MALHEUR LAKE BASIN

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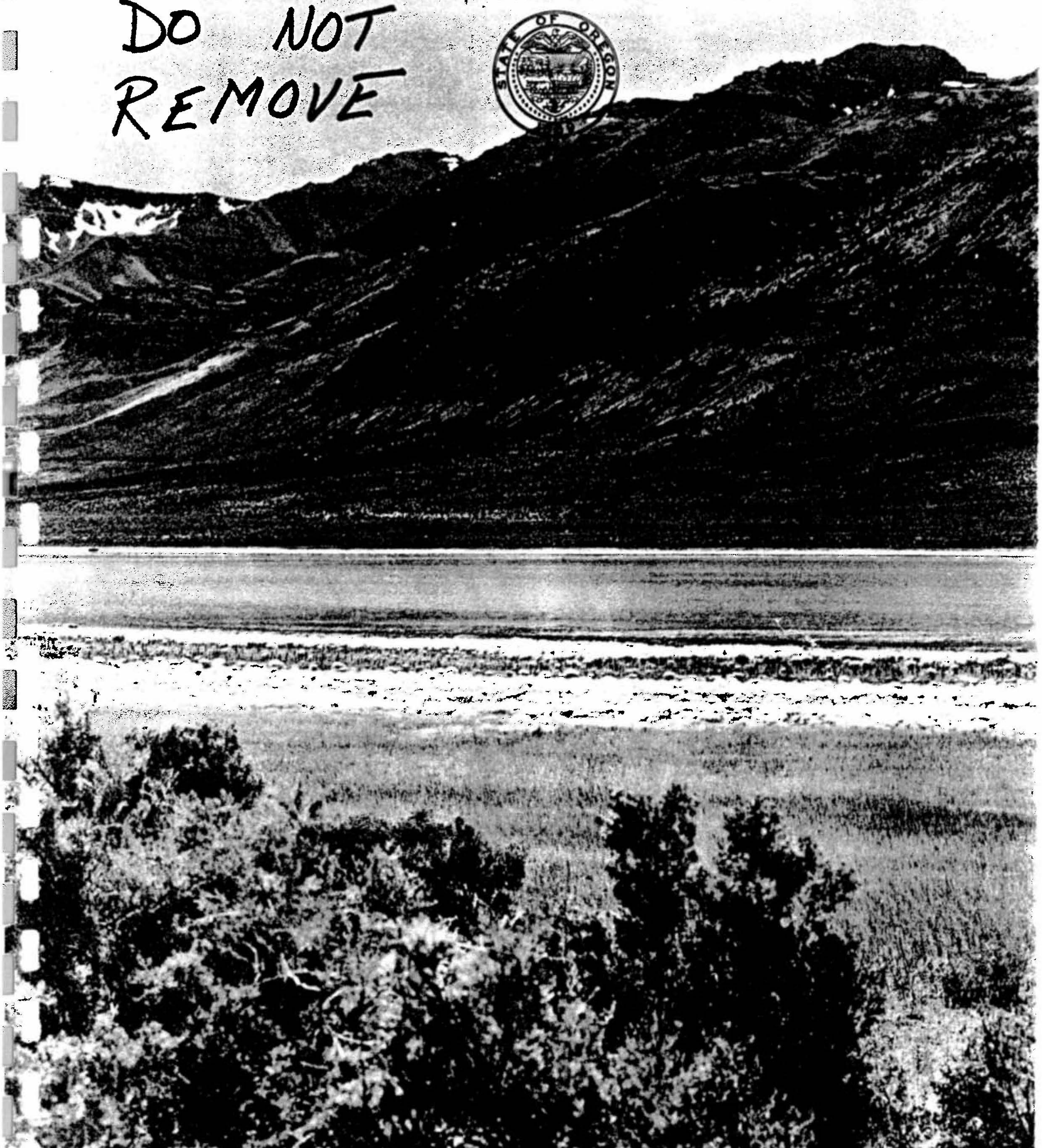

State Water Resources Board *June 1967*

MALHEUR LAKE BASIN

STATE WATER RESOURCES BOARD
SALEM, OREGON
JUNE 1967

COVER PICTURE

Steens Mountain rises abruptly overshadowing Mann Lake. Oregon State Highway Department photo.

Price $2.50

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PURPOSE AND INTRODUCTION

The purpose of this report is to set forth, in a condensed form, the major items considered by the State Water Resources Board in the study of the Malheur Lake Drainage Basin. The study was made to determine the occurrence, if any of unappropriated water in the basin, which would allow the formulation and implementation of an integrated, coordinated program of use and control of the water resources. The board's investigation activities, completed in 1967, were made in conformity with ORS 536.300 (1) which states:

> "The board shall proceed as rapidly as possible to study: existing water resources of this state; means and methods of conserving and augmenting such water resources; existing and contemplated needs and uses of water for domestic, municipal, irrigation, power development, industrial, mining, recreation, wildlife, and fish life uses and for pollution abatement, all of which are declared to be beneficial uses, and all other related subjects, including drainage and reclamation."

The study established that almost all of the surface water resources of the basin are currently appropriated and that no significant amounts of unappropriated water occur for the purpose of formulating and implementing an integrated, coordinated water resources program. The board, therefore, does not propose to adopt a program for the Malheur Lake Drainage Basin.

The study provides basic data required by the State Water Resources Board to further determine the basin's potential development. Part IV of the report analyzes some of the potential development that exists in the basin.

Data for study and evaluation were made available through (1) review of available reports and data, (2) physical field investigations, (3) extensive personal contact, (4) formal hearings on the basin's water needs and problems (Burns, January 19, 1966), (5) data supplied by the U. S. Department of Agriculture (Soil Conservation Service, Forest Service, and Economic Research Service) through a cooperative program with the State Water Resources Board, and (6) submission of data to the board, at its request, by local, state, and federal agencies and other groups.

Contributions by the above is gratefully acknowledged. Special appreciation is extended to the Harney County Water Resources Committee and their Chairman, William D. Cramer, for their valuable contributions to this report.

F I N D I N G S   A N D   C O N C L U S I O N S

A. General

1. The report presents an appraisal of the land and water resources of the Malheur Lake Basin and outlines a comprehensive plan for utilization of the resources for domestic, municipal, irrigation, wildlife, and other purposes.

2. Suggestions are made to assist in resolving the major questions of how to balance land and water development and use between the needs of irrigated agriculture and wildlife.

3. The report does not propose authorization of any new works, but documents the state's position and recommends further study of the most immediately promising possibilities and alternatives thereof.

4. Due to the lack of a clearcut expression of policy on the part of the local people and the federal agencies concerned, recommendations include updating the 1957 U. S. Corps of Engineers' Silvies report to establish a comprehensive development plan. It is important and necessary that the views of all responsible groups and government agencies be made known before final decisions are reached.

5. Support is given to conducting ground-water studies for the purpose of locating and determining quantities available from ground-water aquifers.

6. The basin plan, except for the Catlow-Alvord area, is an assemblage of watershed plans for the purpose of a coordinated development of available water resources. Catlow-Alvord plans stress ground-water developments.

7. The development goal is to provide a timely supplemental supply to presently irrigated land; to maintain, improve, or create wildlife habitat to meet the requirements of the Pacific Flyway and local needs; to provide ample water supplies for municipalities and industries; and to provide for protection against local flood hazards.

8. To accomplish the development, a variety of facilities would be required, ranging from dikes, drains, and wells to major dams and canals. Many of these works

could be constructed by local agencies or by individuals, while other major structures might appropriately be constructed by the Federal Government with state participation. Storage with carryover capacity is a prerequisite to any development plan.

9. Major features of the development plan are shown on the Potential Development map, Plate 2 of the Appendix. Features include constructing storage reservoirs and developing ground-water resources to supplement irrigated land and to provide waterfowl with a more stable water supply.

10. Opportunities exist to increase water areas and to improve or create marshes, which, with larger irrigated grain and pasture acreages, should continue to support the waterfowl population at an improved level. Detailed studies would be required to make certain of the adequacy of the changed waterfowl habitat.

11. Basin streams and lakes supply a growing sport fishery. Additional reservoirs, together with the regulation of streamflow below the dams, could provide increased fishery values at more locations.

12. More recreational development will be required, as population increases accompany agricultural and industrial expansions. This could be obtained by making undeveloped waterfowl areas more effective, improving regulation of streamflows, and constructing recreational facilities at lakes and reservoirs.

13. As shown in the potential development section of this report, the State Water Resources Board recommends further detailed study of the most immediately promising possibilities and alternatives as follows:

    a. SILVIES - Construction of the 190,000 acre-foot Silvies Canyon Reservoir on the Silvies River to reduce flood damage, supply late season water, and improve agricultural production. Features include storage, distribution, augmentation, drainage, research, and management of this multipurpose resource.

    b. SILVER - Alternative construction proposals include the 40,000 acre-foot reservoir site on Silver Creek or the 10,000 acre-foot site on Claw Creek with supplemental storage in Chickahominy Reservoir.

c. DONNER UND BLITZEN - Development plans include storage of floodwaters and more efficient, water use through construction, extension or rehabilitation of irrigation canals, field laterals, flumes, control structures, diversion structures, drainage ditches, dikes, cross-dikes, intraseasonal storage ponds, land leveling, sprinkler installations, and general management features.

d. CATLOW-ALVORD - The primary objective is a study to determine the approximate location and size of economically recoverable bodies of ground water, to determine their recharge capabilities, and to ascertain the rate at which water can be withdrawn without depleting the supply.

The future destiny of the basin's economic expansion is dependent largely upon the comprehensive multiple-purpose development of its land and water resources. Agriculture and wildlife productivities of the basin can be increased simultaneously by improving land and water utilization. A plan for the comprehensive development of the Malheur Lake Basin is essential if the economy of the basin is to flourish and its ultimate potential is to be realized.

B. Water Supply

14. The average annual yield, from streams and ground water, supplies a partial water requirement for 226,700 irrigable acres; other consumptive needs; about 290,000 acre-feet of surface outflow to interior lakes; and an unidentified ground-water outflow.

15. There are sufficient surface and ground-water resources to supplement the present irrigated acreage, plus supplying additional needs for domestic, municipal, industrial, and recreational purposes.

16. The watershed surface water supply, even with maximum justifiable control and more efficient utilization,

is inadequate, in most areas, to provide for other than supplemental uses by present right holders.

17. Additional detailed investigations should be made on possible storage reservoirs, ground-water supplies, ground-water withdrawal, and ground-water recharge, as well as more efficient use of presently developed supplies.

18. Table 23 and Plate 2 locate 23 potential reservoir sites. Economically feasible storage generally is limited by steep canyon gradient in the watershed.

19. Available data indicate that the ground-water resource is limited in quantity and location, but represents an important source for domestic, livestock, municipal, industrial, and irrigation needs, both present and future.

C. Water Rights

20. The basin has practically no unappropriated surface water during the irrigation season. Storage is essential for best use of the water.

21. No water has been withdrawn by the State Engineer for out-of-basin diversion.

22. There are about 2,000 water rights for 4,566 cfs in the basin. Surface rights equal 4,393 cfs and ground-water rights equal 173 cfs. Irrigation rights account for the greatest consumptive use with 4,253 cfs for 292,539 acres. Summer flows have been overappropriated for many years.

23. About 45 percent of the land, having water rights, is not irrigated because of the water shortage. All of the power rights have been abandoned or are not utilized for power purposes. There are domestic, municipal, and industrial rights, totaling 105 cfs.

D. Water Use and Control

24. Diversion and pumping requirements for increased consumptive uses of domestic, municipal, industrial, and livestock are estimated to be less than 4,000 acre-feet annually.

25. With proposed developments, irrigation will require diversion of over 90 percent of the consumptively used water on the 226,700 acres presently under irrigation.

26. There are over 284,000 acres of mapped irrigable land within the basin. Suitable land areas greatly exceed water supplies.

27. Only a few thousand acres of the irrigated lands receive an adequate water supply during the June to September irrigation season in an average water year, and practically all irrigated areas experience severe shortages in critically low-water years.

28. Worthwhile advantages could be obtained from extensive rehabilitation programs on most irrigated land and distribution facilities. More canal lining, control structures, land leveling, drainage, and sprinkler systems are needed to save water, reduce erosion, and increase production.

29. There is no present use of water for hydroelectric power and the future potential is economically and physically limited.

30. Mining use of water is for sand and gravel production.

31. Fish life will continue to be an important nonconsumptive user of water in the headwater streams. Flows recommended by the Oregon State Game Commission cannot be provided because present flows are overappropriated.

32. A conflict exists between domestic, irrigation, recreation, wildlife, and fish life uses of water.

33. Restrictions on further appropriations of natural streamflow would not be of material aid, on most streams during low-flow periods, because they are overappropriated during this time.

34. Pollution of ground and surface water is localized, intermittent in occurrence, and is not a critical problem, except in a few of the urban and industrial areas around Burns and Hines.

FINDINGS AND CONCLUSIONS

35. Flooding and erosion are serious local problems in only a few urban, rural, and range areas where the permanent grass cover has been disturbed.

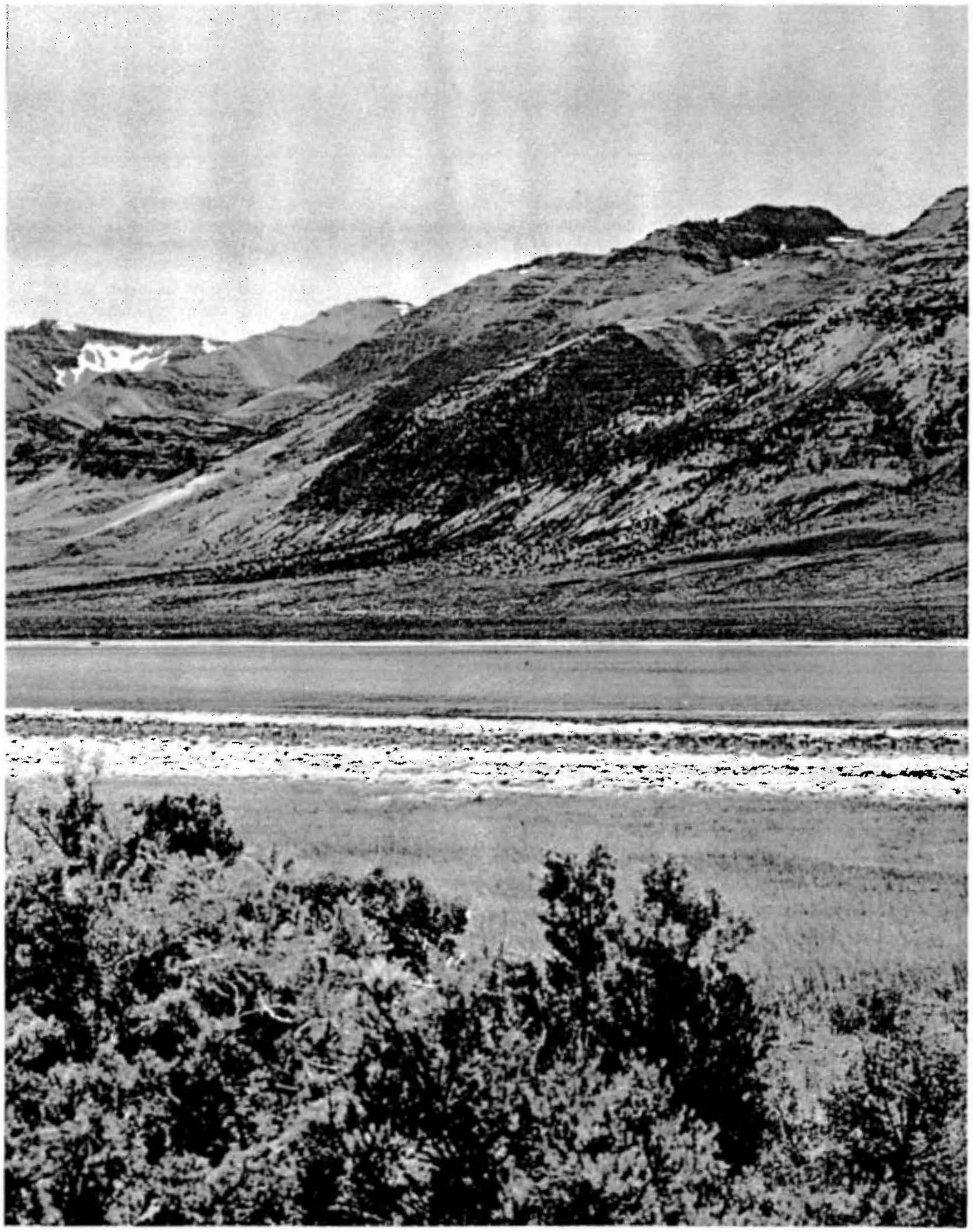
36. Benefits are not great enough to justify large single-purpose structures. Multipurpose structures are needed and could be more easily justified.

37. Small reservoirs on important tributaries could reduce local flooding and provide late-season water for irrigation, livestock, wildlife, and fish life.

38. Further knowledge of surface flows is needed to determine reservoir requirements. Re-establishment of inactive gages and establishing of stations at new sites are needed, as documented in Appendix Table B.

39. Detailed studies of ground-water location and yield capabilities are needed.

THE BASIN



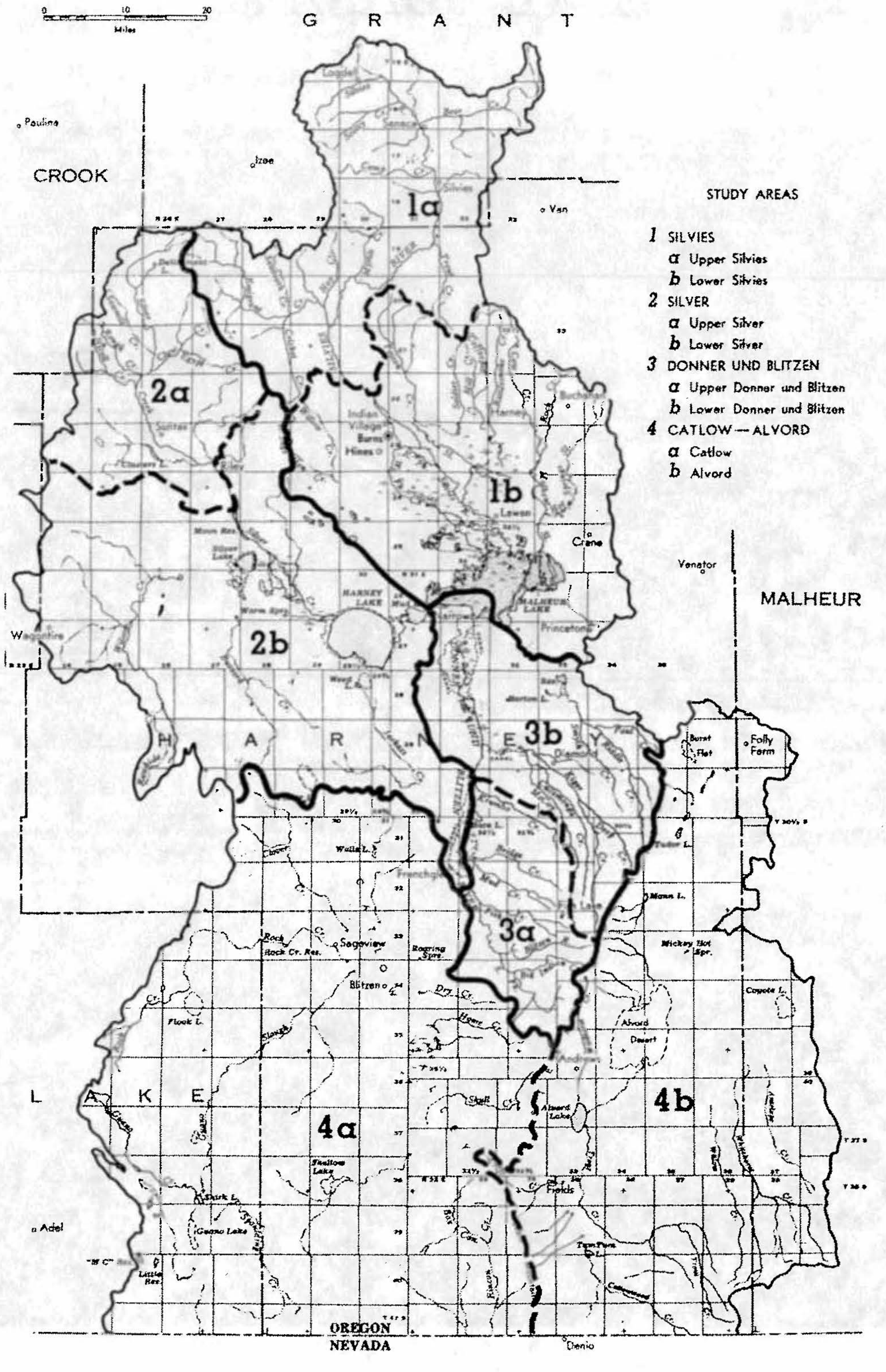


FIGURE 1. Malheur Lake Basin.

Oregon State Highway Department photo

MALHEUR LAKE BASIN STUDY

PART I THE BASIN

NATURAL FEATURES

Location and Description

The Malheur Lake Basin, as designated by the State Water Resources Board, Figure 1, facing this page, consists of a number of independent but contiguous watersheds in southeastern Oregon of which the most important are the Silvies, Silver, Donner und Blitzen, and Catlow-Alvord. Measuring about 160 miles from north to south and 100 miles from east to west, the basin encompasses an area of 9,965 square miles.

Table 1 shows basin area in square miles and acres by county.

TABLE 1

BASIN AREA BY COUNTY

COUNTY	TOTAL AREA Sq. Mi.	AREA WITHIN MALHEUR LAKE BASIN			
		Sq. Mi.	Acres	Percent of County	Percent of Basin
Harney	10,185	8,122	5,198,100	79.7	81.5
Malheur	9,925	480	306,900	4.8	4.8
Lake	8,340	892	570,700	10.7	8.9
Grant	4,533	454	290,800	10.0	4.6
Crook	2,982	17	11,100	0.6	0.2
BASIN TOTAL	-	9,965	6,377,600	-	100.0

Data Source: U. S. Dept. of Agriculture's Cooperative Report

As shown in Table 1, the basin includes 80 percent of Harney County, 11 percent of Lake County, 10 percent of Grant County, 5 percent of Malheur County, and 1 percent of Crook County. Malheur Lake Basin is bounded on the west by the Goose and Summer Lakes and Deschutes Basins, on the north by the John Day Basin, on the east by the Malheur and Owyhee Basins, and on the south by the State of Nevada. The basin drains an area of 6,377,600 acres, which is slightly over 10 percent of the state's area.

THE BASIN

Because of pronounced differences in physical and hydrological characteristics, the basin is divided into four study areas (Figure 1): (1) Silvies, (2) Silver, (3) Donner und Blitzen, and (4) Catlow-Alvord. The first three water-use areas all drain eventually into Harney Lake while the fourth, Catlow-Alvord, drains into numerous, separate, variable sized depressions. The four areas will be discussed separately where appropriate.

The basin's physiography is characterized by large valleys with elevations varying between 4,025 and 4,600 feet, extensive semidesert benchlands with elevations varying around 4,500 feet, and adjacent mountains reaching elevations up to 9,670 feet.

Figure 2 depicts a north-south cross section through the highest and lowest portions of the basin.

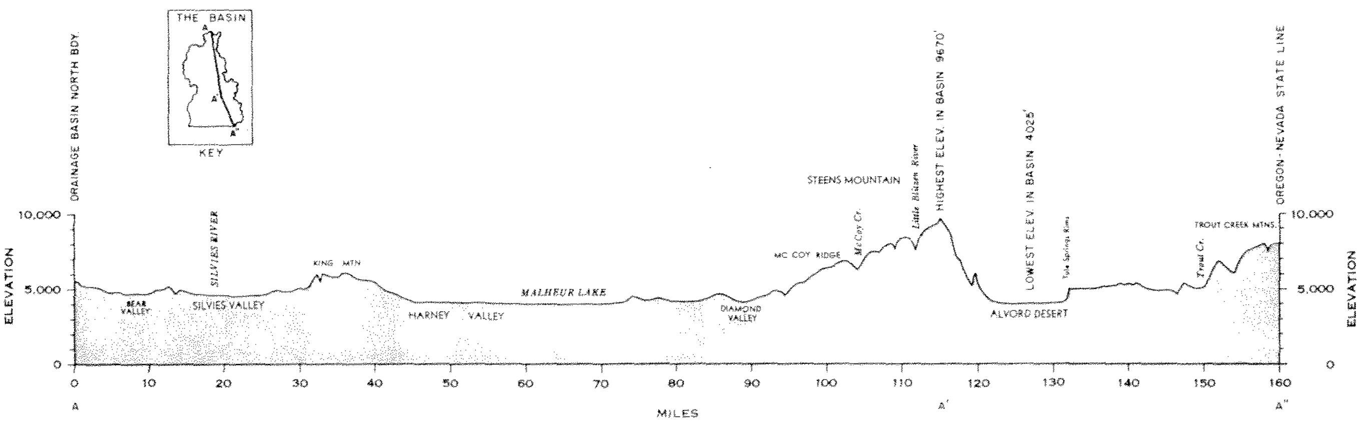


FIGURE 2. Cross Section of the Basin.

A low flat area of more than 600 square miles, lying between elevations 4,100 and 4,150 feet, borders Malheur and Harney Lakes. Nearly two-thirds of this area lies to the north of Malheur Lake and is commonly referred to as Harney Valley. The low area northwest of Harney Lake is called Warm Springs Valley, and the low area south of Malheur Lake, on either side of the Donner und Blitzen River, is referred to as Blitzen Valley. The large semidesert region extending southward to the Oregon-Nevada state line is referred to as the Catlow-Alvord area.

T H E B A S I N

The area of low flatlands surrounding Harney and Malheur Lakes was at one time the bed of prehistoric Delake. There are indications that the level of the lake dropped slowly to the present low water level of Malheur Lake.

Lakes also inundated Catlow Valley and the Alvord Desert depression. Generally, having no surface outflow, most of the present lakes fluctuate in size depending upon the rates of inflow, transpiration, and evaporation. The larger valley lakes become dry at infrequent intervals while most of the lakes are dry except for a short period following the spring runoff. The most important small streams in the Catlow area are Home, Sixmile, Threemile, Skull, Guano (Slough), Deer, and Rock. The most important small streams in the Alvord area are Trout, Cottonwood, Wildhorse, Indian, Pike, Little Alvord, and Mosquito. The Catlow-Alvord area is practically devoid of timber, except for scattered juniper and shade trees planted around ranch buildings. The most common plant species include big sagebrush, rabbit brush, greasewood, cheatgrass, and Sandberg's bluegrass.

The soils are extremely shallow in depth, light in texture, and susceptible to erosion except for alluvial fans at the mouth of many of the streams. These deltas supply the lands most suitable for cultivation and other agricultural purposes.

Various sections of this report cover conditions basinwide, then by study area or stream system. Separate analysis is made, where appropriate, of each of the 10 beneficial uses of water listed in ORS 536.300 domestic, municipal, irrigation, power development, industrial, mining, recreation, wildlife, and fish life uses and for pollution abatement.

Stream System

Plate 1 of the Appendix illustrates the basin's stream system. This map locates all known water features including streams, springs, lakes, reservoirs, canals, and wells. Streams and lakes that normally contain water throughout the year are shown by a solid line, while those that are intermittently dry are shown by broken lines. Such streams as the Silvies River, lower Silver Creek, and the Donner und Blitzen River, with some of their major tributaries, are shown by a solid line. The vast majority of the basin's streams are designated as intermittent.

T H E B A S I N

All of the larger perennial streams head either in the Ochoco and Malheur National Forest of the northern portion of the basin or in the Steens Mountain in the south central portion of the basin. Except for the Catlow-Alvord area, larger streams ultimately drain into Harney Lake. All streams have zero flows in some parts of their channels during the low-flow period of most years. The Catlow-Alvord area is characterized by small, intermittent streams, which end in shallow lakes. Some water drains from the area as ground water, but the amount so discharged is only a very small part of the total yield from precipitation.

Silvies Area

The Silvies area, occupying the northeast portion of the basin and draining into Malheur Lake, is the most important in terms of population and resource development. This river system, plus miscellaneous streams, drains about 1,346,400 acres.

Principal tributaries of the Silvies River are Bear, Camp, Trout, Emigrant, and Sage Hen Creeks. This area also includes about 15 named miscellaneous streams, up to 20 miles in length, which flow directly into Harney Valley and eventually into Malheur Lake, if not consumed by evapotranspiration enroute.

Figure 3 shows a profile of the Silvies River from its source to Malheur Lake.

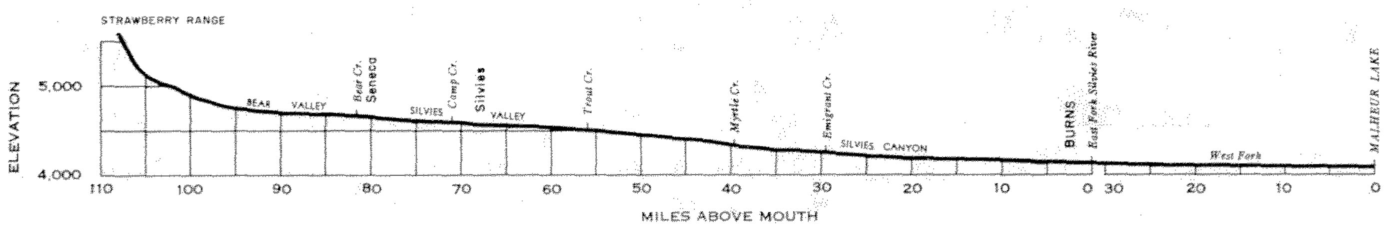


FIGURE 3. Profile of the Silvies River.

Within the upper watershed of Silvies River, is the Silvies Valley, which extends northward between stream mile 55 and 80. Bear Valley continues northward to about stream mile 100. Progressing downstream, Camp, Trout, Myrtle, and Emigrant Creeks are the most important tributaries.

THE BASIN

Emigrant Creek is one of the largest tributaries of the Silvies River with a drainage area of 118,400 acres and a runoff of about one-fourth the total flow of Silvies River. Its junction with the Silvies River is at stream mile 29 within the Silvies River canyon.

From the lower end of Silvies Valley to about stream mile 13, a distance of 42 miles, the Silvies River flows through a canyon with high, steep sidewalls.

At about stream mile 13, the canyon opens out into Harney Valley. Harney Valley is one of the largest compact bodies of nearly level lakebed alluvium in Eastern Oregon, extending about 25 miles east and west by 15 to 20 miles north and south, with an area of somewhat more than 250,000 acres. The Silvies River water is divided into several channels as it flows through Harney Valley and the surplus flows into Malheur Lake.

Malheur Lake levels fluctuate annually depending on the total runoff available from the Silvies and Donner und Blitzen Rivers. Whenever the lake level rises above elevation 4,091.5 feet, overflow occurs from Malheur Lake into Mud Lake at The Narrows, and when it is above 4,093.5 feet there is overflow from Mud Lake into Harney Lake. Harney Lake normally has a water surface elevation about 8 feet lower than Malheur Lake. During extremely dry years, such as 1889, 1924, and 1934, these lakes have been dry.

The area of Malheur Lake varies from an average minimum of about 25,000 acres to an average maximum of 45,000 acres. At this higher stage, it contributes a rather large flow to Harney Lake through The Narrows. The maximum depth of Malheur Lake at normal stage is not more than 7 feet.

A number of small streams head in the foothill areas north and east of Harney Valley. Poison, Prater, Soldier, Coffeepot, Rattlesnake, Cow, and Rock Creeks all emerge into Harney Valley from the north and have watersheds somewhat similar in size and capabilities.

Silver Creek Area

The Silver Creek area in the northwestern part of the Malheur Lake Basin comprises all drainage into Harney Lake west of The Narrows. The total area is about 1,306,700 acres.

T H E   B A S I N

Figure 4 shows a profile of Silver Creek from its source to Harney Lake.

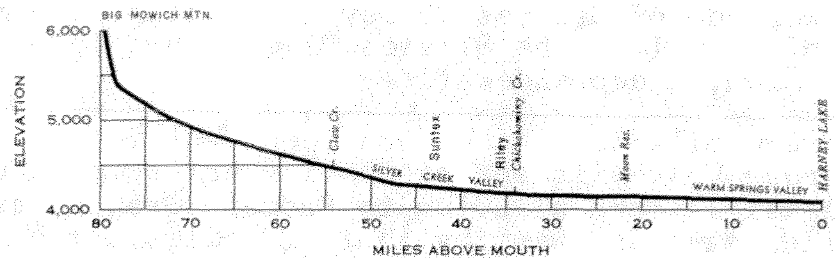


FIGURE 4. Profile of Silver Creek.

The upper Silver Creek drainage area includes about 332,500 acres. Claw, Rough, and Nicoll Creeks drain the southern portion of the Ochoco National Forest where the most dependable summer flows are encountered. The runoff is comparatively the same in time of occurrence and total amount with that of the adjoining Emigrant Creek, which flows into the Silvies River.

The lower elevation tributaries have intermittent flows. Valley lands in the vicinity of Claw Creek, Riley, and Warm Springs Valley are used for irrigated agriculture.

Water of Silver Creek is divided, in flood stage, at the upper end of Warm Springs Valley, so that a part of the flow continues in a southerly direction along the eastern side of Warm Springs Valley, another part spreads over the western part of the valley, and a third part flows westward into Silver Lake through a gap in the sand-ridged shore. When water is not desired for irrigation, the largest part of it enters Silver Lake.

In years of exceptionally large runoff, Silver Lake reaches a level so high that it flows back through another gap in the sand ridge on the east shore of the lake to Warm Springs Valley, then east to Harney Lake. The bed of Silver Lake occasionally is dry except for some small pools supplied by springs at the northern and western edges of the lakebed.

When filled to the point of overflowing, Silver Lake covers an area of about 4,000 acres and has a maximum depth of 4 to 6 feet.

T H E   B A S I N

The Wilson and Buzzard Creek areas south and west of Harney Lake, has an area of about 500,000 acres contributing to the lake, but due to the character of the watersheds, the runoff is very low in average years, and during minimum years no runoff reaches Warm Springs Valley. Occasionally, flood flows are sufficient to fill various mud flats, west of the Warm Springs Valley and then overflow into Silver Lake. The erratic character of this runoff is such that it probably cannot be considered as a source of irrigation supply, but flood control measures are desirable on these intermittent drainages in connection with the development of the Warm Springs Valley.

Sage Hen Creek and adjoining tributaries, which serve the area between Warm Springs Valley and north of Harney Lake, head mainly in desert and rangelands having a low-water yield capability. These streams generally flow only during the spring snowmelt.

Harney Lake is deeper than Malheur Lake and has comparatively steep shores. Fluctuation of its water surface area varies around an average of 30,000 acres. Harney Lake is largely independent of the altitude of Malheur Lake and the water level may be as much as 10 feet lower.

Donner und Blitzen Area

Figure 5 shows a profile of the Donner und Blitzen River

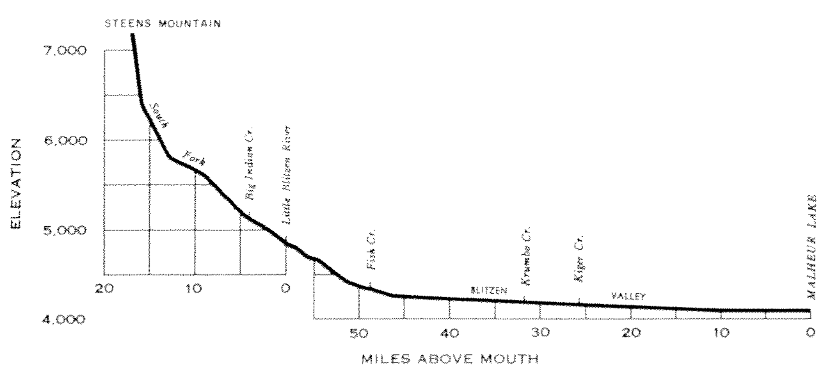


FIGURE 5. Profile of the Donner und Blitzen River.

from its source on Steens Mountain to Malheur Lake.

THE BASIN

The Donner und Blitzen area receives its flow from streams penetrating the western and northern sides of the Steens Mountain. Tributaries of the Donner und Blitzen River, progressing from south to north, include Little Blitzen River and the following creeks: Big Indian, Fish, Bridge, Krumbo, McCoy, Cucamonga, Kiger, Swamp, and Riddle. The entire area of about 626,900 acres drains from the south into Malheur Lake.

The topographic characteristics consist of fairly steep gradients on Steens Mountain and very low gradients in Blitzen Valley.

About 128,000 acres of this area is tributary to the Diamond Swamp, 102,000 acres is tributary to the P Ranch Swamp, and 128,000 acres above the P Ranch is tributary to the main stem of the Blitzen River. About one-fourth of this latter drainage area is from the higher part of Steens Mountain and furnishes at least 50 percent of the total discharge of Blitzen River above the P Ranch. The runoff from this higher part of the drainage area occurs chiefly in May and June and produces a reasonably good irrigation supply without storage. Similarly, the larger part of the water of the Diamond area streams, Kiger, Cucamonga, and McCoy Creeks comes from the higher portions of Steens Mountain and is available for much of the irrigation season.

Steens Mountain is barren of timber with the exception of a few scattered patches of juniper, quaking aspen, and two small groves of fir trees in one of the canyons. The snow forms immense drifts in the canyons, and for this reason often produces a season-long runoff. The main flow occurs from a month to six weeks later than flows from the upper Silvies watershed, and a much larger flow continues throughout the summer.

As shown on Plate 1 of the Appendix, most unmentioned tributary streams are small and have intermittent flows. This plate also shows numerous irrigation diversions which vitally affect the streamflow regimen.

Catlow-Alvord Area

The Catlow-Alvord area, occupying the southern portion of the basin, is best described as a large, semidesert plateau with no perennial streams, no well defined large river valleys, and very little water available for beneficial use.

T H E   B A S I N

The Catlow-Alvord study area of 3,097,600 acres is very large, comprising almost 50 percent of the total basin or 5 percent of the state's area.

Hart Mountain to the west supplies small flows to Rock Creek, Guano Creek, and Guano Slough, plus numerous other small streams which end in lakebeds, which usually are dry except after spring runoff. The central portion of this area is supplied minimum quantities of water from springs along the edge of Steens Mountain and one small south-flowing creek, Rincon, originating in the Pueblo Mountains.

The Alvord Desert area is supplied by small streams from Steens Mountain, such as Mosquito Creek and Wildhorse Creek. The most valuable streams in the southeastern corner are Trout Creek, Willow Creek, and Whitehorse Creek. Except along the streams mentioned, there is very little agriculture or land use other than grazing of livestock.

Climate

Figure 6 shows that the mean temperature at Seneca is 3 to 16 degrees cooler than at Burns. The average winter temperatures at the P Ranch are slightly warmer than at Burns.

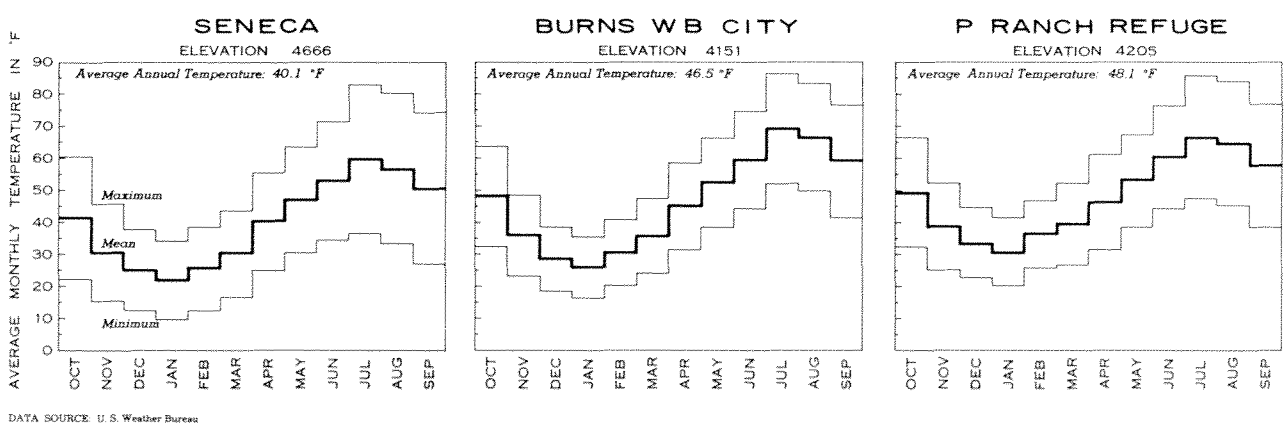


FIGURE 6. Average Monthly Temperature at Selected Stations.

The basin climate is semiarid with long, rather severe winters and short summers, which have a high proportion of clear sunny days. Temperatures at Burns for January, which are typical of the open valleys, range from an average maximum of 35.7 degrees Fahrenheit (°F.) to an average minimum of 16.3° F. Corresponding temperatures for July, the warmest month, are 86.2° F. and 52.1° F. Extremes of -40° F. and 109° F. have been recorded in higher elevations of the basin. The growing season varies from 72 to 98 days in the open lower valleys and is shorter in the upper valleys.

The wide diurnal range of temperatures, particularly during the summer months, is well illustrated by the difference between the mean maximum and the mean minimum temperatures. The difference between the average monthly temperatures in July and January is more than 40 degrees. The relative humidity values also reflect the diurnal variation in temperature, early morning readings are high because of nocturnal cooling of the air and daytime values are low because of high temperatures. Percentage of possible sunshine is very high during July and August, the driest months, decreasing to comparatively low values during the winter months.

The basin is subjected to easterly flows of dry air which result in high temperatures and very low humidities during the summer season. During the winter a cold front from the northeast brings subzero weather over the basin. Freezing weather has been recorded in every month of the year.

Most of the high desert varies around 5,200 feet, with the lowest point about 4,025 feet in the Alvord Desert and the highest point about 9,670 feet on the adjacent Steens Mountain.

In the basin area there are 10 climatological stations with more than 20 years of records. These stations are at Seneca, Burns, Harney Branch Experiment Station, Squaw Butte, Buena Vista, Malheur Refuge, Hart Mountain Refuge, P Ranch Refuge, Sunrise Valley, and Andrews.

Isolated points have experienced precipitation in excess of one-half inch in 10 minutes and 1 inch in an hour. The 24-hour amounts generally are less than 2 inches. Occasionally, precipitation is in the form of hail resulting in considerable damage to crops.

A large percentage of the precipitation falls as snow, which accumulates during the period from November through March.

Mean annual snowfall ranges from a few inches in the valleys to over 70 inches in the mountains. Thunder showers are quite frequent during the summer months.

Annual precipitation ranges from under 10 inches in the lower agricultural areas to more than 40 inches in the headwaters. As shown in Figure 7, monthly precipitation varies

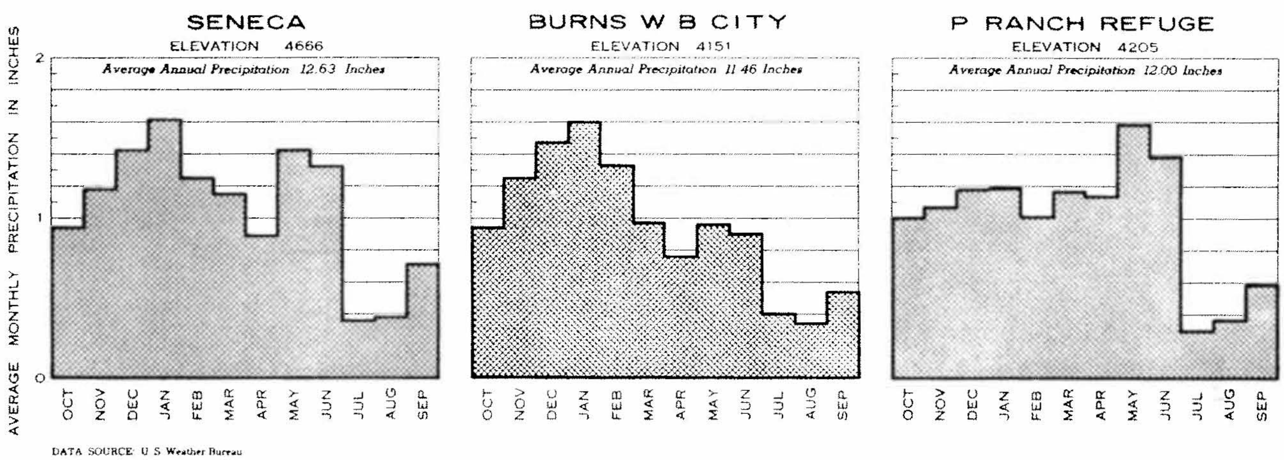


FIGURE 7. Average Monthly Precipitation at Selected Stations.

materially between the Seneca, Burns, and P Ranch Refuge stations, but the average annual yield is quite similar. Monthly rainfall varies from less than one-half inch during the major part of the growing season to about 1.6 inches during the variable high rainfall period.

ECONOMIC FACTORS

Population

Earliest appraisal of the region was made in the first half of the 19th century by parties sent out by the Federal Government and by representatives of the Hudson's Bay Company. Later, following the discovery of gold in the John Day and Powder River regions, the basin was traversed by prospectors. It was not until about 100 years ago, however, that the first emigrants settled in the basin.

The basin supports a relatively small population, concentrated in towns such as Burns, Hines, and Seneca and open valleys such as Harney Valley. Large areas are uninhabited due to inadequate water supplies or adverse physical features. Present population of the basin is about 7,000, of which approximately 340 reside in the vast Catlow-Alvord area.

Table 2 shows the 1960 county population distribution.

TABLE 2

COUNTY POPULATION
DISTRIBUTION BY STUDY AREA
1960

STUDY AREA	HARNEY	LAKE	CROOK	GRANT	MALHEUR	TOTAL
1. SILVIES	5,620	0	0	580	0	6,200
2. SILVER	280	0	0	0	0	280
3. DONNER UND BLITZEN	160	0	0	0	0	160
4. CATLOW-ALVORD	300	30	0	0	10	340
TOTAL	6,360	30	0	580	10	6,980

Data Source: U. S. Bureau of Census

Figure 8 illustrates population trends in the basin. The population has shown a moderate but consistent increase since 1890, when the first records were published.

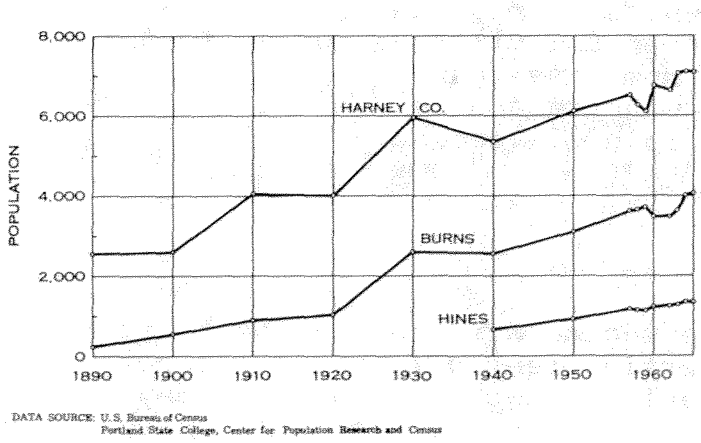


FIGURE 8. Population Trends.

The low population density of about 0.7 persons per square mile, compared to the average density in Oregon of 18 persons per square mile, is indicative of the sparseness of the population throughout the desert and mountain areas. About 67 percent of the inhabitants live in or around the city of Burns, which is the county seat of Harney

County as well as the economic and cultural center of the basin. The population of Burns in 1960 was over 3,500. Hines, with a population of about 1,200, is the only other incorporated city in the basin. Seneca is the largest unincorporated community in the basin with a reported population of 400 in 1960. Other communities include Crane, Diamond, Frenchglen, Fields, Lawen, Princeton, Riley, and Andrews.

Table 3 presents the population figures for Harney County, Burns, and Hines. Harney County with a gain of 4,185 persons

TABLE 3

POPULATION IN HARNEY COUNTY
1890 to 1960

LOCATION	1890	1900	1910	1920	1930	1940	1950	1960	INCREASE Number	INCREASE Percent
County	2,559	2,598	4,059	3,992	5,920	5,374	6,113	6,744	4,185	2.3
Burns	264	547	904	1,022	2,599	2,566	3,093	3,523	3,259	17.6
Hines	-	-	-	-	* 217	677	918	1,207	790	12.1

* Local Census
Data Source: U. S. Bureau of Census
Univ. of Oregon, Bureau of Municipal Research and Service.

had an average annual increase of 2.3 percent between 1890 and 1960. The city of Burns experienced a gain of 3,259 persons for an average annual increase of 17.6 percent. The city of Hines, since its inception in 1930, experienced a steady 12 percent average growth in population.

Economic Conditions

The three principal activities contributing to the basin's economy are agriculture, consisting mostly of livestock production; forestry, including manufacturing of wood products; and recreation, in the form of services to visiting tourists and sportsmen. Although local markets are increasing to some extent, most of the products in the basin are shipped to major consuming centers in Oregon and California.

Absent from the list of basin resources is an anadromous fishery. This interior basin has no stream outlet to the ocean. The lack of waterpower potential is another significant difference between this and most other basins in Oregon.

Ownership and use of the basin's land are listed in Table 4. As shown in the table, 73.6 percent of the 6,377,600 acres is federally owned.

TABLE 4

LAND OWNERSHIP OR ADMINISTRATION
Acres

OWNERSHIP	RANGE	CROP AND PASTURE	FOREST	OTHER	TOTAL	PERCENT
Federal:						
National Forest	50,400	-	528,780	8,200	587,380	9.2
Other	3,891,870	29,520	162,700	23,800	4,107,890	64.4
State	209,390	500	9,760	5,100	224,750	3.5
County and Municipal	8,000	-	-	5,000	13,000	0.2
Private	1,120,140	232,680	78,160	13,600	1,444,580	22.7
TOTAL	5,279,800	262,700	779,400	55,700	6,377,600	100.0

Data Source: U. S. Dept. of Agriculture's Cooperative Report.

The state, county, and municipalities own 3.7 percent and 22.7 percent is in private ownership. Only about 4 percent of the total area is in cropland, while the remaining private land is used for forest, range, or pasture purposes.

Agriculture

Stockmen, who settled upon the open valley lands of the basin about 100 years ago, found an abundance of water and wild hay meadows, which could readily be adapted to their needs. Although subsequent development has included varying degrees of water spreading, diking, and drainage improvements, only nominal advancements have been made in water use designed to increase hay yields and improve pasture production.

Economic, climatic, and biological limitations practically have limited the production of crops to lands which are irrigated in some manner. Various Homestead and Desert Land Act legislation, in the early 1900's, encouraged hundreds of dryland farmers to settle in the basin, but these farmers, by 1920, realized that dryland farming generally was uneconomical.

Malheur Lake Basin is essentially a livestock producing area, and agriculture, of necessity, is devoted largely to the production of feed crops for livestock. With the short growing season, commercial crop production is limited generally to hardy varieties of alfalfa, pasture mixes, wild hay, and spring grain.

Of the basin's total acreage, 5,279,800 acres are rangeland and only 262,700 acres are used for crops. The largest cropland area, 123,000 acres, is in Harney Valley. Cattle ranches average 100 acres of irrigated land in the farm unit which averages over 4,000 acres in size.

Table 5 shows general land use in the basin by study area.

TABLE 5

GENERAL LAND USE
Acres

STUDY AREA	FOREST LAND	RANGELAND	CROPLAND	TOWNS, ROADS. ECT.	TOTAL
1. SILVIES					
a. Upper	430,400	152,000	27,000	3,300	612,700
b. Lower	111,700	491,700	123,000	7,300	733,700
2. SILVER					
a. Upper	177,300	142,800	11,300	1,100	332,500
b. Lower	17,100	937,800	17,400	1,900	974,200
3. DONNER UND BLITZEN					
a. Upper	18,700	204,300	8,300	400	231,700
b. Lower	7,800	351,800	34,900	700	395,200
4. CATLOW-ALVORD					
a. Catlow	6,500	1,801,400	13,200	4,600	1,825,700
b. Alvord	9,900	1,198,000	27,600	36,400	1,271,900
TOTAL	779,400	5,279,800	262,700	55,700	6,377,600

Data Source: U. S. Dept. of Agriculture's Cooperative Report.

Most of the livestock raised is beef cattle because dairy cattle and sheep have been less able to compete on an economic basis. According to the Oregon State Extension Service and U. S. Department of Agriculture's estimate for 1963, crop sales amounted to $348,000, while animal product sales amounted to $5,777,000.

Forestry

Forested land covers 779,400 acres or 12.2 percent of the basin. Timber production is dependent mainly on lands of the Malheur National Forest and the eastern portion of the Ochoco National Forest. Ninety percent of the lumber is ponderosa pine and the remainder is fir and larch.

Table 6 shows the forest areas by ownership and type. Ten percent of the forest land is privately owned while 90 percent is publicly owned by the Federal and State Governments. Most of the sawtimber is produced by the national forest. The lumber company at Hines, cuts timber in the national forests on a sustained-yield basis and operates the largest mill and plywood plant in the area. The other large mill is at Seneca.

TABLE 6

FOREST AREAS BY OWNERSHIP AND TYPE
Acres

TYPE	FEDERAL	STATE	PRIVATE	TOTAL
Ponderosa Pine	460,920	1,230	34,720	496,870
Associated Species	51,700	30	-	51,730
Lodgepole Pine	7,810	-	-	7,810
Hardwood	-	-	-	-
Nonstocked	1,800	-	-	2,340
Noncommercial	169,250	8,500	42,900	220,650
TOTAL	691,480	9,760	78,160	779,400

Data Source: U. S. Dept. of Agriculture's Cooperative Report.

Timber harvest from 1950 to 1964 fluctuated from a low of approximately 24 million board feet to a high of nearly 59 million board feet in 1964. The forest land also is used extensively by recreationists and sportsmen.

Industry

Manufacturing industries are based almost entirely on wood and livestock products. Small industries include sand and gravel operations. These industries are of material significance to the basin because they provide an important source of income and help to diversify the basin's economy.

Industrial expansion in 1965 can be credited to the opening of the plywood plant in the city of Hines.

Table 7 shows the employment in Harney County by industry between 1940 and 1960.

TABLE 7

EMPLOYMENT IN HARNEY CO.

INDUSTRY	1940	1950	1960
Agriculture	778	715	525
Forestry	3	26	50
Mining	17	14	23
Construction	113	107	92
Manufacturing	463	580	711
Transportation and Utilities	97	102	99
Wholesale and Retail Trades	220	352	385
Services and other industry	484	547	724
TOTAL	2,175	2,443	2,609

Data Source: U. S. Bureau of Census.

This table shows a decrease in agricultural employment and a marked increase in forestry, manufacturing, trades, and services. Total employment was 2,609 people in 1960.

Mining

The mining of mineral resources has not increased the basin's economy significantly, because deposits generally are small or are of inferior grade. Harney County mineral production figures, reported by the U. S. Bureau of Mines for 1965, amounted to $261,000 all for sand and gravel.

Present principal mining activities are limited to cinders west of Hines and sand and gravel near Burns. Most sand and gravel for concrete aggregate is imported from Ontario and John Day.

Various minerals occur in the basin. Gold, zinc, and magnetite prospects have been worked north of Burns. Pumice was excavated west of Hines. Cinnabar, copper, and gold are found in small pockets in the Steens and Pueblo Mountains. Diatomite, its quality impaired by abundant interbeds of volcanic ash, occurs in a considerable area west of the Whitehorse Ranch. Volcanic tuff, structurally suitable for building stone but now little used because of its drab color, is widespread.

A dozen exploratory oil wells, nine of which exceed 1,000 feet in depth, have been drilled between Burns, Crane, and Harney Lake. None has produced commercial oil or gas. The deepest well, drilled in 1949 in the eastern outskirts of Burns, bottomed at 6,480 feet in Miocene basalt.

Recreation

A large part of the Malheur Lake Basin is undeveloped constituting one of the relatively large unaltered semidesert regions of the United States. Its specific recreational potential has not been defined thoroughly and thus is not fully realized even among the basin's residents.

The basin is a paradise for rock hounds, offering obsidian, agate, jasper, thundereggs, sunstones, petrified wood, and fossils. There are also many Indian relics and symbolic writings and carvings found on cliffs, large rocks, and walls of caves. Outstanding values of natural history, lava caves and tube formations have remained relatively unchanged since their formation.

The few developed recreation areas are shown in Table 8.

TABLE 8

RECREATION AREAS

MAP NO.	NAME	WATER SUPPLY	COMFORT STATIONS	STOVES	TABLES	CAMP SITES	TLR. SITES	SWIM	BOAT	FISH	HUNT	HIKE
	FOREST CAMPS											
1	Blue Spring	piped	2	x	-	3	-	-	-	-	x	-
2	Delintment Lake	well	8	-	29	26	16	x	x	x	x	-
3	Idlewild	piped	8	21	45	22	8	-	-	-	x	x
4	Josquin Miller	piped	4	31	37	14	4	-	-	-	x	x
5	Parrish Cabin	piped	-	-	7	4	19	-	-	-	x	x
6	Rock Spring	piped	-	-	7	2	-	-	-	-	x	x
7	Starr Ridge	piped	-	-	x	12	7	-	-	-	x	x
	B L M PARK											
8	Page Spring	x	x	x	x	20	x	-	-	x	x	-
	O S H D PARK											
9	Buchanan Springs	x	2	-	2	-	-	-	-	-	-	-
	BOAT LANDINGS											
10	Chickahominy Res.	-	x	-	-	x	-	-	x	x	-	-
11	Delintment Lake	well	8	-	29	26	16	x	x	x	x	-
12	Fish Lake	x	x	x	-	x	-	-	x	x	-	-
13	Krumbo Res.	-	-	-	-	x	-	-	x	x	-	-
14	Moon Res.	-	-	-	-	-	-	-	x	x	-	-
15	Rock Creek Res.	-	-	-	-	-	-	-	x	x	-	-

Data Source: U. S. Forest Service
Oregon State Highway Department
Harney County Water Resources Committee.

Figure 9 shows 7 forest camps within the approximately 850 square miles of national forest. There are no county parks

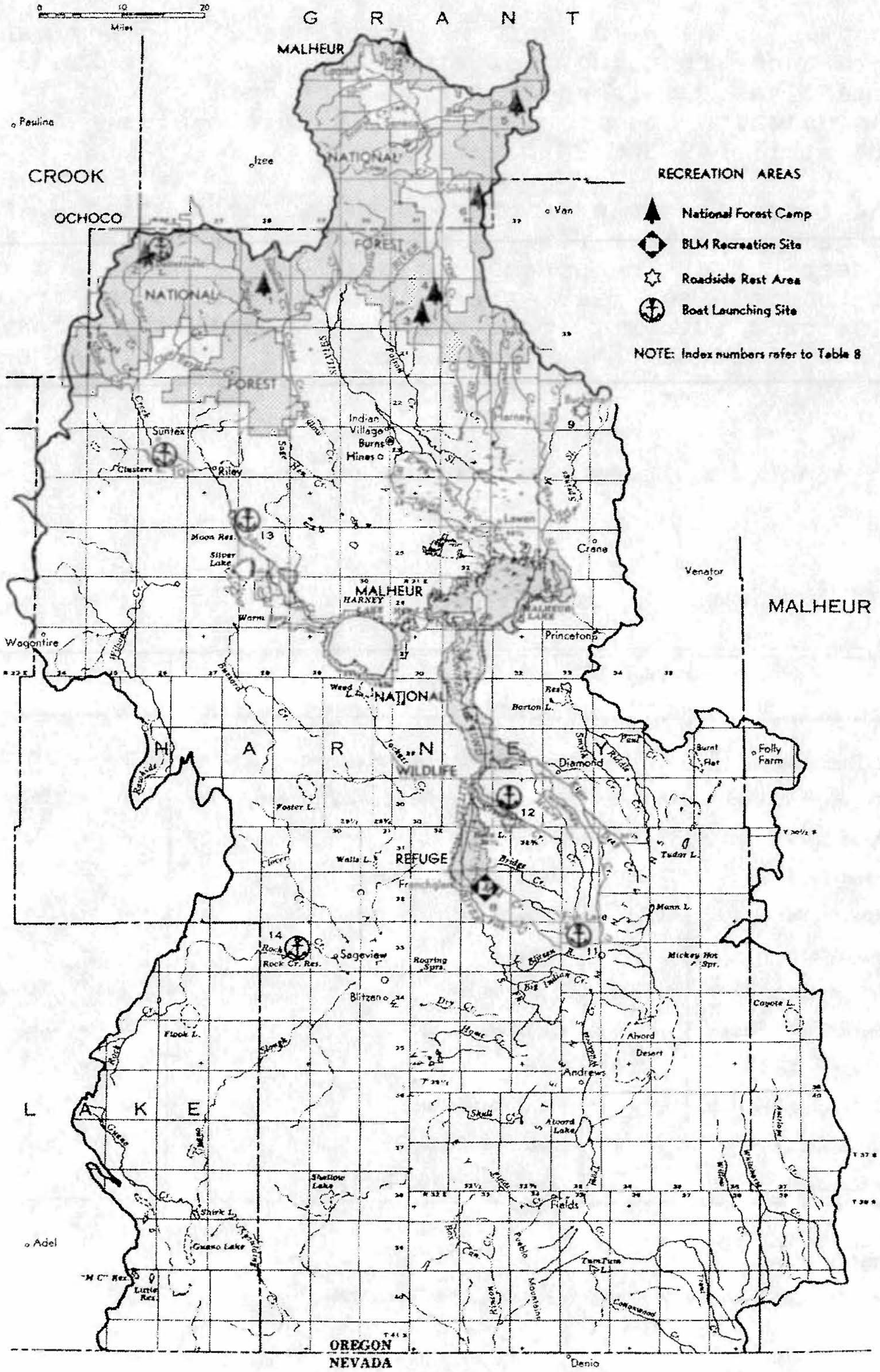


FIGURE 9. Recreation Areas.

within the basin. The state has not established any parks other than one roadside rest area. The Bureau of Land Management has developed a park at Page Spring near Frenchglen which has trailer sites, picnic tables, stoves, comfort stations, and 20 campsites.

Present recreation use is predominently the hunting of deer, upland game, and waterfowl. In the past five years of record, deer hunters numbering up to 8,500 in one season in the Steens Mountain and Silvies areas combined have had from 50 to 79 percent success. Game birds, resident of the basin, include ringnecked pheasants, valley quail, mountain quail, Hungarian partridge, chucker partridge, sage grouse, doves, and waterfowl.

The most popular lakes are listed in Table 9.

TABLE 9

LAKE AND RESERVOIR SUMMARY

NAME	ANNUAL VISITS	ACTIVITIES	AREA Acres
Malheur Lake	4,500	Sightseeing, waterfowl hunting	120 - 64,000
+*Delintment Lake	3,000	Fish, water ski, camp, picnic, swim	35 - 52
+ Baca Lake	3,000	Fish	- - 600
+*Fish Lake	2,800	Fish, picnic, swim	- - 20
+*Krumbo Res.	1,000	Fish, picnic	- - 158
+ Mann Lake	1,000	Fish	0 - 325
Harney Lake	500	Sightseeing	0 - 33,000
+*Rock Creek Res.	500	Fish, water ski	2 - 384
Juniper Lake	200	Fish	0 - 200
+*Chickahominy Res.	-	Fish, water ski	3 - 529
+*Moon Res.	-	Fish, water ski	8 - 619
Wildhorse Lake	-	Fish, waterfowl hunting	15 - 16

+Fish stocked.
*Boat Landing.

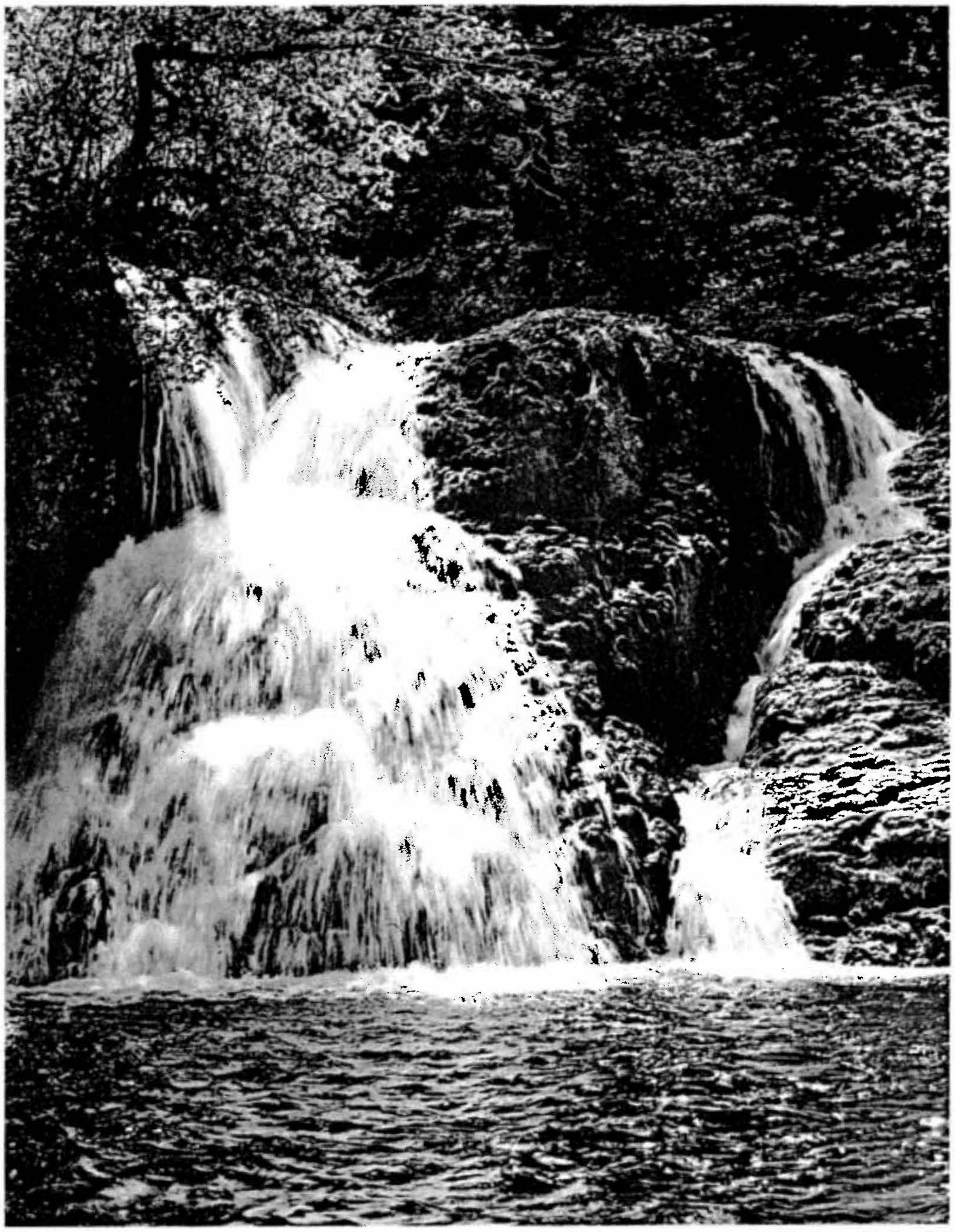
Data Source: Harney County Water Resources Committee.

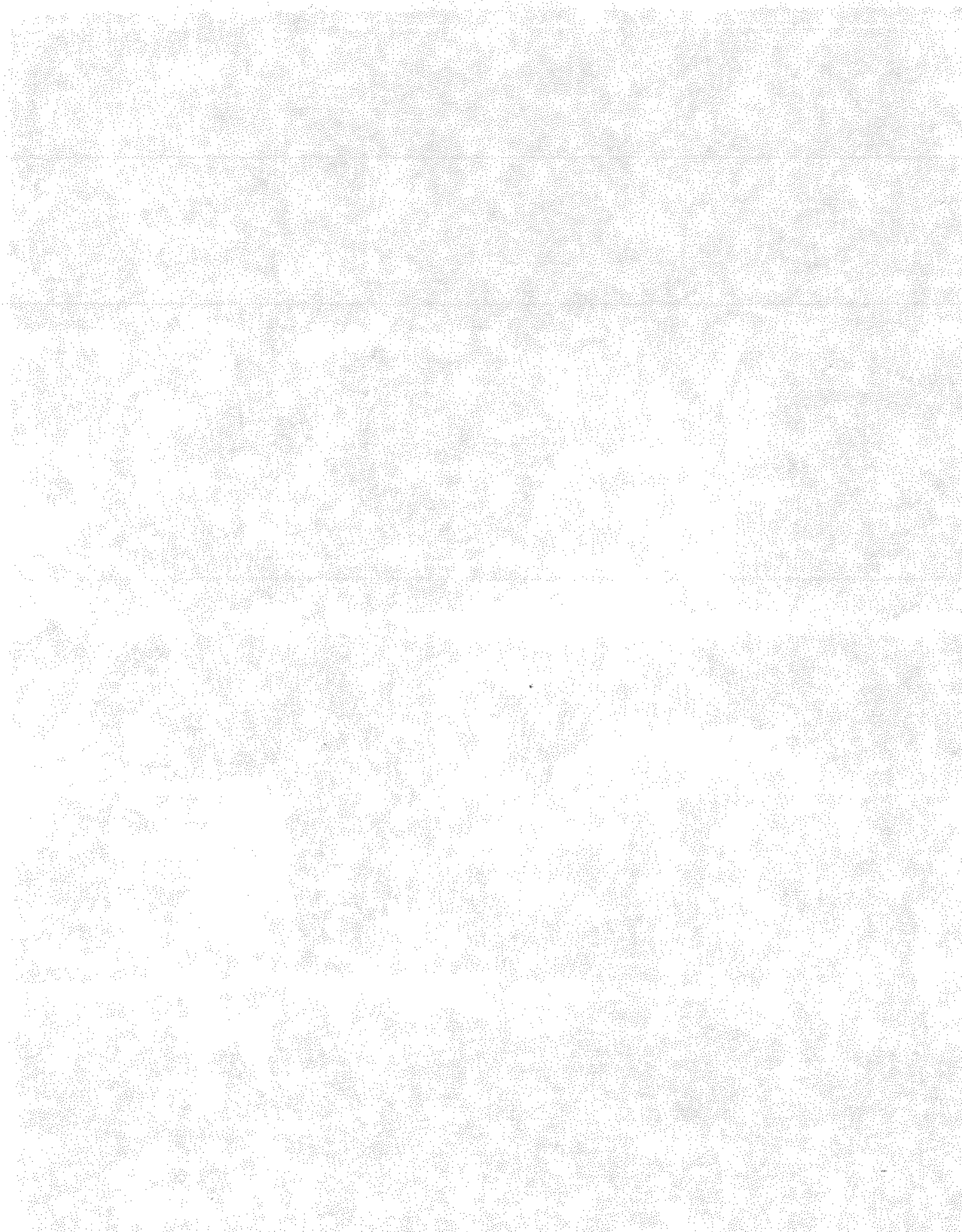
A number of the lakes and reservoirs of the basin, some of which are stocked, provide fishing, boating, water skiing, camping, picnicking, and sightseeing. Boat landings are available at six lakes within the basin.

Pleasure boats in Harney County increased from 123 in 1962 to 165 in 1966 resulting in 23.2 boats per thousand residents, an increase of 5.0 in the 4-year period. This is slightly greater than the statewide increase of 4.7 for the same period, however, the county still ranks below the 29.8 boats per thousand residents statewide. In 1962, between 50 and 75 percent of the boating in Harney County was by visitors to the area, while a 1966 survey shows that over 50 percent is by the local residents.

The 180,850-acre Malheur National Wildlife Refuge and the 241,000-acre Hart Mountain Wildlife Refuge attract thousands of visitors annually to observe the several hundred known species of waterfowl and wildlife that use the refuges. Snow geese, Canadian geese, Whistling swans and other northern breed waterfowl use the refuge in their annual migration south along the Pacific Flyway. Also within the refuge, one can fish on Krumbo Reservoir and on the Donner und Blitzen River and its tributaries above Bridge Creek. Waterfowl hunting is permitted on portions of Malheur Lake. Muskrats are trapped under a permit system when their numbers are out of balance with other wildlife uses. Recreational use of the refuge has risen steadily, over the past ten years, from about 7,200-visitor days in 1956 to over 17,500 in 1965. About 15,000 of the latter were classed as visits for nature study, sightseeing, picnicking, and camping while 2,000 were classed as visits for hunting and over 500 for fishing.

WATER SUPPLY





Oregon State Highway Department photo

PART II

WATER SUPPLY

SURFACE WATER

Introduction

The determination of stream yields, monthly distributions, and extreme discharges are based primarily on State Engineer-U. S. Geological Survey stream gaging records. All hydrological stations, active and inactive, are shown in Table A in the Appendix which lists these stations by name, number, location, type, and period of record.

Short-term streamflow records have been extended to the base period, by correlations with selected long-term records. Estimates of the yield of some of the ungaged watersheds were made on the basis of precipitation-consumptive use correlations.

Base Period

In order to facilitate the comparison of the streamflow characteristics of several watersheds within the basin, a representative 30-year base period (1935-64) was selected. The mean annual precipitation for this period is nearly equal to the long-term average precipitation in Harney Valley.

Yield

The maximum, minimum, and average annual outflow of a number

TABLE 10

ACTUAL AND ESTIMATED MINIMUM, MAXIMUM AND AVERAGE ANNUAL OUTFLOW AT GAGED LOCATIONS 1935-64

STREAM AND GAGE	DRAINAGE AREA Sq. Mi.	COMPLETE WATER YEARS OF RECORD	ANNUAL OUTFLOW IN ACRE-FEET			
			MINIMUM	MAXIMUM	AVERAGE	Inches
Silvies River near Burns (3935)	934	51	44,170	270,400	127,200	2.6
Silver Creek near Riley (4030)	228	13	10,300*	61,500	29,400*	2.4
Donner und Blitzen River near Frenchglen (3960)	200	34	45,100	145,700	84,100*	7.9
Trout Creek near Denio (4065)	88	33	5,200	27,000	11,200	2.3

* Correlations.
Data Source: Oregon State Engineer.

of major streams of the basin are listed in Table 10.

Figure 10 illustrates the base period outflow of the Silvies

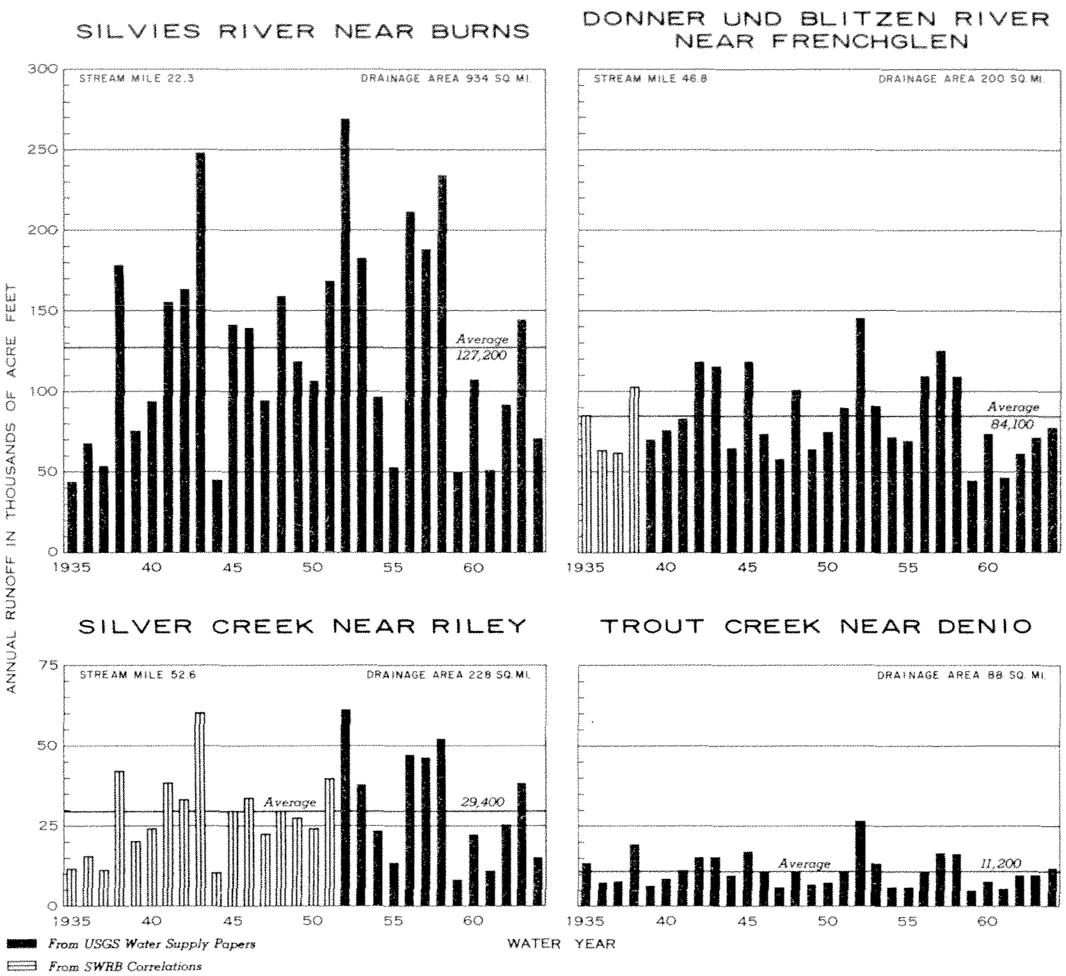


FIGURE 10. Average Annual Outflow of Selected Streams.

River, Donner und Blitzen River, Silver and Trout Creeks.

Annual outflow on Silvies River may vary from under 45,000 acre-feet to over 270,000 acre-feet. The outflow pattern on Silver Creek is similar, with the outflow in good water years being 6 times those of poor water years, (10,000 to 61,000 acre-feet).

The Donner und Blitzen River has the most stable flow pattern.

W A T E R   S U P P L Y

Annual outflow on Donner und Blitzen above the cropland varies from about 45,000 to 146,000 acre-feet.

Table 11 shows the average annual usable yield, consumption,

TABLE 11

ESTIMATED AVERAGE ANNUAL USABLE
YIELD, CONSUMPTION AND RUNOFF
Acre-feet

STUDY AREA	USABLE YIELD (surface)	CONSUMPTION		RUNOFF		EVAPOTRANSPIRATION	
		Dom. Mun. Ind. Irr.	Other	Surface	Ground	Malheur Lake	Harney Lake
1. SILVIES							
a. Upper	167,000	31,000	5,000	128,000	3,000	0	0
b. Lower	58,000	92,000	10,000	-59,000	15,000	71,000	16,000
Total	225,000	123,000	15,000	69,000	18,000	71,000	16,000
2. SILVER							
a. Upper	41,000	10,000	0	31,000	0	0	0
b. Lower	17,000	6,000	10,000	-4,000	5,000	0	32,000
Total	58,000	16,000	10,000	27,000	5,000	0	32,000
3. DONNER UND BLITZEN							
a. Upper	106,000	12,000	13,000	81,000	0	0	0
b. Lower	48,000	21,000	37,000	-13,000	3,000	59,000	12,000
Total	154,000	33,000	50,000	69,000	3,000	59,000	12,000
TOTAL	437,000	172,000	75,000	164,000	26,000	130,000	60,000
4. CATLOW-ALVORD							
a. Catlow	100,000	20,000	40,000	0	40,000		
b. Alvord	170,000	50,000	60,000	0	60,000		
TOTAL	270,000	70,000	100,000	0	100,000		

Data Source: U. S. Dept. of Agriculture's Cooperative Report.

and runoff by study area, as well as an estimate of both surface-water runoff and ground-water discharge to interior lakes in the basin.

About 190,000 acre-feet evaporates or is used by vegetation annually from Harney and Malheur Lakes to form a zero water balance.

W A T E R   S U P P L Y

The yield of these streams varies widely, the lower flows being associated with watersheds having a large percentage of area receiving low precipitation.

The highest yield stream is the Silvies River which has an average annual runoff of 127,200 acre-feet measured at USGS Gage No. 3935 near stream mile 24. The runoff of the Donner und Blitzen River above Blitzen Valley averages 8,400 acre-feet. The other large yield stream is Silver Creek with an average runoff of 29,400 acre-feet above Silver Creek Valley. These streams, which drain directly into Harney Valley, supply an average usable yield of about 437,000 acre-feet, of which about 190,000 acre-feet, enters Malheur and Harney Lakes. Of the approximate 190,000 acre-feet, it is computed that 87,000 acre-feet is combined surface and ground-water outflow from the Silvies area, and about 71,000 acre-feet is from the Donner und Blitzen River and tributaries. In poor water years, the Donner und Blitzen River provides the highest outflow.

An estimated 100,000 acre-feet of water resulting from precipitation in the Catlow-Alvord area percolates to ground water. How much of this is available for beneficial uses, is lost to desert vegetation or escapes from the basin, requires further study to better understand and utilize the available water supply of this area.

The average annual outflow of the basin totals about 290,000 acre-feet after present beneficial uses. Computations indicate that, of the 700,000 acre-feet annual yield usable by man, about 240,000 acre-feet is consumed by domestic, municipal, industrial and irrigation uses, an estimated 170,000 acre-feet is lost in distribution, and 190,000 acre-feet is dissipated by evapotranspiration from Malheur and Harney Lake and marsh surfaces.

The yield pattern of basin streams is typical for semiarid regions, exhibiting large variations in annual yield from year to year.

Seasonal Distribution

The peak months of discharge are March, April, and May for all streams except the Donner und Blitzen River and Trout Creek, which peak about one month later. These three months account for between 60 and 80 percent of the basin's annual outflow. The month of maximum outflow varies, depending on the percentage of the watershed area that is in the higher elevations and thus has later snowmelt. The Donner und Blitzen distribution pattern illustrates the influence of the canyon snowpack on seasonal discharge. There is a higher base flow and the discharge peaks are more subdued.

Figure 11 illustrates the seasonal distribution of the annual

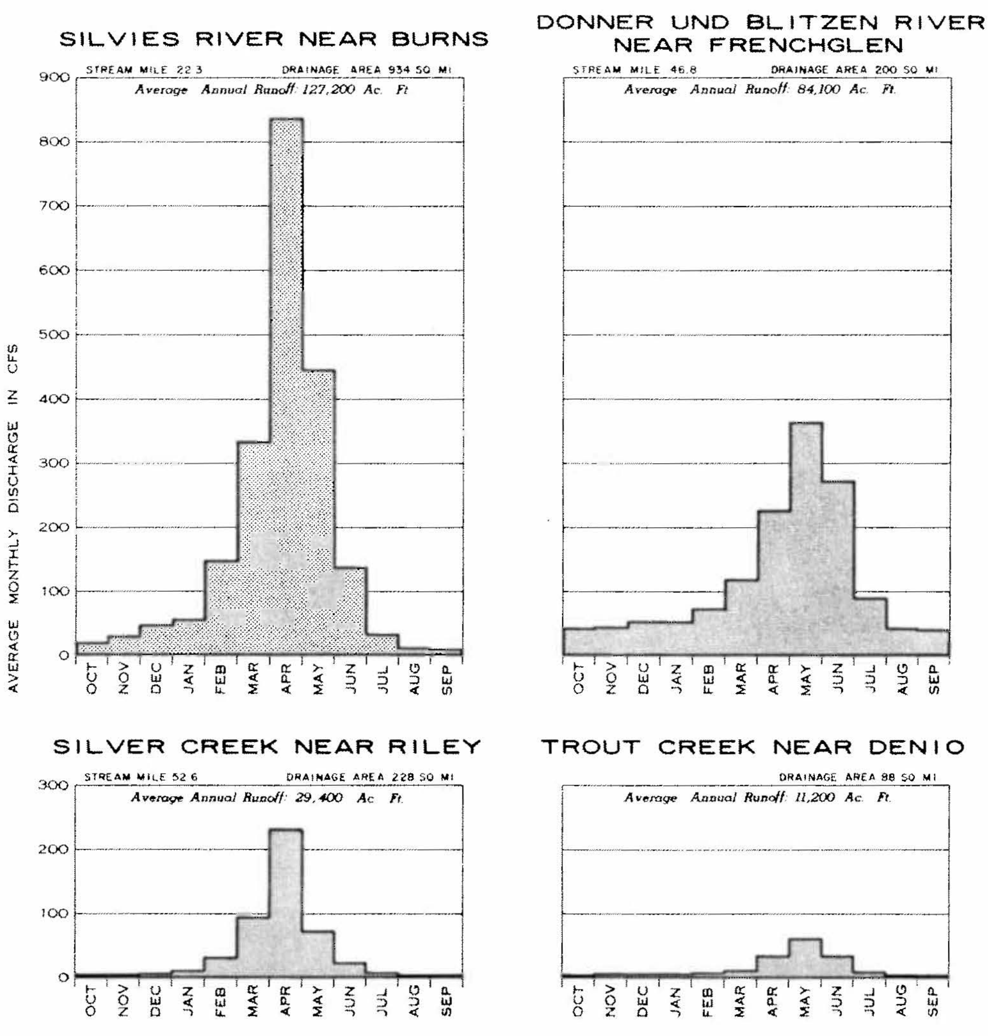


FIGURE 11. Monthly Distribution of Annual Outflow of Selected Streams.

outflow at stream gaging stations in each study area.

Table 12 shows the average monthly discharge of Silvies

TABLE 12

AVERAGE MONTHLY DISCHARGE AT GAGED LOCATIONS
1935-1964
Cfs

STREAM AND GAGE	COMPLETE WATER YEARS OF RECORD	OCT.	NOV.	DEC.	JAN.	FEB.	MAR.	APR.	MAY	JUNE	JULY	AUG.	SEP.
Silvies River near Burns (3935)	51	18.4	31.9	47.7	54.5	156.4	324.8	852.2	434.6	140.5	31.0	12.1	11.1
Silver Creek near Riley* (4030)	13	3.2	4.4	6.0	9.7	33.3	92.4	235.9	70.6	22.9	6.2	2.2	2.0
Donner und Blitzen River near Frenchglen* (3960)	34	39.6	42.5	50.0	50.5	78.3	114.7	223.9	354.3	273.8	86.2	41.4	38.1
Donner und Blitzen River near Voltage* (4015)	5	32.7	64.0	80.8	102.2	123.1	89.4	104.9	129.9	207.4	58.0	18.9	19.5
Bridge Creek near near Frenchglen* (3970)	30	11.6	11.4	11.1	10.7	11.9	13.3	19.7	22.0	14.9	11.6	11.6	11.9
Trout Creek near Denio (4065)	33	4.7	5.8	5.7	5.7	7.6	11.6	34.3	59.7	33.9	9.3	3.3	3.1

*Contains correlated values

Data Source: U. S. Geological Survey

and Donner und Blitzen Rivers and Silver, Bridge, and Trout Creeks at gaged locations.

Extreme Discharges

Recorded extreme discharges on Silvies River near Burns show several zero flows and a maximum of 4,930 cubic feet per second (cfs) on April 6, 1952. Available data on Silver Creek above Suntex show frequent zero flows and a maximum of 1,760 cfs on April 14, 1904. Discharge records on the Donner und Blitzen River near Frenchglen show a minimum of 6.6 cfs on December 29, 1960 and a maximum of 2,750 cfs on May 19, 1953.

The extremely low July through February flows and the high percentage of yearly runoff occurring in April on Silvies River is typical of runoff patterns for most of the basin's streams, except for the month's lag in time noted earlier for the Donner und Blitzen River and Trout Creek.

Extreme differences in daily flows are illustrated in Figure 12, a daily flow hydrograph for a low-water year on the Silvies River above Burns. It can be seen that monthly averages rusult from periods of discharges that vary frequently from zero to substantial flows. Under these conditions, averages are not a reliable guide to expected mean minimum flows.

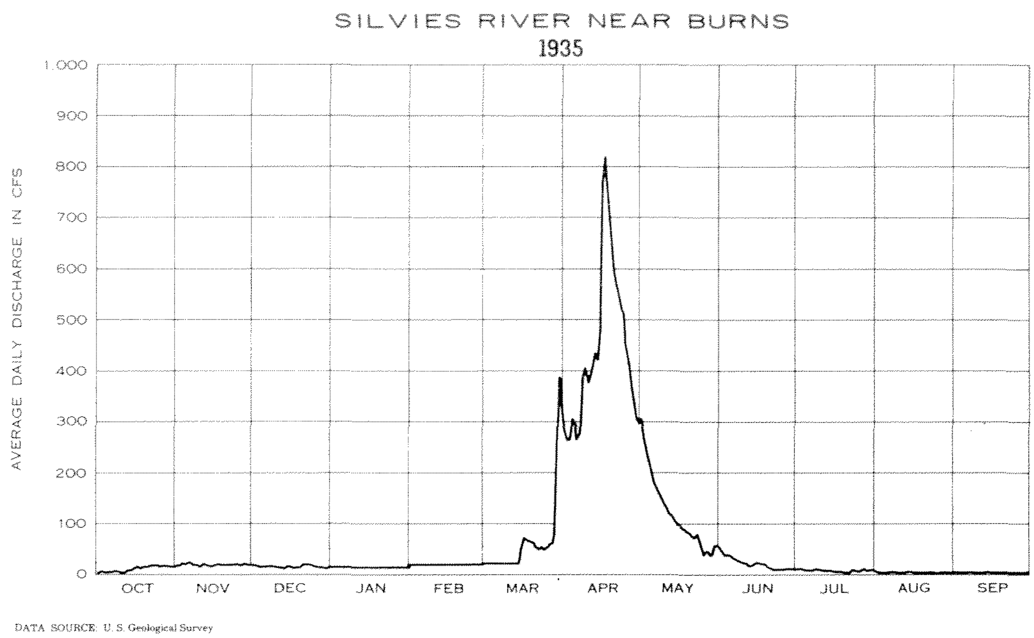


FIGURE 12. Daily Discharge Hydrograph of Silvies River.

Water Rights

The State Water Resources Board has prepared and filed Malheur Lake Basin water rights compilation sheets which list the rights by stream, application, permit, or certificate number, priority date, use, and diversion point.

The Malheur Lake Basin has no appreciable quantities of unappropriated surface water subject to the jurisdiction of the State Water Resources Board. In some headwater streams, there still may exist limited possibilities for such nonconsumptive uses as fish life and recreation.

Table 13 summarizes this compilation by study area.

TABLE 13

SURFACE WATER RIGHTS SUMMARY
March 1, 1967
Cfs

STUDY AREA	DOMESTIC	IRRIGATION	Acres	POWER & MINING	REC.	WILDLIFE	TOTAL
1. SILVIES							
a. Upper	7.24	334.77	22,673	34.00@	0.02	0	376.03@
b. Lower	16.92*	1,667.35	125,302	0	0.10	0	1,684.37*
Total	24.16*	2,002.12	147,975	34.00@	0.12	0	2,060.40*@
2. SILVER							
a. Upper	3.86	160.71	11,515	0	5.00	0	169.57
b. Lower	2.31	267.59	18,591	0	0	0	269.90
Total	6.17	428.30	30,106	0	5.00	0	439.47
3. DONNER UND BLITZEN							
a. Upper	0.16	194.89	12,094	0	0.33	3.19	198.57
b. Lower	0	868.29	44,683	0	0	215.00	1,083.29#
Total	0.16#	1,063.18	56,777	0	0.33	218.19	1,281.86#
4. CATLOW-ALVORD							
a. Catlow	1.61	321.39	25,283	0	0	0	323.00
b. Alvord	5.88	282.64	16,038	0	0	0	288.52
Total	7.49	604.03	41,321	0	0	0	611.52
TOTAL	37.98*#	4,097.63	276,179	34.00@	5.45	218.19	4,393.25*@#

* Includes 0.04 cfs for industrial on Poison Creek.
@ Includes 5.00 cfs for mining on Silvies River Misc.
# The adjudication allowed an unspecified amount for domestic and stock use.

Data Source: Oregon State Engineer.

Depletion

Surface water rights have been obtained for the irrigation of 276,179 acres, but only about 218,120 acres have been irrigated in most years due to water shortages. The average annual consumption of 340,000 acre-feet for irrigation contrasts with the legal right to use 712,855 acre-feet. The only other substantial consumptive rights are for domestic purposes in the amount of 27,404 acre-feet.

The largest nonconsumptive rights are for wildlife in the amount of 157,970 acre-feet. These are refuge rights on one spring (Sodhouse), Krumbo Creek, and around the shoreline of Malheur and Harney Lakes. Other nonconsumptive rights include 20,996 acre-feet of power rights on upper Silvies River, 3,620 acre-feet of mining rights on upper Silvies

River, and 3,945 acre-feet of recreation rights scattered around the three northern study areas.

Table 14 summarizes the maximum legal surface water depletions.

TABLE 14

MAXIMUM LEGAL ANNUAL SURFACE
WATER RIGHT DEPLETIONS
March 1, 1967
Acre-feet

STUDY AREA	DOMESTIC	IRRIGATION	Acres	POWER & MINING	REC.	WILDLIFE	TOTAL
1. SILVIES							
a. Upper	5,242	48,720	22,673	24,616@	14	0	78,592@
b. Lower	12,251*	294,342	125,302	0	72	0	306,665*
Total	17,492*	343,062	147,975	24,616@	86	0	385,257*@
2. SILVER							
a. Upper	2,795	29,061	11,515	0	3,620	0	35,476
b. Lower	1,673	47,132	18,591	0	0	0	48,805
Total	4,468	76,193	30,106	0	3,620	0	84,281
3. DONNER UND BLITZEN							
a. Upper	116	36,582	12,094	0	239	2,310	39,247
b. Lower	0#	133,747	44,683	0	0	155,660	289,407#
Total	116#	170,329	56,777	0	239	157,970	328,654#
4. CATLOW-ALVORD							
a. Catlow	1,164	75,852	25,283	0	0	0	77,016
b. Alvord	4,192	47,419	16,038	0	0	0	51,611
Total	5,356	123,271	41,321	0	0	0	128,627
TOTAL	27,433*	712,855	276,179	24,616	3,945	157,970	926,819*#@

* Includes 29 acre-feet for industrial on Poison Creek.
@ Includes 3,620 acre-feet for mining on Silvies River Misc.
# The adjudication allowed an unspecified amount for domestic and stock use.

Data Source: Oregon State Engineer.

The identity of unappropriated waters of the Silvies River and Silver Creek is obscured by the respective adjudication decrees. On the Silvies River, the decree essentially provides for an open season for irrigation. Although the decree defines the irrigation season as extending from March 20 to September 1, the provision is made that the season thereby fixed shall not prevent water users awarded a right by the decree from using waters of the Silvies and its tributaries at other times when such use will be beneficial to the land and the crops grown thereon when the ground is not frozen and the same can be used without needless waste.

W A T E R   S U P P L Y

The Silver Creek decree defines the irrigation season as extending from March 1 to August 1, but goes on to provide that at all times, other than the irrigation season, dams and obstructions are to be opened in channels of all streams in said stream system prior to March 1, so the floodwaters of said stream may pass down through and spread over the valley lands in their natural manner.

On both the Silvies River and Silver Creek, the beginning of the irrigation season was established to coincide as nearly as possible with the beginning of the spring runoff. This also was established on Trout, Little Cottonwood, and Willow Creeks in the Alvord or southern portion of the basin. On certain other streams such as Wildhorse, Rattlesnake, Mill and Coffeepot Creeks, no irrigation season was set since the court recognized, as stated in the decree, that streamflow varied from year to year according to time and quantity of snowmelt and thus had to be used when available, providing of course, the water could be used beneficially.

Storage of presently appropriated surface water and further ground-water development are the principal sources of future supplies for consumptive uses.

At present, there are no water rights for out-of-basin diversions, and such rights should not be allowed in the future.

Silvies - Figure 13 graphically presents the Silvies River and tributaries natural (usable) average annual yield, in blue, versus the legal annual rights, in red. The 385,000 acre-feet of legal depletions exceed by more than 50 percent the yield of 225,000 acre-feet.

Silver - Figure 14 graphically presents the Silver Creek and Harney Lake tributary streams natural (usable) average annual yield, in blue, versus the legal annual rights, in red. As on the Silvies, rights greatly exceed available water, 84,000 acre-feet of rights as compared to but 58,000 acre-feet of available water.

Donner und Blitzen - Figure 15 graphically presents the Donner und Blitzen River and miscellaneous streams natural (usable) average annual yield, in blue, versus the legal annual rights, in red. On this stream system and the miscellaneous associated streams, the legal depletions of 329,000 acre-feet are more than double the 154,000 acre-feet of water available.

W A T E R   S U P P L Y

SILVIES RIVER

NATURAL YIELD: 225 000 ACRE FEET
LEGAL RIGHTS: 385 000 ACRE FEET

FIGURE 13. Natural Average Annual Yield vs Water Rights on Silvies River.

WATER SUPPLY

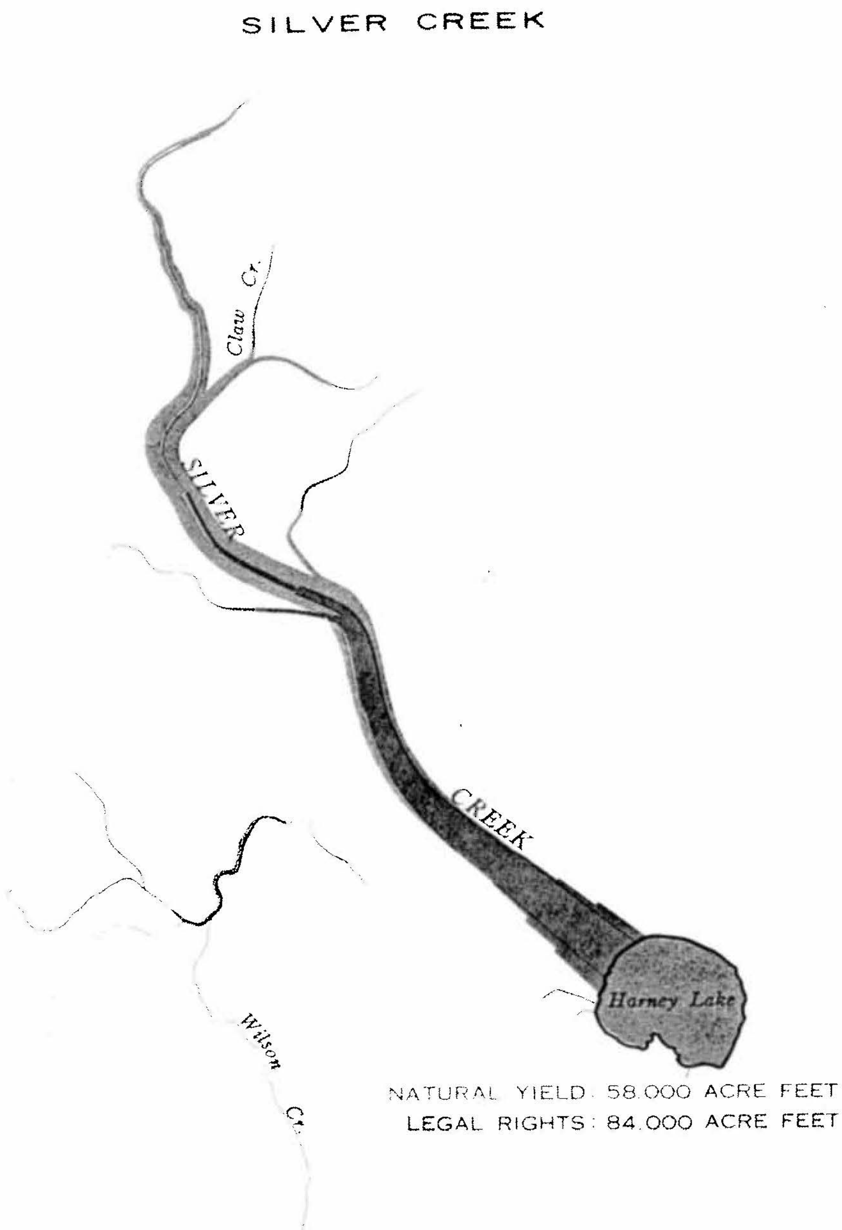


FIGURE 14. Natural Average Annual Yield vs Water Rights on Silver Creek.

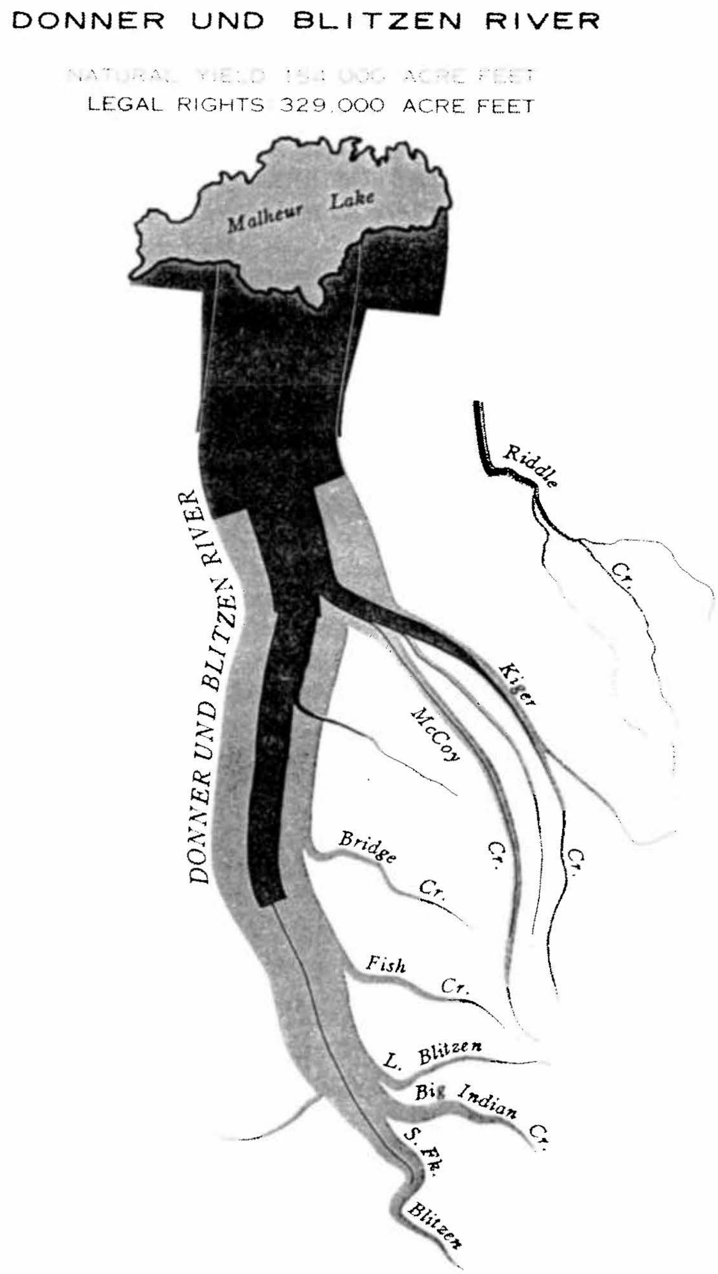


FIGURE 15. Natural Average Annual Yield vs Water Rights on Donner und Blitzen River.

WATER SUPPLY

GROUND WATER

Occurrence

Ground-water studies made by the U. S. Geological Survey in 1939, entitled "Geology and Ground Water Resources of the Harney Basin, Oregon," Water Supply Paper 841, supplies the most comprehensive technical data available on the basin's ground-water resources. Their report discusses much of the Silvies, Silver, and Donner und Blitzen study areas as delineated herein.

Geologic and well data available for the Catlow-Alvord study area indicate that portions of these two valleys contain substantial quantities of good quality ground water within economic pumping depths.

Recent chemical water analyses of 59 wells authorized by the Harney County Court, a survey of ground-water use by the county agents office and reconnaissance field investigations by the State Water Resources Board provide a general appraisal of the ground-water regimen. However, these studies are only preliminary data for needed quantitative hydrologic work to delineate the larger ground-water bodies.

The geologic structure of Harney Basin is such that the rocks bordering the central alluvial plain dip inward from all sides to form a closed basin. All drainage, therefore, is toward Malheur and Harney Lakes, the latter being the lowest area in Harney Valley.

The valley fill alluvium washed into Harney Valley by the various streams, constitutes a ground-water reservoir from which a considerable quantity of water can be recovered perennially for irrigation and other purposes. Made up principally of gravel, sand, silt, and clay, the alluvium becomes progressively finer grained and less permeable toward the center of the valley plain. Except in the coarse gravel and sand deposited near stream mouths, the valley fill varies greatly in texture. The water-bearing beds are discontinuous and irregularly distributed and their water yielding capacity varies from place to place.

Figure 16 shows the U. S. Geological Survey ground-water study area in Harney Basin and the Catlow and Alvord potential ground-water use areas.

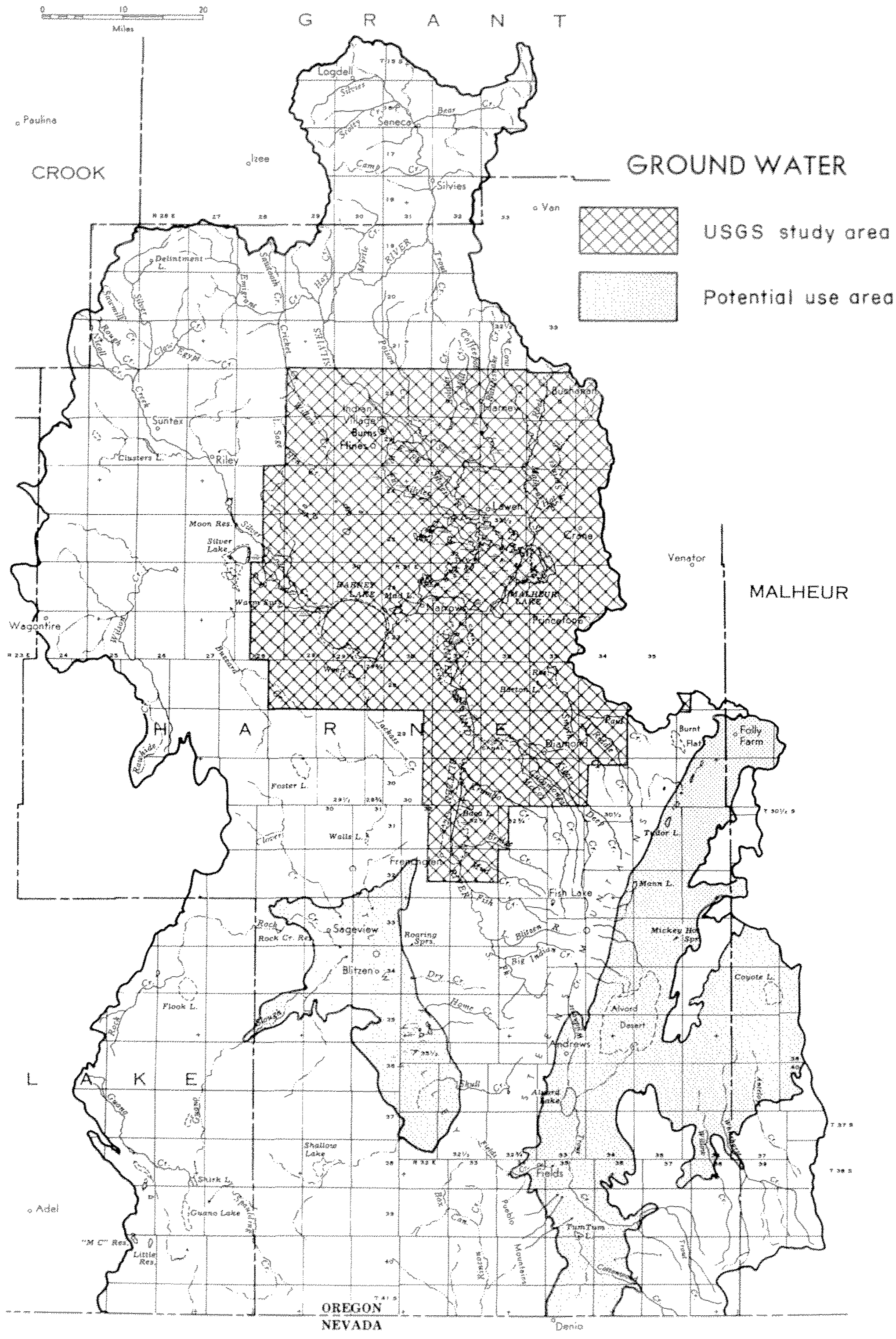


FIGURE 16. Ground-Water Study Areas.

WATER SUPPLY

The Silvies drainage area, including Silvies River and numerous small drainages north of Malheur Lake, is estimated to provide an average annual ground-water recharge of about 40,000 acre-feet to the Harney Valley, according to preliminary water budget computations. At present, some shallow water-bearing strata supply water directly to irrigated crops, which have spring floodwater as their other usable source. A portion is used by deep rooted desert-type and marsh-type vegetation around the lakes and marshes. The residue drains into Malheur Lake.

According to the U. S. Department of Agriculture's cooperative survey of 1967, ground water is used to irrigate 100 acres in the upper Silvies, 400 acres in Emigrant Valley, about 500 acres east and south of Burns, and 700 acres in the Crane-Princeton area along the eastern side of Harney Valley. Many irrigation wells also are used to supplement crop needs during summer low-streamflow periods. In Harney Valley, present studies indicate that not over 5,000 acre-feet are consumed annually by the domestic, municipal, and irrigation users of ground-water sources. Due to the close interrelationship between surface and ground water in the recharge areas, lowering of the ground-water table could adversely affect surface flows. Conversely, lowering of the water table below the reach of dense marsh vegetation in the central and lower portions of the valley could materially increase the quantity of water available for beneficial crop production. Recharge to the shallow water-bearing alluvial deposits takes place all along the Harney Valley streams, but recharge to the deep pervious alluvium occurs, mainly, on Silvies River within five miles from the head of the alluvial fan near Burns. The alluvium ranges from 50 to 90 percent clean sand and gravel. Beyond this, confining beds, for the most part, prevent recharge of the deep pervious beds by downward percolation.

The U. S. Geological Survey study shows that the deep water-bearing beds in the valley fill have a moderately large capacity to transmit water away from the area of recharge. These beds constitute the most accessible source from which to recover ground water in quantities adequate for irrigation. If the water-bearing beds are depleted by pumping from wells, they can absorb additional water to replace that withdrawn by pumping. Thus the water-bearing beds may be utilized to absorb and store water that otherwise would be rejected, and their safe yield can be increased by use.

WATER SUPPLY

The better wells are situated in the vicinity of Burns and near the east margin of the study area, extending from Princeton north to 6 miles beyond Crane.

Data pertinent to some representative test pumped high-yield wells are listed in Table 15.

TABLE 15

REPRESENTATIVE TEST PUMPED HIGH-YIELD WELLS

MAP NO.	YIELD Gpm	DRAW-DOWN Feet	SPECIFIC CAPACITY Gpm per foot of drawdown	DEPTH TO STATIC WATER LEVEL Feet and Date	WELL DEPTH Feet	WELL DIAMETER Inches	AQUIFER Rock	WATER USE
SILVIES STUDY AREA								
1.	1800	84	21	8 - 8/62	347	14	Gravel	Irrigation
2.	3200	85	38	Flows 5/59	503	18	Sand, Gravel	Irrigation
3.	1750	2	875	5 - 3/65	200	12	Cinders	Industrial
4.	1280	81	16	14 - 12/58	304	16	Volcanics	Municipal
5.	1100	86	20	54 - 10/62	425	12	Sand, Gravel	Irrigation
6.	1150	57	20	15 - 6/55	240	10	Sand, Gravel	Irrigation
7.	1118	33	34	6 - 9/66	206	12	Sandstone	Irrigation
8.	1000	100	10	30 - 6/64	357	14	Cinders	Irrigation
9.	1255	26	48	24 - 9/63	244	12	Pumice	Irrigation
10.	1500	6	250	24 - 3/54	176	16	Gravel	Irrigation
SILVER STUDY AREA								
11.	700	61	11	- 5/62	221	16	Volcanics	Irrigation
12.	600	67	9	27 - 12/59	97	22	Sand	Irrigation
13.	1500	90	17	1 - 9/62	328	14	Sand, Gravel	Irrigation
14.	900	11	82	7 - 6/59	147	12	Cinders	Irrigation
DONNER UND BLITZEN STUDY AREA								
15.	1400	9	156	12 - 9/59	118	12	Cinders	Irrigation
16.	1150	24	48	32 - 4/59	60	16	Lava	Irrigation
17.	1200	25	48	31 - 5/59	60	16	Lava	Irrigation
CATLOW - ALVORD STUDY AREA								
18.	2200	-	-	- -	995	16	Sand, Gravel	Irrigation
19.	1000	90	11	Flows 6/61	509	8	Sand, Gravel	Irrigation
20.	1000	64	16	6 - 11/60	300	12	Gravel	Irrigation
21.	600	12	50	5 - 8/60	171	8	Sand, Gravel	Irrigation
22.	1760	54	33	39 - 3/63	370	14	Gravel	Irrigation
23.	2000	90	22	10 - 6/66	400	16	Gravel	Irrigation
24.	2200	110	20	38 - 4/64	296	16	Gravel	Irrigation
25.	3000	28	107	65 - 4/61	580	18	Sand, Gravel	Irrigation

NOTE: Map No. refers to well location plotted on Figure 17.

Data Source: Oregon State Engineer.

The locations of these wells are shown in Figure 17.

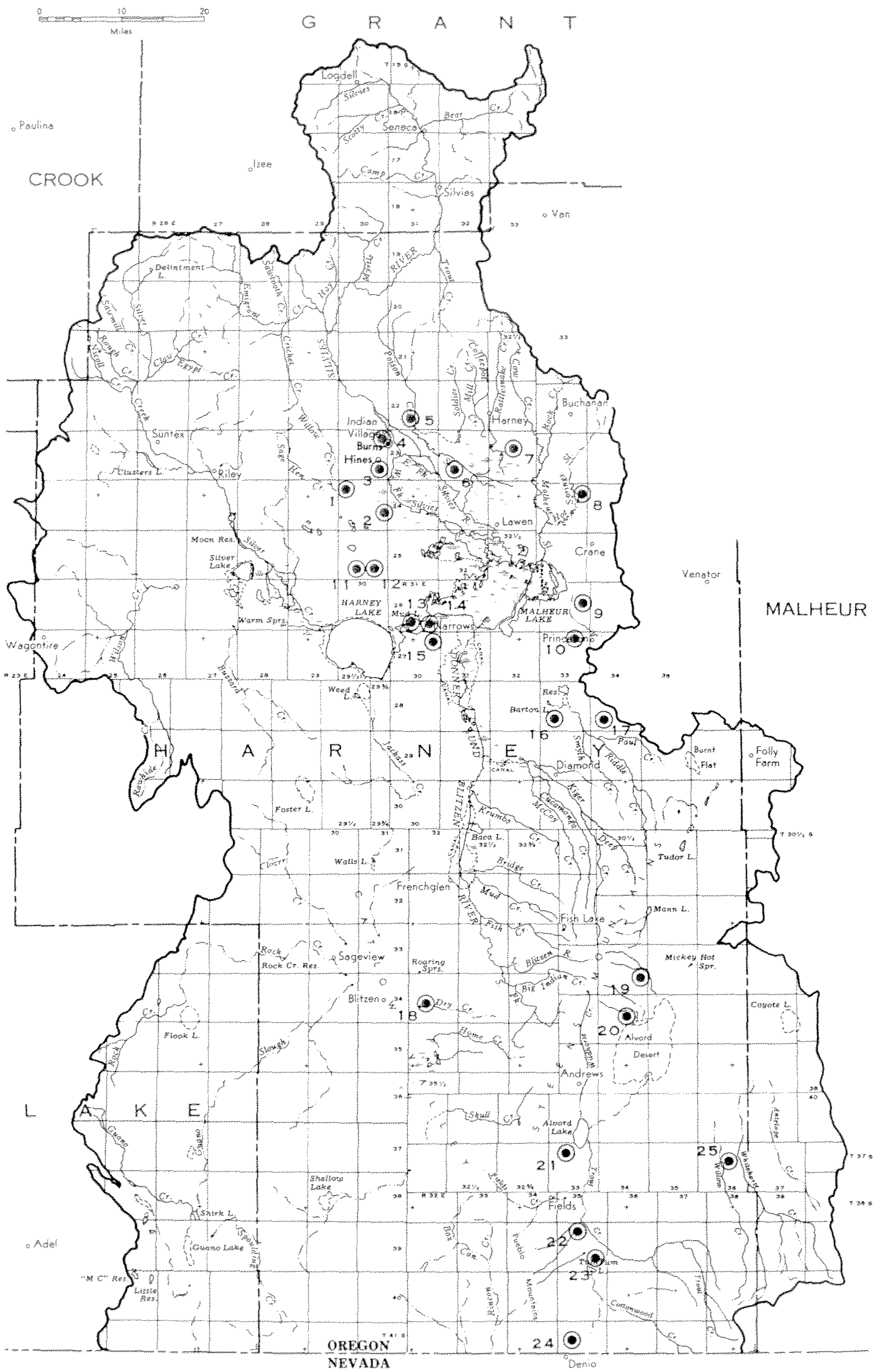


FIGURE 17. Representative Test Pumped Wells.

WATER SUPPLY

The valley fill is estimated to be less than 300 feet thick at most places in the basin. Well records show that the fill is roughly 100 feet thick within 5 miles of Burns and all along the northeastern margin of the valley plain. It thickens steadily toward the south and southeast and is from 200 to about 270 feet thick from 2 to 5 miles north of Malheur Lake. The valley fill south of the lake feathers out and is from 20 to 50 feet thick within one-half mile of the Voltage lava field.

Little is known about ground water in the Silver study area, which drains into Harney Lake. Only Silver Creek is of consequence and its ground-water recharge potential is questionable. Neither the water-yielding capacity of the valley fill nor the safe yield has been ascertained. Geologic conditions, however, indicate that the bedrock underlying some of the Silver Creek Valley might afford wells of sufficient capacity for irrigation. The previously mentioned ground-water use survey indicated that some of the ground water was of poor quality. The numerous springs, aligned along the base of the fault-line escarpment that bounds the Warm Springs Valley on the south, attest to the presence of ground water. Three irrigation wells, located in the Mud Lake area, were test pumped at 900, 1,400 and 1,500 gallons per minute (gpm). The wells range from 118 to 328 feet in depth.

Ground-water data, of consequence, also are lacking for the Donner und Blitzen study area which drains into Malheur Lake. It is likely, however, that the Donner und Blitzen River and the other streams, draining the west slope of Steens Mountain, have deposited considerable quantities of alluvium in the southern or Frenchglen segment of the valley. This deposition, made up of coarse-grained pervious volcanic rock, having a good ground-water potential, would be greatest near the mouths of the streams. Kiger Creek, no doubt, has deposited considerable quantities of pervious alluvium having good ground-water potential near its mouth in the northern segment of the valley. Two 60-foot irrigation wells, located in the Happy Valley area in the northeastern portion of the study area, were test pumped at 1,150 and 1,200 gpm.

In the higher southern plateau areas of the basin, particularly those of the 9,670-foot high, westward-tilting Steens Mountain fault-block, the pervious zones between the many-layered flows of Steens basalt act as ready conduits for the considerable rain and snowmelt that infiltrate them. The upper, exposed edges of the flows may be likened to the edges of an open book. Data are not available on the quantities of ground water thus transmitted to the Catlow and the Donner und Blitzen Valleys. The infiltration and transmittal is confirmed by the large Roaring Springs that issue from the basalt along the west escarpment of Steens Mountain and from other smaller springs issuing from the Donner und Blitzen escarpment.

Roaring Springs, located about 12 miles south of Frenchglen on the east side of Catlow Valley, averaged 5.5 cfs at the time of the 6 measurements recorded during the period 1907-30. The maximum flow was 6.7 cfs in May 1916, and the minimum flow was 3.3 cfs in October 1916. The water temperature was 59° F. when taken in August 1907. Measurements, later than 1930, have not been published.

The Catlow-Alvord study area is underlain by moderately permeable valley fill alluvium that has high ground-water potential along and near the fault-line escarpments that bound the two valleys.

The Catlow Valley has only one operating irrigation well, located several miles south of Roaring Springs. The well penetrates 995 feet of valley fill alluvium and was test pumped at 2,200 gpm. Several applications for additional ground-water rights have been made in this area.

Geologists believe that some of the ground water in the Catlow Valley possibly may drain to the Donner und Blitzen Valley in the vicinity of Frenchglen.

Very good wells have been developed in the Alvord and Pueblo Valleys along the east escarpment of Steens Mountain and the Pueblo Mountains from the Alvord Ranch south to Denio. Several of the wells, ranging from 296 to 400 feet in depth, were test pumped at more than 2,000 gpm. The good ground-water potential indicates that more irrigation wells can be drilled in these valleys.

The Whitehorse Valley to the east, likewise, has several good wells that range from 161 to 593 feet in depth. Two of the wells were test pumped at 3,000 gpm.

Water Quality

The chemical quality of the surface and ground water in Malheur Lake Basin generally is good. The presence of potentially toxic amounts of sodium salts and boron in a few ground-water problem areas indicates that, ground water should be analyzed for chemical quality before it is used for human consumption or applied to crops. Wells and springs known to have water quality problems are concentrated in small areas north of Harney Lake, along the Poison Creek watercourse, and east of Malheur Lake. Salinity of both surface and ground water increases as the water moves toward Malheur and Harney Lakes.

Table 16 summarizes the analyses of water samples from 59 wells in Harney County.

TABLE 16

QUALITY OF WELL WATER
ANALYZED FOR IRRIGATION USE
Number of Wells

QUALITY	SILVIES	SILVER	DONNER UND BLITZEN	CATLOW-ALVORD	TOTAL
Satisfactory	30	-	-	9	39
Marginal	7	-	2	1	10
Unsatisfactory	9	1	-	-	10

Data Source: Harney County Extension Service 1965

This table shows that 39 wells were rated satisfactory, 10 were marginal and 10 were unsatisfactory. Nine of the unsatisfactory samples were obtained in Harney Valley and the one sample taken in Silver Creek Valley was listed as unsatisfactory. A comparison of the analyses of ground and surface water show that the ground water generally has greater concentration of dissolved minerals than the surface water.

Use of the marginal and unsatisfactory water on presently alkaline or poorly drained soils, where excess salts can not be leached downward beyond the crop root zone, results in an adverse effect on crop yields. The qualities most important in determining suitability of water for irrigation in the Malheur Lake basin are the total concentration of soluble salts, the concentrations of boron which may be toxic to farm crops, and the relative proportions of sodium to the principal cations in the water.

Water Rights

Table 17 gives a summary of ground-water rights in the Malheur Lake Basin.

TABLE 17

GROUND WATER RIGHTS
SUMMARY
March 1967
Cfs

STUDY AREA	DOMESTIC	MUNICIPAL	INDUSTRIAL	IRRIGATION	Acres	TOTAL
1. SILVIES						
a. Upper	0.10	0	2.24	0	0	2.34
b. Lower	0.05	3.78	11.04	88.66	8,162	103.53
Total	0.15	3.78	13.28	88.66	8,162	105.87
2. SILVER						
a. Upper	0	0	0	0.01	1	0.01
b. Lower	0.03	0	0	6.13	492	6.16
Total	0.03	0	0	6.14	493	6.17
3. DONNER UND BLITZEN						
a. Upper	0	0	0	0	0	0
b. Lower	0	0	0	0.94	76	0.94
Total	0	0	0	0.94	76	0.94
4. CATLOW-ALVORD						
a. Catlow	0	0	0	4.21	337	4.21
b. Alvord	0	0	0	55.31	7,292	55.31
Total	0	0	0	59.52	7,629	59.52
TOTAL	0.18	3.78	13.28	155.26	16,360	172.50

Data Source: Oregon State Engineer.

The statewide Ground Water Act of 1955 does not require water rights for watering stock, or for irrigating lawns and non-commercial gardens not exceeding one-half acre in area. Nor are water rights required for single or group domestic purposes not exceeding 15,000 gallons per day (gpd), or for any single industrial or commercial purposes not exceeding 5,000 gpd. Not all ground water withdrawn from wells, therefore, is represented by water rights. The quantity used generally is small and unknown.

Water rights are based on the doctrine of prior appropriation and beneficial use.

Table 18 shows legal annual ground-water depletions by study area.

TABLE 18

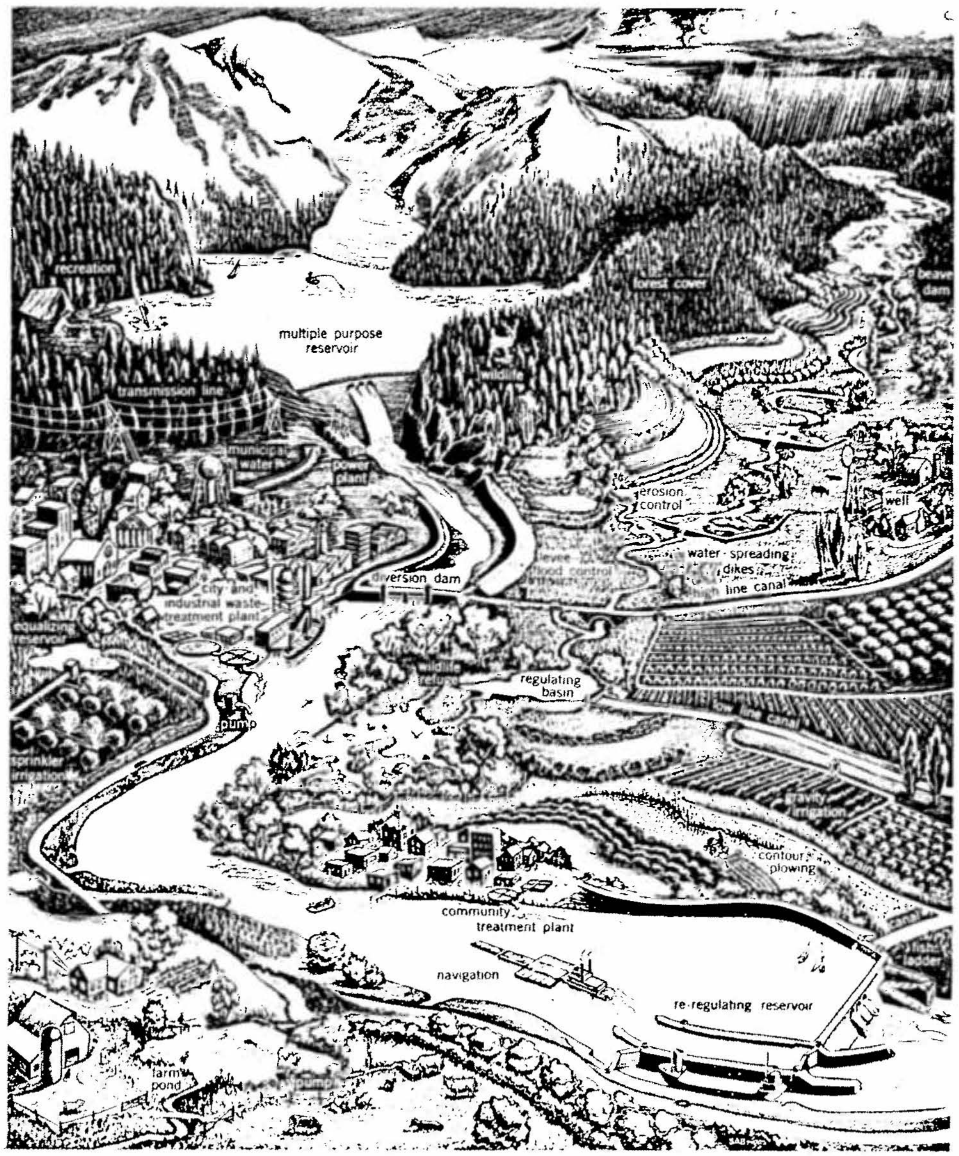
LEGAL ANNUAL GROUND
WATER DEPLETION
March 1967
Acre-feet

STUDY AREA	DOMESTIC	MUNICIPAL	INDUSTRIAL	IRRIGATION	Acres	TOTAL
1. SILVIES						
a. Upper	72	0	1,622	0	0	1,694
b. Lower	36	2,737	7,993	24,486	8,162	35,252
Total	108	2,737	9,615	24,486	8,162	36,946
2. SILVER						
a. Upper	0	0	0	3	1	3
b. Lower	22	0	0	1,476	492	1,498
Total	22	0	0	1,479	493	1,501
3. DONNER UND BLITZEN						
a. Upper	0	0	0	0	0	0
b. Lower	0	0	0	228	76	228
Total	0	0	0	228	76	228
4. CATLOW-ALVORD						
a. Catlow	0	0	0	1,011	337	1,011
b. Alvord	0	0	0	21,876	7,292	21,876
Total	0	0	0	22,887	7,629	22,887
TOTAL	130	2,737	9,615	49,080	16,360	61,562

Data Source: Oregon State Engineer.

As of March 1967, the 100 ground-water rights in the basin permitted annual legal withdrawal of 61,562 acre-feet. The rights, in increasing order, were for domestic, municipal, industrial, and irrigation uses. The irrigation rights, amounting to about 155 cfs or 49,080 acre-feet, accounted for 80 percent of the total legal withdrawal.

WATER USE & CONTROL



PART III

WATER USE AND CONTROL

WATER USE AND ASSOCIATED PROBLEMS

Domestic

About 1,200 people in rural areas and unincorporated commúnities in the basin depend primarily on ground water for their domestic supplies (household, stock, lawns, and gardens). A small percentage of the rural people have springs, creeks, streams, and lakes as their domestic water source.

Domestic surface water rights total 37.85 cfs for a maximum legal annual depletion of 27,403 acre-feet. The maximum legal annual depletion for domestic ground-water rights is 0.18 cfs or 130 acre-feet. These figures do not include small quantities of domestic water used from ground-water sources where no water right is required.

The domestic water right situation in Harney County is somewhat clouded, because many adjudicated irrigation rights provide reasonable amounts of surface water for domestic or stock watering purposes. During the irrigation season, the water for these domestic purposes is part of the irrigation diversion, but the right to divert water for domestic purposes continues throughout the year.

Most domestic wells draw water from alluvial and other sedimentary deposits. According to a survey by the Home Economics Department of the County Extension Service, the depth of wells varies greatly. In the Burns and Riley areas, there are numerous shallow, domestic wells 10 feet and more in depth and a few wells extending to 500 feet. In the Lawen, Diamond, Princeton, Fields, and Denio areas, domestic well depths range from 18 to 200 feet.

According to the survey, the water sources were tested for purity and, except for one sample, no contamination was found. Only a few of these water systems reported using purifiers. Hard water was the major problem reported in all areas, except around Diamond. The mineralized water stains fixtures, corrodes pipes, creates household washing problems, and affects flavor and color of cooked foods. There is a need for continued testing of numerous shallow wells in the Burns area, where contamination could become a serious problem.

No domestic water shortages were reported. With the present trend to urban living and the installation of group water systems, it is unlikely that future rural domestic water use will greatly exceed that of the present.

Municipal

All municipal systems use wells as a source of water and all anticipate using ground water for additional future needs. The municipal systems of Burns, Hines, Fields, and Seneca serve 5,823 people in 2,573 homes and, in addition, serve 138 commercial establishments according to the Harney County Water Resources Committee's survey.

Municipal ground-water rights for the basin total 3.78 cfs for a maximum allowable depletion of 2,737 acre-feet. Most of the rights are concentrated in the Burns-Hines area.

Burns is the only city in the basin with a water right issued specifically for municipal use. Hines and Seneca obtain their water based on rights that were issued primarily for industrial use and Fields obtains its water based on rights that were issued primarily for domestic use.

Table 19 lists the municipal water systems and the results of the local water resource committee's survey pertaining to supply source and present use.

TABLE 19

PUBLIC WATER SYSTEMS

SYSTEM	WELL DEPTH (Feet)	TREATMENT	POPULATION SERVED	ANNUAL USE Acre-Feet	POTENTIAL SOURCE OF SUPPLY
Burns	251, 252, 304	None	4,003	1,072	Deep wells
Hines	350, 378	None	1,400	Unknown	Wells
Seneca	380	None	400+	Unknown	Wells
Fields	38	None	20	Unknown	Wells

Data Source: Malheur Lake Basin Hearing Record.

The total volume of water used is estimated to be under 2,000 acre-feet. Average annual use for Burns, during the last 5 years, was 1,072 acre-feet (46,688,100 cubic feet). Maximum demand for Burns occurs during July and August with a monthly requirement of 6,161,000 cubic feet and 7,392,100 cubic feet, respectively. Individual system capacities include Burns, 2,600 gpm from three deep wells; Hines, 1,800 gpm from two deep wells; Seneca, 300 gpm; and Fields, 13 gpm. At present, there are no serious problems of seasonal deficiency.

As reported for domestic water supplies, the water generally is hard and causes use problems but no treatment problems. The committee study indicates that the Burns water supply is soft and of high quality. Looking to the future, an increase in water use of 2-3 percent is expected annually.

Industrial

Water rights for industrial uses in the basin amount to 13.28 cfs from ground water and 0.04 cfs from surface sources for a total legal annual depletion of 9,644 acre-feet. The industrial users of water are the agricultural, concrete, and wood processing industries.

The largest single industrial water user is the Edward Hines Lumber Company at Hines. The Ellingson Lumber Company at Seneca uses modest amounts. The agricultural, concrete, and service industries use only small quantities of water. Industrial water use is estimated at not over 5,000 acre-feet annually. Most of this water is returned for reuse.

Ground water is the source of practically all industrial use in the basin. Two large wells drilled at the Hines mill in 1965, with capacities of 1,500 gpm and 1,750 gpm, provide the plant requirements. With completion of the new plywood plant, a third well was drilled for mill usage. No ground-water shortage exists in the vicinity of present industries.

Mining

There is no mining use of water in the basin except for a few prospectors using virtually no water, and several sand and gravel operations that use little or no water. No water quantity or quality problems, therefore, are known to exist and none are anticipated in the near future.

The lone mining water right in the basin was cancelled May 19, 1967. The right was for 5 cfs from Myrtle Creek, a tributary of the Silvies River, for placer operations along Gold Creek in Grant County.

Irrigation

About 94 percent of the surface water in the basin is used for irrigation purposes.

Table 20 lists acreages for which water rights are held and those actually irrigated.

TABLE 20

IRRIGATION DEVELOPMENT
Acres

STUDY AREA	LAND WITH IRRIGATION WATER RIGHTS			LAND UNDER IRRIGATION
	SURFACE WATER	GROUND WATER	TOTAL RIGHTS	
1. SILVIES	147,975	8,162	156,137	124,800
2. SILVER	30,106	493	30,599	26,100
3. DONNER UND BLITZEN	56,777	76	56,853	41,100
4. CATLOW-ALVORD	41,321	7,629	48,950	34,700
TOTAL	276,179	16,360	292,539	226,700

Data Source: Oregon State Engineer
U. S. Dept. of Agriculture's Cooperative Report.

The annual irrigated area in the Malheur Lake Basin averages about 226,700 acres, while water rights have been issued for 292,539 acres. The difference includes land for which there is no water available and land which receives only flood-flows in better water years. Most of the present water rights are not fully satisfied.

Surface water rights for irrigation total about 4,100 cfs for a maximum legal annual depletion of 715,625 acre-feet. The maximum legal annual depletion for ground-water irrigation rights is about 155 cfs or 49,080 acre-feet. If exercised to their maximum legal extent, irrigation rights would divert about 764,705 acre-feet which is more than the average annual usable yield of the basin.

Irrigation studies were inaugurated in 1917, at the Harney Branch Experiment Station. These studies were concerned primarily with the development of adapted crop varieties and rotations. This work has shown that, with irrigation, satisfactory yields of adapted crops can be produced. Alfalfa could be expected to yield three to five tons per acre.

W A T E R U S E A N D C O N T R O L

Results obtained by the Harney Branch Station could be applied only to certain lands in the project area, favored by adequate drainage and ample irrigation water. On ranches where water control exists, comparable yields are often obtained.

In 1946, Dr. W. L. Powers, of Oregon State College, aided in completing a soil classification of 60,000 acres along the lower Silvies River. This work was preliminary, but it gave enough soils information to indicate that agricultural production could be increased by the use of a full season water supply and significant benefits could accrue from flood control measures.

The principal problems, other than the inadequate water supply in the basin, are flood control, conservation, and use of the available water. The streamflow is subject to extreme variations from season to season and year to year. Maximum discharges up to 5,000 cfs have occurred in the March-April flood season on Silvies River, whereas flows have dropped to zero in August and September on most streams. Because of seasonal distribution of streamflow, floodflows must be diverted for early irrigation, even though temperatures are not high enough for optimum growing conditions. Much of the limited values such as seasonal irrigation, diversion, and distribution systems are generally rudimentary and little attempt has been made for refinement of the irrigation system or improvement of natural channels. As a result, flood damages are aggravated by irrigation operations, as well as by lack of adequate natural channel capacity.

Floodwaters inundate up to 20,000 acres of land nearly every spring in Harney Valley and appreciable acreages in other valleys. This prolonged annual flooding prevents production of better types of hay and generally limits the crops to native grasses. It damages buildings, irrigation ditches, levees, roads, fences, and haystacks. Further, during years of high runoff, the prevailing method of wild flooding for irrigation suffocates and destroys both native and improved grasses in the area. Because of the rapid decline in streamflow following the spring floodflows, there is not adequate water available for crops during the optimum growing season.

Hay is now produced on permanent wild meadows that are irrigated from the spring floods, which normally occur in late March, April, or May on the Silvies River. This general condition exists throughout the basin, except for the Donner und Blitzen, where high flows occur later in the season. Little water is available after June 15. Hay yields are low, seldom exceeding one ton per acre. During the years of low runoff, the hay production is often a near failure, except on the most favorably situated lands. It is a common custom to carry over a full season's supply of hay as insurance against a crop failure due to a short water year.

Table 21 shows the irrigated and nonirrigated cropland by crop and study area.

TABLE 21

CROPLAND BY
STUDY AREA AND CROP
1965

CROP	SILVIES	SILVER	DONNER UND BLITZEN	CATLOW ALVORD	TOTAL
Irrigated *					
Small Grains	6,800	1,050	200	850	8,900
Hay and Pasture	108,190	22,850	39,100	30,650	200,790
Alfalfa	9,800	2,200	1,800	3,200	17,000
Potatoes	10	-	-	-	10
Total	124,800	26,100	41,100	34,700	226,700
Non-Irrigated					
Small Grains	12,400	1,700	900	1,700	16,700
Hay and Pasture	400	700	-	2,300	3,400
Grass	12,400	200	1,200	2,100	15,900
Total	25,200	2,600	2,100	6,100	36,000
TOTAL	150,000	28,700	43,200	40,800	262,700

*Land Developed for irrigation.
Data Source: U. S. Dept. of Agriculture's Cooperative Report.

Irrigated lands in the basin, generally, obtain their supplies from floodwater or direct stream diversion, with very little hold-over storage for late-summer irrigation use. Inefficient use of water in many areas causes substantial losses through evaporation and low-value vegetation. Application of most water to hay and pasture crops is made by wild flooding methods.

The Harney County Water Resources Committee described their water-resource problems and needs by basin watersheds. Their stated primary need was for storage of floodwaters to reduce flood damage, supply late-season water, and improve agricultural production. In southern semidesert areas, the interest tended toward determining the ground-water potential for more irrigation development. Harney Valley has a ground-water development potential, which should be more fully determined. The committee has supplied data on problems and needs by areas, as discussed in the following paragraphs.

Silvies Area

Table 22 shows irrigation source and application method.

TABLE 22

IRRIGATION SOURCE AND APPLICATION METHOD
1965

Acres

SOURCE AND APPLICATION	SILVIES	SILVER	DONNER UND BLITZEN	CATLOW-ALVORD	TOTAL
IRRIGATION WATER SOURCE					
Streamflow	122,700	23,900	39,600	24,400	210,600
Storage Reservoir	400	2,100	1,400	3,620	7,520
Ground Water	1,700	100	100	6,680	8,580
Total	124,800	26,100	41,100	34,700	226,700
METHOD OF APPLICATION					
Sprinkler	2,700	0	0	40	2,740
Gravity	122,100	26,100	41,100	34,660	223,960
Total	124,800	26,100	41,100	34,700	226,700

Data Source: U. S. Dept. of Agriculture's Cooperative Report.

The upper Silvies area has six damsites, including alternates, with a total capacity of about 353,800 acre-feet (Table 23). There are 18,000 irrigated acres, which would be benefited greatly by supplemental water supplies. There are 9,800 acres of additional land, which could be irrigated if water were available. Water should be transferred from 2,510 acres of alkali land to potentially productive brushland.

None of the acreage has a full water supply, 13,363 acres has a moderate shortage, and 7,280 acres a severe shortage.

W A T E R U S E A N D C O N T R O L

The average yield of hay is three-fourths of a ton per acre, but with full development it could be two and one-half tons. More water for irrigated pastures would show an increase of 21,962 cow months of grazing. Proposed water storage and related developments could increase gross income by about 1.5 million dollars. The Water Resources Committee reported a potential for similar economic and financial improvements for the other basin areas.

Ten reservoir sites including alternates (Table 23) have been located in the lower Silvies area on the following: Willow, Poison, Coffeepot, Cow, Prater, and Rattlesnake Creeks and Mortimer Canyon. These reservoirs would store about 77,500 acre-feet of water. The committee recommends that further consideration be given to the construction of one large reservoir on Silvies River or a series of smaller reservoirs for the storage of runoff water for later, more timely irrigation, and flood control. Critically needed are an improved channel, distribution system, and drainage.

Answering a committee questionnaire, 37 of 40 reporting ranchers were interested in having their spring floodwater stored for more timely use, three were opposed to storage and five were opposed to use of some of this water for fish and wildlife enhancement.

The committee recommended that final adjudication of water rights be made by the State Engineer and that a study be made to update the present ground-water information. The survey is needed due to the increased use of irrigation wells and the attendant problems, which are developing on ground-water quantity and quality.

The best irrigable soils are located along the flood plain of the branches of Silvies River and Foley Slough. The soil type is predominantly silt loam 4 to 6 feet in depth underlain by sandy materials and a high water table.

Silver Area

In the Silver Creek area, three reservoir sites with a capacity of about 49,500 acre-feet have been located (Table 23).

A survey indicated that 8 of 13 ranchers would be willing to have a reasonable portion of their stored water used for fish and wildlife enhancement if warranted in project justification.

WATER USE AND CONTROL

The greatest problem is flooding which occurs frequently in the Silver Creek Valley in February, March, and April. This results in considerable damage to the channels, irrigation systems, and fields, plus the loss of irrigation water which could be more efficiently used during the growing season of May, June, and July.

Eight of 13 landowners surveyed reported irrigation system improvements needed in the following order: headgate repair, canal improvement, diversion dam repair, dike repair, and channel improvement.

Donner und Blitzen Area

The Donner und Blitzen area is discussed under the wildlife section because the Malheur Wildlife Refuge controls most of the irrigated land.

Within this study area, are the Virginia Valley and Riddle Creek areas which were considered by committee members. These combined areas have about 4,000 acres irrigated from surface water and 1,155 acres irrigated from ground water. Ranchers have constructed the Barton Lake and Smyth Reservoirs with a total capacity of 7,660 acre-feet. Thirteen wells drilled to depths of 40 to 300 feet supply both primary and supplemental water. Four of these wells showed either high boron or sodium carbonate, which limits their use potential.

More land could be made productive if irrigation water were available. With ground water as the only appreciable source for expansion, the quantity and quality available needs to be determined. Storage and flood control should be considered at the Lambing Canyon and Paul Creek sites and by enlarging Smyth Creek Reservoir. Consideration was given to a 120,000 acre-foot capacity reservoir site on the Donner und Blitzen River and for enlarging the Krumbo Reservoir. Four of five ranchers, reporting through the survey, indicate they are interested in storing spring floodwater for more timely use. The fifth rancher presently has a storage reservoir.

Survey data indicate that the greatest problem is the lack of late-season water and the next most serious problem is the lack of knowledge about ground water as related to future development.

WATER USE AND CONTROL

Catlow-Alvord Area

The vast Catlow-Alvord area was divided by the committee into water use areas for discussion purposes.

The Juniper, Mann, and Alvord Lakes areas immediately east of Steens Mountain have a variety of streams, lakes, and ground-water sources. The present irrigated area is about 9,800 acres, while the potentially irrigable land ranges upward from 5,000 acres depending upon ground-water availability. Two small reservoir sites, which have been studied, are located on Squaw and Little McCoy Creeks. Typical problems include water shortages, flood damage, and need for distribution system improvements.

The Whitehorse and Trout Creek areas in the southeastern portion of the basin have about 9,400 irrigated acres using stream and ground-water sources. Potential reservoir sites are under consideration on Willow and Trout Creeks. The Whitehorse area obtains a fairly adequate supplemental water supply from four wells with a total capacity of 27 cfs. Along Trout Creek, about 20 percent of the land has a full water supply, 30 percent has moderate shortages, and 50 percent has floodwater rights only.

The Catlow area in the southwestern portion of the basin has about 7,900 acres irrigated annually and 18,500 acres irrigated occasionally from streams and ground-water sources. There are 10 reservoirs in the area with a total capacity of 10,500 acre-feet. In addition, the Bureau of Land Management has developed 71 stock water ponds. One reservoir site is being considered at V Lake southeast of Blitzen. Future water resource developments will depend upon a proposed ground-water study or possible importation of water from outside sources.

Power

An adjudicated 1904 water right, of 29 cfs for power, on the Silvies River near Seneca, is not being utilized at the present time.

The physical and economic potential for hydroelectric power development is limited and practical use of water for this purpose is decreasing. Good undeveloped power sites within the basin have not been located and power presently can be obtained economically from sources outside the basin.

Fish Life

There are no water rights for fish life in the basin.

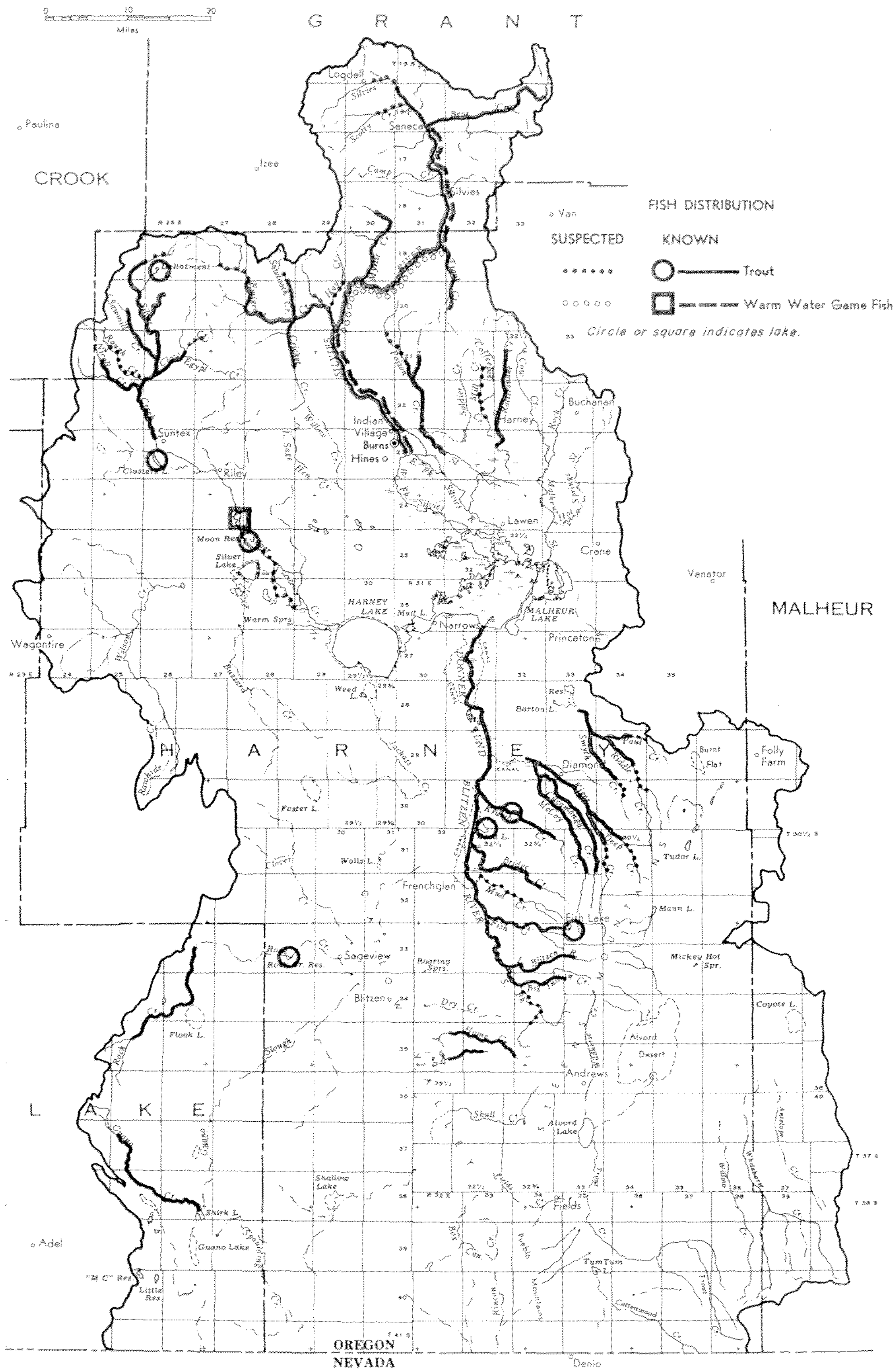
According to the Oregon State Game Commission, the quantities and distribution of resident trout and warm-water game fish populations are the highest in those streams and impoundments maintaining the most favorable perennial water quality and quantity conditions. The upper Silvies River, upper Silver Creek, Donner und Blitzen River, and Trout Creek have the highest trout populations. The best trout angling impoundments are Delintment and Fish Lakes; Chickahominy, Krumbo, Miller, Moon, and Rock Creek Reservoirs; and Burns Gravel Pond. Rainbow comprise the bulk of existing trout populations.

Bluegill and pumpkinseed sunfish, bullhead catfish, white crappie, and yellow perch are the warm-water game fish most plentiful in the Silvies River. Carp formerly were abundant in lower Silvies River and Malheur Lake, but they were controlled by rotenone treatments. Several types of rough fish, predominantly suckers, carp, roach, chisel-mouth, shiners, and squawfish, are scattered throughout most of the basin.

The quantity and quality of much of the available water in the basin often is not desirable for the enhancement of the fish life resources. Unlike most of Oregon's basins, this basin consists of drainages, some of which do not have a common destination. Streamflow originates in mountainous areas, flows a relatively short distance, and terminates in a lake, usually with no visable outlet. Heavy spring runoff and low summer flow are characteristics of the streams. In low water years, irrigation commonly reduces streams to small trickles before they reach the lakes and the lakes in turn become low or dry. The principal habitat for the establishment and maintenance of a fishery is in the high lakes, manmade reservoirs, and headwaters of streams.

Each of the four basin areas have enough water to support small populations of fish on a put-and-take basis. Most of these fish are stocked in the spring because many streams become very low and too warm for trout survival late in the season. Many of the small lakes, ponds, and manmade reservoirs are sufficiently rich in food to rear fingerling trout to legal size within a few months.

Figure 18 shows the distribution of game fish in the basin.



DATA SOURCE: Oregon State Game Commission

FIGURE 18. Fish Distribution.

Anadromous fish are not present as this interior basin is naturally isolated from the ocean.

Wildlife

There are 203.19 cfs of adjudicated water rights and a permit right (Sodhouse Spring) of 15 cfs for wildlife mainly in the Malheur Lake area. The largest right is for 200 cfs from the Blitzen River with a priority date of 1908 for the purpose of providing waterfowl breeding and nesting habitat on the fringes of Malheur and Harney Lakes. There are no wildlife water rights in the Silvies River or Silver Creek watersheds.

Springs, streams, and impoundments furnish fairly well-distributed water supplies for the high mountain areas, but lack of full-season water often limits wildlife use in the central and southern semidesert portions of the basin.

According to the Oregon State Game Commission, the Malheur Lake Basin lies in the center of that portion of the state where water supplies for game are the most limited. The basin's hunter-based recreational activity includes 2 percent of the state's deer, quail and pheasant hunting; 15 percent of the chukar partridge hunting; 25 percent of the pronghorn antelope hunting; and over 50 percent of the sage grouse hunting. There is limited elk hunting and an annual fur pelt harvest valued around $3,000.

The Malheur Refuge and vicinity is nationally recognized as an outstanding area for bird watching and wildlife photography.

Responsibility for waterfowl management is divided between the Federal Government, which has primary responsibility for managing the resource by reason of treaty obligations with Canada and Mexico, and the State of Oregon, which aids in maintaining habitat and law enforcement.

The Bureau of Sport Fisheries and Wildlife's 180,850-acre Malheur National Wildlife Refuge hosts one of the largest concentrations of migrating waterfowl in the state. In the last ten years, about one-half million migratory waterfowl have stopped to rest and feed on the refuge and elsewhere in the basin. Thousands of them stay to breed in the marshlands and along ditches and drains during the spring migrations. That segment of the Pacific Flyway which uses the basin is supported at a reasonably stable level by the areas of open water marsh, hay, and grainland.

FIGURE 19. Waterfowl Production and Maximum Area Surface of Malheur Lake.

Figure 19 compares waterfowl production and water surface acres of Malheur Lake for the period of record between 1957 and 1965. No relationship appears to exist between summer production and available water surface areas. It would appear that other physical, climatic, or biological factors have a greater influence on birdlife reproduction than does the water level factor for Malheur Lake exclusively.

Lands outside the refuge which are used include principally the hay meadows irrigated by the Silvies River and tributaries. Such use is heavy during the spring migration, particularly by mallard and pintail ducks and snow, Ross', and Canada geese and sandhill cranes.

Over 240 species of birds have been seen on this refuge. It is one of the most important nesting areas in the country for the greater sandhill crane. It is one of several sites selected for re-establishment of nesting populations of the rare Trumpeter swan. The refuge is the only place in the state where several species nest, including the horned grebe, Franklin's gull, and white-faced ibis. Malheur Lake contains the largest breeding colonies in the state of a number of colonial nesting birds, including eared and western grebes, blackcrowned night herons, common and snowy egrets, Forster's terns, and black terns. Other interesting nesting species, with specialized habitat requirements, include the white pelican, bitterns, sora, Virginia rail, snowy plover, long-billed curlew, willet, American avocet, black-necked stilt, Wilson's phalarope, and Caspian tern.

More abundant migratory waterfowl species include the scaup, mallard, gadwall, pintail, widgeon, shoveler, redhead, canvasback, golden-eye, and ruddy ducks and green-winged, blue-winged, and cinnamon teal, as well as the following: whistling swan, Canada, white-fronted, snow and Ross' geese.

Figure 20 compares the water surface area of Malheur Lake with the fall migration dates (circles). This graphic

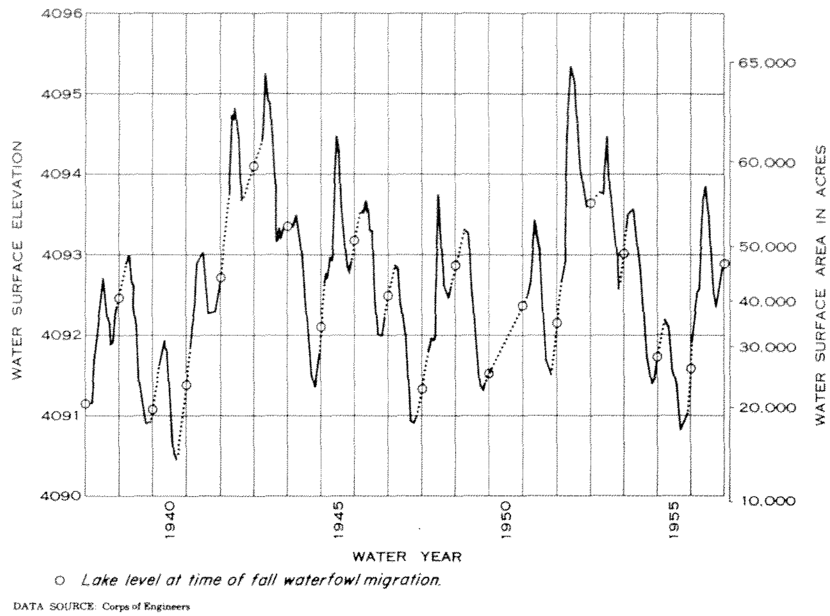


FIGURE 20. Malheur Lake Surface Area and Fall Waterfowl Migration Dates.

indicates that the flights arrive when lake levels frequently are near their low points.

The utilization of Malheur Lake and surrounding areas for waterfowl production is equal in importance to migration use in overall refuge and flyway management plans. Of similar importance, is the habitat provided for nongame species which are of great interest to a large segment of the public.

Malheur Lake and the Blitzen Valley gained early recognition for the habitat they provided for waterfowl and other wildlife. Unlike most of the marshlands of the United States, Malheur Lake has remained relatively untouched by man. Nearly all species, which were recorded in historical records, have remained. The early recognition given to Malheur Lake by explorers and early day naturalists led to the establishment in 1908 of Malheur and Harney Lakes as one of the first national wildlife refuges. Several additions have been made since, including a major portion of the Blitzen Valley, lower Silver Creek, and fringe areas around Malheur Lake. Reclamation of these privately owned marsh areas was in the initial stages at the time of purchase.

Development projects, undertaken by the Bureau of Sport Fisheries and Wildlife since acquisition, have been directed toward the extension and improvement of waterfowl habitat. To date, use and control of water has been pointed toward improved waterfowl management and does not compare with strictly reclamation developments over the west.

A preliminary study of potential developments within the refuge, entitled "Report on the Water Rights, Water Supply, Water Distribution and Water Use of the Malheur National Wildlife Refuge, Oregon," was prepared by the Bureau of Sport Fisheries and Wildlife, dated September 1962. The report pointed out major water problems by management units and proposed various ditching, diking, drainage, structural, and management improvements that were needed. Minor implementation of these plans has been undertaken as funds have become available.

Documented problems of the watersheds included inadequacy of watershed storage sites; inadequate control of floodwaters; shortage of late-season water; need for more adequate control and distribution structures; need to drain and rehabilitate large cattail and tule areas; advisability for dividing the uncontrolled Malheur Lake into smaller, manageable, and more attractive waterfowl units; low-priority water rights in the lower Silver Valley; and a water regimen in the form of either a "feast-or-famine" type of delivery.

Technicians conducted studies which showed that, in September 1965, alkalinity of Malheur Lake water ranged from moderately saline (pH 7.9) in the west and center sections to alkaline (pH 8.6) in the eastern restricted section behind Cole Island dike. Alkalinity apparently varies considerably between high and low-water years and seasons. A flushing action is of great importance in maintaining a favorable water chemistry in Malheur Lake for the development of desirable aquatic plants and invertebrates. Proposals for subdividing the lake must take into account these delicate salt balances.

WATER USE AND CONTROL

Malheur Lake covers an average area of about 46,000 acres. The water is highly productive of aquatic food plants, such as sago pondweed, which is a prime food for waterfowl, especially diving ducks and whistling swans. These aquatic plants supply about 80 percent of the diet of all species during migration periods. The marsh area provides cover for nesting birds, part of the food requirements for some species, and protection from predators.

Malheur Lake is the heart of the refuge waterfowl habitat and comprises the principal area of waterfowl use in the basin. It is a vast, shallow marsh interspersed with open water areas, separated by stands of emergent vegetation, and surrounded by extensive meadows. Its average depth is less than 3 feet, during most years, but varies from 0 to 6 feet or more. A slight reduction in water level results in a large decrease in surface area.

Harney Lake is the ultimate sump for Harney Basin. Having no outlet, its water is extremely alkaline. This high alkalinity, combined with frequent periods of desiccation, prevents the establishment of aquatic vegetation. When Harney Lake is not a dry, alkali lakebed, it is either a mud flat or open water. Occasionally, following periods of desiccation, its waters support populations of invertebrates, which are utilized by waterfowl.

About one-half of the refuge agricultural land is in irrigated native meadows providing favorable habitat for nesting waterfowl and other wild birds. Hay and pasture are by-products of these meadows during the fall and winter. Small areas are devoted to grain, while fairly large areas produce brush and marsh vegetation. The hay and grainlands provide food supply for geese, sandhill cranes, and field feeding species of ducks during the fall and spring migrations.

Pursuant to provisions of the Wilderness Act of September 3, 1964, the U. S. Bureau of Sport Fisheries and Wildlife started hearings on April 12, 1967 to determine the desirability of including 42,000 acres of the Poker Jim Ridge and Fort Warner study areas, which are located within the Hart Mountain National Antelope Refuge, into the National Wilderness Preservation System. This plan will have no material influence on the basin's water resources or their use.

Pursuant to the above provisions, hearings were started on May 2, 1967 for the purpose of developing information with respect to the desirability of including lake portions of the Malheur Lake Wildlife Refuge in the National Wilderness Preservation System. Inclusion of this plan may have a material influence on the basin's water resources by producing a status quo and preventing the optimum utilization of this valuable water resource.

Water rights on about 20,000 acres of refuge lands in Blitzen Valley are being used for a somewhat different purpose than originally authorized by the State Engineer's permits. Prior to 1935, these rights had been granted to individual ranchers and land companies with quantity of water, priorities, use, and distribution defined as follows:

> The quantity of water shall not exceed 1/40 of a cubic foot per second per acre of land irrigated prior to June 15, and not to exceed 1/80 cfs per acre of land irrigated after June 15 of each year, with the total limitation during each irrigation season not to exceed 3 acre-feet per acre.
>
> The rights to use water for irrigation purposes are appurtenant to the land so described and the priorities so confirmed, confer no right to the use of water on any lands other than the specified tracts set forth as appurtenant, and every user is prohibited from using water on other lands without lawful approval of the State Engineer ---.

Documented refuge water-use management primarily is confined to maintaining waterfowl impoundments and irrigation of meadows and grainfields. "The existing natural channels are filled and maintained with irrigation waste water and provide excellent natural nesting and brooding sites for the grassland species of waterfowl. Waterfowl habitat receives top priority for all late summer and fall water. The available water during this period is diverted to more attractive waterfowl use and brooding areas. When water is available in the early fall, it is used to flood the grainfields for use by local and migrant birds." (Source: U. S. Bureau of Sport Fisheries and Wildlife report on Water Rights, Water Supply, Water Distribution and Water Use of the Malheur National Wildlife Refuge, Oregon, dated September 1962.)

Inspection of water-right records indicates that about one-half of the water use in Blitzen Valley is for purposes other than that originally intended in the water-right decrees. On the basis of rights, about one-half the average annual yield of the Donner und Blitzen River or about 90,000 acre-feet are apparently available for augmenting flows to Malheur Lake. Some irrigation rights are being used for ponding of water for wildlife purposes on different lands than authorized by permit. Such activities should be covered by storage rights to meet state requirements.

WATER CONTROL

Flood Control

Flood problems are generally serious only in the heavily populated portions of Harney Valley because flooding is generally encouraged in basin valleys as a means of increasing crop production. Flood problems are caused by both natural factors and human management of land.

Man has greatly intensified flooding problems in some areas, while he has controlled floodflows in other areas. The main source of floodwater is spring snowmelt, although other causes such as rainfall augmented by snowmelt and thunderstorms result in occasional flooding. Floods are most likely to occur in March, April, and May, and frequently when the ground is still frozen. Agricultural land along the main rivers and tributary streams is subject to overflow during high-runoff periods.

Approximately 50,000 acres of land are flooded annually to varying degrees; the largest portion of this acreage is cropland. Crop damage is minimized because a large percentage of the land is in sod-forming crops. Manmade structures, some towns, roads, and farmsteads are often damaged by floods.

According to studies made by the U. S. Corps of Engineers in 1957, major floods have occurred in the city of Burns and its suburban areas. This report states that the average annual flood damage for the lower Silvies River is estimated at $154,000. Of this amount, about 83 percent is agricultural, 10 percent is urban, and 7 percent is unclassified.

Concurrent with the present basin study, the State Water Resources Board is conducting a flood plain identification study to determine methods of controlling floodwaters that originate on hillside areas west of Burns. The studies include photogrammetry of the area along with plans for channel and structural controls.

Drainage

According to the U. S. Department of Agriculture's cooperative studies, the present system of wild flood irrigation causes a critical drainage problem in portions of the basin. The elimination of prolonged flooding is frequently a prerequisite for effective drainage.

Estimates show that approximately 121,000 acres, or about one-third of the irrigable soils have a major wetness problem. Wet soils have been either drained to a degree necessary for the crops being grown or are used for pasturing where the drainage problem is not as critical as for cultivated crops. An estimated 75,300 acres, or about 62 percent of the excessively wet soils, need to be drained under present use.

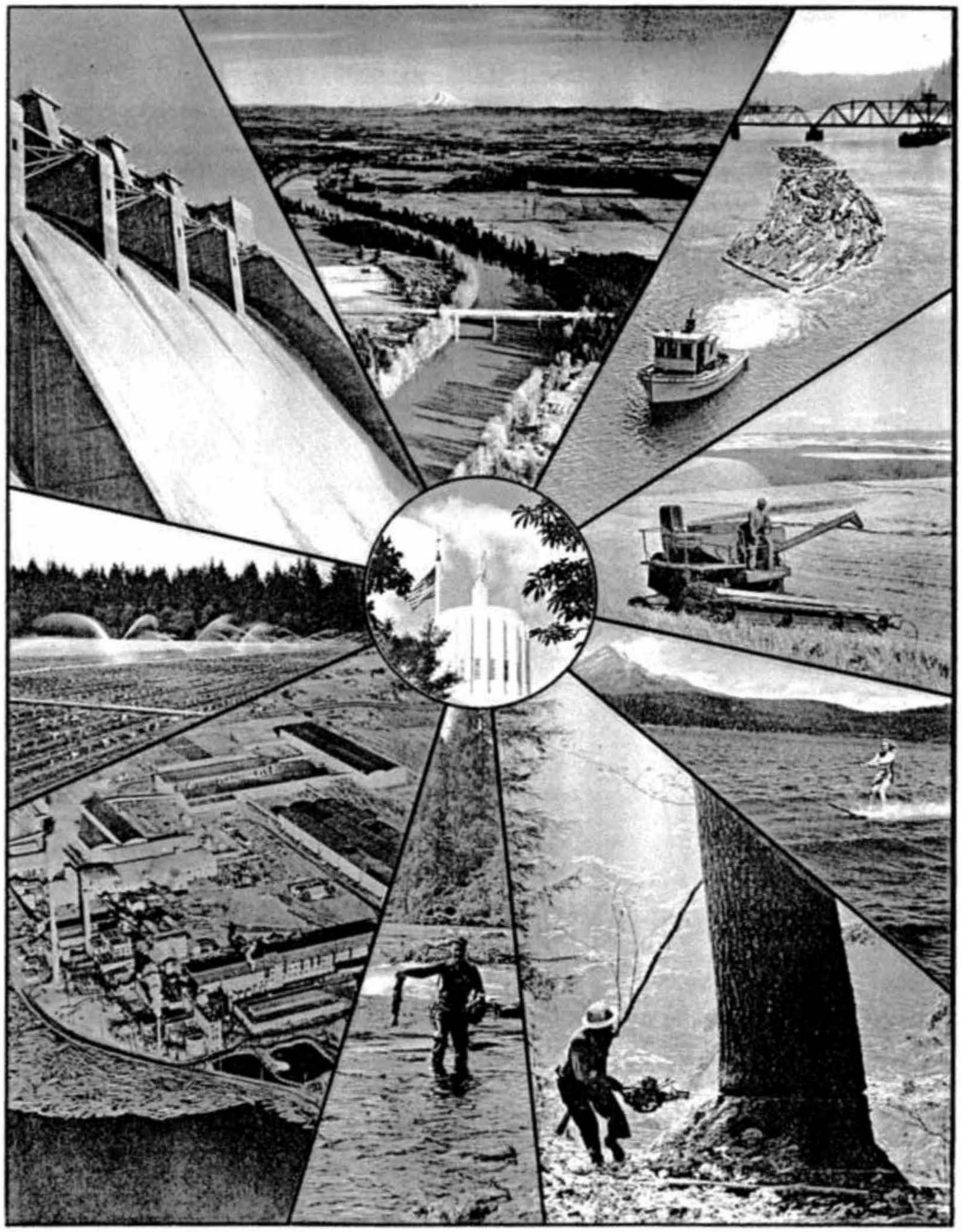
Phreatophytes are heavy water-use plants that thrive in wet soils along the stream systems and contribute appreciably to water losses in the basin.

Erosion

Surveys indicate that 650,000 acres of arable or potentially arable land have a predominant problem of erosion. Erosion, a more serious problem on rangeland than on cropland, primarily is due to low precipitation and a resultant inadequate range vegetative cover for the soil. Overgrazing on the steeper land, also, is a serious problem, which subjects the land to both water and wind erosion.

Considerable land is lost through streambank erosion. Damage usually is more severe in the high-velocity portions of the streams. However, a lesser problem exists in the slow, meandering portions of the streams. Gully erosion is prevalent in the steeper reaches of the watersheds of the basin where deep soils exist. Sediment deposition in irrigation structures, canals, road culverts, and reservoirs has been damaging and is expensive to control.

POTENTIAL DEVELOPMENT



PART IV

POTENTIAL DEVELOPMENT

General

This section presents features of plans that would be required for maximum control, development, conservation, and utilization of the water resources of the Malheur Lake Basin. It outlines a comprehensive plan for utilization of water resources for domestic, municipal, irrigation, wildlife, recreation, flood control, and other uses but does not contain adequate detail to direct construction activities.

Studies indicate that the surface water resources development potential of the Malheur Lake Basin is limited to storing available supplies for more timely use and making more effective use of the available water. The development potential from ground-water sources is appreciable, but the limits of this potential cannot be determined without further detailed studies. Determining the location and extent of large ground-water bodies in the basin is a high-priority need.

A water budget, based on precipitation runoff correlations and consumptive-use factors, shows that over 365,000 acre-feet (Table 11) of water is lost annually by evapotranspiration to poor quality desert shrub vegetation, inferior quality marsh plants, and by evaporation from low-value water surfaces. Harney and numerous other shallow basin lakes are examples of valuable water lost through evaporation. Such water could be used more advantageously for beneficial uses as domestic, municipal, industrial, irrigation, recreation, fish life, and wildlife purposes. The basin economy could probably be strengthened at least one-third by higher beneficial use of available water resources.

An ultimate needs study, not analyzed here, includes an extensive potential development from use of imported water.

If maximum beneficial use of the water resource is to be achieved, compromises will be necessary. Compatibility requires that development in any one area must be related to developments in other areas. The interrelationship between all beneficial uses of water must be determined so that all interests will receive adequate consideration in project planning and development.

The Harney County Water Resources Committee stated that their primary need was for storage of floodwaters to reduce flood damage, supply late-season water, and improve agricultural production. The committee gave high priority to determining ground-water availability in Harney, Catlow, and Alvord Valleys.

Water resources development factors to be considered include provision for adequate storage, diversion and transmission facilities, control of the quantity and quality of surface return flows for reuse, maximum utilization and protection of ground-water supplies, improvement in methods of control and application, and the desire and economic ability of water users to develop the existing potential.

Table 23 presents data on 23 reservoir sites, including alternates, for storage of the spring runoff. Included in the

TABLE 23

MALHEUR LAKE BASIN
POTENTIAL WATER DEVELOPMENT PROJECTS
DAM AND RESERVOIR SITES

STUDY AREA AND STREAM	MAP INDEX NO.	LOCATION Twp.	Rng.	Sec.	DRAINAGE AREA Acres	AVERAGE ANNUAL YIELD Ac-ft	PURPOSE	DAM HEIGHT Feet	CREST LENGTH Feet	RESERVOIR POOL ELEV. Ft-MSL	POOL AREA Acres	TOTAL STORAGE Ac-ft	SOURCE NO.
1. SILVIES													
a. Upper													
Jack Cr.	1	16S	30E	14	3,200	500	I,R	19	800	-	90	500	1
Silvies R.	2	19S	31E	14	-	-	I,F,R,S	55	350	-	5,500	100,000	2
Bear Canyon Cr.	3	20S	27E	3/10	4,700	900	R	45	500	5320	80	1,300	1
Emigrant Cr. (Alternate)	4	20S	28E	35	66,200	12,400	I,F,R	115	780	4563	800	22,000	1
Emigrant Cr.	5	20S	29E	30/31	115,200	21,600	I,F,R	85	400	4550	1,500	40,000	1&2
Silvies R.	6	21S	29E	2	576,000	109,800	I,F,R,S	147	1,700	-	3,200	190,000	3
b. Lower													
Dry Cr.	7	20S	30E	35	10,400	1,600	I,F,R	45	700	-	190	3,000	1
Poison Cr. (Alternate)	8	21S	31E	18	20,400	3,200	I,F,R	105	700	-	150	6,000	1
Poison Cr.	9	21S	31E	29	24,500	3,800	I,F,R	75	600	-	90	2,600	1
Prater Cr.	10	22S	31E	24	9,300	900	I,F,R	65	500	-	105	2,500	1
Coffeepot Cr.	11	22S	32E	14	8,300	1,400	I,F,R	115	1,150	-	130	5,700	1
Rattlesnake Cr. (Alt.)	12	22S	32 1/2E	8	9,600	1,600	I,F,R	65	400	-	70	1,600	1
Rattlesnake Cr.	13	22S	32 1/2E	18	9,700	1,700	I,F,R	185	1,500	-	440	31,300	1
Cow Cr.	14	22S	32 1/2E	10	16,600	2,600	I,F,R	85	1,300	-	260	8,300	1
Mortimer Can.	15	22S	32 1/2E	21	2,800	500	I,F,R	125	1,600	-	250	12,000	1
Willow Cr.	16	23S	29E	25	23,700	3,700	I,F,R	85	300	-	140	4,500	1
2. SILVER													
a. Upper													
Silver Cr.	17	20S	26E	31	46,300	9,300	R	40	300	4880	140	2,000	1
Claw Cr.	18	21S	26E	22	48,000	7,500	I,F,R	75	-	-	-	7,500	1
Silver Cr.	19	22S	26E	6	166,400	33,500	I,F,R	77	360	-	1,300	40,000	2
3. DONNER UND BLITZEN													
a. Upper													
Donner und Blitzen R.	20	34S	32 3/4E	7	52,000	20,300	I,F,R	157	955	-	201	9,660	1
Donner und Blitzen R.	21	30S	31E	15	-	-	I,F,R	37	1,000	-	9,000	120,000	2
4. CATLOW-ALVORD													
a. Catlow													
Kuney Can.	22	33S	32E	14/23	6,000	600	I,R	27	500	5012	72	900	1
b. Alvord													
Trout Cr.	23	39S	36E	24/25	44,200	9,000	I,F,R	-	-	-	-	10,000	1

Note: Includes damsites with conflicting reservoir areas.

Purpose: F - Flood Protection
I - Irrigation
R - Recreation
S - Water Supply

Source No: 1 - U. S. Soil Conservation Service
2 - U. S. Bureau of Reclamation
3 - U. S. Corps of Engineers

Data Source: U. S. Dept. of Agriculture's Cooperative Report.

table are damsites with conflicting reservoir areas.

POTENTIAL DEVELOPMENT

The minimum, maximum, and average yield of principal streams in the basin are listed in Table 10. To obtain the maximum storage potential, the yields of lesser streams were included where they could help serve proposed developments. As shown in Table 10 and other sources, annual storable surface water averages about 700,000 acre-feet, but usable quantities in dry years are closer to one-third that amount, Table 11.

Data supplied in transcripts of hearings, before the U. S. Corps of Engineers and the State Water Resources Board, reflected the excessive waste of the basin's water resources and need for the concerted effort of the involved individuals and groups to utilize more fully this valuable water resource. Responsibility for these wastes rests equally among the individuals and agencies using this water.

A present conflict of interest exists mainly between agricultural and wildlife uses, but these problems can be greatly reduced, and hopefully eliminated, by adhering closely to the water laws of Oregon and to water right priorities, which presently exist for the use of all surface water supplies available in the basin.

Complications imposed by county, state, and federal rules and regulations has made the solving of the complex water problems even more difficult. Major complications include the 160-acre irrigation limitation, complicated court decisions, private agreements, overappropriation of water, conflicts in water use, lack of structural controls, and limited productivity. Clarification of important legal and technical problems should assist in finding the solution to obtaining the maximum development potential.

Although detailed studies are needed in order to locate more ground-water aquifers and identify their characteristics, analysis of available data and evaluation of the relationship between precipitation, runoff, and consumptive use by existing ground cover lends weight to the conclusion that there is sufficient ground water, when used in conjunction with surface water, to provide some new development and provide supplemental supplies for better lands in several areas. The economic and physical feasibility of developing both ground and surface water should be determined concurrently in each area.

Because of the relatively small quantity (under 6 percent) of water required to meet anticipated needs for domestic, municipal, and industrial purposes, it is assumed that, in most cases, little difficulty will be encountered in securing adequate supplies. Practically all municipal water is derived from ground-water sources where neither a quantity nor quality problem exists. For these reasons, the following discussion of the potential development by study area will deal primarily with the dominant water requirement uses, irrigation and wildlife. For the Silvies and upper Silver areas, irrigation claims the dominant early rights, but on Donner und Blitzen and the Malheur and Harney Lakes area these rights are shared with wildlife uses.

Table 24 shows the natural average annual yield versus legal water rights for the streams draining into Harney Lake.

TABLE 24

USABLE YIELD VS LEGAL RIGHTS
Acre-feet

STUDY AREA	LEGAL RIGHTS	USABLE YIELD	SHORTAGE	PERCENT SHORTAGE
1. SILVIES	385,300	225,000	160,300	42
2. SILVER	84,300	58,000	26,300	31
3. DONNER UND BLITZEN	328,700	145,000	183,700	56
TOTAL	798,300	428,000	370,300	46

Data Source: Oregon State Engineer.

The table shows the usable average annual yield is about 437,000 acre-feet, while the legal rights to use this water is nearly 800,000 acre-feet.

Recorded legal rights to the use of the basin's surface water is the dominant factor in determining the development potential. All surface water rights are overappropriated to the point that users must subjugate their individual rights to allow for group storage or development.

Since legal rights are almost double the usable water yield, surface water is not available for additional developments or for supporting any appreciable changes in water use. The only opportunities that exist are for adoption of structural controls and distribution facilities by present water users for better utilization of limited available supplies. This water-right factor and priority of right will be fully analyzed by study area.

The present average annual runoff to Harney and Malheur Lakes is shown in Table 11 as 190,000 acre-feet. The runoff to the lakes is computed at 117,000 acre-feet after the potentially irrigable lands have been developed. This is a difference of 83,000 acre-feet of average annual runoff.

Table 25 lists the components of the 490,000 acre-feet of

TABLE 25

ESTIMATED FUTURE
DIVERSION REQUIREMENTS

STUDY AREA	USABLE YIELD	PRESENT		POTENTIAL		
		IRRIGATED LAND	ADDITIONAL WATER REQUIREMENTS	POTENTIALLY IRRIGABLE LAND	WATER REQUIREMENTS	RUNOFF
	Ac-ft	Acres	Ac-ft	Acres	Ac-ft	Ac-ft
1. SILVIES						
a. Upper	167,000	26,300	27,000	7,600	16,700	
b. Lower	58,000	98,500	124,700	20,300	44,700	
Total	225,000	124,800	151,700	27,900	61,400	12,300
2. SILVER						
a. Upper	41,000	9,800	11,600	200	400	
b. Lower	17,000	16,300	29,900	2,900	6,400	
Total	58,000	26,100	41,500	3,100	6,800	9,700
3. DONNER UND BLITZEN						
a. Upper	106,000	8,100	5,800	200	400	
b. Lower	48,000	33,000	51,600	500	1,000	
Total	154,000	41,100	57,400	700	1,400	95,000
TOTAL	437,000	192,000	250,000	31,700	69,400	117,000
4. CATLOW-ALVORD						
a. Catlow	100,000	9,400	9,000	23,900	65,000	
b. Alvord	170,000	25,300	26,000	21,500	70,000	
Total	270,000	34,700	35,000	45,400	135,000	100,000

Data Source: U. S. Dept. of Agriculture's Cooperative Report.

irrigation storage and ground-water withdrawal requirements; first, to supply supplemental needs to presently irrigated land; and second, to meet needs of potentially irrigable land. Irrigation requirements will equal over 90 percent of the so-called consumptive needs which include domestic, municipal, industrial, and irrigation. Refuge requirements for irrigation and wildlife are closely interrelated and must be so considered, based on their dates of priority.

Table 25 is based primarily on the lower Silvies needs with conditions varied somewhat upward for proposed developments outside the Harney Valley area. Harney Valley water duty involves consideration of the conditions of water use, climate, and cropping pattern. A further condition which must be considered for much of the area is the somewhat unique fact that ground water is near enough to the surface to aid plant growth by capillary rise to a height within the reach of plant roots. The storage requirement is based on 3 acre-feet per irrigated acre requiring supplemental water. The net diversion requirement would be about 2.2 acre-feet when return flows are included in the computations.

Quantities of water used and available in the Catlow-Alvord study area are estimates only. Considerably more geological investigations on ground-water occurrence, recharge, movement, discharge, quantity, and utilization will be required before the development potential can be determined in this area.

Supplemental crop irrigation requirements are based on an average requirement of 1.0 acre-feet per presently irrigated acre. The actual requirement on different farms will vary from under one-half acre-foot to over 1.5 acre-feet due to differences in water rights, distribution facilities, soil characteristics, and crops grown. Ground-water withdrawal is based on pumping 2.2 acre-feet per irrigable acre for potentially irrigable lands and on 1.0 acre-feet for supplemental irrigation purposes.

These low consumptive-use figures are predicated upon constructing lined canals and laterals through porous soil areas, developing more efficient water distribution facilities, and conserving waste water by reuse. When comparing crop yield with available surface water supplies, it would appear that irrigated crops grown on the Silvies River flood plain normally receive between one-half to one acre-foot per acre of their needs from ground water.

Silvies Area

The existence of legal water rights is the dominant factor of determining the potential development of the Silvies area and in avoiding conflicts of interest in this development. Oregon Revised Statutes 593.010 (7) states:

> "All rights granted or declared by the Water Right Act shall be adjudicated and determined in the manner and by the tribunals provided therein. The Water Rights Act

> shall not be held to bestow upon any person any riparian rights where no such rights existed prior to February 24, 1909."

The State Engineer was asked to analyze the Bureau of Sport Fisheries and Wildlife's statement of January 19, 1966 to the State Water Resources Board, concerning the bureau's rights to Silvies River water. Quoted from the State Engineer's letter of February 25, 1966 are the following relevant statements:

> "The relative rights to the use of the Silvies River and its tributaries have been adjudicated and the only valid claims existing by right of use are those that were determined in the decree. Any use that existed and on which the owner failed to make a claim in that proceedings is by the terms of the decree barred and stopped from asserting any claim at this time. The circuit court decree on Silvies River was entered August 11, 1923, some 14 years after the refuge was created. If the refuge had any valid claims, it would have asserted it in this decree.
>
> "The Bureau of Sports Fisheries and Wildlife has no water rights to be interfered with and as stated above, the adjudications have already been made and the rights determined. They are, therefore, res judicata and for any rights sought at this date either for the proposed storage or for a claim, the Bureau of Sports Fisheries and Wildlife would have to make application for the State Engineer's permit."

As shown in Table 13 and the accompanying statements, the Silvies area which includes the Silvies River, its tributaries, and streams which flow directly into Harney Valley, has legal surface water rights as follows: domestic, 24.12 cfs; irrigation, 2,002.12 cfs; power, 29.00 cfs; industrial, 0.04 cfs; mining, 5.00 cfs; and recreation, 0.12 cfs; for a total of 2,060.40 cfs. As shown in Figure 13, the natural average annual water yield (before consumptive use) of the Silvies area is 225,000 acre-feet, while the legal rights to use of this water amount to 385,000 acre-feet. These figures confirm the fact that all normal flows have been appropriated and that present legal-right holders must subjugate their rights to storage if the development potential is to be realized.

In compliance with the terms of an agreement of May 5, 1913 between the United States and the State of Oregon, the water required for the Harney irrigation and drainage project was withdrawn as follows: "On April 8, 1914, 400,000 acre-feet of the waters of Silvies River and Emigrant Creek to be stored in the upper and lower Silvies River Reservoirs and Emigrant Creek Reservoir, were withdrawn by the State Engineer under application No. 3586." This application is still valid and pending according to the State Engineer's records.

Silvies Development

A study of water-right priorities indicated that the upper Silvies would have very little water available for additional development. Within this area, there are 11 irrigation rights with priority dates of 1882 to 1887 for the irrigation of 938 acres and rights to use 1,876 acre-feet of water. Later priority-right holders can satisfy only a portion of their rights to use 47,724 acre-feet due to the preponderance of early priority rights along the lower Silvies River.

This section of the report presents the features of the lower Silvies development plan that would be required for the control, development, conservation, and utilization of the water resources of the lower Silvies area. The additional water needed to supply present Silvies study area rights is about 200,000 acre-feet, while Figure 10 shows that the major source, Silvies River, would be able to supply such quantities during only 4 of the 30 base-period years. This figure also shows that yearly gaged outflows varied from under 50,000 to over 250,000 acre-feet. Figures 11 and 12 show that most of the outflow occurs before the optimum May through September irrigation and other heavy-use season. These factors all lead to the conclusion that storage, with carryover capacity, is a prerequisite to any water resources development plan.

Although minor details of the plan may change as a result of further recommended investigations, they were prepared in accordance with the goals enumerated by the Water Resources Committee. Features of the plan can and might be built by local or state agencies without impairing the efficiency of the overall plan.

Water supply studies, on which this report is based, illustrate clearly that in dry years, as severe as those occurring heretofore, developable water supplies will be inadequate for planned needs unless ground water is developed to supplement these needs. However, on the basis of reconnaissance studies, an engineeringly feasible plan of development is possible which can satisfy present water-right holders and attain maximum overall resource development.

Reference to large reservoir storage sites on Silvies River is made in a cooperative report by the U. S. Bureau of Reclamation and the State Engineer, dated 1916, and the U. S. Corps of Engineers' report on Silvies River and Tributaries, dated 1957. Both reports deal with development plans for Silvies River and much of their background data were used in formulating the development plan presented in this report.

Priority consideration should be given to construction of the proposed Silvies Canyon Reservoir, located immediately downstream from the confluence of Silvies River and Emigrant Creek. Foundation explorations and drilling at the site indicate that conditions are satisfactory for construction of an earthfill or earth and rockfill dam. Because of the previously determined superiority of this site by the U. S. Corps of Engineers, it has been provisionally recommended for the lower Silvies development plan. The proposed development plan consists of a dam and reservoir with 190,000 acre-feet of storage for fish life and recreation enhancement purposes, of which 10,000 acre-feet would be dead storage. Shortages would be shared by the water users on a proportional basis.

Silvies Canyon Reservoir would extend upstream from the damsite about eight miles on Silvies River and about six miles on Emigrant Creek. U. S. Corps of Engineers' cost estimates for the dam and reservoir were $3,764,000 in 1957. Other costs, such as lands, damages, channel protection, and an off-farm irrigation distribution system, were estimated at $1,690,000 for a total cost of $5,454,000. Updating these costs to 1967 would reflect an adjustment of approximately 25 to 30 percent. As a compensating factor, more of the construction costs can be allocated to such features as recreation and water quality control on federally constructed projects. Updating of the Silvies project plans would include prorating the costs chargeable to each of the multipurpose benefits.

An irrigation or water control district formation would be required to contract for repayable storage and distribution costs. Reactivation of the district with modification of its boundaries would be the simplest approach.

Figure 21 shows the proposed Silvies Irrigation District.

PROPOSED SILVIES IRRIGATION DISTRICT

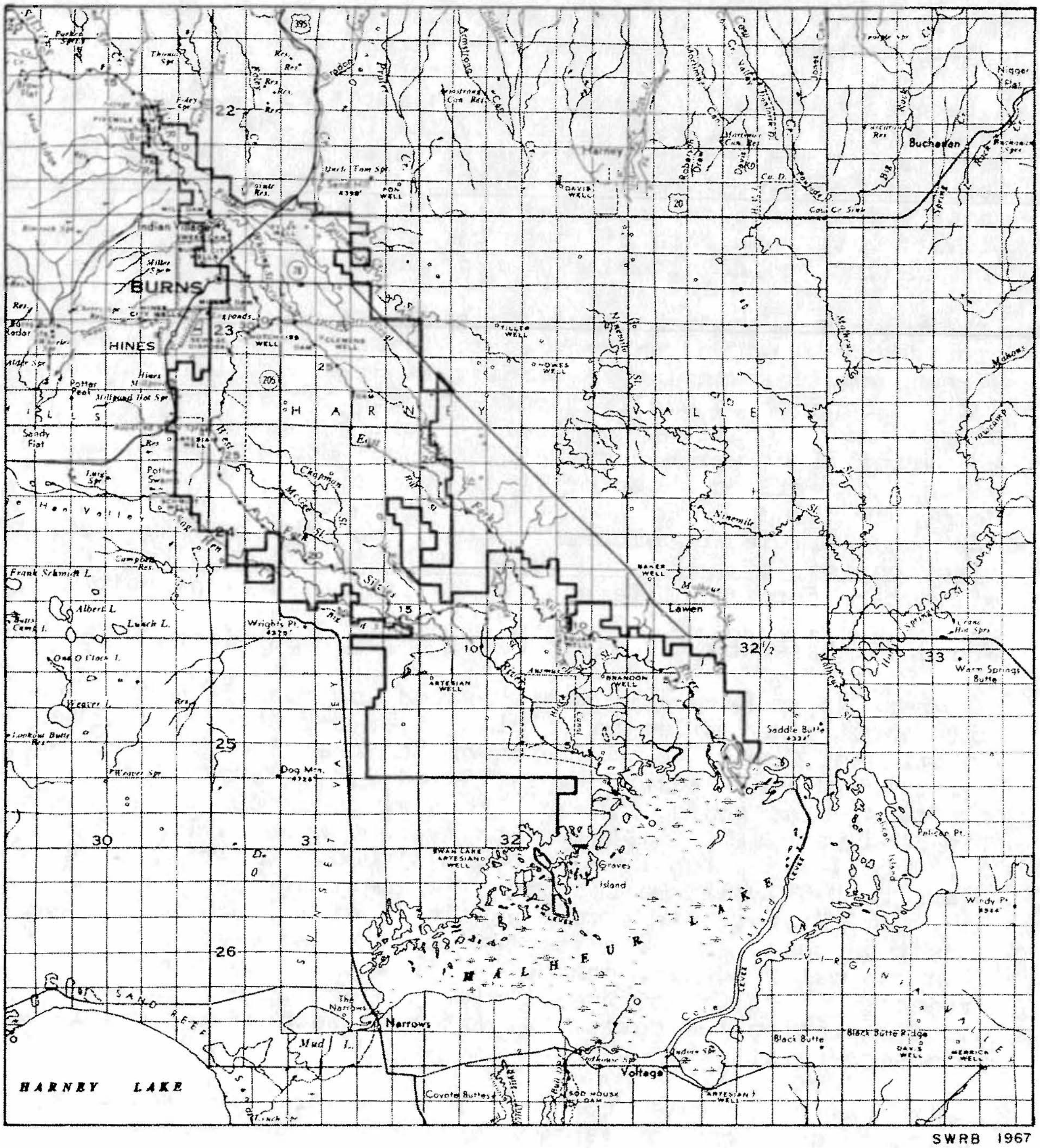


FIGURE 21. Proposed Silvies Irrigation District.

POTENTIAL DEVELOPMENT

District boundaries could be synonymous with Figure 21 boundaries, or the area could be reduced to exclude water-right holders who do not wish to be included within the district. Irrigation rights call for service to 63,000 acres, but net use would be reduced to about 60,000 acres when roads, towns, marshes, and other waste areas are subtracted. Availability of stored water to supply irrigation and other minor consumptive needs, would equal about 120,000 acre-feet when evapotranspiration losses are considered. There are several imponderable factors which must be refined in preconstruction planning, but the above is considered to be a close estimate of available surface water resources and the committed needs for this water.

A water duty of 2.2 acre-feet per presently irrigated acre would fully utilize the average storable yield so that surface water resources would be inadequate for increasing the irrigated acreage. Even with the project and the carryover storage, a shortage would exist during consecutive dry years. This is the major reason why ground-water development and use should be considered conjunctively with the proposed surface water developments.

There is a strong trend toward managing the surface and ground water jointly in water-short western areas. The overriding desire by ranchers is to assure themselves of an adequate water supply regardless of flow conditions of surface streams. Under district management, ground-water pumping can be integrated with surface water distribution, allowing more control over extended periods of water shortage and ground-water depletions. The value of supplemental supply lies in decisions based, most of the time, on individual needs and on optimizing productive activities, as well as insurance against disastrous crop failure.

Predicated on the basis of historic Silvies River flows, ground-water yield, and assuming centralized control of the well fields for the benefit of the entire area, pumping facilities could provide about 90 percent assurance of a full supply of irrigation water for all appropriators. Only a small fraction of this potential is currently realized.

At this date, water wells are being installed at an accelerated rate. Although the perennial demand for total ground-water requirements probably will not exceed the recharge, safe perennial yield often depends upon the proper location and spacing of wells to avoid excessive localized drawdown.

P O T E N T I A L   D E V E L O P M E N T

A suggested administrative mechanism, by which the hydrologic system can be managed in an effective manner, is one in which the operating water district purchases and operates wells and reservoirs, thereby supplying supplemental water for the entire area, quite likely, at a cost below other administrative approaches. The need for further economic analysis of this, approach is needed, based on preliminary results of the study.

The basic reason for conducting basin investigations is that the water belongs to the people of the state and no one individual or group has the right to waste this valuable resource to the economic detriment of others involved.

Main Canals and Laterals

River channels, with modifications, should continue to be used as a basis for the distribution system because they normally traverse the higher land elevations and serve present farm distribution systems. Serious consideration should be given to straightening and lining these channels in the upper flood plain gravelly section of the valley where 40,000 acre-feet are estimated to be lost to shallow and deep ground-water aquifers annually. Some of this ground water could be used for conjunctive surface and ground-water usage but the majority is lost to low-value uses, such as deep rooted desert shrubs, marsh grass, and the residue to evaporation in Harney Lake.

In order to provide capacity sufficient to handle reservoir discharge, channel improvements are needed below Fivemile Dam in the form of brushing and clearing, channel enlargement, dikes, levees, control structures, and measuring devices for more equitable water distribution. Some new channel construction is needed near the lower end of the project where the distribution system is less well defined and less effective. In total, about 75 miles of the present distribution system would require channel improvement to make better use of proposed storage. Distribution system construction activities will be simple and low in cost because no rock and practically no hardpan will be encountered. The main area to be served is compact with moderate canal gradients and no expensive structural work envisioned.

Drainage

The water supply allowed for lands, with existing water rights, is sufficient to make drainage desirable in this development proposal. A main drainage channel should extend upstream from Malheur Lake through the lower area within Silvies River channels. Consideration should be given to constructing a channel and control structures between Malheur and Harney Lakes. The main drains would act as an outlet for future individual-farm and group-farm drains as an essential part of a modern irrigation development.

While project soils generally are deep, of good texture, and well supplied with plant food, some areas have excessive soluble alkali salts. Drainage with proper irrigation affords the best means of alkali control. Some drainage arteries, in the nature of open ditches to supplement or deepen and straighten natural channels and relieve the chief swamps of the different localities, would help to control the water table and lessen the drainage problem.

Although most drains are constructed after irrigation practices and land use have been established and behavior of the ground water can be determined, a determination of the overall requirements should be included in the definite plan report for the project.

The construction of major project drainage and flood control channels would make it possible for most individual ranchers to economically install their internal water control facilities without interfering with the operation of neighboring ranches. The channels would provide satisfactory outlets, which are not available now to much of the area.

Irrigation

The shift from wild flooding of the uncontrolled spring runoff to controlled storage releases presents a radical shift in on-farm water distribution methods and structural controls. Flows that were once wildly fluctuating and unpredictable are measured at the farm headgate as smaller dependable stable flows. These flows must be spread over irrigable areas by well designed and installed border dikes, furrows, corrugations, or sprinklers. Land husbandry includes land leveling and use of adaptable farm machinery.

Land Management

This development proposal is based on continuation of the present ownership pattern, involving irrigation of relatively large acreages under individual ownership. Estimated benefits over costs can be realized only if the present pattern is continued or slowly modified as future economic conditions warrant such change. Existing climatic and economic conditions require several times more than 160 acres to make a family-sized farm unit efficient with beef cattle as the major enterprise.

The livestock industry would benefit substantially from the insurance features of an assured water supply. Production of high quality hay, improved pastures, and low-cost feed grains could permit a better balanced and more diversified livestock industry. With protection from flood and drought, typical improvements include higher production through use of improved crop varieties, improved water-use efficiency, more efficient tillage practices and effective use of fertilizers. Experiment station and local rancher records, indicate that yields of 3 to 5 tons of alfalfa hay or 1 to 2 tons of barley could be expected per acre following project development.

Wildlife

Recognition is given to the fact that agriculture and waterfowl represents a competitive demand for the present and potential Silvies River water supplies. The Fish and Wildlife Service anticipates that irreparable damage to the refuge and the waterfowl, which use it, would occur if the project were constructed.

It is true that more complete and efficient use of Silvies River water for irrigation purposes would lower the floodwater levels of Malheur Lake and the surrounding land areas. It is possible, however, that the agencies interested in the use of water for the production and preservation of waterfowl might, likewise, conduct investigations leading to construction of facilities for better utilization of available water. Reservoir operations would reduce the extent of undesirable annual lake-level fluctuations and supply more late-summer return flows, which would be highly beneficial to refuge management. An exchange of high-elevation storage water for uncontrolled low-elevation spring floodflows could produce an ameliorating benefit to spring waterfowl migrations if properly managed.

It is probable that both agriculture and wildlife uses could be expanded and improved with a resultant economic gain for the area, the state, and the nation.

POTENTIAL DEVELOPMENT

Development Outline

1. Update Silvies River project proposal

   A. Harney County Water Resources Committee indicated interest in the updating in a meeting, November 29, 1966, with Henry Stewart, U. S. Corps of Engineers.

   B. Committee Chairman, William D. Cramer, on December 9, 1966, initiated letter requests to Representative Al Ullman and Senator Wayne Morse to obtain legislative support. This support was received, according to a letter, dated April 14, 1967, from Senator Mark O. Hatfield which stated that the Senate Committee on Public Works directed the U. S. Corps of Engineers to undertake a further review of the Silvies report.

2. Special features to be considered

   A. U. S. CORPS of ENGINEERS - Revised plans and cost estimates, flood control benefits, development plan.

   B. U. S. BUREAU of RECLAMATION - Land classification, agricultural development plan, benefit-cost ratio, conjunctive surface-ground-water use, main drains, 160-acre equivalency formula.

   C. U. S. BUREAU of SPORT FISHERIES and WILDLIFE - Development plan, beneficial water-use plan, biological factors, water requirements.

   D. U. S. DEPARTMENT of HEALTH, EDUCATION and WELFARE Domestic-municipal requirements, water quality benefits, recreation benefits.

   E. U. S. GEOLOGICAL SURVEY - Ground-water aquifers, available sustained yield, water quality.

   F. OREGON STATE GAME COMMISSION - Minimum reservoir pool, fish and wildlife benefits.

   G. OREGON STATE UNIVERSITY EXPERIMENT STATION - Crop improvement, fertilizer requirements, reclamation of alkali land.

POTENTIAL DEVELOPMENT

Silver Creek Area

Potential development in the Silver Creek area is limited to developments initiated by present water-right holders. As shown in Table 24 and report statements, Silver Creek and associated drainages have a natural average annual yield of 58,000 acre-feet, while the surface rights to use this water amount to 84,281 acre-feet. Legal surface water rights are as follows: domestic, 6.17 cfs; irrigation, 428.30 cfs; and recreation, 5.00 cfs; for a total of 439.47 cfs.

The only all-inclusive reconnaissance plan for use of Silver Creek water is included in a cooperative study by the Reclamation Service and the State Engineer, entitled "Harney and Silver Creek Projects," dated February 1916. Since that date, Moon Reservoir has been constructed and the Claw Creek Reservoir site is being planned for construction. With completion of Claw Creek Reservoir, it is doubtful if any large scale developments could be determined feasible in the foreseeable future. Consideration is being given to storing additional Silver Creek floodwater in Chickahominy Reservoir for regulated releases on adjoining irrigated land.

Three reservoir sites, with a total storage capacity of 49,500 acre-feet, are shown in Table 23. A small reservoir has been located on upper Silver Creek within the national forest for storage of 2,000 acre-feet for recreation purposes. Consideration has been given, for many years, to the proposed 40,000 acre-foot upper Silver Creek reservoir site.

At the request of the contracting engineer, the State Water Resources Board supplied the following hydrological data on the proposed Claw Creek Reservoir site. Claw Creek is a major tributary of Silver Creek. The annual yield of Claw Creek, 2.5 miles above the mouth, should average about 7,400 acre-feet. The drainage area is 75 square miles and the yield would be slightly under 100 acre-feet per square mile. A storage reservoir with a capacity of 10,000 acre-feet would fill 10 times during the 1935-64 base period. During 14 years of record, Silver Creek had an annual runoff varying from 8,330 to 61,530 acre-feet and an average of 29,300 acre-feet over the correlated 30-year base period. Using Silver Creek as a basis for computations, water available for storage on Claw Creek would vary from 28 to 210 percent of the average and supply storable water varying from 2,000 to 15,300 acre-feet.

POTENTIAL DEVELOPMENT

Figure 10 and the above computations show the 29,300 acre-feet of average annual runoff that could be expected at the 40,000 acre-feet potential site on Silver Creek near USGS Gage No. 4030.

Ground-Water Potential

A thorough quantitative study, leading to optimum development of ground-water resources of the basin, would require a long-term investigation. This would require the drilling of test wells, as well as the collection of precipitation, surface runoff, and water-level records from wells. Although the basin now has about 85 high-yield, pump-tested wells, many of them have been established in the last few years. No critical ground-water area has yet developed. A minimum of 4 or 5 years of record collection would be required before the ground-water fluctuation pattern would begin to materialize.

The ultimate goal of the study would be the determination of the approximate location and size of economically recoverable bodies of ground water, their recharge capabilities, and the safe yield or rate at which water can be withdrawn without depleting the supply. Such a study should be initiated in Harney, Riddle, Catlow, and Alvord Valleys in conjunction with other water resources studies now planned for the basin.

The U. S. Geological Survey is authorized to enter into cooperative agreements with state and local government agencies to share the cost of water resource investigations. Under the cooperative water resources program, the Geological Survey may match up to 100 percent of local funds provided for these investigations. The Harney County Water Resources Committee has made needed contacts and obtained approval of such studies in Harney Valley.

In conjunction with these studies, physical and economical analyses should be made of features such as location of best irrigable land, crop adaptability, and cost-benefit factors. Not only has sustained demand for farm products made it possible for the farmer to attempt development of ground water, but the lower cost of electric power and better pumping equipment have encouraged this operation. To those lands at a distance from any unappropriated surface water, either ground water or imported surface water provides the only hope of irrigation in dry basin areas.

POTENTIAL DEVELOPMENT

Wildlife Potential

Well-balanced, multipurpose-development plans for the Malheur Lake Basin must make provision for wildlife resources. Migratory waterfowl and related species are, by far, the most prolific water users and the most susceptible to being adversely affected by developments for other purposes. The basin is a key area in the Pacific Flyway which extends from breeding grounds in Alaska and Canada to wintering grounds in central California and south to Mexico and South America.

The purposes of this section of the report are: (1) to record the wildlife resources of the Malheur Lake Basin; (2) to evaluate the effects on these resources of additional developments proposed for inclusion in the multipurpose-development program; and (3) to recommend measures that insure the perpetuation of the existing wildlife resource and allow future increases as resources permit.

Developmental plans considered herein are proposed by the State Water Resources Board after consultation with the U. S. Bureau of Sport Fisheries and Wildlife and the Oregon State Game Commission who helped analyze the development potential and supplied basic data.

The Malheur Lake Basin can be compared with the Klamath and Summer Lake Basins where multipurpose water resources development have progressed to the point where a much higher beneficial use for agriculture is being made of the available water supplies. Some improvements have accrued to waterfowl, but other developments have been detrimental to their reproduction and use.

Storage is a basic need in the Blitzen Valley to better utilize available supplies, reduce distribution system rehabilitation costs, and to increase production of higher quality field crops. The first major necessity in any rehabilitation plan is to further stabilize the erratic flows. The gage on Blitzen River near Frenchglen shows flows that vary from 7 to 2,700 cfs and annual yields that vary from 45,000 to 145,700 acre-feet.

With limited availability of watershed storage sites, more studies are needed on offstream storage and valley-ponding structures. Topographically, it would appear feasible to divert floodflows from Bridge, Mud, and Fish Creeks, plus upper Blitzen River to sump and canyon storage sites in the Webb

Spring and Krumbo Creek areas. The lower Klamath and Tule Lake diking programs to store spring floodflows are examples of methods which could be adopted in upper Blitzen Valley. A low dam with dikes and low-lift, high-volume pump on the Blitzen River at the P Ranch site, is another location with limited possibilities.

With peak floods controlled, water management and land improvement would be more refined on the 43,200 acres of irrigable land in Blitzen Valley. Complete water control would entail construction, extension, or rehabilitation of irrigation canals, field laterals, flumes, control structures, diversion structures, drainage ditches, dikes, cross-dikes, intraseasonal storage ponds, pump distribution systems, land leveling, and sprinkler installations. Topographic and land classification mapping is needed as a base.

Proposals for all areas should take into account provision of an adequate water supply to cover consumptive use in maintenance of water in marsh areas, agricultural operations on refuge lands, and to meet special management requirements, such as aquatic food production and disease control.

The U. S. Bureau of Sport Fisheries and Wildlife has developed plans for habitat manipulation in the refuge's 10,000-acre Diamond unit. Plans include completing the 9-mile Diamond drain with related structures, plus about 5 miles of minor lateral drains to reduce and intersperse the dense marsh vegetation with meadows. Developments would be required within the refuge units of P Ranch, Boca Lake, Malheur Lake, and Double-O, to properly drain the bulrush, cattail, and burreed zones which exist in some areas, and reduce the habitat for waterfowl use. For further documentation of development needs, reference can be made to the aforementioned U. S. Bureau of Sport Fisheries and Wildlife's report of September 1962.

Malheur Lake receives water from the Silvies River drainage from the north and from the Blitzen drainage from the south. This water supply is erratic in nature (Figure 20) with wide variation in supply from year to year. It is quite evident that a much higher beneficial use of water for wildlife and agricultural purposes in the Malheur Lake Basin should be strongly encouraged.

If additional water resource developments take place in Harney Valley, water levels of the lake will be reduced and become more stabilized. Then it will be necessary to divide this uncontrolled area into small manageable waterfowl units. The U. S. Bureau of Sport Fisheries and Wildlife has a development plan which would divide Malheur Lake into six segments for better control and utilization of water reaching this impoundment.

Table 26 shows maximum surface area of Malheur Lake from 1938 through 1965.

TABLE 26

MAXIMUM SURFACE AREA
MALHEUR LAKE

YEAR	ELEV. FT.	ACRES
1938	4,092.70	43,000
1939	4,093.00	47,000
1940	4,091.92	25,000
1941	4,093.02	48,000
1942	4,094.81	60,000
1943	4,095.24	64,000
1944	4,093.50	52,000
1945	4,094.48	59,000
1946	4,093.60	53,000
1947	4,092.80	44,000
1948	4,093.77	56,000
1949	4,093.30	51,000
1950	4,092.56	40,000
1951	4,093.42	51,000
1952	4,095.39	67,000
1953	4,094.44	60,000
1954	4,093.57	53,000
1955	4,092.20	36,000
1956	4,093.84	56,000
1957	4,095.12	66,000
1958	4,095.16	66,000
1959	4,093.30	51,000
1960	4,091.82	22,000
1961	4,090.88	8,000
1962	4,090.78	7,000
1963	4,091.50	20,000
1964	4,091.92	25,000
1965	4,094.34	58,000
Average	4,093.30	46,000

Data Source: U. S. Geological Survey
Bureau of Sport Fisheries and Wildlife.

It has been proposed that if Malheur Lake were divided into a series of smaller, more easily managed ponds, the water levels could be controlled by drainage or pumping from one pond (or ponds) to another, as the situation demanded; dense bulrush and cattail zones could be controlled; portions of the lakebed could be rotated in crops for wildlife food; open water could be maintained for waterfowl resting; and productive nesting marshes on the west could be protected by a more stable water supply.

To prevent salt accumulations, entering streams should be channeled to the east and water movement would be westward toward Harney Lake. Control structures would be installed at The Narrows between Malheur Lake and Mud Lake, and between Mud Lake and Harney Lake to better control outflows as an adjunct to the diking of Malheur Lake.

The refuge has water rights for irrigation of about 9,900 acres on Silver Creek below Moon Reservoir. Silver Creek flows, in this area, are not dependable while flows from springs are nominal but quite dependable. Due to higher salinity of both the spring flows and much of the land to be served, the development potential is limited to drainage and management practice which would increase productivity and reduce salinity.

As a means of providing sufficient waterfowl food and to reduce the hazard of damage to privately owned crops, the Bureau of Sport Fisheries and Wildlife could increase small grain production on suitable available lands within the existing refuge. The program of leaving areas of unharvested grain crops, at strategic locations where birds can feed, is quite effective in reducing depredation on private land.

Ducks and geese are a renewable resource, and opportunity must be provided the public to participate in their harvest. This opportunity can be afforded by establishing public hunting areas. Basic requirements of food, resting area, and sanctuary also are a necessity.

Nongame migratory birds are of great interest to the public and afford untold pleasure and recreational values. Further opportunity to enjoy these values should be provided with due consideration to the development features and habitat requirements.

It is recognized that, in the Silvies, Silver, and Blitzen Valleys, the use of water by agriculture and the bird refuge represents a competitive demand for present and potential water supplies. It is also recognized that there are possibilities for much greater efficiency in water use by both the ranchers and refuge operators. Studies indicate that both agriculture and wildlife uses could be expanded and improved without conflict and detriment to progress. A plan for comprehensive development of the Malheur Lake Basin is essential if the economy of the basin is to flourish and its ultimate potential is to be realized.

Reference is made to a Oregon State Game Commission Master Plan, "Angler Access and Associated Recreational Uses, Donner und Blitzen River Basin," dated November 1966. This plan calls for solving access problems, construction of recreation facilities, roads, and trails.

APPENDIX

"(5) Competitive exploitation of water resources of this state for single-purpose uses is to be discouraged when other feasible uses are in the general public interest;

"(6) In considering the benefits to be derived from drainage, consideration shall also be given to possible harmful effects upon ground water supplies and protection of wildlife;

"(7) The maintenance of minimum perennial streamflows sufficient to support aquatic life and to minimize pollution shall be fostered and encouraged if existing rights and priorities under existing laws will permit;

"(8) Watershed development policies shall be favored, whenever possible, for the preservation of balanced multiple uses, and project construction and planning with those ends in view shall be encouraged;

"(9) Due regard shall be given in the planning and development of water recreation facilities to safeguard against pollution;

"(10) It is of paramount importance in all cooperative programs that the principle of the sovereignty of this state over all the waters within the state be protected and preserved, and such cooperation by the board shall be designed so as to reinforce and strengthen state control;

"(11) Local development of watershed conservation, when consistent with sound engineering and economic principles, is to be promoted and encouraged; and

"(12) When proposed uses of water are in mutually exclusive conflict or when available supplies of water are insufficient for all who desire to use them, preference shall be given to human consumption purposes over all other uses and for livestock consumption, over any other use, and thereafter other beneficial purposes in such order as may be in the public interest consistent with the principles of this Act under the existing circumstances."

"I, John H. Lewis, State Engineer of the State of Oregon, in accordance with the authority vested in me by virtue of Chapter 87, Laws of Oregon for 1913, do hereby withdraw and withhold from appropriation on behalf of the State of Oregon 400,000 acre-feet at the waters of Silvies River and Emigrant Creek to be stored in upper and lower Silvies River reservoirs and Emigrant Creek Reservoir, for irrigation purposes, which may be required for the project under investigation or to be investigated under the provisions of said Act and that certain contract between the United States of America, by Franklin K. Lane, Secretary of the Interior, and the State of Oregon, by John H. Lewis, State Engineer, approved by Oswald West, Governor, on the 5th day of May 1913, executed thereunder.

"Dated this 8th day of April, 1914.

/s/ JOHN H. LEWIS

John H. Lewis,
State Engineer of the State of Oregon."

APPLICATION NO. 3586, dated April, 1914, is in the name of John H. Lewis, State Engineer, for a permit to appropriate the waters listed in the above withdrawal.

"I, John H. Lewis, State Engineer of the State of Oregon in accordance with the authority vested in me by virtue of Chapter 87, laws of Oregon for 1913, do hereby withdraw and withhold from appropriation on behalf of the State of Oregon, 400 second feet of water of Silver Creek and its tributaries and Silver Creek Reservoir, for irrigation, power and domestic purposes, which may be required for the project under investigation or to be investigated under the provisions of said Act and that certain contract between the United States of America, by Franklin K. Lane, Secretary of the Interior, and the

A U T H O R I T Y

The authority for the preparation and presentation of this report is set forth in ORS 536.300. The Legislative Assembly recognizes and declares in ORS 536.220 (1) that:

"(a) The maintenance of the present level of the economic and general welfare of the people of this state and the future growth and development of this state for the increased economic and general welfare of the people thereof are in large part dependent upon a proper utilization and control of the water resources of this state, and such use and control is therefore a matter of greatest concern and highest priority.

"(b) A proper utilization and control of the water resources of this state can be achieved only through a coordinated, integrated state water resources policy, through plans and programs for the development of such water resources and through other activities designed to encourage, promote and secure the maximum beneficial use and control of such water resources, all carried out by a single state agency.

"(c) The economic and general welfare of the people of this state have been seriously impaired and are in danger of further impairment by the exercise of some single-purpose power or influence over the water resources of this state or portions thereof by each of a large number of public authorities, and by an equally large number of legislative declarations by statute of single-purpose policies with regard to such water resources, resulting in friction and duplication of activity among such public authorities, in confusion as to what is primary and what is secondary beneficial use or control of such water resources and in a consequent failure to utilize and control such water resources for multiple purposes for the maximum beneficial use and control possible and necessary."

The authority for the report, the study on which it is based, and the actions effected are specifically delegated to the State Water Resources Board in ORS 536.300 (1) and (2) which state:

"(1) The board shall proceed as rapidly as possible to study: existing water resources of this state;

means and methods of conserving and augmenting such water resources; existing and contemplated needs and uses of water for domestic, municipal, irrigation, power development, industrial, mining, recreation, wildlife, and fish life uses and for pollution abatement, all of which are declared to be beneficial uses, and all other related subjects, including drainage and reclamation.

"(2) Based upon said studies and after an opportunity to be heard has been given to all other state agencies which may be concerned, the board shall progressively formulate an integrated, coordinated program for the use and control of all the water resources of this state and issue statements thereof."

Within the limits of existing data and knowledge, the study has taken into full consideration the following declarations of policy under ORS 536.310:

"(1) Existing rights, established duties of water, and relative priorities concerning the use of the waters of this state and the laws governing the same are to be protected and preserved subject to the principle that all of the waters within this state belong to the public for use by the people for beneficial purposes without waste;

"(2) It is in the public interest that integration and coordination of uses of water and augmentation of existing supplies for all beneficial purposes be achieved for the maximum economic development thereof for the benefit of the state as a whole;

"(3) That adequate and safe supplies be preserved and protected for human consumption, while conserving maximum supplies for other beneficial uses;

"(4) Multiple-purpose impoundment structures are to be preferred over single-purpose structures; upstream impoundments are to be preferred over downstream impoundments. The fishery resource of this state is an important economic and recreational asset. In the planning and construction of impoundment structures and milldams and other artificial obstructions, due regard shall be given to means and methods for its protection;

state of Oregon, by John H. Lewis, State Engineer, approved by Oswald West, Governor, on the 5th day of May, 1913, executed thereunder.

"Dated this 14th day of February, 1916.

/s/ JOHN H. LEWIS

John H. Lewis,
State Engineer of the State of Oregon."

APPLICATION NO. 4755, dated February, 1916, is in the name of John H. Lewis, State Engineer, for a permit to appropriate the waters listed in the above withdrawal.

"I, Percy A. Cupper, State Engineer of the State of Oregon, in accordance with the authority vested in me by virtue of Chapter 87, Laws of Oregon for 1913, do hereby withdraw and withhold from appropriation on behalf of the State of Oregon any and all unappropriated waters of the Donner und Blitzen River and its tributaries, tributary of Malheur Lake, to be stored in various reservoirs for irrigation, power and domestic purposes, which may be required for the project investigated or to be investigated under the provisions of said Act, and that certain contract between the United States of America, by Franklin K. Lane, Secretary of the Interior, and the State of Oregon by John H. Lewis, State Engineer, approved by Oswald West, Governor, on the 5th day of May, 1913, executed thereunder.

"Dated this 22nd day of May, 1920.

/s/ PERCY A. CUPPER
State Engineer of the State of Oregon."

APPLICATION NO. 7296, dated May, 1920, is in the name of Percy A. Cupper, State Engineer, for a permit to appropriate the waters listed in the above withdrawal.

W I T H D R A W A L S B Y S T A T E E N G I N E E R

"I, Percy A. Cupper, State Engineer of the State of Oregon, in accordance with the authority vested in me by virtue of Chapter 87, Laws of Oregon for 1913, do hereby withdraw and withhold from appropriation on behalf of the State of Oregon, any and all unappropriated waters of the Donner und Blitzen River and its tributaries, tributary of Malheur Lake, in Harney County, Oregon, for irrigation, power, domestic and storage purposes, which may be required for the project investigated or to be investigated within the Malheur Lake drainage basin, under the provisions of said Act, and that certain contract between the United States of America, by Franklin K. Lane, Secretary of the Interior, and the State of Oregon by John H. Lewis, State Engineer, approved by Oswald West, Governor, on the 5th day of May, 1913, executed thereunder.

"Dated this 22nd day of May, 1920.

/s/ PERCY A. CUPPER

Percy A. Cupper
State Engineer of the State of Oregon."

APPLICATION NO. 7297, dated May, 1920, is in the name of Percy A. Cupper, State Engineer, for a permit to appropriate the waters listed in the above withdrawal.

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TABLE A

HYDROLOGICAL STATION SUMMARY

MAP INDEX NO.	NAME	STATION NO.	LOCATION Twp.	Rng.	Sec.	STREAM MILE	DRAINAGE AREA Sq. Mi.	ELEVATION Feet	TYPE	ACTIVE	WATER YEARS OF RECORD	COMPLETE WATER YEARS	SOURCE
	SILVIES - STREAM GAGING												
1	Silvies River near Silvies	3925	19S	31E	14	55.5	510	4,500	Staff		1903-06, 1909-12, 1916, 1921-23	2	USGS OSE
2	Emigrant Creek near Burns	3930	20S	29E	26	2.3	240	4,400	Staff		1921	0	USGS
3	Silvies River near Burns	3935	21S	30E	31	22.3	934	4,195	Recording	x	1003-06, 1909-64	51	USGS
4	Poison Creek near Burns	3940	22S	31E	34	-	81	4,100	Staff		1921,1922	0	USGS
5	Prater Creek near Burns (Prather Creek near Burns 1921-23)	3945	22S	31E	25	-	20	4,150	Staff		1921-23	0	USGS
6	Cow Creek near Harney	(9618)	22S	32½E	26	-	-	-	Staff		1941	0	OSE
7	Rattlesnake Creek near Harney	(9619)	22S	32½E	18	-	-	-	Staff		1941	0	SSE
8	East Fork Silvies River near Lawen	3950	25S	32E	8	4.8	-	4,090	Staff		1916	0	USGS
9	West Fork Silvies River near Lawen	3955	25S	32E	24	2.7	-	4,100	Staff		1916-17, 1919,1921, 1922	0	USGS OSE
10	Rock Creek near Burns	3957	22S	33E	16	-	-	-	Recording		1964	0	OSE*
	SILVIES - WATER TEMPERATURE												
(3)	Silvies River near Burns	3935	21S	30E	31	22.3	934		Spot	x	1954-64		USGS
	SILVIES - SNOW SURVEY AND SOIL MOISTURE												
11	Bear Valley	19E8	15S	31E	32			4,800	SS		1929-32, 1935		SCS
12	Call Meadows	18F7a	20S	33E	29			5,340	ASD	x	1959-64		SCS
13	Idlewild Camp	18F3	20S	31E	27			5,200	SS	x	1929-64		SCS
14	Izee Summit	19E9	16S	29E	28			5,293	SS	x	1936-64		SCS
15	Rock Spring	18F1	18S	32E	23			5,100	SS	x	1936-64		SCS
16	Star Ridge	19E7M	19S	26E	1			5,150	SS,SM	x	1944-64		SCS
17	Willow Bald	19F4m	22S	29E	19			5,000	SM	x	1958-64		SCS
	SILVIES - CLIMATOLOGICAL												
18	Bear Valley	-	15S	30E	33			5,000	P		1909-30	20	USWB
19	Burns Mill	-	21S	28E	36			4,300	P		1909-13	0	USWB
20	Burns W.B. City (Burns 1892-1921, 1930-48)	1176	23S	31E	7			4,151	P,T	x	1892-1921, 1930-64	39	USWB
21	Camp Harney	-	22S	32½E	18			-	P,T		1867-80	11	USWB
22	Crane	-	25S	34E	7			4,135	P,T		1923	0	USWB
23	Harney Branch Experimental Station	3659	23S	32E	7			4,139	P,T		1922-54	30	USWB
24	Harriman	-	25S	35E	10			4,135	P		1915-18	-	USWB
25	Seneca	-	16S	31E	35			4,666	P,T	x	1908-13, 1931-44, 1947-64	23	USWB
26	Trout Creek	-	21S	32E	16			5,280	P		1910	-	USWB
	SILVER CREEK - STREAM GAGING												
27	Silver Creek near Riley	4030	22S	25E	1	52.6	228	4,450	Recording	x	1951-64	13	USGS
28	Silver Creek above Suntex (Silver Creek near Riley 1904-06, 1909-11) (Silver Creek above Riley 1912, 1914-18)	4035	22S	26E	30	47.1	260	4,340	Staff		1904-06, 1909-12, 1914-23, 1925,1926	1	USGS
29	Chickahominy Creek near Suntex (Chickahominy Creek near Riley 1917)	4040	23S	26E	29	-	90	4,200	Staff		1917,1922, 1923	0	USGS
30	Rock Quarry Creek near Suntex	4045	23S	27E	34	-	-	-	Recording		1921,1922	0	OSE
31	Silver Creek below Suntex (Silver Creek below Riley 1912-15, 1917,1919)	4050	24S	27E	14	29.2	550	4,270	Recording		1912-15, 1919, 1921-23	0	USGS OSE
32	Silver Creek above Moon Reservoir near Riley	(9621)	24S	27E	25	-	-	-	Recording		1953	0	OSE*
33	Silver Creek below Moon Reservoir near Riley	(9622)	25S	28E	17	-	-	-	Recording		1953-54	0	OSE*
34	Silver Creek near Narrows	4060	25S	28E	21	19.3	630	4,140	Staff		1917, 1919-23	0	USGS
35	Malheur Lake Outlet at Narrows (Malheur Lake at Narrows 1903-06, 1909, 1911-13)	4020	26S	31E	26	-	2,150	4,089	Staff		1903-06 1909, 1911-14, 1916	0	USGS
36	Mud Lake Outlet near Narrows	4025	27S	30E	17	-	2,160	4,085	Staff		1916-18, 1921,1922	0	USGS
	SILVER CREEK - WATER TEMPERATURE												
(27)	Silver Creek near Riley	4030	22S	25E	1	52.6	228		Spot	x	1951-64		USGS

MAP INDEX NO.	NAME	STATION NO.	LOCATION Twp.	Rng.	Sec.	STREAM MILE	DRAINAGE AREA Sq. Mi.	ELEVATION Feet	TYPE	ACTIVE	WATER YEARS OF RECORD	COMPLETE WATER YEARS	SOURCE
	SILVER CREEK - SNOW SURVEY AND SOIL MOISTURE												
37	Buckskin Lake	18G8a	30S	30E	2			5,200	ASD	x	1962-64		SCS
38	Delintment Lake	19F2	19S	26E	28			5,600	SS	x	1949-64		SCS
39	Emigrent Lake	19F3	21S	27E	14			5,000	SS	x	1957-64		SCS
40	Foster Flat	19G4a	30S	29E	15			5,020	ASD	x	1962-64		SCS
41	Snow Mountain	19F1M	19S	26E	1			6,300	SS,SM	x	1944-64		SCS
	SILVER CREEK - CLIMATOLOGICAL												
42	O O Ranch	6302	26S	28E	36			4,136	P,T	x	1941-42, 1950-64	13	USWB
43	Riley	-	23S	27E	29			4,225	P,T		1905-06, 1912-14, 1926,1927	-	USWB
44	Squaw Butte Experimental Station	8029	24S	25E	15			4,675	P,T	x	1936-64	23	USWB
45	Sunset Valley (Sunset 1915-17)	-	26S	31E	26			4,110	P		1915-17	-	USWB
46	Suntex	8250	23S	26E	9			4,310	P,T	x	1962-64	2	USWB
47	Suntex Juniper Hills Ranch	8252	22S	24E	d			4,620	P,T		1956-62	5	USWB
48	Wagontire	8948	27S	24E	8			4,726	P,T	x	1961-64	3	USWB
	DONNER UND BLITZEN - STREAM GAGING												
49	Donner und Blitzen River near Frenchglen (Donner und Blitzen River near Diamond 1911-21) (Donner und Blitzen River at P Ranch near Diamond 1929, 1930)	3960	32S	32½E	20	46.8	200	4,254	Recording	x	1909-21 1929, 1930, 1938-64	34	USGS OSE
50	Warm Springs Canal near Krumbo	(951a)	32S	32½E	8	-	-	-	Staff		1930	0	OSE
51	Mud Creek near Diamond	3965	32S	32½E	4	-	30	4,200	Staff		1911-16, 1930	5	USGS
52	Bridge Creek near Frenchglen (Bridge Creek near Diamond 1911-16,1930)	3970	31S	32½E	33	-	30	4,185	Recording	x	1911,-16, 1930 1938-64	30	USGS
53	Knox Springs near Frenchglen	(9515)	31S	32½E	21	-	-	-	Est.		1930	0	OSE
54	Krumbo Creek near Diamond (Krumbo Creek near Frenchglen 1930)	3975	30S	32E	19	-	37	4,170	Staff		1911, 1930	0	USGS
55	Buena Vista Canal near Narrows	3980	29S	31E	26	-	-	-	Staff		1915-20	0	USGS
56	Donner und Blitzen River near Narrows	3985	29S	31E	26	27.7	420	4,140	Staff		1915-20	1	USGS
57	Busse Canal near Rockyford Lane	(951-c)	28S	31E	22	-	-	-	Staff		1930	0	OSE
58	Donner und Blitzen River at Rockyford Lane	(9517)	28S	31E	22	-	-	-	Staff		1930	0	OSE
59	Stubblefield Canal near Rockyford Lane	(951-d)	28S	31E	21	-	-	-	Staff		1930	0	OSE
60	Kiger Creek near Diamond	3990	30S	33E	3	-	75	4,250	Staff		1909-13, 1916-21, 1930,1941	1	USGS OSE
61	Cucamonga Creek near Diamond (Cucamonga Creek near Diamond 1911)	3995	30S	33E	8	-	15	4,250	Staff		1916,1930	0	USGS
62	McCoy Creek near Diamond	4000	30S	32E	2	-	45	4,200	Staff		1910-14, 1916-21, 1930,1941	4	USGS OSE
63	McCoy Creek near Diamond	(959A)	29S	32E	35	-	-	-	-		1909	0	OSE
64	Riddle Creek near Smith	4005	29S	34E	6	-	60	4,250	Staff		1911	0	USGS
65	Riddle Creek near Diamond	4010	28S	33E	23	-	120	4,100	Staff		1917 -21	0	USGS
66	Donner und Blitzen River near Voltage	4015	27S	31E	2	4.3	760	4,098	Recording		1916-19 1921,1922, 1938-46	5	USGS OSE
	DONNER UND BLITZEN - WATER TEMPERATURE												
(49)	Donner und Blitzen River near Frenchglen	3960	32S	32½E	20	46.8	200		Spot	x	1947-64		USGS
(52)	Bridge Creek near Frenchglen	3970	31S	32½E	33	-	30		Spot	x	1947-64		USGS
	DONNER UND BLITZEN - SNOW SURVEY AND SOIL MOISTURE												
67	Fish Creek	18G2MA	33S	33E	4			7,900	SS,SM,ASD	x	1939-64		SCS
68	Buck Pasture (Riddle Creek 1957-60)	18F6a	29S	35E	21			5,700	ASD	x	1957-64		SCS
69	Silvies	18G1MA	32S	32½E	35			6,900	SS,SM,ASD	x	1936-64		SCS

MAP INDEX NO.	NAME	STATION NO.	LOCATION Twp.	Rng.	Sec.	STREAM MILE	DRAINAGE AREA Sq. Mi.	ELEVATION Feet	TYPE	ACTIVE	WATER YEARS OF RECORD	COMPLETE WATER YEARS	SOURCE
	DONNER UND BLITZEN - CLIMATOLOGICAL												
70	Buena Vista	-	29S	31E	10			4,130	P,T		1942-43	1	USWB
71	Buena Vista Station (Happy Valley 1890-1900) (Diamond 1910-14,1942-55) (Diamond 4 WNW 1955-57)	1124	29S	32E	27			4,135	P,T	x	1890-1900, 1910-14, 1942-64	24	USWB
72	Malheur Refuge Headquarters (Sod House 1937-47) (Voltage 2 NW, Sod House 1947-59)	5162 8942	26S	31E	35			4,109	P,T	x	1937-64	25	USWB
73	Narrows	-	26S	31E	26			4,100	P		1908-10	0	USWB
74	P Ranch Refuge (P Ranch 1897-1901, 1909,1910) (P Ranch Wildlife Refuge 1942-52)	6853	32S	32½E	6			4,205	P.T	x	1897-1901 1909-10, 1942-64	29	USWB
	CATLOW-ALVORD - STREAM GAGING												
75	Home Creek near Beckly	4080	35S	32E	10	-	38	4,600	Staff		1911,1912, 1915-17	1	USGS
76	Threemile Creek near Blitzen	(978)	35S	32E	25	-	-	-	Staff		1930	0	OSE
77	Skull Creek near Blitzen	(979)	36S	32½E	21	-	-	-	Staff		1930	0	OSE
78	Trout Creek near Denio	4065	39S	36E	26	-	88	4,352	Recording	x	1911,1912, 1922-64	0	USGS
79	Little Cottonwood Creek near Denio	4070	39S	35E	28	-	8	4,200	Staff		1911,1912	0	USGS
80	Van Horn Creek near Denio	4075	41S	35E	3	-	10	4,300	Staff		1911	0	USGS
81	Wildhorse Creek near Andrews	(972)	34S	33E	34	-	-	-	-		1951-53	0	OSE*
	CATLOW-ALVORD - SNOW SURVEY AND SOIL MOISTURE												
82	Deer Creek	19G3	36S	26E	17			6,670	SS		1940-49		SCS
83	Denio Creek	18G6a	41S	34E	14			6,000	ASD	x	1959-64		SCS
84	Guano Creek	19G2	36S	25E	13			6,480	SS		1940-49		SCS
85	Hart Mountain	19G1a	36S	25E	1			6,350	ASD	x	1939-64		SCS
86	Jenkins Homestead	18F7a	29S	35E	34			5,800	ASD		1957-60		SCS
87	Oregon Canyon	17G5a	40S	40E	9			6,950	ASD	x	1959-64		SCS
88	Trout Creek	18G5a	41S	38E	10			7,800	ASD	x	1959-64		SCS
89	"V" Lake	18G7a	35¾ S	32½E	31			6,600	SM	x	1958-64		SCS
	CATLOW-ALVORD - CLIMATOLOGICAL												
90	Andrews 2S (Andrews 1915-42,1959)	0188	36S	33E	10			4,100	P,T		1915-42, 1959-60	25	USWB
91	Andrews 23 ESE	0190	37S	36E	12			4,275	P,T	x	1959-64	4	USWB
92	Alvord Ranch	0170	34S	34E	3			4,180	P,T	x	1960-64	3	USWB
93	Blitzen (Beckley 1914-16)	-	34S	31E	21			4,300	P,T		1914-33	17	USWB
94	Hart Mountain Refuge	3692	35S	26E	10			5,900	P,T	x	1939-64	25	USWB
95	Juniper Lake	4347	30S	36E	31			4,100	P,T	x	1959-64	5	USWB
96	Roaring Springs Ranch	7250	34S	32E	5			4,630	P,T		1959	0	USWB
97	Rock Creek Ranch	7260	33S	30E	28			4,575	P,T	x	1961-64	3	USWB
98	Sunrise Valley (Juniper Ranch 1928-33)	8245	29S	36E	24			3,710	P,T		1913-36	22	USWB

*Unpublished records.

Note: Station number in parentheses refers to numbering system prior to September 30, 1951.

ABBREVIATIONS

OSE - Oregon State Engineer
SCS - Soil Conservation Service
USGS - U. S. Geological Survey
USWB - U. S. Weather Bureau

ASD - Aerial Snow Depth Gage
P - Precipitation
SM - Soil Moisture
SS - Snow Survey Course
T - Air Temperature

TABLE B

PROPOSED STREAM GAGING SITES

RECOMMENDED

NAME	LOCATION TWP.	RNG.	SEC.
SILVIES STUDY AREA			
Emigrant Creek near the mouth	21S	29E	2
Poison Creek at U. S. Highway 395 bridge	22S	31E	9
East Fork Silvies River at Lawen Road bridge	25S	32½E	5
West Fork Silvies River near mouth	25S	32E	24
Rattlesnake Creek near Harney	22S	32½E	8
Cow Creek near Harney	22S	32½E	3
SILVER STUDY AREA			
Silver Creek near Riley	23S	27E	34
Silver Creek below Moon Reservoir	25S	28E	17

RE-ESTABLISH

NAME	USGS NO.	LOCATION TWP.	RNG.	SEC.
DONNER UND BLITZEN STUDY AREA				
Mud Creek near Diamond	3965	32S	32½E	4
Krumbo Creek near Diamond	3975	30S	32E	19
Kiger Creek near Diamond	3990	30S	33E	3
Cucamonga Creek near Diamond	3995	30S	33E	8
McCoy Creek near Diamond	4000	30S	32E	2
Riddle Creek near Smith	4005	29S	34E	6
Donner und Blitzen River near Blitzen	4015	27S	31E	2

TABLE C

RECONNAISSANCE DATA ON STUDY AREAS

ACRES	SILVIES		SILVER		DONNER UND BLITZEN		CATLOW - ALVORD		TOTAL
	Upper	Lower	Upper	Lower	Upper	Lower	Catlow	Alvord	
Watershed Area	612,700	733,700	332,500	974,200	231,700	395,200	1,825,700	1,271,900	6,377,600
Forest Land	430,400	111,700	177,300	17,100	18,700	7,800	6,500	9,900	779,400
Cropland	27,000	123,000	11,300	17,400	8,300	34,900	13,200	27,600	262,700
Rangeland	152,000	491,700	142,800	937,800	351,800	204,300	1,801,400	1,198,000	5,279,800
Irrigation Water Source:									
Streamflow	25,700	97,000	8,800	16,100	7,800	31,800	6,700	17,700	210,600
Ground Water	500	1,200	100	0	0	100	80	6,600	8,580
Water Shortage	25,700	53,200	4,700	15,100	300	32,900	6,500	18,040	156,440
Potentially Irrigable Land	5,800	120,100	4,500	18,100	200	1,900	41,560	92,000	284,160
Arable Land Needing Drainage	9,050	20,000	100	700	0	0	240	2,200	32,290
Flooding	13,800	24,100	4,800	800	0	2,800	2,200	1,050	49,550
Number of Farms	24	102	23	19	3	33	11	28	243

Data Source: U. S. Dept. of Agriculture's Cooperative Report.

TABLE D

OREGON STATE GAME COMMISSION
RECOMMENDED MINIMUM FLOWS FOR FISH LIFE

CFS

STREAM	MARCH-MAY	JUNE		JULY-FEBRUARY	LOCATION
DONNER UND BLITZEN RIVER					
Donner Und Blitzen River					Flows not determined
SILVER CREEK					
Silver Creek	5.0	5.0	3.0	1.5	0.5 mile below Copper Creek
Silver Creek	5.0	5.0	3.0	2.0	USGS gage No. 4030
Nicoll Creek	3.0	3.0	1.5	0.6	Mouth
Sawmill Creek	3.0	3.0	1.5	0.7	Mouth
SILVIES RIVER					
Silvies River	15.0	15.0	12.0	10.0	2 miles above Fisk Gulch
Silvies River	15.0	15.0	12.0	10.0	USGS gage No. 3935
Bear Creek	12.0	12.0	9.0	6.0	2.3 miles below Little Bear Creek
Bear Creek	12.0	12.0	9.0	6.0	Mouth
Emigrant Creek	12.0	12.0	9.0	6.0	Mouth
Bear Canyon Creek	2.0	2.0	1.0	0.5	Below Blue Creek
Crowsfoot Creek	3.0	3.0	1.5	1.0	Mouth
Little Emigrant Creek	3.0	3.0	2.0	1.0	Mouth
Sawtooth Creek	4.0	4.0	2.0	1.0	Mouth
Whisky Creek	3.0	3.0	2.0	0.8	Mouth
Rattlesnake Creek	3.0	3.0	2.0	1.0	1.5 miles below East Fork Rattlesnake Creek
Trout Creek	4.0	4.0	2.0	1.5	Above Lost Creek

Note: Listed flows are primarily for trout production, but would also accommodate warm-water game fish an provide fair conditions for angling. Quantities listed are not necessarily the flows which would be recommended below existing or future impoundments.

Data Source: Oregon State Game Commission.

TABLE E

SURFACE WATER RIGHTS
SUMMARY

March 1, 1967

CFS

STREAM	DOMESTIC	INDUSTRIAL	IRRIGATION CFS	IRRIGATION ACRES	POWER AND MINING	RECREATION	WILDLIFE	TOTAL
1. SILVIES STUDY AREA								
1A. Upper								
Silvies R. & Misc.	4.84	0	167.37	11,901	34.00@	0.01	0	206.21@
Eddington Cr. & Misc.	0.20	0	7.51	485	0	0	0	7.71
Scotty Cr. & Misc.	0.40	0	29.64	1,979	0	0	0	30.04
Damon Cr. & Misc.	0.10	0	7.61	516	0	0	0	7.71
Bear Cr. & Misc.	0.30	0	80.23	5,159	0	0	0	80.54
Trout Cr. & Misc.	0.40	0	15.01	995	0	0.01	0	15.42
Emigrant Cr. & Misc.	1.00	0	27.40	1,638	0	0	0	28.40
Total	7.24	0	334.77	22,673	34.00@	0.02	0	376.03@
1B. Lower								
Silvies R. & Misc.	5.20	0	127.15	10,855	0	0	0	132.35
E. Fk. Silvies R. & Misc.	4.90	0	362.51	29,258	0	0	0	367.41
W. Fk. Silvies R. & Misc.	2.60	0	416.06	33,372	0	0	0	418.66
Willow Cr. & Misc.	2.41	0	41.68	3,335	0	0	0	44.09
Poison Cr. & Misc.	1.65	0.04	136.70	10,290	0	0	0	138.39
Prater Cr. & Misc.	0	0	37.70	2,008	0	0	0	37.70
Soldier Cr. & Misc.	0	0	32.62	2,285	0	0	0	32.62
Coffeepot Cr. & Misc.	0	0	64.79	3,580	0	0	0	64.79
Rattlesnake Cr. & Misc.	0	0	84.59	3,535	0	0	0	84.59
Cow Cr. & Misc.	0	0	322.85	23,774	0	0	0	322.85
Little & Big Rock & Misc.	0.12	0	7.02	559	0	0	0	7.14
Malheur Lake & Misc.	0	0	33.68	2,451	0	0.10	0	33.78
Total	16.88	0.04	1,667.35	125,302	0	0.10	0	1,684.37
TOTAL	24.12	0.04	2,002.12	147,975	34.00@	0.12	0	2,060.40@
2. SILVER STUDY AREA								
2A. Upper								
Silver Cr. & Misc.	3.45	0	138.39	9,897	0	5.00	0	145.84
Chickahominy Cr. & Misc.	0.41	0	22.32	1,618	0	0	0	22.73
Total	3.86	0	160.71	11,515	0	5.00	0	169.57
2B. Lower								
Silver Cr. & Misc.	2.11	0	245.51	16,846	0	0	0	247.63
Capehart Lake & Misc.	SP	0	0	0	0	0	0	0
Warm Springs Cr. & Misc.	0	0	2.94	235	0	0	0	2.94
Buzzard Cr. & Misc.	SP	0	0	0	0	0	0	0
Wilson Cr. & Misc.	0.20	0	4.38	332	0	0	0	4.58
Weed Lake & Misc.	0	0	8.00	640	0	0	0	8.00
Harney Lake & Misc.	0	0	6.75	538	0	0	0	6.75
Total	2.31	0	267.58	18,591	0	0	0	269.90
TOTAL	6.17	0	428.29	30,106	0	5.00	0	439.47
3. DONNER UND BLITZEN STUDY AREA								
3A. Upper								
Donner und Blitzen R. & Misc.	0.16	0	179.31	10,684	0	0.33	0	179.80
Krumbo Cr. & Misc.	0	0	15.58	1,410	0	0	3.19	18.77
Total	0.16	0	194.89	12,094	0	0.33	3.19	198.57
3B. Lower								
Donner und Blitzen R. & Misc.	0	0	653.81	35,881	0	0	215.00	868.81
Kiger Cr. & Misc.	0 #	0	178.15	7,230	0	0		178.15#
Riddle Cr. & Misc.	0 #	0	36.33	1,572	0	0		136.33#
Total	0 #	0	868.29	44,683	0	0	215.00	1,083.29#
TOTAL	0.16#	0	1,063.18	56,777	0	0	218.19	1,281.86#
4. CATLOW-ALVORD STUDY AREA								
4A. Catlow								
Catlow Valley & Misc.	1.02	0	259.74	20,275	0	0	0	260.77
Foster Lake & Misc.	SP	0	0	0	0	0	0	0
Guano Slough & Misc.	SP	0	3.61	289	0	0	0	3.61
Kegg Spring Valley	SP	0	0	0	0	0	0	0
Rock Cr. & Misc.	0.40	0	46.94	3,755	0	0	0	47.34
Guano Valley & Misc.	0.18	0	11.10	964	0	0	0	11.28
Total	1.61	0	321.39	25,283	0	0	0	323.00
4B. Alvord								
Alvord Desert & Misc.	0.11	0	1.86	150	0	0	0	1.97
Alvord Lake & Misc.	0	0	3.38	343	0	0	0	3.37
Trout Cr. & Misc.	5.32	0	154.14	7,214	0	0	0	159.56
Tum Tum Lake & Misc.	0.13	0	22.87	1,835	0	0	0	23.00
Wildhorse Cr. & Misc.	0.22	0	79.08	4,805	0	0	0	79.30
Mann Lake & Misc.	0.01	0	9.26	749	0	0	0	9.27
Whitehorse Cr. & Misc.	0	0	6.68	538	0	0	0	6.68
Rincon Cr. & Misc.	0.10	0	5.37	404	0	0	0	5.47
Total	5.88	0	282.64	16,038	0	0	0	288.52
TOTAL	7.40	0	604.03	41,321	0	0	0	611.52
BASIN TOTAL	37.93	0.04	4,097.62	276,179	34.00@	5.45	218.19	4,393.25#@

Note: @ Includes 5.00 cfs for mining on Silvies River Misc.
The adjudication allowed an unspecified amount for domestic and stock use.
SP Stock Ponds.

Data Source: Oregon State Engineer.

TABLE F

MAXIMUM LEGAL ANNUAL SURFACE
WATER RIGHT DEPLETIONS

March 1, 1967

ACRE-FEET

STREAM	DOMESTIC	INDUSTRIAL	IRRIGATION		POWER AND MINING	RECREATION	WILDLIFE	TOTAL
			ACRE-FEET	ACRES				
1. SILVIES STUDY AREA								
1A. Upper								
Silvies R. & Misc.	3,501	0	24,502	11,901	24,618@	7	0	52,629
Eddington Cr. & Misc.	145	0	1,042	485	0	0	0	1,187
Scotty Cr. & Misc.	290	0	5,652	1,979	0	0	0	5,942
Damon Cr. & Misc.	72	0	1,146	515	0	0	0	1,218
Bear Cr. & Misc.	217	0	10,984	5,159	0	0	0	11,201
Trout Cr. & Misc.	290	0	2,011	995	0	0	0	2,308
Emigrant Cr. & Misc.	724	0	3,383	1,638	0	0	0	4,107
Total	5,242	0	48,720	22,673	24,618@	14	0	78,592@
1B. Lower								
Silvies R. & Misc.	3,765	0	21,926	10,855	0	0	0	25,691
E. Fk. Silvies R. & Misc.	3,548	0	58,604	29,258	0	0	0	62,152
W. Fk. Silvies R. & Misc.	1,882	0	71,884	33,372	0	0	0	73,766
Willow Cr. & Misc.	1,745	0	7,156	3,335	0	0	0	8,901
Poison Cr. & Misc.	1,195	29	23,618	10,290	0	0	0	24,842
Prater Cr. & Misc.	0	0	6,024	2,008	0	0	0	6,024
Soldier Cr. & Misc.	0	0	6,729	2,285	0	0	0	6,729
Coffeepot Cr. & Misc.	0	0	8,948	3,580	0	0	0	8,948
Rattlesnake Cr. & Misc.	0	0	10,605	3,535	0	0	0	10,605
Cow Cr. & Misc.	0	0	71,322	23,774	0	0	0	71,322
Little & Big Rock Cr. & Misc.	87	0	1,398	559	0	0	0	1,485
Malheur Lake & Misc.	0	0	6,128	2,451	0	72	0	6,200
Total	12,222	29	294,342	125,302	0	72	0	306,665
TOTAL	17,464	29	343,062	147,975	24,618@	86	0	385,257@
2. SILVER STUDY AREA								
2A. Upper								
Silver Cr. & Misc.	2,498	0	25,016	9,897	0	3,620	0	31,134
Chickahominy Cr. & Misc.	297	0	4,045	1,618	0	0	0	4,342
Total	2,795	0	29,061	11,515	0	3,620	0	35,476
2B. Lower								
Silver Cr. & Misc.	1,528	0	42,494	16,846	0	0	0	44,022
Capehart Lake & Misc.	SP	0	0	0	0	0	0	0
Warm Springs Cr. & Misc.	0	0	588	235	0	0	0	588
Buzzard Cr. & Misc.	SP	0	0	0	0	0	0	0
Wilson Cr. & Misc.	145	0	830	332	0	0	0	975
Weed Lake & Misc.	0	0	1,600	640	0	0	0	1,600
Harney Lake & Misc.	0	0	1,620	538	0	3,620	0	1,620
Total	1,673	0	47,132	18,591	0	3,620	0	48,806
TOTAL	4,468	0	76,193	30,106	0	3,620	0	84,281
3. DONNER UND BLITZEN STUDY AREA								
3A. Upper								
Donner und Blitzen R. & Misc.	116	0	32,352	10,684	0	239	0	32,707
Krumbo Cr. & Misc.	0	0	4,230	1,410	0	0	2,310	6,540
Total	116	0	36,582	12,094	0	239	2,310	39,247
3B. Lower								
Donner und Blitzen R. & Misc.	0	0	107,342	35,881	0	0	155,660	263,002
Kiger Cr. & Misc.	-#	0	21,689	7,230	0	0	0	21,689#
Riddle Cr. & Misc.	-#	0	4,716	1,572	0	0	0	4,716#
Total	-#	0	133,747	44,683	0	0	155,660	289,407#
TOTAL	116#	0	170,329	56,777	0	239	157,970	328,654#
4. CATLOW-ALVORD STUDY AREA								
4A. Catlow								
Catlow Valley & Misc.	741	0	60,825	20,275	0	0	0	61,566
Foster Lake & Misc.	SP	0	0	0	0	0	0	0
Guano Slough & Misc.	SP	0	867	289	0	0	0	867
Xegg Spring Valley	SP	0	0	0	0	0	0	0
Rock Cr. & Misc.	290	0	11,268	3,755	0	0	0	11,558
Guano Valley & Misc.	133	0	2,892	964	0	0	0	3,025
Total	1,164	0	75,852	25,283	0	0	0	77,016
4B. Alvord								
Alvord Desert & Misc.	77	0	450	150	0	0	0	527
Alvord Lake & Misc.	0	0	1,029	343	0	0	0	1,029
Trout Cr. & Misc.	3,852	0	21,651	7,214	0	0	0	25,503
Tum Tum Cr. & Misc.	94	0	5,505	1,835	0	0	0	5,599
Wildhorse Cr. & Misc.	92	0	13,197	4,805	0	0	0	13,289
Mann Lake & Misc.	7	0	2,223	749	0	0	0	2,230
Whitehorse Cr. & Misc.	0	0	2,152	538	0	0	0	2,152
Rincon Cr. & Misc.	70	0	1,212	404	0	0	0	1,282
Total	4,192	0	47,419	16,038	0	0	0	51,611
TOTAL	5,356	0	123,271	41,321	0	0	0	128,627
BASIN TOTAL	27,404#	29	712,855	276,179	24,618@	3,945	157,970	926,819#@

Note: @ Includes 3,620 acre-feet for mining on Silvies River Misc.
The adjudication allowed an unspecified amount for domestic and stock use.
SP Stock Pond

Data Source: Oregon State Engineer.

ACKNOWLEDGMENTS

The State Water Resources Board expresses grateful appreciation to those organizations which have permitted the use of material from their publications listed under Selected Bibliography in this report. In accordance with cooperative agreements, the U. S. Department of Agriculture's Field Party supplied agricultural, economic, and water use data which was used extensively throughout this report. The Oregon State Game Commission and the U. S. Bureau of Sport Fisheries and Wildlife supplied the basic data for fish and wildlife water uses.

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The Malheur Lake Basin Water Resources Committee, represented by the following chairmen and functional committee leaders, presented valuable basin data at the State Water Resources Board hearing:

Chairman - William Cramer
Secretary - Ray Novotny
Basin Subcommittees:

Watershed - Co-chairmen: Cal Weissenfluh, Stewart Hanna, Vern Stahl, John Scharff
Domestic - Chairwoman, Judy Beck
Municipal - Chairman, William E. Garner
Industrial & Mining - Chairman, Joe Miles
Fish, Wildlife, & Recreation - Chairman, J. O. Harris
Pollution - Chairman, Noah Squires
Irrigation - Chairman, Jim Tackman,
Area Chairmen: Henry Ausmus, Homer Otley, Ray Novotny

The above agencies and committees collaborated with the following members of the technical staff of the State Water Resources Board in preparation of this report:

Fred D. Gustafson	Chief Engineer
Quentin Bowman	Fielf Representative
William H. Farmer	Basin Engineer

ABBREVIATIONS AND SYMBOLS

Ac-ft.	Acre-feet
Can.	Canyon
Cfs	Cubic feet per second
Co.	County
Cr.	Creek
D.	Ditch
Dom.	Domestic
Elev.	Elevation
°F.	Degrees Fahrenheit
Fk.	Fork
Ft.	Feet, Foot
Gpd	Gallons per day
Gpm	Gallons per minute
Ind.	Industrial
Irr.	Irrigation
Jct.	Junction
L.	Lake, Little
Mdw.	Meadow
MSL	Mean Sea Level
Mtn.	Mountain
Mun.	Municipal
No.	Number
Pt.	Point
R.	River
Rec.	Recreation
Res.	Reservoir
Rng.	Range
Sec.	Section
Sl.	Slough
Spr.	Spring
Sq. Mi.	Square mile
SWRB	State Water Resources Board
TLR.	Trailers
Twp.	Township
USAF	United States Air Force
USGS	United States Geological Survey
Vs	Versus

APPROXIMATE HYDRAULIC EQUIVALENTS

1 acre foot
- = a volume 1 acre in area and 1 foot in depth
- = 326,000 gallons
- = 43,560 cubic feet
- = 0.5 cubic feet per second for 1 day

1 cubic foot per second
- = 7.5 gallons per second
- = 450 gallons per minute
- = 2.0 acre-feet per day
- = 650,000 gallons per day

1 inch per day
- = 0.04 cubic feet per second per acre
- = 27 cubic feet per second per square mile
- = 19 gallons per minute per acre

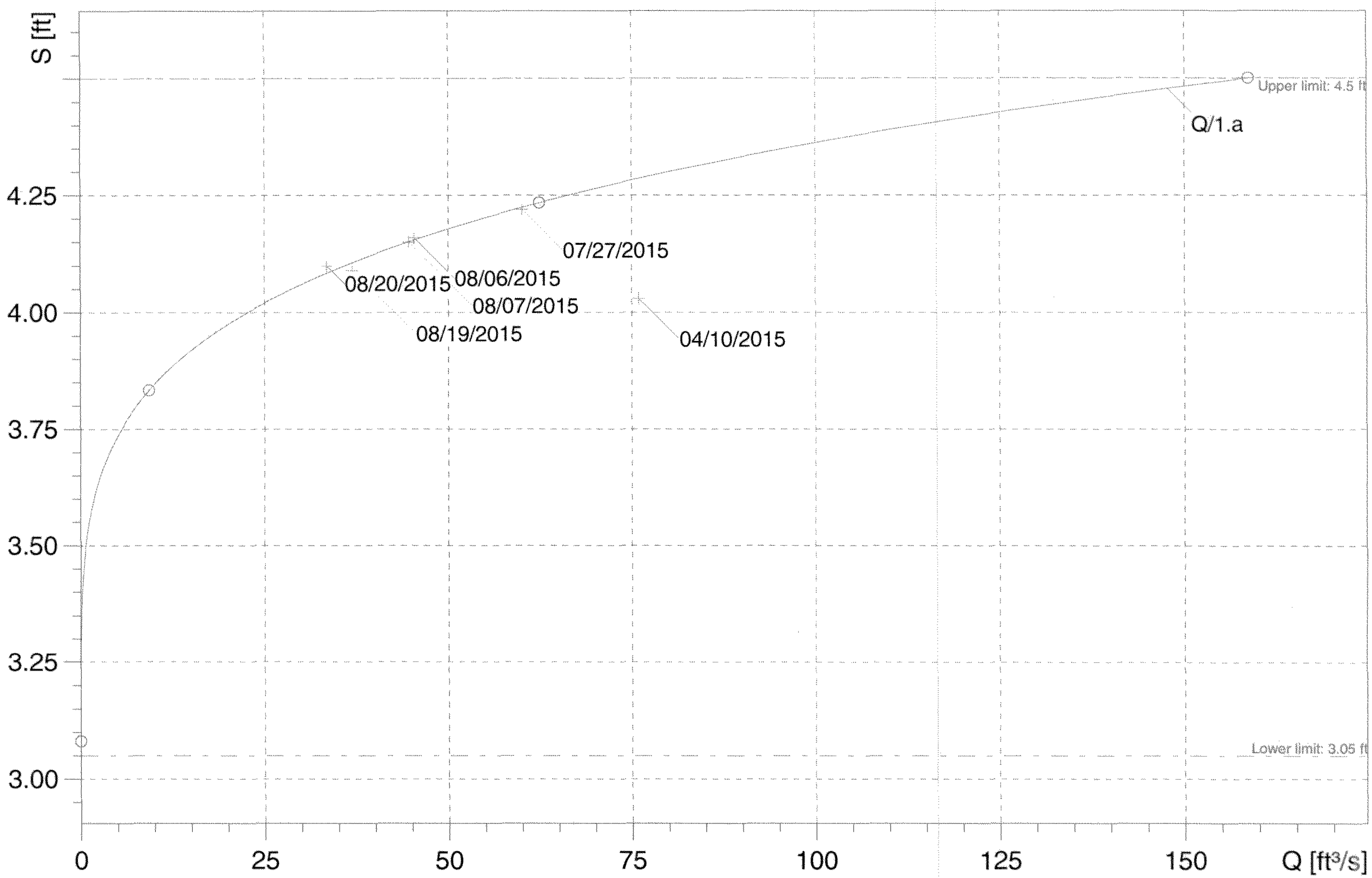
1 inch per hour
- = 1.0 cubic feet per second per acre
- = 640 cubic feet per second per square mile
- = 450 gallons per minute per acre

1 million gallons per day
- = 690 gallons per minute
- = 1.5 cubic feet per second
- = 3.0 acre-feet per day

Site / WALLOWA R AB WALLOWA LAKE NR JOSEPH
Parameter Q

Station number: **13325500**
River:
River number:

Staff gauge zero **0.000ft**
Catchment area: **0.00sqm**



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