UNITED STATES DEPARTMENT OF THE INTERIOR
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WATER RESOURCES DIVISION
GROUND WATER BRANCH

PRELIMINARY REPORT ON GROUND WATER IN THE MICHAUD FLATS PROJECT, POWER COUNTY, IDAHO

By

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Prepared in cooperation with the U. S. Bureau of Reclamation
and the Idaho State Department of Reclamation

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CONTENTS

TABLES

ILLUSTRATIONS

PRELIMINARY REPORT ON GROUND WATER IN THE MICHAUD FLATS PROJECT, POWER COUNTY, IDAHO

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Abstract

The Michaud Flats Project area, as here described, includes about 65 square miles in central Power County, south of the Snake River in the southeastern Snake River Plain of Idaho. The principal town and commercial center of the area is American Falls.

The immediate purpose of work in the area by the United States Geological Survey was to investigate the possibility of developing substantial quantities of ground water for irrigating high and outlying lands in the proposed Michaud Flats Project area of the United States Bureau of Reclamation. Initial findings are sufficiently favorable to warrant comprehensive further investigation. Advanced study would assist proper utilization of ground-water resources and would aid ultimate evaluation of total water resources available in the area.

About 10,000 acres of low-lying lands in the Michaud Flats project could be irrigated with water from the Snake River under a low-line distribution system involving a maximum pumping lift of about 200 feet above the river. An additional larger area of high and outlying lands is suitable for irrigation with water pumped from wells. If sufficient ground water is economically available

the expense of constructing and operating a costly highline distribution system for surface water could be saved.

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.

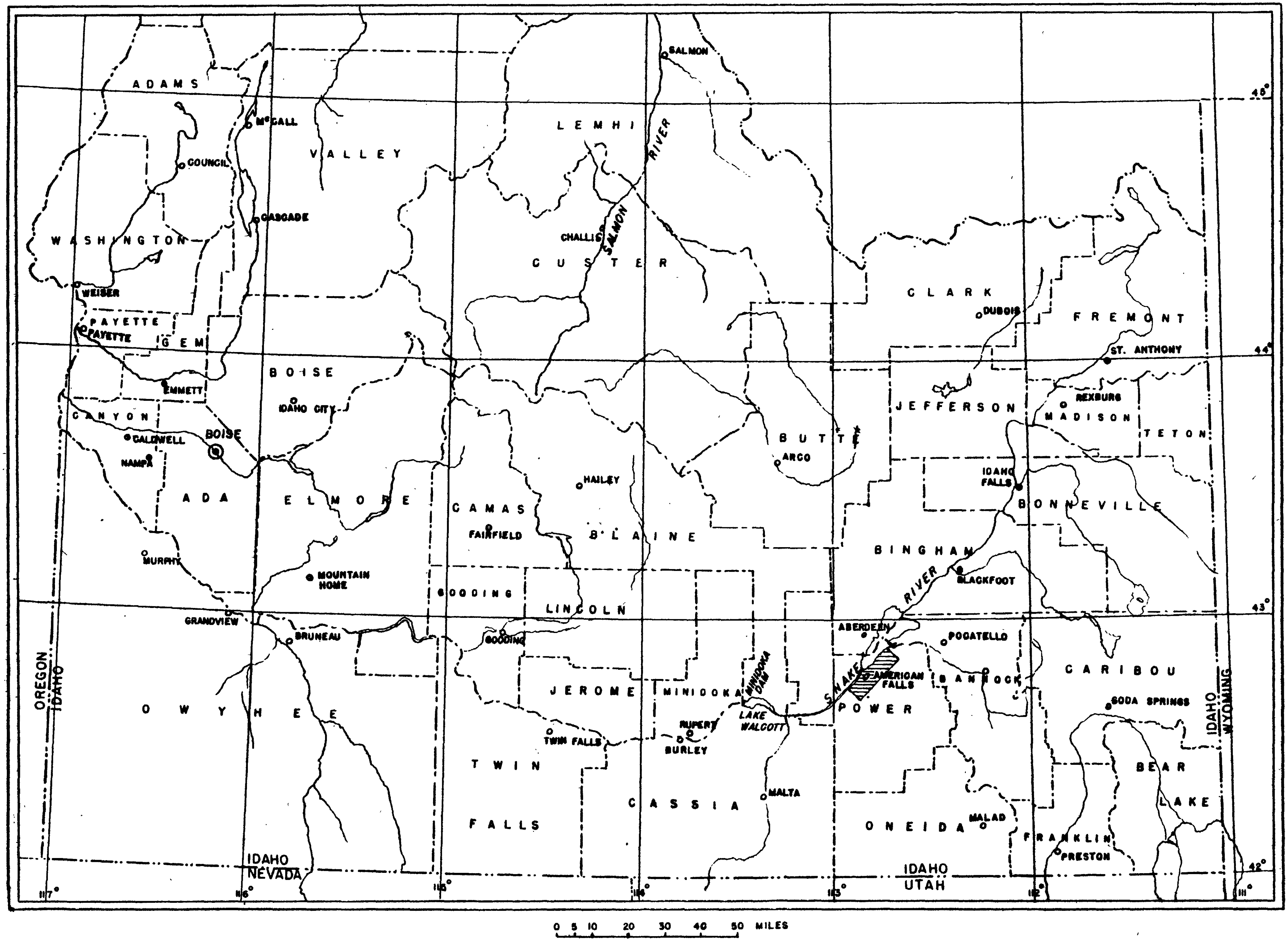
Evidence indicates that at least moderate supplies of ground water can be obtained in low-lying areas southwest and northeast of American Falls, but the safe perennial yields of the aquifers cannot now be estimated. The ground-water potential in high and outlying lands is not known. It is unlikely that 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.

Introduction

Location and General Features

Power County includes approximately 1,411 square miles in southeastern Idaho. The area here described occupies about 65 square miles in parts of Tps. 6-9 S., Rs. 30-32 E., in central Power County (index map, fig. 1), and includes the Michaud Flats Project of the United States Bureau of Reclamation. Michaud Flats, a flat plain from which the project name is derived, is in the Fort Hall Indian Reservation, about 12 miles northeast of the town of American Falls. Michaud Flats Project is the name applied by the Bureau of Reclamation to the whole area of flat to rolling land that extends from the Portneuf River westward to the vicinity of Neeley on the south side of the Snake River below American Falls. The irrigable land in this area is divided by the western boundary of the Fort Hall Indian Reservation into a Michaud Flats Extension of the Fort Hall Indian Project, and the Michaud Flats Project, which is now under investigation by the Bureau of Reclamation.

The ground-water investigation herein reported upon was limited to an area west of the Indian reservation boundary. The area covered is a narrow belt of land at the southeastern edge of the Snake River Plain, bounded on the northwest by the Snake River and American Falls Reservoir and on the southeast by the Deep Creek Mountains. The belt of land is about 18 miles long from northeast to southwest, and about 3 to 4 miles wide.



MAP OF SOUTHERN IDAHO SHOWING AREA COVERED BY THIS REPORT

American Falls, the principal town and commercial center of Power County, had a population of 1,890 in 1950. Much of the area is dry-farmed lands from which the principal crops are wheat, oats, barley, and rye. The area is served by the Union Pacific Railroad, U. S. Highway 30N, State Highway 37, and numerous local roads.

Previous Investigations

A geologic study of petroleum possibilities in Power and Oneida Counties was made by Piper in 1923.[1] A report by Stearns and others [2] on the geology and water resources of the Snake River

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[1] Piper, Arthur M., 1924, Possibilities of petroleum in Power and Oneida Counties, Idaho: Idaho Bur. Mines and Geology Pamphlet 12, 24 pp., 4 pls, 1 fig., December.

[2] Stearns, H. T., Crandall, Lynn, and Steward, W. G., 1938, Geology and ground-water resources of the Snake River Plain in southeastern Idaho: U. S. Geol. Survey Water-Supply Paper 774, pp. 69-72, 117-118.

Plain included data on the Michaud Flats Project area. A plan map and profile of the Snake River in this area has been published. [3]

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[3] Werner, E. L., and Lundberg, John, Jr., 1939, Plan and profile of Snake River, Milner to Pine Creek, Idaho; Henry's Fork, mouth to St. Anthony Dam site: U. S. Geol. Survey, 12 plan and 7 profile sheets.

D. P. Affleck and L. D. Jarrard, of the Bureau of Reclamation, canvassed many wells in the area in August 1949, as a part of the Bureau's preliminary study of the proposed Michaud Flats Project.

Purpose and Scope of Report

This report reviews the results of a preliminary investigation by the United States Geological Survey of the source, direction of underflow, quantity, and availability of ground water for irrigation in the American Falls area. The immediate purpose of the investigation was to assist study by the Bureau of Reclamation of the relative economy and feasibility of developing ground water, rather than diverting surface water, for irrigating part of the Michaud Flats Project.

Approximately 10,000 acres of land bordering the reservoir and river northeast and southwest of American Falls (herein called the lowline tract), is comparatively flat and is included in the project proposed to be irrigated with surface water from the Snake River. A maximum lift of about 200 feet would be required to get water from the river to the distribution system. An area of about 20,000 additional acres (herein called the highline tract), is very irregular in configuration and has considerable relief. Part of the highline tract is above the lowline distribution system; other parts either are isolated from the system or are too rough for practical gravity irrigation. If water from local underground sources could be developed on a substantial scale, irrigation from wells in the highline tract might be economically feasible. Irrigation from strategically located wells would eliminate the need for relift pumps to raise water to parts of the highline tract, and for costly structures to deliver water to isolated tracts. Areas that are too rough to be leveled might be irrigated with sprinkler systems supplied with water from wells.

The data contained herein were obtained chiefly during rapid reconnaissance in an area for which little subsurface information is available. Observations of water-level fluctuations have not been of sufficient duration to be of much use. The inferences and recommendations herein are of a preliminary and highly generalized nature; they may be modified appreciably after further study.

Field Work and Acknowledgments

Data were obtained during a brief field study, September 13-27, 1950, and from subsequent periodic observations of water-level fluctuations in wells. A geologic reconnaissance was made, existing wells were canvassed, water levels in wells were measured, and available well logs and pumping information were collected. Twenty-four wells were selected for continued observation, and periodic measurements of water levels in these wells have been made. A brief discharge-drawdown test was made on well 8S 30E-14cb1. Well canvassing and engineering study were by J. W. Stewart. Geological reconnaissance was by Morris Deutsch. General reconnaissance and supervision were by R. L. Nace. S. W. Fader, P. T. Voegeli, and G. E. Brandvold, of the Geological Survey, assisted in the field and laboratory work.

Fred Sawyer, superintendent of the American Falls Power Plant, furnished the logs of diamond-drill cores from the site of the power

plant. Robert Cure, well driller, collected cuttings from several wells in the area. T. C. Sparks, Water Superintendent of American Falls, and local residents of the American Falls area furnished useful information. The investigations were financed largely by the Bureau of Reclamation. The Idaho State Department of Reclamation participated in the operation and maintenance of the network of project observation wells, and in the duplication of the report.

The investigation here reported was made at the request of the Planning Division, Central Snake River District, Bureau of Reclamation. Investigations of ground water by the Geological Survey in Idaho are under the general direction of A. N. Sayre, Chief of the Ground Water Branch, Washington, D. C., and under the immediate supervision of R. L. Nace, District Geologist, Boise, Idaho. Mark R. Kulp, Idaho State Reclamation Engineer, participates in the direction of the cooperative ground-water investigations.

Physiography

Where the Snake River borders on the Michaud Flats Project area the river has carved a narrow gorge which is about 100 feet deep at American Falls. From there to Massacre Rocks, about 10 miles to the southwest, the depth of the gorge ranges from 100 to 150 feet. The dam at American Falls impounds a reservoir about 22 miles long and 2 to 8 miles wide. The maximum upstream extent of backwater is to a point about 24 miles downstream from Blackfoot. The central Snake River basalt plain lies north and west of this segment of the river.

An alluvial plain 3 to 4 miles wide borders the southeast side of the river in the area here discussed. Alluvial fans extend onto the plain from the mouths of the canyons in the adjacent mountains. Gently rolling foothills of the Deep Creek Mountains occupy much of the reclamation project area and grade into the alluvial plain. The foothills are relatively rugged along the southeast margin of the area.

All drainage in the area is to the Snake River, through Ferry Hollow, Sunbeam, Cold, and Little Creeks. These are intermittent at their mouths and across the alluvial plain, but their headwaters are perennial and have cut deep canyons in the Deep Creek Mountains.

The total phsiographic relief in the area is about 900 feet, the altitude ranging from 4,230 feet at the project boundary on the south bank of the Snake River below the reservoir, to 5,130 feet in the foothills of the Deep Creek Mountains southeast of American Falls. The altitude of the water surface in American Falls Reservoir during the period September 14 to 22, 1950, when measurements of ground-water levels were made, was 4,338.8 feet above mean sea-level datum. The altitude of the water surface in the Snake River at the Neeley gaging station during the same period was 4,247.3 feet. At the rated reservoir capacity of 1,700,000 acre-feet the altitude of the reservoir water surface is 4,354.5 feet. The altitude for rated zero capacity is about 4,296 feet. The maximum altitude that actually has been reached is about 4,355 feet.

Areal Geology

Paleozoic sedimentary rocks in the Deep Creek Mountains are the oldest rocks that crop out in the area. The late Cenozoic American Falls lake beds and Neeley lake beds, consisting of clay, silt, sand, pebbly sand, and tuff, crop out in the Snake River gorge and in tributary valleys below the American Falls dam. The beds accumulated in ancient basalt-dammed lakes of wide areal extent, including all or most of the area here reported on, whose shorelines at times were about 100 feet higher than that of American Falls reservoir. At some places the lake beds are interbedded with volcanic rocks. Tuff and basalt of the Eagle Rock tuff and Massacre volcanics crop out in the gorge of the river below the dam and in small scattered outcrops south of the river.

In most of the project area older beds are covered by Quaternary flood-plain and alluvial-fan sediments deposited by the Snake River and its principal local tributaries, Sunbeam, Cold, and Little Creeks and Blind Stream. The Deep Creek Mountains were the source of much of these sediments. In much of the area the sediment and rock units are overlain by a mantle of unconsolidated light-tan to brown loess.

Subsurface Geology

Basalt and more acidic types of volcanic rock are interbedded with clastic sediments to an unknown depth beneath the surface. Rhyolite tuff and obsidian tuff are present at shallow depth. Drill logs show that beds of clay, silt, sand, and gravel overlie the major basalt flows. In the southern part of the area extensive deposits of rhyolite tuff and obsidian tuff are intermixed with the sediments. The "black sand" reported by some drillers consists of grains of basalt; some of the "black sand" may be volcanic tuff of basic composition. The so-called blackjack of drillers in the area is obsidian tuff.

Northeastward from American Falls volcanic rock apparently was not encountered by the drill in any of the wells reported herein. The materials drilled below the American Falls Lake beds in that area are sandy, ranging from unconsolidated sand to hard well-cemented sandstone. Tongues and lenses of silt and clay are interbedded with coarser materials at many places. Both the lake beds and underlying sand contain gravel lenses but generally these are in thin beds of small volumetric importance.

Occurrence of Ground Water

Available subsurface data from drillers' logs and reports of well owners is not sufficient to indicate the details of ground-water occurrence in the Michaud Flats Project. The amount of information about existing wells is extremely small because about three-fourths of all wells in the area have been abandoned and for these no drilling, construction, or production data are available. For many producing wells information could not be obtained about the amount of casing and the size and position of perforations. Records show that water from some deeper sources that have been drilled may be under low artesian pressure. At depths greater than those yet drilled there may be untapped sources of water.

Some useful available data pertain to the region northeast of American Falls, between the reservoir and the foothills of the Deep Creek Mountains. In that area irrigation wells 200 to 300 feet deep tap two principal depth-zones of water-bearing material. The upper zone, extending from the surface to a maximum known depth of about 80 feet, contains water that may be perched or semiperched in a zone of saturation ranging from 10 to 35 feet in thickness. Below this is 60 to 115 feet of relatively impervious material, chiefly clay, clayey silt, silt, and fine sand. An underlying zone of gravel and sandstone, extending to unknown depth, contains water that has been tapped by several irrigation wells.

It is reported that the water table in the shallow zone fluctuates widely and wells that tap only this source yield very limited quantities of water. The areal extent of the shallow water body is not known but it appears to be limited largely to the northeastern part of the area.

Evidence is not sufficient to determine whether water of the lower zone is confined, but it is believed to be under low artesian pressure at some localities.

The driller's log of the Eames well (7S 31E-1da2), about 1¼ miles southeast of the shore of the American Falls Reservoir, records shallow water in sand from 65 to 77 feet, and a deeper source of water in gravel and sandstone from 195 to 292 feet. The material separating the two water-bearing zones is predominantly clay, silt, and fine sand. It is believed that the casing in this well is perforated in both the upper and lower zones, and the driller reported a depth of 48 feet to the static water level when the well was completed. This is 17 feet above the depth to water reported when only the shallow zone had been pentrated. In September 1950 the depth to water was 54.4 feet below the land surface. Possibly the lower water is under artesian pressure and is leaking out into the upper zone of saturation.

The log of the Smith well (7S 32E-7da2), about 1½ miles southeast of the Eames well near the foothills of the Deep Creek Mountains, records water in sand from 35 to 68 feet, and deeper water in sandstone from 190 to 295 feet. Clay, sandy clay, gravel, and sandstone separate the two aquifers. There is no evidence that any source of water tapped by this well is under artesian pressure.

Available drillers' logs indicate only one main aquifer in the southwestern part of the area, but the data are not sufficient to show the lateral extent and thickness of the water-bearing formation.

The reconnaissance hydrologic map (pl. 1) shows by contours the approximate altitude and configuration of the ground-water pressure surface in the American Falls area. The map is based on water-level measurements by the Geological Survey, chiefly in September 1950. Bureau of Reclamation local leveling records were used to compute the altitude of the water surface in feet above mean sea-level datum of 1929, Pacific Northwest Supplementary Adjustment of 1947. The pressure-surface contours are subject to revision for reasons noted below.

1. A few wells had been pumped immediately before being measured, and the water levels as measured may not have represented accurately the position of the water table.

2. Confined, unconfined, and perched or semiperched water could not be distinguished in all wells. Therefore the hydrologic contours do not necessarily represent a normal pressure surface (water table) at all places. The contours may be somewhat distorted, especially in parts of the area northeast of American Falls, where water levels were used as though they represent a normal pressure surface, whereas in some wells they may represent unrecognized low-artesian-pressure surfaces.

3. Altitudes of some wells in the area have not been determined. Completion of the leveling would improve the accuracy and extend the area of contouring. Reconnaissance leveling that has been done is not sufficiently precise to permit accurate map compilation.

As a whole the hydrologic map is believed to be a reasonably accurate representation of the general configuration of the water table, and of the general directions of ground-water underflow, but it cannot be used rigidly to predict the altitudes at which water would be struck or at which it would stand in new wells.

Movements of Ground Water

Movement of ground water in the area mapped is generally northwestward toward the Snake River and American Falls Reservoir. The hydraulic gradient is about 50 to 70 feet per mile in the hilly section in the southwestern part of the area, and about 15 feet per mile in the nearly level flat area in the northeast. The trends and altitudes of the water table contours south of the river in the vicinity of American Falls and Neeley suggest that the southwestern part of the reservoir basin, and a reach of the river channel below the reservoir, may be above the water table. The materials underlying the basin and channel may be of sufficiently low permeability to perch the reservoir and river. Although measurements of ground-water levels could not be made in the critical areas adjacent to the river and reservoir, it is apparent that the water-table contours would have to curve downstream as they approach these areas. Recent test drilling by the Bureau of Reclamation at the Eagle Rock Dam site, about 3 miles southwest of Neeley, shows that the water table in that area is below the river level. It is likely that both the river and the southwestern part of the reservoir lose appreciable amounts of water to the ground. Southwest of American Falls ground water may pass beneath the river from the south to the north side. From the vicinity of Seagull Bay northeastward the ground water appears to be tributary to the reservoir.

Between American Falls and the former location of the Neeley gaging station in sec. 11, T. 8 S., R. 30 E., "There is about 35 second-feet of ground-water inflow to the river along the north bank. About 25 second-feet of this comes from Ruegar Springs, about 1 mile below American Falls. The remainder comes from various small seeps, apparently mostly from irrigation at the southwest end of the Aberdeen irrigation project." 1/ There is no

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1/ Crandall, Lynn, personal communication, August 31, 1951.

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apparent hydraulic connection between the ground water represented by the contours on the south side of the river (pl. 1) and the ground water that discharges to the north bank of the river below American Falls. Seeps or springs have not been found in the south bank of the river.

Recharge of Ground Water

Present Regimen

Natural recharge to the ground-water reservoirs in the American Falls area is derived directly and indirectly from precipitation, of which the annual average in the area is about 13 inches. Much of the recharge is from surface-water seepage losses along the channels of the numerous streams that cross the area from the Deep Creek Mountains, especially during periods of heavy runoff. Because of the limited precipitation and its strongly seasonal distribution, most of the streams are intermittent below their headwater areas.

Except during the period of heavy spring runoff, very little surface water is discharged by these streams into the Snake River.

Some recharge may be derived from seepage losses from the southwestern part of the American Falls Reservoir, where the reservoir bottom appears to be above the water table, and from the Snake River below the reservoir. The northeastern part of the Michaud Flats Project may receive recharge by underflow from areas to the northeast, where there are known large supplies of ground water.

Water levels in the wells generally rise in seasons of melting snow and decline during the dry months of summer and fall. Erratic fluctuations of water levels in wells 8S 31E-18db1 and 8S 30E-13ac2, which tap shallow water-bearing material, appear to be caused by seepage losses from nearby Warm Creek. In September 1950 and June 1951 water levels in most project observation wells rose from a tenth to a few tenths of a foot. The September rise may reflect local recharge from late summer precipitation. The June rise may be a tardy effect of spring precipitation and of regional recharge from melting snow in the nearby mountains. Records of water-level fluctuations cover too short a period to support much interpretation.

An estimate of the amount of water discharged from the area by surface runoff, evapotranspiration, ground-water underflow, and other means is beyond the scope of this preliminary report. Further study is needed to determine the relations of ground-water recharge and discharge to storage levels in American Falls Reservoir and to the stages and channel conditions of the Snake River.

Regimen Under Irrigation

The effective precipitation, available for consumptive use by crops and other vegetation during the growing season in the Michaud Flats Project, is not known. Diversion requirements for irrigation with surface water, expectable consumptive use, and probable losses by deep percolation also are not known. Therefore there is no adequate basis for estimating the amount of ground-water recharge that might result from percolation losses of irrigation water. An estimate of the order of magnitude of these losses may be gained from speculations based on experience and observation elsewhere. Assuming a diversion requirement of 4.1 acre-feet per acre and farm delivery of 3.6 acre-feet per acre, for 10,000 acres under surface-water irrigation, total annual diversions would amount to 41,000 acre-feet of water. Canal losses by seepage, evaporation, and waste might amount to 5,000 acre-feet, of which perhaps 3,000 acre-feet would reach the zone of saturation as ground-water recharge. Farm delivery of 36,000 acre-feet might result in the contribution of 18,000 acre-feet to ground-water recharge. Total ground-water recharge thus might be about 21,000 acre-feet. These figures have no factual standing whatever, but they can be used to illustrate qualitatively the changes in ground-water regimen that may occur with irrigation.

Increased ground-water storage would cause the water table to rise in and near the irrigated area. Where the subsurface materials are of low permeability and low porosity, or both, the rise would be relatively rapid. Soil-drainage problems might develop in some areas. Increased hydraulic gradients would increase the ground-water contribution to the American Falls Reservoir, and build-up of the water table might reduce seepage losses from the southwestern part of the reservoir. The time lag between application of water to the land surface and increase of return flow to the reservoir might range from days to months, depending upon the permeability of aquifers, the distance of the recharge area from the area of discharge, the velocity of the induced ground-water recharge wave, and other factors. All the induced recharge could not be credited as return flow to the reservoir, however, because some of the water would pass beneath the river downstream from the reservoir and join the body of ground water beneath the central Snake River Plain north of the river. On the other hand, the upper part of Lake Walcott, and a considerable reach of the river above it, is fed by ground water from the central plain, down the ground-water gradient from the area of loss from the Michaud Flats Project. Therefore, a part of the water lost by underflow from the project below American Falls would appear as return flow above Minidoka Dam. For these reasons, net depletion of the surface-water supply above Minidoka Dam would be less than the total diversion for the Michaud Flats Project.

Irrigation of only a small tract with surface water alone has been considered above. Concurrent irrigation of a larger tract with pumped ground water would alter materially the trend of effects from irrigation with surface water. Assuming that 54,000 acre-feet of water might be pumped, of which possibly 27,000 acre-feet might return to the zone of saturation, net depletion of ground water would be about 27,000 acre-feet, which is substantially more than the supposed recharge induced by irrigation with surface water. The net depletion of total ground- and surface-water resources in this instance would be the amount of pumped ground water consumptively used, less the amount of diverted surface water that reaches the zone of saturation, plus the amount of surface water consumptively used, or about 26,000 acre-feet. The proportion of net depletion above American Falls to that below cannot be estimated at present.

Again it is emphasized that the above computations are illustrative only. They have no necessary relation to actual conditions that may develop, and they have been introduced only to indicate the probable nature of those conditions and the interplay of hydrologic factors that are or will be operative.

Utilization of Ground Water

Ground water in the Michaud Flats Project area is obtained largely from dug and drilled wells. Springs are utilized to a limited extent.

Springs

Minor springs in the foothills area were not investigated. In the SE$\frac{1}{4}$ sec. 18, T. 8 S., R. 31 E., the large Indian Springs emerge from a hillside along an inferred fault, where there are large deposits of travertine. The springs are reported to yield 1.5 million gallons a day. The temperature of the water on September 22, 1950, was 90° F. A swimming pool formerly was maintained near the springs, but all the water now is used for irrigation.

Wells

The depth to water in wells ranges from 25 to 70 feet below the land surface in the valley bottoms, 80 to 140 feet along the edge of the valley slopes, and 150 to 245 feet in the foothills of the Deep Creek Mountains south of American Falls.

Dug wells:— Some domestic water supplies in the area are obtained from dug wells in the valley bottom and in the alluvial plain on the south side of the Snake River. Nearly all the dug wells are in T. 8 S., R. 30 E., in the vicinity of the Village of Neeley, about 4 miles southwest of American Falls. Most of the finished dug wells are 2 to 4 feet in diameter and are cribbed with either wood or stone. The depths range from 6 feet at Indian Springs to a reported 100 feet at Neeley. Dug wells yield from 5 to 20 gallons a minute.

Drilled wells.— Most irrigation wells are situated in valley bottoms near the edges of valley slopes. Drilled domestic wells are scattered throughout the area, including the foothills of the Deep Creek Mountains. Wells drilled by the cable-tool (percussion) method are the more common type and range in diameter from 4 to 16 inches. Most domestic wells are 6-inch; a large number of 4-inch wells have been drilled but very few are now in use. Most of the domestic wells are cased to about 10 to 15 feet below the land surface, with open hole below. A few, drilled in exceptionally unstable materials, are cased throughout. The most common casing is no. 20 galvanized iron, locally called "stove-pipe casing". 1/

1/ This is not true stovepipe casing, which is double-walled. The term is used by local well drillers in reference to the thin wall and light weight of 20-gage casing.

Irrigation wells range in diameter from 8 to 16 inches, the 10- and 12-inch sizes being the most common. Most irrigation wells drilled within the past 5 years are 14 to 16 inches in diameter. The common types of casing in current use are (1) black-iron, (2) steel, and (3) flume-pipe. Practically all the earlier wells were cased partially with no. 20 galvanized iron. An appreciable percentage of irrigation wells is equipped with improvised casing made from hot-water tanks and steel oil drums. Commonly the casing is seated just below the water table, regardless of the total depth of the well or the character of the aquifer. In wells finished with slotted casing in the zone of saturation no apparent effort was made to relate the slot sizes to the grain-size characteristics of sedimentary aquifers, or with the expected or desired pumping rates. In at least some wells the slot openings provide insufficient water-entrance area, causing excessive head loss in the wells and large drawdown during pumping. For these and other reasons satisfactory pumping tests cannot be made in existing wells.

The methods and materials generally in use for construction of domestic and irrigation wells in this area are unsuitable for the type of materials drilled. The wells deteriorate rapidly, caving is common, and there is a very high percentage of abandoned wells. Approximately 50 of the 80 wells that were canvassed have been abandoned (table 1). Further study is needed to determine the types of well construction that are suitable for the water-bearing materials in the area.

The depth of the wells varies widely. Irrigation wells, even in areas where the water table is only 25 to 60 feet below the land surface, are 200 to 300 feet deep, depending upon the quantity of water needed and the driller's estimate of the necessary depth. Most stock and domestic wells are more than 24 and less than about 370 feet deep.

<u>Performance of wells</u>.— Irrigation wells in the area are pumped by deep-well turbines having 3 to 7 stages; most stock and domestic wells are pumped by windmill and lift pump. A few domestic wells are connected with closed pressure systems.

Very few data are available on the rates and quantities of water pumped from wells. Information from well owners and drillers indicates that the capacities of most irrigation wells are severely limited; many can be pumped "dry" at rates of 600 to 800 gallons a minute. The drawdown in some wells pumped at these rates ranges from a few feet to 50 feet.

The Kramer irrigation well (8S 30E-22aa1) penetrates lava in the lower part of the well, which has a total yield of about 1,400 gallons a minute with a 10- to 12-foot drawdown. The Zaring irrigation well (8S 30E-14db1) yields about 1,180 gallons a minute with a drawdown of 4 feet. In the Eames well (7S 31E-1da2) the drawdown was about 41 feet after 7 hours' pumping 1,400 gallons a minute. The water pumped from this well in September 1950 contained an excessive amount of sand.

The drawdown in two public-supply wells (7S 31E-29 da1, -da2) at American Falls was reported to be 6 and 8 feet after 60 days' pumping 375 and 550 gallons a minute, respectively.

Discharge-drawdown tests.-- The Zaring irrigation well (8S 30E-14db1) was pumped for 3 hours on November 27, 1950, after drilling was completed, but it was possible to make only incidental observations relating to the water-bearing properties of the aquifer. The well is near the river slope on the north side of U. S. Highway 30 about a mile east of the Snake River. The well was not cased at the time of the test; the hole diameter was 10 inches and the depth about 180 feet. The discharge test was with a deep-well turbine pump powered by a diesel engine. The end of the suction pipe was 180 feet below the land surface. Water-level measurements were by steel tape and electric tape; the discharge was measured with a 6-inch orifice weir and manometer gage on an 8-inch discharge pipe.

The average rate of pumping was 900 gallons a minute for 1 hour and 1,180 gallons a minute for the succeeding 2 hours. A large amount of sand was discharged but during the first hour the water cleared considerably. The later increase in pumping rate caused additional sand movement and the water contained much sand throughout the test.

The depth to static water level in the well before the test was 121.4 feet below the measuring point, which is 0.3 foot above the land-surface datum. After pumping for 15 minutes the water level had dropped 2 feet (fig. 2). The maximum drawdown of 4.2 feet occurred after 115 minutes of pumping, and at the end of the test the net drawdown was 3.7 feet. Erratic fluctuations of the water level during the test were caused by varying pumping rate and excessive caving of sand, presumably from the depth interval 121 to 169 feet. A steadily increasing pumping rate and dewatering of a cone of depression in the aquifer probably caused unstable material to slump and partially fill the hole, reducing pump efficiency and steadily increasing the drawdown until most of the loosened sand was pumped from the well. Caving continued at intervals throughout the test.

The test was too short to permit determining the water-bearing properties of the aquifer. Moreover, the results obtained are not representative of the drawdown that would occur during continuous pumping at a steady rate for a longer period in a properly constructed and developed well. The test does indicate, however, that the permeability of the aquifer is high, and moderate to large yields can be expected from properly constructed wells south of American Falls along the slope near the river.

It is reported that a test of the Lish irrigation well (7S 31E-32bd2) was attempted, but that the well was pumped "dry" in less than an hour, at a pumping rate of 600 gallons a minute. The well is 103 feet deep and the depth to water is 86 feet below the land surface.

The Thornton irrigation well (8S 30E-7ac2) was pumped in October 1950. The depth of the well is 315 feet and the depth to water 259 feet below the land surface. The well was pumped "dry" after several hours of pumping at 800 to 1,000 gallons a minute.

Conclusions

The low yield of most existing wells in the Michaud Flats Project is not an accurate index of the quantity of water that is available or that could be developed, because improper well construction limits the output of many wells. Sand screens have not been used and in those wells that are equipped with slotted casing the slot dimensions were selected at random, without regard to the mechanical composition of the unconsolidated aquifer. Artificial gravel packing has not been tried and any natural gravel packs that are present were developed unintentionally.

The safe yield of the water-bearing materials cannot be determined until more basic data are obtained about the hydraulic properties, areal extent, thickness, sources and amount of recharge, and fluctuations of water levels in the aquifers.

(25a follows)

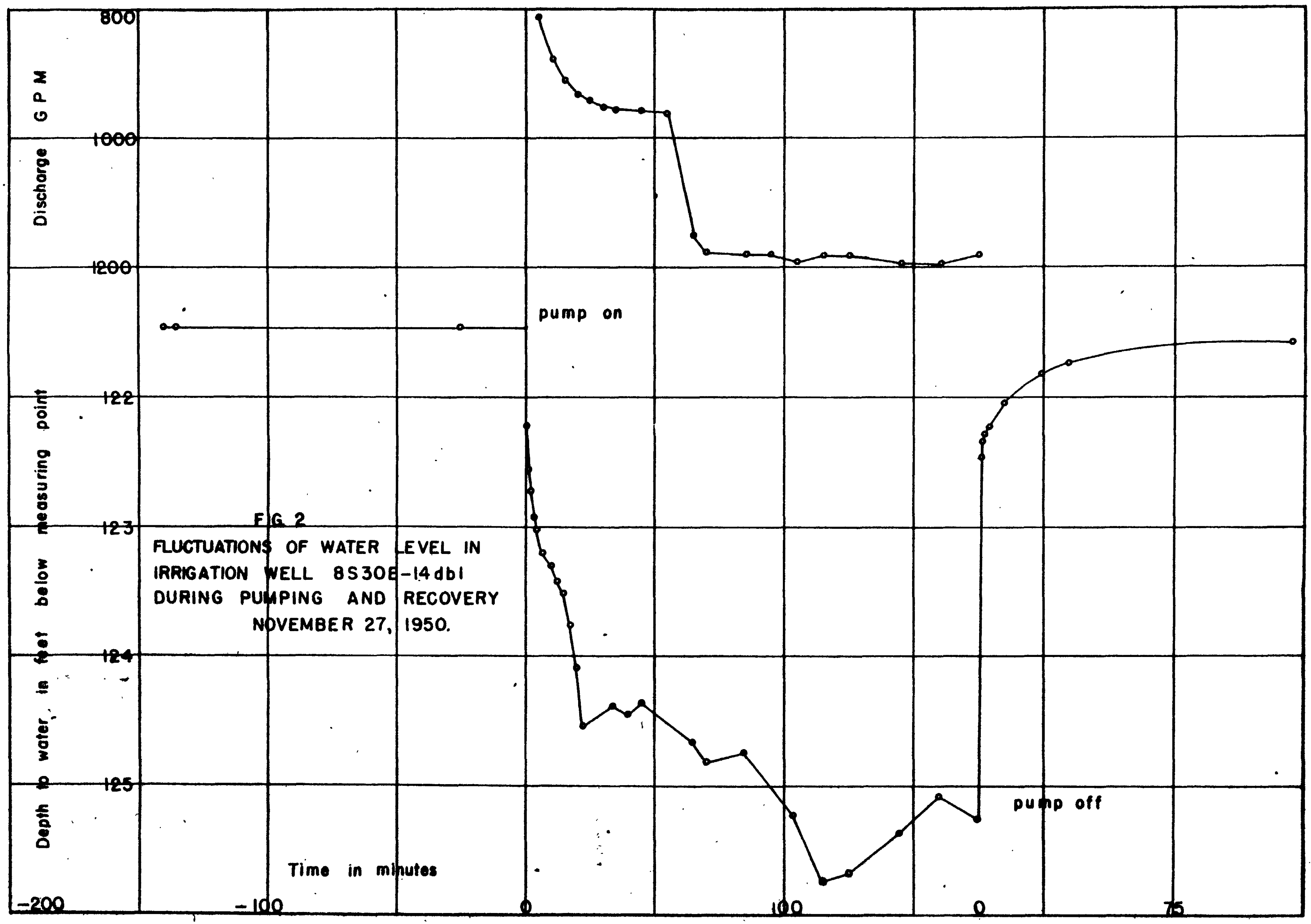


FIG. 2
FLUCTUATIONS OF WATER LEVEL IN IRRIGATION WELL 8S30E-14dbl DURING PUMPING AND RECOVERY NOVEMBER 27, 1950.

A moderate supply of ground water is available in the alluvial and volcanic aquifers in the plain southwest of American Falls. Northeast of American Falls moderate yields can be developed from wells in some areas; other parts of the northeastern area are less favorable for ground-water development. Thus at least a part of the lowline tract could be irrigated with ground water if that becomes desirable. The effects of heavy pumping on the ground-water regimen and return flow to the American Falls Reservoir and the Snake River cannot be quantitatively estimated on the basis of available data. It is possible that, from the vicinity of Sunbeam Creek southwestward, pumping from wells would not materially influence local return flow to the river or reservoir. The situation is complex, however, and needs careful study.

The probable individual and aggregate yield of future wells in the highline tract cannot now be estimated accurately. Shallow aquifers containing perched or semiperched water would yield only limited supplies. Deeper aquifers doubtless would yield sufficient water to irrigate parts of the tract. Assuming that there are 15,000 irrigable acres in the highline tract, and that the diversion requirement would be 3.6 acre-feet of water per acre (applied during a 150-day irrigation season), the annual water demand would be 54,000 acre-feet. Sprinkler irrigation of some crops and areas would reduce substantially the water demand. The rate of pumping from all wells during the season thus might be about 180 second-feet or less. Assuming wells of moderate capacity, probably 50 to 90 wells would be needed. Thus there would be one well per 200 to 400 acres of total area - perhaps two or three wells per section of land. Though this would not be an unreasonable number and spacing of wells for a highly productive area, the safe yield of the aquifers in the Michaud Flats project is unknown.

Available information is inadequate for definite conclusions as to the feasibility of pumping ground water for irrigation of all or part of the Michaud Flats Project. The productive capacities of the aquifers have not been demonstrated, recharge data are qualitative and incomplete, and the relations between ground- and surface-water bodies are poorly known. The prospect that development of ground water for part of the tract might be feasible is sufficiently good to warrant thorough investigation of the area. If further study leads to definite project plans, these plans, because of the small size of the area in which ground-water sources would be tapped, should provide for development of small units on a semi-experimental basis, supported by adequate continued observations.

Suggestions for Further Study

Investigations and observations within the appropriate field of activity of the Geological Survey, leading to an adequate appraisal of ground-water resources in the Michaud Flats Project, would include the phases outlined below:

1. Test drilling to assist delineation of the extent, occurrence, and characteristics of water-bearing materials. The ultimate number of needed test holes necessarily could be determined only after an initial few had been drilled. Several tests, at geologically favorable localities, should extend to depths of at least 1,000 feet, to explore the possibilities for developing ground water from more permeable zones within economic limits. These test holes logically would be drilled early in an exploration program.

2. Pumping tests to determine the hydraulic properties of aquifers at representative localities. These tests would assist an estimate of the expectable yield of production wells, and of the probable range of drawdown and pumping lifts.

3. Maintenance and improvement of the project observation-well net in order to determine the seasonal and other fluctuations in ground-water levels and storage. All or most of the test holes (par. 1, above) would become observation wells. If and when development of an irrigation project was under way, the observation wells would assist estimation of the effects of heavy pumping on ground-water storage. Ultimately the safe annual yield of the aquifer might be determined.

4. Study of the hydraulic relations of American Falls Reservoir and the Snake River to the ground-water bodies, and the effect of heavy ground-water pumping on these relations. Pumping from some areas and aquifers unquestionably would deplete the total

annual contribution to the surface-water system by ground-water discharge. The magnitude and time of year of these effects, however, could be determined only by careful study. Pumping from deep ground-water sources might not measurably affect the river and reservoir regimen.

5. Census of total annual pumpage of ground water. A census should be made and repeated yearly, as a phase of water budgeting.

6. Study of the infiltration rate, through soils and subsoils, of water applied to the surface. The derived data, in conjunction with information about consumptive use of water, would assist estimation of probable depletion of total water supply.

7. Leveling of all wells in accordance with Third-Order leveling standards. Permanent altitude reference marks should be established in order to insure permanence and accuracy of the measuring datum for wells.

8. Refinement and extension of the water-table contour map, with the aid of new leveling and other data, and extension of the area of investigation to the southwest. The complex interrelations of ground- and surface-water bodies in the southeastern Snake River Plain emphasize that the water in the plain must be treated as a single resource, not two. The full water potential of the area cannot be developed without appraisal of the total surface- and ground-water resources. Development of water from one source inevitably will affect the other source, and the effects may extend far beyond the boundaries of the project. In order to evaluate properly the effects

of development of the Michaud Flats Project, therefore, ground-water investigations should be extended southwestward on both sides of the Snake River from American Falls to Minidoka Dam.

9. Survey of the chemical quality of ground water in the area, to determine the range of variation in composition and the suitability of the water for irrigation of the types of soils that are present.

Possibly additional irrigation or experimental wells will be drilled in the American Falls area by private or other interests. To obtain the maximum yield with a minimum of drawdown it is suggested that wells should be drilled and developed in accordance with the following general principles:

1. Dependence should not be placed on shallow sources of perched or semiperched water.

2. Deeper sources should be efficiently exploited with the aid of detailed test-hole logging. At most locations the cost of a preliminary test hole would be adequately repaid because (a) it would eliminate the cost of large-bore drilling in nonproductive areas, and (b) it would guide large-bore drilling and construction design in productive areas.

3. Wells in unconsolidated sediments and loose volcanic rock should be equipped with screens or perforated casings and gravel packs, in order to stabilize surrounding subsurface materials and to insure the maximum production of clear water with the minimum of drawdown. The size of opening in perforated casings and screens should

be chosen individually for each well and aquifer on the basis of analyses of the mechanical composition of water-bearing materials.

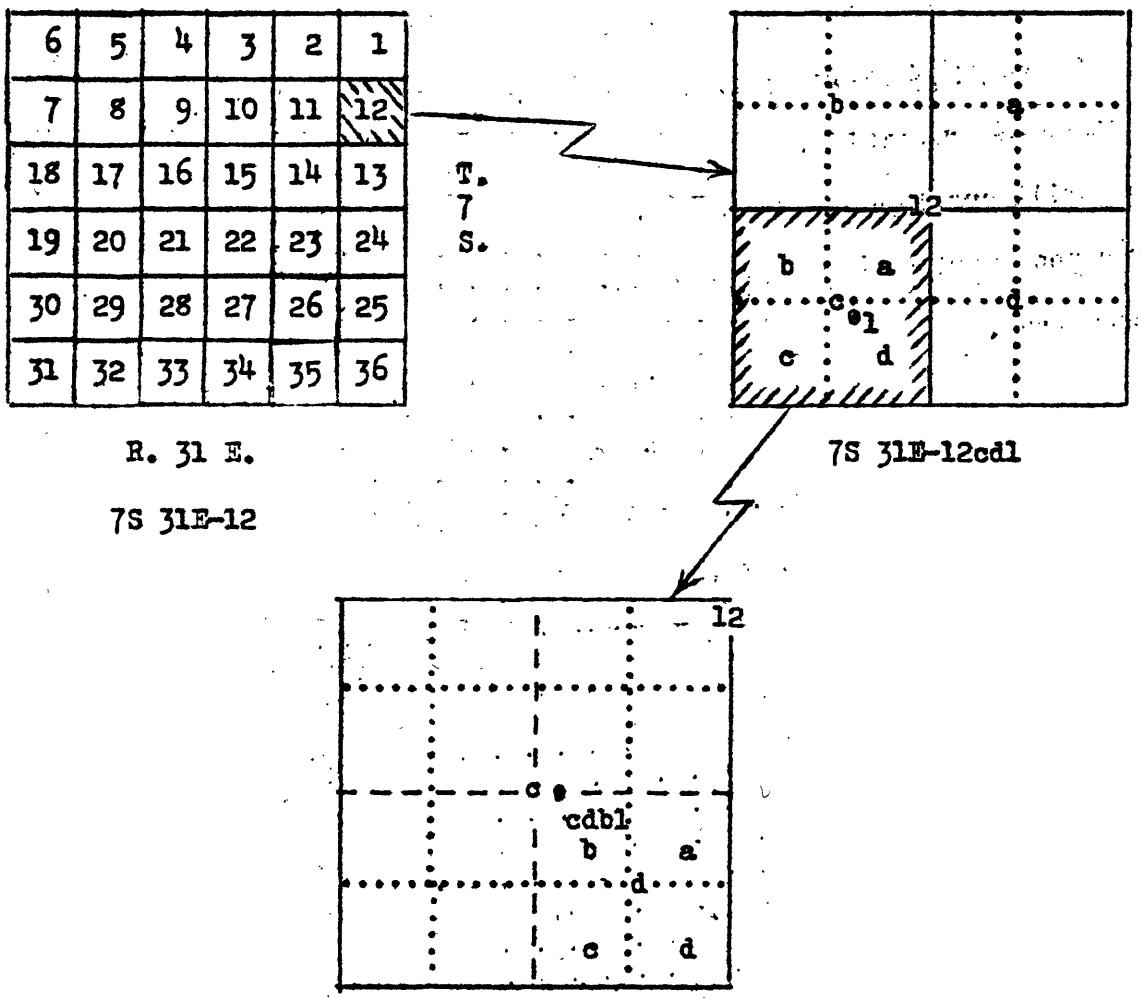
4. Screens and perforated casing should not be set indiscriminately in all water-bearing materials. Natural pressure heads in artesian basins differ from bed to bed and free communication between separate beds may permit subsurface migration and loss of water. Thus in some instances tapping several sources of water may lead to less pump production than would be obtained from a single source.

5. Well sites should be distributed so as to minimize mutual interference and competition.

6. Pumping rates should be controlled in accordance with the hydrologic properties of the aquifers at individual well sites.

Well-Numbering System

Idaho well numbers indicate the locations of wells within the official rectangular subdivisions of the public lands, with reference to the Boise base line and meridian. The first two segments of a number designate the township and range. The third segment gives the section number, followed by two or three letters and a numeral, which indicate the quarter-section, the 40 acre tract, the 10-acre tract, and the serial number of the well within the tract. Quarter sections are lettered a, b, c and d in counterclockwise order, from the northeast quarter of each section (see diagram). Within the quarter-sections 40-acre tracts are lettered in the same manner. Well 7S 31E-12cdl is in the SE$\frac{1}{4}$SW$\frac{1}{4}$ sec. 12, T. 7 S., R. 31 E., and is the well first visited in that tract. Where wells are numerous and closely spaced the 40-acre tracts may be subdivided into 10-acre tracts, designated by a third letter in the third segment of the number. Thus well 12cdbl is in NW$\frac{1}{4}$SE$\frac{1}{4}$SW$\frac{1}{4}$ sec. 12.



7S 31E-12cdbl

Logs of Wells and Test Borings

The following logs, except as noted, are drillers' logs that were obtained from either drillers or well owners. The terminology of drillers' logs has been slightly modified in order to achieve a degree of uniformity. The few logs that were compiled from a study of drill cuttings may be inaccurate because collection of cuttings was unsupervised and sampling methods did not conform to acceptable standards.

Wells

7S 31E-1da2. Vern Eames irrigation well

Log obtained from driller September 22, 1950.

Material	Thickness (feet)	Depth (feet)
Soil	10	10
Clay, sandy	55	65
Sand and water	12	77
Clay, blue	15	92
Sand, blue	38	130
Sand and blue mud	35	165
Clay, brown, sandy	30	195
Gravel and water	13	208
Mud, brown, with sandstone shelves	84	292

Water level 48 feet below land surface September 20, 1950.

7S 31E-29da2. American Falls public-supply well

Log obtained from T. C. Sparks, Water Superintendent, American Falls, September 21, 1950; terminology of original log slightly modified herein.

Material	Thickness (feet)	Depth (feet)
Soil	8	8
Sandstone, gray, soft	5	13
Sandstone, red, soft	50	63
Sandstone, red, hard	17	80
Alternate 5-6 inch layers	5	85
Sandstone, red, very hard	3	88
Sandstone, gray, hard	6	94
Limestone, very hard	3	97
Gravel (water)	3	100
Sand and gravel, compact	7	107
Gravel, coarse, free; (water)	3	110
Sandstone, brownish red, soft	35	145
Clay, solid bluish gray; impervious; interbedded with fragments of gravel	6	151

Water level was reported to be 92 feet below land surface fall, 1933.

7S 31E-32bd2. Ed Lish irrigation well

Log by Geological Survey from examination of drill cuttings.

Material	Thickness (feet)	Depth (feet)
Clay, sandy, reddish-tan; contains a few angular fragments	8	91
Gravel, dark pink; rounded pebbles are mostly quartzitic conglomerate	3	94
Gravel and sand, dark pink, subangular to rounded	3	97
Gravel and sand, dark pink, subangular to rounded; more gravel and less sand than in cuttings from 94 to 100 feet	6	103

Water level 88.8 feet below land surface October 11, 1950.

7S 32E-7da2. Bill Smith irrigation well

Log obtained from Vollmer Drilling Co. September 27, 1950.

Material	Thickness (feet)	Depth (feet)
Soil	30	30
Sand	5	35
Sandstone and water	3	38
Sand, gray	30	68
Clay, gray	10	78
Clay, red, sandy	26	104
Gravel	4	108
Clay, red, sandy	22	130
Sandstone, gray	10	140
Sandstone, red	30	170
Sand and gravel, water-bearing	20	190
Sandstone, white, water-bearing	50	240
Sandstone, red	40	280
Sandstone, gray	15	295

Water level 26 feet below land surface September 26, 1950.

8S 30E-14db1. Roy Zaring irrigation well

Log by Geological Survey from examination of cuttings obtained November 27, 1950.

Material	Thickness (feet)	Depth (feet)
Loessial soil, calcareous, poorly cemented, tan	20	20
Cuttings not recovered. Driller reported "soft formation"	20	40
Cuttings not recovered. Driller reported hard drilling	15	55
Basalt, light gray	3	58
Cuttings not recovered. Drilled hard	6	64
Cuttings not recovered. Driller reported gray cinders	6	70
Volcanic tuff and ash, with obsidian fragments	3	73
Volcanic tuff, tan and pink, with fragments of obsidian	5	78
Cuttings not recovered. Driller reported tan volcanic ash	6	84
Volcanic tuff, tan ash and obsidian fragments	13	97
Cuttings not recovered. Driller reported red volcanic ash	6	103
Volcanic tuff, tan; also ash and obsidian fragments	6	109
Cuttings not recovered. Driller reported tan volcanic ash	6	115
Volcanic tuff, cinders, and obsidian fragments. Driller reported gray sandstone	6	121
Cuttings not recovered. Driller reported water-bearing sand and cinders	12	133
Sand, angular, light-gray to gray	6	139
Cuttings not recovered. Driller reported water-bearing sand and cinders	24	163
Basalt, amygdaloidal, grayish-black; vesicles filled with carbonate	3	166
Basalt, vesicular, gray; carbonate filling in some vesicles	3	169
Cuttings not recovered. Driller reported hard gray lava	4	173
Cuttings not recovered. Driller reported hard water-bearing lava	8	181

Water level was 121.4 feet below land surface November 27, 1950.

8S 31E-7ac2. Eldron Thornton irrigation well

Log for upper 243 feet of hole from driller's record (modified); log from 243 to bottom of well by Geological Survey from examination of cuttings obtained September 23, 1950.

Material	Thickness (feet)	Depth (feet)
Soil	16	16
Cinders and gravel	18	34
Basalt and cinders, black	16	50
Clay and gravel	10	60
Clay	8	68
Sandstone, red	104	172
Sand, red, coarse	13	185
Lava, hard	11	196
Sand, black	6	202
Sand, red, fine, clayey	5	207
Gravel, coarse, cemented	7	214
Not recorded	29	243
Basalt. Silt in cuttings may be from above	2	245
Cuttings not recovered	11	256
Rhyolite, porphyritic; about 50 percent gravel in cuttings	3	259
Rhyolite, prophyritic; small amount of gravel in cuttings, probably from above	3	262
Rhyolite, prophyritic; obsidian fragments; gravel containing quartz and basalt grains	3	265
Rhyolite; obsidian fragments; gravel	3	268
Basalt, dense, blue-gray; obsidian fragments; some rhyolite in cuttings probably from above	3	271
Rhyolite; obsidian; basalt, light to dark blue	3	274
Basalt, blue to gray; obsidian; rhyolite. Clay comprises about 25 percent of cuttings	3	277
Silt and clay, white to buff; fragments of light to dark blue-gray basalt and rhyolite	3	280
Basalt, blue-gray; also rhyolite, silt, clay and traces of gravel	3	283
Basalt, porphyritic; minor amount of gravel	3	286
Basalt, prophyritic; also rhyolite, gravel and calcareous-cemented conglomerate	3	289
Basalt, porphyritic; also obsidian and rhyolite	3	292
Basalt, prophyritic; calcite crystals; some rhyolite	3	295
Basalt, dark-gray. Trace of rhyolite	3	298
Basalt, dark-gray	3	301
Basalt, dark-gray, olivine; also obsidian	3	304

Water level 217 feet below land surface October 3, 1950.

8S 31E-17ab3. Fred Mayer domestic well

Log obtained from owner September 20, 1950.

Material	Thickness (feet)	Depth (feet)
Light red formation	56	56
Sandstone, soft, black	6	62
Obsidian	4	66
Sandstone, brown	42	108
Sandstone, light brown	29	137
Hard Rock	3	140
Hard Rock	20	160
Sand and rock, hard, some gravel	14	174
Clay, red, sticky	6	180
Light red formation, similar to silt	15	195

Struck water at 160 feet in brown formation. Water rose to 135 feet below surface. Water-bearing bed about 14 feet thick.

Test borings

The Idaho Power Company has tested and bored subsurface rocks at the site of the hydroelectric plant at American Falls. Logs of test borings were furnished to the Geological Survey by Fred Sawyer of the Idaho Power Co. on September 22, 1950. The principal variations in the logs of these closely spaced test holes are minor differences in the recorded thicknesses of the various formations. The two logs reproduced below are typical of all the test borings.

7S 31E-31ab; Core Hole 1

Material	Thickness (feet)	Altitude, top of bed (feet)
Clay and sand	1.5	4283 (at top)
Concrete (from building)	1.8	4281.5
Basalt, black. Contains seam of calcite near bottom	26.6	4279.7
Basalt, brown	0.6	4253.1
Clay, baked, brick red	9.4	4252.5
Clay, brown, sandy	3.7	4243.1
Sandstone, red; clay seam in this bed dips 60°	1.5	4239.4
Sand, black	1.0	4237.9
Black jack [= obsidian tuff]	15.2	4236.9
Sand and gravel, black	4.8	4221.7
Sandstone, black, fine, hard	2.1	4216.9
Sandstone, black, coarse	4.6	4214.8
Sandstone, gray, fine, soft	8.2	4210.2
Clay, sandy, light brown	2.8	4202.0
Altitude of bottom of hole		4199.2
Total rock drilled 83.8 feet.		

7S 31E-31ab; Core Hole 7

Material	Thickness (feet)	Altitude, top of bed (feet)
Sandstone, very fine-grained, black	2.1	4222.0
Sandstone, coarse, black	4.4	4219.9
Sandstone, gray	4.5	4215.5
Sandstone, white, with lenses of calcite .	0.1	4211.0
Sandstone, gray. Layer of ash 3/8 inch thick included	2.5	4210.9
Sandstone and lava	0.6	4208.4
Clay, sandy, brown	31.5	4207.8
Clay, sandy, brown with black veins	26.0	4176.3
Sandstone, brown	0.1	4150.3
Sandstone and clay; transition	1.0	4150.2
Sandstone, brown; also clay in black veins	10.8	4149.2
Clay, very sticky, light-brown with black veins	6.7	4138.4
Clay, sandy, light-brown	8.5	4131.7
Clay, sandy, light-brown	24.9	4123.2
Altitude of bottom of hole		4098.3
Total rock drilled 123.7 feet.		