor" means generally unsatisfactory. "Fair" and "good" are relative ratings.
[4] Includes both public and private land that is topographically suitable for irrigation. The character of the soil is not considered.

Maximum development of ground water in any of the areas here described would entail salvaging natural water losses so far as is economically feasible and consistent with established valid water rights. Three of the ground-water districts and subdistricts in the South Side area, the Dry Creek, Raft River, and Western Michaud Flats districts, have received preliminary investigation. None has been studied comprehensively.

The possibility of artificially recharging aquifers in areas where the water supply is not adequate for the irrigable land has not been studied in Idaho. After the completion of Palisades Dam the average yearly surplus flow of the Snake River at Milner Dam probably will exceed 500,000 acre-feet. The time of year when the surplus will be available has not been studied by the writer, but presumably it will not coincide with the need for irrigation water in South Side districts. Surplus water might be diverted to tributary valleys of the South Side area, and the economics and practicability of such diversions warrant study. Flood irrigation is, in effect, a method of artificially recharging ground water, and its effectiveness has been strikingly demonstrated by the plague of drainage problems in irrigated areas. Some of the basins undoubtedly contain areas suitable for artificial recharge; the big problem would be to move surplus river water to suitable areas.

Further investigations in the South Side area are needed. Lack of detailed and accurate hydrologic maps is an especially critical deficiency. Because of the intimate relation between surface water and ground water, and because of the migration of water between the north and south sides of the Snake River, maps for most districts should include a strip of land on the north side of the river. Investigations are necessary to assist prudent and orderly development and use of water. For that purpose estimates are needed of the sources and amounts of ground-water recharge and of the effects of ground-water withdrawals on the total water supply. Soil drainage, evapotranspiration losses, the chemical quality of the water and its suitability for irrigation, and other related problems also need attention.

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INDEX