MALHEUR-OWYHEE BASINS

STATE WATER RESOURCES BOARD
SALEM, OREGON
June 1969

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COVER PICTURE

The Malheur River near Juntura, Oregon. Price $2.50
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PURPOSE AND INTRODUCTION

The purpose of this report is to set forth in a condensed form the data compiled and conclusions reached by the State Water Resources Board as the result of a reconnaissance study of the Malheur and Owyhee Basins leading to the formulation of an integrated, coordinated program for the use and control of the water resources of the basins.

The board's investigation was completed in 1969. The study was made in compliance with ORS 536.300 which states:

"(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, reclamation, flood plains and reservoir sites."

Having completed the study necessary to formulate and implement an integrated, coordinated water resources program, the board proposes to adopt a program for the Malheur and Owyhee Basins. This program will fulfill the requirements of ORS 536.300 which states:

"(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."

The program will be based on the provisions outlined in ORS 536.300 and the data obtained in the basin investigation. A summary of the basic data and factors examined in the study are contained in the report. Detailed information is available for examination in the files of the board in Salem, Oregon.

This study provides basic data enabling the State Water Resources Board to analyze the potential for water and related land resource development in the basins. In response to a request from the Malheur County Court,

particular emphasis was placed on determining the location and amount of land, and related water requirements, that could be developed utilizing Snake River water. This complex question involved the potential for (1) applying water directly to presently nonirrigated land; (2) providing supplemental water to irrigated lands having an inadequate water supply; and (3) substituting Snake River water for that presently used to irrigate low elevation basin lands along the Snake River and along the lower reaches of the Malheur and Owyhee Rivers. This would permit using the present water supplies, thereby released, for supplemental or full water supply to lands too remote to be served directly from the Snake River.

It was decided to concentrate on those lands considered to have the greatest potential for development in the near future and for which a reasonably accurate analysis could be completed with the time available and fiscal capability of the board. The area selected, to be served directly from the Snake River, was designated the Malheur Project. Although some consideration was given to items (2) and (3) cited above, further study is needed before the full potential of lands to be irrigated using Snake River water can be quantified.

Because of economic and other factors applied in determining the relatively short-range potential for development, projections made in this study will differ from and are not to be confused with projections in the board's concurrent but separate "ultimate needs" study, "Oregon's Long-Range Requirements for Water," published in 1969.

FINDINGS AND CONCLUSIONS

A. Water Supply

1. The Malheur-Owyhee Basins' average annual yield of over 1 million acre-feet, from surface and ground water sources, supplies water for the irrigation of about 273,900 of the 306,590 acres for which water rights have been established and for all other of the basins' needs. About one-half of the annual yield is lost to outflow either as ground water or as widely dispersed surface water return flows, due primarily to irrigation concentrated along the lower reaches of the Malheur and Owyhee Rivers and along the Snake River.

2. There are sufficient ground and surface water resources to more than double the presently irrigated acreage by increasing it to the approximately 564,000-acre level of identified irrigable lands, plus supplying additional water for domestic, municipal, industrial, and recreation purposes. This determination is based on the presumption that adequate Snake River water, after an average annual depletion of 1,063,000 acre-feet for anticipated future upstream development, will be available for use in the basins.

3. The in-basins' surface water supply, with maximum justifiable control and more efficient utilization, is not adequate in most areas to satisfy the needs; therefore, the coordinated development of the Snake River and the in-basins water supplies, based on additional studies of both sources, is needed to maintain the economic growth and well-being of the basins.

4. There are numerous potential reservoir sites in the basins (shown on Plates 3 and 4 of the Appendix), but economically feasible storage projects are limited by widely fluctuating seasonal watershed yields and prior water rights of users in the lower valleys.

5. Available data indicate that the ground water resource is appreciable and represents an important potential water source.

B. Water Rights

6. There is practically no unappropriated in-basins' surface water during the irrigation season. Additional storage with appreciable carryover capacity is

a prerequisite to any developmental plan of significant scope.

7. The only right for out-of-basins diversion is a storage right in Owyhee Reservoir to use 213,060 acre-feet on 31,800 acres of Owyhee Project lands in Idaho.

8. There is justification for review of certain present water rights, such as the 100 cfs domestic water right in Agency Valley Reservoir which is not being used for that purpose; and water rights for power (231 cfs) and mining (about 39 cfs) which are practically unused.

C. Water Use and Control

9. Surface and ground water requirements for domestic, livestock, municipal, and industrial uses of water are relatively small compared to those for irrigation.

10. Industrial use of surface water is mainly for sand and gravel production along the Snake River.

11. Irrigation presently accounts for, and will continue to account for, over 95 percent of the water used.

12. About 48,500 acres of the presently irrigated lands do not receive an adequate water supply during the June to September period in an average water year. All irrigated lands dependent upon surface water experience shortages in critical low-water years.

13. Extensive rehabilitation programs for most irrigated land and distribution facilities - additional canal lining, control structures, land leveling, drains, and sprinkler systems - are needed to conserve water, reduce erosion, and increase production.

14. The physical and economic potential of hydroelectric power development in the basins is minor.

15. Fish life is and will continue to be an important nonconsumptive user of water in the Malheur and Owyhee Rivers and their tributaries.

16. Flooding is a serious local problem on about 8,700 acres of cropland in the Vale-Ontario and Jordan

Valley areas. This occurs on an average of about once every five years.

17. Erosion is a problem on 18,700 acres of cropland and on 694,000 acres of range and pastureland.

18. Pollution of ground and surface water presently does not appear to be a widespread problem in either basin, although it is serious in some localities.

19. A conflict exists between flood control regulation and uses of water for irrigation, recreation, industry, pollution abatement, and fish life.

20. Restrictions on further appropriations by establishment of minimum perennial streamflows would not be of material aid on most streams during low-flow periods because of the present state of overappropriation.

D. Potential Development

21. Small reservoirs on strategic tributaries could reduce local flooding and erosion and provide late-season water for livestock, irrigation, and fish life.

22. Irrigation development has been restricted by the economic limitations of high pump lifts and distances of irrigable lands from the water sources. Technological progress in the design of high lift pumps and sprinkler irrigation equipment is helping to improve the feasibility of potential irrigation projects.

23. There are 290,400 acres of potentially irrigable land within the basins which have been so identified, plus large areas which have been less intensively studied.

24. Detailed soil classification of potentially irrigable lands is needed at locations shown on the Potential Development map in the Appendix.

25. Annual pumping requirements from the Snake River would average 1,454,000 acre-feet to irrigate, adequately, the approximately 564,000 acres of presently irrigated and potentially irrigable land.

26. Long-range plans should provide for the use of Snake River water on the lower elevation lands that are now being served by water from the Malheur and Owyhee

Rivers. Water of the Malheur and Owyhee Rivers could then be applied to the higher elevation lands.

27. Installing streamflow gages at key locations in potential development areas shown on Plates 3 and 4 of the Appendix would provide urgently needed data to increase the knowledge of surface water flows.

28. Detailed comprehensive investigations should be made of potential reservoir sites; ground water recharge and management; more efficient use of presently developed surface water; and, ultimately, intrabasin diversions and exchanges involving Snake River water.

29. In the absence of any currently feasible major flood control projects within the basin, consideration should be given to county and municipal flood plain management programs.

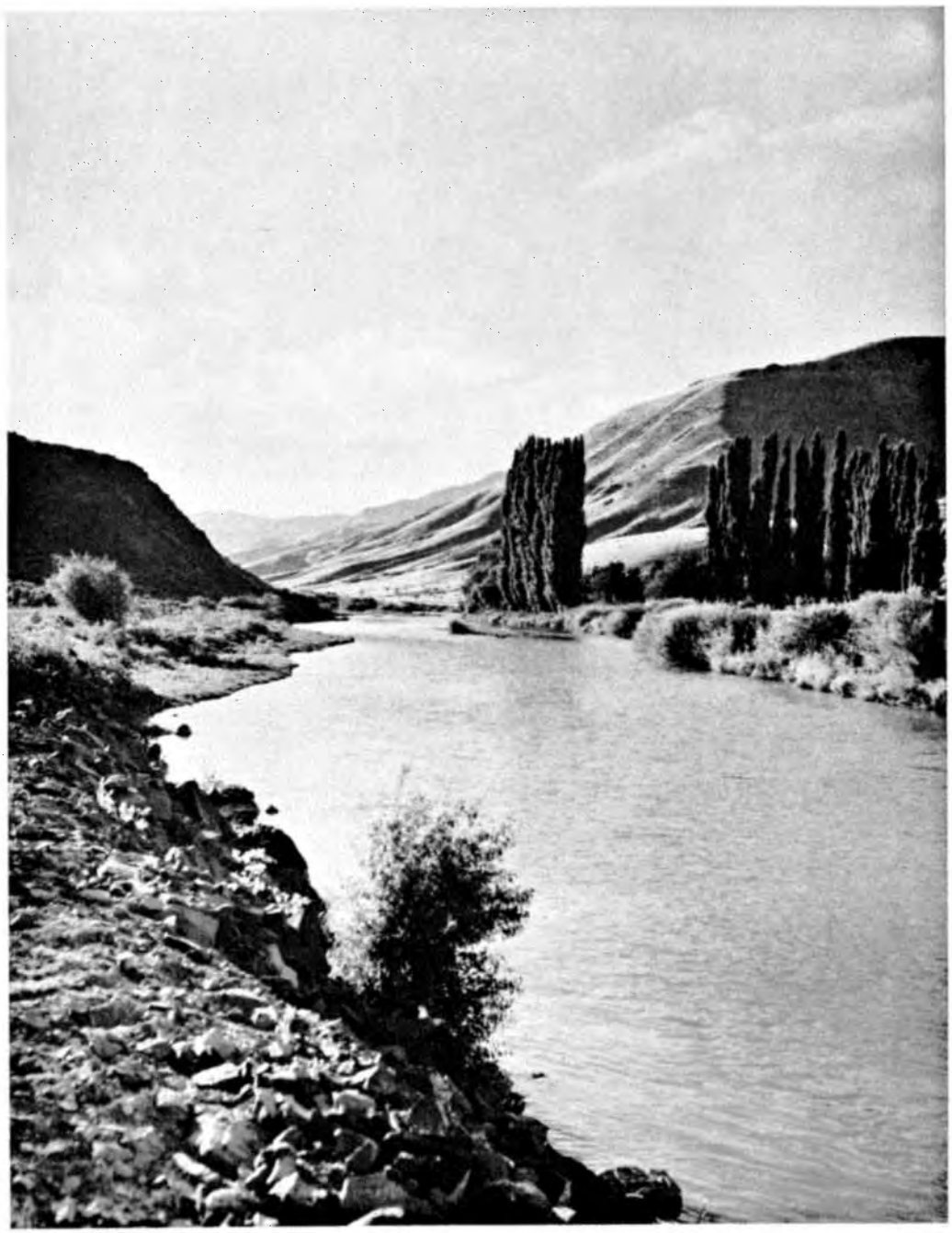
30. Summer minimum flows recommended by the Oregon State Game Commission cannot be provided due to overappropriation of present flows.

31. The continued growth of the basins' economy is dependent upon the comprehensive multipurpose development of its water and related land resources.

32. Reconnaissance investigation shows a sufficient degree of feasibility for the irrigation of 211,000 acres of land (the Malheur Project) in the Vale-Ontario area of the basins, utilizing 1,128,600 acre-feet of water annually to be pumped from the Snake River, to warrant proceeding with detailed feasibility studies and development plans.

33. Consideration should be given to early development of those areas within the Malheur Project amenable to stage construction.

THE BASIN



Oregon State Highway Department photo

MALHEUR-OWYHEE BASINS

PART I THE BASINS

NATURAL FEATURES

Location and Description

The Malheur-Owyhee Basins, as designated by the State Water Resources Board and delineated in Figure 1, are located in the extreme southeastern portion of the State of Oregon. The combined basins measure about 170 miles from north to south and about 95 miles from east to west; contain 11,247 square miles, or 7,198,400 acres; and comprise 11.6 percent of the state's total area. Table 1 shows the area distribution of the basins by county.

TABLE 1

BASINS' AREA BY COUNTY

COUNTY	TOTAL AREA (Sq. Mi.)	AREA WITHIN MALHEUR & OWYHEE BASINS			
		Sq. Mi.	Acres	Percent of County	Percent of Basins
Baker	3,084	107	68,400	3	1
Grant	4,533	390	249,900	9	3
Harney	10,132	1,324	847,300	13	12
Malheur	9,925	9,426	6,032,800	95	84
TOTAL	-	11,247	7,198,400	-	100

Data Source: USDA, Oregon River Basin Survey Staff

The Malheur-Owyhee Basins are bounded on the west by the Malheur Lake Basin, on the northwest by the John Day Basin, on the north by the Powder Basin, and on the east and south by the States of Idaho and Nevada.

The basins' physiography is generally characterized by over 419,000 acres of high-elevation forestland; 6,154,000 acres of intermediate-elevation semidesert benchlands; and 273,000 acres of lower-elevation cropland which is concentrated mainly in the lower valleys of the Malheur and Owyhee Rivers.

Most of the basins' area lies in the 3,000 to 6,000-foot elevation range. It consists of undulating high desert, except in the middle Owyhee and upper Malheur drainages, where the topography is rough and the canyons are deeply

THE BASINS

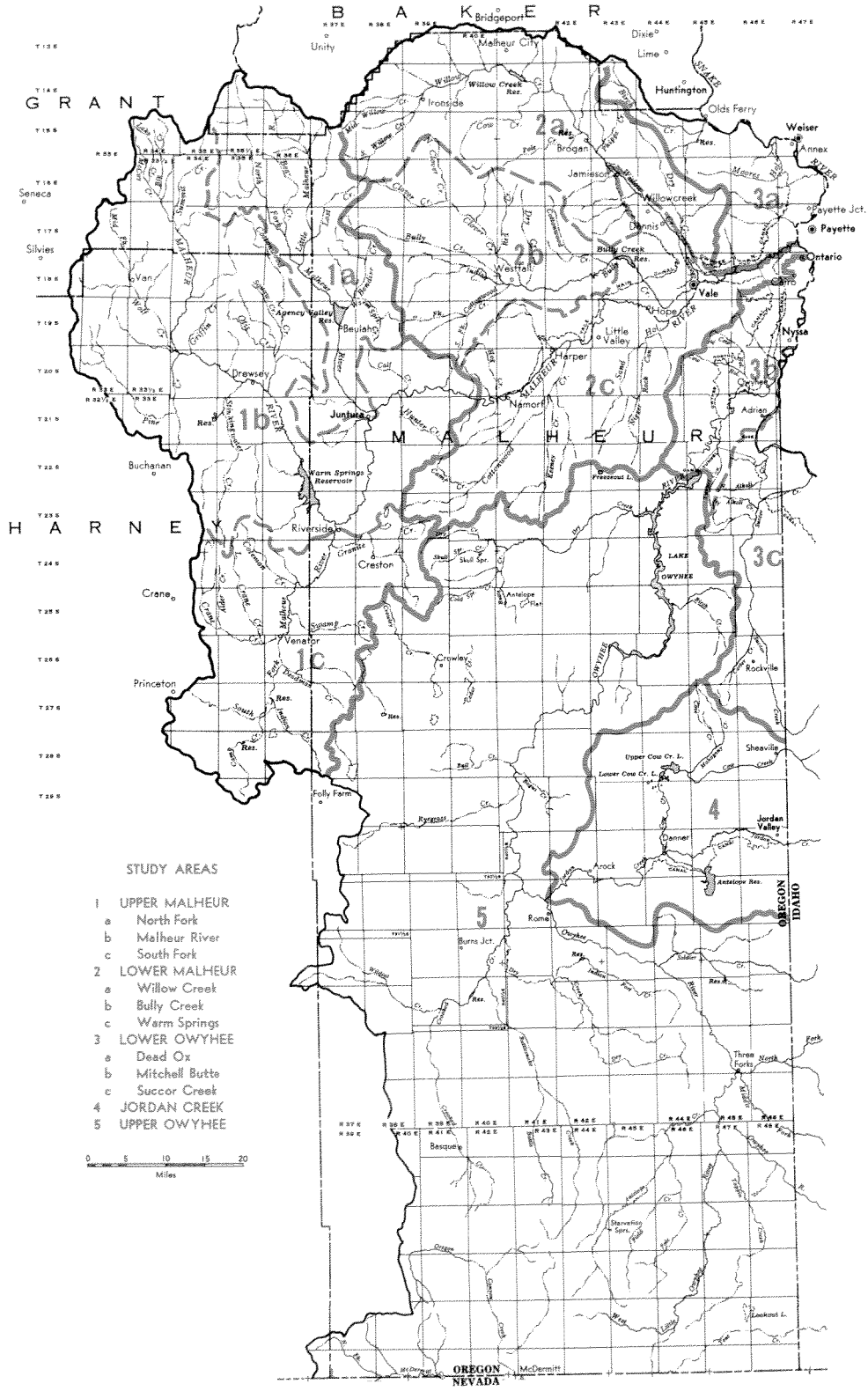


FIGURE 1. Malheur-Owyhee Basins.

incised. Elevations range from approximately 2,000 feet along the Snake River to 8,600 feet on the northwestern edge of the Malheur Basin.

For study purposes and in consideration of pronounced differences in physical and hydrological characteristics, the Malheur Basin has been divided into the upper and lower Malheur study areas while the Owyhee Basin has been divided into the upper Owyhee, Jordan Creek, and lower Owyhee study areas (see Figure 1). For this study, the boundary established between the lower Malheur and lower Owyhee study areas is predicated on water use.

The Special "Malheur Project" study area also has been designated, partially overlapping the lower Malheur and Owyhee study areas. The project involves relatively level, semidesert benchlands north and south of Malheur River near Vale, Oregon. Plates 1 and 2 show the location of the Malheur Project area in relation to other potential development features in the two basins.

Benchlands within the project and elsewhere in the basins were formed during a period of intensive volcanic activity in southwestern Idaho and eastern Oregon. Lava flows filled the stream valleys, including the Snake River, damming them and impounding large lakes. Several thousand feet of sediments were deposited in the lakes, which subsequently were drained by streams eroding through the basalt dams. Loess sediments and alluvial materials mantle extensive portions of the area and have subdued the sharp, local relief of the volcanic materials.

Within the project the topography is varied. Numerous deeply-incised waterways and steep terrace scarps divide the gentler slopes of irrigable land. About 95 percent of the project is located on upland slopes and terraces, with the remainder in small valleys that intersect the terraces.

Stream Systems

Plates 3 and 4 illustrate the stream systems of the Malheur-Owyhee Basins and locate all known water features including streams, springs, lakes, reservoirs, canals, and wells. The Snake River enters Oregon northwest of Homedale, Idaho at stream mile 409 as designated on Plates 3 and 4. Thence it meanders back and forth across the Oregon-Idaho state line to river mile 396, whence its

northerly course constitutes the Oregon-Idaho boundary. Lower reaches of the Malheur and Owyhee Rivers have perennial flows while the higher reaches, as well as a majority of the minor streams, have intermittent flows. All unused flows from surface and ground water sources, except along the southern border, drain to the Snake River.

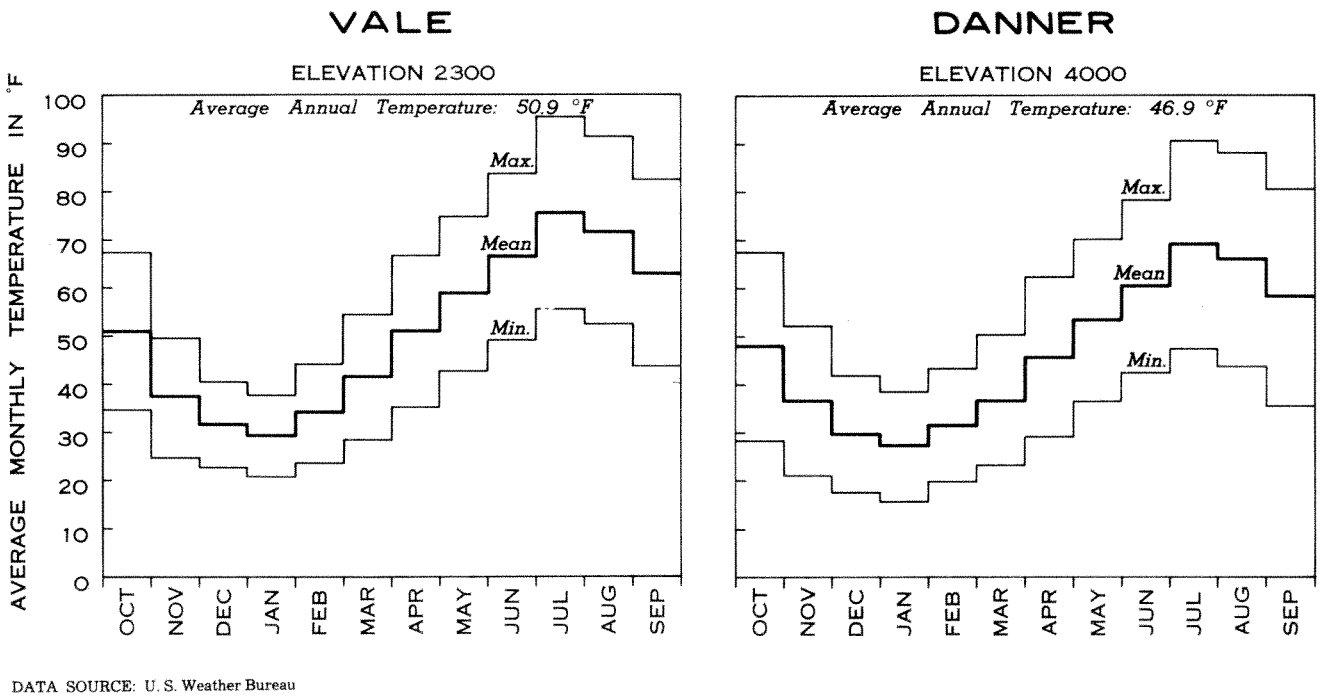
The Malheur River originates west of the Snake River in Strawberry Range, a southern spur of the Blue Mountains. From its source the stream flows southeasterly 70 miles, then turns northerly for 24 miles to its junction with the North Fork Malheur River. From there its course is northeasterly to its confluence with the Snake River near stream mile 370. The total length of the Malheur River is 190 miles, and its drainage area is about 4,000 square miles. The principal tributaries are its North and South Forks, Bully Creek, and Willow Creek.

The Owyhee River, one of the more important tributaries of the Snake River, rises in northern Nevada, flows northwesterly through a small portion of Idaho to the mouth of Jordan Creek in Oregon, and thence northerly to enter the Snake River near stream mile 394. The principal tributaries are its North, South, and Middle Forks; Little Owyhee River and Jordan Creek. The total length of the Owyhee River is about 280 miles; and its drainage area is about 11,340 square miles, 6,200 of which lie in Oregon. Succor Creek, which flows directly into the Snake River, is the only other Owyhee Basin stream with an appreciable water yield. Small intermittent streams such as McDermitt Creek and Oregon Canyon Creek, which drain 355,000 acres of desert land in their Oregon portions, flow into the Quinn River closed basin in Nevada.

Climate

The climate can be considered as semiarid, with the basins experiencing hot summers, cold winters, and moderate spring and fall temperatures. Figure 2 shows the average monthly temperatures for the Vale, Oregon weather station (1935-64) at elevation 2,300 feet - average annual temperature of 50.9 degrees Fahrenheit (^{o}F.) and the Danner, Oregon weather station (1935-64) at elevation 4,000 feet - average annual temperature 46.9^{o} F.

Records from the Vale station are considered typical of the climatic conditions in the Lower Malheur-Owyhee Basins. Those from the Danner station are representative of conditions in Jordan Valley and the Upper Malheur-Owyhee Basins.



DATA SOURCE: U. S. Weather Bureau

FIGURE 2. Average Monthly Air Temperatures at Vale and Danner.

Most of the areas' precipitation occurs during the winter and at higher elevations. Average annual precipitation ranges from 8 inches along the Malheur River main stem, near the Snake River and in the Rome area, to more than 25 inches in the forested headwater areas of the Malheur River. Figure 3 shows the average monthly and annual precipitation at Vale and Danner as well as illustrating the extremely low average rate of precipitation during the summer months.

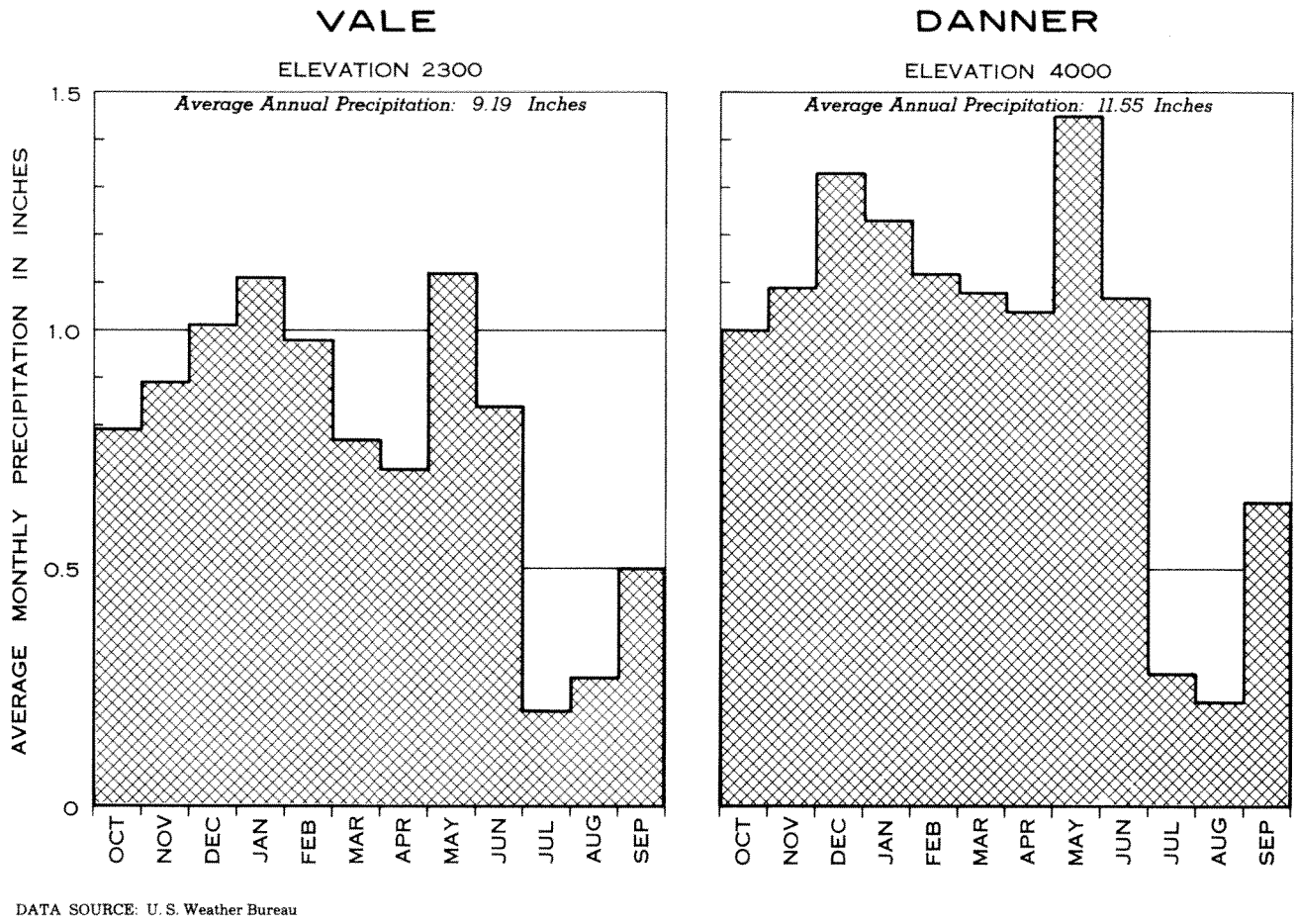


FIGURE 3. Average Monthly Precipitation at Vale and Danner.

ECONOMIC FACTORS

Population

The earliest documented exploration of the basins was made by Peter Skene Ogden of the Hudson's Bay Company in 1826 with the first emigrants crossing the area in 1842. It was not until the gold rush of 1863, however, that the first settlement was established, being located in Jordan Valley.

The basins' 1965 population of 25,800 was concentrated in the agriculturally developed areas with 39 percent residing in five incorporated cities having populations as follows: Ontario 5,350; Nyssa 2,485; Vale 1,810; Jordan Valley 200; and Juntura 90.

Table 2 presents the basins' population distribution by county, as of 1965.

TABLE 2

BASIN POPULATION
BY STUDY AREA AND COUNTY
1965

MALHEUR BASIN	BAKER	GRANT	HARNEY	MALHEUR	TOTAL
Upper Malheur	40	20	310	200	570
Lower Malheur	0	0	0	7,600	7,600
OWYHEE BASIN					
Lower Owyhee	30	0	0	16,800	16,830
Jordan Creek	0	0	0	500	500
Upper Owyhee	0	0	0	300	300
TOTAL	70	20	310	25,400	25,800

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

Census data show that about 95 percent of the population is located in the lower Malheur and lower Owyhee study areas while the upper portions of the basins are sparsely populated. Population increases in recent years have been concentrated in the lower-elevation, irrigated valleys. As can be seen in Figure 4, Malheur County has had a fairly consistent growth of about 1.2 percent per year since 1890.

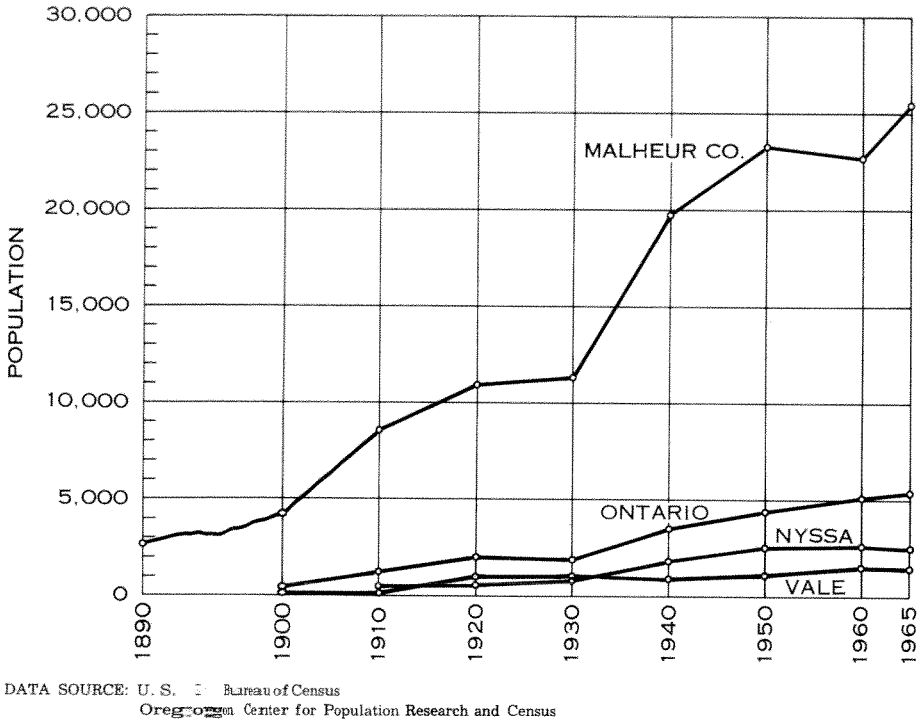


FIGURE 4. Population Trends.

Transportation

The basins are served by the main line of the Union Pacific Railroad, which passes through Ontario and Nyssa with branch lines extending west from Ontario and south from Nyssa. U. S. Highway 80N enters the northeastern portion of the basins, passes through Ontario and proceeds southeasterly into Idaho. U. S. Highways 20 and 26 provide routes to the west while U. S. Highway 95 passes southwesterly through Idaho enroute to Jordan Valley, then southward through McDermitt, Nevada. Much of the basins is without road access or has only unimproved roads serving individual ranches. The Bureau of Land Management, however, is undertaking an extensive program to improve access to federal lands.

The areas' only airport with commercial facilities is located at Ontario. There are nine widely separated airfields for small planes.

Industry

Water is vital to the industries of the basins, being used primarily for food processing, construction, sand and gravel processing, and by the service industries. There were 34 manufacturing establishments in the basins in 1966. The largest, the Amalgamated Sugar Company's plant at Nyssa, employs 1,100 persons and processes an average of 875,000 tons of sugar beets annually.

Table 3 presents the employment figures for Malheur County from 1940 to 1960 and illustrates the changing character of the areas' employment. The significant rise in food processing employment and the companion decrease in agricultural employment can be explained by a growing market for processed food products and the increased use of labor-saving farm machinery and improved farming methods.

TABLE 3

EMPLOYMENT IN MALHEUR COUNTY

INDUSTRY	1940	1950	1960
Agriculture	3,865	4,132	3,176
Mining	50	25	24
Construction	427	614	476
Manufacturing	83	214	133
Food Processing	91	193	716
Transportation & Communications	187	312	211
Wholesale & Retail Trades	810	1,286	1,634
Services and Other Industry	1,211	1,798	2,263
TOTAL	6,724	8,574	8,633

Data Source: U.S. Bureau of Census.

Recreation is also a significant factor in the growth of the areas' economy. Contributing thereto is a broad

range of activities such as rock hounding, hunting, fishing, water sports, camping, and sightseeing.

Agriculture

The basins' economy consistently has been dependent upon water from the placer mining of the 1860's to the irrigated-agriculture base of the present. Considerable secondary economic benefits of this base accrue to such activities as construction, manufacturing, transportation, communications, utilities, and finance. Agricultural production and processing are the basins' primary sources of income. The diversification of production is evident in Table 4 showing Malheur County's agricultural production in 1966.

TABLE 4

MALHEUR COUNTY AGRICULTURAL PRODUCTION
1966

CROP	ACREAGE	YIELD	EST. VALUE
Sugar Beets	17,200	22.5 Ton	$ 5,418,000
Potatoes	14,500	255 Cwt	4,990,000
Onions	4,132	490 Cwt	4,362,000
Alfalfa Hay	58,000	3.2 Ton	5,197,000
Other Hay	39,000	1.0 Ton	1,170,000
Alfalfa Seed	9,000	475 lbs.	1,710,000
Wheat	10,500	65 Bu.	989,000
Barley	12,000	65 Bu.	819,000
Oats	3,000	65 Bu.	136,000
Other Grain	2,500	60 Bu.	175,000
Corn	4,000	75 Bu.	435,000
Corn Silage	9,000	19 Ton	1,282,000
Red Clover Seed	600	320 lbs.	51,800
All Other Seed	250		40,000
Sweet Corn	3,500	6.5 Ton	438,000
Mint	700	50 lbs.	175,000
Misc. Crops	1,900		551,000
Livestock			12,275,000
Dairy Products			3,875,000
All Poultry			319,000
Other Livestock Products			331,000
TOTAL	189,782		$44,738,800

Data Source: Malheur County Extension Service.

The most intensive and diversified agriculture is practiced in the lower reaches of the Malheur and Owyhee River valleys where the more important crops produced are alfalfa, clover, sugar beets, onions, potatoes, corn, small grains, and truck and seed crops. The economic

base of the upper Malheur, upper Owyhee, and Jordan Valley areas, however, is based on the raising of livestock, with irrigated lands used primarily for growing hay and forage crops.

Basin lands are classified by use as follows: about 85 percent as rangeland; 4 percent as cropland, of which 97 percent is irrigated; 6 percent as forestland; and 5 percent for other uses. Forage crops are produced on about one-half of the basins' croplands and generally are marketed in the form of livestock and livestock products. The remaining croplands produce seed crops, cereals, and intensive row crops.

Table 5 shows general land use in the Malheur-Owyhee Basins by study areas.

TABLE 5

GENERAL LAND USE

STUDY AREA	NUMBER OF FARMS	ACRES				
		Forestland	Rangeland	Cropland	Other	TOTAL
1. UPPER MALHEUR TOTAL	77	359,000	1,193,300	35,500	55,700	1,643,500
A. North Fork	21	160,000	154,000	4,600	17,000	335,600
B. Malheur R.	42	191,000	622,400	22,300	25,900	861,600
C. South Fork	14	8,000	416,900	8,600	12,800	446,300
2. LOWER MALHEUR TOTAL	585	36,000	1,101,200	91,500	50,300	1,279,000
A. Willow Creek	33	29,000	372,500	13,600	10,500	425,600
B. Bully Creek	19	7,000	293,800	5,500	7,400	313,700
C. Warmsprings	533	-	434,900	72,400	32,400	539,700
3. LOWER OWYHEE TOTAL	1,045	400	390,400	124,600	29,600	545,000
A. Dead Ox	275	-	108,200	48,600	4,900	161,700
B. Mitchell Butte	650	-	116,700	63,000	13,200	192,900
C. Succor Creek	120	400	165,500	13,000	11,500	190,400
4. JORDAN CREEK	44	7,000	426,200	21,500	35,500	490,200
5. UPPER OWYHEE	34	16,600	3,033,000	9,000	182,100	3,240,700
TOTAL	1,785	419,000	6,144,100	282,100	353,200	7,198,400

Data Source: USDA, Oregon River Basin Survey Staff.

Forest and Range

The basins' vegetation is typical of the semidesert. Sagebrush, bluebunch wheatgrass, Sandberg bluegrass, cheatgrass, Idaho fescue, and squirreltail are the predominant vegetative forms. Crested wheatgrass is being seeded on vast areas of rangeland to restore and improve its productivity. Scattered areas of timber are located at the higher elevations.

Forest and brush lands totaling 419,000 acres produce only limited quantities of commercial forest products that do not add materially to the economy. About 6,155,000 acres of rangeland and forestland is used for livestock grazing. Increased livestock projection is dependent on improving the forage-producing capabilities of the rangeland.

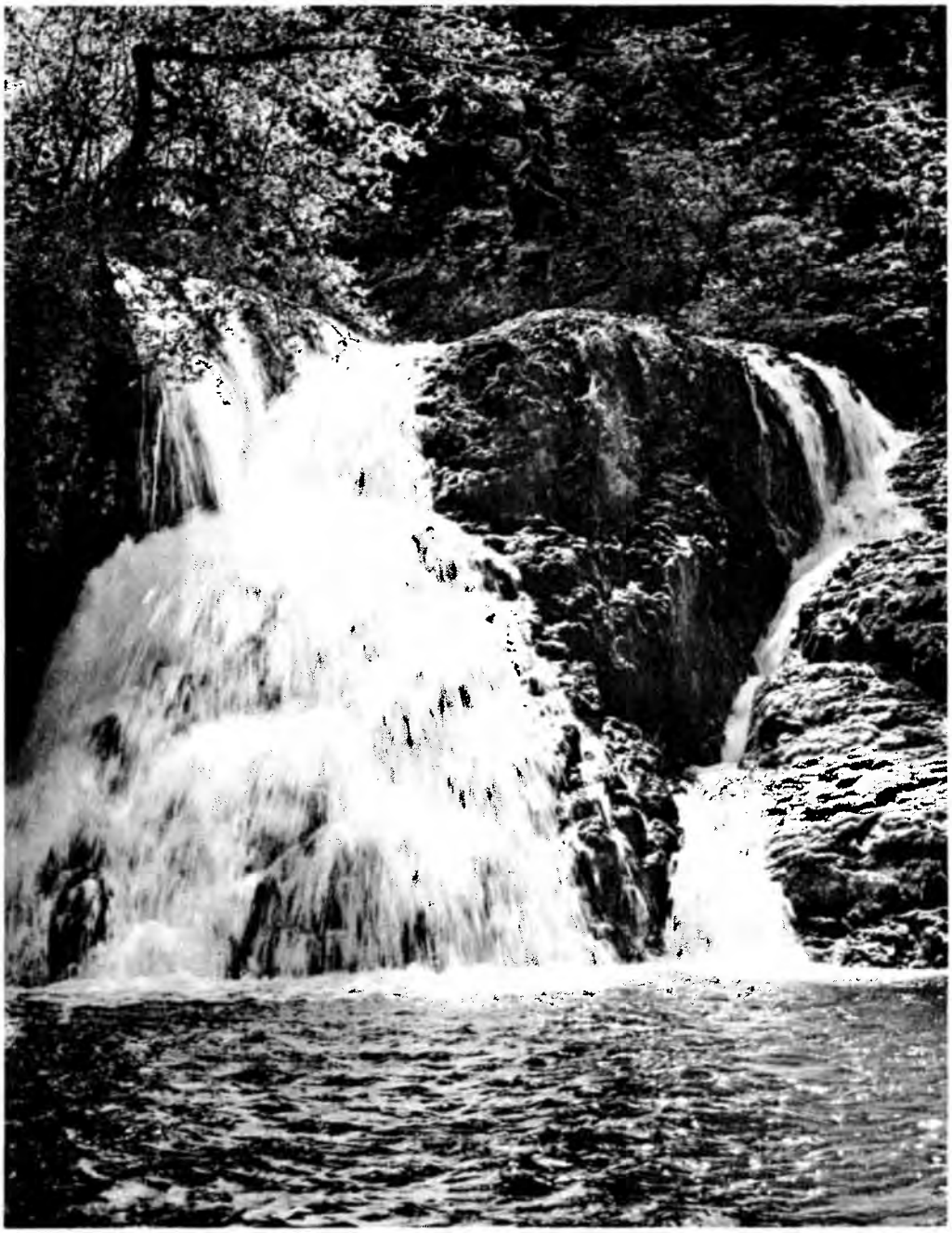
Mineral Resources

The mining of mineral resources has been a relatively insignificant contributor to the basins' economy because the deposits generally are small or of inferior grade. Numerous gravel terraces along and adjacent to the Snake River, however, afford excellent quality sand and gravel suitable for most construction uses.

Other mineral commodities having economic importance are building stone, cinders, mercury, semiprecious stones, and volcanic ash. The potentials of extensive deposits of zeolites are being investigated. Nearly 70 square miles of land have recently been leased for uranium exploration.

Oil and gas exploration has centered in the general Vale-Ontario area, underlain by Tertiary nonmarine sediments. The seven deepest of the 20 exploratory wells listed by the Oregon Department of Geology and Mineral Industries range from 4,336 feet to 7,470 feet in depth with the lowest 900 feet of the deepest well being in lava rock. No commercial quantities of gas or oil have been produced. Several excellent gas shows from relatively shallow sedimentary horizons, however, indicate that a commercial field may yet be found. It is to be noted that the entire Tertiary section of rocks has never been penetrated and that potential pre-Tertiary oil or gas horizons in the basin remain untested.

WATER SUPPLY



Oregon State Highway Department photo

PART II

WATER SUPPLY

SURFACE WATER

Stream gaging records of the U. S. Geological Survey and the State Engineer provide the basis for the subsequent sections on annual runoff, monthly distribution, and extreme discharges of in-basin water supplies for the selected 30-year base period (1935-64). Information presented in those sections will be referred to in Part III, Water Rights, in formulating a conclusion as to the quantities of unappropriated surface water in the basins subject to the jurisdiction of the State Water Resources Board.

Report of numerous federal, state, and private studies have been published concerning Snake River water supply, quality, use, and control. These reports, listed in the Bibliography in the Appendix, were used extensively in a study, summarized at the end of Part II, to determine availability of Snake River water for use in the Malheur-Owyhee Basins.

In general, the streams of the Malheur-Owyhee Basins possess characteristics attributable to the semiarid climate. On an average annual basis, low precipitation produces relatively low runoff although large variations can be expected on both annual and seasonal bases. Natural flows, except for those resulting from snowmelt in the spring, are usually quite low. Occasional high flows occur in the winter and spring months from rainstorms augmented by snowmelt and/or frozen ground conditions. Flow characteristics of nearly all major streams in the lower valleys, however, and of the Snake River, reflect the impact of upstream storage reservoirs, irrigation diversions, and return flows.

In the Malheur Basin, streamflow is regulated primarily by the following reservoirs, which are further identified by location, usable capacity, and other information:

1. Warm Springs Reservoir, Malheur River above South Fork, 191,000 acre-feet.

2. Agency Valley Reservoir (also known as Beulah Reservoir), North Fork of Malheur River, 60,000 acre-feet.

3. Bully Creek Reservoir, Bully Creek, 30,000 acre-feet.

4. Malheur Reservoir (also known as Willow Creek Reservoir and Willow Creek Reservoir No. 3), Willow Creek, 49,000 acre-feet (storage limited to about 20,000 acre-feet by State Engineer due to instability of the structure).

Plate 1 shows the location of the reservoirs in the Malheur Basin.

In the Owyhee Basin, flows of the upper Owyhee River are partially controlled by the recently reconstructed Wild Horse Reservoir in Nevada (capacity 50,000 acre-feet) and by numerous small reservoirs; while downstream, the Owyhee River is extensively regulated by Owyhee Reservoir (capacity 1,122,000 acre-feet). Part of Jordan Creek's floodflows are diverted by canal to the offstream Antelope Reservoir (capacity 45,000 acre-feet). Plate 2 shows the locations of the principal reservoirs in the Owyhee Basin.

Annual Runoff

The maximum, minimum, and average annual runoff at gaged locations on principal streams of the basins are listed in Table 6. Runoff values shown are for the 1935-64 base period and reflect irrigation diversions and reservoir regulations upstream of gage locations which are shown in Plates 3 and 4 of the Appendix.

In Table 6, the largest average annual runoff is the Owyhee River's 670,000 acre-feet (above Owyhee Reservoir), although it has experienced extremes of 195,000 and 1,750,000 acre-feet. Comparative runoff values for the Malheur River (near Namorf) show the average to be 258,000 acre-feet with a minimum and maximum of 103,000 and 494,000 acre-feet, respectively.

Average annual values for runoff present a distorted picture as to water actually available on a usable, year to year basis. Figure 5 illustrates the average annual runoff during the 30-year base period for the Malheur and Owyhee Rivers, as well as for Bully and Jordan Creeks. It will be noted that only on Jordan Creek does the number of years with above average annual runoff values exceed the number of years of below average runoff. Only about one-third of the time do the other

TABLE 6

ANNUAL RUNOFF AT GAGED LOCATIONS

STATION LOCATION	USGS GAGE No.	COMPLETE YEARS OF RECORD	ANNUAL RUNOFF Acre-feet		
			Maximum	Minimum	Average
MALHEUR BASIN					
Upper					
Malheur R. near Drewsey	2140	39	274,000	57,800	135,000
Malheur R. below Warmsprings Reservoir, near Riverside	2150	50	254,000	57,000	132,000
N. Fk. Malheur R. above Agencyy Valley Reservoir, near Beulah	2165	28	165,000	53,600	87,000*
N. Fk. Malheur R. near Beulah	2175	39	175,000	39,600	94,000
Lower					
Malheur R. near Namorf 1/	2190	2	494,000*	103,000*	258,000*
Malheur R. at Little Valley, near Hope 2/	2200	42	377,000	46,600	143,000
Bully Creek at Warmsprings, near Vale	2265	0	66,500	900*	22,700*
Malheur R. below Nevada Dam, near Vale 3/	2290	13	546,000*	25,400	159,000*
OWYHEE BASIN					
Upper					
Owyhee R. near Rome	1810	15	1,711,000	148,000	620,000*
Jordan Cr. above Lone Tree Cr. near Jordan Valley	1780	16	275,000	50,000	133,000*
Owyhee R. above Owyhee Reservoir	1820	22	1,750,000*	195,000*	670,000*
Lower					
Owyhee R. below Owyhee Dam	1830	37	1,169,000	16,200	230,000
Succor Cr. near Homedale	1729	0	32,000*	6,000*	15,000*

*Correlated

1/ Total of gages 2191 and 2192

2/ Includes recorded streamflow at gage 2205 but does not include diversion via Vale Main Canal.

3/ Does not include diversion via Nevada Main Canal or return flow around gage.

Data Source: U. S. Geological Survey
State Engineer

three streams exhibit above average runoffs and these are marked by occasional extreme highs such as in 1952 when, on the Owyhee, the year's runoff almost tripled the average annual runoff.

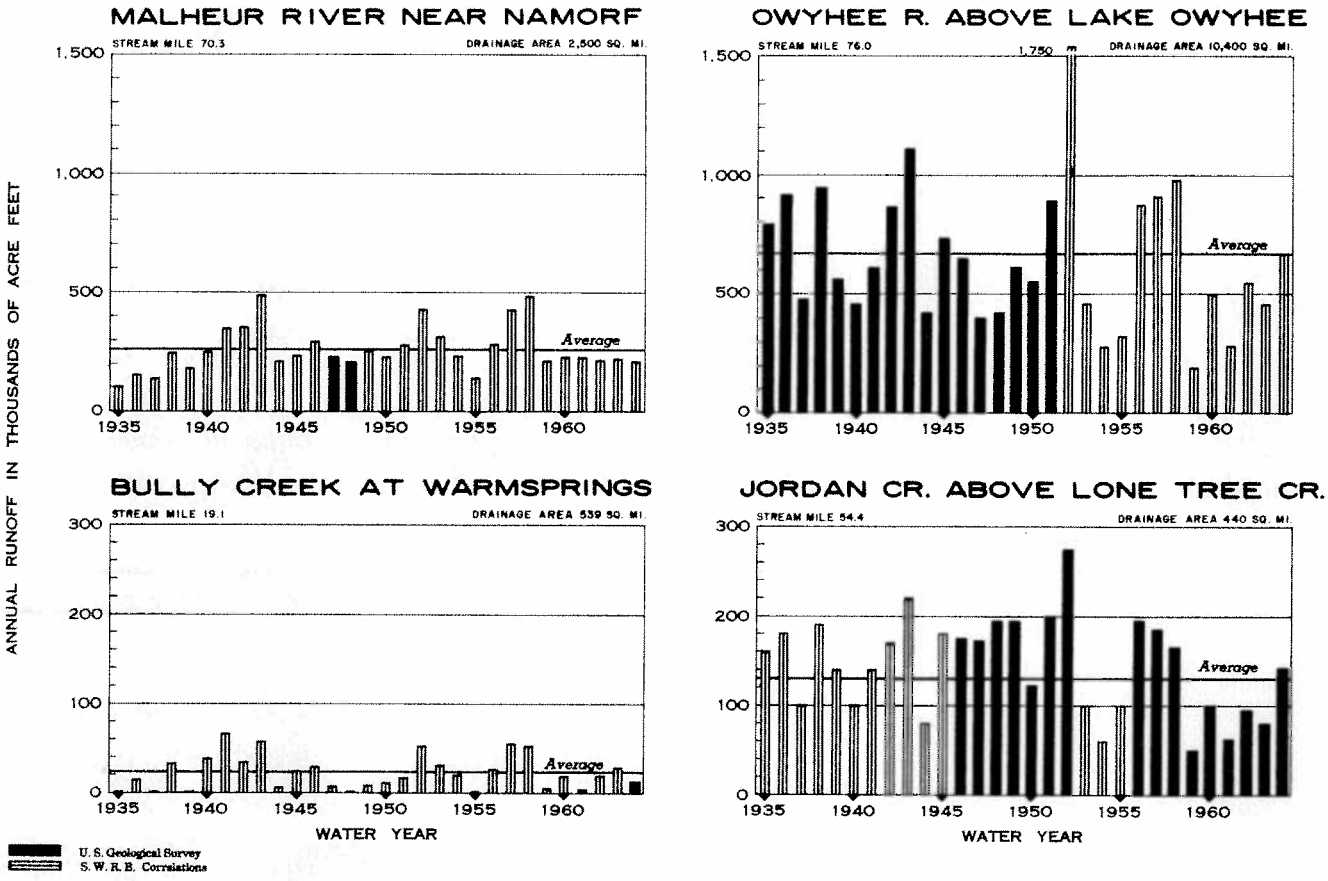
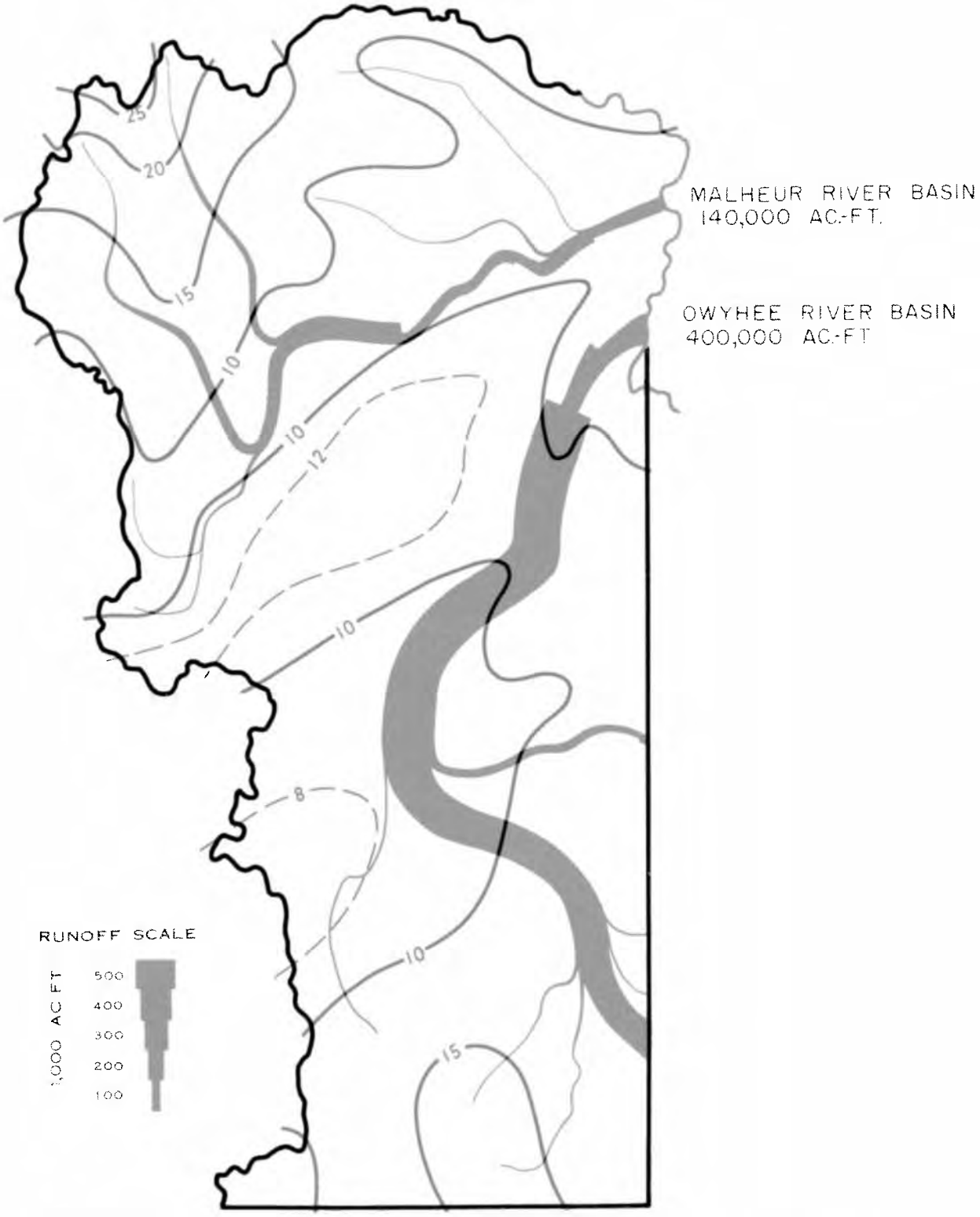


FIGURE 5. Annual Runoff of Selected Streams.

The Malheur-Owyhee Basins' average annual precipitation and runoff patterns are illustrated in Figure 6. Runoff from the Malheur and Owyhee Rivers to the Snake River is estimated to average 140,000 and 400,000 acre-feet, respectively. Gaging records indicate that these quantities are predominantly return flows from the irrigation of Vale and Owyhee Project lands. The Malheur Basin runoff is reasonably well substantiated by the gage below Nevada Dam at stream mile 19. Average monthly flows



NOTE. Comparative runoff is indicated by line band width and includes surface and ground wafers.

DATA SOURCE: U. S. Army, Corps of Engineers – precipitation
Oregon State Engineer, U. S. G. S. – gaged runoff

FIGURE 6. Average Annual Precipitation and Runoff to Snake River.

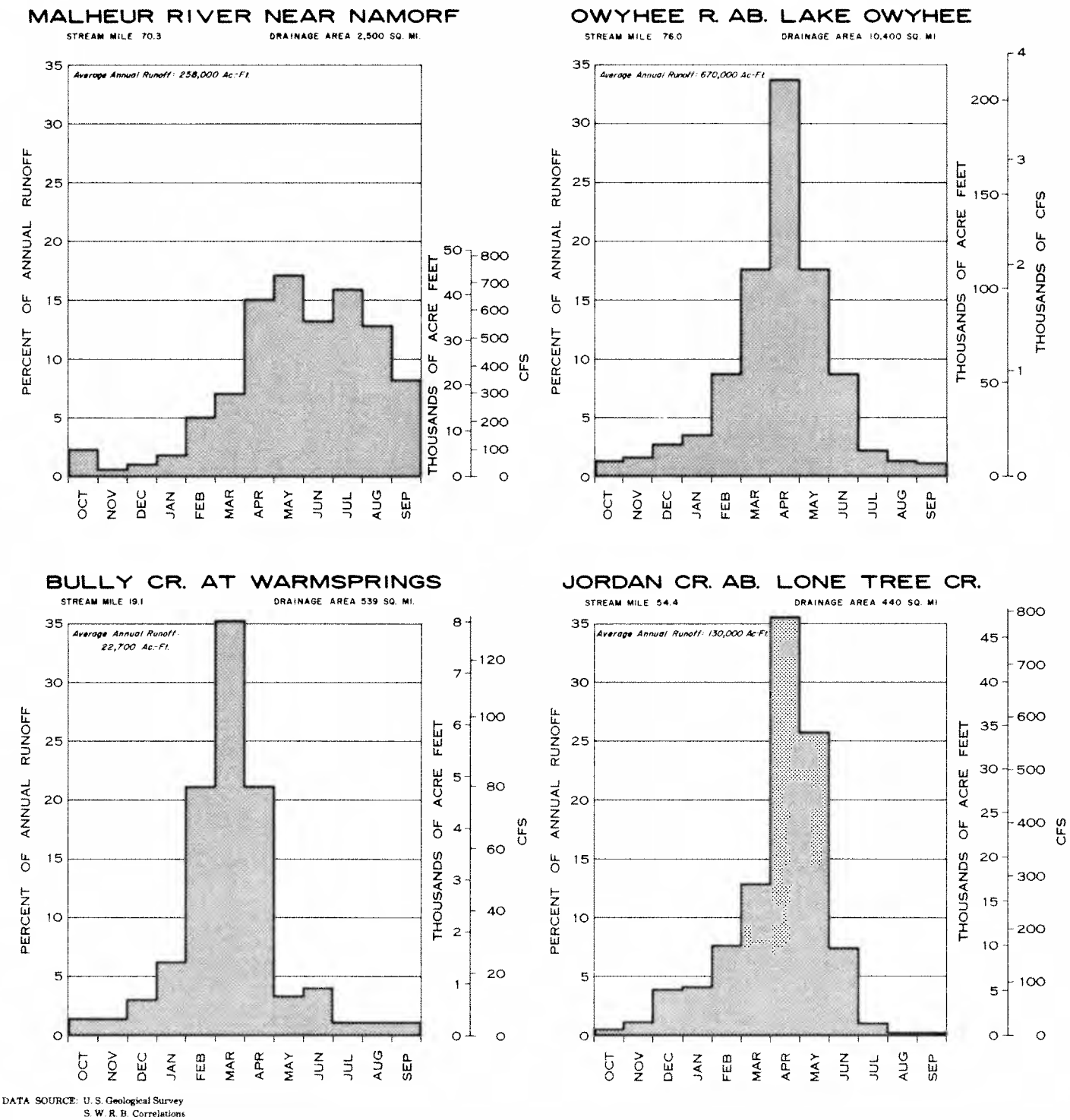
vary from as little as 0.8 percent of the average annual runoff in August, about 20 cubic feet per second (cfs) on a continuous flow basis, to as much as 24.3 percent in March. The Malheur Basin runoff, cited above, reflects the estimated depletion of the average annual streamflow at the gage, 159,000 acre-feet, by the net effect of several downstream diversions and return flows to the river either direct or via drainage canals from project lands. Notwithstanding the average, zero flows have been recorded during each of the summer months.

Runoff from the Owyhee Basin is less clearly defined. Except for the months of May, June, July, and August when irrigation releases were being made from Owyhee Reservoir, mean daily flows ranging from as little as 1.0 to 3.0 cfs have been recorded at the gage below Owyhee Dam during each month of the year. Records from the gage above Owyhee Reservoir document well the streamflow to that point. Gage records above and below Owyhee Dam and Reservoir together with Owyhee Project diversions and allowance for reservoir evaporation losses indicate a residual average annual runoff from Owyhee River to Snake River of about 181,000 acre-feet.

Return flows from Owyhee Project diversions, however, contribute further to the basin runoff. Project lands skirt the westernmost edge of Snake River for a length of about 60 miles, about 43 of which are in Oregon, the balance in Idaho. The return flows, thus, are widely dispersed. Some occur as a ground water contribution to the lower reaches of the Owyhee and Malheur Rivers and to the Snake River; others flow directly, or are conveyed by drainage canals to these streams. In the absence of records documenting return flows, a consumptive use analysis was made of Owyhee Project diversions. From this analysis it was estimated, with allowance for evaporation losses, that return flows from the project are about 219,000 acre-feet. This quantity was added to the reasonably well documented 181,000 acre-feet of stream runoff below Owyhee Dam to arrive at the 400,000 acre-feet previously cited.

Monthly Distribution

Figure 7 illustrates the monthly distribution of the annual runoff for Malheur River, Owyhee River, Bully Creek,



DATA SOURCE: U. S. Geological Survey
S. W. R. B. Correlations

FIGURE 7. Monthly Distribution of Annual Runoff.

and Jordan Creek at key stream gaging stations. The runoff pattern from Malheur River (near Namorf) is strongly influenced by storage and summer releases of irrigation water from Agency Valley and Warm Springs Reservoirs while the other streams shown in Figure 7 reflect only minor regulation at the gaged locations. The peak months of discharge are in the March through May period and account for 60 to 80 percent of the average annual runoff of Bully Creek, Owyhee River, and Jordan Creek.

Extreme Discharges

The regimen of the Owyhee River (near Rome) is illustrated in Figure 8 by a daily discharge hydrograph for the

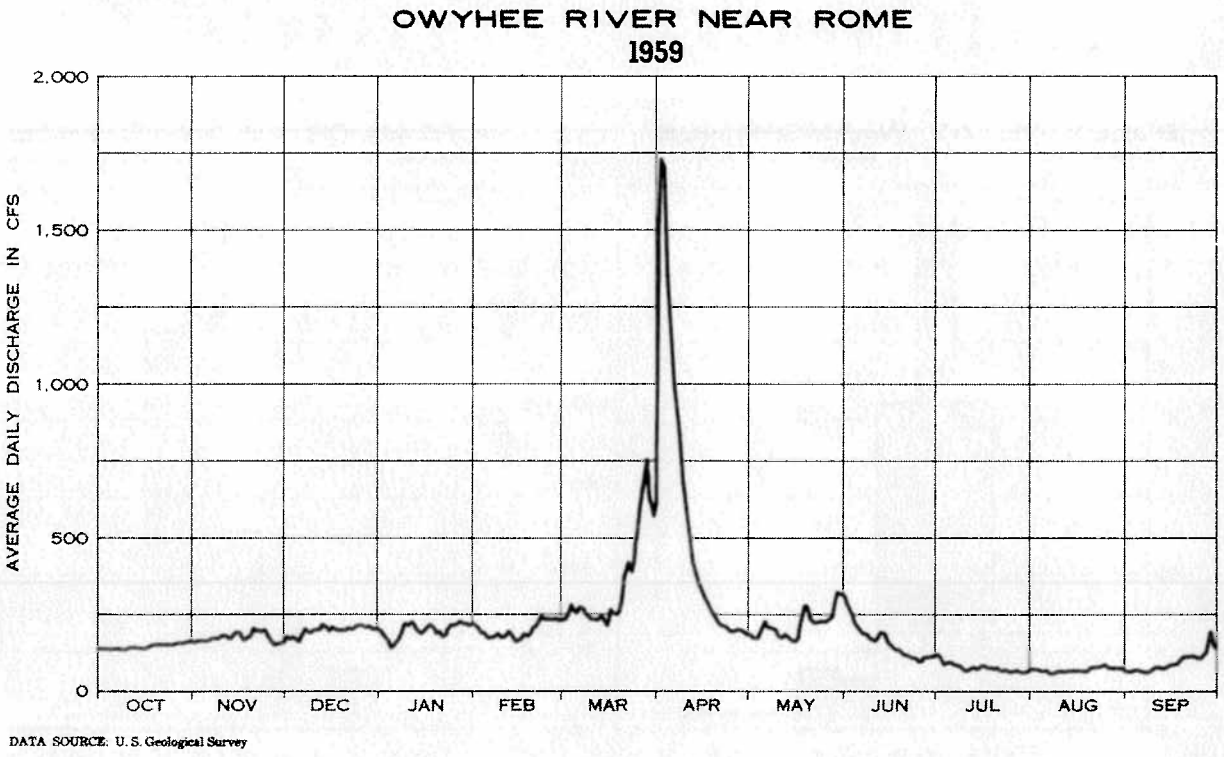


FIGURE 8. Daily Discharge of the Owyhee River near Rome.

below-average water year of 1959. Flows fluctuated between 60 and 300 cfs during the May through February period and peaked at over 1,700 cfs during early April. Similar fluctuations, though not as pronounced, are characteristic of most of the basins' other streams where not influenced by storage reservoirs.

Quality

The Malheur River originates in the Strawberry Range of the Blue Mountains and is of excellent quality. As the river passes through agricultural areas, however, its flow is depleted for irrigation use and the quality of return flows is modified, resulting in higher temperatures, altered chemical composition, and large concentrations of sediment and dissolved solids. Annual flood flows also contribute large amounts of problem-causing sediment. The North Fork also originates in the Blue Mountains and its water is of excellent quality. Even though it accumulates return flows from irrigation, the quality remains high enough to enhance the quality of main stem flows. The South Fork originates in the arid hills which separate the Malheur and Owyhee Basins and has a very low summer flow consisting almost entirely of irrigation return flows. In the lower reaches of the Malheur River, the combined effects of upstream irrigation with its impact on quality of return flows; runoff from areas of large livestock concentrations; food processing discharge; and a flat gradient combine to make the river a turbid, sluggish, heavily enriched (chemical compounds, sediment, dissolved solids) waterway as it flows into the Snake River.

The situation of Owyhee River quality is similar to the Malheur River in that it also shows the effects of irrigation use, although the adverse effect is not quite as pronounced. In the lower reach, such use is intensive and contributes to sizable return flows in the summer months. During the winter months, the river experiences very low flows.

In general, there are no serious quality problems of a continuous nature in either the Malheur or Owyhee Rivers. Seasonal problems occur but have not yet precluded utilization of the waters when adequate corrective measures are instituted.

GROUND WATER

The U. S. Geological Survey has made a detailed ground water study of Cow Valley in the Malheur Basin and reconnaissance studies of the Malheur-Owyhee Basins. These reports, which form the basis for the greater part of this ground water text, are listed in the bibliography. Additional data were provided by the County Water Resources Committee and by the State Engineer who also has made a detailed study of Cow Valley relative to its designation as a critical ground water area.

Geology

Rocks forming the Malheur-Owyhee Basins are predominantly lavas and other volcanic types, with large areas underlain by tuffaceous sediments. A relatively small area in the extreme northern part of the Malheur Basin is underlain by older metamorphic rock types. The larger valleys contain alluvium in considerable depth. The rocks, depending on their permeability and porosity, range from low to moderate in their ability to transmit and yield ground water to wells.

Occurrence

Well yields and depths to the regional ground water table in the Malheur Basin vary considerably. Good irrigation supplies are obtained from wells in the Ironside, Brogan, Jamieson, and Westfall areas where some pump tests exceed 1,000 gallons per minute (gpm). The valley areas between Harper and the Snake River yield adequate domestic and municipal water supplies, but supplies for other purposes vary greatly. Some irrigation wells in waterlogged areas also serve the dual purpose of drainage wells.

Cow Valley, located between Brogan and Ironside, was designated by the State Engineer as a critical ground water area in 1959; and state-imposed controls equate discharge to recharge by limiting withdrawals to an average of 4,500 acre-feet per year. Ground water withdrawal in other parts of the Willow Creek drainage is also approaching recharge limits. However, withdrawal in most of the remaining parts of the Malheur Basin can be increased.

The regional ground water table south of the Snake River

in the Owyhee Basin is well below land surface; and well yields are generally poor except in the larger basins and valleys. Four irrigation wells drilled in Jordan Valley in 1966 were test pumped at 1,800 to 4,100 gpm and their yields have remained stable. Several other high-yield wells are located near the Ryegrass Reservoir northwest of Burns Junction and in the vicinity of McDermitt.

Data on 25 representative wells are shown in Table 7 and Figure 9.

TABLE 7

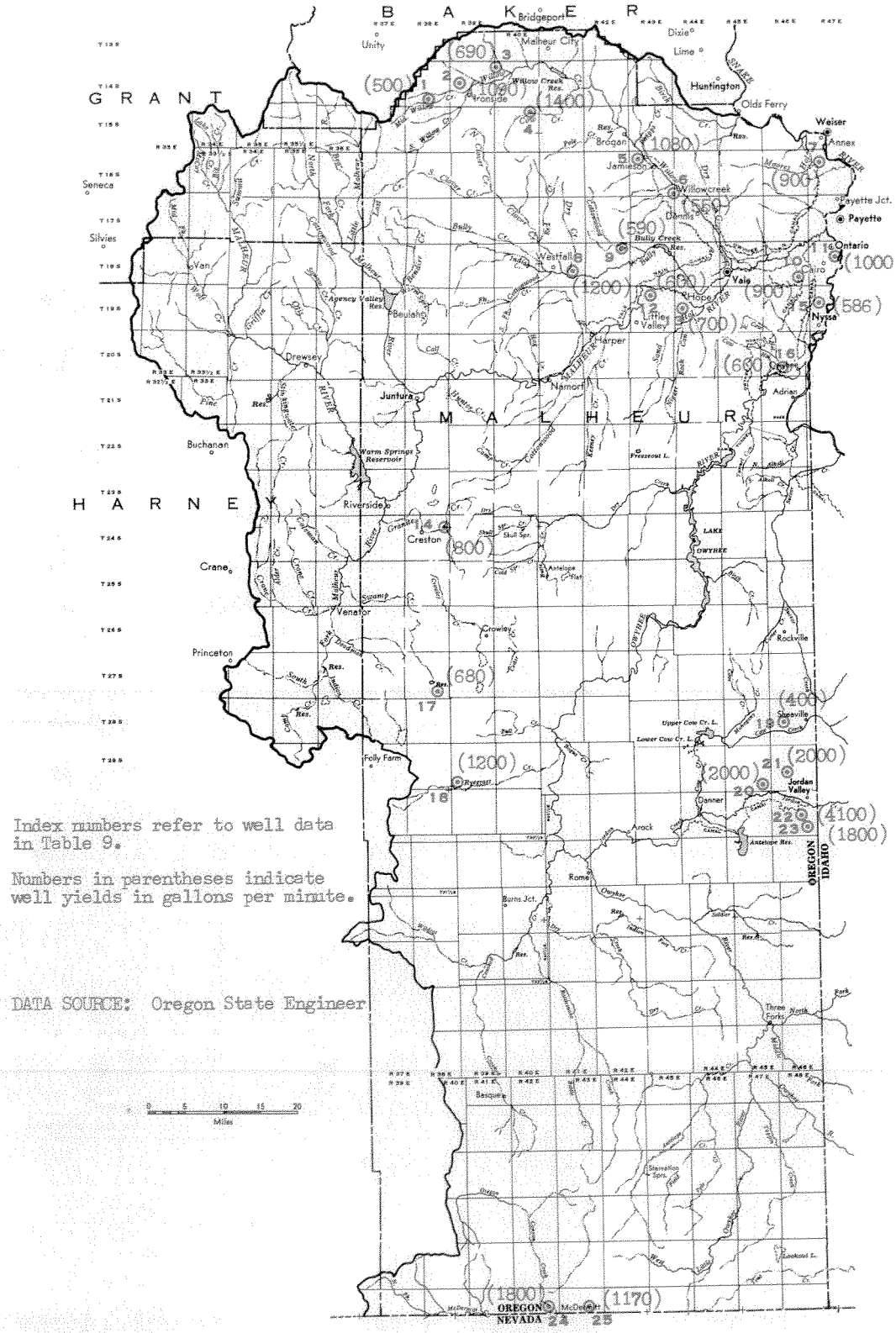
MALHEUR-OWYHEE BASINS
REPRESENTATIVE TEST PUMPED HIGH-YIELD WELLS

INDEX 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
1	500	69	7	22 - 3/54	170	12	Gravel, Lava	Irrigation
2	1090	96	11	14 - 7/55	365	14	Basalt	Irrigation
3	690	139	5	11 -11/56	590	14	Sandstone	Irrigation
4	1400	70	20	90 - 6/55	330	14	Gravel, Lava	Irrigation
5	1080	100	11	7 - 7/65	262	12	Sand, Gravel	Irrigation
6	550	15	37	15 - 7/61	45	16	Gravel	Irrigation
7	900	45	20	12 - 5/66	70	15	Sand	Irr. & Drain
8	1200	80	15	120 - 7/63	930	14	Basalt	Irrigation
9	590	75	8	Flows - 8/56	462	12	Basalt	Irrigation
10	900	26	35	29 - 7/55	145	12	Sand, Gravel	Irrigation
11	1000	27	37	10 - 6/61	50	16	Sand, Gravel	Municipal
12	600	120	5	20 - 7/61	680	16	Lava	Irrigation
13	700	30	23	70 - 9/58	115	12	Gravel	Irrigation
14	586	96	6	24 - 6/67	145	12	Sand	Irrigation
15	600	40	15	20 - 6/57	110	12	Gravel	Irrigation
16	800	37	22	210 -12/60	397	12	Lava	Irrigation
17	630	100	7	42 - 5/56	390	14	Basalt	Irrigation
18	1200	45	27	7 - 3/60	118	12	Gravel	Irrigation
19	400	-	-	Flows - 2/67	240	16	Basalt	Irrigation
20	2000	220	9	20 - 7/66	300	24	Gravel	Irrigation
21	2000	110	18	10 - 4/66	230	12	Gravel	Irrigation
22	4100	104	39	25 - 8/66	420	14	Gravel	Irrigation
23	1800	110	18	24 - 9/66	165	12	Gravel	Irrigation
24	1800	153	12	12 - 6/61	615	16	Gravel	Irrigation
25	1170	151	8	193 - 2/63	1225	12	Sand, Gravel	Irrigation

Note: Index No. refers to well locations plotted in Figure 9.

Data Source: State Engineer

Wells produce sufficient water for livestock in the Cow



Index numbers refer to well data in Table 9.

Numbers in parentheses indicate well yields in gallons per minute.

DATA SOURCE: Oregon State Engineer

FIGURE 9. Representative Test Pumped High-Yield Wells.

Creek and Soldier Creek grazing areas and for domestic purposes at Arock and Rome. These aquifers are presently considered inadequate for irrigation use.

Most or all parts of the Upper Owyhee, Lower Owyhee, and Crooked Creek drainages are capable of supplying additional ground water withdrawals of an undetermined amount.

Quality

The chemical quality of ground water in the Malheur-Owyhee Basins ranges from good to poor, with most of it hard or very hard. Wells in the lower Malheur area generally yield very hard water, although wells adjacent to the Snake River yield hard or moderately hard water. Several communities have problems of ground water quality due to odor, sulfur, iron, and pipe-corrosion.

Shallow wells in the city of Jordan Valley are subject to continuous or sporadic contamination from septic tanks. In a 1965 sanitary survey of the city by the County Health Department, 24 of 58 water samples taken from domestic wells did not meet bacteriological standards for human consumption.

In general, ground water quality throughout the basins is considered adequate for domestic, municipal, and industrial purposes although treatment is usually required. Although the County Extension Office reports that nowhere has ground water proved unsatisfactory for irrigation, it seems prudent that ground water sources be analyzed prior to utilization for human consumption and irrigation use.

SNAKE RIVER

General

Recognizing that in-basin sources of water were inadequate to meet the needs of the Malheur and Owyhee Basins, a substudy was conducted to determine the adequacy of the Snake River as a source of water supply. As explained in the Introduction to this report, time available to the board did not permit fully quantifying the needs for Snake River water in the basins. The water requirements for the Malheur Project, however, were determined.

The substudy supporting data on file with the board, indicates that the Snake River's average flows are in excess of the project's water requirements. These requirements are discussed under the Malheur Project in Part V, Potential Development. The substudy further determined that the Snake River water is of relatively high quality for irrigation use.

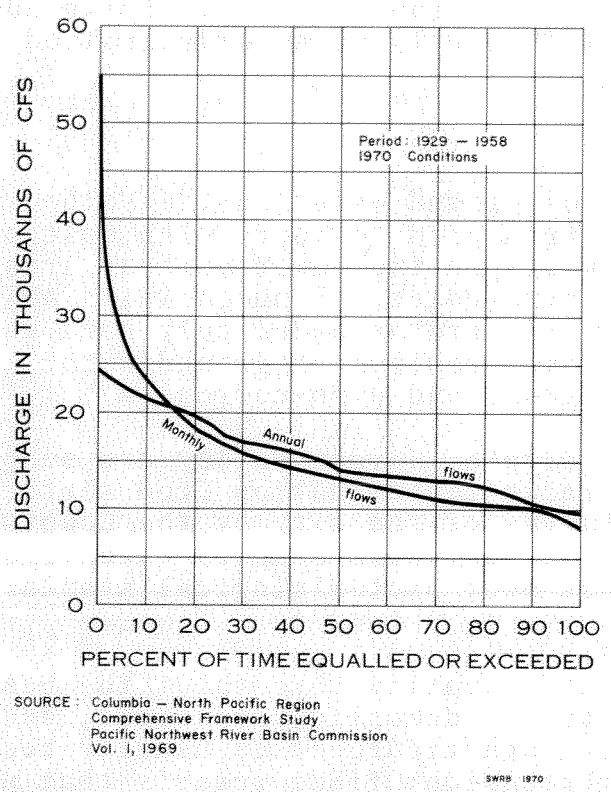


FIGURE 10. Duration Curves, Snake River at Weiser Idaho.

Duration curves for the monthly and annual flow of Snake River at Weiser are presented in Figure 10. Under 1970 projected development conditions, monthly combined flows of the Snake River, five tributary rivers in the project area, plus ground water inflow could be expected to exceed 10,000 (7,240,000 acre-feet) cfs 90 percent of the time.

On a different basis but with much the same general result, Table 8 shows the discharge data at representative gaging stations on the Snake River and its tributaries in the reach from King Hill downstream to Oxbow. Table 9 shows the annual water supplies under 1960 conditions at representative gaging stations. Of particular interest are the points on the Snake River at the gages "near Murphy" and "at Weiser," where, under 1960 conditions, federal agency studies indicate mean annual flows of 7,048,000 and 11,677,000 acre-feet, respectively. This situation is presented graphically in Figure 11. The studies, which were based on the 30-year period of record of 1928 to 1957, also determined that the annual depletion of

recorded runoff at Murphy due to upstream development amounted to 488,000 acre-feet. Several adjustments

TABLE 8

DISCHARGE DATA - REPRESENTATIVE GAGING STATIONS

STREAM	LOCATION	AREA Sq. Mi.	PERIOD Water yrs.	DISCHARGES		
				Max. cfs	Min. cfs	Avg. cfs
Snake River	at King Hill	35,800	09-57	47,200	1,250	10,700
Snake River	near Murphy	41,900	12-57	47,300	3,900	10,940
Bruneau River	near Hot Springs	2,010	10-15, 44-57	6,500	40	408
Owyhee River	below Owyhee Res.	11,160	29-57	22,900	0	366
Boise River	at Notus	3,820	20-57	20,500	10	1,120
Malheur River	near Hope	3,010	49-57	12,300	12	208
Payette River	near Payette	3,240	35-57	23,400	180	3,169
Weiser River	near Weiser	1,460	95-57	19,900	14	1,207
Snake River	at Weiser	69,200	11-57	100,000	5,100	19,050
Burnt River	near Hereford	309	28-57	2,220	0	81
Powder River	near Robinette	1,660	29-57	5,500	18	534
Snake River	at Oxbow	72,800	23-57	89,700	4,890	17,740

Data Source: Joint U. S. Bureau of Reclamation and U. S. Corps of Engineers, Upper Snake River Basin Report, 1961

were made in determining such a depletion, including the depletion effect of irrigating the 439,000 acres above Murphy which were developed during the 1928 to 1960 period. Nevertheless, applying this depletion, Snake River streamflow was increased by 4,629,000 acre-feet between Murphy and Weiser.

Federal studies also projected the effect that possible irrigation development during the 1960 to 2010 period would have on the flows of the Snake River at the gage locations. The total projected development resulted in an average depletion of 1,536,000 1/ acre-feet

1/ Southwest Idaho Water Development Project Report. Bureau of Reclamation, 1966.

annually between Murphy and Weiser under the year 2010

TABLE 9

ANNUAL WATER SUPPLIES - 1960 CONDITIONS 1/
REPRESENTATIVE GAGING STATIONS

STREAM	LOCATION	ACRE-FEET (1,000)		
		Max.	Min.	Mean
Snake River	at King Hill	9,214	5,193	6,762
Snake River	near Murphy	9,524	5,411	7,048
Owyhee River	below Owyhee Res.	1,169	16	150
Malheur River	near Hope	321	47	144
Snake River	at Weiser	18,774	7,944	11,677
Burnt River	near Hereford	107	22	60
Powder River	near Robinette	665	156	392
Snake River	at Oxbow	19,452	8,320	12,213

Note 1/ For 30-year period 1928-1957

Data Source: Joint U. S. Bureau of Reclamation and U. S. Corps of Engineers, Upper Snake River Basin Report, 1961

conditions. Applying this depletion to the increase in the Snake River streamflow between Murphy and Weiser, there would appear to be a residual increase of about 3,093,000 acre-feet.

WATER RIGHTS

STATE OF OREGON

COUNTY OF

CERTIFICATE OF WATER RIGHT

This Is to Certify, That

, State of , has made proof of to the satisfaction of the STATE ENGINEER of Oregon, of a right to the use of the waters of

for the purpose of

a tributary of

under Permit No. of the State Engineer, and that said right to the use of said waters has been perfected in accordance with the laws of Oregon; that the priority of the right hereby confirmed dates from

that the amount of water to which such right is entitled and hereby confirmed, for the purposes aforesaid, is limited to an amount actually beneficially used for said purposes, and shall not exceed

or its equivalent in case of rotation, measured at the point of diversion from the stream. The point of diversion is located in the

The amount of water used for irrigation, together with the amount secured under any other right existing for the same lands, shall be limited to of one cubic foot per second per acre,

and shall conform to such reasonable rotation system as may be ordered by the proper state officer.

A description of the place of use under the right hereby confirmed, and to which such right is appurtenant, is as follows:

The right to the use of the water for the purposes aforesaid is restricted to the lands or place of use herein described.

WITNESS the signature of the State Engineer, affixed this date.

State Engineer

Recorded in State Record of Water Right Certificates, Volume , page



PART III

WATER RIGHTS

WATER RIGHTS AND DEPLETIONS

For the Malheur-Owyhee Basins, the State Water Resources Board obtained from State Engineer's records water rights by stream, diversion point, quantity, priority date, and use. For surface water, Tables 10 and 11 summarize this data by study areas while Tables B and C of the Appendix present similar summaries by stream systems. Rights are listed for domestic, municipal, industrial, irrigation, and other uses (power, mining, and recreation), with the surface water rights for irrigation being the largest, totaling about 7,200 cfs for the irrigation of 296,416 acres within the basins.

As indicated in tables 10 and 11, the only right for out-of-basins diversion is for the use of 530 cfs (213,060 acre-feet) of water from Owyhee Reservoir on 31,800 acres in Idaho.

Malheur River

Shown in Figure 12 are the legal depletions by stream mile, indicating the maximum rate of diversion which could legally occur above each point along the Malheur River and its major tributaries.

Figure 12 and Tables 10 and 11 show that total legal annual surface water depletions for the Malheur River amount to 3,894 cfs, or 631,249 acre-feet. The largest legal use of water is for irrigation in the amount of 401,394 acre feet for 120,360 acres. Other water rights consist of 151,591 acre-feet for mining and power production, 1,549 acre-feet for domestic, 76,606 acre-feet for municipal, and 109 acre-feet for industrial purposes.

Figure 12 and Table 11 do not fully illustrate the actual or seasonal pattern of water use in the Malheur Basin. The actual rate of use is variable, and in some cases unknown because certain rights are no longer active. Other rights are not used every year and many are used intermittently during the year because of seasonal deficiencies in water supply. It is reasonable to assume that the total actual annual diversion of water is probably much less than the maximum legal diversion. Notwithstanding this assumption, the rights do constitute a legal demand for the quantity of water specified in

TABLE 10

SURFACE WATER RIGHTS
cfs

STUDY AREA	DOMESTIC	MUNICIPAL	INDUSTRIAL	IRRIGATION	(Acres)	OTHER	TOTAL
1. UPPER MALHEUR							
a. North Fork	0.32	100.00	0	309.49	(7,074)	0	409.81
b. Malheur River	0.34	0	0	697.44	(17,976)	0	697.78
c. South Fork	0.21	0	0	294.97	(7,642)	0	295.18
Total	0.87	100.00	0	1,301.90	(32,692)	0	1,402.77
2. LOWER MALHEUR							
a. Willow Creek	0.58	0.06	0	201.58	(16,126)	38.38(M)	240.60
b. Bully Creek	0.13	0	0	272.28	(6,142)	0	272.41
c. Warmsprings	0.56	5.75	0.15	1,801.06	(65,400)	171.00(P)	1,978.52
Total	1.27	5.81	0.15	2,274.92	(87,668)	209.38	2,491.53
3. LOWER OWYHEE							
a. Dead Ox	0.59	10.00	4.00	866.59	(50,321)	0	881.18
b. Mitchell Butte	0.61	2.00	16.86	954.93	(61,350)	0	974.40
c. Succor Creek	0.03	0	0	291.24	(17,669)	0	291.27
Total	1.23	12.00	20.86	2,112.76	(129,340)	0	2,146.85
4. JORDAN CREEK							
Total	1.00	0	0	1,300.35	(34,493)	0	1,301.35
5. UPPER OWYHEE						0.09(M) 60.00(P) 0.10(R)	
Total	1.83	0.03	0	209.31	(12,223)	60.19	271.36
TOTAL	6.20	117.84	21.01	7,199.24	(296,416)	269.57	7,613.86
	.08	1.54	.28	94.5		3.5	

Note: M = Mining, P = Power, R = Recreation
Lands in Idaho have rights for use of 530.00 cubic feet per second of water from Owyhee Reservoir on 31,800 acres that are not included in this table.

Data Source: State Engineer

TABLE 11

LEGAL ANNUAL SURFACE WATER DEPLETIONS
Acre-Feet

STUDY AREA	DOMESTIC	MUNICIPAL	INDUSTRIAL	IRRIGATION	(Acres)	OTHER	TOTAL
1. UPPER MALHEUR							
a. North Fork	232	72,400	0	21,222	(7,074)	0	93,854
b. Malheur River	246	0	0	53,928	(17,976)	0	54,174
c. South Fork	152	0	0	22,926	(7,642)	0	23,078
Total	630	72,400	0	98,076	(32,692)	0	171,106
2. LOWER MALHEUR							
a. Willow Creek	420	43	0	48,378	(16,126)	27,787(M)	76,628
b. Bully Creek	94	0	0	25,740	(6,142)	0	25,834
c. Warmsprings	405	4,163	109	229,200	(65,400)	123,804(P)	357,681
Total	919	4,206	109	303,318	(87,668)	151,591	460,143
MALHEUR TOTAL	1,549	76,606	109	401,394	(120,360)	151,591	631,249
3. LOWER OWYHEE							
a. Dead Ox	427	7,240	2,896	265,838	(50,321)	0	276,401
b. Mitchell Butte	442	1,448	12,207	334,165	(61,350)	0	348,262
c. Succor Creek	22	0	0	110,050	(17,669)	0	110,072
Total	891	8,688	15,103	710,053	(129,340)	0	734,735
4. JORDAN CREEK							
Total	724	0	0	137,972	(34,493)	0	138,696
5. UPPER OWYHEE						65(M) 43,440(P) 72(R)	
Total	1,325	22	0	48,892	(12,223)	43,577	93,816
OWYHEE TOTAL	2,940	8,710	15,103	896,917	(176,056)	43,577	967,247
TOTAL	4,489	85,316	15,212	1,298,311	(296,416)	195,168	1,598,496

Note: M = Mining, P = Power, R = Recreation
Lands in Idaho have rights for use of 213,060 acre-feet of water from Owyhee Reservoir on 31,800 acres that are not included in this table.

Data Source: State Engineer

the rights.

The study of the Malheur River by the State Water Resources Board indicates that the average annual yield,

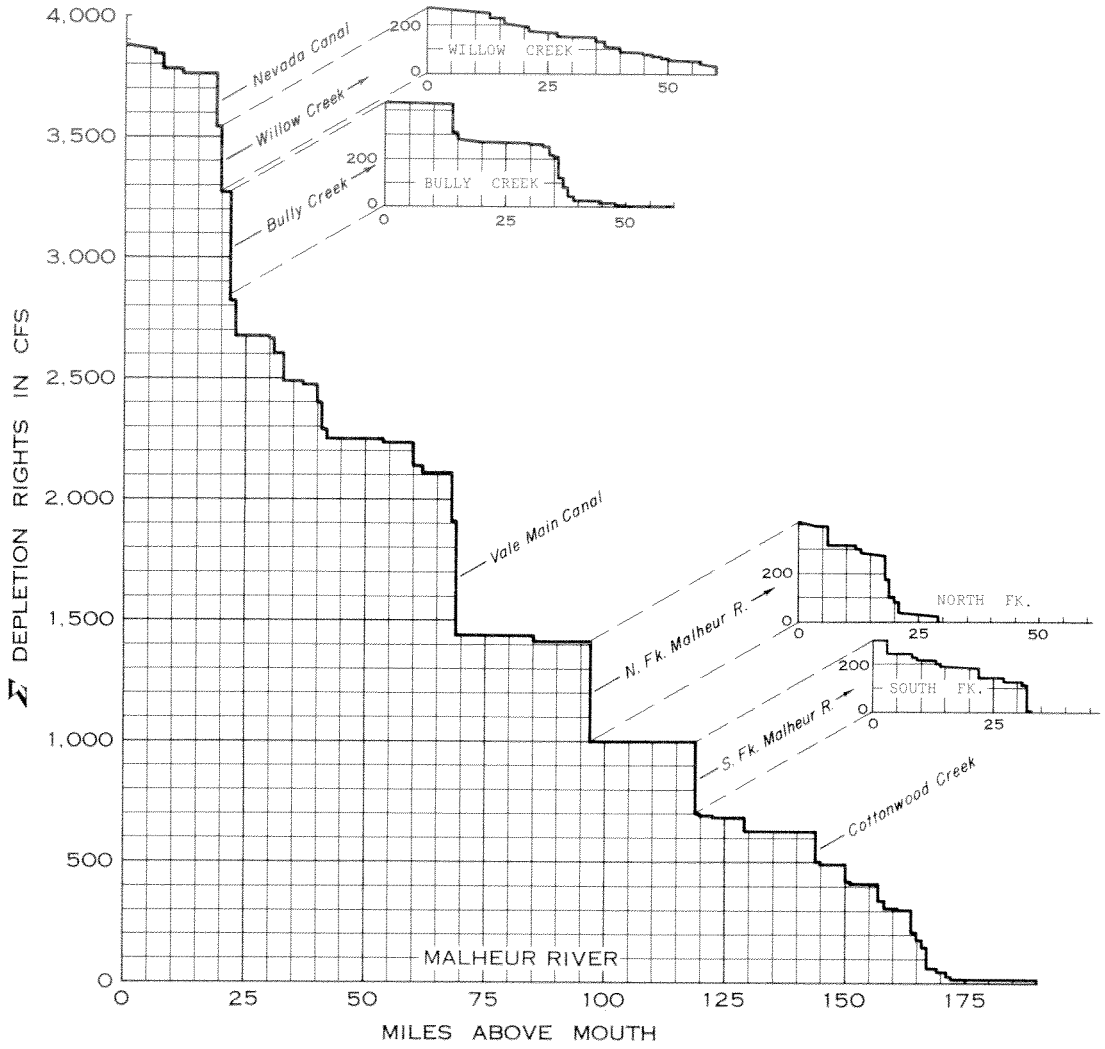


FIGURE 12. Malheur River Legal Depletions as of October 25, 1967.

based on consumptive use calculations, is about 380,000 acre-feet. Therefore, to satisfy water rights utilized to the maximum legal extent would require nearly twice the average annual yield.

The study indicates that the Malheur Basin has no appreciable quantities of unappropriated (in-basin) surface water subject to the jurisdiction of the State Water Resources Board. In some headwater streams, there still may exist limited possibilities for storage. Generally, such nonconsumptive water uses as fish life and recreation occur only in stream reaches where water must remain in the stream to satisfy downstream water rights. As the water reaches the high-use areas of the lower valleys, legal rights exceed yield in all years except those of unusually high amounts. It is apparent that an out-of-basin water supply would have to be developed either to fully satisfy existing rights or to meet the future needs of the basin.

Owyhee River

Shown in Figure 13 are the legal depletions by stream mile, indicating the maximum rate of diversion which could legally occur above each point along the Owyhee River and the Jordan Creek tributary.

Figure 13 and Tables 10 and 11 show that total legal annual surface water depletions for the Owyhee River amount to 3,720 cfs or 967,247 acre-feet. The largest legal use of water is for irrigation in the amount of 896,917 acre-feet for 176,056 acres. Other water rights consist of 43,577 acre-feet for power, mining, and recreation; 15,103 acre-feet for industrial; 8,710 acre-feet for municipal; and 2,940 acre-feet for domestic purposes.

Figure 13 and Table 11, just as with the Malheur Basin, do not fully illustrate the actual or seasonal pattern of water use in the Owyhee Basin. Under present operating conditions, the Owyhee Project requires an average of 670,000 acre-feet of water annually, or about 5.6 acre-feet per acre. Due to an inadequate yield from the Owyhee Basin about one-half the time, a program of carry over storage in Owyhee Reservoir and supplemental pumping from the Snake River has been adopted. In years of low Owyhee Basin yield, about 220,000 acre-feet is pumped from the Snake River. In years when an adequate water supply is available, the Snake River pumping plants supply a minimum of about 135,000 acre-feet so that part of the Owyhee River runoff can remain stored in Owyhee Reservoir.

The study of the Owyhee River indicates conditions similar to those found in the Malheur Basin; only the magnitude changes.

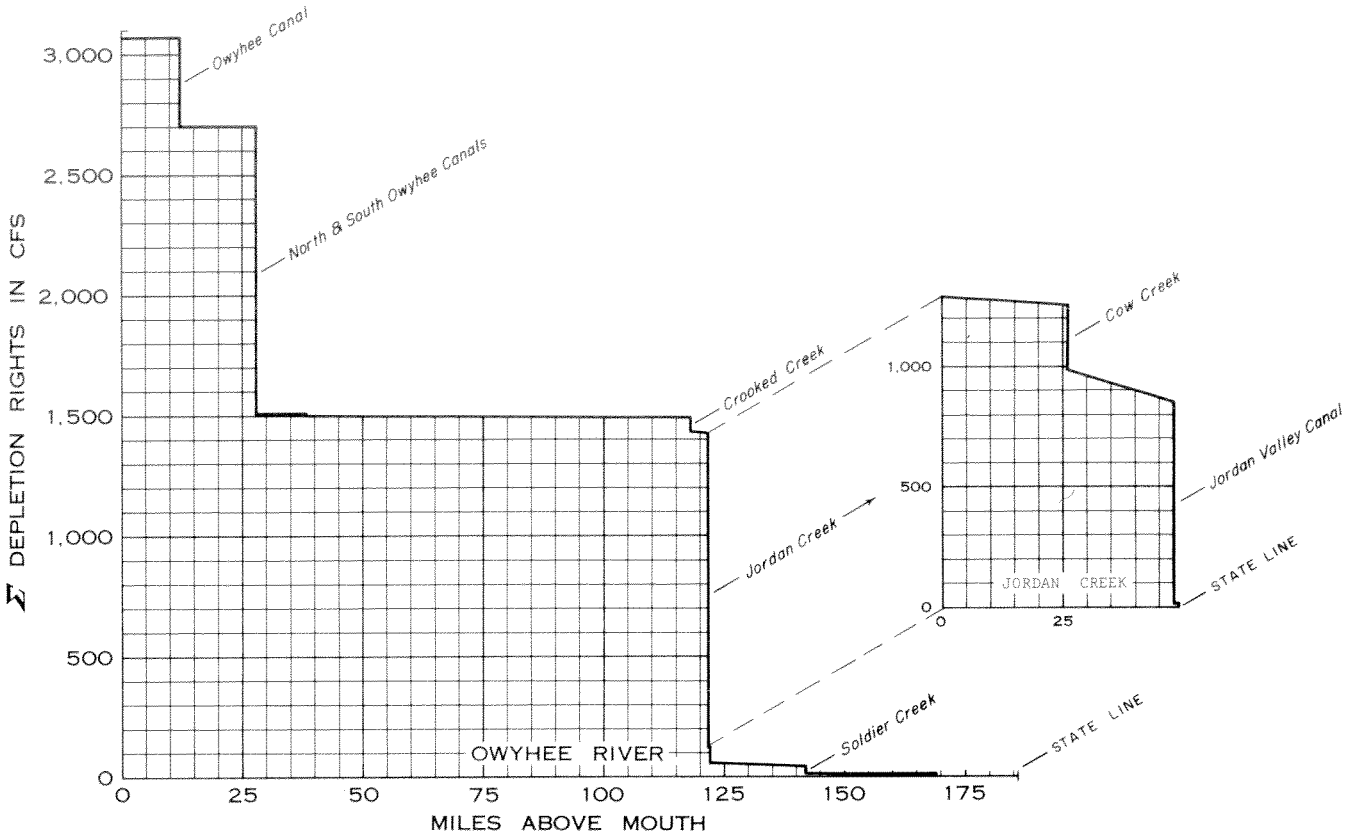


FIGURE 13. Owyhee River Legal Depletions as of October 25, 1967.

The average annual yield, based on consumptive use calculations, is about 670,000 acre-feet; to satisfy rights utilized to the maximum legal extent would require about 25 percent more than the average annual yield.

The study indicates that the Owyhee Basin, similar to the Malheur Basin, has no appreciable quantities of unappropriated (in-basin) surface water subject to the jurisdication of the State Water Resources Board, although in some headwater streams, there still may exist limited possibilities for storage. In the Owyhee Basin, too, nonconsumptive water uses such as fish life and recreation

generally occur only in stream reaches where the water must remain in the stream to satisfy downstream water rights. As the water reaches the high-use areas of the lower valleys, legal rights exceed yield in all years except those of unusually high amounts. Thus, future development of the Owyhee Basin probably will depend on development of an out-of-basin water supply.

Ground Water

Table 12 summarizes the basins' maximum legal annual ground water depletions. The largest rights are for the

TABLE 12

LEGAL ANNUAL GROUND WATER DEPLETIONS
Acre-Feet

STUDY AREA	MUNICIPAL	INDUSTRIAL	IRRIGATION	(Acres)	MINING	TOTAL
1. UPPER MALHEUR						
a. North Fork	0	0	0	(0)	0	0
b. Malheur River	0	0	585	(198)	0	585
c. South Fork	0	0	565	(188)	0	565
Total	0	0	1,150	(386)	0	1,150
2. LOWER MALHEUR						
a. Willow Creek	0	0	12,480	(4,160)	0	12,480
b. Bully Creek	0	0	2,161	(720)	0	2,161
c. Warmsprings	0	195	3,701	(1,234)	0	3,896
Total	0	195	18,342	(6,114)	0	18,537
3. LOWER OWYHEE						
a. Dead Ox	0	0	1,325	(442)	0	1,325
b. Mitchell Butte	6,950	5,611	1,547	(516)	0	14,108
c. Succor Creek	0	0	112	(28)	0	112
Total	6,950	5,611	2,984	(986)	0	15,545
4. JORDAN CREEK						
Total	0	0	2,587	(862)	0	2,587
5. UPPER OWYHEE						
Total	0	0	5,478	(1,826)	319	5,797
TOTAL	6,950	5,806	30,541	(10,174)	319	43,616

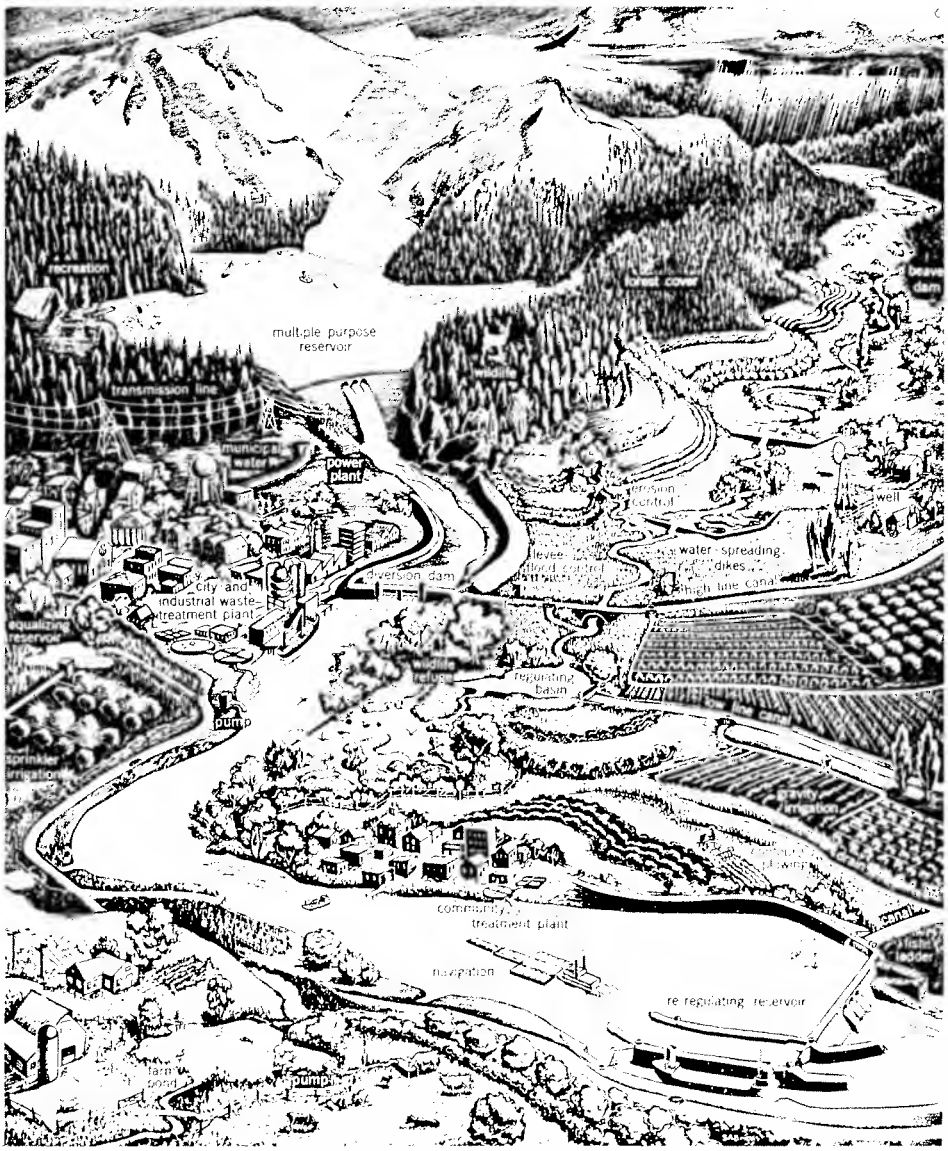
Data Source: State Engineer

irrigation of 10,174 acres, for the maximum allowable depletion of 30,541 acre-feet.

LEGAL RESTRICTIONS AND LIMITATIONS ON WATER USE

A Special Order of the State Engineer, dated November 12, 1959, orders that Cow Valley be declared a critical ground water area and describes the boundaries of the declared area. The Order also declares that the area is closed to further appropriation of ground water except for domestic, stock, lawn, garden, and small commercial wells exempted by ORS 537.545, and that applications for permits to appropriate ground water in this area will not be accepted.

WATER USE & CONTROL



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PART IV

WATER USE AND CONTROL

WATER USE AND ASSOCIATED PROBLEMS

Domestic

According to the Malheur County Water Resources Committee's cooperative survey of 1967, about 15,865 people in the rural areas and unincorporated communities of the basins depend primarily on ground water for their domestic supplies (household, livestock, lawns and gardens), while a small percentage of the rural populace depend on springs, streams, ditches, and lakes.

Water quality problems are not yet serious, however, there is: (1) water hardness in all areas except in a few upstream valleys; and (2) the potential for dangerous bacterial contamination of shallow wells in the Vale, Ontario, Nyssa, and Jordan Valley areas.

Domestic water shortages were reported only in the Ridgeview area south of Adrian and in the Lincoln Heights benchland area southwest of Ontario. To alleviate the shortages of livestock water on the federally-owned, semidesert rangelands, the Bureau of Land Management has initiated an extensive pond, spring, and ground water development program.

Municipal

All municipal systems rely on wells. Continued reliance on ground water for future municipal needs is anticipated. The city of Nyssa has developed wells on the Idaho side of the Snake River, and the city of Ontario is planning for wells on the Idaho side.

According to the State Sanitary Authority (Department of Environmental Quality) and the County Water Resources Committee, the municipal systems in Ontario, Nyssa, Vale, and Adrian served 10,260 people in 2,677 homes during 1967 and, in addition, served 508 commercial and 62 industrial establishments. Table 13 supplies additional data on the basins' municipal water systems.

The Ontario and Vale systems are metered, which, in addition to indicating that the 1965 annual water use was 1,656 acre-feet (540 million gallons), also reveal that the maximum-demand months are July and August, each of

which average about 445 acre-feet (145 million gallons).

TABLE 13

MUNICIPAL WATER SYSTEMS
1967

CITY	WATER SUPPLY	POPULATION SERVED	TREATMENT	AVERAGE ANNUAL USE		POTENTIAL SOURCE OF SUPPLY
				Ac.-Ft.	Mil. Gal.	
Ontario	4 Wells	5,750	Chlorinated Partially softened	1,420	450	Wells or Payette R.
Nyssa	Ranney Collector & 2 Wells (Ida.)	2,600	Chlorinated	860	280	Wells + Storage
Vale	4 Wells	1,850	Chlorinated	252	82	Wells
Adrian	2 Wells	60	None	9	3	Wells
TOTAL		10,260		2,541	815	

Data Source: State Sanitary Authority.

Industrial

Ground water is the source of practically all industrial water used in the basins with the largest users being the Amalgamated Sugar Company of Nyssa and Ore Ida Foods of Ontario. Other large industrial users include four meat packers, one cannery, and three dairies. The sand, gravel, and service industries use only small quantities of water. Total industrial water use is estimated at 8,000 acre-feet annually, most of which is nonconsumptively used.

Mining

The State Engineer's records show several mining water rights for the Willow Creek and Upper Owyhee study areas that have received only limited use in recent years. Those mining rights that have not been used in accordance with statutory requirements should be cancelled.

Irrigation

Irrigated agriculture represents the most important element in the economic structure of the Malheur-Owyhee

Basins, providing employment for most of the populace. Consequently, it is apparent that water holds the key to the areas' economic well-being and growth.

Generally, the principal problems of irrigation water use in the Malheur-Owyhee Basins are inadequate water supply, inadequate conservation of available water, and flood damage to agricultural land.

As shown in Table 14, the average annual irrigated area in the Malheur-Owyhee Basins is about 273,900 acres. Water rights, however, have been issued to serve 306,590 acres. The difference in acreage represents land for which water is not normally available and land which receives water only from floodflows in better water years. Most of the existing water rights for irrigation are not fully satisfied in poor water years unless adequate storage water is available. About 95 percent of all surface water rights issued for the basins are for irrigation use.

TABLE 14

AVERAGE IRRIGATED LAND
Acres

STUDY AREA	IRRIGATED LAND		
	SURFACE WATER	GROUND WATER	TOTAL
1. Upper Malheur	34,400	200	34,600
2. Lower Malheur	96,100	3,400	99,500
3. Lower Owyhee	112,300	0	112,300
4. Jordan Creek	20,700	800	21,500
5. Upper Owyhee	3,700	2,300	6,000
TOTAL	267,200	6,700	273,900

Data Source: USDA, Oregon River Basin Survey Staff

The Water Resources Committee Survey revealed surface water shortages in critical years of up to 75 percent on the Vale and Warm Springs Projects; 35 percent on the Owyhee Project; 95 percent in upper Jordan Valley; and no water after July 1 for most of the upstream valleys where storage has not been developed. Streams without

reservoir storage usually have zero flows. Because of unfavorable distribution of streamflow on uncontrolled streams, irrigators are forced to divert and apply flood discharges even though temperatures may be below that for optimum growing conditions.

Table 15 shows, by study area, the irrigation source and the acres with water shortage.

TABLE 15

IRRIGATION SOURCE
AND
ACRES WITH WATER SHORTAGE (1968)

SOURCE	UPPER MALHEUR	LOWER MALHEUR	LOWER OWYHEE	JORDAN CREEK	UPPER OWYHEE	TOTAL IRRIGATED ACRES
Streamflow	32,200	11,800	43,300	10,200	2,200	99,700
Ground Water	200	3,400	0	800	2,300	6,700
Reservoir Storage	2,200	84,300	69,000	10,500	1,500	167,500
Total Irrigation	34,600	99,500	112,300	21,500	6,000	273,900
Shortage: Acres	24,600	11,900	3,700	4,500	3,800	48,500
Percent of Irrigated Land	71	12	3	21	63	18

Data Source: USDA, Oregon River Basin Survey Staff

The larger irrigation projects in the basins generally have resulted from combining small ditch systems with other structural development. The amount of Oregon's participation in the construction of the Warm Springs Reservoir is not generally known or appreciated. The cost to Oregon was about $42,000 as part of the Oregon Cooperative Surveys. The 170,000 acre-foot Warm Springs Reservoir and Dam was completed in 1919 by the Warm Springs Irrigation District to irrigate 30,000 acres. After a few years of irrigation, drainage and alkali problems resulted in a decrease in the area irrigated to about the present size of 18,398 acres. In 1926 the Bureau of Reclamation was authorized to construct the storage and distribution features of the 32,000-acre Vale Project, including Agency Valley Reservoir, Harper Diversion Dam, and the Vale Main Canal distribution system and drainage works. After negotiating contracts

with the Vale-Oregon and Warm Springs Irrigation Districts, the Bureau in 1929 and 1930 enlarged the Warm Springs Reservoir to 191,000 acre-feet and in 1935 completed construction of the 60,000 acre-foot Agency Valley Reservoir and Dam. Bully Creek Reservoir was constructed in 1962 to complete the development plan.

The Owyhee Project consolidated several ditch companies and irrigation districts that formerly obtained water from Owyhee River, Succor Creek, and Snake River. Approximately 71 percent of the project's acres is in Oregon and 29 percent in Idaho. The project furnishes a full supply of irrigation water to approximately 105,000 acres along the west side of the Snake River in eastern Oregon and southwestern Idaho. In addition, about 13,800 acres are furnished supplemental water.

The key facility of the Owyhee Project is Owyee Reservoir, which acts as both a storage and diversion structure. The project also includes 107 miles of canals, 443 miles of laterals, 9 pumping plants, and 155 miles of drains. Originally, the irrigation works were designed to supply water to the project entirely by gravity from Owyhee River and Reservoir. Because of the variation in annual discharge of the Owyhee River, however, water users have found it advisable to store a two-year supply in Owyhee Reservoir. This storage is made possible by utilizing water pumped from the Snake River to irrigate 30,000 to 35,000 acres of the lower lands.

In the 1920's, the Jordan Valley Irrigation District constructed the 35,000 acre-foot capacity Antelope Reservoir to serve 7,400 acres in the lower valley. In later years, the reservoir's capacity was enlarged to 45,000 acre-feet.

Power

There are two unused water rights, totaling 171 cfs, for power on the Malheur River; one at Warm Springs and the other near Vale. The 60 cfs for power on the upper Owyhee River is for an abandoned waterwheel. The physical and economic potential for hydroelectric power development in the basins generally is considered as quite limited due to the lack of good, undeveloped power sites and to the adequacy of out-of-basin power.

Malheur County is served primarily by the Idaho Power Company whose generating capacity of nearly 1,500,000 kilowatts is based on 16 hydroelectric plants and access to the Northwest Power Pool. Another source of power in the area, although not water originated, is through the Cascade Natural Gas Corporation. Future high power use development, such as irrigation, will probably necessitate significant adjustments by the current suppliers.

Fish and Wildlife

No water rights have been issued specifically for fish or wildlife uses in the Malheur-Owyhee Basins.

Springs and streams furnish fairly constant supplies in the higher mountain areas, but intermittent water supplies limit both fish and wildlife existence in the vast central and lower portions of the basins. Even though the basins support a big game population of approximately 100 elk (found only in the timbered northwestern portion), 15,000 pronghorn antelope and 45,000 mule deer, the lack of a well distributed and dependable water supply is the principal reason for the basins' low density of big game. Distributions of upland game birds, waterfowl and furbearing animals are also rigidly controlled by the availability of water although irrigated areas in the lower valleys host nominal waterfowl and extensive game bird populations.

Prior to the 1900's, the streams of the Malheur-Owyhee Basins were inhabited by chinook salmon and possibly by steelhead trout and coho salmon. Downstream power dams on the Columbia and Snake Rivers plus irrigation development, with its storage and diversion dams, has made the principal spawning areas inaccessible to upstream migrants. Unfavorable stream conditions such as low flows, high temperatures, unscreened irrigation ditches and siltation have rendered the remaining accessible areas generally unsuitable for the production of salmon and steelhead. Many of the streams contain trout while warm-water game fish predominate in the lower elevation streams as shown in Figure 14. The Oregon State Game Commission's recommended minimum flows for fish life are shown in Table E of the Appendix.

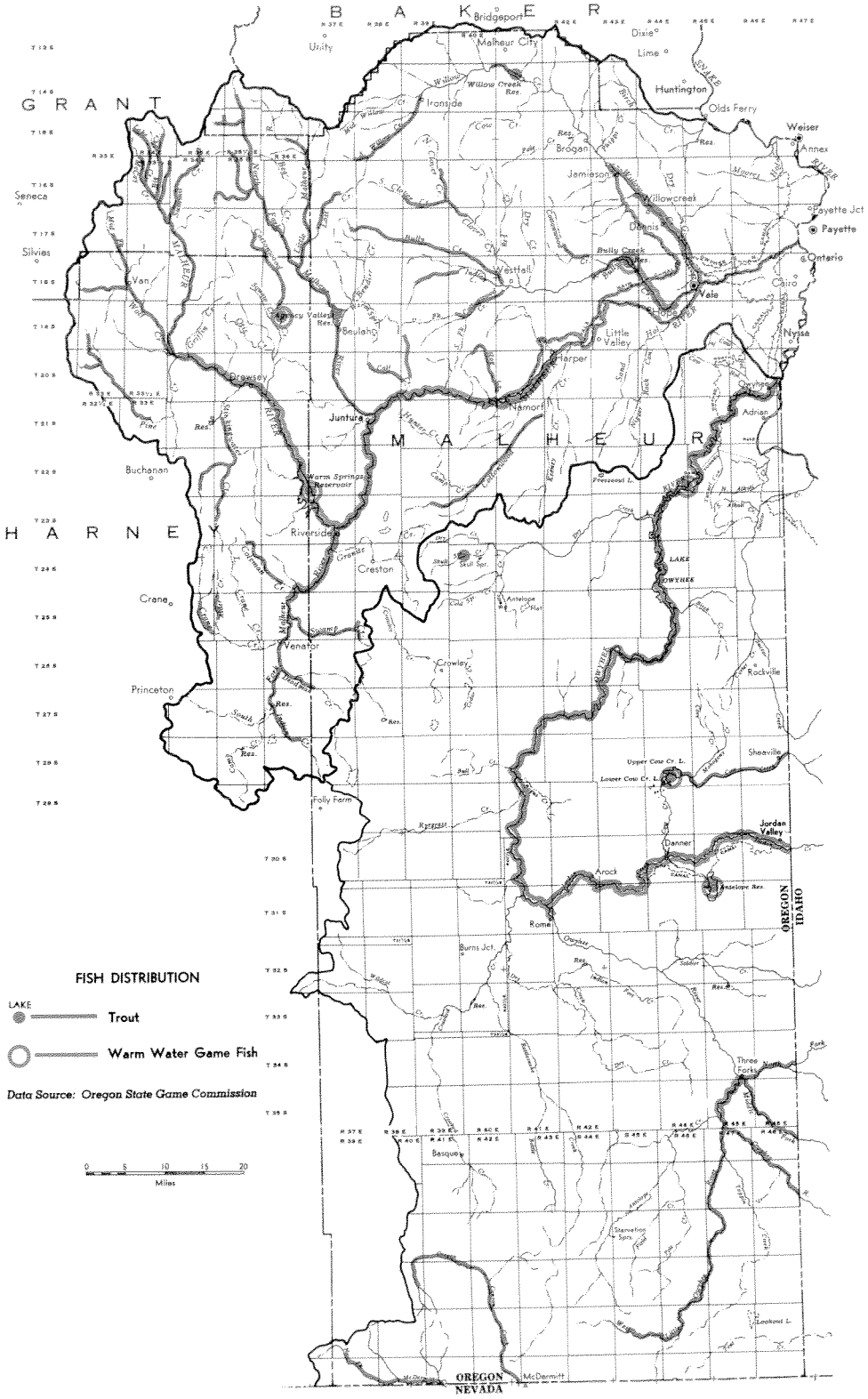


FIGURE 14. Game Fish Distribution.

Recreation

The only water right for recreation use is for 0.10 cfs at Owyhee State Park.

Recreation activities in the basins include rock hounding, hunting, fishing, water sports, camping, and sightseeing. According to the County Water Resources Committee, the annual recreation visitation to the basins is approximately 200,000 with 300,000 expected by 1975.

WATER CONTROL

Flood Control

The Malheur-Owyhee Basins have a long history of flood problems which have been only partially alleviated by the construction of storage reservoirs and several channel projects. The reservoirs, although operated primarily for irrigation, also have the capability of affording incidental regulation of floods. Because of the large area encompassed by the basins and the numerous runoff variables affecting flood patterns, significant reduction of flooding by any one project is difficult to achieve. Within the basins, serious floods occur along the lower portions of the Owyhee and Malheur Rivers with flooding also occurring at times and to varying extents along Succor, Jordan, Bully, and Willow Creeks.

Damages caused by recent floods have been primarily agricultural although some residential, commercial, and industrial damages also occur. The latter, urban related damages, were severe prior to completion of local protection works for the city of Vale in 1961. About 8,700 acres of cropland are estimated to be subject to flooding on a once-in-five year recurrence interval of which 7,100 acres are in the upper and lower Malheur study areas.

Recurring flood losses and increasing conservation water needs provided the basis for the U. S. Army, Corps of Engineers' "Review Report on Malheur River and Tributaries, Oregon," dated March 1968. Pertinent excerpts from that report state: "Total damages in the Malheur Basin for five of the most recent floods were estimated as follows:

March 1952	$ 229,000
February 1957	2,176,000
February 1963	403,000
December 1964	232,000
January 1965	328,000"

and "The existing reservoirs in the basin, together with the local protection works at Vale, provide a substantial degree of flood protection along the main stem of Malheur River. There is need for additional flood protection above the existing reservoirs and on some tributaries. However, projects for flood control alone were not found feasible."

The Owyhee Basin has not been studied in as much detail or as recently as the Malheur Basin. The extent of recent flood damage can be compared, however, from estimates given in the Walla Walla District Corps of Engineers "Postflood Report for December 1964 and January 1965," dated January 1966. The report states that flood damages of $327,300 and $40,000 were experienced in the Owyhee Basin from the floods of December 1964 and January 1965, respectively.

Drainage

With the present system of wild-flood irrigation, drainage is a critical problem in some areas of the basins. In many cases, drainage can be classified as surface flooding needing flood control; however, surface drainage is required in some instances where the land lies in broad, flat valleys and the channel gradient is fairly flat. The lower Willow Creek valley near Vale is one such area in the Malheur Basin. In the Owyhee Irrigation District area a hardpan underlying much of the presently irrigated land contributes to the drainage problem

Estimates show that approximately 42,500 acres have a major wetness problem. An estimated 23,100 acres, or about 54 percent of the excessively wet soils, need to be drained under present usage.

Seepage water from high land is also a common drainage problem. This problem is becoming more critical in portions of the basins due to development of the uplands for irrigation. Overirrigation on these higher lands prolongs the wetness of lower land unless drains are

installed to control the water movement. Further irrigation development will increase the need for drainage.

Erosion

Damage to land from erosion and scour is significant but extremely difficult to evaluate and is probably inadequately appraised. Estimates show that about 18,700 acres of cropland and 694,000 acres of range and pasture-land have problems due to various types of erosion.

Erosion of irrigated cropland has increased in the last ten years and is expected to increase even more in the future. Erosion on irrigated land can occur as the result of runoff from either precipitation or irrigation with most of the erosion of irrigated land occurring where small grain and row crops are grown. In the cycle of growing these crops, the soil is left bare at critical periods of the year unless cover crops are grown. Various types of scour have occurred on this bare soil, resulting in the exposure of subsoils having poor chemical and physical properties which ultimately result in poorer yields.

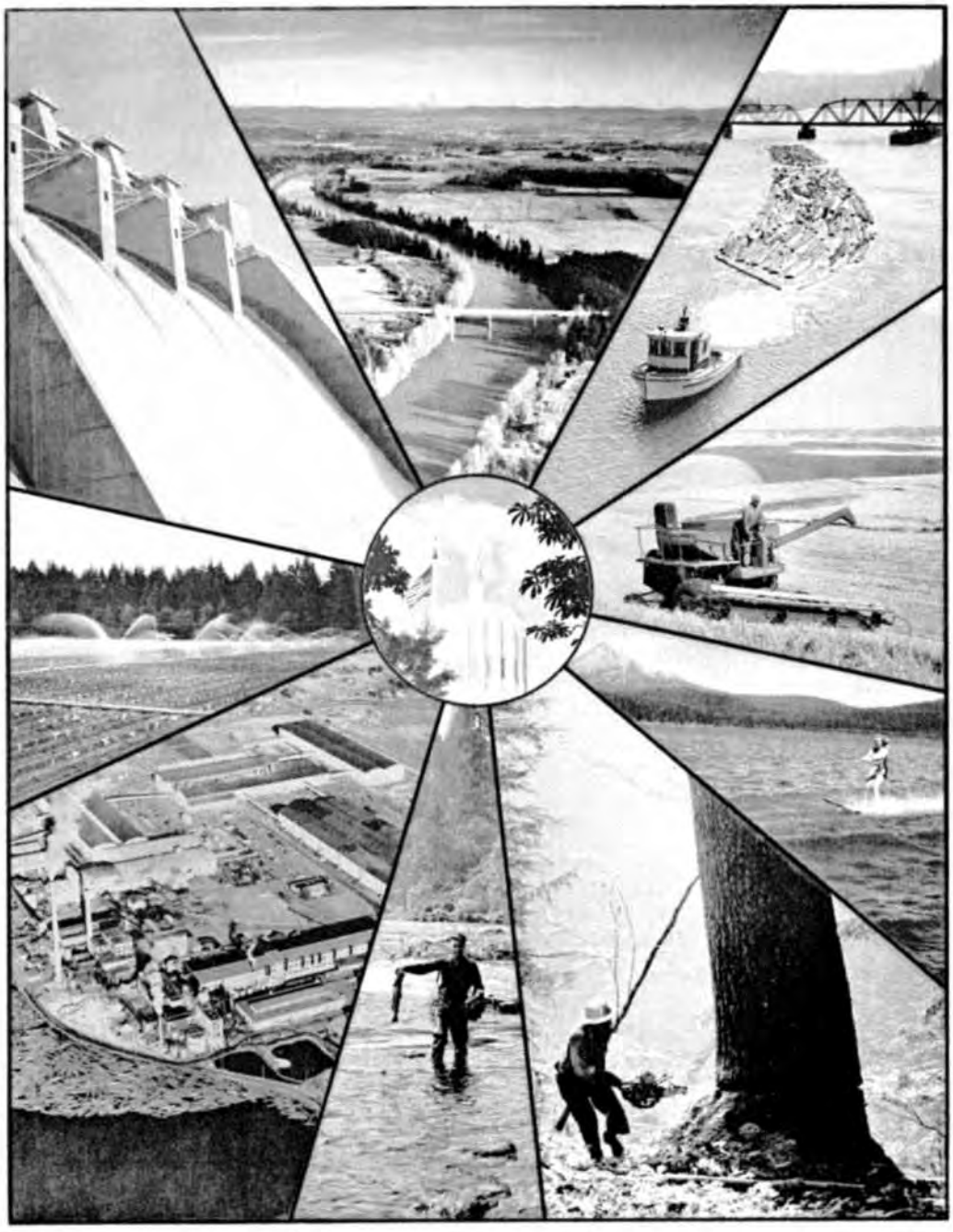
Considerable land is lost through streambank erosion. Damage is usually more severe in the steeper, high velocity portions of the streams, although a problem exists in the slow, meandering portions of the streams. A considerable amount of gully erosion is prevalent in the steep upper reaches of the watersheds of the basins where the deeper soils exist.

Pollution

Water pollution does not appear to be an extremely serious or widespread problem in either basin at the present. Much of the pollution that does occur is in the form of erosion-produced sediments in the surface water. In isolated instances, ground water supplies are threatened by effluents from septic tanks and drain fields.

Potential problems, if allowed to occur, will probably be associated with population and industrial growth attributable to expansion of the agricultural economy.

POTENTIAL DEVELOPMENT



Photos from Corps of Engineers, Oregon State Highway Department, Crown Zellerbach Corporation, John Deere Company, R. M. Wade and Company, and Weyerhaeuser Company

PART V

POTENTIAL DEVELOPMENT

GENERAL

The very appreciable land resource which characterizes the Malheur-Owyhee Basins is the key to their economic growth and prosperity. Development of this land resources potential will involve continued expansion of irrigation farming and a corresponding increase in the quantity of water required. As shown in Table 16, nearly

TABLE 16

PRESENT AND POTENTIAL CROPLAND AND IRRIGATED LAND
Acres

STUDY AREA	PRESENT CROPLAND	POTENTIAL CROPLAND	PRESENTLY IRRIGATED LAND	POTENTIALLY IRRIGABLE LAND
1. UPPER MALHEUR				
a. North Fork Malheur R.	4,600	300	4,600	300
b. Malheur River	22,300	34,000	21,400	16,400
c. South Fork Malheur R.	8,600	5,400	8,600	5,400
Total	35,500	39,700	34,600	22,100
2. LOWER MALHEUR				
a. Willow Creek	13,600	60,000	12,600	59,500
b. Bully Creek	5,500	7,900	5,500	7,900
c. Warmsprings	81,400	74,700	81,400	74,700
Total	100,500	142,600	99,500	142,100
3. LOWER OWYHEE				
a. Dead Ox	48,600	44,400	45,300	44,400
b. Mitchell Butte	54,000	32,600	54,000	32,600
c. Succor Creek	13,000	9,000	13,000	3,500
Total	115,600	86,000	112,300	80,500
4. JORDAN CREEK	21,500	32,000	21,500	32,000
Total	21,500	32,000	21,500	32,000
5. UPPER OWYHEE	9,000	89,500	6,000	13,700
Total	9,000	89,500	6,000	13,700
TOTAL	282,100	389,800	273,900	290,400

Data Source: USDA River Basin Survey Staff.

274,000 of the 282,000 acres now being farmed are irrigated; while about 290,000 of the nearly 390,000 acres of potential farmland are considered irrigable by USDA standards.

Any assessment of future water requirements for the Malheur-Owyhee Basins must consider the significant

irrigation water shortages that currently exist as well as the large quantities necessary for development of the potentially irrigable lands.

It is estimated, as shown in Table 17, that an additional

TABLE 17

ESTIMATED POTENTIAL WATER SHORTAGE/SURPLUS
Acre-feet

STUDY AREA	PRESENTLY IRRIGATED (Acres)	PRESENTLY IRRIGATED WATER REQUIREMENT	POTENTIALLY IRRIGABLE (Acres)	POTENTIALLY IRRIGABLE WATER REQUIREMENT	TOTAL WATER REQUIREMENT	ESTIMATED YIELD	POTENTIAL SHORTAGE OR SURPLUS
1. UPPER MALHEUR							
a. North Fork	4,600	11,500	300	700	12,200	100,700	+88,500
b. Malheur River	21,400	53,500	16,400	41,000	94,500	152,900	+58,400
c. South Fork	8,600	21,500	5,400	13,500	35,000	56,400	+21,400
Total	34,600	86,500	22,100	55,200	141,700	310,000	+168,300
2. LOWER MALHEUR							
a. Willow Creek	12,600	44,100	59,500	321,300	365,400	33,700	-331,700
b. Bully Creek	5,500	19,200	7,900	42,700	61,900	41,500	-20,400
c. Warmsprings	81,400	284,900	74,700	403,300	688,200	277,800	-410,400
Total	99,500	348,200	142,100	767,300	1,115,500	353,000	-762,500
3. LOWER OWYHEE							
a. Dead Ox	45,300	254,000	44,400	248,000	502,000	156,000	-346,000
b. Mitchell Butte	54,000	302,100	32,600	182,900	485,000	186,000	-299,000
c. Succor Creek	13,000	72,800	3,500	19,200	92,000	45,500	-46,500
Total	112,300	628,900	80,500	450,100	1,079,000	387,500*	-691,500
4. JORDAN CREEK	21,500	53,400	32,000	74,700	128,100	146,500	+18,400
Total	21,500	53,400	32,000	74,700	128,100	146,500	+18,400
5. UPPER OWYHEE	6,000	15,000	13,700	35,400	50,400	547,500	+497,100
Total	6,000	15,000	13,700	35,400	50,400	547,500	+497,100
TOTAL	273,900	1,132,000	290,400	1,382,700	2,514,700	1,060,700**	-1,454,000**

Note: * Does not include 282,500 acre-feet used in Idaho from Owyhee River and Succor Creek.
** Nonadditive.

Data Source: SWRB estimates based on USDA cooperative study and U. S. Geological Survey - Oregon State Engineer stream gage records.

1,454,000 acre-feet of water will be required to irrigate, adequately, the approximately 564,000 acres of presently irrigated and potentially irrigable land.

Surface Water

With respect to in-basins sources of water, it is estimated that complete development of the surface waters would enable satisfaction of only about one-half the potential irrigation water requirements. Such development would require a considerable undertaking, i.e., the construction of large reservoirs with carryover capacity at the few locations remaining, largely involving regulation of water supply covered by existing water rights, as well as numerous smaller capacity reservoirs. (Potential damsites are listed in Table B of the Appendix and are shown on Plates 1 and 2.) In addition, it would be necessary to improve upon distribution system efficiencies, upon reuse of water supplies, and eventually to implement intrabasin diversions in conjunction with water exchange. An example of the latter case would be to pump from the Snake and lower Malheur Rivers to irrigate lands currently served from upstream sources of water, thereby permitting use in the upstream areas of some of the water now being stored there for downstream use. This would apply, particularly, to potentially irrigable lands or lands with an inadequate water supply above Drewsey and along Cottonwood Creek, to lands along the South Fork Malheur River above Riverside, and possibly, to some of the benchlands above Harper.

The water exchange principle, applied to the Owyhee, might permit development of upstream storage at the Duncan Ferry damsite near Rome or at the Soldier Creek damsite further upstream to serve lands in the vicinity of Arock. Adverse effects on the scenic Owyhee Canyon would have to be thoroughly investigated, however. Conceivably, the uppermost Three Forks damsite could provide storage, both for irrigation and for augmenting low summer streamflow through the canyon. The Bureau of Reclamation, in their Upper Owyhee Reconnaissance Report, cited a hydroelectric power generating capability of 14,000 kilowatts (204 feet of head) at the Duncan Ferry site and 28,000 kilowatts (343 feet of head) at the Three Forks site.

It appears unlikely that any high degree of in-basin surface water development will occur within a reasonable period of time. This study has determined that only limited quantities of surface water within the basin remain available for appropriation.

During the past 10 to 12 years practically every application to the State Engineer for permit to construct any reservoir that might affect the water supply to the Warm Springs and Vale-Oregon Irrigation Districts has been protested by the districts or preceded by a stipulation, included in the permit, reaffirming the prior rights of the districts. In the Corps of Engineers' investigation of the Malheur River and tributaries, this situation resulted in the finding that the multiple-purpose storage projects considered were infeasible because of the inability of remaining dependable water supplies to provide sufficient project benefits. 1/

Ground Water

Ground water is anticipated to continue as the source for the nonirrigation consumptive water use which comprises a relatively insignificant demand compared to that for irrigation.

The potential for ground water development will increase as improved drilling techniques and pumps make withdrawing water from greater depths economic. A basic limitation to such increase, however, is the fact that precipitation is so small in most valleys that recharge to ground water is negligible and therefore some aquifers may easily be overpumped. None of the 53 state ground water observation wells throughout the county, except in the Cow Valley critical ground water area near Ironside, indicate present depletion of ground water resources. Nevertheless geologic and meteorologic conditions dictate eventual controlled withdrawal and ground water management as now practiced in Cow Valley.

A 1968 open file report by the U. S. Geological Survey estimates the natural recharge in the basins at 430,000 acre-feet per year and the withdrawals by wells at 50,000 acre-feet per year. It appears that an additional 380,000 acre-feet per year could be developed from ground water within the natural recharge capability. This would be contingent upon the aquifers being so situated, either geographically or by depth, relative to irrigable lands, to enable economic development. Some of this potentially available ground water is known

1/ Review Report on Malheur River and Tributaries, Oregon, U. S. Army, Walla Walla District, Corps of Engineers, March 1968.

to underlie lands presently being served from surface water sources. There would appear to be at least a limited possibility for development of such ground water to replace surface water which then could be used on other lands. With the exception of the Willow Creek drainage area, nearly all parts of the basins are listed as having a potential for additional ground water withdrawals. (See Table 18.)

The future may bring conditions under which it is economic to artificially charge or recharge ground water aquifers in the basins and use the stored ground water when needed. The above report lists additional storage areas, 3,000,000 acres with a manageable storage volume of 8,300,000 acre-feet, far in excess of that having an adequate natural recharge or in-basins source of water for charge or recharge. Further investigation of this tremendous potential, using Snake River water, the logical out-of-basins source, is warranted.

PROJECTS INVESTIGATED OR UNDER INVESTIGATION

Although it is apparent that appreciable development involving either surface or ground water will have to depend upon sources of water outside the Malheur-Owyhee Basins, there are areas where development may occur utilizing in-basin sources of water as well as those utilizing Snake River water. Some of these have been briefly alluded to in the general discussion of potential for developing surface and ground water. Others are the subject of specific studies, ranging in scope from reconnaissance to feasibility, that have been or are being conducted. These are discussed in the following sections on Small Watershed Projects, Large Reclamation Projects, Flood Protection, and Private Development. The latter is followed by a discussion of the Malheur Project Study conducted by the State Water Resources Board.

Small Watershed Projects

Technical planning assistance for small watershed projects is available either from the State Engineer or the Soil Conservation Service of the U. S. Department of Agriculture. The on-going program of the Soil Conservation Service includes technical assistance to farmers and ranchers in all phases of soil and water

POTENTIAL DEVELOPMENT

TABLE 18

ESTIMATED EXISTING AND POTENTIAL GROUND WATER STORAGE

		MALHEUR			OWYHEE				TOTAL
		Malheur	Willow	Total	Upper Owyhee	Crooked Creek	Lower Owyhee	Total	
TOTAL AREA	Square miles	3,250	1,600	4,850	2,000	1,700	1,700	5,400	10,250
	Millions of acres	2.1	1.0	3.1	1.3	1.1	1.1	3.5	6.6
GROUND-WATER CONDITIONS	Natural recharge (millions of acre-ft. per year	.2	.1	.3	.05	.05	.03	.13	.43
	Artificial recharge (millions of acre-ft. per year)	-	-	-	-	-	-	-	-
	Ground-water withdrawals (millions of acre-ft. per yr.)	.02	.02	.04	Little	Little	.01	.01	.05
	Relative potential for additional withdrawals	+	x		+	+	+		
SATURATED ZONE	Area of recoverable storage (millions of acres)	.5	.2	.7	1.0	.8	.8	2.6	3.3
	Effective porosity factor	4	7		1	2	2		
	Average depth to base of zone of recoverable water (feet)	1,000	800		1,000	1,000	1,000		
	Average thickness above 500 feet (feet)	400	300		200	300	300		
	Ground water above 500 feet (millions of acre-feet)	8	4	12	2	5	5	12	24
	Ground water below 500 feet (millions of acre-feet)	6	3	9	8	6	6	20	29
POTENTIAL ADDITIONAL SOURCE	Estimated area (millions of acres)	.5	.2	.7	1.0	.8	.5	2.3	3.0
	Average thickness of zone (feet)	25	50		200	100	100		
	Effective porosity factor	5	7		1	3	5		
	Volume of manageable storage (millions of acre-feet)	.6	.7	1.3	2.0	2.5	2.5	7.0	8.3

EXPLANATION: GROUND-WATER CONDITIONS - + Most or all parts of the area show potential for additional ground-water withdrawal

x Overall ground-water withdrawals are near limit without "mining" (withdrawing more water than is recharged).

SATURATED ZONE - Greater than figure shown

Data Source: U. S. Geological Survey

conservation. This assistance is provided to local landowners through the Soil and Water Conservation Districts which completely cover Malheur County but do not cover the Harney or Grant Counties' portions of the basins. Three watersheds have definite potential and have been or are being studied under Public Law 566, administered by the Soil Conservation Service.

Succor Creek Watershed The project is being planned and has as project purposes flood protection, land treatment, irrigation, and recreation.

Brogan Watershed (Willow Creek below Malheur Reservoir) An application for planning assistance has been filed with the State Engineer but has not yet been approved. Project purposes will probably include flood protection, land treatment, irrigation, drainage, and fish and wildlife.

Upper Bully Creek Watershed The project was approved for planning but has been terminated recently. Reactivation is possible, however, at the request of local sponsors.

Several other watersheds appear to have potential which will be further defined through studies of lesser detail. Water use and control needs related to those potential projects are discussed below.

Drewsey Area (three watersheds) Problems include flooding, drainage, erosion, and shortage of irrigation water. A project in this area would necessitate water exchange.

Cottonwood Creek (south of Harper) Problems include flooding, erosion, and shortage of irrigation water.

Jordan Valley (two watersheds) Problems include flooding, inefficiency of irrigation water distribution and use, and inadequate drainage and land treatment.

Large Reclamation Projects

Investigation of projects larger than those eligible for planning assistance under Public Law 566 must be conducted either privately through consulting engineering

firms or through the Bureau of Reclamation. Projects currently being studied by the Bureau are as follows:

"Upper Owyhee Project, Idaho-Oregon, Jordan Valley Division." The proposed project, on which a report is scheduled for completion in Fiscal Year 1971, includes a dam on Jordan Creek, upstream from the town of Jordan Valley, to serve the functions of irrigation, flood control, fish and wildlife, and recreation. The reservoir's active capacity would be used jointly for flood control, a late season supplemental supply for about 9,000 acres, and possibly as a full supply for 1,500 to 2,000 acres.

Other Major Reclamation Projects

The feasibility of other Bureau of Reclamation potential projects, such as storage on the upper Malheur and Owyhee Rivers and pumping additional Snake River water to Owyhee Project lands, have not been determined.

Flood Protection Projects

The investigation of major flood control projects is the responsibility of the U. S. Army, Corps of Engineers. The most recent major activity in the Malheur-Owyhee Basins by the Corps resulted in the previously mentioned "Review Report on Malheur River and Tributaries," wherein it is stated that "The existing reservoirs in the basin, together with the local protection works at Vale, provide a substantial degree of flood protection along the main stem of Malheur River. There is need for additional flood protection above the existing reservoirs and on some tributaries. However, projects for flood control alone were not found feasible. The studies made indicate that, considering the existing water rights, including diversion to Bully Creek Reservoir, remaining dependable water supplies were insufficient to provide significant benefits for irrigation, sports fishing, recreation, or power. There is no need for storage of water for municipal and industrial supply or for water quality control. Consequently, multiple-purpose storage projects were found to be infeasible."

In the absence of any currently feasible major flood control projects within the basins consideration should be given to county or municipal adoption of flood

plain management programs. These are programs which, through enactment of zoning ordinances and/or building codes, control the use of the flood plains. Technical assistance in procurring flood plain information pertinent to flood plain management is available either through the State Water Resources Board or through the following federal agencies: Corps of Engineers, Soil Conservation Service, or Geological Survey. Applications for flood plain information studies should be forwarded through the State Water Resources Board, the state agency responsible for coordinating and assigning priorities for the state and federal studies.

Private Development Projects

With the increasing availability of resource data and technological advances - coupled with favorable markets and individual initiative, and assuming adequate financing can be provided - varying levels of private development can be expected to occur in the basins. Two recent irrigation developments in Malheur County have helped spark the interest in pumped, sprinkler irrigation: Skyline Farms developed by Ore-Ida Foods, Inc., Frozen Foods Division of the H. J. Heinz Company, and the Batt farm development north of Ontario by Harold, Wendall, and Donald Batt. These two projects, together with recent developments nearby in Idaho using medium to high left pump installations, and concern over the possibility of major out-of-basin diversions, were the basis of the Malheur County Court's request to the State Water Resources Board to identify the potentially irrigable land that could be served using Snake River water and the amount of water that would be needed to serve those lands.

Due to limitations of time and fiscal capability, the board directed that emphasis be placed on those lands considered to have the greatest potential for development in the next few years. Preparation of a reconnaissance level plan was considered essential for the determination of the cost of an irrigation system to serve the designated Malheur Project lands.

THE MALHEUR PROJECT

Land Resources - General

Within the 7,198,400 acres comprising the Malheur-Owyhee Basins in Oregon, there are an estimated 1,654,200 potentially irrigable acres, according to data supplied from land classification surveys made cooperatively for the State Water Resources Board by Soil Conservation Service of the U. S. Department of Agriculture and Oregon State University relative to the board's study, "Oregon's Long-Range Requirements for Water." Of this long range potential, the approximately 564,000 acres of presently irrigated and potentially irrigable land shown in Table 16 reflect the application of economic and other factors to arrive at the quantity considered to have a relatively short range potential for development. The largest concentration of irrigable lands, in the relatively short range category, susceptible to irrigation by pumping directly from the Snake River (see area shaded in red on Plates 1 and 2) was found bordering presently irrigated lands of the Vale-Oregon, Ontario-Nyssa, Owyhee, and Payette-Oregon Slope Irrigation Districts complex. This concentration constitutes the Malheur Project area. In order to facilitate the study, the project was divided into four development areas: Birch Creek, Wickiup, and Jacobsen Divisions on the north side of Malheur River: and Dunaway Division on the south side. (See Figure 15)

Land Classification

The project boundaries include a gross area of 221,500 acres, of which 211,000 have irrigability classifications of excellent, good, fair, and poor. Included in the 211,000 acres are about 2,600 acres not in the approximately 564,000 acres previously cited. They are included because of their amenability to irrigation by a distribution system to supply water to the better lands with which they are intermingled. The remaining 10,500 acres, tentatively considered nonirrigable, comprise soils which, due to the reconnaissance nature of the classification, were classed as "intermixed" or "barren sediments." These were mapped together with areas classed as irrigable. A more detailed classification will be required to further define these small complex soil areas.

Most of the project land is composed of undeveloped semidesert land on the fringes of the present irrigation

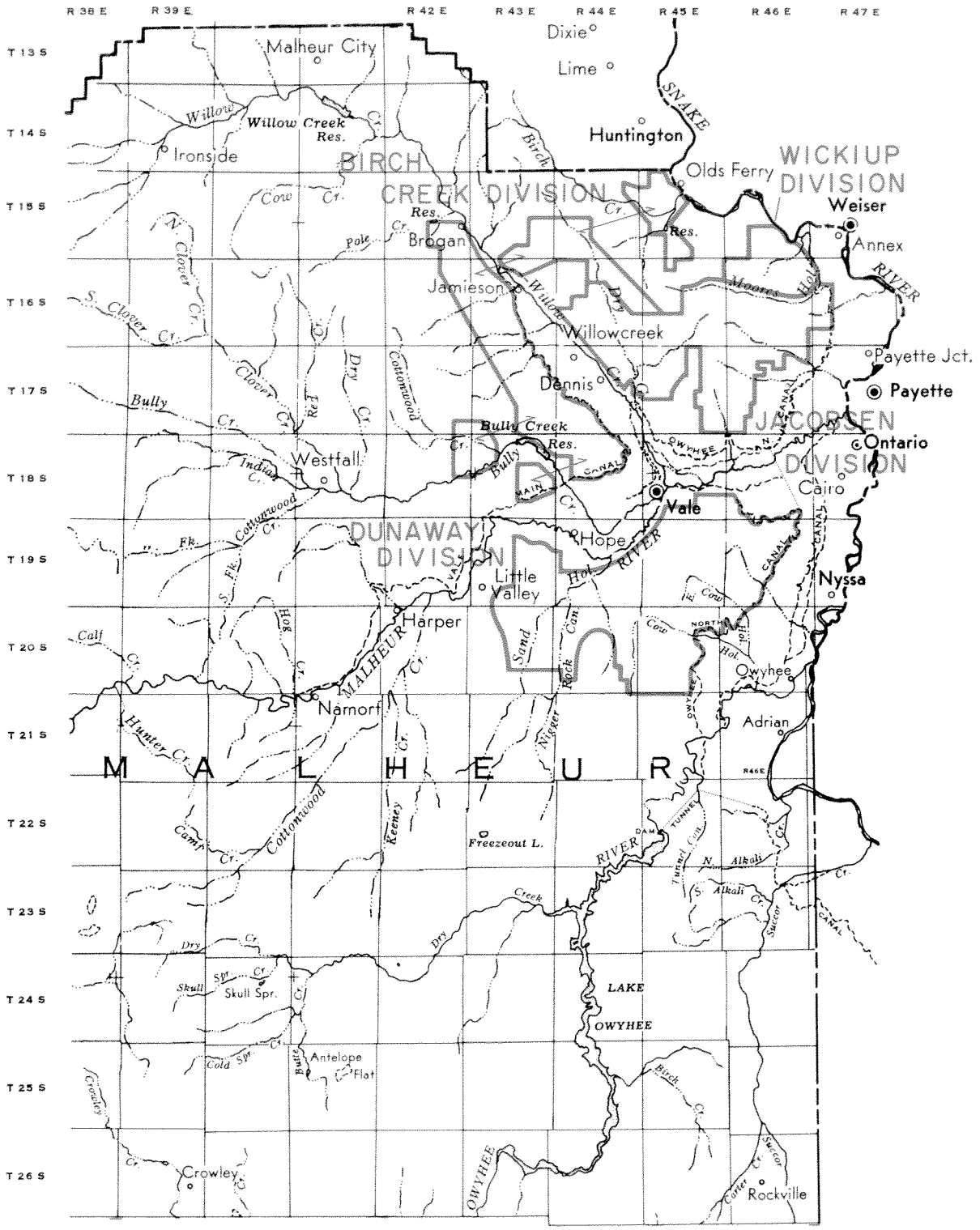


FIGURE 15. Malheur Project Area.

projects. Other project lands include 3,300 acres of dry-farmed land in the Wickiup Division and small undetermined areas, with spring floodwater spreading, in Birch Creek, Moores Hollow, Jacobsen Gulch, Willow Creek, and lower Cow Valley above the presently irrigated land.

Most of the suitable lands of lower elevation, less than 2,400 feet in elevation, are presently irrigated. Elevations of the mapped irrigable land range from 2,400 to slightly over 3,000 feet. Lands above 3,000 feet, with a few exceptions, are nonirrigable.

Irrigation Classifications

The criteria for the five irrigability classifications into which the project lands have been divided in this study are as follows:

1. Excellent lands consist of highly productive soils, occurring mainly in the valleys and alluvial fans, but to a minor extent in favorable positions on benches and terraces. The soils are deep, fertile, free of toxic salt concentrations, and have good moisture-holding properties.

2. Good lands occur more commonly on the benches and terraces and include soils of intermediate depth. Underlying, very compact or softly-cemented subsoils or substrata somewhat limit root development and may restrict moisture penetration and subsurface drainage. Other conditions which may make these uplands less favorable for irrigation farming than the "excellent" lands are shorter or steeper slopes, more uneven surface, and soils with lower water-holding capacity or slight salt concentration.

3. Fair lands are moderately good but have more extreme physical limitations than those of "good" classification. Characteristic are relatively steep slopes, shallow soils in some areas, and a lower yield capability. Most of the "fair" class lands occur on terraces and benches where the subsoils and substrata are compact or cemented. Although some of the indurated layers are softened under irrigation, in general, they resist root penetration and are of low permeability.

4. Poor lands have definite deficiencies, such as: light textured, shallow and gravelly soils; very compact or cemented hardpan; or dense clay subsoil at shallow depths. Some of the "poor" class lands occupy low marshy areas with soils usually high in soluable salts, while others have steep slopes or other unfavorable topography.

5. Nonirrigable lands have excessive deficiencies in soils, topography, and drainage, or high toxic concentrations of salts and alkali. This classification also includes arable lands in acreages too small to be served with water, and land in isolated or high elevation locations beyond reasonable reach of a distribution system.

Table 19 shows the acreage, by development area, of each irrigable land class within the project and the gross area.

TABLE 19

MALHEUR PROJECT
LAND CLASSIFICATION SUMMARY
ACRES

DEVELOPMENT AREA	EXCELLENT	GOOD	FAIR	POOR	TOTAL IRRIGABLE	GROSS AREA
NORTH SIDE						
Birch Creek	--	3,315	3,055	--	6,370	6,370
Birch Creek	1,350	1,340	6,425	3,060	12,175	12,670
U. Dry Gulch	3,780	16,280	20,985	13,470	54,515	55,290
Willow	5,130	20,935	30,465	16,530	73,060	74,330
Subtotal						
Wickiup	510	190	4,755	3,585	9,040	9,540
Jacobsen	2,080	950	5,030	3,040	11,100	11,100
North Jacobsen						
Upper Jacobsen	340	1,060	3,570	3,200	8,170	8,210
North Side	395	2,020	7,380	3,050	12,845	13,120
South Side	1,420	2,360	15,825	2,180	21,785	23,010
L. Dry Gulch	4,235	6,390	31,805	11,470	53,900	55,440
Subtotal						
NORTH SIDE TOTAL	9,875	27,515	67,025	31,585	136,000	139,310
SOUTH SIDE						
Dunaway	--	5,015	1,935	1,035	7,985	8,030
Big Sage	660	5,695	10,165	6,390	22,910	24,580
East Cow	1,160	2,570	3,260	1,250	8,240	9,530
Cow Hollow						
Sand Hollow	2,070	5,150	9,335	5,375	21,930	14,280
Low Lift	1,010	5,515	5,515	1,895	13,935	15,770
High Lift						
SOUTH SIDE TOTAL	4,900	23,945	30,210	15,945	75,000	82,190
PROJECT TOTAL	14,775	51,460	97,235	47,530	211,000	221,500

Data Source: USDA Oregon River Basin Survey Staff.

Land Ownership and Use

Land Ownership

Ownership of irrigable land within the Malheur Project is about one percent state, 42 percent federal, and 57 percent private. Federal lands are under management of the Vale District, Bureau of Land Management.

Table 20 lists irrigable land ownership by project divisions and Plate 5 shows land ownership location.

TABLE 20

LAND OWNERSHIP
Acres

DIVISION	STATE	FEDERAL	PRIVATE	TOTAL IRRIGABLE
Birch Creek	640	23,420	49,000	73,060
Wickiup	160	2,360	6,520	9,040
Jacobsen	1,530	13,720	38,650	53,900
Dunaway	640	49,240	25,120	75,000
Total	2,970	88,740	119,290*	211,000

* Small undesignated county acreage included.
Data Source: USDA Oregon River Basin Survey Staff.

Land Use and Problems

Present land use within the 221,500-acre project area is predominantly grazing. About 5,000 acres are dry farmed or practice floodwater spreading.

Some problems have been alleviated in formulating the Malheur Project plans, while others must be handled during later stages of development. Based on experience gained by others who have developed adjoining lands, several problems are apparent.

Project irrigators will have a relatively large construction and operation obligation because it is not likely that substantial amounts can be charged off to flood control, power, recreation, or other benefits. The operation of large, irrigated farm units will be the only practical way of competing with nearby lower cost irrigation developments.

Much of the project area, particularly the lower lying lands, will be faced with continuing drainage problems. In addition, the high rate of surface runoff on some lands will necessitate the maintenance of adequate and, in some areas, extensive drainage systems.

On some soils, the slow infiltration rate is a problem but is not considered insurmountable since use of subsoiling and approved tillage methods are alleviating the situation on most adjoining, developed farms.

If the Malheur Project, or a major portion thereof, is to be developed under Bureau of Reclamation land limitation regulations, Congressional review and modification of the 160-acre limitation should be sought.

Water Requirements

Project Requirements

Table 20 shows the calculated irrigation requirements

TABLE 21

OWYHEE PROJECT COMPARISON

IRRIGATION REQUIREMENT AND RATE FOR SYSTEM DESIGN

(5-Year Average)

	ACRES	CONSUMPTIVE USE INCHES	IRRIGATION IN. REQUIREMENT	TOTAL REQUIREMENT ACRE-FEET	ACRE-FEET PER ACRE	TOTAL REQUIREMENT GPM	GPM PER ACRE
Alfalfa	38,105	29.65	45.65	144,862.51	3.80	307,507	8.07
Irrigated Pasture	23,289	25.31	38.94	75,572.81	3.25	176,763	7.59
Cereal Grains	22,274	23.49	34.14	67,081.86	3.01	179,751	8.07
Sugar Beets	16,134	22.22	34.18	45,955.01	2.85	45,982	7.12
Potatoes	8,838	22.22	34.18	25,173.57	2.85	25,188	7.12
Specialty Crops	31,936	24.58	37.82	100,651.63	3.15	242,394	7.59
TOTAL OR AVERAGE	140,576	25.48	39.20	459,297.39	3.27	977,585	7.68

Data Source: Ag. Exp. Sta. Bul. 500 and Special Report 194
Soil Conservation Service Tech. Release No. 21
Bureau of Reclamation Crop Census

for divisions and units of the Malheur Project. Crop irrigation requirements within the project were calculated using the modified Blaney-Criddle formula as described in USDA Technical Release No. 21 and the OSU Agricultural Experiment Station Special Report 194. The irrigation requirements represented crops, soils, and weather data for Vale, Nyssa, Adrian, and Malheur Branch Experiment Station conditions.

Table 22 shows a 5-year Owyhee Project comparison of irrigation requirements and rate for system design.

TABLE 22

IRRIGATION REQUIREMENTS

DEVELOPMENT DIVISIONS	IRRIGABLE ACREAGE	ACRE-FEET	MAXIMUM* RATE (CFS)
Birch Creek			
Birch Creek	6,370	35,040	160
U. Dry Gulch	12,175	64,530	300
Willow	54,515	288,100	1,000
Subtotal	73,060	388,500	1,280
Wickiup	9,040	48,600	160
Jacobsen			
North Jacobsen	11,100	61,290	285
Upper Jacobsen	21,015	111,400	352
L. Dry Gulch	21,785	115,410	363
Subtotal	53,900	288,100	1,000
Dunaway			
Big Sage & E. Cow	30,895	164,600	417
Cow & Sand Hollows	44,105	238,800	643
Subtotal	75,000	403,400	1,060
Project Total	211,000	1,128,600	3,500*

* Rates are nonaddative due to reservoir storage, release, and re-use.
Data Source: SWRB computations based on revised Blaney-Criddle formula.

Irrigation Requirements

Based on the above stated criteria, the following water requirements were determined:

	Requirement	Units per acre
1.	Crop Irrigation	2.6 acre-feet
2.	Farm Delivery	4.0 acre-feet
3.	Snake River Diversion	5.3 to 5.5 acre-feet
4.	Design Delivery Rate	8.0 (plus) GPM

These quantities are considered adequate for irrigation water supplies and incidental losses for all irrigable lands within the project.

Annual water requirements for a "full season" crop such as alfalfa served as a basis for the estimate of water requirements under full irrigation development. The probability of increased intensification of production practices through increasing plant populations, increasing fertilizer use, double cropping, and the need for salinity-leaching water was the reason for using alfalfa water requirements as a base for future needs.

With full development, estimated project water withdrawal requirements at designated stream mile locations on the Snake River would be as shown in Table 23.

TABLE 23

WATER REQUIREMENTS

PUMP LOCATION	STREAM MILE	RATE Cfs	ANNUAL A.F.
Birch Creek	335.9	1,280	388,500
Wickiup Flat	346.6	160	48,600
Jacobsen Gulch	368.7	1,000	288,100
Dunaway	393	1,060	403,400
Totals (Rounded)		3,500	1,128,600

As was discussed in the Snake River Section of Part II, Water Supply, it appears that under the year 2010 projected level of development conditions there would be over 3.5 million acre-feet of water available on a mean annual basis in that reach of the Snake River where Malheur Project diversions would occur, which would amount to over three times the maximum annual requirement for the project.

Irrigation Development Plan

Formulation of Development Plan

The planning objective has been to prepare a reconnaissance irrigation distribution system for the Malheur Project. The plan considers delivering 1,128,600 acre-feet of water to 211,000 acres of potentially irrigable land. Preliminary routing locations and design of the construction features were undertaken to the extent necessary to prepare estimates of project costs.

No attempt has been made in these preliminary studies to allocate costs of possible multipurpose features; nor has consideration been given to nonreimbursable funds for items such as flood control, fish life, wildlife, or recreation, even though some of these features would probably be enhanced. Therefore, costs presented herein could be considerably higher than those which the water user would be required to repay under available cooperative programs.

Capital costs of pumping plants, pipelines, canals, reservoirs, and appurtenant structures included in the proposed works, were estimated from preliminary designs based on data from surveys made during the investigation. Approximate construction quantities were estimated from these preliminary designs. Unit prices (1968) of construction items were determined from costs of constructing similar projects. The estimates of capital cost include purchase of rights-of-way across private land and of providing engineering and supervision. Other overhead costs were included within unit costs that have been used in the capital costs budget.

Consideration was given to the design of an enclosed pipeline distribution system that would save approximately one-third of the water lost in open channel conveyance. However, the 6 to 15 airline miles between the source and use areas make the cost of a completely enclosed system considerably greater than the open system design used in this estimate.

Proposed Facilities and Operation

The project development plan includes the construction of four large pumping plants along the Snake River,

booster pumps as required, five reservoirs within the project area to reduce peak pumping requirements, and an adequate canal and lateral distribution system to serve the project area. Development plans are analyzed by division for the four project development areas.

Birch Creek Division

Table 24 lists the significant features of the Birch Creek Division.

TABLE 24

BIRCH CREEK DIVISION
SIGNIFICANT FEATURES

Irrigable Area	
Birch Creek	6,370 acres
Dry Gulch	12,175 acres
Willow Creek	54,515 acres
Total	73,060 acres
Pumping Plants	
Peak Flow	1,280 cfs
Horsepower	67,300
Pump Lift	330'
Relift	
Peak Flow	1,120 cfs
Horsepower	72,600
Pump Lift	455'
Penstocks	
Diameter	12'-0"
Length	3.2 miles
Diameter	11'-4"
Length	1.0 mile
Siphons	
Diameter	12'-0"
Length	4.7 miles
Canal Length	12 miles
Lateral Length	94 miles
Booster Pumps	
Number	5
Horsepower	47,130
Storage Reservoir	
Dry Gulch	44,000 A.F.
Dam Height	196'
Crest Length	5,150'
Right-of-Way	
Through Private Lands	350 acres

The Birch Creek Division includes 73,060 potentially irrigable acres on the Birch Creek, upper Dry Gulch, and Willow Creek benchlands. This area would be susceptible to stage development which, upon completion of the final stage, would serve all irrigable lands in the northwestern portion of the project to elevations of slightly over 3,000 feet.

From an investigation of the development area, it appears that the most feasible pumping station location is on a basalt foundation upstream from the mouth of Birch Creek at Snake River stream mile 335.9. The 67,300-horsepower (HP) pumps would lift 1,280 cfs to 72,600-HP booster pumps located in Birch Creek Valley, for a total vertical pump lift from Snake River to McCarthy pass of 785 feet.

Enroute, 160 cfs would be diverted to irrigate 6,370 acres of low lift lands on both sides of Birch Creek.

The booster pumps would lift the remaining 1,120 cfs through a 100-foot cut through McCarthy pass into Dry Gulch. The cut to elevation 2,855 feet was computed to reduce the booster pump head, serve Dry Gulch reservoir, and command the greatest possible irrigable areas in the Dry Gulch and Willow Creek units.

The 196-foot high Dry Gulch dam and reservoir are designed to store 44,000 acre-feet during April and May when crop water requirements are low and to release water for irrigation during the July-August peak irrigation requirement period. The reservoir is designed to store 13 percent or 0.69 acre-feet per acre of the Dry Gulch and Willow Creek irrigation requirement, and the system is designed to transport this stored water. Figure 16 illustrates the typical theoretical pumping and storage requirements and system operating schedule for Dry, Bridge, and Alkali Gulch reservoirs to reduce maximum monthly capacities and capital costs of river pumping facilities by about 32 percent.

The system design calls for Snake River pumps to operate at full capacity from mid-April to September with a resultant improved facility efficiency and a more favorable annual power rate. The distribution system includes: 4.2 miles of penstock, 4.7 miles of siphon, 12 miles of main canal, and 94 miles of laterals.

Distribution facilities provide for the diversion of 300 cfs to serve 12,175 potentially irrigable acres in the Dry Gulch area. From the Dry Gulch area, a canal and siphon with a 1,350 cfs capacity are designed to deliver water for 54,515 potentially irrigable acres on the west side of Willow Creek. About 22,000 acres lie below this canal system while the remainder requires additional pumping to slightly over 3,000 feet elevation.

The Birch Creek distribution system plan is presented on Plate 6 of the Appendix.

Potentially irrigable lands in the Bully Creek reservoir area can either be served by this system, or by water exchange, from Bully Creek reservoir or the Vale main canal.

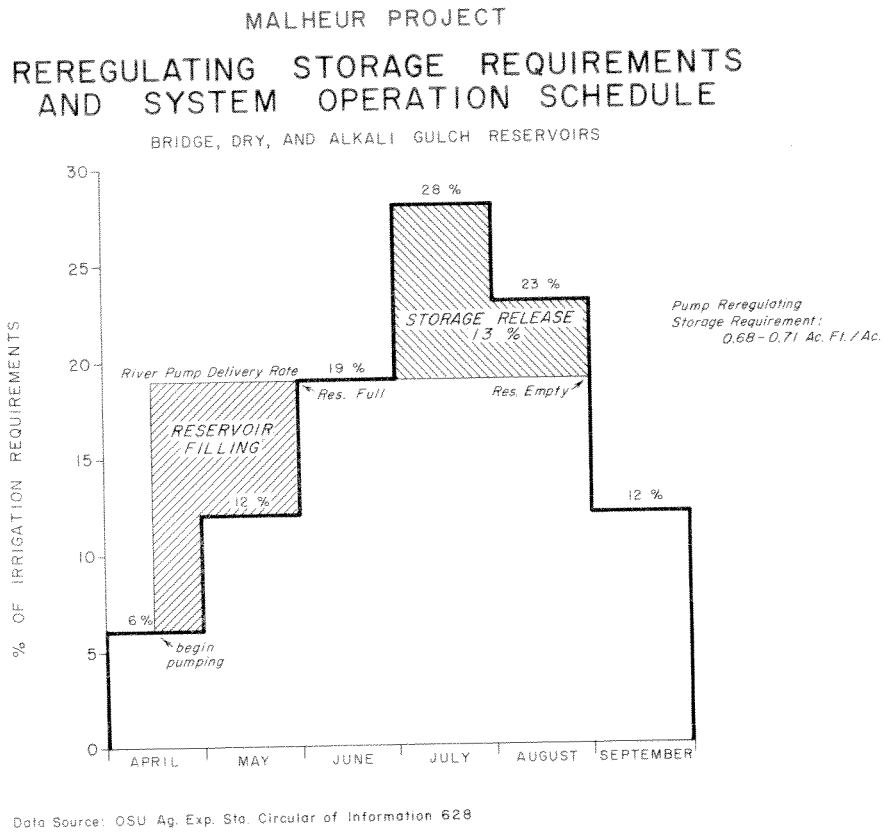


FIGURE 16. Reregulating Storage Requirements and System Operating Schedule.

Table 25 shows estimated construction costs for the Birch Creek Division of the Malheur Project.

TABLE 25

BIRCH CREEK DIVISION
SUMMARY OF CAPITAL COSTS

ITEM	QUANTITY	UNIT PRICE	COST
Pumping Plants			
Mainline	139,900 HP	$55.00	$ 7,694,500
Booster	47,130 HP	46.00	2,167,980
Penstock			
Mainline	22,500 LF	243-297	6,385,500
Booster	19,300 LF	20-109	1,214,585
Siphon	25,000 LF	297.00	7,425,000
Canals			
Earthwork	1,504,300 CY	0.35	526,505
Structures			163,125
Laterals			
Earthwork	1,304,240 CY	0.35-0.45	464,085
Structures			53,770
Pass Cuts	2,131,400 CY	0.35-0.45	945,850
Reservoir			
Earthwork	4,771,000 CY	0.35-3.24	5,455,100
Structures			179,600
Right-of-Way	350 Ac.	30-400	46,200
Engr. & Adm.			3,272,200
TOTAL			35,994,000

Data Source: SWRB computations of cost data from agency and private companies.

Not included in this study are some slightly higher elevation, potentially irrigable lands of the Orchard Water Company near Brogan. The company states that they have 2,270 acres of irrigated land needing an additional 1.77 acre-feet per acre and 6,025 potentially irrigable acres within the company boundary requiring a full water supply. The total water needs would be 28,173 acre-feet.

Future studies should consider the advisability of eliminating some scattered, hard-to-serve tracts west of the proposed Dry Gulch reservoir and using the water instead, to serve additional lands in the Orchard Water Company area. There are also several thousand acres of potentially irrigable land in Baker County that join the Birch Creek area on the north which could be

incorporated in this development proposal. A more detailed classification of some Birch Creek Division lands will be required to refine irrigable acres and boundaries.

Wickiup Division

Table 26 lists the significant features of the Wickiup Division.

TABLE 26

WICKIUP DIVISION
SIGNIFICANT FEATURES

Irrigable Area	
Low Lift	3,475 acres
High Lift	5,565 acres
Total	9,040 acres
Pumping Plant	
Peak Flow	160 cfs
Horsepower	12,320
Pump Lift	525'
Relift	
Peak Flow	140 cfs
Horsepower	5,960
PumplLift	280'
Penstocks	
Diameter	4'-6"
Length	.76 miles
Diameter	4'-0"
Length	.57 miles
Canals	
Length	1.5 miles
Laterals	
Length	13.8 miles
Storage Reservoir	
Bridge Gulch	7,100 A.F.
Dam Height	140'
Crest Length	2,160'
Right-of-Way	
Through Private Lands	30 acres

The Wickiup Division includes 9,040 acres of potentially irrigable land on a high bench adjacent to the Snake River. This relatively small area would be susceptible to separate development because it has less dependence upon interrelated power and distribution system facilities than do other project divisions.

From the cost standpoint, the most feasible pumping station location is at Snake River stream mile 346.6. Although a more stable pumping station site and penstock routing is available from stream mile 347.3, penstock costs would increase appreciably. The 12,320-HP pumps would lift 160 cfs 525 feet to Bridge Gulch reservoir then booster pumps at the reservoir would relift a maximum of 140 cfs 280 feet to 5,565 acres of higher elevation land.

The 140-foot high Bridge Gulch dam was designed to store 7,100 acre-feet and release this water to irrigable lands during the July-August peak irrigation requirement period. The reservoir is designed to store about 15 percent or

0.79 acre-feet per acre of the division irrigation requirements during April and May when crop water requirements are low (see Figure 16).

System design calls for Snake River pumps to operate at full capacity from early April into September, with a resultant improved facility efficiency and a more favorable annual power rate. The distribution system includes: 1.3 miles of penstock, 1.5 miles of main canal, and 13.8 miles of main laterals.

Table 27 shows the estimated construction costs for the Wickiup Division of the Malheur Project.

TABLE 27

WICKIUP DIVISION
SUMMARY OF CAPITAL COSTS

ITEM	QUANTITY	UNIT PRICE	COST
Pumping Plant			
Mainline	12,300 HP	$55.00	$ 676,000
Booster	5,960 HP	46.00	274,160
Penstock			
Mainline	4,000 LF	49.37	197,480
Booster	3,000 LF	43.25	129,750
Canals			
Earthwork	18,400 CY	0.35	6,440
Structures			2,500
Laterals			
Earthwork	38,200 CY	0.35-0.45	14,560
Structures			10,350
Reservoir			
Earthwork	702,700 CY	0.35-3.24	991,635
Structures			56,410
Right-of-Way	26 Ac.	30-400	2,800
Engr. & Admin.			237,415
TOTAL			2,600,000

Data Source: SWRB computations of cost data from agency and private companies.

The Wickiup Division distribution system is shown on Plate 6 of the Appendix.

Jacobsen Division

The Jacobsen Division includes 53,900 acres of potentially irrigable land in the North Fork Jacobsen, Upper Jacobsen, and Alkali-Lower Dry Gulch units. This area would be susceptible to stage development whereby lower elevation lands could be developed in the first stage and booster pumps to higher elevation lands could be installed later. About 27,000 acres could be served by pump-lifts of 534 to 575 feet, while booster pumps are required for the remaining acreage.

Table 28 lists the significant features of the Jacobsen Division.

TABLE 28

JACOBSEN DIVISION
SIGNIFICANT FEATURES

Irrigable Area	
N. Fk. Jacobsen	11,100 acres
Upper Jacobsen	21,015 acres
Alkali-Dry Gulch	21,785 acres
Total	53,900 acres
Pumping Plants	
N. Fk. Unit	
Peak Flow	285 cfs
Horsepower	28,100
Pump Lift	534'
S. Fk. Unit	
Peak Flow	715 cfs
Horsepower	60,000
Pump Lift	534'
Penstocks	
Diameter	6'-0"
Length	4.5 miles
Diameter	10'-0"
Length	6.1 miles
Siphons	
Diameter	2'-3" to 6'-8"
Length	3.1 miles
Canal Length	36 miles
Lateral Length	54 miles
Storage Reservoir	29,500 A.F.
Dam Height	150'
Crest Length	2,800'
Right-of-Way	
Through Private Lands	360 acres

The most feasible pumping plant site inspected is at Snake River stream mile 368.7 adjacent to the Ore-Ida pumping plant. Separate pumps and penstocks would deliver water to the North Fork Jacobsen irrigable lands and the Upper Jacobsen-Alkali-Dry Gulch irrigable lands.

For the North Fork Unit, 28,100-HP pumps would lift 285 cfs a vertical height of 575 feet through a 4.5-mile penstock to serve 11,100 acres of potentially irrigable land. A 3,450-HP booster pumping plant would relift 120 cfs to the 4,600 acres located above the low lift canal plus a portion of Moores Hollow. No suitable reservoir site was located, so this area would be served directly from the Snake River pumping plant. This unit could be developed, by stages, separately from the remainder of the Jacobsen Division.

To serve the 42,800-acre Upper Jacobsen-Alkali-Lower Dry Gulch, 60,000-HP pumps would lift 715 cfs 534 feet. The 35-foot cut through South Jacobsen pass to elevation 2,655 feet, was computed to reduce the pump head in transit to Alkali Gulch reservoir and to serve irrigable lands in lower Dry Gulch.

Table 29 shows estimated construction costs for Jacobsen Division of the Malheur Project.

TABLE 29

JACOBSEN DIVISION
SUMMARY OF CAPITAL COSTS

ITEM	QUANTITY	UNIT PRICE	COST
Pumping Plant			
Mainline	88,100 HP	$55.00	$ 4,845,500
Booster	34,450 HP		1,584,700
Penstocks			
Mainline	84,000 LF	80.95-107.50	8,392,800
Booster	9,500 LF	24.50-103.72	643,000
Canals			
Earthwork	907,100 CY	0.35	317,485
Structures			487,300
Laterals			
Earthwork	429,820 CY	0.35-0.45	154,047
Structures			39,808
Siphons	11,600 LF	71.00-91.09	1,026,500
Pass Cut	380,400 CY	0.35	133,140
Reservoir			
Earthwork	1,615,000 CY	0.35-3.24	3,457,520
Structures			108,460
Right-of-Way	360 Ac.	30-400	53,300
Engr. & Adm.			2,124,440
TOTAL			23,368,000

Data Source: SWRB computations of cost data from agency and private companies.

The Jacobsen Division distribution system plan is presented on Plate 6 of the Appendix.

The 150-foot high dam on Alkali Gulch is designed to impound 29,500 acre-feet or 0.69 acre-feet per acre during early irrigation season pumping for subsequent release to irrigable lands during the July-August peak irrigation requirement period. The reservoir is designed to store 13 percent of the Upper Jacobsen, Alkali, and Lower Dry

Gulch irrigation requirement. Use of this reservoir reduces the size and capital cost of the Snake River pumping plant and penstock by about 32 percent. The system design calls for pumps operating at full capacity from mid-April to September with a resultant improved facility efficiency and a more favorable annual power rate.

The distribution system includes: 6.1 miles of penstock, 3.1 miles of siphons, 36 miles of main canal, 65 miles of laterals and facilities for the pumping of 715 cfs to serve 42,800 acres in the Upper Jacobsen-Alkali-Lower Dry Gulch units. An acreage determination and distribution system design was not completed for some of the broken tracts of irrigable lands in the Henry's Gulch area because cost analysis factors indicated that some of this land should be eliminated from the project. A more detailed land classification in Henry's Gulch is needed to refine irrigable areas and project boundaries.

Dunaway Division

The Dunaway Division includes 75,000 acres of potentially irrigable land in the Big Sage-East Cow and Cow Hollow-Sand Hollow units. This division would be susceptible to stage development whereby lower elevation lands could be developed during the first stage and booster pumps to higher elevation lands could be installed later. About 28,000 acres can be served by pump lifts of 395 and 525 feet while the remainder requires secondary pump lifts.

The most feasible pumping plant site inspected is at Snake River stream mile 393, adjacent to the Ontario-Nyssa pumping plant. Separate pumping facilities would deliver water to the Big Sage and Sand Hollow units of the division.

For the Big Sage-East Cow unit, 28,900-HP pumps would lift 417 cfs 395 feet through a 5.9 mile penstock to the proposed Locket Gulch reservoir whence water would be delivered by gravity to 4,080 acres and by booster pump to 26,815 acres. The distribution system includes 36 miles of main canals and lateral ditches to serve 30,895 acres of potentially irrigable land.

The 160-foot high Locket Gulch dam and reservoir were designed to store 42,000 acre-feet for release to irrigable

lands during the June-July-August peak irrigation requirement period.

Table 30 lists the significant features of the Dunaway Division.

TABLE 30

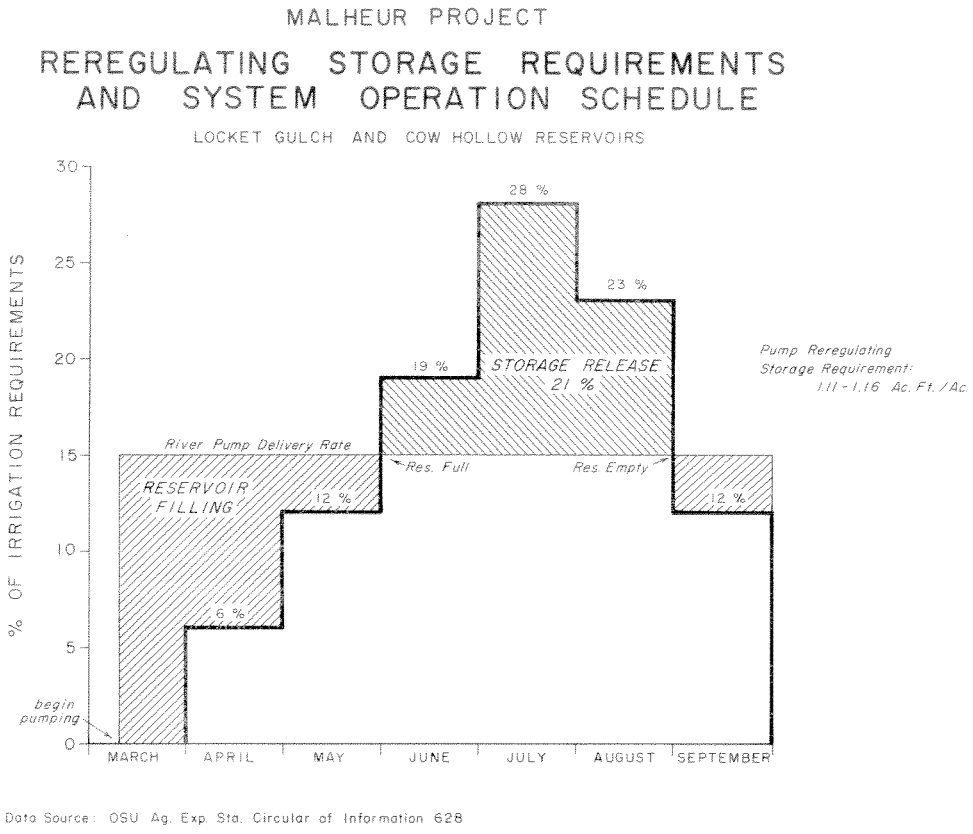
DUNAWAY DIVISION
SIGNIFICANT FEATURES

Irrigable Area	
Big Sage	7,985 acres
East Cow	22,910 acres
Cow Hollow	8,240 acres
Sand Hollow	35,865 acres
Total	75,000 acres
Pumping Plants	
Big Sage Unit	
Peak Flow	417 cfs
Horsepower	28,900
Pump Lift	395'
Cow Hollow Unit	
Peak Flow	643 cfs
Horsepower	55,800
Pump Lift	525'
Penstocks	
Diameter	7'-6"
Length	5.9 miles
Diameter	10'-0"
Length	7.8 miles
Canals	
Big Sage	9 miles
Cow Hollow	28 miles
Laterals	
Big Sage	27 miles
Cow Hollow	44 miles
Booster Pumps	
Number	6
Horsepower	58,140
Storage Reservoirs	
Locket Gulch	42,000 A.F.
Dam Height	160'
Crest Length	2,800'
Cow Hollow	57,000 A.F.
Dam Height	190'
Crest Length	6,455'
Right-of-Way	
Through Private Lands	210 acres

The reservoir is designed to store 25.5 percent or 1.36 acre-feet per acre of the irrigation requirements during March, April, May, and September while crop water requirements are low. System design calls for Snake River pumps to operate at full capacity from early March through September which maximizes facility efficiency and enables more favorable annual power rates (see Figure 17).

For the Cow Hollow-Sand Hollow units 55,800-HP pumps would lift 643 cfs 525 feet to the Cow Hollow-Sand Hollow gravity canal which supplies: irrigable land enroute, the Cow Hollow reservoir, and the Sand Hollow area by a 39-foot cut through the Cow Hollow-Sand Hollow divide.

The 159-foot high Cow Hollow dam was designed to impound 57,000 acre-feet for release to potentially irrigable lands during the June-July-August peak irrigation requirement period. The reservoir is designed to store about 24 percent or 1.29 acre-feet per acre of the irrigation requirements during March, April, May, and September while crop requirements are low.



Data Source: OSU Ag. Exp. Sta. Circular of Information 628

FIGURE 17. Reregulating Storage Requirements and System Operating Schedule.

Figure 17 illustrates the typical theoretical pumping and storage requirements and system operating schedule for Locket Gulch and Cow Hollow Reservoirs that make the greatest practical use of storage to reduce capital construction costs, provide a more favorable power rate, and to assure an adequate water supply within the division area when needed.

Table 31 shows estimated construction costs for the Dunaway Division of the Malheur Project.

TABLE 31

DUNAWAY DIVISION
SUMMARY OF CAPITAL COSTS

ITEM	QUANTITY	UNIT PRICE	COST
Pumping Plants			
Mainline	84,700 HP	$55.00	$ 4,658,500
Booster	58,140 HP		2,674,440
Penstocks			
Mainline	72,700 LF	97.44-129.42	8,417,454
Booster	29,700 LF	25.56-110.20	2,488,770
Canals			
Earthwork	816,300 CY	0.35	285,705
Structures			960,690
Laterals			
Earthwork	594,150 CY	0.35-0.40	212,000
Structures			67,100
Reservoirs			
Locket Gulch			
Earthwork	1,672,400 CY	0.35-3.24	2,691,200
Structures			139,145
Cow Hollow			
Earthwork	3,527,800 CY	0.35-3.24	5,035,020
Structures			178,540
Pass Cut	160,900 CY	0.35	56,315
Right-of-Way	210 Ac.	30-400	55,500
Engr. & Adm.			2,792,621
TOTAL			30,713,000

Data Source: SWRB computations of cost data from agency and private companies

The booster pumping plant at Cow Hollow was designed to pump from the reservoir to adjacent higher lands as required. Beyond Cow Hollow reservoir, a 555 cfs capacity canal was designed to serve 35,865 acres in the Sand Hollow unit.

As shown on Plate 6 of the Appendix, plans for Dunaway Division project facilities will include: one two-way river pumping plant utilizing 84,700-HP to pump 1,060 cfs for 75,000 potentially irrigable acres; 13.7 miles of buried penstock to transport water across presently irrigated land; 37 miles of main canals and 71 miles of laterals to serve potentially irrigable lands; two storage reservoirs with a total capacity of 99,000 acre-feet; and six booster pumps requiring 58,140-HP to serve higher elevation lands.

Summary of Capital Costs

A summary of capital costs for all Malheur Project Divisions is shown in Table 32.

TABLE 32

MALHEUR PROJECT
SUMMARY OF CAPITAL COSTS

DIVISION	ACRES	CAPITAL COST	PER ACRE
Birch Creek	73,060	$35,994,000	$493
Wickiup	9,040	2,600,000	288
Jacobsen	53,900	23,368,000	434
Dunaway	75,000	30,713,000	410
Project Total	211,000	92,675,000	
Average Per Acre			439

Farm Irrigation Systems

The development plans presented for the Malheur Project show only main canals and laterals. Distribution to and within the farmers' fields also must be considered in total project development. Costs for farm distribution facilities can vary from as little as $50 to over $300 per acre depending upon location, soil characteristics, type of crop grown, equipment used, and water user preference. Irrigation in adjacent areas is predominantly by surface methods. Similar practices may be adopted on favorable lying land within the proposed Malheur Project. However, due to high water delivery costs and undulating topography on about 70 percent of the irrigable land, serious consideration should be given to sprinkler irrigation.

Sprinkler irrigation is adapted to a wide range of soil, topographic, and climatic conditions. Sprinklers are well suited to sandy soils having high water intake rates, soils too shallow for gravity irrigation, and land with steep or irregular topography. Water application can be varied more readily with sprinklers to match the water penetration rates and water-holding ability of the soil than with gravity irrigation. Frequent applications of small amounts of water can be applied to reduce surface runoff and leaching of crop nutrients and to lessen ground water buildup. Most of the recently developed projects served by high-cost pumped water are utilizing the sprinkler method for water distribution.

A study was made on the Columbia Basin Project in 1967 by the University of Washington Extension Service to determine the important physical features that determined capital investment and annual operating costs of sprinkler systems. By adapting these findings to Malheur Project conditions, the costs per acre for applying 3.5 acre-feet per acre to a typical 160-acre tract for each of several types of sprinkler systems were computed. The capital investment and annual operating costs are shown in Table 33.

TABLE 33

CAPITAL INVESTMENT AND ANNUAL OPERATING COSTS PER ACRE

	SPRINKLER TYPE		
	Hand-Move	Wheel-Roll	Self-Propelled
CAPITAL INVESTMENT	$87.00	$162.00	$190.00
OPERATING COSTS			
Irrigation Labor	16.30	6.55	1.34
Electricity	6.12	6.13	6.72
Water	35.00	35.00	35.00
Other Operating	4.30	5.77	6.44
Investment Overhead	11.53	18.45	22.50
TOTAL ANNUAL COSTS	$73.25	$71.90	$72.00

In the past semiportable hand-move systems have been most commonly used. However, more farmers are now installing solid-set or self-propelled systems to reduce irrigation labor requirements and to increase irrigation efficiency. Although hand-move systems involve the lowest capital investment, their annual cost of operation is not lower for farmers who hire irrigation labor. Manufacturers now have a broad variety of (1) hand-move

systems, (2) side-roll systems, (3) circular self-propelled systems, and (4) solid-set systems.

Economics of Project Development

General

The economic reconnaissance analyses presented herein was summarized from a report supplied by the U. S. Department of Agriculture Oregon River Basin Survey Staff. This report, which includes numerous basic assumptions and individual crop production costs and benefits, is on file in the State Water Resources Board office.

The basic assumptions dealt with management levels, markets, prices, cropping patterns, cultural practices, and soil productivity which were projected from conditions which exist on similar presently irrigated land. The individual crop budgets were prepared for seven crops and were based on similar work done at several Oregon and Idaho sources.

The economic data is presented for two situations: (1) assuming private financing with 7 percent interest and a 30-year repayment period; and (2) assuming federal financing with 5 percent interest and a 100-year repayment period.

The survey staff refers to an extract from the University of Idaho Progress Report 112, which compares the economic sizes of farming units in similar areas of Idaho. This study shows that there is a rapid increase in income through increased efficiency to a farm size of 1,200 acres and then a lesser increase until it peaks at about 2,400 acres.

Benefit Analysis

This analysis is made on a per acre basis, without allowance for cost sharing on nonreimbursable features, which would be included in federal project development. Typical costs and returns for major irrigated crops are shown in the various crop budgets which in turn were

summarized at a specific production level and are shown in Table 34.

TABLE 34

ESTIMATED CROP COSTS AND RETURNS
FOR TYPICAL IRRIGATED CROPS
Per Acre

CROP	SELECTED YIELD	PRODUCTION COST	HARVEST COST	TOTAL COST	GROSS RETURN	NET RETURN
Sweet Corn	8 Tons	$ 90.00	$ 44.00	$134.00	$220.00	$ 86.00
Silage	25 Tons	74.00	62.50	136.50	200.00	64.50
Sugar Beets	28 Tons	166.00	77.00	243.00	406.00	163.00
Barley	100 Bu	44.00	8.00	52.00	110.00	58.00
Alfalfa	6 Tons	33.00	55.00	86.50	135.00	48.50
Potatoes	300 CWT	188.00	106.00	294.00	390.00	96.00
Pasture	600 lbs.	40.00	41.50	81.50	138.00	56.50

Data Source: USDA Oregon River Basin Survey Staff

The budget data for the seven selected crops show a net return per acre from $48.50 to $163.00.

Cost Analysis

In evaluating a potential irrigation project, the rate of interest used and the repayment period have a significant effect on project feasibility. In this study no determination has been made as to how or by whom the Malheur Project could or would be built. For contrast, however, two different interest cost frameworks have been developed:

1. Private capital @ 7 percent for 30 years.

2. Public funds @ 5 percent for 100 years.

Table 35 compares the difference in annual costs per acre assuming different interest rates and the extreme limits in repayment periods. It also lists the per acre annual project costs for the two frameworks,

showing the impact that interest and time have on project costs.

TABLE 35

COST VARIABLES ANALYZED

PROJECT DIVISION	CONSTRUCTION COST PRIVATE CAPITAL 30 YEARS Per Acre	ANNUAL INTEREST COST 5%	6%	7%
Birch Creek	493.00	32.05	35.80	39.74
Wickiup	289.00	18.78	20.98	23.29
Jacobsen	434.00	28.21	31.51	34.98
Dunaway	410.00	26.65	29.77	33.04
PUBLIC CAPITAL 100 YEARS				
Birch Creek	493.00	24.85	29.68	34.51
Wickiup	289.00	14.56	17.40	20.23
Jacobsen	434.00	21.87	26.13	30.38
Dunaway	410.00	20.66	24.68	28.70

Data Source: USDA Oregon River Basin Survey Staff

This table shows that annual construction costs are increased 19.6 percent when increasing the interest rate from 5 to 7 percent; and that annual construction costs are 37.5 percent less when using 5 percent interest and a 100-year repayment period than when using a 7 percent interest rate and a 30-year repayment period. The table was developed to show the extreme limits, but actual financial arrangements consumated probably will be nearer the mid-point of the extremes.

With the annual construction costs identified, the on-farm costs were computed, based on published farm operations costs in similar areas. Table 36 lists the development costs which provide a comparison of irrigation development costs for private and public financing for part or all of the cost items (see foot notes).

TABLE 36

DEVELOPMENT COSTS

	BIRCH CREEK		WICKIUP		JACOBSEN		DUNAWAY	
	CAPITAL COST	ANNUAL COST	CAPITAL COST	ANNUAL COST	CAPITAL COST	ANNUAL COST	CAPITAL COST	ANNUAL COST
Private Development 1/								
Project construction cost	$493.00	$39.75	$289.00	$23.30	$434.00	$35.00	$410.00	$33.05
Land (interest)	50.00	3.50	50.00	3.50	50.00	3.50	50.00	3.50
Land clearing	5.00	.40	5.00	.40	5.00	.40	5.00	.40
Land leveling	60.00	4.85	60.00	4.85	60.00	4.85	60.00	4.85
Land chisel	3.80	.30	6.20	.50	2.60	.20	1.40	.10
Farm distribution system	40.00	3.20	40.00	3.20	40.00	3.20	40.00	3.20
Total	651.00	52.00	450.20	35.75	591.60	47.15	566.40	45.10
Public Development 2/								
Project construction cost	493.00	24.85	289.00	14.55	434.00	21.85	410.00	20.65
Land	50.00	3.50	50.00	3.50	50.00	3.50	50.00	3.50
Land clearing	5.00	.40	5.00	.40	5.00	.40	5.00	.40
Land leveling	60.00	4.85	60.00	4.85	60.00	4.85	60.00	4.85
Land chisel	3.80	.30	6.20	.50	2.60	.20	1.40	.10
Farm distribution system	40.00	2.00	40.00	2.00	40.00	2.00	40.00	2.00
Total	651.00	35.90	450.20	25.80	591.60	32.80	566.40	31.50

1/ Private development assumes repayment of all cost items, except land, within 30 years at 7 percent interest.
2/ Public development assumes the project construction cost and farm distribution to be paid back in 100 years at 5 percent interest. The other cost items were evaluated as local costs and paid out in 30 years at 7 percent interest.

Data Source: USDA Oregon River Basin Survey Staff

Table 37 entitled "Variable Power Costs," summarizes

TABLE 37

VARIABLE POWER COSTS

EVALUATION UNITS	PROJECT COSTS		PER ACRE COSTS			TOTAL COSTS	
	PRIVATE	PUBLIC	OPERATION & MAINTENANCE	POWER RATE	POWER COST	PRIVATE	PUBLIC
Birch Creek	$52.00	$35.90	$3.56	8.5 mills	$26.38	$81.94	$65.84
				4.5 mills	13.98	69.54	53.44
				3.8 mills	11.87	67.43	51.33
Wickiup	35.75	25.80	2.99	8.5 mills	22.30	61.04	51.09
				4.5 mills	11.82	50.56	40.61
				3.8 mills	10.04	48.78	38.83
Jacobsen	47.15	32.80	3.35	8.5 mills	30.33	80.83	66.48
				4.5 mills	16.07	66.57	52.22
				3.8 mills	13.65	64.15	49.80
Dunaway	45.10	31.50	3.05	8.5 mills	27.93	76.08	62.48
				4.5 mills	14.80	62.95	49.35
				3.8 mills	12.57	60.72	47.12

Data Source: USDA Oregon River Basin Survey Staff

the effects of various power rates on the per acre costs of supplying water. Power costs will have a dominating influence on feasibility due to high pump lifts required to serve Malheur Project lands.

Cost Benefit Comparison

Table 38 shows that, with public financing and intensive row crop production, better project lands in the Wickiup and Dunaway Divisions could probably justify the 8.5-mill power rate while only portions of the Birch Creek and Jacobsen Divisions would qualify. The rate of 8.5 mills precludes project development on all project divisions under private development. Based on the 4.5-mill rate and public development, the Birch Creek Division is barely justified. The other three divisions are justified under either public or private development.

TABLE 38

COST-BENEFIT COMPARISON

EVALUATION UNIT	PROJECT COSTS	1980 CROP PROJECTIONS		50 PERCENT ROW CROP 1/ ASSUMPTION	
		BENEFIT	RESIDUAL	BENEFIT	RESIDUAL
Private development 30-year repayment 7 percent					
Birch Creek	$69.54	$53.60	-$15.94	$63.80	-$ 5.74
Wickiup	50.56	57.30	6.74	68.70	18.14
Jacobsen	66.57	64.00	- 2.57	78.80	12.23
Dunaway	62.95	64.35	1.40	79.35	16.40
Public development 100-year repayment 5 percent					
Birch Creek	53.44	53.60	.16	63.80	10.36
Wickiup	40.61	57.30	16.69	68.70	28.09
Jacobsen	52.22	64.00	11.78	78.80	26.58
Dunaway	49.35	64.35	15.00	79.35	30.00

1/ Assumes that 50% of the land will be various row crops, which is about double that projected for 1980.
Note: Based on a 4.5-mill power rate.
Data Source: USDA Oregon River Basin Survey Staff.

The most likely alternative to the use of electrical power for pumping would be natural gas. Through an inspection of the rate schedule of the natural gas company serving this area (see Appendix), it was surmised that natural gas rates would be about 60 percent of the rate shown by the private electrical utility. However, gas engine installation and operation costs

would be considerably higher. Further analysis of capital costs and the attainment of firm power prices is needed to determine the most feasible power source.

Based on preliminary studies, net returns from farm operations with irrigation should be adequate to establish feasibility of major portions of the project. Considering that some cost sharing probably would be available under federal development, the Malheur Project appears to have adequate justification for proceeding with detailed feasibility studies and development plans.

APPENDIX

AUTHORITY

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, reclamation, flood plains and reservoir sites.

"(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;

"(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 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."

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TABLE A

HYDROLOGICAL STATION SUMMARY

MALHEUR RIVER DRAINAGE BASIN

MAP[1] 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
	STREAM GAGING												
1	Malheur River at Jones Ranch, near Drewsey Malheur River near Drewsey (1914)	2135	20S	34E	5	162.5	530	3,690	Staff		1914	0	USGS
2	Malheur River near Drewsey	2140	20S	36E	31	142.1	910	3,479	Recorder	x	1920-23, 1926-67	39 39	USGS USGS
3	Malheur below Warm Springs Reservoir, near Riverside Middle Fork of Malheur River at Riverside (1906-07) Malheur River above South Fork near Riverside (1906-10) Middle Fork of Malheur River above South Fork, at Riverside (1909-10) Malheur River at Warm Springs Reservoir site, near Riverside (1914-17)	2150	23S	37E	17	121.6	1,100	3,305	Recorder	x	1906-10, 1914-17, 1919-67	48	USGS
4	South Fork of Malheur River at Riverside	2155	23S	37E	27	0.4	630	3,270	Staff		1910-15, 1919,20, 1927-29, 1938,39	2	USGS
5	Malheur River at Riverside Middle Fork Malheur River at Riverside (1910-12)	2160	23S	37E	22	118.9	1,750	3,265	Chain		1909-15	3	USGS
6	North Fork Malheur River above Agency Valley Reservoir, near Beulah North Fork Malheur River at Scotts Ranch, near Beulah (1914)	2165	19S	37E	22	21.1	355	3,351	Recorder	x	1914, 1936-67	29	USGS
7	North Fork Malheur River at Beulah North Fork Malheur River near Beulah (1926-37)	2175	19S	37E	22	17.6	440	3,261	Recorder	x	1926-67	39	USGS
8	North Fork Malheur River at Foley's Ranch, near Beulah North Fork of Malheur River near Beulah (1909-12)	2180	20S	37E	22	9.0	470	3,160	Staff		1909-12, 1914	2	USGS
9	North Fork Malheur River at Juntura	2185	21S	38E	17	0.9	530	2,940	Recorder		1919-22, 1926-32, 1935-40	2	USGS
10	Malheur River at Namorf	2190	20S	40E	36	70.3	2,590	2,840	Recorder		1913-24, 1926-30	13	USGS
11	Malheur River near Namorf	2192	20S	41E	31	66.8	2,840		Recorder	x	1931-67	16	OSE
12	Cottonwood Creek near Harper	(1329)	20S	42E	31				Recorder		1927-30	0	OSE
13	Malheur River near Westfall Malheur River near Harpers Ranch above Vale (1904)	2195	19S	42E	26	51.9	2,970	2,450	Staff		1904-06	1	USGS
14	Malheur River at Little Valley near Hope	2200	19S	42E	24	48.2	3,010	2,424	Recorder	x	1949-67	16	USGS
15	Malheur River near Hope	2205	19S	43E	5	43.3	3,030	2,370	Recorder		1919-49	26	USGS
16	Malheur River near Little Valley	2215	18S	43E	32	42.0	3,030	2,350	Staff		1904,05, 14,19,37-41	0	
17	Malheur River at McLaughlin Bridge, near Vale	2235	19S	44E	6	33.9	3,060	2,310	Chain		1905,06	0	USGS
18	Bully Creek near Westfall Bully Creek at Westfall (1911)	2255	18S	41E	20	37.3	160	2,990	Staff		1911-14,23	1	USGS
19	Cottonwood Creek near Westfall	2260	18S	41E	30		82	3,090	Recorder		1922,23	0	USGS
20	Clover Creek near Westfall	(1324)	18S	41E	8	3.3			Chain		1911,22,23	0	OSE
21	Bully Creek at Warmsprings near Vale Bully Creek near Vale (1903,07) Bully Creek above Vale (1904-06,10)	2265	18S	43E	9	19.1	539	2,527	Recorder	x	1903-07, 1910-17,22, 23,64,67	8	USGS
22	Bully Creek near Vale	2270	18S	44E	33	8.3	570	2,313	Recorder		1933-62	26	USGS
23	Bully Creek at Vale	2275	18S	45E	30	0.6	620	2,230	Chain		1904-05	0	USGS
24	Bully Creek at mouth near Vale	(131-k)	18S	45E	29	0.2			Staff		1938	0	OSE
25	Malheur River at Vale	2280	18S	45E	29	20.7	3,880	2,230	Staff		1890,91,95-97,1903-14, 19	11	USGS
26	Willow Creek near Malheur	2295	14S	41E	6	45.6	250	3,400	Recorder		1912-15, 21-29	7	USGS
27	Willow Creek below Reservoir, near Malheur Willow Creek near Malheur (1905-06) Willow Creek at Reservoir site, near Malheur (1910)	2305	14S	41E	14	41.0	290	3,310	Staff		1905,06,11 21-29	7	USGS
28	Cow Creek near Brogan	2310	14S	41E	24		75	3,250	Recorder		1912-14	2	USGS
29	Willow Creek near Brogan	2315	15S	42E	2	31.0	420	2,745	Recorder		1904-06,10, 12-14	2	USGS OSE
30	Willow Creek at Cole's Ranch, near Brogan Willow Creek near Dell (1904-06) Willow Creek near Brogan (1904-06)	2320	15S	42E	14	28.2	455	2,640	Staff		1904-06	1	USGS

TABLE A

HYDROLOGICAL STATION SUMMARY

MALHEUR RIVER DRAINAGE BASIN
(continued)

MAP 1/ 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
	STREAM GAGING												
31	Pole Creek near Brogan	2325	15S	42E	27		14	3,250	Recorder		1912	0	USGS
32	Pole Creek below Block Creek Feed Canal, near Brogan Pole Creek near Brogan (1913)	2330	15S	42E	27		14	2,840	Staff		1913	0	USGS
33	Willow Creek below Warmsprings District Diversion Canal, near Vale	(131-p)									1939-40	0	OSE
34	Willow Creek above Gellerman Fromen Canal near Vale	(131-j)	18S	45E	16				Staff		1936-40	0	OSE
35	Malheur River below Nevada Dam, near Vale Malheur River below Nevada Dam, at Vale (1926)	2290	18S	45E	21	19.2		2,280	Recorder		1926-34,36-42,44-53, 63-65	21	USGS OSE*
36	Malheur River at Halliday's Bridge, near Ontario	2335	18S	45E	13		4,620	2,180	Chain		1905	0	USGS
37	Malheur River near Ontario	2340	17S	47E	29		4,680	2,130	Staff		1904	0	USGS
38	Snake River at Weiser	2690	11N	5W	31+	351.4	69,200	2,087	Staff		1911-65		USGS
	CREST STAGE GAGING												
39	Malheur River tributary near Drewsey	2139	20S	35E	36		2.29			x	1964-67		USGS
40	Moores Hollow tributary near Weiser	2692	16S	46E	18		0.90			x	1964-67		USGS
	CANAL GAGING												
41	Owyhee Canal near Owyhee	1835	21S	46E	18				Recorder	x	1905,1912-16, 20-67	8	USGS OSE*
42	Sourza - Jones - Sizemore Canal near Beulah		19S	37E	22				Staff		1937	0	OSE
**	Scotty - Hay - Stollard Canal near Beulah		19S	37E	27				Staff		1937	0	OSE
**	Murray Highline Canal near Beulah		20S	37E	3				Staff		1937	0	OSE
43	Murray East Canal near Beulah		20S	37E	3				Staff		1937	0	OSE
44	Murray West Canal near Beulah		20S	37E	9				Staff		1937	0	OSE
**	Nutt No. 2 Canal near Juntura		20S	37E	22				Staff		1937	0	OSE
45	Jones - Hoffman - Curry - Mosterson - Goodman Canal near Juntura		20S	37E	26				Staff		1937	0	OSE
46	Juntura Investment Company canal near Juntura		20S	37E	35				Staff		1936-41	0	OSE
**	New Woodruff Canal near Juntura		21S	38E	18				Staff		1937	0	OSE
47	Carter Canal near Juntura		20S	39E	31				Staff		1937	0	OSE
48	Jonesboro Canal near Vale		20S	39E	33				Staff		1937	0	OSE
49	Fromen Canal near Harper		21S	40E	1				Staff		1937	0	OSE
50	Vale Oregon Canal near Namorf	2191	20S	41E	32				Recorder	x	1930-67	9	OSE*
51	Bully Creek Reservoir Feed Canal near Vale	2191.5	18S	43E	13				Recorder	x	1964-67	0	OSE* USGS
**	Upper Harper Ditch near Harper	(131)	20S	41E	13				Recorder		1919-23,27-30,31,32,36,	0	OSE
52	Lower Harper Ditch near Harper	(131a)	20S	41E	13				Recorder		1919-23,27-30,31,32,35-40	0	OSE
53	Vines Canal Ditch near Vale Vines Ditch above Vale (1904,05) Vines Ditch near Little Valley (1914)	2210	18S	43E	32				Staff		1904,05,14, 19,37-41	0	USGS OSE
**	Farmers Canal Diversions near Vale	(131fs)	18S	43E	34				Staff		1941	0	OSE
54	Farmers Canal near Hope Malheur Farmers Canal above Vale	2220	18S	43E	33				Recorder	x	1904,05,19, 36,37,40, 62-67	0	OSE OSE*
**	Farmers Canal Spillway near Vale	(131fs)	19S	44E	5				Staff		1938,41	0	OSE
**	Farmers Canal Spillways into Bully Creek near Vale	(131fsb)	19S	44E	4				Staff		1941	0	OSE
55	J. H. Canal near Hope	2230	19S	43E	3				Recorder	x	1904,05,19, 38-41,62-67	0	OSE OSE*
**	McLaughlin Ditch near Vale	2225	19S	43E	3				Staff	x	1904,05,14,19	0	OSE
**	J. H. Canal Spillways near Vale	(131ds)							Staff		1938-41	0	OSE
56	Gellerman Fromen Canal near Hope Gellerman Fromen Ditch above Vale	2240	19S	44E	8				Recorder	x	1904,05,19, 36,37-41, 62-67	0	OSE OSE*
57	Gellerman - Fromen Canal near Vale	(131c)	19S	44E	16				Recorder		1937-41	0	OSE
**	Gellerman - Fromen Spillway near Vale	(131cs)	19S	44E	3				Staff		1941	0	OSE
**	Willow Creek Spillwey from Gellerman - Fromen Canal into Willow Creek near Vale	(131g)	20S	18E	20				Staff		1938-41	0	OSE

TABLE A

HYDROLOGICAL STATION SUMMARY

MALHEUR RIVER DRAINAGE BASIN
(continued)

MAP[1] 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
	CANAL GAGING												
**	Gellerman - Froman Canal Spillways below Nevada Canal near Vale	(131r)							Staff		1941	0	OSE
58	Eldorado Ditch near Ironside	(131s)	14S	38E	20				Recorder		1920-23,28	0	OSE
**	Willow Creek Diversion Canal near Vale	(131q)	14S	38E	20				Recorder		1940-41	0	OSE
59	Nevada Canal near Vale	2285	16S	45E	21						1904,05,19, 38-41,62	0	USGS OSE OSE*
**	Nevada Canal Spillways near Vale	(131s)									1941	0	OSE
	RESERVOIR GAGING												
60	Warm Springs Reservoir near Riverside	2145	23S	37E	8	122.9	1,100	3,327	Tape	x	1920-67	46	USGS
61	Agency Valley Reservoir near Beulah	2170	19S	37E	15	18.1	440		Pressure	x	1936-67	29	USGS
62	Bully Creek Reservoir near Vale	2268	16S	43E	12	14.0	547		Pressure	x	1963-67	2	USGS
63	Willow Creek Reservoir near Malheur	2300	14S	41E	15	41.1	290		Staff		1923-28	5	OSE
	WATER TEMPERATURE												
(2)	Malheur River near Drewsey	2140	20S	36E	31	142.1	910		Spot	x	1955-67		USGS
(3)	Malheur River below Warm Springs Reservoir near Riverside	2150	23S	37E	17	121.6	1,100		Spot	x	1949-55, 58-67		USGS
(6)	North Fork Malheur River above Agency Valley Reservoir, near Beulah	2165	19S	37E	4	21.1	355		Spot	x	1955-67		USGS
(7)	North Fork Malheur River at Beulah	2175	19S	37E	22	17.6	440		Spot	x	1955-67		USGS
(14)	Malheur River at Little Valley near Hope	2200	19S	42E	24	48.2	3,010		Spot	x	1955-67		USGS
(22)	Bully Creek near Vale	2270	18S	44E	33	8.3	570		Spot Recorder		1946-51,55-62,59-60	2	USGS
64	Bully Creek at County Bridge near Vale		19S	44E	3	6.3	570		Spot		1959-60		USGS
	WATER QUALITY												
65	Snake River at NR Bridge above Nyssa	Sn-5	20S	47E	5	389.0					1960,61		OSSA
66	Snake River at Highway 20 Bridge in Nyssa	Sn-4	19S	47E	32	387.0					1960,61		OSSA
67	Snake River at Ontario Bridge	Sn-3	18S	47E	2	374.1					1960,61		OSSA
68	Malheur River at Vale	2280	18S	45E	29	20.7					1905,06		OSSA
69	Malheur River 5½ miles East of Vale	Mh-2	18S	46E	18	14.2					1960,61		OSSA
(27)	Malheur River 1½ miles North of Ontario	Mh-1	17S	47E	28	1.0					1960,61		OSSA
70	Snake River at Payette Bridge	Sn-2	17S	47E	13	365.8					1960,61		OSSA
(38)	Snake River at Weiser Bridge	Sn-1	11N	5W	31+	351.4					1960,61		OSSA
	SEDIMENTATION												
(22)	Bully Creek near Vale	2270	18S	44E	33	8.3	570		Sus. Sed.		1958-60		USGS
(25)	Malheur River at Vale	2280	18S	45E	29	20.7	3,880		Sus. Sed.		1905,06		USGS
	CLIMATOLOGICAL												
71	Adrian Owyhee (1909-17) Nyssa (1917-21) Kingman (1921-50)	0041	21S	46E	14			2,231	PT	x	1909-67	53	USWB
72	Beulah	0723	19S	37E	15			3,270	PT		1889-96,98-1900-06,39,41	7	USWB
73	Blue Mountain Springs	0831	15S	35E	21			5,900	SGP	x	1964-67	1	USWB
74	Brogan		15S	42E	24			2,600	PT		1911-13	1	USWB
75	Drewsey 12 WNW Drewsey 1915-29	2419	19S	34E	16			3,860	PT	x	1915-29,67	13	USWB
76	Harper	3666	20S	42E	5			2,510	PT	x	1920-44, 54-67	34	USWB
77	Ironside		14S	39E	28			3,500	P		1909-16	6	USWB
78	Ironside 11E	4170	15S	40E	2			3,911	SGP	x	1964-67	1	USWB
79	Ironside 2W	4175	14S	39E	30			3,915	PT	x	1956-67	9	USWB
80	Little Valley	4943	19S	43E	29			2,500	PT		1944-48, 51-54	2	USWB
81	Malheur Branch Experimental Station	5160	18S	46E				2,230	PT	x	1942-67	23	USWB
82	Nyssa	6179	19S	47E	32			2,185	PT	x	1938-67	24	USWB
83	Ontario KSRV Ontario CAAAP (1941-56)	6294	17S	47E	33			2,145	PT	x	1941-67	17	USWB
84	Parma (Idaho) Experimental Station	6844						2,275					USWB
85	Payette (Idaho)	6891						2,150					USWB
86	Princeton		27S	35E	17			4,000	P		1916-19	1	USWB
87	Princeton 13 E		26S	36E	32			3,910	P		1962-64	2	USWB
88	Reservoir No. 3		14S	41E	15			3,100	PT		1915-27	12	USWB
89	Riverside		23S	37E	21			3,000	PT		1897-1943	43	USWB
90	Riverside 2E		23S	37E	14			3,233	PT	x	1967-	0	USWB

TABLE A

HYDROLOGICAL STATION SUMMARY

MALHEUR RIVER DRAINAGE BASIN
(continued)

MAP INDEX NO. 1/	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
91	Vale, Vale 1W (1953-56)	8797	18S	45E	28			2,240	PT	x	1953-67	62	USWB
92	Van		18S	33½E	20			3,500	PT		1906-13	0	USWB
93	Warm Springs Reservoir	9046	23S	37E	17			3,336	PT	x	1928-67	37	USWB
94	Weiser (Idaho) 2 SE	9638						2,120					
95	Westfall		18S	41E	20			3,000	PT		1911-12	0	USWB
	SNOW SURVEY												
96	Berney Creek	18E14	14S	35E	16			5,950	SS	x	1945-67		SCS
97	Blue Mountain Springs	18E16M	15S	35E	21			5,900	SS & SM	x	1929-67		SCS
98	Buck Pasture	18F6a	29S	35E	21			5,700	ASD	x	1959-67		SCS
99	Bully Creek	18E21a	17S	37E	10			5,300	ASD	x	1958-67		SCS
100	Call Meadows	18F7a	20S	33E	29			5,340	ASD	x	1959-67		SCS
101	Clover Creek	17E2	16S	39E	36			4,100	SS		1957-61		SCS
102	Cottonwood - Indian	17F2a	23S	39E	29			4,320	ASD	x	1958-67		SCS
103	Crane Prairie	18E19M	16S	34E	24			5,375	SS & SM	x	1938-67		SCS
104	Crow Camp	18F8a	24S	35E	5				ASD	x	1963-67		SCS
105	Eldorado Pass	18E20	14S	38E	20			4,600	SS	x	1955-67		SCS
106	Eldorado Summit	18E17	14S	38E	14			4,660	SS		1929-35		SCS
107	Flag Prairie	18E26a	16S	36E	32			4,750	ASD	x	1961-67		SCS
108	Lake Creek	18E18	16S	33½E	10			5,120	SS	x	1938-67		SCS
109	Logan Valley	18E22a	16S	33½E	13			5,100	ASD	x	1958-67		SCS
110	Rock Spring	18F1	18S	32E	23			5,100	SS	x	1936-67		SCS
111	Stinking Water	18F1M	21S	34E	33			4,800	SS & SM	x	1938-67		SCS
112	Shumway Ranch	17F1	23S	39E	29			4,400	SS		1957-60		SCS

* Unpublished Records
** Not shown on SWRB Hydrological Station Map
\+ Idaho Grid

1/ Map index numbers refer to plate 1

Note: Station numbers in parenthesis refer to numbering system prior to September 30, 1951.

ABBREVIATIONS

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

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

TABLE A

HYDROLOGICAL STATION SUMMARY

OWYHEE RIVER DRAINAGE BASIN

MAP INDEX NO. 2/	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
	S FRK GAGING												
**	Snake River near Murphy	1725	1N	1W	35	453.5	41,900	2,271	Recorder	x	1914-67	54	USGS
1	Succor Creek near Jordan Valley	1729	27S	46E	11	39.0	82		Recorder	x	1965-67	0	OSE
2	Succor Creek near Homedale	1730	23S	46E	22	11.8	417	2,495	Staff		1919-23	3	USGS
3	Succor Creek near Adrian	1733	23S	46E	1	6.1	360		Staff	x	1967-67	0	OSE
**	Succor Creek at mouth near Homedale	1735	3N	5W	4	0.7	494	2,210	Staff		1903-10	2	USGS
4	Jordan Creek above Lone Tree Creek, near Jordan Valley	1780	6S	5W	19+		450	4,495	Recorder	x	1946-53, 55-67	19	USGS
5	Trout Creek near Jordan Valley	(120)	5S	6W	20+				Staff		1920	0	OSE
6	Jordan Creek near Jordan Valley	1790	30S	45E	9	35.0	660	4,280	Recorder		1911-20,30, 32-42	6	USGS
7	Jack Creek (N. Antelope Canal) below Antelope Reservoir near Denner	1793	30S	45E	31				Recorder	x	1930,32,33 1958-67	0	OSE OSE*
8	Jack Creek near mouth, near Denner	(1228)	30S	45E	30				Recorder		1925,30,32,33 36-41	0	OSE
9	Jordan Creek below Palmer Dam, near Denner	(1231)	30S	44E	26	29.0			Staff		1925	0	OSE
10	Cow Creek at Caldwell-Jordan Valley Road crossing near Jordan Valley	(120)	28S	46E	13				Staff		1920	0	OSE
11	Cow Creek Slough at Caldwell-Jordan Valley Road crossing, near Jordan Valley	(120)	28S	46E	12				Staff		1920	0	OSE
12	Mahogany Creek near Jordan Valley	(120)	29S	45E	16				Staff		1920	0	OSE
13	Cow Creek at Narrows near Jordan Valley Cow Creek at outlet of upper Cow Creek (Upper Cow) Lake near Jordan Valley (1914)	1795	28S	44E	28		250	4,330	Recorder		1914,20	0	USGS
14	West Fork (West) Cow Creek above Azcuenaga Meadows, near Jordan Valley	(120)	29S	44E	16				Recorder		1920	0	OSE
15	West Fork (west) Cow Creek below Azcuenaga Meadows, near Jordan Valley	(120)	29S	44E	28				Staff		1920	0	OSE
16	Cow Creek below Azcuenaga Meadows, near Jordan Valley	(120)	29S	44E	28				Recorder		1920	0	OSE
17	Cow Creek at Denner Cow Creek at mouth near Jordan Valley (1914)	1800	30S	44E	16		330	4,210	Staff		1914,20,30	0	USGS
18	Jordan Creek at Denner	1805	30S	44E	16	26.0	1,100	4,210	Staff		1920,23,25,30	0	USGS
19	Jordan Creek below diversion Dam, near Denner	(1221)	31S	43E	1	19.0			Staff		1926	0	OSE
20	Owyhee River near Rome	1810	31S	41E	14	121.3	8,000	3,344	Recorder	x	1950-67	18	USGS
21	Crooked Creek near Rome Crooked Creek near Jordan Valley	1815 (1235)	32S	41E	6	9.0	1,700	3,540	Recorder		1950-52	3	USGS OSE*
22	Owyhee River above Owyhee Reservoir	1820	27S	43E	18	76.0	10,400	2,690	Recorder		1929-51	22	USGS
23	Owyhee River below Owyhee Dam Owyhee River below Owyhee Reservoir (1929-59)	1830	22S	45E	17		11,160	2,344	Recorder	x	1929-67	38	USGS
24	Owyhee River near Owyhee Owyhee River at Rigsby (1890-93) Owyhee River at Nyssa (1895-96) Owyhee River at Owyhee	1840	21S	46E	2	3.5	11,300	2,200	Chain		1890-96 1903-16,20-29	22	USGS OSE
	CANAL GAGING												
25	Jordan Valley Feed Canal, near Jordan Valley	1785	30S	46E	10				Recorder		1920,23,26-30 32-42	0	USGS
26	Jordan Valley Feed Canal above Antelope Reservoir, near Jordan Valley	1789	30S	45E	16				Recorder	x	1925-26,30, 32-41,58-67	0	OSE* OSE
27	Jordan Valley Feed Canal at mouth near Denner	(1229)	30S	45E	28				Recorder		1925,30,32-41	0	OSE
28	South Antelope Canal below Antelope Reservoir near Jordan Valley	1792	30S	45E	32				Recorder	x	1930,32-34 31-41,58-67	10	OSE*
29	North Antelope Canal (Jack Cr.) near Denner	(1228)	30S	45E	30				Staff		1930-33,37-40	0	OSE
30	Oliver Ditch near Jordan Valley	(1217)	28S	44E	28						1920	0	OSE
31	North Side Canal near Denner	(1223)	30S	43E	36				Staff		1925,30,32-34, 37-40	0	OSE
32	South Side Canal near Denner	(1224)	30S	43E	36				Staff		1930,32,33, 36-40	0	OSE
33	South (Owyhee South) Canal near Adrian	1823	22S	46E	9				Recorder	x	1963-67	4	OSE* OSE
34	North (Owyhee North) Canal near Adrian	1824	22S	45E	2				Recorder	x	1963-67	4	OSE* OSE
35	Owyhee Canal near Owyhee	1836	21S	46E	18				Recorder	x	1903-05,12-16 20-67	9	USGS OSE* OSE

TABLE A

HYDROLOGICAL STATION SUMMARY

OWYHEE RIVER DRAINAGE BASIN
(continued)

MAP 2/ 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
	RESERVOIR GAGING												
36	Lake Owyhee at Owyhee Dam Owyhee Reservoir at Owyhee Dam, near Nyssa	1825	22S	45E	17	27.0	11,160	MSL	Staff	x	1933-67	30	USGS
37	Antelope Reservoir near Jordan Valley	1791	30S	45E	32		4,198		Tape	x	1926-27,30, 32-42,58-60, 62,66-67		OSE
	WATER TEMPERATURE												
(20)	Owyhee River near Rome	1810	31S	41E	14	121.3		8,000		x	1955-67	10	USGS
	WATER QUALITY												
(24)	Owyhee River near Owyhee	1840	21S	46E	2	3.5		11,300	Chem An.		1911-12	0	USGS
	SEDIMENTATION												
(24)	Owyhee River near Owyhee	1840	21S	46E	2	3.5		11,300	Sus.Sed.		1911-12	20	USGS
	CLIMATOLOGICAL												
38	Adrian	0041	21S	46E	14			2,231	PT	x	1909-67	57	USWB
39	Crowley Ranch	2000	26S	39E	15			4,145	PT	x	1962-67	1	USWB
40	Danner	2135	30S	44E	16			4,000	PT	x	1929-67	38	USWB
41	Hutchinson Ranch	4114	27S	38E	26			4,040	PT		1956-62	5	USWB
42	Jordan Valley	4321	30S	46E	2			4,397	PT	x	1890-1913 13,14,41-46, 46-52,52-54, 54-67	14	USWB
43	McDermitt 2SW	5355	36S	43E	25			4,464	PT	x	1956-67	11	USWB
44	Nyssa									x			
45	Owyhee Dam	6405	22S	45E	20			2,400	PT	x	1935-67	33	USWB
46	Parma												
47	Rockville 5N	7277	25S	46E	29			3,820	PT	x	1964-67	3	USWB
48	Rome Rome 2 NW	7310	31S	41E	24			3,410	PT	x	1951-52, 52-54,54-65, 66-67	12	USWB
49	Sheaville	7736	28S	46E	13			4,800	PT	x	1931-38, 52-67	15	USWB
**	Sunrise Valley	8245	29S	36E	24			3,710	PT		1913-36	22	USWB
	SNOW SURVEY												
50	Lookout Butte	17C6a	40S	47E	2			5,650			1961		SCS
51	Louse Canyon	17C4a	40S	42E	27			6,440			1959-		SCS

* Unpublished Records
** Not shown on SWRB Hydrological Stations Map
\+ Idaho Grid

2/ Map index numbers refer to plate 2

Note: Station numbers in parenthesis 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

PT - Precipitation & Air Temperature

TABLE B

POTENTIAL WATER DEVELOPMENT PROJECTS
DAMSITES

MALHEUR - OWYHEE BASINS

MAP INDEX NO.	SITE NAME	STREAM	LOCATION Twp. S	Rng. E	Sec.	DRAINAGE AREA ACRES	ESTIMATED ANNUAL YIELD Ac. Ft.	PURPOSE *	MAXIMUM WATER DEPTH Feet	CREST L. Feet	MAX. POOL AREA Acres	TOTAL STORAGE Ac.Ft.	SOURCE **
	UPPER MALHEUR												
	A. North Fork												
1	Crane Prairie	Crane Cr.	16	35	30	7,200	3,600	I,R					FS
	B. Malheur River												
2	Summit Prairie	Summit Cr.	16	34	3	9,200	8,000	R	90		800	27,200	FS
3	Summit Creek	Summit Cr.	16	34	31	15,800	11,000	I,R	90		130	4,400	FS
4	Logan Valley	Malheur R.	17	33½	2	45,800	27,000	I,F,R	60		1,180	26,000	FS
5	Wheelers Bend	Malheur R.	17	33½	13	68,000	24,000	I,F,R	35		50	700	FS,SCS
6	Sego's Bar	Malheur R.	17	34	13	73,000	30,000	I,F,R	55		50	1,100	FS
7	Cliffs	Malheur R.	17	34	18	75,000	31,000	I,F,R	55		45	990	FS,SCS
8	Bridge	Malheur R.	19	34	5	-	-	F	70		530	13,000	CE
9	Bridge Site	Malheur R.	19	34	19	147,200	60,000	I,R	65		540	13,000	CE,FS
10	Calamity Creek	Calamity Cr.	18	33	30	8,800	7,000	I,F,R	35		95	1,300	FS
11	Crewfield	Calamity	18	33	25	34,000	12,500	I,F,R	76		190	2,700	FS,SCS
12	Yan	Wolf Cr.	19	33½	4	83,000	28,000	I,F,R	50		240	4,800	SCS
13	Alkali	Pine Cr.	20	33	5	12,900	5,000	I,F,R	90		195	6,600	FS
14	Upper Pine Cr.	Pine Cr.	20	33	23	21,900	10,000	I,F,R	55		165	3,300	FS
15	Pine Creek	Pine Cr.	20	34	31	67,840	15,000	I	85	700	170	5,500	BR,CE
16	Pat Gap	Pine Cr.	20	33	26	23,900	11,000	I,F,R	70		150	3,900	FS,SCS
17	Grange Site	Malheur R.	20	34	5	347,500	110,000	I	88	1,080	2,630	60,000	CE,FS
18	Stinkingwater Cr.	Stinkingwater Cr.	20	35	33	112,000	22,000	I,F	77	370	1,520	22,800	CE
19	Black Butte	Malheur R.	22	36	13			P	194			-	BR
20	Riverside	Malheur R.	23	37	23	1,100,800	151,000	I	145	1,600	3,070	250,000	CE
21	Reservoir No. 2	Malheur R.	22	38	8			P	300				BR
22	Juniture	Malheur R.	21	38	9	376,000	140,000	I,F					BR
	C. South Fork												
23	Coleman Creek	Coleman Cr.	24	36	29			F	90		115		CE
24	Coleman Creek	Coleman Cr.	24	36	28	17,300	3,000	I	85		115	3,000	CE
25	South Fork	S. Fk. Malheur R.	24	37	21	96,000	42,000	I,F	150	400			BR
26	McRae Ranch	S. Fk. Malheur R.	24	37	9	352,000	50,000	I,F	95	1,300	2,400	59,000	CE
27	Granite Creek	Granite Cr.	24	37	2			I,F					CE
	LOWER MALHEUR												
	A. Willow Creek												
28	McPherson	Willow Cr.	14	40	9	39,200	7,500	I	68		550	15,000	BR
29	Golden Eagle	Willow Cr.	14	40	3	39,200	7,500	I	70		585	15,000	BR
30	Malheur Res.	Willow Cr. (Rehab.)	14	41	14	46,400	8,400	I,F				35,000	BR
31	Cow Valley No. 1	Cow Cr.	14	41	33	47,900	12,000	F	29		740	6,800	SCS
32	Cow Valley No. 3	Cow Cr.	14	41	27	47,900	12,000	F	57		895	12,800	SCS
33	Cow Valley No. 2	Cow Cr.	14	41	33	47,900	12,000	F	34		815	9,400	SCS
34	Basin Creek	Basin Creek	14	42	17	7,900	1,700	F	124		100	4,200	SCS
35	Rap	Willow Cr.	14	42	27	77,900	19,500	F	175		385	31,500	SCS
36	Dry Gulch	Dry Gulch	15	44	29	N/A	Pump Storage	I	109		245	10,600	SCS,SWRB
37	Alkali Flats	Alkali Gulch	16	45	27	N/A	Pump Storage	I	60		200	4,800	SCS,SWRB
38	Alkali Springs	Alkali Gulch	17	45	5	N/A	Reregulating Storage	I	60		1,270	30,480	SCS
	B. Bully Creek												
39	Upper Bully Cr.	Bully Cr.	17	38	23	23,000	1,800	I,F	46	440	40	600	SCS
40	Jenkins	Bully Cr.	17	39	28	32,400	3,000	I,F	85		50	4,200	BR
41	Upper John Smith	Bully Cr.	18	40	3	57,300	5,000	I,F	50		105	1,900	SCS
42	Chuckar	Bully Cr.	18	40	3	57,300	4,800	I,F	94		325	12,200	SCS
43	Lower John Smith	Bully Cr.	18	40	11	59,900	11,300	I,F	64		240	5,900	SCS
44	Vesa	Bully Cr.	18	40	12	60,200	5,000	I,F	45		400	400	SCS
45	Bully Creek	Bully Cr.	18	40	13	60,500	11,300	I,F	94		230	7,300	SCS
46	Lamberson	Bully Cr.	18	41	19	113,800	9,000	I,F	85		680	20,100	CE,SCS
47	Indian Creek	Indian Cr.	18	40	14	41,000	3,400	I,F	83		350	10,900	SCS
48	Upper Cottonwood	Cottonwood Cr.	19	40	9	26,400	2,200	I,F	60		48	1,200	SCS
49	Cottonwood	Cottonwood Cr.	18	40	35	32,800	4,000	I,F	72		235	5,400	CE,SCS
50	Lower Cottonwood	Cottonwood Cr.	18	41	29	37,800	3,150	I,F	75		300	7,800	SCS
51	Clover Springs	N. Clover Cr.	16	39	2	13,500	2,000	I,F	45		65	900	SCS
52	North Clover	N. Clover Cr.	16	39	12	16,500	2,000	I,F	40		90	1,500	SCS
53	Hawkins	N. Clover Cr.	16	39	13	16,500	2,000	F	94		110	4,100	SCS
54	Lower Clover	Clover Cr.	17	40	23	80,900	7,000	I,F	81		140	8,000	SCS
55	Nepton	Clover Cr.	17	40	25	81,500	7,000	I,F	98		130	6,000	SCS
56	Ritchie Flat	Off Channel	18	41	17	N/A	N/A	I	34		175	2,400	SCS
	C. Warmsprings												
57	Namorff	Malheur R.	21	41	6			P	425				BR
58	Upper Cottonwood	Cottonwood Cr.	22	41	7	38,400	3,600	I	55		120	3,500	SCS
59	Star Mountain	Cottonwood Cr.	22	41	5	64,700	5,400	I	75	530	125	5,000	CE
60	Middle Cottonwood	Cottonwood Cr.	21	41	14	71,900	6,000	I					SCS
61	Lower Cottonwood	Cottonwood Cr.	21	42	6	80,700	6,700	I	93		100		SCS
62	Little Valley	Malheur R.	19	42	35	475,200	294,000	I,F				80,000	BR
63	Harper	Malheur R.	19	43	17	481,600	135,000	I					BR
64	McLoughlin	Malheur R.	19	43	5			P	225				BR
65	Poison Springs	Nigger Rock Can.	21	43	14	N/A	Pump Storage	I	190		2,365	179,600	SCS,SWRB
66	Hanging Rock	Nigger Rock Can.	21	43	1	N/A	Pump Storage	I	175		640	45,000	SCS,SWRB
	LOWER OWYHEE												
	A. Dead Ox												
67	Birch Creek	Birch Cr.	15	44	14	47,400	1,740	I	80		850	16,000	BR
68	Bridge Gulch	Bridge Gulch	15	46	33	1,280	Pump Storage	I	131	2,160	199	7,100	SWRB
	B. Mitchell Butte												
69	Locket Gl.	Locket Gl.	19	46	20	22,400	Pump Storage	I	150	2,800	655	42,000	SWRB
70	Cow Hollow	Cow Hollow	20	44	12	99,800	Pump Storage	I	100	6,455	600	24,100	SCS,SWRB
	C. Succor Creek												
71	Malloy	Succor Cr.	27	46	2	64,000	32,500	I,F,R	100	200	435	14,200	BR,SCS
72	Cunningham-Freeley	Carter Cr.	26	46	18	15,500	2,600	I,F	52		60	1,200	SCS
73	Rocky Ford	Succor Cr.	25	46	8	144,300	14,400	I,F	79		645	20,600	SCS
74	Lower Succor Cr.	Succor Cr.	24	46	29	155,900	13,000	I,F	135		180	9,800	SCS
75	Griffield	Succor Cr.	24	46	5	198,800	16,200	I,F,R	82		275	11,000	BR,SCS
76	Gesie	Succor Cr.	23	46	28	204,600	25,600	I,F	86		257	8,900	SCS
77	Issac	Succor Cr.	23	46	10	225,500	28,200	I	86		382	13,200	SCS
	JORDAN CREEK												
78	Jordan Creek	Jordan Cr. (Ida.)	# 6	5	28		125,700	I,F,R	135	820	4,657	60,000	BR,CE
79	Skinner Ranch	Jordan Cr.	30	45	16	34,500	4,300	I				15,000	BR
	UPPER OWYHEE												
80	Three Forks	Owyhee R.	34	45	34	225,500	18,800	I				635,000	BR
81	Soldier Creek	Owyhee R.	32	44	32			P					GS
82	Duncan Ferry	Owyhee R.	31	41	4	1,280,000	590,000	I,F,R	207	520	8,900	1,000,000	BR
83	Bogus Cr.	Owyhee R.	28	41	28			P	320				GS
84	Mahogany	Owyhee R.	27	41	28			P	240				GS
85	Upper Owyhee L.	Owyhee R.	27	42	25			P	90				GS

Note: * F=Flood Control, I=Irrigation, P=Power, R=Recreation
** BR=Bureau of Reclamation, CE=Corps of Engineers, FS=Forest Service, GS= Geological Survey.

Boise Meridian.

TABLE C

SURFACE WATER RIGHTS
cfs

STREAM	DOM.	MUN.	IND.	IRRIGATION	IRRIGATION (Acres)	OTHER	TOTAL
1. UPPER MALHEUR							
a. North Fork							
North Fork Malheur R. & Misc.	0.02	100.0	0.0	219.67	4,878	0.0	319.69
Little Malheur R. & Misc.	0.30	0.0	0.0	23.23	620	0.0	23.53
Warm Springs Cr. & Misc.	0.0	0.0	0.0	66.59	1,576	0.0	66.59
Total	0.32	100.0	0.0	309.49	7,074	0.0	409.81
b. Malheur							
Malheur R. & Misc.	0.21	0.0	0.0	301.42	7,747	0.0	301.63
Wolf Cr. & Misc.	0.0	0.0	0.0	89.47	2,046	0.0	89.47
Muddy Cr. & Misc.	0.0	0.0	0.0	15.57	376	0.0	15.57
Little Muddy Cr. & Misc.	0.0	0.0	0.0	46.13	1,006	0.0	46.13
Pine Cr. & Misc.	0.0	0.0	0.0	39.57	1,221	0.0	39.57
Griffin Cr. & Misc.	0.0	0.0	0.0	11.38	375	0.0	11.38
Stinkingwater Cr. & Misc.	0.10	0.0	0.0	70.55	2,331	0.0	70.65
Cottonwood Cr. & Misc.	0.02	0.0	0.0	102.40	2,220	0.0	102.42
Otis Cr. & Misc.	0.01	0.0	0.0	20.95	654	0.0	20.96
Total	0.34	0.0	0.0	697.44	17,976	0.0	697.78
c. South Fork							
South Fork Malheur R. & Misc.	0.04	0.0	0.0	239.58	5,887	0.0	239.62
Granite Cr. & Misc.	0.17	0.0	0.0	55.39	1,755	0.0	55.56
Total	0.21	0.0	0.0	294.97	7,642	0.0	295.18
TOTAL	0.87	100.0	0.0	1,301.90	32,692	0.0	1,402.77
2. LOWER MALHEUR							
a. Willow Creek*							
Willow Cr. & Misc.	0.56	0.0	0.0	151.40	12,499	17.76M	169.72
South Fork Willow Cr. & Misc.	0.0	0.0	0.0	13.93	1,006	0.0	13.93
Middle Fork Willow Cr. & Misc.	0.0	0.0	0.0	23.22	1,850	0.0	23.22
Cow Cr. & Misc.	0.02	0.0	0.0	9.49	580	0.0	9.51
Basin Cr. & Misc.	0.0	0.06	0.0	3.54	191	20.62M	24.22
Total	0.58	0.06	0.0	201.58	16,126	38.38M	240.60
b. Bully Creek*							
Bully Cr. & Misc.	0.10	0.0	0.0	125.64	2,601	0.0	125.74
Indian Cr. & Misc.	0.0	0.0	0.0	40.93	1,104	0.0	40.93
Cottonwood Cr. & Misc.	0.0	0.0	0.0	16.16	344	0.0	16.16
Clover Cr. & Misc.	0.0	0.0	0.0	85.52	1,850	0.0	85.52
Cottonwood Cr. & Misc.	0.03	0.0	0.0	4.03	243	0.0	4.06
Total	0.13	0.0	0.0	272.28	6,142	0.0	272.41
c. Warmsprings							
Malheur R. & Misc.	0.33	5.50	0.15	1,574.01	55,596	171.00P	1,750.99
Cottonwood Cr. & Misc.	0.10	0.0	0.0	14.07	475	0.0	14.17
Sand Hollow Cr. & Misc.	0.03	0.0	0.0	0.65	52	0.0	0.68
Nigger Rock Can. Cr. & Misc.	0.10	0.25	0.0	4.19	335	0.0	4.54
Bully Cr. & Misc.	0.0	0.0	0.0	173.76	5,717	0.0	173.76
Willow Cr. & Misc.	0.0	0.0	0.0	34.38	3,225	0.0	34.38
Total	0.56	5.75	0.15	1,801.06	65,400	171.00	1,978.52
TOTAL	1.27	5.81	0.15	2,274.92	87,668	171.00P	2,491.53
TOTAL MALHEUR	2.14	105.81	0.15	3,576.82	120,360	171.00P 38.38M	3,894.30

* Lower Portions are under Warmsprings.

Note: M = Mining, P = Power

TABLE C

SURFACE WATER RIGHTS
cfs

STREAM	DOM.	MUN.	IND.	IRRIGATION	(Acres)	OTHER	TOTAL
3. LOWER OWYHEE							
a. Dead Ox							
Snake R. & Misc.	0.59	10.00	4.00	461.19	25,901	0.0	475.78
Birch Cr. & Misc.	0.0	0.0	0.0	6.92	511	0.0	6.92
Owyhee Res.	0.0	0.0	0.0	398.48	23,909	0.0	398.48
Total	0.59	10.00	4.00	866.59	50,321	0.0	881.18
b. Mitchell Butte							
Snake R. & Misc.	0.0	0.0	0.0	68.85	2,523	0.0	68.85
Owyhee R. & Misc.	0.61	2.00	16.86	338.15	25,951	0.0	357.62
Owyhee Res.	0.0	0.0	0.0	547.93	32,876	0.0	547.93
Total	0.61	2.00	16.86	954.93	61,350	0.0	974.40
c. Succor Creek							
Snake R. & Misc.	0.0	0.0	0.0	38.85	2,522	0.0	38.85
Succor Cr. & Misc.	0.03	0.0	0.0	9.34	564	0.0	9.37
Owyhee Res.	0.0	0.0	0.0	243.05	14,583	0.0	243.05
Total	0.03	0.0	0.0	291.24	17,669	0.0	291.27
TOTAL	1.23	12.00	20.86	2,112.76	129,340	0.0	2,146.85
4. JORDAN CREEK							
Jordan Cr. & Misc.	0.30	0.0	0.0	1,028.58	24,443	0.0	1,028.88
Cow Cr. & Misc.	0.70	0.0	0.0	271.77	10,050	0.0	272.47
TOTAL	1.00	0.0	0.0	1,300.35	34,493	0.0	1,301.35
5. UPPER OWYHEE							
Owyhee R. & Misc.	1.05	0.03	0.0	67.19	4,072	60.00P 0.10R	128.37
Soldier Cr. & Misc.	0.10	0.0	0.0	36.01	2,111	0.0	36.11
Crooked Cr. & Misc.	0.05	0.0	0.0	60.02	3,057	0.0	60.07
Crowley Cr. & Misc.	0.10	0.0	0.0	18.30	1,399	0.0	18.40
Dry Cr. & Misc.	0.51	0.0	0.0	11.29	602	0.0	11.80
McDermitt Cr. & Misc.	0.02	0.0	0.0	16.50	982	0.09M	16.61
TOTAL	1.83	0.03	0.0	209.31	12,223	60.19	2,271.36
TOTAL OWYHEE	4.06	12.03	20.86	3,622.42	176,056	60.19	3,719.56
TOTAL	6.20	117.84	21.01	7,199.24	296,416	269.57	7,613.86

* Lower Portions are under Warmsprings.

Note: M = Mining, P = Power, R = Recreation

Data Source: State Engineer.

TABLE D

LEGAL ANNUAL SURFACE WATER DEPLETIONS
Acre-feet

STREAM	DOM.	MUN.	IND.	IRRIGATION	(Acres)	OTHER	TOTAL
1. UPPER MALHEUR							
a. North Fork							
North Fork Malheur R. & Misc.	15	72,400	0	14,634	4,878	0	87,049
Little Malheur R. & Misc.	217	0	0	1,860	620	0	2,077
Warm Springs Cr. & Misc.	0	0	0	4,728	1,576	0	4,728
Total	232	72,400	0	21,222	7,074	0	93,854
b. Malheur							
Malheur R. & Misc.	152	0	0	23,241	7,747	0	23,393
Wolf Cr. & Misc.	0	0	0	6,138	2,046	0	6,138
Muddy Cr. & Misc.	0	0	0	1,128	376	0	1,128
Little Muddy Cr. & Misc.	0	0	0	3,018	1,006	0	3,018
Pine Cr. & Misc.	0	0	0	3,663	1,221	0	3,663
Griffin Cr. & Misc.	0	0	0	1,125	375	0	1,125
Stinkingwater Cr. & Misc.	72	0	0	6,993	2,331	0	7,065
Cottonwood Cr. & Misc.	15	0	0	6,660	2,220	0	6,675
Otis Cr. & Misc.	7	0	0	1,962	654	0	1,969
Total	246	0	0	53,928	17,976	0	54,174
c. South Fork							
South Fork Malheur R. & Misc.	29	0	0	17,661	5,887	0	17,690
Granite Cr. & Misc.	123	0	0	5,265	1,755	0	5,388
Total	152	0	0	22,926	7,642	0	23,078
TOTAL	630	72,400	0	98,076	32,692	0	171,106
2. LOWER MALHEUR							
a. Willow Cr. *							
Willow Cr. & Misc.	406	0	0	37,497	12,499	12,840M	50,743
South Fork Willow Cr. & Misc.	0	0	0	3,018	1,006	0	3,018
Middle Fork Willow Cr. & Misc.	0	0	0	5,550	1,850	0	5,550
Cow Cr. & Misc.	14	0	0	1,740	580	0	1,754
Basin Cr. & Misc.	0	43	0	573	191	14,947M	15,563
Total	420	43	0	48,378	16,126	27,787	76,628
b. Bully Cr. *							
Bully Cr. & Misc.	72	0	0	9,805	2,601	0	9,877
Indian Cr. & Misc.	0	0	0	4,968	1,104	0	4,968
Cottonwood Cr. & Misc.	0	0	0	1,548	344	0	1,548
Clover Cr. & Misc.	0	0	0	8,325	1,850	0	8,325
Cottonwood Cr. & Misc.	22	0	0	1,094	243	0	1,116
Total	94	0	0	25,740	6,142	0	25,834
c. Warmsprings							
Malheur R. & Misc.	239	3,982	109	185,080	55,596	123,804P	313,214
Cottonwood Cr. & Misc.	72	0	0	2,138	475	0	2,210
Sand Hollow Cr. & Misc.	22	0	0	234	52	0	256
Nigger Rock Can. Cr. & Misc.	72	181	0	1,508	335	0	1,761
Bully Cr. & Misc.	0	0	0	25,727	5,717	0	25,727
Willow Cr. & Misc.	0	0	0	14,513	3,225	0	14,513
Total	405	4,163	109	229,200	65,400	123,804	357,681
TOTAL	919	4,206	109	303,318	87,668	151,591	460,143
TOTAL MALHEUR	1,549	76,606	109	401,394	120,360	151,591	631,249
3. LOWER OWYHEE							
a. Dead Ox							
Snake R. & Misc.	427	7,240	2,896	103,604	25,901	0	114,167
Birch Cr. & Misc.	0	0	0	2,044	511	0	2,044
Owyhee Res.	0	0	0	106,190	23,909	0	160,190
Total	427	7,240	2,896	265,838	50,321	0	276,401
b. Mitchell Butte							
Snake R. & Misc.	0	0	0	10,092	2,523	0	10,092
Owyhee R. & Misc.	442	1,448	12,207	103,804	25,951	0	117,901
Owyhee Res.	0	0	0	220,269	32,876	0	220,269
Total	442	1,448	12,207	334,165	61,350	0	348,262

TABLE D (cont.)

STREAM	DOM.	MUN.	IND.	IRRIGATION	(Acres)	OTHER	TOTAL
c. Succor Creek							
Snake R. & Misc.	0	0	0	10,088	2,522	0	10,088
Succor Cr. & Misc.	22	0	0	2,256	564	0	2,278
Owyhee Res.	0	0	0	97,706	14,583	0	97,706
Total	22	0	0	110,050	17,669	0	110,072
TOTAL	891	8,688	15,103	710,053	129,340	0	734,735
4. JORDAN CREEK							
Jordan Cr. & Misc.	217	0	0	97,772	24,443	0	97,989
Cow Cr. & Misc.	507	0	0	40,200	10,050	0	40,707
TOTAL	724	0	0	137,972	34,493	0	138,696
5. UPPER OWYHEE							
Owyhee R. & Misc.	760	22	0	16,288	4,072	72R 43,440P	60,582
Soldier Cr. & Misc.	72	0	0	8,444	2,111	0	8,516
Crooked Cr. & Misc.	36	0	0	12,228	3,057	0	12,264
Crowley Cr. & Misc.	72	0	0	5,596	1,399	0	5,668
Dry Cr. & Misc.	370	0	0	2,408	602	0	2,778
McDermitt Cr. & Misc.	15	0	0	3,928	982	65M	4,008
TOTAL	1,325	22	0	48,892	12,223	43,577	93,816
TOTAL OWYHEE	2,940	8,710	15,103	896,917	176,056	43,577	967,247
TOTAL	4,489	85,316	15,212	1,298,311	296,416	195,168	1,598,496

* Lower Portions are under Warmsprings

Note: M = Mining, P = Power, R = Recreation.

Data Source: State Engineer.

TABLE E

GAME COMMISSION FLOW RECOMMENDATIONS
cfs

	Oct-Dec	Jan-Feb	Mar-May	June-July	Aug-Sept	LOCATION
Malheur R.	40	40	50-60	60	50-45	Stream Mile 4
Willow Creek	15	15	15-20	20-15	15	Mouth
S. F. Willow Cr.	3	3-5	6	5-4	3	Stream Mile 4
Bully Creek	10	10	10-12	12	10	Mouth
Malheur R.	40	40	50	50	50-40	Stream Mile 34
Malheur R.	25	25	30-40	40-30	30	USGS Gage -2200
Malheur R.	30-25	25	40-45	45-40	40	Stream Mile 57
Malheur R.	20	20	30-40	40	35-30	Stream Mile 61
Malheur R.	25-20	20	25-40	40	35-30	Stream Mile 82
Pole Creek	0.5	0.5	0.5- 1	1	1-0.5	Mouth
Calf Creek	0.5	0.5	0.5- 1	1	1-0.5	Mouth
N. F. Malheur R.	10	10	15-30	30	30	Mouth
N. F. Malheur R.	50	50-70	70	70-60	50	USGS Gage -2165
N. F. Malheur R.	40	40-50	50	50-40	40	Stream Mile 30
Little Malheur R.	10	10-25	25	25-15	10	Mouth
Little Malheur R.	8-30	30	30	20-10	8	Stream Mile 18
Crane Creek	15-25	25	25	20-15	15	Mouth
Little Crane Cr.	3-10	10	10	8- 4	3	About 5.2 mi. above mouth in T16S, R35E, Sec. 9
N. F. Malheur R.	30-35	35	35	35-30	30	Stream Mile 44
Elk Creek	5- 8	8	8	8- 6	5	Mouth
Malheur R.	25-20	25	25-40	40	35	Stream Mile 98
Malheur R.	25-20	25	25-40	40	35-30	Stream Mile 119
S. F. Malheur R.	10	10	15	15	10	Mouth
S. F. Malheur R.	4	4	4- 6	6	6	Stream Mile 6
S. F. Malheur R.	3	3	3- 4	4	3	Stream Mile 19
Swamp Creek	0.5	0.5	1- 2	2- 1	1	Mouth
S. F. Malheur R.	2	2	2- 3	3	2	Stream Mile 20
Malheur R.	15	30-40	40	40-30	15	USGS Gage -2140
Pine Creek	2	6	6	6- 3	2	2.3 mi. Upstream from Dry Cr.
Pine Creek	1	1- 4	4	4- 2	2- 1	Just Upstream from W. Fk. Pine Creek
W. F. Pine Cr.	6-15	15	15	15- 6	6	Mouth
Malheur R.	35	35-50	50	50	35	Stream Mile 168
Malheur R.	35	35-50	50	50	35	Stream Mile 185
Summit Creek	6-15	15	15	15- 6	6	Mouth
Summit Creek	3- 8	8	8	6- 4	3	Stream Mile 10
Bosenberg Creek	3- 5	5	5	5- 3	3	Mouth
Big Creek	15-20	20	20	20-15	15	Mouth
Lake Creek	10-15	15	15	15-10	10	Mouth
McCoy Creek	1- 4	4	4	4- 2	1	Mouth
Owyhee River	10	15	25	25	25	Stream Mile 4.3
Owyhee River	10	10	10-15	15	15	Stream Mile 10.6
Owyhee River	10	10	15-25	25	25	Stream Mile 13.8
Owyhee River	10	10	15-35	35	30	USGS Gage -1830
Owyhee River	130	130	130-150	150	130	Stream Mile 70
Bogus Creek	3	3	3	3	3	T29S, R41E, Sec. 2 SE
Owyhee River	95	95	100-120	120-100	100	USGS Gage -1810
Crooked Creek	15	15	20	20-15	15	1 mi. above mouth
Crooked Creek	15	15	20	20-15	15	Stream Mile 9
Jordan Creek	10	10	25-32	32-30	25	Mouth
Jordan Creek	12	12	20	20-15	15	Stream Mile 10.5
Jordan Creek	12	12	20-25	25-15	15	Stream Mile 26
Cow Creek	5	5	10	10	8	Head of Upper Cow L.
Jordan Creek	12	12	15-20	20-15	15	Stream Mile 36
Jordan Creek	15	15	15-30	30-25	25	Stream Mile 48.3 (State Line)
N. Fk. Owyhee R.	7	7	15-15	15	15	1 mi. above mouth
Middle Fk. Owyhee R.	4	4	6- 8	8- 6	6	¼ mi. above mouth
Owyhee River	45	45	50-65	65	65-50	Stream Mile 163
Owyhee River	20	20	25-30	30-25	25	Stream Mile 181.5

Data Source: State Game Commission

ACKNOWLEDGMENTS

The State Water Resources Board expresses appreciation to those individuals, organizations, and agencies which offered assistance in many ways during the course of the Malheur-Owyhee Basins investigation. Those publications utilized during the investigation are listed in the Selected Bibliography of this report. Special credit is extended to two agencies, the Oregon State Engineer and the U. S. Department of Agriculture's Oregon River Basins Survey Staff, which so ably and willingly provided much of the information utilized for this report. The contributions of the latter agency were provided through a formal cooperative agreement with the State Water Resources Board.

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The Malheur County Water Resources Committee, which presented valuable data at the information hearing, March 9, 1967 in Vale, Oregon, was comprised of the following persons:

Judge Ellis A. White, Malheur County Court
William Moore, Chairman
Robert Lytle, Coordinator
Jan Stanton, Secretary

Subcommittees

Watershed
- Blaine Girvin - Chairman
- John Fournier
- Bud Town

Irrigation
- Joe Hobson - Chairman

Domestic
- Lester Hammack - Chairman
- Harry Sandquist - Secretary
- Leeds Bailey and Extension Service Staff

Municipal
- Gordon Capps - Chairman

ACKNOWLEDGMENTS

Industrial, Mining, and Power
Edgar Dilley - Chairman
Walter Gillespie - Mining Chairman

Fish, Wildlife, and Recreation
William McKnight - Chairman

Pollution
William Olson - Chairman

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

Fred D. Gustafson	Chief Engineer
Jack G. Johnson	Planning Director
Quentin G. Bowman	Field Representative
William H. Farmer	Basin Engineer
Melvin R. Casselman	Assistant Basin Engineer
John D. Burdett	Hydrologist
Gordon W. Olcott	Geologist
Gerald N. Holman	Chief Draftsman
Franklin P. Hopkins	Data Engineer

ABBREVIATIONS

Ac.-Ft.	Acre-Feet
Can.	Canyon, Canal
Cfs	Cubic feet per second
Cr.	Creek
D.	Ditch
Dr.	Drain
Est.	Estimated
^{o}F.	Degrees Fahrenheit
Fk.	Fork
For.	Forest
Ft.	Fort
F.Y.	Fiscal Year
G.	Gulch
Gpm	Gallons per minute
Hol.	Hollow
I.D.	Irrigation District
Irr.	Irrigation
Is.	Island
Jct.	Junction
L.	Lake, Little
Lat.	Lateral
Max.	Maximum
Mdws.	Meadows
Mid.	Middle
Mil. Gal.	Million Gallons
Min.	Minimum
Mtns.	Mountains
ORS	Oregon Revised Statutes
P.L.	Public Law
Pl.	Plant
P.O.S.	Payette Oregon Slope
Pt.	Point
R, Rng.	River, Range
Res.	Reservoir
S.C.S.	Soil Conservation Service
Sl.	Slough
Sprs.	Springs
Sq. Mi.	Square Mile
T, Twp.	Township
USDA	United States Department of Agriculture
USGS	United States Geological Survey

APPROXIMATE

HYDRAULIC EQUIVALENTS

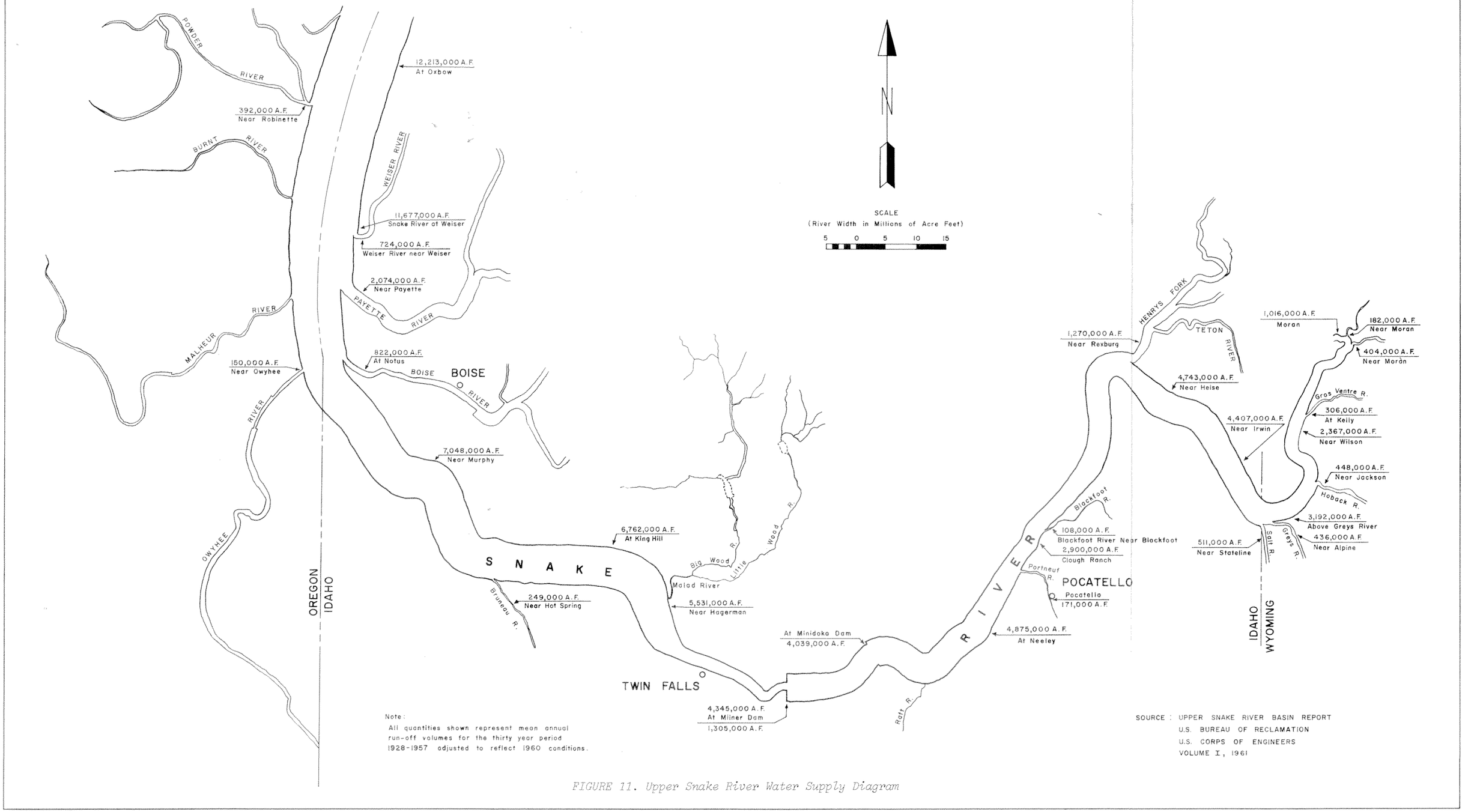
1 acre foot
= a volume 1 acre in area and 1 foot in depth
= 326,000 gallons
= 43,560 cubic feet
= 0.5 cubic feet per second for 1 day

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



Note:
All quantities shown represent mean annual run-off volumes for the thirty year period 1928-1957 adjusted to reflect 1960 conditions.

SOURCE: UPPER SNAKE RIVER BASIN REPORT
U.S. BUREAU OF RECLAMATION
U.S. CORPS OF ENGINEERS
VOLUME I, 1961

FIGURE 11. Upper Snake River Water Supply Diagram

MALHEUR RIVER DRAINAGE BASIN

POTENTIAL DEVELOPMENT

PLATE 1

MAP NO. 10.6

STATE WATER RESOURCES BOARD
SALEM, OREGON
1967

JOHN DAY BASIN

POWDER BASIN

OWYHEE BASIN

MALHEUR LAKE BASIN

BAKER CO.
GRANT CO.
HARNEY CO.
MALHEUR CO.
WASHINGTON CO.
PAYETTE CO.
OWYHEE CO.

PRAIRIE CITY
UNITY
BAKER
MALHEUR
HUNTINGTON
WEISER
ONTARIO
PAYETTE
FRUITLAND
VALE
NYSSA
PARMA
HOMEDALE
JUNTURA
DREWSEY
VALLEY
WARM SPRINGS RESERVOIR
AGENCY VALLEY RES.
MALHEUR RES.
BULLY CR. RES.
LAKE OWYHEE

DRAINAGE BASIN KEY

1 NORTH COAST
2 WILLAMETTE
3 SANDY
4 HOOD
5 DESCHUTES
6 JOHN DAY
7 UMATILLA
8 GRANDE RONDE
9 POWDER
10 MALHEUR
11 OWYHEE
12 MALHEUR LAKE
13 GOOSE & SUMMER LAKES
14 KLAMATH
15 ROGUE
16 UMPQUA
17 SOUTH COAST
17A
18 MID COAST

LEGEND

- COUNTY SEAT
- OTHER INCORPORATED CITIES (VALE, NYSSA)
- UNINCORPORATED COMMUNITY (Brogan)
- FORMER COMMUNITY OR PLACE NAME (Malheur City)
- PARK OR CAMPGROUND (Cove Spr. Camp)
- CANAL OR DITCH (Owyhee Canal)
- PIPELINE OR SIPHON (Malheur Siphon)
- WELL
- SPRING (Clara Spr.)
- STREAM OR CANAL GAGE (2800)
- STREAM MILE (25)
- ELEVATION IN FEET (4692)
- NUMBERED HIGHWAY
- OTHER PRINCIPAL ROADS

SCALE OF MILES
0 1 2 3 4 5 6 7 8 9 10

POTENTIAL DEVELOPMENT

- Damsite
- Potentially Irrigable Land 500 Ac.
- Malheur Project
- Presently Irrigated Land

NOTE: Index numbers refer to SWRB Potential Damsite Summary.

MALHEUR BASIN

MALHEUR LAKE BASIN

JUNTURA

Riverside

Creston

Harper

Little Valley

To Westfall

To Vale

To Burns

To Fields

To Denio

To Ontario

NYSSA

Apple Valley

PAYETTE CO.
CANYON CO.

PARMA

To Boise

Roswell

Adrian

Riverview

Owyhee

Kingman

WILDER

Nampa

Ridgeview

HOMEDALE

To Jordan Valley

OREGON
IDAHO

MALHEUR CO.
OWYHEE CO.

Graveyard Pt.

Sheaville

To Hwy 95

To Homedale

Rockville

To Hwy 95

JORDAN VALLEY

To Murphy

Arock

Rome

ANTELOPE RESERVOIR

Antelope

Owyhee Butte 4220

Mahogany Gap

Mahogany Mountain

Owyhee Mountains

Sheepshead Mountains

Crooked Creek Range

Duck Creek Lake Bed

PIUTE LAKE BED

TURNBULL LAKE BED

LAVA BED

JORDAN CRATERS

UPPER COW CR. LAKE

LOWER COW CR. LAKE

LOOKOUT LAKE

OWYHEE RESERVOIR

OWYHEE CANYON

OWYHEE RIVER

BOISE RIVER

SNAKE RIVER

OWYHEE BENCH

Crowley Ranch

Crowley Reservoir

Moorreville

Dry Cr. Pass

Monumental Rock 5710

Star Mtn. 5500

Turnbull Peak 4800

Follyfarm

Coyote Wells

Rufino Butte 4585

Red Butte 4400

Freezeout Mtn. 5485

Freezeout Ridge

Grassy Mtn. 4975

Crowley Mtn.

Cedar Mtn. 5440

Quartz Mtn. 5200

Iron Mtn.

Sheep Heads Mtn.

Hammond Hill

Black Butte 4830

Red Butte 4830

Table Mtn.

Iron Pt.

Coffeepot Crater

Chalk Basin

Dry Cr. Butte 4645

Big Elbow Butte

Burnt Mtn.

Rocky Butte

Gunsight Pass

Spring Mtn. 6065

Old Maids Basin

Table Mountain

Tubbs Hill

Three Fingers Rocks

Pilgrim Peak 6015

Iron Mtn. 4360

Scotts Butte

Flat Top Mtn. 4575

Round Mtn. 4215

Little Grassy Mtn. 4835

Black Butte

Sheepshead Mtns.

Lookout Butte 5840

Defeat Butte 5710

Willow Cr. Butte 5785

Oregon Butte 5785

Oregon Hill

Star Valley Knoll

Whitehorse Butte 6060

Three Forks

Middle Fork Burn Res.

Solid Mtn.

Jackass Butte 4800

Crooked Creek Range

Owyhee Mountains

Sheepshead Mountains

Lake Owyhee State Park

Owyhee Dam 1825

Owyhee Dam

Owyhee Basin

Owyhee Ridge

Duck Creek Ridge

Deep Creek

Battle Creek

Juniper Mtn.

Juniper Pt.

Juniper Butte

Juniper Mtn. 4360

Juniper Mtn. 4370

Juniper Mtn. 4360

Juniper Mtn. 4360

Juniper Mtn. 4360

MALHEUR RIVER DRAINAGE BASIN

HYDROLOGICAL STATIONS

PLATE 3

MAP NO. 10.6

STATE WATER RESOURCES BOARD
SALEM, OREGON
1967

JOHN DAY BASIN

MALHEUR LAKE BASIN

OWYHEE BASIN

POWDER RIVER BASIN

BLUE MOUNTAINS

STRAWBERRY RANGE

BURNT RIVER CANYON

MALHEUR RIVER

SNAKE RIVER

OWYHEE RIVER

PAYETTE RIVER

WEISER RIVER

BOISE RIVER

JUNIPER MOUNTAIN

CRANE CREEK

CROOKED CREEK

BULLY CREEK

WARM SPRINGS RESERVOIR

AGENCY VALLEY RES.

WARMSPRINGS RES.

BULLY CR. RES.

OWYHEE LAKE

BAKER CO

GRANT CO

HARNEY CO

MALHEUR CO

WASHINGTON CO

IDAHO

OREGON

PRAIRIE CITY
Unity
Bridgeport
Rye Valley
Dixie
Lime
HUNTINGTON
Olds Ferry
Porters Fy
Jonathan
WEISER
Weiser Jct.
Amsden
Jamieson
Willowcreek
Dennis
Ontario Heights
Washoe
ONTARIO
Ganey Cr.
FRUITLAND
PAYETTE
Cairo
Palisades Cor.
VALE
Hope
Grove
Arcadia
NYSSA
Apple Valley
PAYETTE CANYON
Owyhee
PARMA
Kingman
Roswell
Adrian
Napton
WILDER
HOMEDALE
Westfall
Little Valley
Harper
JUNTURA
Brogan
Crowley
Moorevile
Cord
Fengollano
Skull Spring
Creston
Riverside
Venator
Crane
Crane Cr. Gap
Lawen
Harney
Buchanan
Voltage
Princeton
Folly Farm
Stockade Mtn.
Table Rock
Ironside
Graham Mtn.
Lookout Mtn.
Little Baldy Mtn.
Sheaviyer Peak
Summit Prairie
Big Creek Summit
Logan Valley
Drewsey Valley
Willowcreek Valley
Juntura Valley
Agency Valley
Harper Valley
Owyhee Valley
Antelope Valley
Silver City
Jordan Valley
To John Day
To Seneca
To Burns
To Silvies
To Unity
To Baker
To Prairie City
To Hwy 30
To McCall
To Emmett
To Horse Heaven
To Boise
To Jordan Valley
R 32 E
R 33 E
R 39 E
R 40 E
R 41
R 42
R 43
R 44
R 45
R 46 E
R 48 E
T 13 S
T 22 S
T 29 S

LEGEND

ACTIVE	INACTIVE	
▲	△	Stream Gaging Station
◭	⚠	Stream Gage (crest-stage)
C▲	C△	Canal Gage
R▲	R△	Reservoir Gage
▲	▲	Water Temperature Station
▲	⚠	Water Quality Station
✦	✧	Sedimentation Station
●–	–○–	Climatological Station (precipitation and air temp.)
⬢	⬡	Climatological Station (precipitation only)
⊠	⊠	Precipitation Storage Gage
●	○	Snow Survey Course
✦●	✦○	Snow Survey Course and Soil Moisture Station

NOTE: Index numbers refer to SWRB Hydrological Station Summary.

DRAINAGE BASIN KEY

NORTH COAST 1 · SANDY 3 · HOOD 4 · UMATILLA 7 · GRANDE RONDE 8 · WILLAMETTE 2 · JOHN DAY 6 · POWDER 9 · MID COAST 18 · DESCHUTES 5 · MALHEUR 10 · UMPQUA 16 · GOOSE & SUMMER LAKES 13 · MALHEUR LAKE 12 · OWYHEE 11 · SOUTH COAST 17A · ROGUE 15 · KLAMATH 14

LEGEND

COUNTY SEAT	VALE
OTHER INCORPORATED CITIES	NYSSA
UNINCORPORATED COMMUNITY	Brogan
FORMER COMMUNITY OR PLACE NAME	Malheur City
PARK OR CAMPGROUND	Cove Spr. Camp
CANAL OR DITCH	Owyhee Canal
PIPELINE OR SIPHON	Malheur Siphon
WELL	
SPRING	Clara Spr.
STREAM OR CANAL GAGE	2200
STREAM MILE	25
ELEVATION IN FEET	4832
NUMBERED HIGHWAY	
OTHER PRINCIPAL ROADS	

SCALE OF MILES
0 1 2 3 4 5 6 7 8 9 10

MALHEUR BASIN

MALHEUR LAKE BASIN

OWYHEE DRAINAGE BASIN

HYDROLOGICAL STATIONS

PLATE 4

MAP NO. 11.6

STATE WATER RESOURCES BOARD
SALEM, OREGON
1967

LEGEND

ACTIVE	INACTIVE	
▲	△	Stream Gaging Station
▲C	△C	Canal Gage
▲R	△R	Reservoir Gage
▲	△	Water Temperature Station
▲	△	Water Quality Station
◆	◇	Sedimentation Station
●—	○—	Climatological Station (precipitation and air temp.)
●	○	Snow Survey Course

NOTE: Index numbers refer to SWRB Hydrological Station Summary.

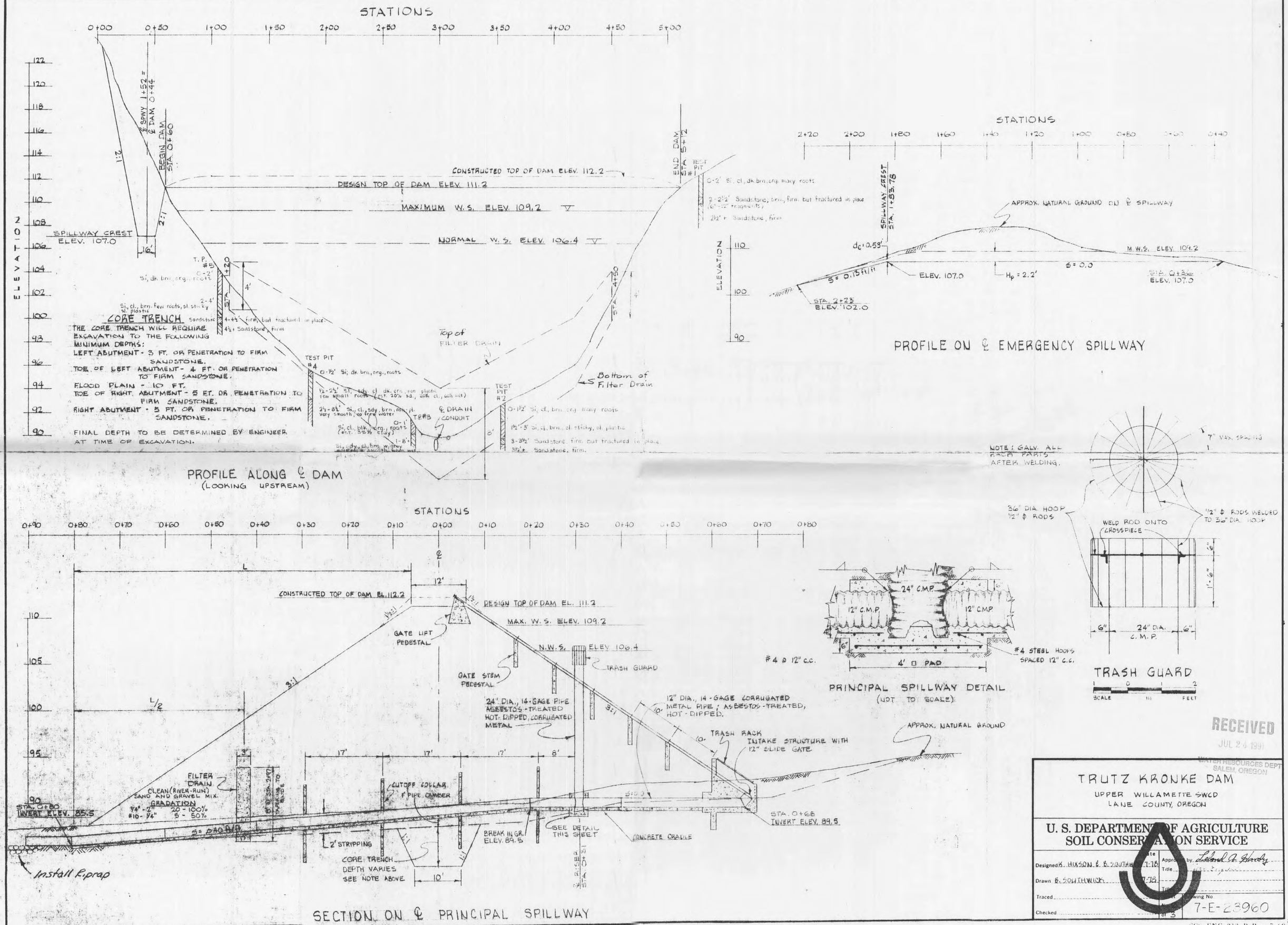
DRAINAGE BASIN KEY

NORTH COAST 1 · HOOD 4 · SANDY 3 · UMATILLA 7 · GRANDE RONDE 8 · WILLAMETTE 2 · JOHN DAY 6 · POWDER 9 · MID COAST 18 · DESCHUTES 5 · MALHEUR 10 · UMPQUA 16 · GOOSE & SUMMER LAKES 13 · MALHEUR LAKE 12 · OWYHEE 11 · SOUTH COAST 17A · ROGUE 15 · KLAMATH 14

LEGEND

INCORPORATED CITY	NYSSA
UNINCORPORATED COMMUNITY	Rome
FORMER COMMUNITY OR PLACE NAME	Crowley
PARK OR CAMPGROUND	Dry Cr. Camp
CANAL OR DITCH	Owyhee Canal
PIPELINE OR SIPHON	Owyhee Siphon
WELL	
SPRING	Baldner Spr.
STREAM OR CANAL GAGE	1630
STREAM MILE	20
ELEVATION IN FEET	4360
NUMBERED HIGHWAY	
OTHER IMPROVED ROADS	
UNIMPROVED ROAD	

MILES 1 0 1 2 3 4 5



RECEIVED
JUL 24 1991
WATER RESOURCES DEPT
SALEM, OREGON

TRUTZ KRONKE DAM

UPPER WILLAMETTE SWCD
LANE COUNTY, OREGON

U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

Designed K. HIXSON & B. SOUTHWICK	Date 7-78	Approved by Leland A. Hooby	
Drawn B. SOUTHWICK	7-78	Title	
Traced		Title	
Checked		Sheet 3 of 3	Drawing No 7-E-23960

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R 42 E | 43 | 44 | 45 | 46 | R 47 E

T 15 S

T 21 S

BAKER CO.
MALHEUR CO.

SNAKE RIVER

WEISER RIVER

PAYETTE RIVER

BOISE RIVER

BULLY CR. RES.

MALHEUR RES.

Brogan | Jamieson | Willowcreek | Dennis | Warmsprings | Hope | Grove | Little Valley | Harper | Olds Ferry | Porters Ferry | Jonathan | WEISER | Annex | Weiser Jct. | Mosquito | Oregon Slope | Payette Jct. | Vernie | Duncan | PAYETTE | Ontario Heights | Washoe | ONTARIO | Gayway Cor. | FRUITLAND | Cairo | White Settlement | Mallett | Luse | VALE | West Bench | East Bench | Ontario | Nyssa | NYSSA | Arcadia | Kiesel Park | Apple Valley | PAYETTE CANYON | PARMA | Kingman | Roswell | Adrian | Riverview | Owyhee | Lincoln Bench | Round Top | Vines Hill | Sugarloaf Butte | Burnt Stump Butte | Double Mtn. | Chalk Butte | Shell Bark Butte | Deer Butte | Tub Mtn. | Striped Mtn. | McDowell Butte | Brogan Mtn. | Dead Ox Flat | Pool Is. | Darrows Is. | Huffman Is. | Filbert Is. | Porters Is. | Wildcat Is. | McRae Is. | Long Is. | Smith Is. | Larson Is. | Ramey Is. | McPhersons Is. | Whitley Bottom | Crow Is. | Gambel Islands | Bridge Is. | Johnson Is. | Ontario Is. | Welch Is. | Banks Is. | L. Banks Is. | Ramey Is. | Morton Is.

LEGEND

- PROJECT LAND
- FEDERAL (Bureau of Land Management)
- STATE
- PRIVATE

MILES
0 1 2 3 4 5

STATE WATER RESOURCES BOARD
SALEM, OREGON

1968

MALHEUR PROJECT AREA

LAND OWNERSHIP

MAP NO. 10-11.526

PLATE 5